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Natural Resource Stewardship and Science

Vegetation Classification and Mapping Project Report, Glen Canyon National Recreation Area and Rainbow Bridge National Monument

Natural Resource Report NPS/NCPN/NRR—2017/1500



ON THE COVER
Lower Halls Creek Canyon
Photgraph by Steven Till

Vegetation Classification and Mapping Project Report, Glen Canyon National Recreation Area and Rainbow Bridge National Monument

Natural Resource Report NPS/NCPN/NRR—2017/1500

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Acronyms, Abbreviations, and Codes

AA	Accuracy Assessment
BPU	Biophysical Unit
CANY	Canyonlands National Park
CARE	Capitol Reef National Park
CCM	Compressed County Mosaic
CEGL	Community Element Code-Global
CEPP	Community Element Code-Proposed
COOP	Cooperative Observer Program
DEM	Digital Elevation Model
DOQQ	Digital Orthophoto Quarter Quadrangle
e2M	engineering-environmental Management, Inc.
EPMT	Exotic Plant Management Team
ESRI	Environmental Systems Research Institute
FGDC	Federal Geographic Data Committee
FSA	Farm Service Agency
GIS	Geographic Information System
GLCA	Glen Canyon National Recreation Area
GPS	Global Positioning Syste
GSD	Ground Sample Distance
I&M	Inventory and Monitoring Program
ISA	Indicator Species Analysis
ITIS	Integrated Taxonomic Information System
KGA	Kass Green & Associates
LDS	Latter-Day Saints
MMU	Minimum Mapping Unit
NAD83	North American Datum of 1983
NAIP	National Agriculture Imagery Program
NAU	Northern Arizona University
NCPN	Northern Colorado Plateau Network
NCPN	Northern Colorado Plateau Network
NHD	National Hydrologic Dataset
NM	National Monument
NMS	Nonmetric Multidimensional Scaling
NP	National Park
NPS	National Park Service
NRA	National Recreation Area
NRCS	Natural Resource Conservation Service
NS	NatureServe
NVC	National Vegetation Classification
NVCS	National Vegetation Classification Standard (or System)

PI	Photo Interpretation or Photo Interpreters
QA/QC, QC	Quality Assurance, Quality Control
RABR	Rainbow Bridge National Monument
SCPN	Southern Colorado Plateau Network
TNC	The Nature Conservancy
UNESCO	United Nations Educational, Cultural, and Scientific Organization
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VMI	Vegetation Mapping & Inventory Program

Executive Summary

The Northern Colorado Plateau Inventory and Monitoring Network (NCPN) worked with the support of the NPS Vegetation Mapping Inventory Program (VMI) to inventory, classify, describe, and map vegetation at Glen Canyon National Recreation Area and Rainbow Bridge National Monument (GLCA/RABR). This collaborative effort involved many project partners, particularly GLCA/RABR park staff, the Western Region office of NatureServe, Northern Arizona University (NAU), and Kass Green Associates.

The mapping area is approximately 505,642 hectares (1,249,468 acres), encompassing Rainbow Bridge National Monument, at 65 hectares (160 acres), as well as Glen Canyon NRA. Guided by a gradsect analysis created by Kass Green Associates, vegetation classification plot and observation point data were collected over three field seasons (2011–2013). A portion of GLCA in the Orange Cliffs section had previously been sampled in the fall of 2004 by NCPN ecologists as part of the Canyonlands National Park vegetation mapping effort. Field crew members collected vegetation and environmental data from 1,164 vegetation classification plots and 51 observation points from 2004 and 2011–2013.

Using various multivariate statistical and tabular tools, and adhering to the guidelines of the National Vegetation Classification Standard (NVCS),vegetation plot data were analyzed by NCPN, GLCA/RABR, and NatureServe ecologists and revealed 193 National Vegetation Classification (NVC) plant associations for GLCA/RABR, representing 80 NVC alliances and 35 NVC groups. The final assignment of plots to associations of the NVC Standard and the local and global plant association descriptions, based on the classification, were completed in 2014, with minor revisions through August 2016. A full summary of this work is described in the Vegetation Classification and Description section of this report.

Aerial photointerpretation was conducted by the Project Manager with the help of an assistant mapper between the fall of 2012 and fall of 2014, using the 2009 1-meter spatial resolution National Agriculture Imagery Program (NAIP) imagery for the Utah portions of GLCA, and the 2010 1-meter spatial resolution NAIP for the Arizona portions of GLCA as the base image layers. The project used the program standard minimum mapping unit (MMU) of 0.5 ha with few exceptions. The majority of the mapping work was performed using ArcGIS editing tools and onscreen, heads-up digitizing, aided by ancillary datasets. Map classes were defined for the project by the primary photointerpreter (PI) with input from the GLCA Chief Scientist. A draft vegetation map and associated spatial database were completed for the Orange Cliffs section of GLCA in the summer of 2014 and for the remainder of GLCA/RABR in the late fall of 2014.

Forty-eight map classes represented by 33,691 polygons were developed for GLCA/RABR. A total of 31,058 polygons represent 37 natural or semi-natural vegetation map classes covering 75% of the mapping project area. Eleven additional land use/land cover and geologic map classes describe 2,633 polygons (25% of the area). Average polygon size across all map classes is 23.1 ha (57.2 acres). Blackbrush Shrublands had the highest number of polygons (5,560) polygons covering 14.5% of the total vegetated mapping area. The Pinyon - Juniper Sandstone Woodland Complex is the most

extensive map class, delineated on 76,373 ha (188,722 acres) or 20.1% of the vegetated mapping area. A full summary of this work is described in the Vegetation Mapping section of this report.

Assessment of map accuracy entailed sampling an additional 1,668 data plots between 2014 and 2015. Field crews were guided by a dichotomous key to the vegetation associations created for the project using the classification (Appendix G). Accuracy assessment (AA) data were analyzed, with results tabulated into a contingency matrix. Results from a thematic accuracy of 29 vegetation map classes remaining following AA analysis indicated an estimate of 81.5% overall map accuracy (Kappa statistic = 80.6%). Nineteen vegetation map classes did not meet the 80% standard for either producer's and/or user's accuracy; eight map classes were not included in the final contingency table because of their rarity and small patch size, making them difficult to accurately assess. These map classes are described in the Accuracy Assessment section of this report, as is the justification for retention.

All geospatial products associated with this project are in the UTM projection, Zone 12, NAD83 datum. Products resulting from the GLCA/RABR vegetation mapping project include (and are available in this report and appendices):

- project summary of methods and results
- illustrated dichotomous field key to the vegetation associations
- illustrated guide to the vegetation map classes
- detailed descriptions of vegetation associations
- samples of completed field forms
- field manual used to guide classification plot, observation point, and AA point data collection.

Available elsewhere:

- geodatabase containing map polygon attributes, land use, plot and point data, and GLCA/RABR project boundaries
- ground photography of vegetation classification plots, observation points, and AA points in digital formats
- all field data (classification plot, observation point, and AA point) stored in a Microsoft Access database
- hard copy vegetation maps
- metadata for all digital products.

Acknowledgments

This project was completed through the efforts and dedication of numerous individuals and organizations. Details of the role of each person mentioned here is described in more detail in the Project Overview section. John Spence (NPS), Tammy Cook (NPS), and Karl Brown (NPS) provided project oversight and coordination. Funding for this project was provided through the NPS Vegetation Mapping Inventory Program (VMI).

Kass Green Associates created a gradsect analysis to help develop target preliminary units for field sampling and summarized this effort in a Sampling Plan Report (Appendix J).

Numerous individuals collected classification plot, observation point, and accuracy assessment field data. We appreciate the hard work of NPS seasonal field crew members Bruce Condie, Elizabeth Ballenger, and Sarah Topp; e²M contract field crew members Peter Williams, Julie Thompson, Travis Belote, Arne Buechling, and Jim Von Loh; and NAU contract field crew members James Roemer, Rob Klotz, Teresa Dekoker, Steve Till, Becky McLemore, Daniel Hastings, Amy Prince, Carrie Veety, Melissa McMaster, Glenn Rink, Rich Crawford, Sam Jones, and Walt McBride.

Marion Reid (NatureServe) created the local association description template and helped assign final association names to plots. Keith Schulz and Gwen Kittel (NatureServe) wrote the final global association descriptions, and Mary Russo (NatureServe) entered GLCA/RABR local and global descriptions into NatureServe's Biotics database.

David Svendson (NPS) participated in photo interpretation. Gery Wakefield and Aneth Wight (NPS) helped produce the contingency tables and final vegetation map coverage. Database management support and development was skillfully performed by Helen Thomas (NPS).

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Introduction

Vegetation Classification and Mapping Project, Glen Canyon National Recreation Area and Rainbow Bridge National Monument

The Glen Canyon National Recreation Area and Rainbow Bridge National Monument (GLCA/RABR) Vegetation Mapping Project was organized and coordinated by the Northern Colorado Plateau Network (NCPN) Inventory and Monitoring (I&M) Program between 2011 and 2016, with assistance from several project cooperators. The purpose of this project was to inventory, classify, describe, and map existing plant associations on 505,642 hectares (1,249,468 acres), within GLCA and the adjoining RABR, at 65 hectares (160 acres); and to provide this information in written, tabular, digital, and spatial formats useful to park resource managers, researchers, and others. The basic project components consist of a classification and description of GLCA/RABR vegetation and a spatial database of the vegetation and land use interpreted from aerial imagery. The vegetation map is an output of this spatial database. The project report contains the methods, findings, and interpretation results of the vegetation inventory.

NPS Vegetation Mapping Inventory Program (VMI)

The NPS Inventory and Monitoring (I&M) Program manages an extensive effort to complete baseline inventories of biological and geophysical resources for each park unit. These inventories cover 12 basic data sets needed by park staff to guide resource management. Vegetation classification and mapping constitute one of these data sets. The NPS Vegetation Mapping Inventory Program (VMI) is a program under the NPS Inventory and Monitoring Program. VMI was initiated in 1994 to inventory, classify, describe, and map vegetation communities in National Park Service units across the United States. While historically the program was a partnering between the USGS and NPS under the program name USGS-NPS Vegetation Mapping Program, for the last several years NPS has assumed full administration of the program. The primary objective of the VMI is to produce high-quality plant community classifications, standardized maps, and associated data sets of the vegetation currently occurring within the parks.

Through implementation of the NPS Natural Resource Challenge (NPS 1999), which encouraged national parks to focus on the preservation of the nation's natural heritage through science, natural resource inventories, and expanded resource monitoring, significant funding became available for completing these important baseline inventories in more than 270 national park units. This information fills data gaps and complements a wide variety of resource assessments, park management, and conservation needs.

Vegetation Mapping Program Standards

Consistent vegetation classification, mapping, and accuracy assessment protocols and standards are applied across projects supported by the Vegetation Mapping Inventory Program and are available to the public on their website (https://science.nature.nps.gov/im/inventory/veg/). In order to make the maps and data generated by the VMI Program useful for resource management at a Service-wide level, a number of standards are applied to vegetation maps and associated data products. These standards are required by the Federal Geographic Data Committee and apply to all maps produced

for the federal government. In addition, stringent quality control procedures ensure the reliability of the vegetation data and encourage the use of resulting maps, reports, and databases at multiple scales.

The following documents outline standards and protocols for the NPS I&M Program:

Protocols

- National Vegetation Classification System (TNC and ESRI 1994a, NatureServe 2003)
- Field methods and mapping procedures (TNC and ESRI 1994b)
- Statistically rigorous and consistent accuracy assessment procedures (ESRI et al. 1994)
- Guidelines for using existing vegetation data (TNC 1996)
- Vegetation Classification Guidelines (Lea 2011).

Standards

- National Vegetation Classification Standard v. 1 and 2 (FGDC 1997, 2008)
- Spatial Data Transfer Standard (FGDC 1998b)
- Content Standard for Digital Geospatial Metadata (FGDC 1998a)
- United States National Map Accuracy Standards (USGS 1999)
- Integrated Taxonomic Information System
- Program-defined standards for thematic accuracy (Lea and Curtis 2010).

Protocols were modified, when necessary, to meet the unique challenges posed by mapping a park as large and difficult to access as GLCA/RABR. Any adjustments to these methods were done in ways that satisfied the Federal Geographic Data Committee standards for vegetation mapping products (FGDC 2008). A 12-Step Guidance document is provided on the VMI website (https://science.nature.nps.gov/im/inventory/veg/) and details all steps needed to complete a classification and mapping project from scoping meetings through close-out. Also available on the website are data products including all geospatial and tabular data as well as reports from completed projects. The Vegetation Inventory Map Viewer, a web-based tool which allows access to completed vegetation inventory data without requiring geographic information system software, is also available on the website.

National Vegetation Classification Standard

The National Vegetation Classification (NVC) is the system used in the GLCA/RABR Vegetation Mapping Project and is based on the National Vegetation Classification Standard (NVCS) adopted by the Federal Geographic Data Committee (FGDC 1997). Prior to 1990, no national vegetation classification existed. The FGDC Vegetation Subcommittee was established in 1991 and coordinated

with the Ecological Society of America (ESA), The Nature Conservancy (TNC), and the NPS/USGS to jointly develop a US National Vegetation Classification. The first National Vegetation Classification Standard was adopted by the FGDC Subcommittee in 1997 and set a 5-level hierarchy (http://usnvc.org/about/history/). The structure of the NVCS is based in part on an earlier international vegetation classification developed by the United Nations Educational, Cultural, and Scientific Organization (UNESCO 1973, Driscoll et al. 1984). Use of a standardized classification system helps to ensure data compatibility throughout the NPS and other agencies. The FGDC Vegetation Subcommittee works to keep this standard current and relevant. To resolve a series of issues with the original NVCS, a revision was issued, the U.S. National Vegetation Classification version 2 (USNVCv2) (FGDC 2008). The new classification hierarchy included middle levels with geographic information which improved the NVC performance by "bridging the large conceptual gap between alliance and formation, an important improvement over the 1997 hierarchy." (http://usnvc.org/data-standard/natural-vegetation-classification/)

Vegetation classification systems attempt to recognize and describe repeating assemblages of plants in similar habitats. The NVCS is a hierarchical system that incorporates physiognomic characters and floristic data to define eight levels of terrestrial vegetation classification. The three upper levels (class, subclass, and formation) are based on physiognomic features that reflect environment at global to continental scales. The three middle levels (division, macrogroup, and group) are based on biogeography (physiognomic features and regional species) and continental to regional environmental factors. The two lower levels (alliance and association) are distinguished by differences in floristic composition reflecting local to regional environmental factors. The physiognomic units have a broad geographic perspective and the floristic units have utility in local and site-specific applications (Grossman et al. 1998). Specific criteria defining these physiognomic units are based on ecologic characteristics that vary among major vegetation groups (FGDC 1997) (Table 1).

The alliance and association levels form the base of the NVCS hierarchy and are determined by the most abundant or diagnostic species comprising the various layers of a homogenous vegetation community. An association is here defined as a plant community type with a consistent species composition, uniform physiognomy, and similar habitat conditions (Flahault and Schroter 1910). Species composition differentiates associations (TNC and ERSI 1994a). An alliance is "a physiognomically uniform group of plant associations sharing one or more dominant or diagnostic species which, as a rule, are found in the uppermost strata of the vegetation" (Reid and Comer 1998). NatureServe coordinates plant association data for the NCPN vegetation mapping projects. Associations are added to the NVC and older concepts are refined as new data become available.

Table 1. Revised National Vegetation Classification System hierarchy for terrestrial vegetation (FGDC 2008).

Level	Criteria Delineating Level	Example
Class	Broad combinations of general dominant growth forms	Forest and Woodland
Subclass	Combinations of general dominant and diagnostic growth forms	Temperate & Boreal Forest & Woodland
Formation	Combinations of dominant and diagnostic growth forms.	Temperate Flooded & Swamp Forest
Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant species that reflect biogeographic differences.	Western North American Interior Flooded Forest
Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences.	Interior Warm & Cool Desert Riparian Forest
Group	Combinations of relatively narrow sets of diagnostic plant species, including dominants and co-dominants, broadly similar composition, and diagnostic growth forms.	Western Interior Riparian Forest & Woodland
Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition.	*Populus fremontii* Great Basin Riparian Forest Alliance
Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition.	*Populus fremontii / Ericameria nauseosa* Riparian Woodland

Group Level Classification

The Project Manager elected to use the updated NVC hierarchical system classification structure (www.usnvc.org) as a framework for organizing and presenting plant community data. The Group level of the hierarchy is defined as a group of plant associations from two or more alliances that have a relatively narrow set of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect regional mesoclimate, geology, substrates, hydrology, and disturbance regimes. The Group classification was developed to provide larger scale classification units for application to resource management, mapping, and conservation. Current estimates are that Utah contains more than 70 NVC Groups (USNVC 2016). This approach complements the NVC; the finer-scale associations provide a basis for interpreting larger-scale Group patterns and concepts. A description of each Group identified in GLCA/RABR appears in Appendix A.

The Group classification addresses natural landscapes. Land-use categories used to identify developed and/or unvegetated areas are described elsewhere in this report. Thirty-five Groups are known to occur within the GLCA/RABR vegetation mapping project area (in alphabetic order with NatureServe identifying codes):

Arid West Interior Freshwater Marsh (G531)
Chihuahuan Desert Sand Scrub (G287)
Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Colorado Plateau Hanging Garden Seep (G545)
Colorado Plateau Pinyon - Juniper Woodland (G250)
Colorado Plateau-Great Basin Juniper Open Woodland (G246)

Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600)
Great Basin-Intermountain Shrub & Herb Wash-Arroyo (G559)
Interior West Ruderal Riparian Forest & Scrub (G510)
Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)
Intermountain Dry Tall Sagebrush Steppe & Shrubland (G303)
Intermountain Dwarf Saltbush - Sagebrush Scrub (G301)
Intermountain Low & Black Sagebrush Steppe & Shrubland (G308)
Intermountain Mountain Big Sagebrush Steppe & Shrubland (G304)
Intermountain Semi-Desert Grassland (G311)
Intermountain Semi-Desert Steppe & Shrubland (G310)
Intermountain Shadscale - Saltbush Scrub (G300)
Intermountain Sparsely Vegetated Dune Scrub & Grassland (G775)
Mojave Mid-Elevation Mixed Desert Scrub (G296)
North American Desert Alkaline-Saline Marsh & Playa (G538)
North American Desert Alkaline-Saline Wet Scrub (G537)
North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Rocky Mountain Subalpine-Montane Aspen Forest & Woodland (G222)
Rocky Mountain-Great Basin Lowland-Foothill Riparian Shrubland (G526)
Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (G506)
Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277)
Southern Rocky Mountain Montane-Subalpine Grassland (G268)
Southern Rocky Mountain Mountain-mahogany - Mixed Foothill Shrubland (G276)
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)
Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh (G521)
Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)
Western Interior Riparian Forest & Woodland (G797)
Western Madrean Chaparral (G281)
Western Montane-Subalpine Riparian & Seep Shrubland (G527)
Western North American Ruderal Marsh, Wet Meadow & Shrubland (G524)

Project Area Description

Location and Setting

Glen Canyon National Recreation Area (GLCA) was established on October 27, 1972 by proclamation of President Richard Nixon, to “provide for public outdoor recreation and enjoyment of Lake Powell and lands adjacent thereto” and to “preserve the scenic, scientific, and historic features contributing to public enjoyment of the area” (P.L. 92-593). It covers approximately 508,042 hectares (1,255,400 acres). Centered on the second largest manmade lake in North America (Lake Powell Reservoir), it follows the Colorado River for 186 miles and the San Juan River for 71 miles, with a shoreline of more than 1,900 miles (NPS 1985).

Rainbow Bridge National Monument (RABR) was established on May 30, 1910 by President William Howard Taft to preserve the “extraordinary natural bridge, having an arch which is in form

and appearance much like a rainbow, and which is of great scientific interest as an example of eccentric stream erosion." It was administered by the Custodian or Superintendent of Navajo National Monument until 1964, when administrative and operational control of Rainbow Bridge was transferred to the superintendent of GLCA (Sproul 2001). RABR lies adjacent to GLCA and sets aside 65 hectares (160 acres) encompassing one of the world's largest known natural bridges, which from its base to the top is 290 feet and spans 275 feet across the river; the top of the arch is 42 feet thick and 33 feet wide (NPS-RABR index).

GLCA/RABR is located in southeastern Utah and northern Arizona, with portions lying in Garfield, Kane, San Juan and Wayne counties in Utah and Coconino County in Arizona (Figure 1). The nearest municipality is Page, Arizona (pop. 7,247), located just southeast of the Glen Canyon Dam and GLCA park boundary. A majority of the Recreation Area is road-less and inaccessible via boat or vehicle. Other parts of GLCA are readily accessible by major travel routes including US Route 89 (and Arizona State Route 98) to access Glen Canyon Dam and Wahweap Marina and Utah State Route 95 to access Hite Crossing, UT (and Spur Road, UT State Route 276 to access Hall's Crossing and Bullfrog Marinas). The Orange Cliffs section in the northernmost portion of GLCA is accessed by two-wheel drive (with four-wheel drive sections), unpaved roads (Rec Rds 633 and 1010); the southwest sections of the park, including Romana Mesa and Sit Down Bench are also accessed by two-wheel-drive, unpaved roads (Rec Rds 230 and 264), as are areas in the Escalante section of the park (Rec Rd 330 or the Hole-in-the-Rock Road). The remaining portions of the park are only accessible by four-wheel-drive, rough, and rarely traveled two-track roads. RABR is accessible only by boat or on foot by permit from the Navajo Nation.

Based on 2010 census data, the area is sparsely populated (U.S. Census Bureau 2013 estimates). Flagstaff (population 68,667), is the county seat of Coconino County; Panguitch (population 1,507) is the county seat of Garfield County; Monticello (population 1,975) is the county seat of San Juan County; Kanab (population 4,468) is the county seat of Kane County; and Loa (population 569) is the county seat of Wayne County. These counties have low to very low population densities, with Coconino County the densest at 7.2 people per square mile, and Garfield County the sparsest at 0.9 people per square mile. Lands adjacent to GLCA are administered by the National Park Service (Canyonlands National Park, Capitol Reef National Park, Rainbow Bridge National Monument, and Grand Canyon National Park), Bureau of Land Management (Grand Staircase-Escalante National Monument and Bears Ears National Monument), Navajo Nation, State of Utah, and some areas are in private ownership. The GLCA project mapping area (Figure 2) includes the entire 508,042 ha (1,255,400 acres) of the Recreation Area and the 65 ha (160 acres) of RABR.

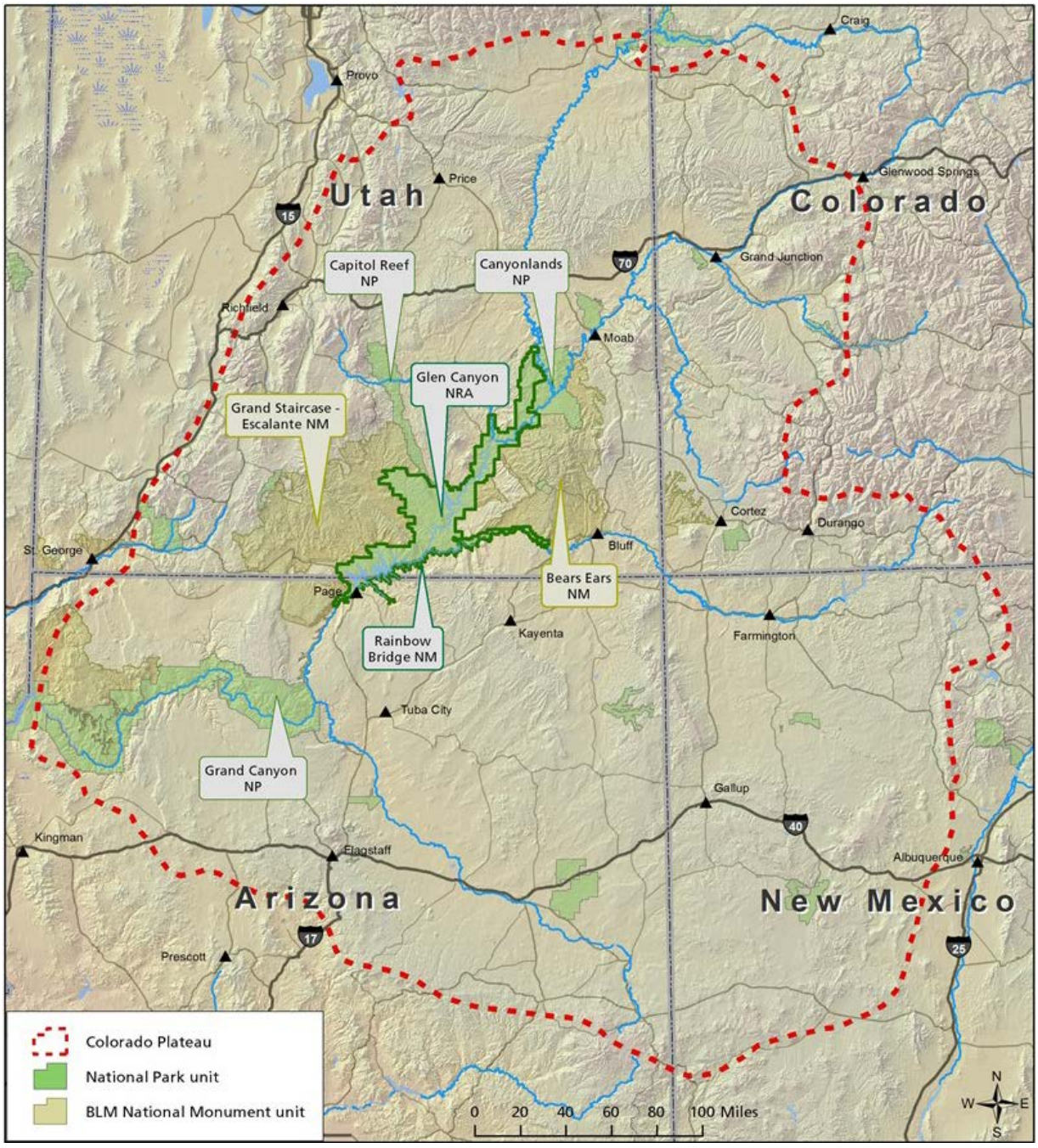


Figure 1. Location of GLCA and RABR on the Colorado Plateau and adjacent National Parks and Monuments.

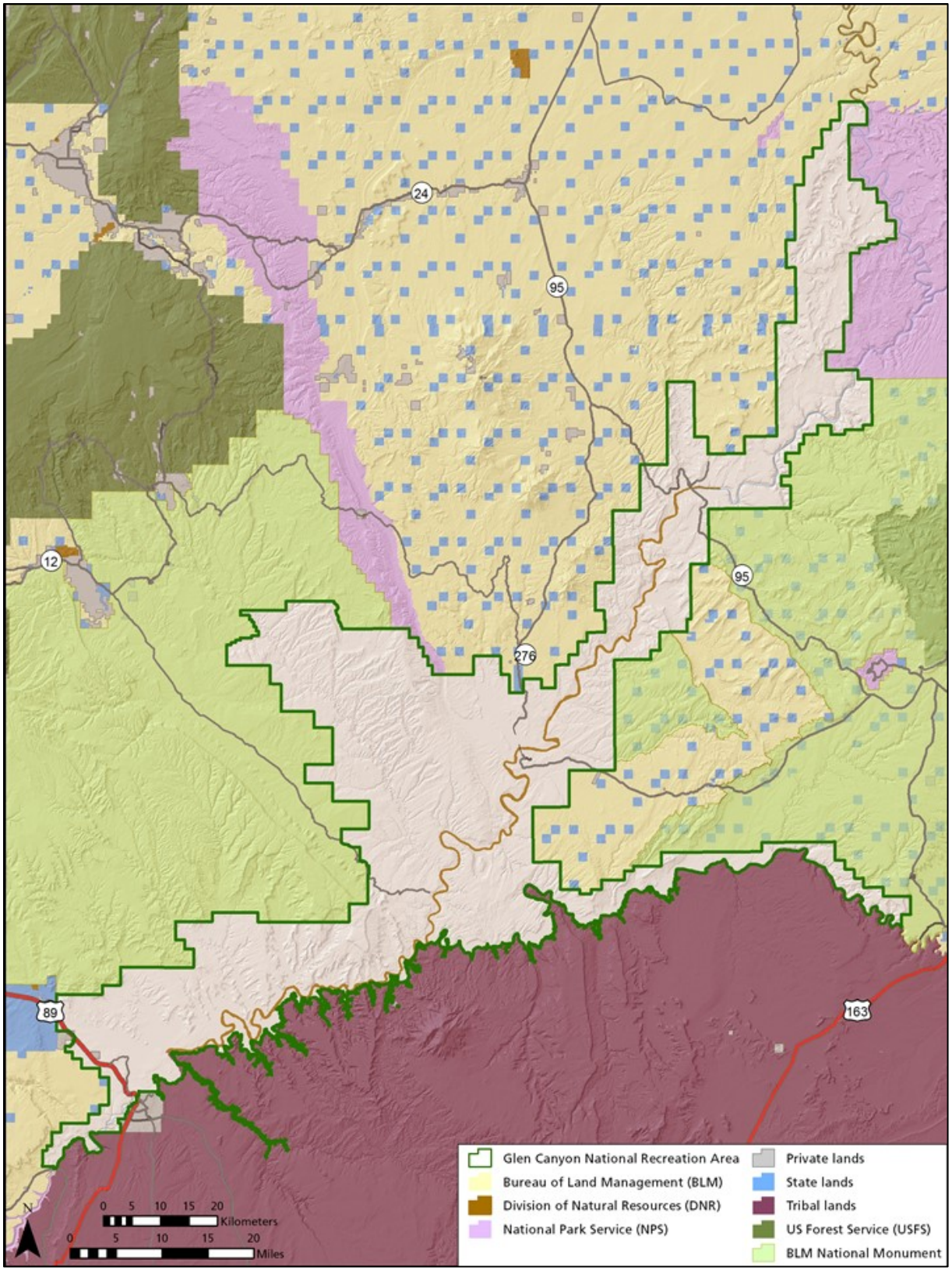


Figure 2. Map of the GLCA/RABR vegetation mapping project area boundary showing adjacent land ownership.

Physiography

Situated in the center of the Canyon Lands section of the Colorado Plateau physiographic province in southeastern Utah, GLCA/RABR contains an array of dramatic scenery. The striking scenery of GLCA/RABR is the result of its geologic history, stratigraphy, and its manmade reservoir, the blue waters of Lake Powell contrasting with the red and brown flat-topped mesas, near-vertical cliffs, and deep canyons that surround it. Over 300 million years ago, the region was inundated by shallow, tropical seas. As the seas retreated, sediments left by a variety of marine and near-shore environments were exposed and then buried under thousands of feet of younger deposits. These hardened to form the shale, siltstone, sandstone, and limestone seen today (Baars 2000). A good portion of GLCA lies within the Henry Mountains Basin, formed in the late Cretaceous Period. GLCA is bounded on the north by the laccolithic Henry Mountains and Kaiparowits Plateau, on the northeast by the Paradox Basin, on the southeast by the Monument Upwarp and White Canyon slope, on the south by the laccolithic Navajo Mountains and Piute Folds, and on the west by the Circle Cliffs Uplift (USGS 1998).

Characterized by mostly flat-lying, sedimentary rocks, the Colorado Plateau region is remarkably stable except where it has been slightly deformed by anticlines, synclines and monoclines. The Waterpocket Fold, as seen near Bullfrog Marina, is an example of a monocline (Lammers 1991). Regional uplift of the Colorado Plateau began about 70 million years ago with the Laramide Orogeny, caused by upward surges from an immense pool of subterranean molten lava (Sproul 2001), with multiple periods of uplift that slowed during the Cenozoic period and then became active again about 20 million years ago. Uplift of the region commenced approximately 5 million years ago, raising the region in total about 1,100 meters (Sahagian 2002). Injection of the laccoliths, dikes, and sills scattered through the region occurred during these periods of active uplift. The uplift also slightly tilted the region to the west, increasing the gradient of streams and thus their downcutting (Graham 2016). By the mid-Miocene, the Colorado River drainage pattern was established (Potter and Pattison 1977). The Colorado River began to carve the Grand Canyon less than 6 million years ago and concurrent water erosion produced the extensive, deeply incised canyons which are one of the defining features of GLCA today (Lammers 1991). All of the Recreation Area is within the Colorado River Watershed. Five major rivers, Colorado, San Juan, Escalante, Paria, and Dirty Devil, flow into the Recreation Area, and ultimately into Lake Powell. The Colorado River flows into the northeast corner of GLCA, Dirty Devil River flows into the northwest corner, San Juan River flows into the southeast corner, Paria River flows into the southwest corner, and Escalante River flows into the central-western portion. Elevations within GLCA range from 955 m (3,150 ft) where the Colorado River exits GLCA at its southern boundary near Lees Ferry to approximately 2,300 m (7,545 ft) on Navajo Point.

Climate

The climate of GLCA can be classified as temperate-arid or semiarid with hot summers, cool to cold winters with sustained periods of freezing temperatures, and low and variable precipitation (Spence 2001). Annual precipitation varies greatly from year to year and decade to decade, ranging from about 3.5 to 28.5 cm (1.4 to 13.6 in) (Hill and Ayers 2009). Temperature and precipitation vary with altitude and latitude, with orographic effects leading to higher precipitation at higher elevations

(Spence 2001). Potential evapotranspiration exceeds precipitation, making effective soil moisture a critical environmental factor (Evenden et al. 2002). In semiarid landscapes, such as GLCA, the composition and structure of plant communities depends largely on the amount and spatial distribution of soil moisture (Breshears and Barnes 1999). Local precipitation and temperature patterns dictate soil-water availability. In the cool desert climate of GLCA, winter precipitation typically occurs in the form of snow, even at the lower elevations (Davey et al. 2006). Gradual snowmelt from winter precipitation provides deeper infiltration into the soil (Spence 2001), and is the primary contributor to groundwater recharge and available soil moisture.

Snow falls between November and March and precipitation in the winter months is usually deposited by frontal storms moving from the west and originating in the eastern North Pacific Ocean (Hereford et al. 2002, Evenden et al. 2002, USDA-NRCS 2010). As the region warms in the spring, the polar jet stream moves northward, replaced by high pressure (Spence 2001). The high pressure system brings with it mostly clear skies, intermittent to sustained winds, and a drop in precipitation across the area (Figures 3–4) as occurring from April through June. This high pressure system begins to move north and/or east in late June or July (Spence 2001), and moist air and convective thunderstorms are drawn into the region from the south and southeast. Warm season precipitation is related to the Mexican monsoon (or North American monsoon) and is caused by a reversal of atmospheric circulation, where moist air from the Gulf of Mexico or Gulf of California moves north or northwest into the region (Hereford et al. 2002). Precipitation is highest during the late summer and early fall months (August through October), with peaks in October (Figures 3–4).

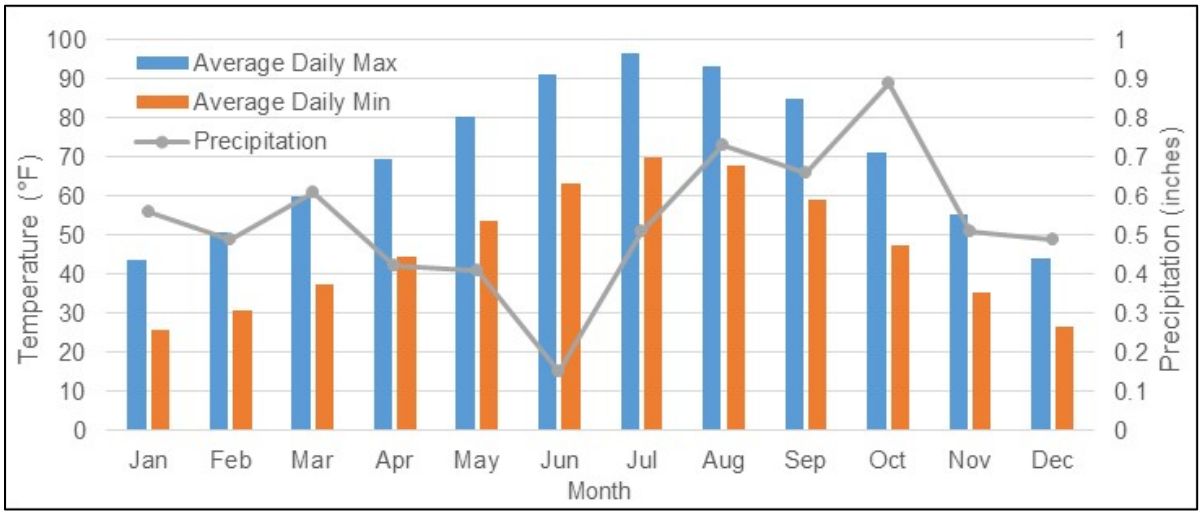


Figure 3. Average precipitation and temperature in Page, Arizona.

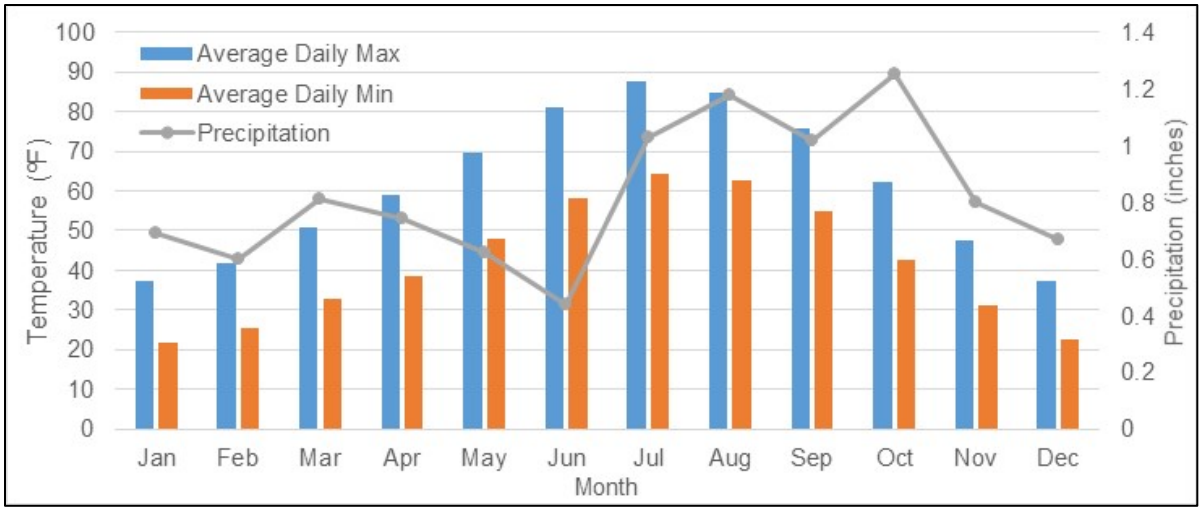


Figure 4. Average precipitation and temperature in Hans Flat, Utah.

There are 12 active and historical climate monitoring stations in GLCA, seven of these are COOP stations. The COOP station with the longest period of record for GLCA is located at Lees Ferry, which has been active since 1916 (Davey et al. 2006). Continuous records of climatic conditions (WRCC 2009) have been maintained since 1957 at Page, Arizona (Page Station site) and since 1980 at Hans Flat Ranger Station, Utah. These two sites were chosen for purposes of this report because they represent the latitudinal range from the southern to northern boundaries of GLCA, as well as the variation in altitude, from a low of 1,301 meters (4,268 ft) at Page to a high of 2,012 meters (6,600 ft) at Hans Flat.

Table 2 summarizes climate data from the two selected sites. Generally, the warmest month is July and the coldest month is January. Snow falls between November and March, with the highest snowfall accumulations occurring in December and January. In contrast to Page, Hans Flat has lower temperatures overall, higher total precipitation, and significantly higher snowfall accumulation. Though the average annual snowfall is high at Hans Flat; average snow depth rarely exceeds 10.2 cm (4 in) in any winter month.

Table 2. Climate data from Page, Arizona, and Hans Flat Ranger Station, Utah (WRCC 2009).

Station Location	Elevation (m)	Avg. Annual Precipitation (cm)	Avg. July Max. Temp (°C)	Avg. January Min. Temp (°C)	Avg. Annual Snowfall (cm)
Page	1,301	16.2	35.8	- 3.5	10.9
Hans Flat	2,012	24.9	30.8	- 5.6	96.7

The climatic differences are also reflected in the vegetation. *Pinus edulis - Juniperus osteosperma* woodlands with tall shrub understories (i.e., *Artemisia tridentata* and *Amelanchier utahensis*) are the dominant vegetation type in the northeastern region of GLCA and at other scattered high elevation locations, but are absent in the southwestern regions where elevations and precipitation are too low to support these species. More common in the southwestern regions of GLCA are low and dwarf

shrubs, specifically sand-loving species (i.e., *Ephedra cutleri* and *Artemisia filifolia*) on sand sheets, and salt- and drought-tolerant species (i.e., *Atriplex* spp. and *Acamptopappus sphaerocephalus*) on clay shales, that have adapted to growing at lower elevations with higher temperatures and lower precipitation.

Geology

GLCA and RABR are home to some of the most spectacular exposed geology in the western United States. From atop Navajo Point, one can view millions of years of geologic history exposed in rock formations for many miles in the distance (Figures 5 and 6). A recent summary of the geology of Glen Canyon can be found in Graham (2016).

Rocks exposed in GLCA/RABR are sedimentary, ranging in age from Middle Pennsylvanian (about 300 million years ago) through the Cretaceous Period (80 million years ago). The area tilts generally to the west, so that the rocks exposed are mostly older in the northeastern reaches of GLCA and younger in the southwestern reaches (USDA-NRCS 2010). The oldest exposures occur in the limestone and mudstone beds of the Pennsylvanian Hermosa Group (Honaker Trail, Paradox Formation, and Pinkerton Trail) and the youngest exposures occur in the sandstone and mudstone beds of the Straight Cliffs Formation. The most common and impressive formations, forming the sheer sandstone cliffs seen from the lake, are in the Lower and Middle Jurassic Groups (Anderson and Sprinkel 2000). The Navajo and Entrada sandstone members of the Jurassic Group are notable for their slot canyons, alcoves, arches, and natural bridges. They are also water-bearing strata and support dozens of alcove wall seeps where some of the biggest alcove vegetation communities in the world are found. Though the rock layers throughout GLCA are mostly flat-lying, this changes as the Colorado River exits Glen Canyon, below the dam, and crosses the Echo Cliffs Monocline. Here the rock layers tilt up about 2,500 feet, bringing older rocks to the surface, including the Kaibab Formation. This area marks the beginning of the Grand Canyon (Graham 2016).

The deposition of geologic formations often determines which plant species will become established, particularly in a semi-arid climate. Formations deposited on dry land or in fresh water support a range of plant communities, while those deposited in salt water support primarily salt-tolerant plant species. Shale restricts water penetration and tends to capture any water that does penetrate, making it difficult for plant roots to use. Thus, shales support sparse communities of the most drought-tolerant plants, usually shrubs and forbs. Sandstone resists root penetration except where fractured; however, roots can penetrate cracks deeply and access water held far below the dry surface. Thus, sandstones often support deep-rooted woodlands. Sandstones with silica cement (e.g., Wingate) are massive cliff formers. Grasslands become established on aeolian substrates, particularly sand or loess. Dense woodlands or shrublands may establish on deep, alluvial, colluvial, or aeolian soils. Colluvium (rockfall slopes) may modify a habitat so that a shale slope can support more mesic plant species (Tendick et al. 2012).

The remainder of this section is a summary of the geologic history and the general distribution of vegetation in relation to geology across the GLCA/RABR mapping area. It is organized from oldest to youngest rocks and illustrated with photographs acquired by field crew members as part of vegetation classification and accuracy assessment efforts.

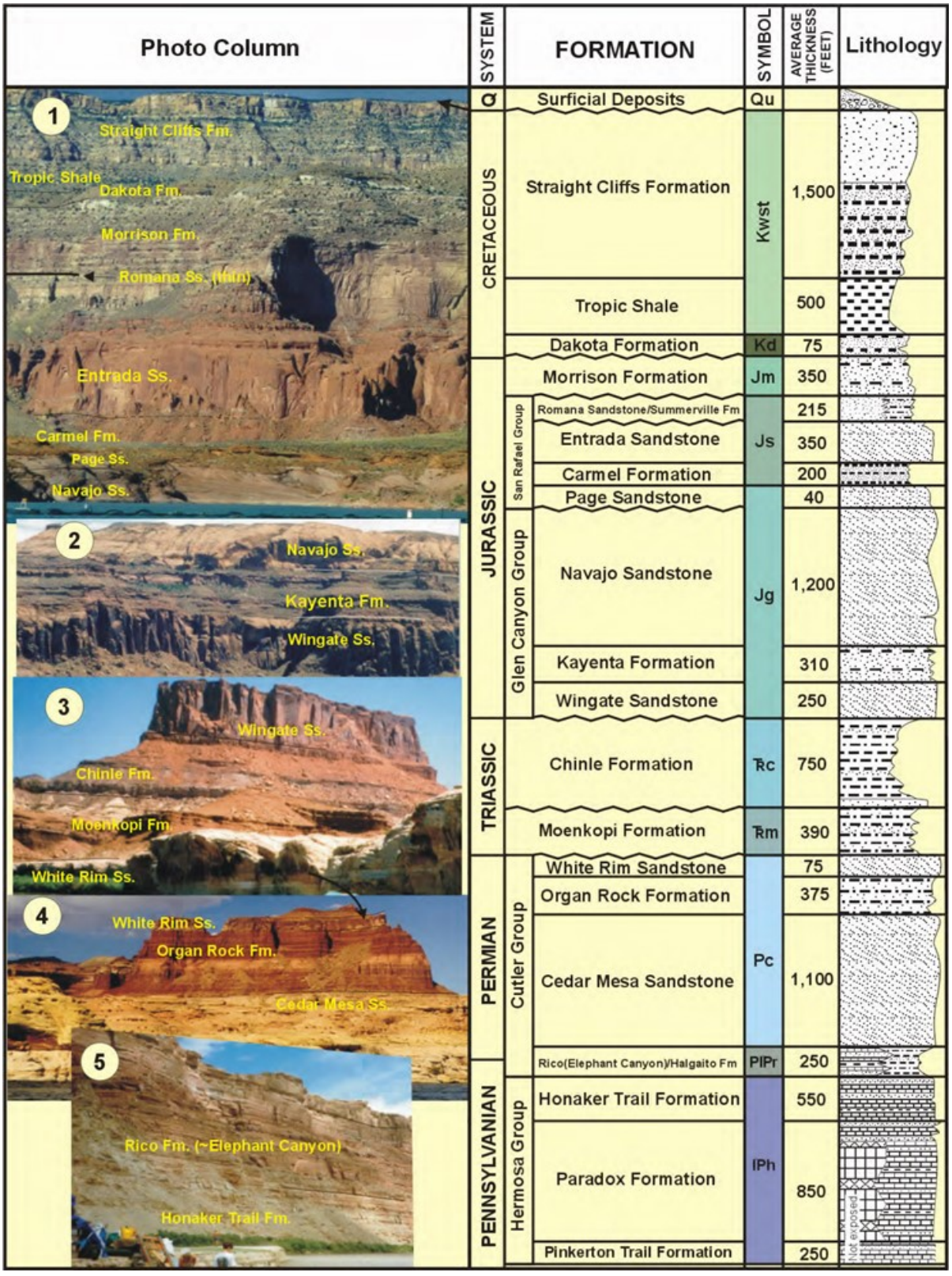


Figure 5. Diagram of the geologic layers (stratigraphy) of Glen Canyon National Recreation Area (Anderson and Sprinkel: Geologic Lake Guide 2000).

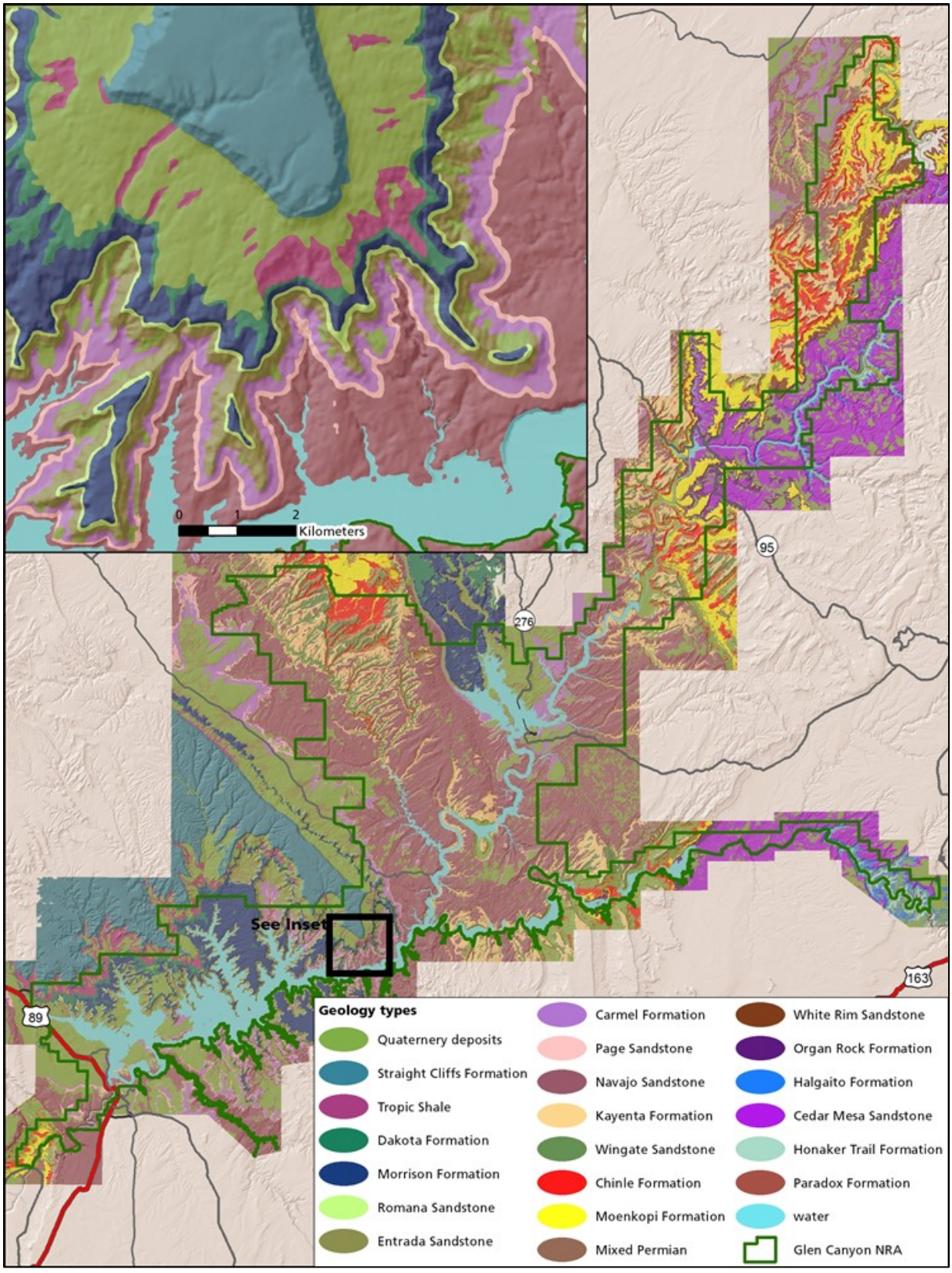


Figure 6. Generalized geology map of Glen Canyon National Recreation Area and Rainbow Bridge National Monument.

Paradox Formation (Pennsylvanian). The oldest rocks exposed within GLCA are part of the Paradox Formation. During the Pennsylvanian Period, seas covered most of present-day Utah. Approximately 300 million years ago, the Ancestral Rocky Mountains and the Uncompahgre Plateau of eastern Utah and western Colorado were uplifted. Concurrently, the Paradox Basin was formed by subsidence (Foos 1999). Cycles in which deep marine conditions changed to shallow water conditions due to drops in sea level caused the seawater to stagnate in this elongate depression and the Paradox Formation evaporites formed from gypsum salts accumulating on the sea floor (Baars 2000). The remainder of this formation is made up of gray limestone, dolomite, and shale, and is seen in GLCA as the lowest scree slopes descending to the river in the heart of Cataract Canyon from the park boundary to the mouth of Gypsum Canyon, and in the Goosenecks of the San Juan from the park boundary to Sulphur Spring. Vegetation growing on the Paradox Formation is sparse and variable, consisting of rubber rabbitbrush (*Ericameria nauseosa*), skunkbush sumac (*Rhus aromatica*), longleaf brickellbush (*Brickellia longifolia*), Torrey's joint-fir (*Ephedra torreyana*), and desert wolfberry (*Lycium andersonii*).

Honaker Trail Formation (Pennsylvanian). Deposited on the Paradox Formation is the Honaker Trail Formation. These sediments were deposited in a shallow sea approximately 290 to 300 million years ago, forming alternating bands of limestone, sandstone, and shale (Foos 1999) (Figure 7). The dominantly marine section of this formation contains numerous marine fossils. In GLCA, the Honaker Trail Formation appears as gray to tan, ledgy, massive cliff bands and scree slopes along the major river corridors from the GLCA-CANY boundary in Cataract Canyon (of the Colorado River) to just downstream of Dark Canyon and in the Goosenecks of the San Juan from the park boundary to the mouth of Grand Gulch. Vegetation is similar to that of the Paradox Formation.



Figure 7. (Top) Scree slopes of Paradox Formation in the Goosenecks of the San Juan (L) and in Gypsum Canyon (R). (Bottom L&R) Honaker Trail cliff bands in Cataract Canyon.

Rico (Elephant Canyon) Halgaito Formation (Pennsylvanian). On top of the Honaker Trail Formation is the Rico (Elephant Canyon) Halgaito Formation. This formation is similar to the Honaker Trail Formation due to layering of fossiliferous marine limestone, dolomite, sandstone, and shale, and was also deposited in a shallow sea environment 280 to 290 million years ago (Baars 2000). In GLCA it appears as yellowish tan to brown limestones and sandstones, and forms ledgy outcrops and mid- and upper scree slopes along the Goosenecks of the San Juan from the park boundary to just downstream of the mouth of Grand Gulch (Anderson and Sprinkel 2000) (Figure 8). Vegetation is similar to that of the Paradox Formation.



Figure 8. (L) Scree slopes of Rico (Elephant Canyon). (R) Halgaito Formation below Muley Point.

Cutler Group (Permian). Above the Rico (Elephant Canyon) Halgaito Formation is the Cutler Group, which is divided into three distinct formations within GLCA: Cedar Mesa Sandstone, Organ Rock Shale, and White Rim Sandstone.

Cedar Mesa Sandstone (Permian). The oldest layer (approximately 260–280 million years old) in the Cutler Group is the Cedar Mesa Formation, which forms yellowish-tan to brown, massive cliffs and broad slickrock benches. This fine-grained sandstone exhibits numerous horizontally bedded strata and is covered in places by thin, unconsolidated, dunal deposits (Campbell 1987, Anderson and Sprinkel 2000) (Figure 9). Cedar Mesa Sandstone has been interpreted as representing a complex shoreline environment with coastal dunes of both aeolian and marine origin (Campbell 1987, Foos 1999). These sandstone deposits are visible in GLCA as the top of the canyon walls in Cataract Canyon and the Goosenecks of the San Juan; as broad slickrock benches north of Hite up the Dirty Devil River and eastward across to Waterhole Flat; and, as rimrock exposures from Clay Hills Crossing east to Muley Point. Most of the slickrock surface is unvegetated, but plant communities established on Cedar Mesa Sandstone grow in joints or cracks in the sandstone, on ramping or broken bedrock exposures with some soil and talus accumulation, or in shallow to somewhat deep pockets/potholes of aeolian soils (mostly stabilized by well-developed biological soil crusts). Characteristic plant communities are patchy dwarfed woodlands and wooded shrublands of two-needle pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) with a diverse assemblage of shrubs and grasses in the understory, including blackbrush (*Coleogyne ramosissima*), little-leaf mountain mahogany (*Cercocarpus intricatus*), Tucker's sand shinnery oak (*Quercus havardii* var. *tuckeri*), Bigelow's sagebrush (*Artemisia bigelovii*), roundleaf buffaloberry (*Shepherdia rotundifolia*), Stansbury's cliffrose (*Purshia stansburiana*), singleleaf ash (*Fraxinus anomala*), jointfir (*Ephedra* spp.), skunkbush sumac, and a variety of native grass and forb species.



Figure 9. Dwarfed pinyon-juniper woodlands with blackbrush, littleleaf mountain mahogany, and skunkbush sumac on Cedar Mesa Sandstone north of Hite (L) and on Muley Point (R).

Organ Rock Shale (Permian). Atop the Cedar Mesa Sandstone are red beds of Organ Rock Shale. Deposited in coastal aeolian and tidal flats environments about 260 million year ago, this layer consists of reddish-brown sandstones, shales and siltstones, and is a soft-weathering, slope-forming unit (Baars 2000, Anderson and Sprinkel 2000) (Figure 10). In GLCA, the Organ Rock Shale is exposed around the mouth of White Canyon north through Hite and up the Dirty Devil drainage to Black Ledge west of Waterhole Flat. A small exposure also occurs on the hills west of Clay Hill's Crossing. Due to the crumbly nature of the Organ Rock Shale, it forms small benches, sloping ledges, and steeply eroding slopes that have a stair-step appearance and provide limited and widely scattered habitats suitable for plant growth. Plant communities it supports are sparse and include blackbrush, crispleaf buckwheat (*Eriogonum corymbosum*), shadscale (*Atriplex confertifolia*), yucca (*Yucca* spp.), joint fir, and snakeweed (*Gutierrezia sarothrae*).



Figure 10. Sparse shrublands on Organ Rock Shale benches around Hite.

White Rim Sandstone (Permian). Above the Organ Rock Shale is a white to yellowish-grey sandstone cliff band that forms a broad topographic bench. This sandstone takes its name from the

White Rim in the Island in the Sky District of Canyonlands NP, where it forms a prominent mid-level bench below the Wingate Sandstone cliffs. The White Rim Sandstone is both aeolian and marine in origin, and is a fine-grained sandstone with largescale cross-stratification (Campbell 1987) (Figure 11). It is believed to have been deposited as coastal dunes and then reworked by shallow marine waters into large sand bars or barrier islands about 250 million years ago (Foos 1999). In GLCA, the White Rim is most visible as a broad slickrock bench extending from the north end of the Millard Canyon benches south to Elaterite Basin, and as a cliff band near Teapot Rock south to the Dirty Devil canyon drainage. The White Rim Sandstone supports scattered plant communities that have become established in joints or cracks in the sandstone or in shallow to somewhat deep pockets of aeolian soils on the surface (mostly stabilized by well-developed biological soil crusts). Characteristic plant communities are sparse dwarfed woodlands of two-needle pinyon pine and Utah juniper with a diversity of shrubs and grasses in the understory, including blackbrush, littleleaf mountain mahogany, yucca, joint fir, and a variety of native grass and forb species.



Figure 11. Sparse shrublands and dwarfed pinyon-juniper woodlands with blackbrush and littleleaf mountain mahogany on White Rim Sandstone on Millard Canyon Benches (L) and in Elaterite Basin (R).

Moenkopi Formation (Triassic). Separated from the underlying White Rim Sandstone by the Tr-1 unconformity (Pipiringos and O'Sullivan 1978) is the Moenkopi Formation (USGS 1998) which was deposited in a near-shore environment of stream channels, tidal flats, muddy lagoons and beaches that existed some 215 to 235 million years ago (Tendick et al. 2012). It is characterized by dark reddish-brown, fine grained claystones, sandstones, siltstones, limestones, and conglomerates that form ledgy slopes and broad rolling benches (Anderson and Sprinkel 2000) (Figure 12). It is the dominant exposure from Red Canyon north to Hite, up the Dirty Devil drainage, in Elaterite Basin, in Millard Canyon, and on the Millard Canyon benches. Scattered two-needle pinyon pine and Utah juniper may occur, but most of the established vegetation is blackbrush, shadscale, and Torrey's joint-fir, with lesser cover by Gardner's saltbush (*Atriplex gardneri*) and snakeweed. Native bunchgrasses may contribute low cover, including Indian ricegrass (*Achnatherum hymenoides*), saline wildrye (*Leymus salinus*), and James' galleta (*Hilaria jamesii*).



Figure 12. Blackbrush and joint fir shrublands on Moenkopi Formation on Millard Canyon Benches (L) and in Elaterite Basin (R).

Chinle Formation (Triassic). The Chinle Formation sits on top of the Moenkopi Formation, and was deposited in terrestrial stream and lake environments approximately 220 to 210 million years ago (Foos 1999). In GLCA, it tends to have a hummocky appearance, forming ledgy slopes, clay hills, and small benches (Figure 13). The upper members of the Chinle Formation form broad slopes, beneath Wingate Sandstone cliffs, which are often obscured by Wingate talus debris/rockfall. The Chinle layer consists of bentonite clays, shales, siltstones, mudstones, sandstones, gritstones, and conglomerates that range from greenish-gray to bluish-purple to reddish-brown in color (Campbell 1987). The swelling clays are derived from altered volcanic ash beds, and are very unstable when they become wet. Lake Powell provides a constant source of water and with the lake level annually and seasonally fluctuating, this cyclic wetting and drying of parts of the Chinle exacerbates an already unstable condition (Anderson and Sprinkel 2000). This formation contains an abundance of petrified wood. The Chinle Formation is the dominant slope-forming unit in the Orange Cliffs section of GLCA from Horsethief Canyon south to The Block. It is also found extensively in slopes along the lake from North Wash south to Good Hope Mesa, and is the dominant exposure in the Purple Hills and along the Moody Canyon drainages. Lesser exposures occur along the San Juan arm of the lake from Zahn Bay east to Clay Hills Crossing. Vegetation of the Chinle Formation is somewhat variable depending on landscape position and what Chinle member is exposed. Sandstone members have vegetation similar to Cedar Mesa Sandstone while the clayey badland members are dominated by shadscale, mat saltbush (*Atriplex corrugata*), and James' galleta. Scree slopes below Wingate cliffs may contain a diversity of shrubs and grasses, as well as two-needle pinyon pine and Utah juniper.



Figure 13. Bentonite clay, slickrock (foreground on right picture) and scree slope (far right on right picture) members of the Chinle Formation in Happy Canyon (L) and Millard Canyon (R).

Glen Canyon Group (Jurassic). The Glen Canyon Group is deposited on the Chinle Formation and consists of Wingate Sandstone, Kayenta Formation, and Navajo Sandstone.

Wingate Sandstone (Jurassic). The Chinle-Wingate boundary is believed to represent the boundary between the Triassic and Jurassic Periods (Baars 2000). Wingate Sandstone was formed by sand dune deposits approximately 200 million years ago, and forms distinctive massive, reddish-orange-to-brown vertically jointed cliffs (Foos 1999) (Figure 14). In the Orange Cliffs section of the Recreation Area, these cliffs can be 300 to 400 feet thick, unbroken, and are generally coated with a dark red-to-black veneer of desert varnish (Baars 2000). The Wingate Sandstone is the prominent cliff former from the northernmost end of GLCA in the Orange Cliffs south to Good Hope Bay, along the Escalante River canyon and its tributaries, and around the Moody Canyon drainages. Wingate Sandstone cliffs are unvegetated; rockfall slopes at the base of the cliffs support colluvial slope vegetation similar to that of the underlying Chinle and Moenkopi formations.



Figure 14. Wingate cliff bands and buttes in the Orange Cliffs.

Kayenta Formation (Jurassic). The fluvial Kayenta Formation caps cliffs of Wingate Sandstone and consists of a lower cliff-forming unit and an upper slope-forming shale unit (Campbell 1987). This formation was deposited approximately 180 to 200 million years ago in river flood plain environments with streams flowing in a west-northwest direction (Anderson and Sprinkel 2000). It forms pale-red to dark-orange sandstone steps and ledges with shallow to moderately deep pockets of soil (Figure 15). It is the dominant formation exposed on the mesa tops in the Orange Cliffs, on mid-level mesa tops from the west side of the Dirty Devil River corridor south to Good Hope Mesa, and on the ledgy, canyon sides surrounding the Escalante River and its many tributaries. Exposures at higher elevations support sometimes dense woodlands of two-needle pinyon pine and Utah juniper with sparse or grassy understories; and at lower elevations, support mostly shrublands or wooded shrublands (with pinyon and juniper), dominated by blackbrush, green Mormon-tea (*Ephedra viridis*), snakeweed, and James' galleta.



Figure 15. Pinyon-juniper woodlands with sparse understories on ledgy Kayenta Sandstone on the Orange Cliffs mesa top.

Navajo Sandstone (Jurassic). Atop the Kayenta Formation are rolling domes of white, tan, and pale orange Navajo Sandstone. This formation originated as coastal to inland sand dunes deposited between 173 and 180 million years ago and exhibits large-scale, sweeping, cross-beds typical of wind-blown sand accumulations (Baars 2000). It forms broad, rolling slickrock expanses, cliff bands with numerous alcoves supporting hanging gardens, and is the formation that Rainbow Bridge was created from (Figure 16). It contains thin oasis limestone beds, indicative of past oases, in a Sahara-like sand dune desert, which persisted for thousands of years (Anderson and Sprinkel 2000). The Navajo Formation is the dominant exposed geology in GLCA, covering a majority of the land area from Ticaboo Mesa southward (on both sides of the lake) to Dangling Rope Marina, including all of the mesa tops in the Escalante arm of GLCA as well as Wilson Mesa. Most of the surface is unvegetated, with plant communities occurring in joints or cracks in the sandstone or in potholes filled with aeolian soils (mostly stabilized by well-developed biological soil crusts). The potholes support a patchy woodland or wooded shrubland community of two-needle pinyon pine, Utah juniper, serviceberry (*Amelanchier utahensis*), blackbrush, little-leaf mountain mahogany, Stansbury's cliffrose, Utah serviceberry, green Mormon-tea, snakeweed, yucca, skunkbush sumac,

and a variety of native grass and forb species. Where deeper wind-blown soils have accumulated atop Navajo Sandstone outcrops, vegetation is similar to that of the Quaternary Deposits and Alluvial Deposits described below.



Figure 16. Sparse pinyon-juniper woodlands with blackbrush and littleleaf mountain mahogany on Navajo Sandstone on Wilson Mesa (L) and near Egypt (R).

San Rafael Group (Jurassic). The San Rafael Group is deposited on top of the Navajo Sandstone and in ascending order consists of Page Sandstone, the Carmel Formation, Entrada Sandstone, and the Romana Sandstone/Summerville Formation.

Page Sandstone (Jurassic). Very similar to the underlying Navajo Sandstone, but separated by the major J-2 unconformity, is the tan to light reddish-brown Page Sandstone (Figure 17). This formation originated as ancient sand dunes deposited approximately 170 million years ago (Anderson and Sprinkel 2000). Of limited extent in GLCA, it is mostly exposed as bare rolling slickrock or sandstone cliff bands from Iron Top Mesa south to Rock Creek, and from Antelope Island south to Death Pockets. It supports sparse and variable vegetation, with blackbrush being the most common species.



Figure 17. Navajo Sandstone below with a thin band of Page Sandstone on top near Dangling Rope (L) and in Rock Creek Bay (R).

Carmel Formation (Jurassic). Above the Page Sandstone lies the Carmel Formation, which was deposited as tidal flats in a marginal to shallow seaway between about 160 and 172 million years ago. This formation is composed of greenish-gray to red- and white-banded silty shales, platey limestones, sandstones, siltstones, and minor gypsum (Anderson and Sprinkel 2000) (Figure 18). The Carmel Formation is a slope-forming unit seen in GLCA from Ticaboo Point south to the Waterpocket Fold in Halls Creek Canyon and from Fortymile Ridge around the base of Navajo Point to Rock Creek. It is dominated by blackbrush, shadscale, joint-fir, rabbitbrush (*Chrysothamnus* spp.), fourwing saltbush (*Atriplex canescens*), Fremont indigo bush (*Psorothamnus fremontii*), snakeweed, mat saltbush, James' galleta, and a variety of native grass and forb species.



Figure 18. Blackbrush and shadscale shrublands on Carmel Formation in Rock Creek Bay (L) and Halls Creek Bay (R).

Entrada Sandstone (Jurassic). Above the Carmel Formation is the Entrada Sandstone. Mostly aeolian in origin, it was deposited 155 to 160 million years ago as mudflats, tidal flats, and coastal sand dunes. It is composed of dark reddish-orange to white, very fine-grained sandstones and minor siltstones (Anderson and Sprinkel 2000) (Figure 19). Mostly unvegetated in GLCA, the Entrada

Sandstone has an upper, cliff-forming banded unit extending from the base of Fiftymile Bench west along the edge of the lake to Wahweap Creek. The more southern exposures in GLCA form rounded slickrock domes, deformational injection and infill/collapse features, and giant weathering pits, best seen on Cookie Jar Butte (Anderson and Sprinkel 2000).



Figure 19. Domes of Entrada Sandstone in Rock Creek Bay.

Romana Sandstone and Summerville Formation (Jurassic). The J-3 unconformity separates the Entrada Sandstone from the overlying Romana Sandstone. A soft, dark red mudstone included in the base of the Romana Sandstone, regionally referred to as the "Summerville bed," thickens over infill features in the Entrada (Anderson and Sprinkel 2000). These deposits represent a variety of environments including coastal plain, tidal inlet, aeolian, and fluvial. Likely deposited in a broad, shallow inland basin by streams, 152 to 155 million years ago, the Romana Sandstone is a light tan to grey-green, thick-bedded sandstone cliff former, while the Summerville Formation is a distinctive red- and white-banded siltstone and sandstone (Anderson and Sprinkel 2000) (Figure 20). Mostly unvegetated in GLCA, or sparsely vegetated with a variety of low shrubs typical of scree slopes, the Romana Sandstone extends as a thin cliff band from the base of Fiftymile Bench west to Wahweap Creek (Anderson and Sprinkel 2000).



Figure 20. Romana Sandstone and Summerville Formation cliff bands near the lake at the mouth of Crosby Canyon.

Morrison Formation (Jurassic). Famous for dinosaur bones and fossils, and as a source of uranium ore, the Morrison Formation lies unconformably atop the Romana Sandstone and was deposited 146 to 156 million years ago. Composed of maroon to gray-green siltstones, mudstones, conglomerates, and tan sandstone outcrops, the Morrison Formation was deposited in marine and tidal flat environments, swampy lowlands, lakes, river channels, mudflats, and floodplains, with some aeolian deposits (Anderson and Sprinkel 2000). On the Colorado Plateau, the Morrison Formation is divided into four members: Windy Hill, Tidwell, Salt Wash, and Brushy Basin (Wikipedia). In GLCA, most Morrison Formation exposures are either the whitish sandstones of the Salt Wash Member or the colorful, bentonitic clays (formed from volcanic ash) of the Brushy Basin Member (Figure 21). Other than an outcrop on Hall Mesa just west of Bullfrog, the majority of exposures occur from around the base of Navajo Point west to Wahweap Creek, including on Billie Flat Top, Grand Bench, Alstrom Point, and Bull Points. Vegetation growing on the Morrison Formation is dominated by blackbrush, green Mormon-tea, Torrey's joint-fir, James' galleta, and where slickrock outcrops of the Salt Wash Member occur, by two-needle pinyon pine and Utah juniper.



Figure 21. Salt Wash Member of Morrison Formation near Oley Knolls (L) and blackbrush growing on Tidwell Member on Sit Down Bench (R).

Dakota Formation (Cretaceous). The youngest Morrison Formation strata are followed by a 30-million-year gap in the geologic record. The Dakota Formation was deposited 90 to 100 million years ago in stream and near-shore marine environments, including lagoons and swamps, on the western edge of the Western Interior (Cretaceous) Seaway, which covered eastern Utah at that time (Graham 2016). It consists of a lower sandy conglomerate, middle mudstones, and upper sandstones in tan to light grey to brown shades, with minor coal seams (Anderson and Sprinkel 2000). In GLCA, it is exposed around the base of talus slopes descending from the end of the Kaiparowits Plateau, and from Sit Down Bench west to Wahweap Creek (Figure 22).



Figure 22. Shadscale, budsage, and Gardner's saltbush growing on the Dakota Formation on West Sit Down Bench (L) and Sit Down Bench (R).

Vegetation growing on the Dakota Formation is dominated by Torrey's joint-fir, shadscale, blackbrush, Gardner's saltbush, budsage (*Artemisia spinescens*), rayless goldenhead (*Acamptopappus sphaerocephalus*), and James' galleta.

Tropic Shale (Cretaceous). One of the most fossil-rich formations in the area is the Tropic Shale, containing numerous ammonites and oyster shells. It was deposited 70 to 90 million years ago as mud and silt layers on top of the Dakota Formation as the Western Interior Seaway became deeper and calmer (Wikipedia). Composed of gray to black marine, clayey shales, it forms mostly broad benches or undulating flats and badlands (USGS-NGMDB 1934). In GLCA, it is exposed from Sit Down Bench west to Wahweap Creek. Mostly unvegetated, it may support sparse shrublands dominated by mat saltbush (Figure 23), with occasional James' galleta, shadscale, seepweed (*Suaeda nigra*), and Indian ricegrass. Drought-tolerant and salt-loving plant species are the only plants capable of growing on the Tropic Shale, as shales tend to capture any water that does penetrate, making it difficult for plant roots to absorb available water, and then hold the water near the soil surface where it evaporates faster, leaving the salts behind.



Figure 23. Mat saltbush-dominated (L) and unvegetated (R) sections of the Tropic Shale.

Straight Cliffs Formation (Cretaceous). Deposited by a retreating Western Interior Seaway 70 to 90 million years ago, and representing a variety of ancient environments, including marine and near-shore, coastal swamps, lagoons, and fluvial (rivers) (Graham 2016), the Straight Cliffs Formation is the most recent geologic formation exposed in GLCA. It consists of alternating layers of whitish to yellow-gray sandstones and shales, with occasional mudstones, coal seams, and often abundant fossil species (Wikipedia). In GLCA, it is exposed as rocky benches near the northern park boundary from Wahweap Creek to Warm Creek, but is most notably the formation topping the Kaiparowits Plateau, and seen as the cliff bands and mesa top of Navajo Point (Figure 24). Other than a few small exposures near Wahweap Creek that are dominated by shadscale, the majority of the Straight Cliffs Formation in GLCA is dominated by two-needle pinyon pine, Utah juniper, Gambel oak (*Quercus gambelii*), and Wyoming sagebrush (*Artemisia tridentata* ssp. *wyomingsis*).



Figure 24. Sparse shrublands of shadscale in SW corner of GLCA (L) and cheatgrass, Wyoming sagebrush, and pinyon pine on Navajo Point (R).

Quaternary Deposits. The exodus of the Western Interior (Cretaceous) Seaway marked the end of the Cretaceous Period. During the latter Tertiary and Quaternary Periods, sand, gravel, terrace material,

and igneous intrusions were deposited, but since no inland sea returned to the lower Colorado Plateau, “no massive compression took place. The permanent recession of water from this point on did not allow these periods to have a lasting geologic impression.” (Baars 1995, Baars 1983). Unconsolidated surficial deposits (deposited from present day to up to 2.5 million years ago) within GLCA are the products of weathering, erosion, and deposition. Sheets and dunes of wind-blown sand occur on valley bottoms, mesa tops, and lower slopes. Alluvial deposits and slope wash cover floodplains, partially fill valleys, and modify gentle slopes. Talus, colluvium, and landslide deposits cover steeper slopes on canyon walls. In many parts of GLCA, several types of surficial deposits may occupy the same area; for example, sand dunes may cover part of an alluvial valley floor or form a sand ramp covering a colluvial slope (Coles et al. 2009).

Alluvial deposits. Alluvial deposits are sheets of water-deposited sands and gravels and are of minor extent in GLCA. In the canyons of the Escalante River and its tributaries, and in the many tributaries of the Colorado and San Juan Rivers, alluvial terraces of varied ages and elevations fill the spaces between the active channel and the canyon wall or between the active channel and talus slopes along the bases of canyon walls. The vegetation growing on alluvial deposits varies depending on the coarseness of the alluvium, the availability of surface or groundwater, and the frequency of disturbance by flooding. Ephemerally flooded wash channels may support mixed shrublands of fourwing saltbush, sand sagebrush (*Artemisia filifolia*), jointfir, and rubber rabbitbrush, with occasional singleleaf ash and Stansbury’s cliffrose. Canyon terraces directly adjacent to perennial or intermittent streams or rivers with frequent flooding and a high water table support more mesic riparian vegetation including Fremont cottonwood (*Populus fremontii*), Gooddings willow (*Salix gooddingii*), box-elder (*Acer negundo*), tamarisk (*Tamarix chinensis*), sandbar willow (*Salix exigua*), rushes (*Juncus* spp.), scouring rushes (*Equisetum* spp.), cattails (*Typha* spp.), and a variety of mesic grass species, including saltgrass (*Distichlis spicata*), common reed (*Phragmites australis*), alkali sacaton (*Sporobolus airoides*) and reed canary grass (*Phalaris arundinacea*). Higher terraces less likely to flood support stands of Gambel oak, skunkbush sumac, and basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) (Figure 25).

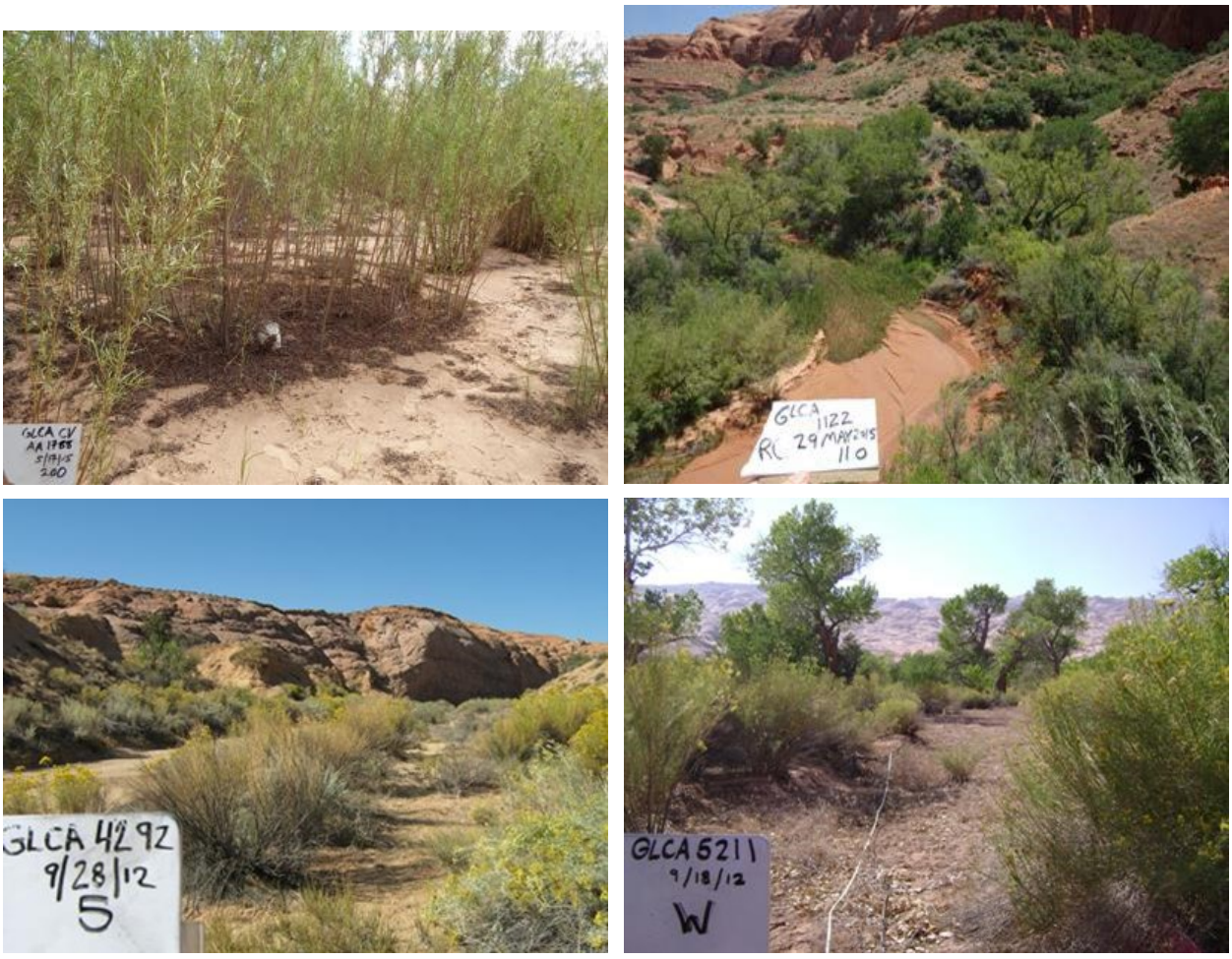


Figure 25. (Top L&R) Alluvial terraces farther from active wash channel support rubber rabbitbrush and sand sagebrush – (Bottom L&R) Alluvial soils on or near active wash channel support sandbar willow, Fremont cottonwood, tamarisk, and mesic grass and forb species.

Narrow canyon bottoms with high terraces or with colluvial slopes right up to the wash edges support pinyon-juniper woodlands with mixed shrub understories, including Fremont barberry (*Mahonia fremontii*), Gambel oak, and single-leaf ash, among others. These high terraces are often modified by eolian processes, and although they are too high to be flooded regularly, they may be destroyed or undercut by an exceptional flood event.

Eolian deposits. Wind-deposited sheets of sand in GLCA take many forms. They are primarily derived from local Navajo, Wingate, and Cedar Mesa sandstones and accumulate in bedrock hollows, on ledges, between fins, on mesas, and on valley floors. Sands blown from the top of cliffs may accumulate in a sand ramp or falling dune at the base of slopes. Likewise, sands migrating across a valley may form a climbing dune as they ascend the downwind valley wall (Coles et al. 2009). GLCA contains both sand sheets and coppice dunes; the sand dunes vary in their level of stability. Some dunes are moderately active and sparsely vegetated while other dunes support grass and shrub species and are relatively more stable. The soils that form on dunes are generally young fine sands, which are undeveloped or weakly developed, and have weak or nonexistent soil structure (USDA-

NRCS 2010). Sand sheets are relatively more stable and more developed than sand dunes, and will generally remain stable with eventual soil development (USDA-NRCS 2010). The vegetation growing on eolian sands relates directly to their degree of stability. Loose, blowing sands support a sparse shrubland composed of a combination of hoary rosemarymint (*Poliomintha incana*), sand buckwheat (*Eriogonum leptocladon*), and pillar false gumweed (*Chrysothamnus stylosa*), accompanied by Indian ricegrass and rush lemonweed (*Psoralidium junceum*), and occasionally by cheatgrass (*Bromus tectorum*) or Russian thistle (*Salsola tragus*) (Figure 26a). Sands with a degree of stabilization (usually indicated by the development of rudimentary biological soil crusts) may include sand sagebrush (Figure 26b), Navajo ephedra (*Ephedra cutleri*), a clump-forming shrub (Figure 26c), and plains pricklypear (*Opuntia polyacantha*); with a sparse to dense understory of Indian ricegrass, needle-and-thread (*Hesperostipa comata*), and/or James' galleta. Sands that have been stable for some time are dominated by blackbrush and may include scattered Tucker's sand shinnery oak, saltbush, and Torrey's jointfir (Figure 26d).



Figure 26. (Top L) Eolian sands within GLCA support a range of shrubland communities depending on the stability of the sand - loose, blowing sands support a unique shrubland with sand buckwheat, pillar false gumweed, and rush lemonweed. (Top R) Sand sagebrush, cacti, mixed shrubs, and weedy annuals occupy sand sheets that are newly stabilized. (Bottom L) Rhizomatous Cutler Mormon-tea forms a distinctive community with bunchgrasses or weedy annuals as codominants. (Bottom R) Blackbrush and Tucker's sand shinnery oak indicate a mature, stable sand sheet community.

Colluvial deposits. Colluvial deposits result from the tumbling of rocks and boulders down steep landscapes; soils accumulate along the sideslopes, and especially near the bottoms of the slopes (USDA-NRCS 2010). Spaces between the fallen rocks are filled by sand and silt blown from adjacent valley floors and plateaus. The larger rocks provide islands of stability on otherwise mobile slopes for long-lived, woody plants to root (Coles et al. 2009). Shattered and fallen rocks cover the slopes below a variety of geologic formations in GLCA, from the steep faces of Wingate cliffs in the Orange Cliffs to Navajo Sandstone cliffs throughout much of the rest of GLCA including near Lees Ferry. The soil texture depends largely upon the geologic origin of the colluvial material (USDA-NRCS 2010). Sandstone usually develops into sandy soils. Soils derived from the Moenkopi and Morrison formations have loamy textures (USDA-NRCS 2010). The most unstable slopes support grasses, especially saline wildrye and muttongrass (*Poa fendleriana*). Because of the variability of substrate, stability, and exposure, there is no typical plant community on these slopes. Vegetation classification plots sampled on colluvial slopes recorded up to 27 species of trees, shrubs, grasses, and forbs. Dry exposures tend to have more xeric shrub cover, especially Torrey's joint-fir, rubber rabbitbrush, shadscale, Bigelow sage, green Mormon-tea, Gardner's saltbush, and blackbrush. Cooler exposures often support scattered Utah juniper and two-needle pinyon pine and more mesic shrubs such as skunkbush sumac, roundleaf buffaloberry, alder-leaf mountain mahogany, single-leaf ash, Utah serviceberry, and Stansbury's cliffrose (Figure 27). Vegetation density is limited by the amount of exposed soil.



Figure 27. Slopes covered by colluvium in GLCA show the variability of vegetation communities typical of these slopes: (L) pinyon - juniper with mixed tall shrubs and (R) Bigelow sagebrush and Torrey's joint-fir sparse vegetation.

Soils

The development of soils in GLCA (and elsewhere) is determined by five basic factors: parent material, climate, topography, living organisms, and time. In general, the more arid the climate, the more influence parent material has on soils (USDA NRCS 2010).

Four distinct parent materials are involved in the soil formation process in GLCA: aeolian, alluvium, colluvium, and residuum. Aeolian (wind-deposited) soils are generally composed of recently

deposited fine sands but may be thousands of years old. Alluvial (water-deposited) soils have different textures based on whether the water moves quickly (resulting in gravels, rocks, and sand) or slowly (resulting in clays or silts). Colluvial (gravity-deposited) soils can have sandy or loamy textures and include rocks (gravel to boulder-sized) on the surface and throughout the soil profile. Residual soils are weathered in place and have the same general chemistry as the original rocks; they are rare in GLCA, found only where soils are especially shallow (<20 inches deep) or as a minor component of the soil profile in other soil types near the zone of bedrock contact (USDA-NRCS 2010).

Climate, especially precipitation, is the main factor controlling soil productivity at GLCA; the regional semi-arid climate generally results in naturally low soil productivity (Tendick et al. 2012). Low precipitation rates limit vegetative cover and primary productivity, and therefore soil development and soil organic matter (Hansen 1989). Precipitation within GLCA is sufficient to facilitate translocation of materials such as salts and clays through the soil profile. These materials, however, accumulate at the depth in the soil profile to which soil moisture generally percolates before evaporating, and create a caliche layer or calcic horizon (a hardened deposit of calcium carbonate), limiting plant root growth beyond that depth (USDA-NRCS 2010).

Topography, as characterized by the length, shape, aspect, and degree of slope, affects soil formation through its influence on runoff, erosion, rate of water infiltration, and amount of residual parent material (USDA-NRCS 2010). Steep slopes usually lack the soil surface zones of structure and organic matter accumulation because erosion and runoff continually remove the top layers of soil, and water infiltration into the soil is low due to the high velocity of water as it travels down slope (Tendick et al. 2012). Low slopes and flats have minimal erosion, slower runoff, and greater water infiltration into the soil, allowing for more profile development in the soil horizon.

Plants, animals, and microbial life all influence the soil-formation process. Plants trap sediments, reduce soil erosion, increase porosity, deposit organic matter, and cycle nutrients throughout the soil profile (USDA-NRCS 2010). Humans, livestock, and other animals influence soil formation by mixing soil horizons, changing or modifying the dominant vegetation type, destroying cryptobiotic crusts, and increasing erosion (USDA-NRCS 2010). Microbial life, including cyanobacteria, cyanolichens, green algae, microfungi, and mosses, function as composite organisms living on undisturbed desert soils, and may take decades or even centuries to develop (Harper and Belnap 2001). Soil microbial life (biological soil crusts) provides a variety of beneficial services such as building soil organic matter, fixing atmospheric nitrogen, stabilizing and protecting soil surfaces from wind and water erosion, aiding in plant nutrient uptake, and retaining soil moisture (Eldridge and Greene 1994, Belnap et al. 2001). Biological soil crusts are widespread in GLCA. A lack of plant or bio-crust cover can lead to increased wind and water erosion, which further retards soil development by continually removing surface soil layers and litter.

The majority of soils in GLCA are poorly developed, deposited more recently by wind, water or gravity. However, there are older, more developed soils with a strong structure and distinct subsoil horizon, and these are evidenced by a concentration of calcium or other minerals in the subsoil or an

argillic horizon indicating the movement of clays through the soil horizons (USDA-NRCS 2010). These soils occur on Navajo Point.

The 2010 soils map for GLCA (USDA-NRCS 2010) identifies 46 soil map units, most of which are complexes of individual soil types (series), representing 39 soil series, and 34 soil families (USDA-NRCS 2010) (Figure 28). For the generalized soil map, the map units were combined into 9 broad associations and one unvegetated class (water), each with a distinctive pattern of soils, relief, and drainage: (1) Rock Outcrop-Needle, (2) Torriorthents-Rock Outcrop, (3) Pagina-Farb-Rock Outcrop, (4) Typic Torriorthents-Rock Outcrop-Badland, (5) Rock Outcrop-Arches, (6) Reef-Rizno-Rock Outcrop, (7) Ustic Torriorthents-Rock Outcrop-Badland, (8) Earlweed-Anasazi, and (9) Gladel-Rock Outcrop.

Just under half of GLCA was mapped as having no soil development, about 35% was mapped as bare rock outcrop (occurring as a percentage of all associations with Rock Outcrop in their name) and 13% was mapped as water. The two most abundant soil map classes together cover 21% of GLCA: Rock Outcrop-Needle and Torriorthents-Rock Outcrop. The Rock Outcrop-Needle association is composed of shallow, aeolian soils derived from sandstone, with sand sagebrush dominant, and occurs on interfluves and sideslopes of structural benches. The Torriorthents-Rock Outcrop association is composed of sandy and gravelly talus or residuum weathered from sandstone and shale, with blackbrush and shadscale dominant, and occurs on talus slopes, interfluves and sideslopes of structural benches. The next two most abundant map classes cover 15% of GLCA: Rock Outcrop-Arches and Reef-Rizno-Rock Outcrop. The Rock Outcrop-Arches association is composed of shallow, aeolian soils derived from sandstone, with pinyon-juniper dominant, and occurs on interfluves and side slopes of plateaus. The Reef-Rizno-Rock Outcrop association is composed of shallow, sandy and gravelly talus derived from sandstone and shale or residuum weathered from sandstone, with pinyon, juniper and blackbrush dominant, and occurs on talus slopes, interfluves, and sideslopes of structural benches. The next two most abundant map classes cover 13% of GLCA: Pagina-Farb-Rock Outcrop and Typic Torriorthents-Rock Outcrop-Badland. The Pagina-Farb-Rock Outcrop association is composed of shallow to moderately deep aeolian soils or residuum weathered from sandstone, with blackbrush dominant, and occurs on interfluves, shoulders, and side slopes of structural benches. The Typic Torriorthents-Rock Outcrop-Badland association is composed of shale or colluvium derived from sandstone and shale, with mat saltbush and shadscale dominant, and occurs on talus slopes, interfluves, and side slopes of structural benches. The remaining 3% of the land area in GLCA is covered with three soil map class associations: Ustic Torriorthents-Rock Outcrop-Badland, Earlweed-Anasazi, and Gladel-Rock Outcrop. The Ustic Torriorthents-Rock Outcrop-Badland association is composed of moderately deep shales, colluvium and/or slope alluvium derived from sandstone and shale, with pinyon-juniper dominant, and occurs on talus slopes. The Earlweed-Anasazi association is composed of moderately to very deep, aeolian soils or residuum weathered from sandstone, with fourwing saltbush and blackbrush dominant, and occurs on interfluves and sideslopes of structural benches. Finally, the Gladel-Rock Outcrop association is composed of shallow slope alluvium or residuum weathered from sandstone, with pinyon-juniper dominant, and occurs on interfluves of plateaus.

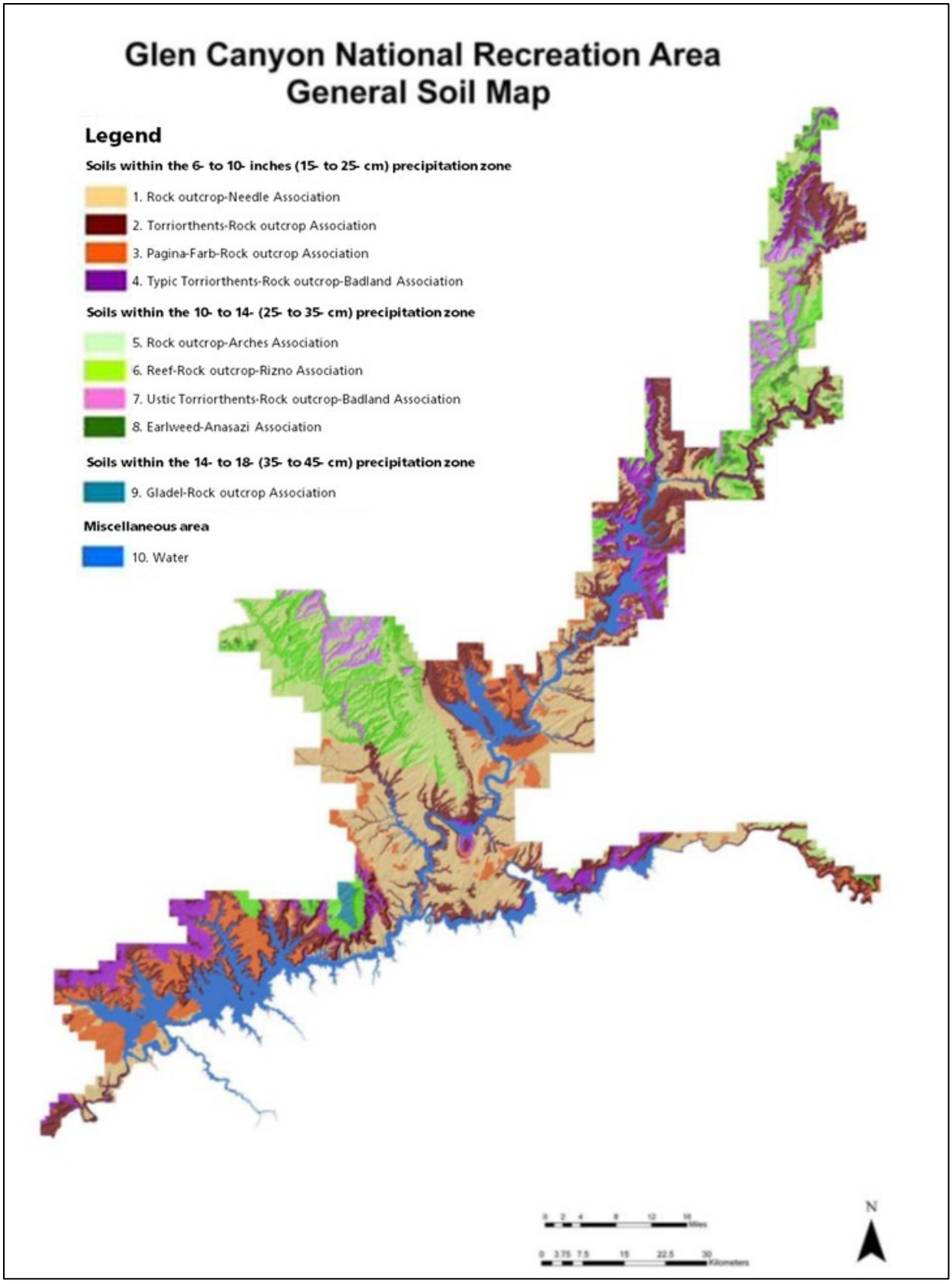


Figure 28. Generalized soils map of Glen Canyon National Recreation Area.

Hydrology and Water Resources

GLCA contains a diversity of surface water resources, including lakes, rivers, intermittent and ephemeral streams, springs, seeps, and waterpockets/tinajas. The manmade lake (which covers more than 255 square miles at full pool [163,00 acres or approx. 66,000 hectares]) and rivers of GLCA (Figure 29) are the premier park resources and receive high levels of public use and enjoyment in the form of boating, fishing, swimming, watersports, river rafting, and lakeside camping (NPS 1985).



Figure 29. Lake Powell view taken from Alston Point.

Five rivers (including two major rivers) flow into Lake Powell within GLCA; these include the Colorado, San Juan (Figure 30), Escalante, Paria, and Dirty Devil. The Escalante River, the last major stream in the contiguous United States to be mapped and named, is also one of the last undammed tributaries of the Colorado River (TNC 2014). Its periodic flood events have prevented the complete takeover of its banks by *Tamarix chinensis* (an invasive shrub species from Eurasia), which has thoroughly invaded all of the other major rivers in GLCA. The Colorado River below Glen Canyon dam supports a “blue ribbon” trout fishery. These introduced fish species thrive there due to the clear, cold water released from the bottom of the reservoir (NPS 1985).



Figure 30. San Juan River in the Goosenecks.

GLCA has four perennial streams, Halls Creek, Harris Wash, Lake Canyon, and Coyote Gulch (Figure 31), and at least 19 intermittent streams with perennial reaches supporting stands of riparian and wetland vegetation. There are both spatially and temporally intermittent streams in GLCA. Spatially intermittent streams have water above the stream bed in certain reaches (generally where there is a zone of contact with an impermeable bedrock layer or where a fractured water-bearing stratum/bedrock aquifer is exposed) and below the stream bed in other reaches (NPS 1987). Temporally intermittent streams have water flow originating from alluvial aquifers that fluctuate seasonally and depend mainly on spring time flow from snow melt and precipitation events to drive fluvial processes and support riparian vegetation (Tendick et al. 2012). The intermittent streams in GLCA include Gypsum Canyon, Red Canyon, Trachyte Creek, Ticaboo Creek, Forgotten Canyon, Moqui Canyon, Bowns Canyon, Ribbon Canyon, Llewellyn Gulch, Last Chance Creek, Navajo Creek, Wahweap Creek, Twentyfive Mile Wash, Forty Mile Wash, Willow Gulch, Davis Gulch, Fifty Mile Creek, Stevens Canyon, and Cow Canyon.



Figure 31. View of Coyote Gulch.

Many smaller, ephemeral tributary washes dissect the landscape of GLCA; these contain surface water only briefly following precipitation events. Unlike intermittent and perennial streams, ephemeral streams do not have a water table close enough to the surface to permit the growth of riparian vegetation. However, these wash channels do support larger shrubs and denser and more diverse vegetation than occurs further away from the wash channel and floodplain due to their slight differences in soil-water availability. All drainages within GLCA (perennial, intermittent or ephemeral), are subject to flash floods, especially following summer thunderstorms. Floods erode and re-deposit bank sediments and in extreme events can eliminate streambank vegetation.

Riparian ecosystems are water-dependent biotic communities. In GLCA, they occur as riverbank and stream communities in the many tributaries feeding the lake, as lakeshore communities, and as often small, isolated areas surrounding springs and seeps. In terms of structure, they range from deciduous forests and woodlands to shrublands to herbaceous vegetation types, including hanging gardens and marshes. The Escalante River has the most extensive native riparian community in GLCA. The San Juan and Dirty Devil rivers also support significant riparian communities; though their flows are affected by consumptive withdrawals for agricultural and municipal uses. Riparian areas provide critical habitat for birds, and though they only cover about 1% of the land area of GLCA, they support 23–47% of the total plant species encountered in the Recreation Area (Hill and Ayers 2009). The most serious adverse impacts on the riparian ecosystems within GLCA are from domestic and feral livestock (NPS 1987), competition from exotic invasive species, specifically *Tamarix chinensis* and *Elaeagnus angustifolia*, impacts from recreational activities (trampling, swimming), surface water diversions, and climate change.

Found along the walls and heads of canyons, they help to form the alcoves they inhabit. When rainwater percolates down through pores in water-bearing sandstones and encounters a low-permeability bed that impedes continued downward water flow, it begins to move horizontally along a less resistant flow path until it exits the rock, thus forming seeps and springs (Anderson and Sprinkel 2000). There, the water begins to dissolve cementing minerals in the sandstone, causing the rock to weaken relative to the rock elsewhere on the cliff face. The processes of weathering and erosion proceed faster on the weakened rock and eventually form a recess or alcove in the cliff (Laity and Malin 1985; Anderson and Sprinkel 2000).The principal water-bearing strata of GLCA include the Cedar Mesa, Entrada, and Navajo sandstones, and hanging garden sites most commonly occur at the Navajo-Kayenta interface (Spence 2004). Hanging gardens (Figure 32) are a specialized vegetation community supported by seeps and consist of a variety of plants not typical of arid regions including ferns, sedges, lilies, primroses, and orchids (Welsh 1989). They contain the highest concentrations of relict species (*Ostrya knowltonii, Celtis reticulata, Cercis occidentalis, Andropogon gerardii,* and *Calamagrostis scopulorum*) and endemic species (*Cirsium rydbergii, Aquilegia micrantha, Mimulus eastwoodiae, Primula specuicolia,* and *Zigadenus vaginatus*) on the Colorado Plateau (Spence 2008). GLCA supports some of the greatest concentrations of and some of the largest hanging gardens in the world.



Figure 32. Hanging garden located at head of Explorer Canyon.

Waterpockets or tinajas (rainwater-filled depressions in exposed sandstone surfaces) are the most numerous source of surface water in GLCA. Most are ephemeral, but some are large enough to be virtually permanent (NPS 1987). They support a diverse assemblage of invertebrate fauna and an often diverse, yet inconsistent, assemblage of plant species, which are limited by the depth and

degree of soil development. They are a unique resource in arid regions such as the Colorado Plateau, and are of critical importance to the survival of water-dependent terrestrial invertebrates and vertebrates, as well as an important water source for other desert fauna (NPS 1987). Many of the best developed tinajas are associated with the Waterpocket Fold of Capitol Reef NP and GLCA (Spence and Henderson 1993).

Cultural, Land Use, and Settlement History

Pre- and Proto-historic Occupation

The following summary of the area's prehistory is largely from the unpublished "Ruins Preservation Plan," (NPS 2004), with other sources cited as appropriate:

Portions of GLCA have been periodically used by human groups from about 11,500 years ago through the present. Current classificatory systems divide the Native American cultural history of GLCA into six distinct temporal and/or cultural periods: the Paleoindian period (ca. 11,500 B.C.E. - 8,050 B.C.E.), the Archaic period (ca. 8,050 B.C.E. - 400 B.C.E.), the Preformative period (ca. 400 B.C. to C.E. 500), the Formative period (C.E. 500 - 1300), the Late Prehistoric period (C.E. 1300 - 1500), and the Protohistoric period (C.E. 1500 - 1850). Several different prehistoric cultures and current Native American groups are represented in the cultural history of GLCA, and the Recreation Area represents somewhat of a cultural interface zone where different groups were periodically coming into contact with one another over long periods of time. Today, many modern descendants of these groups still have important cultural ties to the area. In addition to the Native American presence, many historic sites are located in the Recreation Area, including early Latter-Day Saints (LDS) settlements and later mineral exploration sites (Geib 1994).

Approximately 2,400 cultural resource sites have been recorded within GLCA, the majority of these being prehistoric sites. There are relatively scarce remains dating to the Paleoindian period. The Archaic period is well represented in GLCA, and a growing body of data collected from stratified cave deposits (e.g., Cowboy Cave) suggests a general continuity of occupation from the beginning of the Archaic to its end. The Preformative period is relatively poorly represented in GLCA and includes the transition from a hunter-gatherer based subsistence strategy to agricultural food production. The Formative period is characterized by increasingly sedentary populations more dependent on agricultural production, permanent habitations, and pottery production. The early Formative period has only recently been discussed at length in archaeological studies of GLCA, based on several sites in portions of the Escalante drainage. The Late Prehistoric period remains one of the most poorly understood eras within GLCA. This temporal period falls right on the heels of the migration of Anasazi groups out of the area, and includes the expansion of Paiute groups into portions of GLCA. The hunter-gatherer adaptation employed by Paiute groups resulted in relatively frequent residential moves and produced only ephemeral sites consisting of hearths, stone wickiup outlines, and various processing artifacts (Geib 1994).

Euro-American Exploration and Settlement

The Protohistoric period presents another temporal era which needs further study and definition. The span can roughly be divided between the time of the Dominguez and Escalante expedition in 1776 and ending with the LDS exploration and colonization of southern Utah in the mid-1800s (Geib

1996). The exploration of Dominguez and Escalante, Spanish friars who crossed the area near Padre Bay in 1776, provides one of the first historic accounts of the area. Several different recognized ethnic groups including the Navajo, Hopi, Havasupai, Southern Paiutes and Southern Utes are known to have utilized the area during this period, and the emerging influence of Spanish and Anglo explorers and settlers were beginning to affect cultural organization and result in significant cultural modifications during this time period.

The 1859 San Juan Exploring Expedition under Captain John Macomb of the U.S. Army Corps of Topographical Engineers produced the first scientific observations of the region. The expedition made strong contributions to knowledge of the geology, paleontology, geography and archaeology of the greater Canyonlands region. Major John Wesley Powell revealed the geographic complexity of the Colorado Plateau and performed baseline ethnographic studies of the Paiute and Ute tribes over the decade following the 1859 survey. The Powell Survey studied Colorado Plateau geology, hydrology and ethnology. Powell merged his journal notes with those from other members of the 1869 and 1871 river expeditions into a narrative in order to publish his well-known book, *The Exploration of the Colorado River of the West*, which was reprinted for popular publication in 1895 (Tendick et al. 2012, Schmieding 2008).

In the late 1850s, LDS leaders sent missionaries into what is now northern Arizona and southern Utah in order to carry their religion to native groups. Jacob Hamblin headed one of the first LDS expeditions into the GLCA area and crossed the Colorado River at what would later be known as Lees Ferry on his way to the Hopi Mesas. Later LDS expeditions and colonization efforts would greatly influence the cultural landscape of the area. In 1871, John Doyle Lee established a ferry service for LDS missionaries and settlers near the confluence of the Paria and Colorado rivers. This crossing was to provide an important means of negotiating the rugged and isolated Colorado River and would serve as a landmark to travelers passing through the area. Later, in 1879 and 1880, the San Juan or Hole-in-the-Rock Mission crossed through portions of GLCA and brought 250 men, women and children to a site in the present town of Bluff.

Native Americans continued to use the area in and around GLCA during this period, although conflicts between Mormon settlers and the Navajo, Ute and other tribes resulted in relocation of some native peoples to newly established reservations. Many of the native peoples inhabiting the area at this time were subsequently relocated to newly established reservations from the 1860–1870s. Southern Paiutes remained in the area during this time, however, and many bands were not relocated to reservations until the early 1900s.

The first Euro-American expedition to Rainbow Bridge was led by Byron Cummings, William B. Douglass, and John Wetherill in 1909. Teddy Roosevelt visited the bridge in 1913. The first comprehensive surveys of Rainbow Bridge took place in the 1950s. From 1956–1958, archeological surveys were conducted in all areas that would be inundated behind the dam, documenting granaries, small habitations, chipped hand-and-toe-hold trails, and terraced garden plots, pottery, lithic tools, and more (Sproul 2001).

Mineral Exploration and Exploitation

Increased prospecting and mineral exploration occurred in GLCA in the late 1800s and early 1900s. Cass Hite began prospecting for silver and gold in the northern portion of the Recreation Area in 1883, and helped to establish the town of Hite on the Colorado River. After gold was discovered on the San Juan River near Navajo Mountain, every canyon of the San Juan River was prospected from top to bottom. Later in the 1800s and early 1900s, several attempts were made to extract the fine 'flour' gold present in the area, but all were relatively unsuccessful, and most operations were quickly abandoned. In the 1940s and 1950s, the Cold War spurred the search for uranium in GLCA, and from 1946–1959, over 300,000 claims were filed in southeastern Utah counties. A large portion of this activity took place in the northern portion of GLCA. The authorization of the Glen Canyon Dam in 1956 coincided with the end of major uranium exploration in GLCA, and ultimately ushered in the current public use of the area. The 1972 Act establishing Glen Canyon NRA allowed for "the removal of the nonleasable…(and) leasable minerals…if such...would not have significant adverse effects…on the administration of the national Recreation Area" and stated that "the administration of mineral leases within the recreation area shall be by the Bureau of Land Management." There have been no new mineral leases issued since the Recreation Area was established (NPS 1985).

Ranching and Livestock Management

Domestic livestock grazing first entered the GLCA area in the late 1700s, as herds were driven along the Old Spanish Trail. Early Mormon settlers who arrived in Bluff via the Hole-in-the-Rock route brought with them 1,800 head of cattle. In the mid-1880s, Bluff settlers formed a grazing association, The Bluff Pool, in part to defend their rangelands from larger operations originating in Texas and New Mexico. The Scorup Brothers ran cattle in the White and Dark Canyon areas starting in the 1890s (NPS 1983).

By the late 1800s, ranchers grazed livestock (sheep, cattle, and horses) on millions of acres of USFS, General Land Office (now BLM), and private lands in southeastern Utah. Prehistorically and historically grazed by smaller herds of wild ungulates, the rangelands in the GLCA region were not adapted to the pressures of continuous and heavy grazing by large numbers of livestock (Tendick et al. 2012). Peak livestock numbers in the 1890s combined with a severe drought and poor land management practices resulted in environmental damage to areas around natural water sources and stock ponds, areas of massive trail drives, areas susceptible to erosion, and widespread degradation of native grasslands and biological soil crust communities (Schmieding 2008). Riparian areas and springs were especially hard hit, as they provide critical water resources for domestic livestock. Trampling of these areas led to eroding banks and decreasing water quality, resulting in a loss of wetland plants and soils. The Taylor Grazing Act of 1934 helped restore many areas from previous damage by regulating grazing on federal public land (NPS-GLCA).

The 1972 Act establishing Glen Canyon NRA authorized domestic livestock grazing to continue. Currently, it is managed jointly between the BLM and NPS, and is guided by a Grazing Management Plan completed in 1998. "Five BLM resource areas administer 34 grazing allotments that partially or entirely occur within Glen Canyon NRA. Grazing is permitted on 28 of those allotments. About

882,678 of Glen Canyon NRA's 1.2 million acres are in allotments, 85% of this area was subject to grazing use in 1998 (NPS-GLCA)."

Glen Canyon Dam and Recreation Area

Construction of Glen Canyon Dam was initiated in 1956 by the Bureau of Reclamation and completed in 1966. With a capacity of 27 million acre feet, it took until 1980 to fill to capacity. The effects of the dam on the cultural, vegetation, and aquatic resources of GLCA have been significant. As lake levels have fluctuated with drought cycles in the region, new areas have been exposed that were once inundated by the lake, and are often quickly colonized by exotic plant species.

Recreation opportunities on the lake continue to draw millions of visitors to GLCA. Visitation to GLCA was recorded at 196,400 during the 1964 calendar year, and had nearly quintupled by 1972 (the year the Recreation Area was established) to 962,742 annual visitors. That number more than doubled within five years, to over two million annual visitors. Visitation stayed at or around two million for the next decade, then hit peak levels in the late 1980s and early 1990s, with numbers at or around three million. The highest recorded annual visitation of 3,587,754 occurred in 1992. Since 1993, GLCA annual visitation has been documented at between two and three million visitors annually. The majority of visitors are recorded at the Wahweap District, the most easily accessible and least remote of the six districts in the Recreation Area (NPS-IRMA).

Previous Vegetation Studies

Plant Species

Hill and Ayers (2009) include a history of plant collectors working in GLCA or its immediate vicinity. The following summarizes the information found there.

No in-depth study of the flora of Glen Canyon NRA existed until the 1980's. The earliest known floristic work done within a portion of GLCA was by Alice Eastwood in 1895, although her specimens have been lost. Pre-dam collections along the Colorado River Corridor through GLCA were done by Elzada Clover and Lois Jotter (1938), Xerpha Gaines (1960), Seville Flowers and Delbert Lindsey (1959), and Walter McDougall (1959). Their inventories resulted in a total of 485 documented species from 47 families.

During the late 1970s, Stanley Welsh collected throughout the Kaiparowits Basin, including areas within GLCA south of the Escalante River and west of the San Juan River. In 1984 he published the first flora of GLCA, which documented 533 species from 68 families. In 1987 a flora of the Orange Cliffs was completed (Schultz et al. 1987), which documented 209 species from 49 families. John Spence and Julie Zimmerman completed a flora for GLCA in 1996, which brought the count for GLCA to 727 species from 85 families. Spence added at least 25 vouchered species to this checklist over the next decade (Spence 2005). With the work of Hill and Ayers (2009), GLCA has vouchered 780 species, from 362 genera, and 90 families; in addition, their study includes 75 unvouchered, but previously reported plant species. With this work, they added 129 previously unreported species to the flora (Hill and Ayers 2009).

With 856 reported taxa, the flora of GLCA is one of the largest floras on the Colorado Plateau. The floristic richness of GLCA results in part from its large size and wide environmental gradients intersecting a broad range of substrates that it encompasses. Influences from adjacent floristic regions and a large number of endemic taxa also contribute to the diversity of the Recreation Area (Hill and Ayers 2009). Three species documented for GLCA are federally listed as threatened or endangered: Jones' Cycladenia (*Cycladenia humilis* var. *jonesii*), Navajo sedge (*Carex specuicola*), and Brady's hedgehog cactus (*Pediocactus bradyi*); however, 22 additional species are considered rare by state heritage programs (Arizona and Utah) and 40 species are defined as narrowly endemic (Hill and Ayers 2009).

Vegetation Communities

Vegetation communities are natural groupings of plant species which form a relatively uniform patch and are defined by their dominant plant species and unique vegetation structure; they are generally distinguishable from neighboring patches of different plant communities based on composition or physiognomy. Their distribution on the landscape depends largely on climate, elevation, and substrate (Shimwell 1971, Brown 1994, Spence 1995). The following is a summary of some of short-term and long-term studies of the vegetation communities in GLCA.

The pre-grazing condition of the vegetation was described anecdotally by John Wesley Powell, but any scientific measurement or quantitative description is lacking from that period. Mesa tops and other sites that are inaccessible to cattle or sheep can provide clues to pre-European conditions (Tuhy and MacMahon 1988). Vegetation on Mazuki, Romana, 5381, Horn, Mancos and Monument mesas shows both similarities and differences to adjacent grazed areas. For example, until recently these mesa tops supported better-developed grasslands (Spence 2017). Packrat midden studies (Fisher et al. 2009) also show that pre-European vegetation tended to support more grassland and herbaceous species and significantly fewer disturbance adapted shrubs such as snakeweed (*Gutierrezia* spp.) and rabbitbrush (*Ericameria* and *Chrysothamnus* spp.).

Woodbury (1959) and Woodbury et al. (1959) briefly described riparian and spring communities along the Colorado River through Glen Canyon prior to the construction of Glen Canyon Dam. Irvine and West (1979) studied the environmental-vegetation interrelationships along the lower Escalante River from the mouth of Harris Wash to where the Escalante River enters Lake Powell. During the course of their field work they recorded detailed observations on riparian plant species composition and correlations with soil substrate, soil saturation, geology, and geomorphology, and surmised the effects of regulated river flow on riparian plant communities in GLCA.

Tuhy and MacMahon developed a vegetation map for GLCA using existing soil survey maps and then developed a vegetation type legend corresponding with the soil map units (Tuhy and MacMahon 1988). As part of this project, they also developed a classification using existing information sources, modified by field observations. They came up with 20 vegetation associations based on indicator species, and an additional six types based on substrate characteristics and topographic position. They described the species composition of each plant community recorded for GLCA.

In addition to the vegetation map, they also identified 21 areas of relict or near-relict vegetation. Of these 21 sites, 10 had permanent monitoring plots established within them. Vegetation types captured by these 10 plots included: *Atriplex confertifolia* / *Hilaria jamesii*, *Coleogyne ramosissima* / *Stipa hymenoides* and/or *Hilaria jamesii*, *Atriplex canescens* / *Stipa hymenoides* - *Hilaria jamesii*, *Juniperus osteosperma* / mixed grass, *Stipa hymenoides* - *Hilaria jamesii*, and a sand shrub type. Some of these relict mesa plots were re-read in 2014 (Spence 2017).

During a two-year field season (1990–1991), Butler and coworkers (Butler et al. 1995) followed up on the work done by Tuhy and MacMahon (1988), specifically, on their observations of livestock grazing impacts on the vegetation of Grand Bench. They established four plots on Grand Bench and recorded data on the effects of livestock grazing on the vegetation, using distance from a permanent water source as a proxy for grazing intensity. They observed decreased density and basal area of ricegrass with increased grazing intensity, but the opposite effect for galletta grass (increased density and basal area with increased grazing intensity). Broom snakeweed was observed to be nearly absent in the climax communities least affected by grazing and showed an increase in abundance in the more heavily grazed sites. They also sampled four pinyon-juniper sites in the Orange Cliffs (two grazed sites) and on The Block (two relict sites) to study the effects of grazing on pinyon-juniper understory vegetation. However, their data failed to show any consistent trends in vegetation composition. They postulated that The Block may have not been a true relict site, as it may still be recovering from grazing conducted there in the 1930s.

A classification of side canyon riparian vegetation was completed for the park in 1994 (Spence 1996). Surveys of the water quality and biotic components in isolated springs in GLCA, CANY, ARCH, and GRCA were completed in 1997–1998 (Spence 2004); twenty-nine of the springs sites were in GLCA. Elevation (as a proxy for climate) was the most important factor influencing vegetation structure at springs along the Colorado River, followed by water conductivity (related to geology), and solar radiation (Spence 2008). Strong floristic similarities in backwall communities were also noted among springs a great distance apart. Using cluster analyses and TWINSPAN, Spence identified four principal spring vegetation types: 1) hanging gardens and backwalls, 2) hanging garden colluvial slopes, 3) wetlands, and 4) riparian-like woodlands. He described characteristic species for each vegetation type and 21 vegetation alliances (Spence 2004, Spence 2012). Vegetation sampling at springs in GLCA has continued, with approximately 170 springs sampled through 2016.

Limited field work on forest and woodland vegetation at GLCA includes descriptions of relict Douglas fir (*Pseudotsuga menziesii*) stands (Spence 1994), and characterization of old-growth pinyon-juniper woodlands on Navajo Point (Floyd et al. 2008). Finally, an unpublished draft classification for GLCA was developed (Spence 2012, based in part on Spence et al. 1995) that includes 86 potential alliances.

Upland vegetation in areas grazed by livestock were studied between 2008 and 2015. Through 2016, 92 permanent upland plots have been established (Spence 2017) to monitor vegetation and soil changes over time due to climate change and grazing. These plots sample soil characteristics, vegetation composition, species cover, and ecological functions along three parallel 50-meter

transects (Spence 2017). The 17 Indicators of Rangeland Health developed by the BLM are used to describe functional aspects of each vegetation plot following Pellant et al. (2005). Forty additional vegetation plots were established between 1995 and 2001, although many of these have not been re-sampled. Long-term monitoring plots were established largely in shrub and herbaceous communities from 1,150 to 1,805 meters elevation, including shadscale, blackbrush, mixed desert shrub (*Ephedra, Eriogonum, Chrysothamnus* sp.), sand shrub (*Poliomintha incana, Ephedra cutleri, Artemisia filifolia, Quercus havardii*) sites, and shrub-steppe grasslands (*Atriplex canescens*-grassland).

Starting in 2010, long-term monitoring plots were established along the Escalante River, including five in GLCA, to track changes in riparian vegetation and channel morphology following removal of Russian olive (*Elaeagnus angustifolia*). Ten to 15 cross-channel transects were established at each site and vegetation sampled using point-counts. These sites are part of the long-term monitoring strategy for the Escalante River Watershed Partnership (Spence and Wheeler 2011, Spence and Whitham 2015).

Long-term upland vegetation monitoring by the Southern Colorado Plateau Network (SCPN) was initiated in to determine the status and trends in composition, structure and diversity of plant communities and the relationships between vegetation patterns and soil stability/hydrologic function within selected upland ecological sites. The pilot data collection consisted of sampling 10 randomly selected plots in the Desert Sand ecological site to determine the range of variability for key metrics (DeCoster et al. 2012). Once the soil survey was completed, the sampling frame was expanded to include the entirety of the Desert Sand ecological site that meets the sampling criteria within the park (USDA-NRCS 2010). A long-term operational revisit design was implemented in 2013, and included the installation of 26 additional plots. Plots will be sampled long-term over a five-year revisit schedule. An additional ecosite, desert shallow sandy loam, was added to the sampling frame and sampling will begin in that ecosite in 2018 (M. Swan, Botanist, pers. comm., December 2016).

Long-term springs monitoring in GLCA will be initiated by the SCPN, but the protocol for this work is still in draft form. Springs will be monitored on a five-to-seven-year, rotating basis. In addition to water quality and other aquatic aspects, measurements will be taken on the composition and structure of wetland vegetation. The objectives of the monitoring effort are to: (1) track trends in spring flow, water quality, and biotic diversity; (2) document effects of human impacts on spring ecosystems; (3) determine ranges of hydrologic and biologic variability in spring ecosystems; and (4) document spring ecosystem response to climate change (NPS 2012).

Exotic Plant Management

Of the 856 vascular plant taxa reported for GLCA, 86 species (11.2%) are non-native; of these, 36 species are on the Utah State Noxious Weed List (Hill and Ayers 2009). Weed inventories were conducted in 2003 (Orton 2003), 2009 (NPS 2009), 2011 (Pilkington et al. 2011), and 2016 (Jorgensen and Henry 2016 and Morris et al. 2017). Targeted areas for surveying invasive species in GLCA primarily include riparian zones, roads and highways, and along lake shores (Figure 33). Approximately 1,200 acres have been surveyed to date (L. Pilkington pers. comm. February 2017).

Tamarisk (salt cedar) is an exotic tall shrub native to Eurasia, and has been one focus of exotic plant species control and monitoring in GLCA. Tamarisk first appeared on the lower Colorado River in the late 1890s, was recorded at Lees Ferry by 1920, and was well-established along the Colorado River corridor by the 1930s (Clover and Jotter 1944). Graf (1978) investigated fluvial adjustments in the Green and Colorado rivers and the spread of tamarisk. He analyzed historic photographs along the rivers and estimated that tamarisk spread at a rate of about 20 km/yr. He estimated an average reduction in channel width of 27%, from sediments stabilized by tamarisk.

Recently, a coalition of public and private interests introduced tamarisk leaf beetles (*Diorhabda* sp.) to the region in an effort to reduce salt cedar vigor and spread (Higgs 2009 and Johnson et al. 2012). Though never released in Glen Canyon, the tamarisk leaf beetle has spread from neighboring areas into GLCA and has thrived at many locations within the park (https://www.nps.gov/glca/learn/nature/tamarisk-leaf-beetle.htm). In 2010, six tamarisk leaf beetle permanent monitoring plots were established in GLCA to monitor the spread of beetle activity and determine its ecological impacts on native and non-native plant populations and wildlife habitat. These were monitored in 2010, 2011, and 2012. The data has not yet been analyzed (L. Pilkington pers. comm. February 2017).

Russian olive (*Elaeagnus angustifolia*) is an exotic tree native to Eurasia, and has been another focus of exotic plant species control and monitoring in GLCA. It was first introduced in the central and western United States in the late 1800s as an ornamental tree and windbreak (www.columbia.edu/itc/cerc/danoffburg/invasion_bio/inv_spp_summ/Elaeagnus_angustifolia.htm). By the mid-1980s, it became established along the Escalante River. Beginning in 2001, a public-private partnership began removing Russian olive from the Escalante River, including reaches within GLCA. By the end of 2016, the partnership had successfully removed Russian olive from approximately 80% of the Escalante River corridor and its tributaries within GLCA. The goal is 100% removal by 2018 (L. Pilkington pers. comm. February 2017). A recent article on the Russian olive work appeared in Spence et al. (2016).

Since 2001, GLCA resource management staff, partners, and volunteer groups have worked to eradicate/reduce invasive vegetation within GLCA via mechanical and chemical methods. Targeted exotic species include Russian thistle (*Salsola kali*), Russian olive, Russian knapweed (*Centaurea repens*), tamarisk, camelthorn (*Alhagi maurorum*), black locust (*Robinia pseudoacacia*), broad-leaf pepperweed (*Lepidium latifolium*), Dalmatian toadflax (*Linaria dalmatica*), ravenna grass (*Saccharum ravennae*), and mullein (*Verbascum* sp.). Since 2010, Lake Mead EPMT and SW EPMT have focused primarily on controlling Russian olive and ravenna grass in GLCA. GLCA is currently partnering with the University of Nevada, Las Vegas and the Southwest EPMT to map, treat, and restore areas impacted by ravenna grass (L. Pilkington pers. comm. February 2017).



Figure 33. Russian thistle and tamarisk in Cataract Canyon (L) and camelthorn on the San Juan River (R).

Project Overview

The goals of this project were to inventory, classify, describe, and map the existing vegetation at Glen Canyon National Recreation Area and Rainbow Bridge National Monument. The project boundary includes all lands within these two parks for a total area of 505,642 hectares (1,249,468 acres). The process included: inventory vegetation through field sampling with the intent to cover as much of the ecological variation as possible, classify vegetation into distinct and standardized units, describe these units using summaries of field data, and finally map the distribution of these units across the project area. These tasks were completed more or less in order with some overlap between components. Once sampling began, the project took just over five years to complete. Primary project partners included Glen Canyon National Recreation Area, NatureServe, Northern Arizona University (NAU), and Kass Green & Associates.

A “Draft Work Plan for Vegetation Classification and Mapping of Glen Canyon National Recreation Area” was submitted by engineering-environmental Management, Inc. (e2M) to Dr. Angie Evenden, then Vegetation Program Manager for NCPN, in August 2004 and served as a guide on the timing, scope and expected costs of all phases of the project. Several phone meetings were held in early February 2005 between NCPN and NatureServe staff to discuss elements of a Glen Canyon proposal (including relevant tasks, approaches, needs, timelines, and necessary staffing to complete the project). A formal project workplan was submitted by the Project Manager to Karl Brown, Vegetation Mapping Inventory Program Manager, in December 2010 and approved for funding in early 2011.

A gradsect analysis utilizing spatial representations of the environmental variables associated with regional vegetation diversity was developed by Kass Green & Associates to help determine classification plot placement. A cost surface analysis was also generated to aid in the efficient sampling of classification plots. Vegetation classification plot and observation point data were collected by botanists contracted through NAU over the course of three field seasons (2011–2013). A 160,000 acre (64,750 ha) portion of GLCA (i.e., Orange Cliffs section) had previously been sampled in the fall of 2004 by NCPN ecologists as part of the effort to inventory, describe, and map the vegetation of Canyonlands National Park. Field crew members collected vegetation and environmental data from 1,164 vegetation classification plots and 51 observation points between 2004 and 2013.

Electronic data collected in the field were uploaded into the project database and the remainder of the vegetation plot data were entered into a MS Access database developed for the project (modified version of the database developed by NCPN). Using various multivariate statistical and tabular tools, and adhering to the guidelines of the National Vegetation Classification Standard (NVCS),vegetation plot data were analyzed by NCPN, GLCA/RABR, and NatureServe ecologists and revealed 193 National Vegetation Classification (NVC) plant associations for GLCA/RABR, representing 80 NVC alliances and 35 NVC groups. The final assignment of plots to associations of the NVC Standard and the local and global plant association descriptions based on the classification were completed in 2014, with minor revisions through August 2016. Ten of the 193 final associations were described

only from John Spence's springs data and are, therefore, only included in the classification section of the final report and not in the mapping section or associated appendices. Thirty associations were documented exclusively from accuracy assessment data, with the remainder from vegetation plots and observation points. Twenty-four associations required the creation and description of new associations. An additional 14 associations (not included in the 193) were retained as "Park Specials" because, although unique, they lacked sufficient information and abundance to justify creating new associations. A dichotomous key to the vegetation associations was created by the Project Manager and tested by NAU personnel both in the field and using existing data sets, and was finalized in 2016 after incorporating field crew inputs (Appendix G).

Aerial photointerpretation was conducted between the fall of 2012 and fall of 2014, using the 2009 1-meter spatial resolution National Agriculture Imagery Program (NAIP) imagery for the Utah portions of GLCA, and the 2010 1-meter spatial resolution NAIP for the Arizona portions of GLCA as the base image layers. The project used the program standard minimum mapping unit of 0.5 ha with few exceptions. Feature Analyst was used as a starting point for the mapping effort, but the majority of the mapping work was performed using ArcGIS editing tools and onscreen, heads-up digitizing, aided by ancillary datasets. Polygons representing vegetation or land use map classes were delineated directly on-screen and attribution was completed by the PI. The majority of map classes created for GLCA were complexes of closely related vegetation types/associations. A draft vegetation map and associated spatial database were completed for the Orange Cliffs section of GLCA in the summer of 2014 and for the remainder of GLCA/RABR in the late fall of 2014.

Forty-eight map classes represented by 33,691 polygons were developed for GLCA/RABR. A total of 31,058 polygons represent 37 natural or semi-natural vegetation map classes covering 75% of the mapping project area. Eleven additional land use/land cover and geologic map classes describe 2,633 polygons (25% of the area). Average polygon size across all map classes is 23.1 ha (57.2 acres). Blackbrush Shrublands had the highest number of polygons (5,560) polygons covering 14.5% of the total vegetated mapping area. The Pinyon - Juniper Sandstone Woodland Complex is the most extensive map class, delineated on 76,373 ha (188,722 acres) or 20.1% of the vegetated mapping area.

The 12-Step Guidance provided by the Vegetation Mapping Inventory Program (https://science.nature.nps.gov/im/inventory/veg/docs/Veg_Inv_12step_Guidance_v1.1.pdf) requires a map validation effort prior to a formal accuracy assessment; however, due to the complexity of access and on the basis of cost, project timeline, and excessive travel time, this step was not completed. Some map verification work was conducted concurrently with the vegetation plot data collection from the spring of 2012 to the fall of 2013, visiting and observing the vegetation in several distinct and remote areas of GLCA. Assessment of map accuracy entailed sampling an additional 1,668 data plots between 2014 and 2015 and was completed by botanists contracted through NAU. AA data were entered into the project database and then analyzed, with results tabulated into a contingency matrix. An AA meeting for GLCA/RABR was held April 28–29, 2016 at the SEUG office in Moab, Utah to determine which map classes should be retained and which should be combined or modified because they failed to meet the 80% accuracy program standard. Results from

a thematic accuracy of the 29 vegetation map classes remaining following AA analysis indicated an estimate of 81.5% overall map accuracy (Kappa statistic = 80.6%). Nineteen vegetation map classes did not meet the 80% standard for either producer's and/or user's accuracy; eight map classes were not included in the final contingency table because of their rarity and small patch size, making them difficult to accurately assess (many of these types were retained as "mapped only where known to occur"). Most of the remaining errors were among closely–related vegetation types and/or among classes which were found in similar habitats and had very similar spectral signatures. Final revisions were made to the vegetation classification, field keys, vegetation map and spatial database from winter 2014 to fall 2016.

Orthophotography

High-quality aerial photography of an appropriate scale is an important part of all NPS Vegetation Mapping Inventory Program projects. Orthophotography provides a base image for mapping vegetation in a digital format and for interpreting vegetation patterns, providing mappers with the basic information (i.e., color, texture and relationship to adjacent areas) needed to differentiate land cover classes from each other. True color, "leaf-on" aerial photography was chosen because it minimizes the effects of shadows in deep canyons and best illustrates the vegetation patterns of the park units being mapped. For the GLCA mapping effort, the decision was made to use the 2009 1-meter spatial resolution National Agriculture Imagery Program (NAIP) imagery for the Utah portions of GLCA, and the 2010 1-meter spatial resolution NAIP for the Arizona portions of GLCA as the base image layers. The 2011 NAIP imagery for Utah was also available when mapping work began but because the color balance was better on the 2009 imagery, it was only used as an ancillary data source, as was the ArcGIS base imagery from ESRI.

NAIP acquires "leaf-on" aerial imagery during the agricultural growing seasons throughout the continental U.S., and makes it "available to governmental agencies and the public within a year of acquisition. NAIP is administered by the USDA's Farm Service Agency (FSA) through the Aerial Photography Field Office in Salt Lake City. NAIP imagery is acquired at a one-meter ground sample distance (GSD) with a horizontal accuracy that matches within six meters of photo-identifiable ground control points, which are used during image inspection. The default spectral resolution is natural color (Red, Green and Blue, or RGB), and every attempt is made to comply with the specification of no more than 10% cloud cover per quarter quad tile, weather conditions permitting. All imagery is inspected for horizontal accuracy and tonal quality. NAIP imagery products are available either as digital ortho quarter quad tiles (DOQQs) or as compressed county mosaics (CCM). The DOQQs are GeoTIFFs, and the area corresponds to the USGS topographic quadrangles. For each state, the most recent year of NAIP Imagery DOQQs is available on an ArcGIS server. The state based services can be added into ArcGIS Desktop by adding https://gis.apfo.usda.gov/arcgis/services" (https://www.fsa.usda.gov/programs-and-services/aerial-photography/imagery-programs/naip-imagery/).

Primary Partners and Project Roles

Many individuals working for several agencies and organizations were involved in completing the GLCA/RABR Vegetation Mapping Project. The roles of each contributor are described below.

engineering-environmental Management, Inc.

- *Jim Von Loh, Senior Biologist* – prepared project work plan, collected classification plot and observation point data
- *Arne Buechling, Consulting Ecologist* – collected classification plot and observation point data
- *Peter Williams, Consulting Ecologist* – collected classification plot and observation point data
- *Julie Thompson, Consulting Ecologist* – collected classification plot and observation point data
- *Travis Belote, Consulting Ecologist* – collected classification plot and observation point data

Northern Arizona University

- *Tina Ayers, Ph.D., Senior Biologist, Crew Leader* – hired and coordinated contractor field crews, hired project botanist, hired project technical editor, ordered, purchased, and inventoried all field supplies, coordinated data entry and field sheet scanning, coordinated travel for field crews
- *Mar-Elise Hill, Senior Botanist* – performed data entry, identified unknown plant species, vouchered new collections for the park
- *Joanne Stucjus, Technical Editor* – edited the final report
- *James Roemer, Consulting Ecologist* – collected classification plot data
- *Rob Klotz, Consulting Ecologist* – collected classification plot data
- *Teresa Dekoker, Consulting Ecologist* – collected classification plot data
- *Steve Till, Consulting Ecologist* – collected classification plot and AA point data
- *Becky McLemore, Consulting Ecologist* – collected classification plot data
- *Daniel Hastings, Consulting Ecologist* – collected classification plot data
- *Amy Prince, Consulting Ecologist* – collected AA point data
- *Carrie Veety, Consulting Ecologist* – collected AA point data
- *Melissa McMaster, Consulting Ecologist* – collected AA point data
- *Glenn Rink, Consulting Ecologist* – collected AA point data
- *Rich Crawford, Consulting Ecologist* – collected AA point data
- *Sam Jones, Consulting Ecologist* – collected AA point data
- *Walt McBride, Consulting Ecologist* – collected AA point data

National Park Service, Northern Colorado Plateau Network

- *Angie Evenden, Ph.D., Vegetation Program Manager* – set NCPN project standards
- *Amy Tendick, Ecologist, Project Manager* – primary author of the final report, coordinated creation of final products, collected plot, observation point, and AA data, primary photointerpreter for the project, developed final map class concepts, wrote field key to associations, map class guide, and local association descriptions, participated in AA analysis meeting, performed data entry and QC
- *David Svendson* – Assistant photointerpreter, performed data entry and QC
- *Liz Ballenger, Biological Technician* – collected plot and observation point data
- *Bruce Condie, Biological Technicians* – collected plot and observation point data
- *Sarah Topp, Biological Technicians* – collected plot and observation point data
- *Margaret Beer, Data Manager* – developed NCPN project database
- *Helen Thomas, Data Manager* – project database support and QC
- *Aneth Wight, GIS Technician* – provided GIS support to field sampling crews, produced maps for field sampling crews, produced geodatabase, coordinated electronic data transfers, provided plots database support, wrote final project metadata

National Park Service, Canyonlands National Park

- *Gery Wakefield, GIS Specialist* – developed target accuracy assessment plots for field sampling using VMI standards, generated final accuracy assessment contingency table

National Park Service, Glen Canyon National Recreation Area

- *John Spence, Ph.D., Chief Scientist and Terrestrial Natural Resources Branch Chief* – wrote sections of the final report, provided expertise on other sections of the final report, developed draft classification for GLCA, provided logistical support to field crews, provided scientific expertise throughout GLCA vegetation mapping project (helped develop the final list of plant associations and participated in AA analysis meeting)
- *Nathaniel Baker, Archeological Technician* – contributed to sections of the final report
- *Lonnie Pilkington, Natural Resources Program Manager* – provided expertise on sections of the final report

National Park Service, National Vegetation Mapping Inventory Program

- *Karl Brown, Ph.D., Vegetation Mapping Inventory Program Manager* – provided national level program oversight

- *Tammy Cook, Vegetation Mapping Inventory Program Biologist* – provided national level program oversight, facilitated generation of final products

Kass Green & Associates

- *Kass Green, Photography Specialist* – reviewed legacy data, created a gradsect from various ecological datasets to develop target preliminary units for field sampling, wrote a Sampling Plan Report for GLCA/RABR (Appendix J)
- *Steve Fugate, Consulting Ecologist* – collected classification plot data
- *Kyle Christie, Consulting Ecologist* – collected classification plot data

NatureServe

- *Marion Reid, Senior Regional Ecologist* – classification project manager, reviewed classification and final association list, reviewed local descriptions, coordinated updates to global descriptions and creation of new associations
- *Keith Schulz, Regional Ecologist* – reviewed classification and final association list, reviewed local descriptions, wrote updates to global descriptions and new association descriptions
- *Gwen Kittel, Regional Ecologist* – reviewed classification and final association list, reviewed local descriptions, wrote updates to global descriptions and new association descriptions
- *Mary Russo, Ecology Data Manager* – entered GLCA/RABR local and global descriptions into NatureServe's Biotics database, formatted descriptions, completed plant species crosswalk, completed final classification spreadsheet with all 8 levels of the NVCS hierarchy
- *Kristin Snow, Assistant Ecologist/Ecological Information Manager* – developed format for NCPN plant association local and global descriptions

Vegetation Classification and Description

This section of the report describes project activities related to collecting data used in the classification stage. It describes pre-fieldwork activities, sampling strategies, plot survey methods, database construction, and classification data analysis and results.

Pre-field Methods

Preliminary Classification List

A preliminary list of plant associations was completed by John Spence for GLCA/RABR and contained 86 plant associations. The association list was crosswalked to existing NVC names and over 80% of the names fit well with existing NVC types. The association list was a useful gauge for estimating and planning field work and for assigning provisional association names to vegetation classification plots and observation points.

Legacy Data Review

Existing vegetation plot data for GLCA were evaluated for adequacy and/or relevance to the Vegetation Classification and Mapping Program project at GLCA. Long-term vegetation monitoring sites were established at 92 sites since 2008, 82 of which occur in GLCA (Spence 2017). Twenty-seven plant community or association types and 11 NRCS ecological sites are represented by the 82 plots.

These legacy data for the vegetation monitoring at GLCA fall within Category I as defined in program standards for legacy data (TNC 1996), i.e., "*Samples are adequate for classification and mapping (i.e., the data are geo-referenced, represent existing vegetation, and contain sufficient structural, compositional, and site information to place the sample within the standard classification framework).*" Data from 82 upland monitoring plots (Spence 2017) were used for: 1) providing aerial photo signature guidance and/or validation; 2) preparing the final classification; and 3) preparing the final mapping project report.

Field Sampling Approach

The following is summarized from the GLCA/RABR Sampling Plan Report (2011) written by Kass Green & Associates (KGA) (for complete report, see Appendix J):

Step Four of the 12-step guidance calls for Field Plot Data collection to support the development of each park's ecological classification, scheme, descriptions, key, and map, and the establishment of a permanent record of floristic characteristics of each vegetation type. One goal of the field plot sampling is to support identification and characterization of the "…full representation of all vegetation types across a park…" (NPS 1994). Field plot collection can be labor intensive and costly, as it involves detailed and comprehensive data gathering across a myriad of landscapes. Careful sample planning is critical to the implementation of cost effective capture of vegetation variation important to each park. Accordingly, *Step Four* calls for plot sampling design which considers "…park size, terrain features, heterogeneity of vegetation types, logistical and safety considerations, and the cost of getting to different areas of the park (NPS 2010)."

Land-Cover Stratification

At 1.2 million acres (485,623 hectares), Glen Canyon National Recreation Ares is classified as a Very Large Park (greater than 250,000 hectares) (NPS 1994), which requires that the park be divided into ecoregions. Representative polygons of the vegetation of each ecoregion are targeted for sampling. GLCA ecoregions were delineated by Dr. John Spence of GLCA, and then digitized by KGA personnel (Figure 34).

In order to develop representative polygons within ecoregions, the park first had to be stratified into areas believed to be relatively homogeneous in terms of vegetation type. The representative polygons serve as a proxy for vegetation variation. Stratification depends on the environmental data available to the park, including imagery, legacy vegetation type maps, soils maps, or maps of biophysical units (BPUs) created by combining ancillary data sets such as geology, elevation, slope, and aspect. The recently created soils maps from the USDA Natural Resources Conservation Service (USDA-NRCS 2010) is digital and very good; however, it is also very coarse in its delineation with considerable vegetation variation within soil types, as evidenced in Figure 35b.

Because vegetation is highly correlated with spectral reflectance, remotely sensed data has long been used to map vegetation. Accordingly, remotely sensed data can also be used to provide a first approximation of the vegetation types within the park through “the interpretation of patterns that can be recognized from aerial photography” (NPS 1994). For this project, Trimble eCognition automated image segmentation software was used to create “representative polygons or segments” for field sampling within each ecoregion. Figure 36 shows the segments (outlined in yellow) developed for the same area in Bullfrog as shown in Figure 35a.

Image Preparation

Four-band 1-meter NAIP imagery was used for all image processing. All processing employed the uncompressed GeoTIFF formats of the NAIP imagery. The segmentation used 2009 1-meter spatial resolution NAIP imagery for the Utah portions of GLCA, and 2007 1-meter spatial resolution NAIP for the Arizona portions of GLCA.

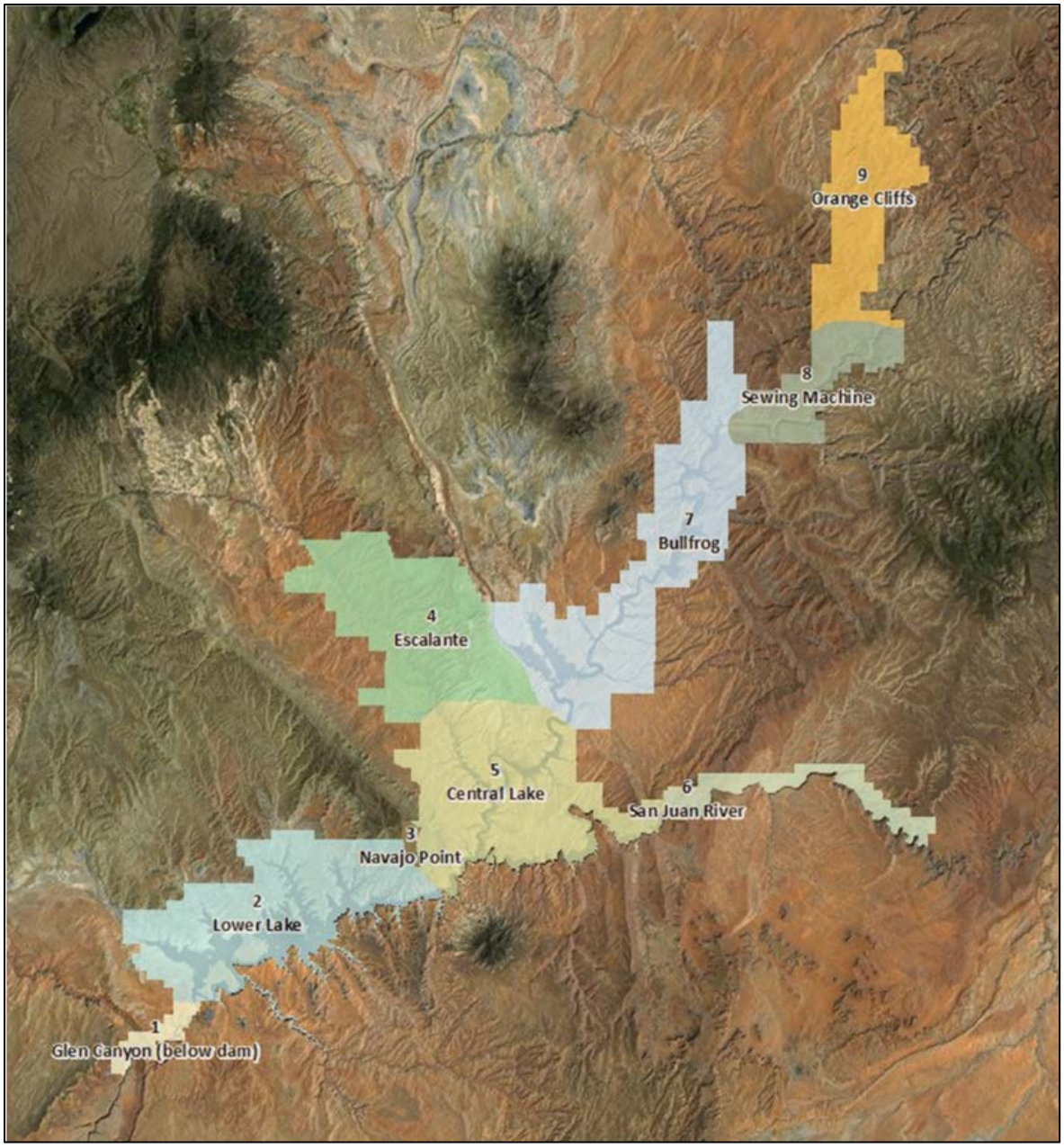


Figure 34. Glen Canyon National Recreation Area ecoregions.

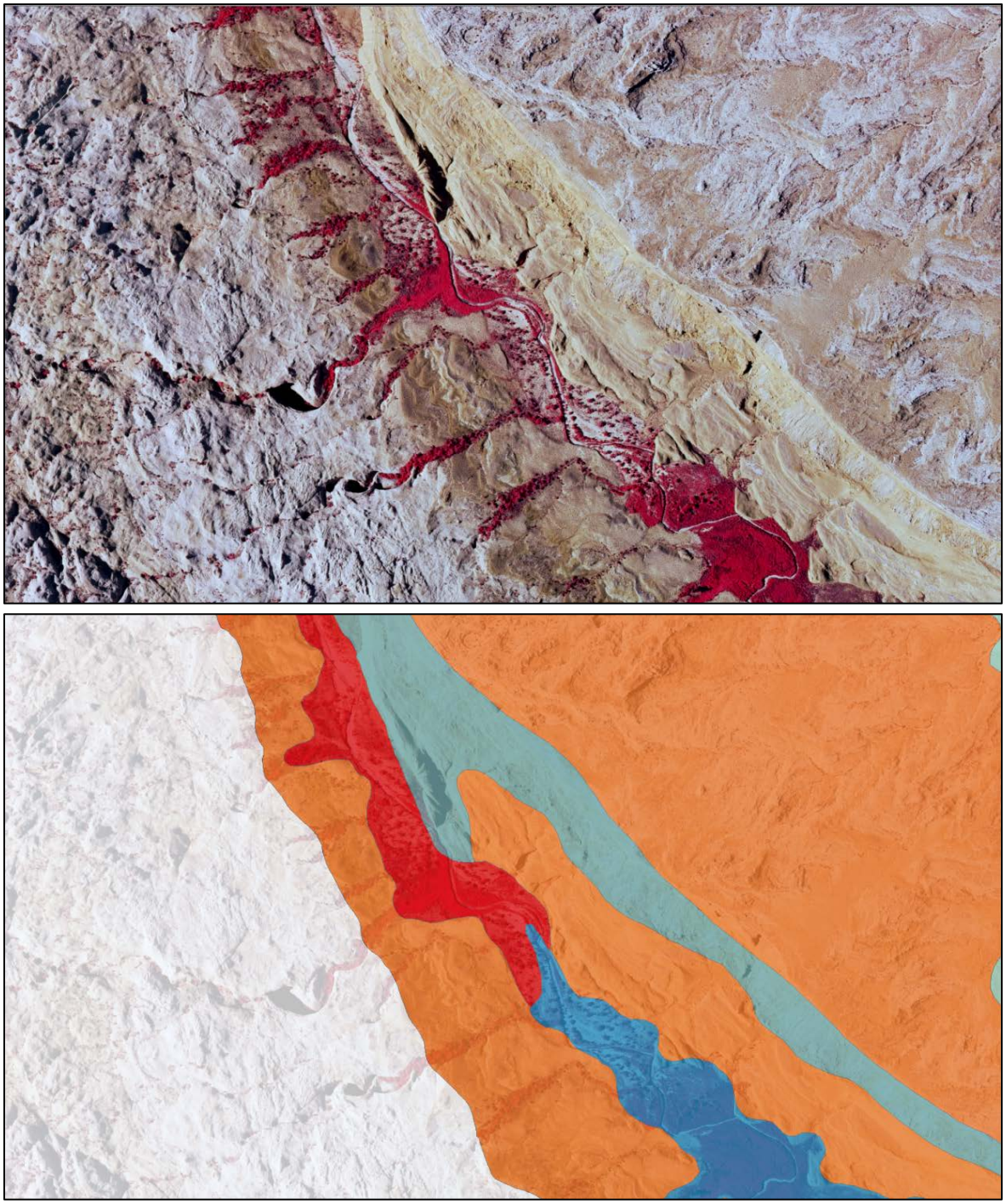


Figure 35. NAIP infrared imagery (top) and NRCS soils map (bottom) for the same area in Ecoregion 5 (along Halls Creek in the Bullfrog Ecoregion). The imagery indicates that there is significant vegetation variation within the NRCS classes.

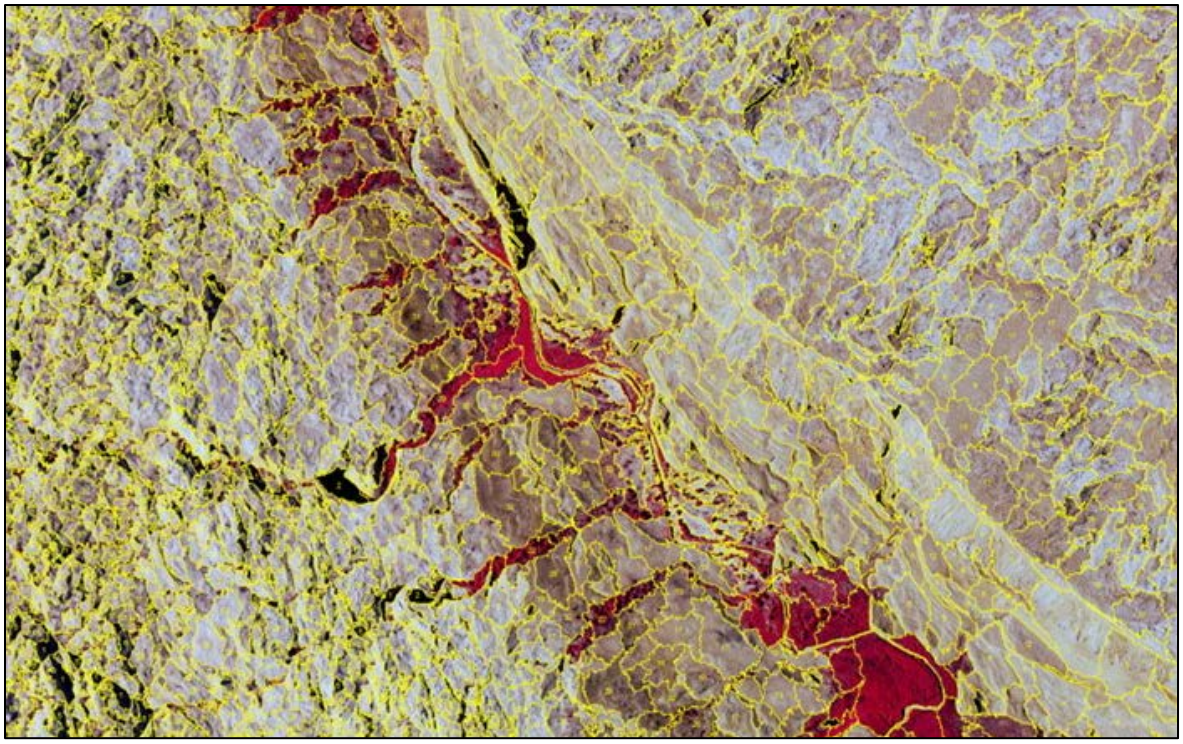


Figure 36. eCognition-generated segments over infrared imagery for a portion of the Bullfrog Ecoregion along Halls Creek.

Segmentation

Segmentation divides the landscape into relatively homogeneous polygons based on the spectral characteristics of the imagery. The goal of segmentation is to divide the landscape into segments that have less within than between spectral variation. Segmentation was conducted using the Trimble eCognition Developer software suite. Multi-resolution image segmentation in eCognition uses a "region growing" technique – it starts with samples of single pixel objects distributed across the imagery, and grows the objects into segments by merging like pixels together based on spectral variation and software parameters chosen by the user. The software created a total of 850,000 segments for all of GLCA, which included a small buffer outside of the park's administrative boundary.

Cluster Generation

A clustering algorithm was used to group the segments into similar spectral types within each ecoregion, with the assumption being that spectral type is highly correlated with land-cover type. Determining the spectral variables upon which to cluster was a highly iterative process which required trying different strategies in a pilot area – a portion of the Bullfrog ecoregion. Bullfrog was chosen because of its high variability of elevation, land form, and land-cover type.

Quality of the clustering was evaluated through manual inspection of the imagery and the clusters against the NRCS soil map. A high correlation of cluster classes with the NRCS map vegetation types was considered an indication that the clusters were correlated with vegetation type. Clusters identified by image analysts as pure water were eliminated from the cluster sampling population.

Thirty-five clusters were generated for each ecoregion. Each ecoregion was joined to each of the 850,000 image segments and then an individual cluster input table was generated.

Cost Access Map Layer

A cost access map layer represents the relative cost of accessing areas of the park for field work. A park such as GLCA/RABR covers large distances and has significantly sloped areas which make portions of the park very difficult to access. The following strategy was applied to the cost analysis:

1. Roads and the main lake and river water bodies were considered easily accessible and not assigned any 'cost' of access.

2. Relative cost was determined by the distance an area of the park was from roads and water bodies.

3. Slope increases cost and a 'slope multiplier' was calculated which increased the access cost for areas that are highly sloped.

4. A rule was implemented which determined that no access was permitted for any portion of the park where the slope exceeds 60%. Any portion of the park that could not be accessed via a path that contains no slope greater than 30% was also considered inaccessible.

An access layer was generated using the NHD water bodies which enabled boat access within the park. A road layer was merged with the boat access layer which provided the basis of access cost. A slope layer was generated from the USGS 10m DEM database. A cost surface multiplier was assigned to each cell based on the slope. It is assumed that travel time decreases with increased slope. Slopes of over 60% were considered inaccessible and given a high value in the cost surface.

The cost distance spatial analysis tool within ArcMap calculated a cost value by cumulatively adding the access cost (as determined by the slope multiplier) of each cell within the raster from each access point. The output cell was given the value of the ‘least cost’ value to access the point. (A longer hike from a road may be preferred versus a very steep climb from a water body). These values were re-classed to relative access cost numbers that can be used as guidelines for selecting plots. Figure 37 displays the final cost access map layer.

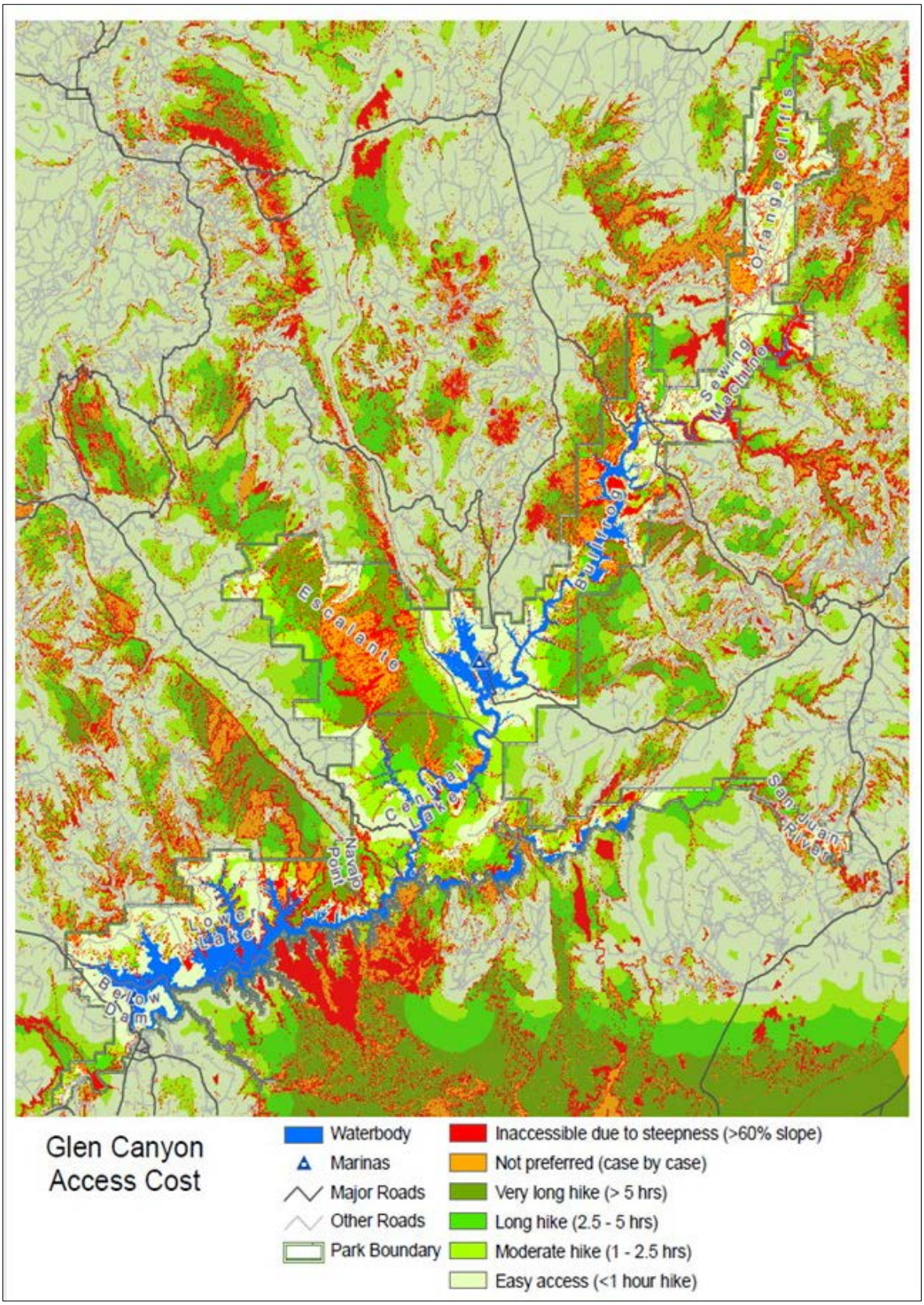


Figure 37. Cost access map layer for GLCA and RABR.

Sample Selection

Glen Canyon sample sites were selected to ensure that all potentially unique vegetation types were represented. Several steps were performed to select a sample site:

1. Each ecoregion was sampled individually.
2. Each region was assigned a unique cluster number, representing potentially unique types of vegetation. Four samples of each cluster class within each region were sub-sampled. A representation of each cluster number was identified for sampling.
3. To minimize the cost to access each cluster, the access cost value was used as a guide to select a sample cluster. The easiest access samples were selected per cluster (plus, there were one or two samples selected from the 'moderate' access cost to enable more geographic diversity.)
4. Among the cluster samples, individual sites were spaced out enough to avoid spatial autocorrelation and to ensure geographic dispersion.

The final selection of samples was made using a combination of automatic and manual processes. An automated process identified potential sample sites using the above steps. The final selection of samples was then performed by an image analyst to ensure good geographic dispersion.

Review of the Sample Selection

The final sample set (1,454 samples) was intended to provide more sampling sites than would receive field visits. Inevitably, rare vegetation types may not be identified in the sampling layer, but will need to be sampled. The final step in the sampling plan process was a review of the sample set by the Project Manager and GLCA Chief Scientist to ensure that the plan was viable and that all important vegetation types were likely to be captured in the field sampling effort, including known rare or relict types. Guidelines for the review included: 1) *Informational homogeneity* – The sample must represent one and only one vegetation class, 2) *Spectral homogeneity* – The sample should have more between- than within-segment spectral response, 3) *Project-wide distribution* – Sample sites should be evenly distributed across that class' extent in the project area, and 4) *Spectral uniqueness* – The sample sites should have spectrally unique characteristics (Kearsely et al. 2015). This review and final selection of sample sites resulted in additions to (using aerial photo signatures and following the guidelines listed above) and subtractions from the sample set submitted by Kass Green & Associates. This review was done in order to facilitate the most thorough and accurate coverage of vegetation types across the landscape, taking into account logistical and budgetary constraints. The final sample set included 1,279 segments.

Field Methods

The primary purpose of classification plot data was to document the composition and structure of GLCA/RABR vegetation and the associated environmental conditions. These data became the basis for classifying the vegetation within the park. Field methods used to gather new data for this project followed national program standards (e.g., TNC and ESRI 1994a, 1994b). Data collected during this project contributed to understanding vegetation relationships across broader landscapes beyond the

boundaries of the park. The plot dataset was enhanced by collecting observation point data, whose primary purpose was to support photo interpretation. Plot forms and individual data field descriptions appear in Appendix B.

Field Crew Training

Field crew training was conducted March 22–23, 2012 and included an overview of the I&M vegetation mapping program, how the sampling segments were chosen, standard operating procedures for safety and check-ins, field form instructions and field sampling protocols, a review of the preliminary list of plant associations, field calendar and logistics, equipment requirements and storage, and electronic data collection on GPS units. A field day with the crews included a more in-depth training on navigating with the Trimble GPS units, logging plot locations, filling out the data fields on the GPS units, practicing taking good representative plot photos, and calibrating ocular plant cover estimates between all crew members. Data collection for this project was accomplished through the use of paper data sheets, which were slightly modified, based on feedback from field crew members in order to streamline work flow and allow separation of plot tasks into logistically coherent groups.

Plot Data Collection

Field crews were led by ecologists and botanists with regional botanical expertise and experience sampling plant communities in national parks and other landscapes. The list of 86 potential plant associations provided a starting point for naming communities sampled in the field. The sampling goal was to collect between four and five classification plots for every vegetation association within the GLCA/RABR project area. However, some common associations were sampled more often to represent their range of variability, including across geologic substrates, and some rare types had fewer samples, as a result of difficulties encountering these types. An effort was made to achieve good spatial distribution of plots across the landscape and to capture the full range of variation of each association. Field data were collected following USGS-NPS protocols during the 2011, 2012, and 2013 field seasons. Nine hundred fifteen classification plots were sampled in GLCA from 2011–2013. In addition, 249 plots and 51 observation points, sampled in 2004 in the Orange Cliffs area of GLCA as part of the vegetation mapping effort for Canyonlands NP, were included as classification plot data for this project.

Field crews located classification plots subjectively within the segment (community of interest) in order to best represent the association being sampled. Ecotones (areas where two or more plant communities intermix) were avoided, or if sufficiently large were sampled using an observation point to guide photointerpretation. Plots were generally located in stands exceeding the minimum mapping unit (MMU) of 0.5 hectares; however, some plots were sampled in smaller patches of distinctive vegetation or communities of rare species. Plot size and shape requirements were consistent with national Vegetation Mapping Program guidelines (TNC and ESRI 1994a). Plot shape was adjusted as needed to sample linear bands of vegetation in drainages (Table 3). Plot size and shape were recorded for all classification plots.

Table 3. Plot sizes and shapes used for vegetation classification sampling at GLCA/ RABR.

Plot Shape	Area (m^2)	Length × Width (m)
Square	400	20 × 20
Rectangular	400	40 × 10
Circular	400	22.6 diameter

Within each classification plot, field staff estimated and recorded an array of vegetation and environmental data using the field forms (Appendix B) and data definitions (Appendix C). Four categories of data were collected for classification plots (Table 4).

Table 4. General plot data categories and specific data components collected at each vegetation classification plot.

Plot Data Category	Data Components
Location and Plot Identifiers	Plot code, park name, site name, state, county, quad name, GPS unit, UTM coordinates, UTM zone, GPS error, 3D differential, survey date, surveyor names, directions to plot, plot dimensions, photograph documentation
Environmental Description	Elevation, slope, aspect, topographic position, landform, geology, Cowardin wetland type, hydrologic regime, ground cover, soil texture, soil drainage, evidence of disturbance and animal use
Vegetation Description	Height and cover of all strata, cover by species, physiognomic type, provisional association name, plot representativeness
Other Information	Narrative description of setting of plot; description of adjacent communities, notation of unusual ecological processes, continuation descriptions from other narrative fields

Location and Plot Identifiers

The bounds of each plot were marked temporarily using measuring tapes. The Universal Transverse Mercator (UTM) coordinates at the center of each plot were recorded (Zone 12, NAD83) on Trimble or Garmin hand-held GPS receivers. Other data fields documenting the location of each plot appear in Table 4 and are described in detail in Appendix C. Locations sampled were recorded on topographic maps during each field trip to avoid duplication of effort and ensure that the park was adequately sampled. The overall character of the vegetation and features of each plot were recorded by two to four photographs taken from plot center in all cardinal directions using digital cameras.

Environmental Description

The physical characteristics of each classification plot were documented in both categorical and narrative fields (Table 3, Appendix B). These characteristics included physical site features (elevation, slope, aspect, topography), hydrology, geology, and soils. Ground surface characterization included estimates of the cover of rocks, sand, litter, bare soil, biological soil crust, moss, and lichen. A narrative field was provided for a general description of the plot setting and the influence of physical factors on the vegetation.

Vegetation Description

Every vascular plant species in each classification plot was assigned to one of 13 physiognomic strata (Appendix B). Within each stratum, the investigator recorded average height and percent canopy cover for all species using the categories in Table 5. Consistent and repeatable ocular cover estimates were obtained by relating the area occupied by an individual species to the area of the entire plot. When it was not possible to identify a species in the field, plant material was collected and pressed for later identification. Provisional plant association names were assigned to each plot in the field using professional judgment, guided by the preliminary association list.

Table 5. Vegetation cover and height classes used in the GLCA/RABR vegetation.

Species and Strata Canopy Cover Classes		Strata Height Classes	
Code	**Range**	**Code**	**Range**
x	few	01	<0.5 m
T	0–1%	02	0.5–1 m
P	>1–5%	03	>1–2 m
1-a	>5–10%	04	>2–5 m
1-b	>10–15%	05	>5–10 m
2	>15–25%	06	>10–15 m
3	>25–35%	07	>15–20 m
4	>35–45%	08	>20–35 m
5-a	>45–50%	09	>35–50 m
5-b	>50–55%	10	> 50 m
6	>55–65%	–	–
7	>65–75%	–	–
8	>75–85%	–	–
9	>85–95%	–	–
10	>95%	–	–

Other Information

Field crews were encouraged to record general observations on how well the plot represented the stand, the relationship of site conditions to vegetation patterns, characteristics of adjacent vegetation communities, and site disturbance history.

Observation Points

In addition to classification plots, field crews collected vegetation and environmental data at 51 observation points within the mapping project area (as well as 12 binocular plots). Vegetation information was recorded only for the most abundant species present at each sampling location.

Observation points varied in size, but usually approximated the minimum mapping unit (MMU) of 0.5 hectares and the data collected at observation points reflected the vegetation of a loosely defined area around the point (the stand) rather than a measured plot (Appendix B). Overall conditions at each observation point were documented by one or more photographs. These data were intended primarily to support modeling and photo interpretation of the aerial imagery for mapping, but were also used to help describe plant associations. Field crews could choose to sample an observation point instead of a full classification plot when:

- crews were sampling outside the park boundary;
- vegetation occupied inaccessible areas where the community could only be viewed from a distance with binoculars;
- crews were sampling a vegetation type that had already been extensively sampled by field crew members earlier that field season; or,
- crews wanted to document a vegetation type that consistently occurred in stands smaller than 0.5 ha (1.24 acres).

Data Processing and Analysis

From 2004 and 2011–2013, 1,215 vegetation plots were sampled within the mapping project area (Figure 38). Plot data were entered into the GLCA/RABR Vegetation Mapping Project Database through a combination of digital and manual methods. Short text fields and numerical fields were entered into a GPS unit in the field and the data uploaded into the project database. Longer text fields were entered manually in the office from paper datasheets filled out by field staff. The project database was developed by the NCPN data management staff and is compatible with the data standards of the PLOTS 3.0 v.4 Database System developed for the NPS Vegetation Mapping Program by TNC (1997) and recently updated; it offers great flexibility in overall data management, and is designed to accommodate all project field data recorded in plots, observation points, and AA points. Fields associated with the GLCA/RABR plots database are described in Appendix C.

A total of 7,623 digital images of plots, observation points, AA points, and scenery were taken as part of this project. A unique identifier allows each photograph to be linked with the plots and spatial databases.

Thorough quality assessment and quality check (QA/QC) procedures were performed on all classification plot and observation point data following entry into the plots database. Individual plot data records were reviewed with the individual field data sheets in hand. These queries ensured that no duplicate plot numbers existed, that all plot site names were appropriately named, and all state, county, and park codes were properly entered. The accuracy of the type, orientation, date, and photographer fields were verified. Queries checked that elevation, slope, and aspect values fell within appropriate value ranges. A spell-check was completed for all comment fields. Omissions in geology and landform fields were corrected. Queries ensured that the total percent cover for substrates values equaled an appropriate value. Additional queries maintained the integrity of the vegetation descriptions by identifying omissions or contradictions in the phenology, leaf type, and physiognomy

fields. Provisional community names were spell-checked. Queries ensured that species were recorded in the appropriate strata and that all cover estimates fell within reasonable parameters.

The spelling and nomenclature of all species names were verified and updated to reflect the primary nomenclatural authority used for plant names for the GLCA/RABR vegetation mapping project, *A Utah Flora* (Welsh et al. 2003). It is important to note that NatureServe, a primary project partner, uses Kartesz (1999) as its primary nomenclatural authority. As a result, nomenclature used in the body of this report follows Kartesz, whereas nomenclature in the project database follows Welsh et al. (2003). Differences between the two nomenclatural authorities are reconciled in a crosswalk table (Appendix D).

Following completion of QA/QC procedures, the database was used by the Project Manager and NatureServe ecologists for vegetation classification analysis. All plot and observation point photos were organized and labeled for use in the classification analysis. A GIS data layer (point data) was developed to document classification plot locations (Figure 38).

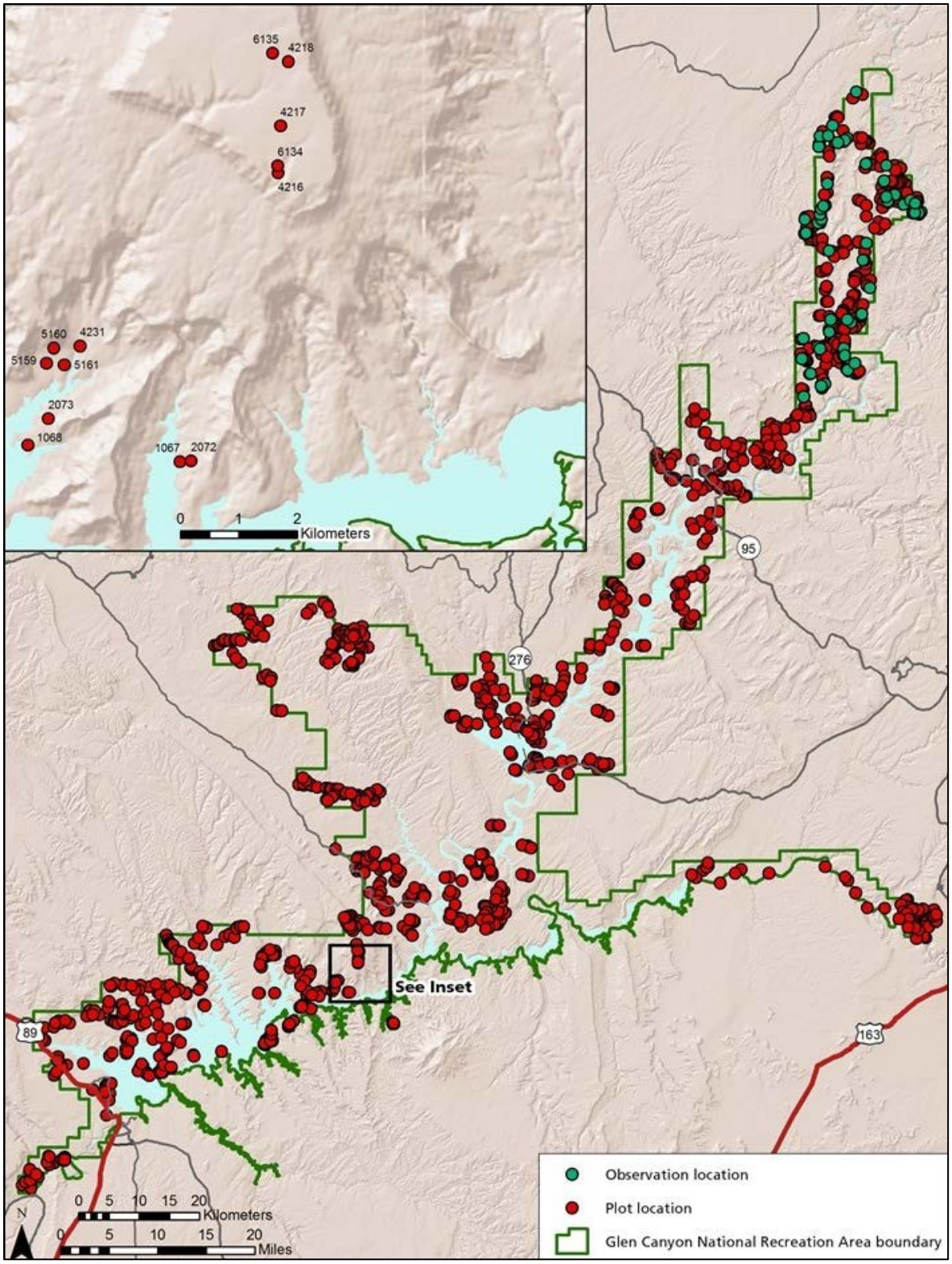


Figure 38. Vegetation plot and observation point locations in the GLCA/RABR mapping project area.

Classification Data Analysis

A total of 1,164 vegetation classification plots were available for analysis. An additional 51 observation points were not used in the analysis. A legacy dataset of 170 springs in the park were also analyzed and classified, with particular reference to hanging garden associations. The data were exported in list format from the Plots database, and then imported directly into an Excel spreadsheet for analysis using PC-Ord Version 5 (McCune and Mefford 1999) after species names and cover classes had been formatted to meet PC-Ord requirements. The raw canopy cover values were used as the absolute cover value for each species, and values for different strata of a single species were combined within a plot. Although stratum information is useful in describing associations once they have been detected, it creates extra noise in the preliminary analysis of large data sets. Non-vascular species were combined under three general categories (moss, lichen, and dark cyanobacteria). Due to the frequency and possible importance of many species with low cover, some of which could be indicator species, all species were retained for the initial analyses. The final vegetation mapping data set contained 1,164 samples and 711 species. Springs data set included 170 springs and 210 native plant species, as well as 32 exotic wetland species. Only herbaceous species-dominated hanging gardens were classified in this study.

A variety of exploratory analytic techniques were used, including summary statistics, outlier analysis, Nonmetric Multidimensional Scaling (NMS) ordination, cluster analysis, two-way cluster analysis, Indicator Species Analysis, TWINSPAN, and tabular (visual inspection) analysis. Due to the large size of the data set and significant compositional differences, the data were first grouped into broad categories, including initially riparian/upland, then woody-dominated and herbaceous-dominated plots. An iterative approach was taken with each category, starting with exploratory analysis of major patterns using ordination. Outliers were then identified and pruned from the data set. These outliers were inspected for species composition and to determine if they represented distinct vegetation types or were simply extreme outliers of other vegetation types. Then cluster analysis was used to stratify the remaining data to identify broad groupings within each major category. TWINSPAN analysis was then done for the same data and compared with the cluster analysis results. Finally, two-way cluster analysis and indicator species analysis were used to refine the broad groupings and define smaller subsets based on species dominance patterns. When groups identified by the initial cluster analysis could not be parsed further with these methods, individual plots and outliers were inspected and assigned to associations or alliances based on species composition, cover and environmental data. As is often the case in datasets like this, these outliers for the most part represent valid vegetation types (often riparian or weedy types) that are uncommon and hence under-sampled. In the GLCA data set there was an unusually large number of rare or outlier types.

The initial NMS ordinations based on broad groupings provided the initial stratification into smaller subsets of plots. Initial inspection of stress was used to determine ordination dimensionality, typically with the result of k = 3 axes, but varying from 2 to 5. Then the ordination was computed using the “slow and thorough” version with Sorenson’s distance measure. Stress and dimensionality were inspected, then the results graphed. Outliers were identified, along with broad groupings of plots. In some analyses, groupings could not be discerned, and the data were then analyzed using cluster analysis methods.

Following initial ordinations, the data were then stratified into smaller sets using cluster analysis (Figure 39). The Euclidean distance measure was used with the flexible clustering linkage method, setting Ward's β to -0.25 (Sorenson's distance is incompatible with Ward's). Ward's linkage method typically produces clusters with relatively low chaining compared to nearest linkage methods, but avoids the extreme grouping resulting from farthest linkage methods. The resulting dendrograms were then inspected for outliers not captured in the ordinations, which were removed from the datasets.

The groups resulting from the cluster analyses were then identified by visual inspection of species presence combined with TWINSPAN analyses to further refine the groups as necessary. However, due to inherent weaknesses in the TWINSPAN method (Peck 2010), cluster analysis results were usually preferentially selected if the two methods differed in their classification groupings.

Finally, a combination of two-way cluster analysis and Indicator Species Analysis (ISA) was used to classify the resulting groups at the alliance and association level. Indicator species analysis (Dufrêne and Legendre 1997), as implemented in PC-Ord and cluster summary queries, were used to interpret the groups revealed by cluster analysis in an ecologically meaningful fashion. ISA is a technique to identify the species that characterize a group of sampling units. The procedure gives a score for each species in each group summarizing how faithful a species is to that group, as well as how exclusive it is to that group. A good indicator species occurs with high relative abundance and high frequency in its own group and at the same time does not occur in other groups. Indicator values range from 0 (no indication) to 100 (perfect indication). The analysis also uses a randomization (Monte Carlo) technique to estimate the statistical significance (p-value) of the scores. One commonly used method is to retain only those indicator species which have a $p \leq 0.05$, *and* an indicator value ≥ 25 (Dufrêne and Legendre 1997).

The final classification steps to develop the GLCA/RABR draft vegetation classification included the following:

1. Identify groups and/or plots that appear to belong to existing alliances and associations.
2. Identify groups/plots that support the description of new associations.
3. Characterize groups/plots that don't fit the above criteria and are likely outliers of or degraded (exotic component abundant or dominant) examples of existing associations.
4. Final tabular analysis and examination of plot data to support the association classifications visually, by workers knowledgeable with the region and vegetation. Techniques for tabular analysis were based on the procedures suggested by Mueller-Dombois and Ellenberg (1974) for classifying vegetation by tabular comparison.

Because GLCA/RABR plots are intended to fit into an existing classification instead of a stand-alone site-specific classification, the analysis techniques described above were used as a secondary justification for assigning plots to associations. Primary justification for plot assignments was a combination of plot floristics, environmental factors and the knowledge and experience of the

authors. Secondary analyses identified >200 subgroups (or associations) within the 27 main groups (or alliances) (Table 6). Of these, 54 associations were types with only one or two plots that represent under-sampled associations.

Table 6. Initial stratification of the vegetation in broad categories, functional life-form groups, and dominant plant species groupings, and final results for number of associations.

Categories	Functional Groups	Preliminary Alliance Groupings	Number of Associations
Upland	Forest and Woodland	*Pinus edulis/Juniperus osteosperma*	20
		Juniperus osteosperma	15
		Miscellaneous plots	5
		Quercus gambelii	4
	Shrubland	Miscellaneous plots	32
		Coleogyne ramosissima	12
		Chrysothamnus/Ericameria spp.	12
		Ephedra spp.	10
		Atriplex canescens-grass	8
		Artemisia spp.	7
		Desert and Semi-desert sand sites	6
		Mat *Atriplex* spp.	5
		Atriplex confertifolia	4
		Eriogonum spp.	2
		Gutierrezia spp.	2
	Herbaceous	Grasslands	12
		Miscellaneous plots	4
Riparian/Wetland	Forest and Woodland	*Populus-Salix-Acer-Celtis*	16
		Miscellaneous woodland plots	4
	Shrubland	*Baccharis, Betula, Fallugia* spp.	5
		Miscellaneous plots	4
		Salix exigua	3
		Elaeagnus angustifolia/Tamarix spp.	2
		Lakeshore plots	1
	Herbaceous	Springs and Hanging Gardens	10
		Herbaceous wetlands	8
		Miscellaneous plots	2
TOTAL			215

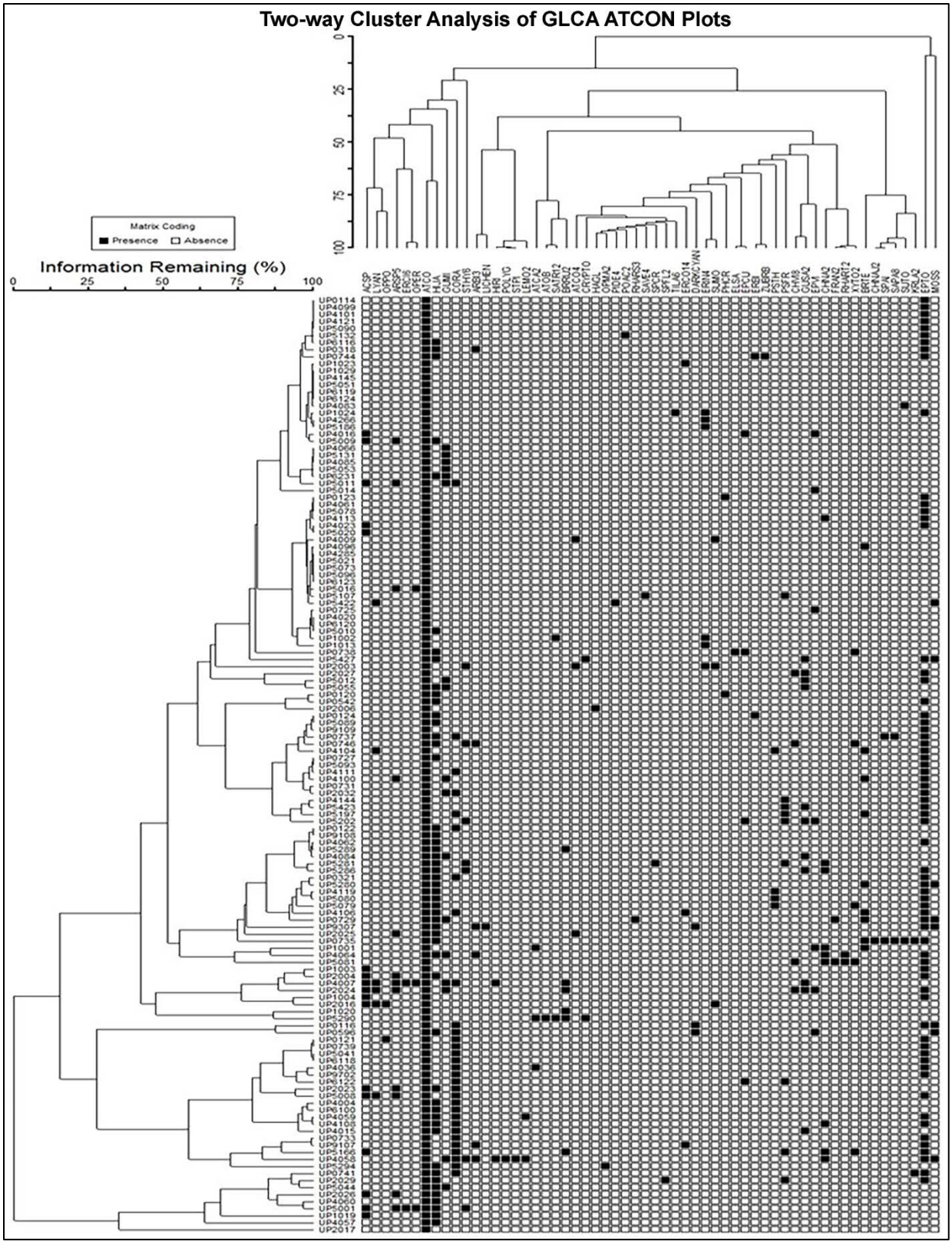


Figure 39. Generalized cluster analysis dendrogram of *Atriplex confertifolia* plots in GLCA.

Classification Results

The draft classification for GLCA/RABR was completed in August 2014, and underwent several revisions prior to the release of the final classification in August 2016. Following the final AA data collection in late 2015, types not previously recognized from the park were analyzed for possible inclusion. Thirty plant associations encountered during AA were added to the GLCA/RABR final classification (Appendix E). Revisions included amending the classification to include these new associations, amending local descriptions based on finding a rare association to be much more common during the AA phase of the project, and writing local descriptions for new types not previously described in the NVC.

The vegetation of the GLCA/RABR mapping project area is classified into 193 community types or associations (Table 7). Of these, 10 are described only from John Spence's unpublished springs data and are not included in the plant association field key (Appendix G) or crosswalked to a map class. They were included in this project as part of the classification effort but not as part of the vegetation mapping effort, partly due to the fact that many of these vegetation associations occur in alcoves or in stands too small to be pulled out and mapped consistently or reliably using the aerial imagery. Eighteen of the 183 mapped associations have no local descriptions written for them because they are known from only one or two plots; they are included in the final classification and all other parts of the final report (tables, lists, and appendices). Fourteen additional associations are described as 'park specials' because they are known from only one or two plots, are known only from GLCA/RABR, and have no known literature references describing the same or closely related types. Park specials are not assigned to NVC associations or alliances, do not have local descriptions written for them, and are generally not included in other parts of the final report (tables, lists, and appendices).

The vegetation of the GLCA/RABR mapping project area includes 80 NVC alliances and 35 groups. One hundred and ten of the communities are shrubland, wooded shrubland, dwarf-shrubland, or sparse shrubland types (12 riparian), 56 are forest or woodland types (21 riparian), and 27 are herbaceous vegetation types (14 wetland). Juniper and pinyon-juniper woodlands dominate the woodland vegetation, accounting for 12 and 22 associations, respectively. Each association, alliance, or park special is represented by between at least one and as many as 92 plot samples (Appendix E). Types with only one or two plots may have been rare in GLCA, or were simply under-sampled as a result of difficult access or limitations of the sampling design. Some of the types that appeared to be rare, after the initial sampling phase, were found to be more common during the AA phase.

Table 7. Classified plant associations for the Glen Canyon National Recreation Area and Rainbow Bridge National Monument vegetation mapping project area, arranged by Group within each physiognomic group.*

Hydrologic Class	Physiognomic Class	NVCS Group	NVCS Association	Common Name	Code
UPLAND ASSOCIATIONS	UPLAND WOODLANDS	Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)	Pseudotsuga menziesii Scree Woodland	Douglas-fir Scree Woodland	CEGL000911
		Colorado Plateau-Great Basin Juniper Open Woodland (G246)	Juniperus osteosperma / Hesperostipa comata Open Woodland	Utah Juniper / Needle-and-Thread Open Woodland	CEGL002815
			Juniperus osteosperma / Leymus salinus Open Woodland	Utah Juniper / Saline Wildrye Open Woodland	CEGL003109
			Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Wooded Shrubland	Utah Juniper - (Two-needle Pinyon) / Blackbrush - Stansbury's Cliffrose -Shinnery Oak Wooded Shrubland	CEGL003774
			Juniperus osteosperma / Artemisia tridentata Woodland	Utah Juniper / Big Sagebrush Woodland	CEGL000730
			Juniperus osteosperma / Cercocarpus intricatus Woodland	Utah Juniper / Little-leaf Mountain-mahogany Woodland	CEGL000733
			Juniperus osteosperma / Coleogyne ramosissima Woodland	Utah Juniper / Blackbrush Woodland	CEGL002909
			Juniperus osteosperma / Mahonia fremontii Woodland	Utah Juniper / Desert Oregon-grape Woodland	CEGL003965
			Juniperus osteosperma / Mixed Shrubs Talus Woodland	Utah Juniper / Mixed Shrubs Talus Woodland	CEGL002266
			Juniperus osteosperma / Pleuraphis jamesii Open Woodland	Utah Juniper / James' Galleta Open Woodland	CEGL002362
			Juniperus osteosperma / Quercus gambelii Woodland	Utah Juniper / Gambel Oak Woodland	CEPP005696
			Juniperus osteosperma / Quercus havardii - Artemisia filifolia - Ephedra cutleri Sandsheet Scrub	Utah Juniper / Shinnery Oak - Sand Sagebrush - Cutler Mormon-tea Sandsheet Scrub	CEPP005694
			Juniperus osteosperma / Sparse Understory Woodland	Utah Juniper / Sparse Understory Woodland	CEGL000732
		Colorado Plateau Pinyon-Juniper Woodland (G250)	Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis) Wooded Shrubland	Two-needle Pinyon - Utah Juniper / (Roundleaf Buffaloberry, Utah Serviceberry) Wooded Shrubland	CEGL002334

* Plant associations as determined from the vegetation plot, observation point, accuracy assessment point, and springs & seeps data sets. Associations are ordered by physiognomy and NVC Group. Identification codes are provided for plant associations and NVC Groups. Because Group units are not constrained by physiognomy, they may appear more than once in the table.

† NatureServe assigns CEGL codes to track NVC associations within their databases. Park Specials are not part of the NVC and therefore do not have a CEGL code.

‡ The NatureServe codes following each Ecological System unit name provide a means of tracking the evolution of the concept in NatureServe's Biotics Tracking Database.

Table 7 (continued). Classified plant associations for the Glen Canyon National Recreation Area and Rainbow Bridge National Monument vegetation mapping project area, arranged by Group within each physiognomic group.*

Hydrologic Class	Physiognomic Class	NVCS Group	NVCS Association	Common Name	Code
UPLAND ASSOCIATIONS (continued)	UPLAND WOODLANDS (continued)	Colorado Plateau Pinyon-Juniper Woodland (G250) (continued)	Pinus edulis - Juniperus osteosperma / Achnatherum hymenoides Woodland	Two-needle Pinyon - Utah Juniper / Indian Ricegrass Woodland	CEGL002364
			Pinus edulis - Juniperus osteosperma / Amelanchier utahensis Woodland	Two-needle Pinyon - Utah Juniper / Utah Serviceberry Woodland	CEGL002329
			Pinus edulis - Juniperus osteosperma / Artemisia bigelovii Woodland	Two-needle Pinyon - Utah Juniper / Bigelow Sagebrush Woodland	CEGL002118
			Pinus edulis - Juniperus osteosperma / Artemisia nova Woodland	Two-needle Pinyon - Utah Juniper / Black Sagebrush Woodland	CEGL002331
			Pinus edulis - Juniperus osteosperma / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland	Two-needle Pinyon - Utah Juniper / Wyoming Big Sagebrush Woodland	CEGL005658
			Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland	Two-needle Pinyon - Utah Juniper / Littleleaf Mountain-mahogany Woodland	CEGL000779
			Pinus edulis - Juniperus osteosperma / Cercocarpus montanus - Mixed Shrub Woodland	Two-needle Pinyon - Utah Juniper / Alderleaf Mountain-mahogany Mixed Shrub Woodland	CEGL005657
			Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland	Two-needle Pinyon - Utah Juniper / Blackbrush Woodland	CEGL000781
			Pinus edulis - Juniperus osteosperma / Ephedra viridis - Gutierrezia sarothrae Woodland	Two-needle Pinyon - Utah Juniper / Mormon-tea - Snakeweed Woodland	CEGL002370
			Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland	Two-needle Pinyon - Utah Juniper / Mixed Shrubs Talus Woodland	CEGL002328
			Pinus edulis - Juniperus osteosperma / Muhlenbergia pungens Woodland	Two-needle Pinyon - Utah Juniper / Sandhill Muhly Woodland	CEGL002373
			Pinus edulis - Juniperus osteosperma / Pleuraphis jamesii Woodland	Two-needle Pinyon - Utah Juniper / James' Galleta Woodland	CEGL002379
			Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland	Two-needle Pinyon - Utah Juniper / Stansbury's Cliffrose Woodland	CEGL000782

* Plant associations as determined from the vegetation plot, observation point, accuracy assessment point, and springs & seeps data sets. Associations are ordered by physiognomy and NVC Group. Identification codes are provided for plant associations and NVC Groups. Because Group units are not constrained by physiognomy, they may appear more than once in the table.

† NatureServe assigns CEGL codes to track NVC associations within their databases. Park Specials are not part of the NVC and therefore do not have a CEGL code.

‡ The NatureServe codes following each Ecological System unit name provide a means of tracking the evolution of the concept in NatureServe's Biotics Tracking Database.

Table 7 (continued). Classified plant associations for the Glen Canyon National Recreation Area and Rainbow Bridge National Monument vegetation mapping project area, arranged by Group within each physiognomic group.*

Hydrologic Class	Physiognomic Class	NVCS Group	NVCS Association	Common Name	Code
UPLAND ASSOCIATIONS (continued)	UPLAND WOODLANDS (continued)	Colorado Plateau Pinyon-Juniper Woodland (G250) (continued)	Pinus edulis - Juniperus osteosperma / Quercus gambelii Woodland	Two-needle Pinyon- Utah Juniper / Gambel Oak Woodland	CEGL005659
			Pinus edulis - Juniperus osteosperma / Quercus havardii var. tuckeri Woodland	Two-needle Pinyon - Utah Juniper / Shinnery Oak Woodland	CEGL002497
			Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland	Two-needle Pinyon- Utah Juniper / Sonoran Scrub Oak Woodland	CEGL004007
			Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia Woodland	Two-needle Pinyon - Utah Juniper / Roundleaf Buffaloberry Woodland	CEGL002335
			Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	Two-needle Pinyon - Utah Juniper / Sparse Understory Woodland	CEGL002148
			Pinus edulis - Juniperus osteosperma / Symphoricarpos longiflorus Woodland	Two-needle Pinyon - Utah Juniper / Desert Snowberry Woodland	CEPP009635
			Pinus edulis - Juniperus spp. / Leymus salinus Woodland	Two-needle Pinyon-juniper species / Saline Wildrye Woodland	CEGL002340
			Pinus edulis - Juniperus spp. / Poa fendleriana Woodland	Two-needle Pinyon - Juniper species / Muttongrass Woodland	CEGL000787
	UPLAND SHRUBLANDS	Southern Rocky Mountain Mountain-mahogany - Mixed Foothill Shrubland (G276)	Amelanchier utahensis Shrubland	Utah Serviceberry Shrubland	CEGL001067
		Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277)	Fraxinus anomala - Rhus trilobata Dry Talus and Slickrock Shrubland	Singleleaf Ash - Skunkbush Sumac Dry Talus and Slickrock Shrubland	CEGL003963
			Quercus gambelii / Amelanchier utahensis Shrubland	Gambel Oak / Utah Serviceberry Shrubland	CEGL001110
			Quercus gambelii / Artemisia tridentata Shrubland	Gambel Oak / Big Sagebrush Shrubland	CEGL001111
			Quercus gambelii / Poa fendleriana Shrubland	Gambel Oak / Muttongrass Shrubland	CEGL002949
			Quercus gambelii / Rhus trilobata Shrubland	Gambel Oak / Skunkbush Sumac Shrubland	CEGL002338

* Plant associations as determined from the vegetation plot, observation point, accuracy assessment point, and springs & seeps data sets. Associations are ordered by physiognomy and NVC Group. Identification codes are provided for plant associations and NVC Groups. Because Group units are not constrained by physiognomy, they may appear more than once in the table.

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‡ The NatureServe codes following each Ecological System unit name provide a means of tracking the evolution of the concept in NatureServe's Biotics Tracking Database.

Table 7 (continued). Classified plant associations for the Glen Canyon National Recreation Area and Rainbow Bridge National Monument vegetation mapping project area, arranged by Group within each physiognomic group.*

Hydrologic Class	Physiognomic Class	NVCS Group	NVCS Association	Common Name	Code
UPLAND ASSOCIATIONS (continued)	UPLAND SHRUBLANDS (continued)	Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277) (continued)	Quercus gambelii / Symphoricarpos oreophilus Shrubland	Gambel Oak / Desert Snowberry Shrubland	CEGL001117
			Quercus gambelii Shrubland	Gambel Oak Shrubland	CEGL002477
		Western Madrean Chaparral (G281)	Quercus turbinella - (Rhus trilobata, Artemisia tridentata) Shrubland	Sonoran Scrub Oak - (Skunkbush Sumac, Big Sagebrush) Shrubland	CEGL005168
		Chihuahuan Desert Sand Scrub (G287)	Artemisia filifolia / Sporobolus flexuosus Shrubland	Sand Sagebrush / Mesa Dropseed Shrubland	CEGL001547
		Mojave Mid-Elevation Mixed Desert Scrub (G296)	Coleogyne ramosissima - Ephedra spp. Warm Desert Shrubland	Blackbrush - Joint-fir species Warm Desert Shrubland	CEGL005297
			Lycium andersonii - Ephedra (torreyana, viridis) Shrubland	Water Jacket - (Torrey's Joint-fir, Mormon-tea) Shrubland	CEGL005150
			Purshia stansburiana Shrubland	Stansbury's Cliffrose Shrubland	CEGL002957
		Intermountain Shadscale - Saltbush Scrub (G300)	Atriplex canescens - Artemisia tridentata Shrubland	Fourwing Saltbush - Basin Big Sagebrush Shrubland	CEGL001282
			Atriplex canescens - Ephedra viridis Shrubland	Fourwing Saltbush - Mormon-tea Shrubland	CEGL003828
			Atriplex canescens / Achnatherum hymenoides Shrubland	Fourwing Saltbust / Indian Ricegrass Shrubland	CEGL001289
			Atriplex canescens / Pleuraphis jamesii Shrubland	Fourwing Saltbush / James' Galleta Shrubland	CEGL001288
			Atriplex canescens Shrubland	Fourwing Saltbush Shrubland	CEGL001281
			Atriplex confertifolia - (Acamptopappus sphaerocephalus, Picrothamnus desertorum) / (Pleuraphis jamesii) Scrub	Shadscale - (Rayless Goldenhead, Bud Sagebrush) / (James' Galleta) Scrub	CEPP005685
			Atriplex confertifolia / Achnatherum hymenoides Shrubland	Shadscale Saltbush / Indian Ricegrass Shrubland	CEGL001311
			Atriplex confertifolia / Pleuraphis jamesii Shrubland	Shadscale Saltbush / James' Galleta Shrubland	CEGL001304
			Atriplex confertifolia Great Basin Shrubland	Shadscale Great Basin Shrubland	CEGL001294
			Atriplex confertifolia Sparse Shrubland	Shadscale Sparse Shrubland	CEGL003830

* Plant associations as determined from the vegetation plot, observation point, accuracy assessment point, and springs & seeps data sets. Associations are ordered by physiognomy and NVC Group. Identification codes are provided for plant associations and NVC Groups. Because Group units are not constrained by physiognomy, they may appear more than once in the table.

† NatureServe assigns CEGL codes to track NVC associations within their databases. Park Specials are not part of the NVC and therefore do not have a CEGL code.

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Table 7 (continued). Classified plant associations for the Glen Canyon National Recreation Area and Rainbow Bridge National Monument vegetation mapping project area, arranged by Group within each physiognomic group.*

Hydrologic Class	Physiognomic Class	NVCS Group	NVCS Association	Common Name	Code
UPLAND ASSOCIATIONS (continued)	UPLAND SHRUBLANDS (continued)	Intermountain Shadscale - Saltbush Scrub (G300) (continued)	Atriplex obovata Talus Dwarf-shrubland	Mound Saltbush Talus Dwarf-shrubland	CEGL001789
			Grayia spinosa Shrubland	Spiny Hopsage Shrubland	CEGL002358
		Intermountain Dwarf Saltbush - Sagebrush Scrub (G301)	Atriplex corrugata Dwarf-shrubland	Mat Saltbush Dwarf-shrubland	CEGL001437
			Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland	Gardner's Saltbush / James' Galleta Dwarf-shrubland	CEGL001441
			Atriplex gardneri Dwarf-shrubland	Gardner's Saltbush Dwarf-shrubland	CEGL001438
		Intermountain Dry Tall Sagebrush Steppe & Shrubland (G303)	Artemisia tridentata Shrubland	Big Sagebrush Shrubland	CEGL000991
			Artemisia tridentata ssp. wyomingensis / Achnatherum hymenoides Shrubland	Wyoming Big Sagebrush / Indian Ricegrass Shrubland	CEGL001046
			Artemisia tridentata ssp. wyomingensis / Bouteloua gracilis Shrubland	Wyoming Big Sagebrush / Blue Grama Shrubland	CEGL001041
			Artemisia tridentata ssp. wyomingensis / Hesperostipa comata Colorado Plateau Shrubland	Wyoming Big Sagebrush / Needle-and-Thread Colorado Plateau Shrubland	CEGL002761
			Artemisia tridentata ssp. wyomingensis / Poa fendleriana Shrubland	Wyoming Big Sagebrush / Muttongrass Shrubland	CEGL002775
			Artemisia tridentata ssp. wyomingensis / Sparse Understory Shrubland	Wyoming Big Sagebrush / Sparse Understory Shrubland	CEGL002768
		Intermountain Mountain Big Sagebrush Steppe & Shrubland (G304)	Amelanchier utahensis - Artemisia tridentata (ssp. vaseyana, ssp. wyomingensis) Shrubland	Utah Serviceberry - (Mountain Big Sagebrush, Wyoming Big Sagebrush) Shrubland	CEGL002820
		Intermountain Low & Black Sagebrush Steppe & Shrubland (G308)	Artemisia bigelovii Shrubland	Bigelow's Sagebrush Shrubland	CEGL000276
		Intermountain Semi-Desert Steppe & Shrubland (G310)	Chrysothamnus viscidiflorus / Disturbed Understory Shrubland	Yellow Rabbitbrush / Disturbed Understory Shrubland	CEPP005695

* Plant associations as determined from the vegetation plot, observation point, accuracy assessment point, and springs & seeps data sets. Associations are ordered by physiognomy and NVC Group. Identification codes are provided for plant associations and NVC Groups. Because Group units are not constrained by physiognomy, they may appear more than once in the table.

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Table 7 (continued). Classified plant associations for the Glen Canyon National Recreation Area and Rainbow Bridge National Monument vegetation mapping project area, arranged by Group within each physiognomic group.*

Hydrologic Class	Physiognomic Class	NVCS Group	NVCS Association	Common Name	Code
UPLAND ASSOCIATIONS (continued)	UPLAND SHRUBLANDS (continued)	Intermountain Semi-Desert Steppe & Shrubland (G310) (continued)	Chrysothamnus viscidiflorus / Hesperostipa comata Shrubland	Yellow Rabbitbrush / Needle-and-Thread Shrubland	CEGL002799
			Ericameria nauseosa / Sporobolus airoides Shrubland	Rubber Rabbitbrush / Alkali Sacaton Shrubland	CEGL002918
			Gutierrezia (microcephala, sarothrae) - (Encelia frutescens, Brickellia microphylla) / Stephanomeria pauciflora Dwarf-shrubland	(Threadleaf Snakeweed, Broom Snakeweed) - (Bush Encelia, Littleleaf Brickellbush) / Brownplume Wirelettuce Dwarf-shrubland	CEPP005693
			Gutierrezia (microcephala, sarothrae) Dwarf-shrubland	(Threadleaf Snakeweed, Broom Snakeweed) Dwarf-shrubland	CEPP009523
			Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii Dwarf-shrubland	Broom Snakeweed - (Prickly-pear species) / James' Galleta Dwarf-shrubland	CEGL002690
			Krascheninnikovia lanata / Hesperostipa comata Dwarf-shrubland	Winterfat / Needle-and-Thread Dwarf-shrubland	CEGL001327
			Krascheninnikovia lanata / Pleuraphis jamesii Dwarf-shrubland	Winterfat / James' Galleta Dwarf-shrubland	CEGL001322
			Krascheninnikovia lanata Dwarf-shrubland	Winterfat Dwarf-shrubland	CEGL001320
			Mahonia fremontii Shrubland	Desert Oregon-grape Shrubland	CEGL003967
			Opuntia (fragilis, polyacantha, phaeacantha) Shrubland	(Brittle Prickly-pear, Plains Prickly-pear, Tulip Prickly-pear) Shrubland	CEGL004009
			Opuntia polyacantha / Pleuraphis jamesii Shrubland	Panhandle Prickly-pear / James' Galleta Shrubland	CEGL002299
		Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)	Acamptopappus sphaerocephalus - Ephedra spp. Shrubland	Rayless Goldenhead - Mormon-tea species Shrubland	CEPP005684
			Artemisia filifolia - Ephedra (torreyana, viridis) Shrubland	Sand Sagebrush - (Torrey's Joint-fir, Mormon-tea) Shrubland	CEGL002786
			Artemisia filifolia - Ephedra cutleri Sandsheet Shrubland	Sand Sagebrush - Cutler Mormon-tea Sandsheet Shrubland	CEPP005686
			Artemisia filifolia Colorado Plateau Shrubland	Sand Sagebrush Colorado Plateau Shrubland	CEGL002697

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Table 7 (continued). Classified plant associations for the Glen Canyon National Recreation Area and Rainbow Bridge National Monument vegetation mapping project area, arranged by Group within each physiognomic group.*

Hydrologic Class	Physiognomic Class	NVCS Group	NVCS Association	Common Name	Code
UPLAND ASSOCIATIONS (continued)	UPLAND SHRUBLANDS (continued)	Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312) (continued)	Coleogyne ramosissima - Acamptopappus sphaerocephalus - Ephedra torreyana Shrubland	Blackbrush - Rayless Goldenhead - Torrey's Joint-fir Shrubland	CEPP005688
			Coleogyne ramosissima - Ephedra cutleri Sandsheet Shrubland	Blackbrush - Cutler Mormon-tea Sandsheet Shrubland	CEPP005687
			Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Shrubland	Blackbrush - Stansbury's Cliffrose - Shinnery Oak Shrubland	CEGL002348
			Coleogyne ramosissima / Pleuraphis jamesii Shrubland	Blackbrush / James' Galleta Shrubland	CEGL001334
			Coleogyne ramosissima Shrubland	Blackbrush Shrubland	CEGL001332
			Ephedra cutleri - Opuntia spp. / Mixed Grass Shrub-Steppe	Cutler Mormon-tea - Prickly-pear species / Mixed Grass Shrub-Steppe	CEPP005691
			Ephedra cutleri / Achnatherum hymenoides - Muhlenbergia pungens - Oenothera pallida Sandsheet Shrubland	Cutler Mormon-tea / Indian Ricegrass - Sandhill Muhly - Pale Evening Primrose Sandsheet Shrubland	CEPP005689
			Ephedra cutleri Shrubland	Cutler Mormon-tea Shrubland	CEGL005804
			Ephedra (torreyana, viridis) - Psorothamnus fremontii Shrubland	(Torrey's Joint-fir, Mormon-tea) - Fremont's Dalea Shrubland	CEPP005690
			Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation	Torrey's Joint-fir - (Fourwing Saltbush, Shadscale) Sparse Vegetation	CEGL005801
			Ephedra torreyana / Achnatherum hymenoides - Pleuraphis jamesii Shrubland	Torrey's Joint-fir / Indian Ricegrass - James' Galleta Shrubland	CEGL002352
			Ephedra torreyana / Pleuraphis jamesii Shrubland	Torrey's Mormon-tea / James' Galleta Shrubland	CEGL003772
			Ephedra viridis / (Achnatherum hymenoides, Hesperostipa comata) Shrubland	Mormon-tea / (Indian Ricegrass, Needle-and-Thread) Shrubland	CEGL002354
			Ephedra viridis / Bouteloua gracilis Shrubland	Mormon-tea / Blue Grama Shrubland	CEGL003934
			Ephedra viridis / Pleuraphis jamesii Shrubland	Mormon-tea / James' Galleta Shrubland	CEGL002356

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Table 7 (continued). Classified plant associations for the Glen Canyon National Recreation Area and Rainbow Bridge National Monument vegetation mapping project area, arranged by Group within each physiognomic group.*

Hydrologic Class	Physiognomic Class	NVCS Group	NVCS Association	Common Name	Code
UPLAND ASSOCIATIONS (continued)	UPLAND SHRUBLANDS (continued)	Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312) (continued)	Poliomintha incana - Artemisia filifolia - Vanclevea stylosa Shrubland	Hoary Rosemarymint - Sand Sagebrush - Pillar False Gumweed Shrubland	CEGL002418
			Polygala acanthoclada - Mixed Scrub	Desert Polygala - Mixed Scrub	CEPP005698
			Quercus havardii var. tuckeri - Eriogonum leptocladon - Artemisia filifolia Sandsheet Shrubland	Shinnery Oak - Sand Buckwheat - Sand Sagebrush Sandsheet Shrubland	CEPP005692
			Quercus havardii var. tuckeri Shrubland	Shinnery Oak Shrubland	CEGL002486
		North American Desert Alkaline-Saline Wet Scrub (G537)	Sarcobatus vermiculatus / Atriplex gardneri Wet Shrubland	Greasewood / Gardner's Saltbush Wet Shrubland	CEGL001360
			Sarcobatus vermiculatus / Sporobolus airoides Wet Shrubland	Greasewood / Alkali Sacaton Wet Shrubland	CEGL001368
			Sarcobatus vermiculatus / Suaeda moquinii Wet Shrubland	Greasewood / Mojave Seablite Wet Shrubland	CEGL001370
			Sarcobatus vermiculatus Disturbed Wet Shrubland	Greasewood Disturbed Wet Shrubland	CEGL001357
			Suaeda moquinii Wet Shrubland	Shrubby Seepweed Wet Shrubland	CEGL001991
		Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)	Brickellia longifolia Shrubland	Longleaf Brickellbush Shrubland	CEGL005392
			Fallugia paradoxa Colorado Plateau Desert Wash Shrubland	Apache Plume Colorado Plateau Desert Wash Shrubland	CEGL002357
			Psorothamnus fremontii Shrubland	Fremont's Dalea Shrubland	CEGL005154
		Great Basin-Intermountain Shrub & Herb Wash-Arroyo (G559)	Atriplex canescens Desert Wash Shrubland	Fourwing Saltbush Desert Wash Shrubland	CEGL003470
			Ericameria nauseosa Desert Wash Shrubland	Rubber Rabbitbrush Desert Wash Shrubland	CEGL002261
		Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)	Artemisia bigelovii - Ephedra (viridis, torreyana) Talus Shrubland	Bigelow Sagebrush - (Mormon-tea, Torrey's Joint-fir) Talus Shrubland	CEGL003755
			Atriplex canescens - Ephedra viridis Talus Shrubland	Fourwing Saltbush - Mormon-tea Talus Shrubland	CEGL001287
			Cercocarpus intricatus Slickrock Sparse Vegetation	Little-leaf Mountain Mahogany Slickrock Sparse Vegetation	CEGL002977

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Table 7 (continued). Classified plant associations for the Glen Canyon National Recreation Area and Rainbow Bridge National Monument vegetation mapping project area, arranged by Group within each physiognomic group.*

Hydrologic Class	Physiognomic Class	NVCS Group	NVCS Association	Common Name	Code
UPLAND ASSOCIATIONS (continued)	UPLAND SHRUBLANDS (continued)	Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570) (continued)	Chrysothamnus viscidiflorus Talus Shrubland	Yellow Rabbitbrush Talus Shrubland	CEGL002347
			Coleogyne ramosissima Sparse Shrubland	Blackbrush Sparse Shrubland	CEGL003834
			Ephedra torreyana - (Atriplex spp.) / Nonvascular Gypsum Sparse Vegetation	Torrey's Joint-fir - (Saltbush species) / Nonvascular Gypsum Sparse Vegetation	CEGL002349
			Ephedra torreyana Sparse Vegetation	Torrey's Joint-fir Sparse Vegetation	CEGL002353
			Ericameria nauseosa - (Xylorhiza tortifolia) Talus Sparse Shrubland	Rubber Rabbitbrush - (Mojave Woodyaster) Talus Sparse Shrubland	CEGL003961
			Eriogonum corymbosum Badlands Sparse Vegetation	Crispleaf Wild Buckwheat Badlands Sparse Vegetation	CEGL002979
			Rhus trilobata - Ephedra (viridis, torreyana) Talus Shrubland	Skunkbush Sumac - (Mormon-tea - Torrey's Joint-fir) Talus Shrubland	CEGL003776
			Zuckia brandegeei Sparse Vegetation	Siltbush Sparse Vegetation	CEGL002493
		Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600)	Alhagi maurorum Ruderal Scrub	Camelthorn Ruderal Scrub	CEGL002784
			Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Ruderal Shrubland	Big Sagebrush - (Rubber Rabbitbrush) / Cheatgrass Ruderal Shrubland	CEGL002699
			Artemisia tridentata ssp. wyomingensis / Disturbed Understory Ruderal Shrubland	Wyoming Big Sagebrush / Disturbed Understory Ruderal Shrubland	CEGL002083
			Ephedra viridis / Bromus tectorum Ruderal Shrubland	Mormon-tea / Cheat grass Ruderal Shrubland	CEGL002355
			Ericameria nauseosa / Bromus tectorum Ruderal Shrubland	Rubber Rabbitbrush / Cheatgrass Ruderal Shrubland	CEGL002937
		Intermountain Sparsely Vegetated Dune Scrub & Grassland (G775)	Ericameria nauseosa Sand Deposit Sparse Shrubland	Rubber Rabbitbrush Sand Deposit Sparse Shrubland	CEGL002980
	UPLAND HERBACEOUS VEGETATION	Southern Rocky Mountain Montane-Subalpine Grassland (G268)	Poa fendleriana Grassland	Muttongrass Grassland	CEGL001925

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Table 7 (continued). Classified plant associations for the Glen Canyon National Recreation Area and Rainbow Bridge National Monument vegetation mapping project area, arranged by Group within each physiognomic group.*

Hydrologic Class	Physiognomic Class	NVCS Group	NVCS Association	Common Name	Code
UPLAND ASSOCIATIONS (continued)	UPLAND HERBACEOUS VEGETATION (continued)	Intermountain Semi-Desert Grassland (G311)	Achnatherum hymenoides - Sporobolus contractus Grassland	Indian Ricegrass - Spike Dropseed Grassland	CEGL001652
			Achnatherum hymenoides Colorado Plateau Grassland	Indian Ricegrass Colorado Plateau Grassland	CEGL002343
			Bouteloua gracilis Grassland	Blue Grama Grassland	CEGL001760
			Hesperostipa comata Great Basin Grassland	Needle-and-Thread Great Basin Grassland	CEGL001705
			Muhlenbergia pungens Grassland	Sandhill Muhly Grassland	CEGL002363
			Pleuraphis jamesii - Sporobolus airoides Grassland	James' Galleta - Alkali Sacaton Grassland	CEGL001778
			Pleuraphis jamesii Grassland	James' Galleta Grassland	CEGL001777
			Sporobolus cryptandrus Great Basin Grassland	Sand Dropseed Great Basin Grassland	CEGL002691
		Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)	Leymus salinus Shale Sparse Vegetation	Saline Wildrye Shale Sparse Vegetation	CEGL002745
		Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600)	Bromus tectorum Ruderal Grassland	Cheatgrass Ruderal Grassland	CEGL003019
			Salsola spp. Ruderal Grassland	Russian-thistle species Ruderal Grassland	CEGL004004
		Intermountain Sparsely Vegetated Dune Scrub & Grassland (G775)	Achnatherum hymenoides - Psoralidium lanceolatum Grassland	Indian Ricegrass - Lemon Scurfpea Grassland	CEGL001650
RIPARIAN, WETLAND AND MESIC ASSOCIATIONS	RIPARIAN AND WETLAND WOODLANDS AND FORESTS	Rocky Mountain Subalpine-Montane Aspen Forest & Woodland (G222)	Acer grandidentatum / Quercus gambelii Forest	Bigtooth Maple / Gambel Oak Forest	CEGL000559
		Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (G506)	Acer negundo / Quercus gambelii Riparian Woodland	Box-elder / Gambel Oak Riparian Woodland	CEGL002797
			Ostrya knowltonii Riparian Woodland	Knowlton's Hophornbeam Riparian Woodland	CEGL003971
			Pseudotsuga menziesii / Cornus sericea Riparian Woodland	Douglas-fir / Redosier Dogwood Riparian Woodland	CEGL000899

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Table 7 (continued). Classified plant associations for the Glen Canyon National Recreation Area and Rainbow Bridge National Monument vegetation mapping project area, arranged by Group within each physiognomic group.*

Hydrologic Class	Physiognomic Class	NVCS Group	NVCS Association	Common Name	Code
RIPARIAN, WETLAND AND MESIC ASSOCIATIONS (continued)	RIPARIAN AND WETLAND WOODLANDS AND FORESTS (continued)	Interior West Ruderal Riparian Forest & Scrub (G510)	Acer negundo / Disturbed Understory Riparian Woodland	Box-elder / Disturbed Understory Riparian Woodland	CEGL002693
			Elaeagnus angustifolia Ruderal Riparian Woodland	Russian-olive Ruderal Riparian Woodland	CEGL005269
			Populus fremontii / Tamarix sp. Ruderal Riparian Woodland	Fremont Cottonwood / Salt-cedar species Ruderal Riparian Woodland	CEGL005485
		North American Warm Desert Riparian Low Bosque & Shrubland (G533)	Celtis laevigata var. reticulata - Quercus gambelii - Cercis orbiculata Slickrock Canyon Spring & Riparian Woodland	Netleaf Hackberry - Gambel Oak - California Redbud Slickrock Canyon Spring & Riparian Woodland	CEGL002359
		Western Interior Riparian Forest & Woodland (G797)	Fraxinus anomala Riparian Woodland	Singleleaf Ash Riparian Woodland	CEGL002752
			Populus fremontii - Salix gooddingii / Salix exigua Riparian Forest	Fremont Cottonwood - Goodding's Willow / Narrowleaf Willow Riparian Forest	CEGL002684
			Populus fremontii - Salix gooddingii Riparian Woodland	Fremont Cottonwood - Goodding's Willow Riparian Woodland	CEGL000944
			Populus fremontii / Acer negundo Riparian Forest	Fremont Cottonwood / Box-elder Riparian Forest	CEGL000662
			Populus fremontii / Baccharis (emoryi, salicina) Riparian Woodland	Fremont Cottonwood / Great Plains Falsewillow Riparian Woodland	CEGL002946
			Populus fremontii / Ericameria nauseosa Riparian Woodland	Fremont Cottonwood / Rubber Rabbitbrush Riparian Woodland	CEGL002465
			Populus fremontii / Frangula betulifolia - Quercus gambelii Spring & Riparian Woodland	Fremont Cottonwood / Birchleaf Buckthorn - Gambel Oak Spring & Riparian Woodland	CEPP005699
			Populus fremontii / Mesic Forbs Riparian Woodland	Fremont Cottonwood / Mesic Forbs Riparian Woodland	CEGL002470
			Populus fremontii / Mesic Graminoids Riparian Woodland	Fremont Cottonwood / Mesic Graminoids Riparian Woodland	CEGL002473
			Populus fremontii / Salix exigua Riparian Forest	Fremont Cottonwood / Coyote Willow Riparian Forest	CEGL000666

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Table 7 (continued). Classified plant associations for the Glen Canyon National Recreation Area and Rainbow Bridge National Monument vegetation mapping project area, arranged by Group within each physiognomic group.*

Hydrologic Class	Physiognomic Class	NVCS Group	NVCS Association	Common Name	Code
RIPARIAN, WETLAND AND MESIC ASSOCIATIONS (continued)	RIPARIAN AND WETLAND WOODLANDS AND FORESTS (continued)	Western Interior Riparian Forest & Woodland (G797) (continued)	Populus fremontii / Scour Riparian Forest	Fremont Cottonwood / Scour Riparian Forest	CEGL005978
			Populus fremontii / Sparse Riparian Forest	Fremont Cottonwood / Sparse Riparian Forest	CEGL005979
			Salix gooddingii / Salix exigua Riparian Woodland	Goodding's Willow / Coyote Willow Riparian Woodland	CEGL003778
	RIPARIAN AND WETLAND SHRUBLANDS	Interior West Ruderal Riparian Forest & Scrub (G510)	Tamarix chinensis Ruderal Lakeshore Scrub	Chinese Salt-cedar Ruderal Lakeshore Scrub	CEPP005697
			Tamarix spp. Ruderal Riparian Shrubland	Salt-cedar species Ruderal Riparian Shrubland	CEGL003114
		Rocky Mountain-Great Basin Lowland-Foothill Riparian Shrubland (G526)	Rhus trilobata Moist Wet Shrubland	Skunkbush Sumac Moist Wet Shrubland	CEGL001121
			Salix exigua / Gravel Bar Wet Shrubland	Coyote Willow / Gravel Bar Wet Shrubland	CEGL005656
			Salix exigua / Mesic Graminoids Western Wet Shrubland	Coyote Willow / Mesic Graminoids Western Wet Shrubland	CEGL001203
		Western Montane-Subalpine Riparian & Seep Shrubland (G527)	Betula occidentalis Desert Spring Shrubland	Water Birch Desert Spring Shrubland	CEPP009680
		North American Warm Desert Riparian Low Bosque & Shrubland (G533)	Baccharis (emoryi, salicina) - Salix exigua Wet Shrubland	(Emory's Baccharis, Willow Baccharis) - Narrowleaf Willow Wet Shrubland	CEGL005947
			Baccharis salicifolia Riparian Shrubland	Mule-fat Riparian Shrubland	CEGL003549
			Frangula betulifolia Wet Shrubland	Birchleaf Buckthorn Wet Shrubland	CEPP009630
			Toxicodendron rydbergii / Mixed Forb Hanging Garden Scrub	Western Poison-ivy / Mixed Forb Hanging Garden Scrub	CEPP005700
		North American Desert Alkaline-Saline Wet Scrub (G537)	Pluchea sericea Wet Shrubland	Arrow-weed Wet Shrubland	CEGL003080
		Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)	Baccharis salicina Shrubland	Willow Baccharis Shrubland	CEGL005007

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Table 7 (continued). Classified plant associations for the Glen Canyon National Recreation Area and Rainbow Bridge National Monument vegetation mapping project area, arranged by Group within each physiognomic group.*

Hydrologic Class	Physiognomic Class	NVCS Group	NVCS Association	Common Name	Code
RIPARIAN, WETLAND AND MESIC ASSOCIATIONS (continued)	RIPARIAN AND WETLAND HERBACEOUS COMMUNITIES (continued)	Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh (G521)	Carex nebrascensis Wet Meadow	Nebraska Sedge Wet Meadow	CEGL001813
		Western North American Ruderal Marsh, Wet Meadow & Shrubland (G524)	Phalaris arundinacea Western Marsh	Reed Canarygrass Western Marsh	CEGL001474
			Phragmites australis Western Ruderal Wet Meadow	Common Reed Western Ruderal Wet Meadow	CEGL001475
		Arid West Interior Freshwater Marsh (G531)	Cladium californicum Seep	California Sawgrass Seep	CEGL009683
			Typha domingensis Western Marsh	Southern Cattail Western Marsh	CEGL001845
		North American Desert Alkaline-Saline Marsh & Playa (G538)	Distichlis spicata Alkaline Wet Meadow	Inland Saltgrass Alkaline Wet Meadow	CEGL001770
			Muhlenbergia asperifolia Wet Meadow	Alkali Muhly Wet Meadow	CEGL001779
			Sporobolus airoides Southern Plains Wet Meadow	Alkali Sacaton Southern Plains Wet Meadow	CEGL001685
		Colorado Plateau Hanging Garden Seep (G545)	Adiantum capillus-veneris - Mixed Forb Hanging Garden	Common Maidenhair Fern - Mixed Forb Hanging Garden	CEPP005701
			Aquilegia micrantha - Calamagrostis scopulorum Hanging Garden	Mancos Columbine - Ditch Reedgrass Hanging Garden	CEGL002592
			Aquilegia micrantha - Mimulus eastwoodiae Hanging Garden	Mancos Columbine - Crimson Monkeyflower Hanging Garden	CEGL002729
			Calamagrostis scopulorum Seep Hanging Garden	Ditch Reedgrass Seep Hanging Garden	CEGL002751
			Cirsium rydbergii - Carex curatorum - Calamagrostis scopulorum Hanging Garden	Rydberg's Thistle - Kaibab Sedge - Ditch Reedgrass Hanging Garden	CEPP005703
			Mimulus eastwoodiae - Primula specuicola Hanging Garden	Crimson Monkeyflower - Cave-dwelling Primrose Hanging Garden	CEPP005702

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Plant Association Descriptions

This section provides a summary of GLCA/RABR vegetation communities and associations by physiognomic group. Appendix F provides detailed local and global descriptions for the 193 plant associations and associated vegetation alliances classified within the mapping project area. Local descriptions are based on classification plot, observation point, and AA point data, as well as on springs and seeps vegetation data collected by John Spence. Local association descriptions were written following standards established by NatureServe and the NPS VMI guidelines and only for types that had more than two plots representing them. Local descriptions were written based on species cover summaries, ground cover summaries, and summaries of data on slope, aspect, elevation, and other environmental conditions recorded during the sampling. Local descriptions were reviewed by NatureServe staff. NatureServe entered all the new associations and their descriptions into NatureServe's Biotics database. Global association descriptions characterize the association across its range and are based primarily on published and unpublished literature; these were updated to include vegetation data collected as part of this project by NatureServe after receiving local descriptions from the Project Manager.

Most of the vegetation types at GLCA/RABR fit into existing NVC association concepts; some were considered significant enough to create new NVC associations. Criteria used to justify creation of a new plant association within the NVC include one or more of the following: 1) high confidence in the type (i.e., many plots), 2) type is known from another location outside the study area, and 3) type is known from the literature. Twenty-four new associations were created for GLCA/RABR; NatureServe designated these as proposed new associations to add to the NVC (e.g., CEPPXXXX vs. the standard ecological association identifier CEGLXXXX).

Upland Woodland Associations

Glen Canyon NRA has extensive cover of upland woodlands, especially Utah juniper woodlands or mixed stands of two-needle pinyon pine and Utah juniper. About 22% of the classification plots sampled at GLCA/RABR belong to juniper or pinyon-juniper woodland associations, and 18% of classified associations belong to juniper or pinyon-juniper woodland types. Juniper was present with low cover in many more sites that were characterized as (wooded) shrublands. A few examples of Douglas-fir woodland types were also sampled. Thirty-five upland woodland associations were documented at GLCA/RABR (Table 7).

Pinyon-juniper woodlands are dominant in the higher elevation portions of the park, including the Orange Cliffs mesa top, Circle Cliffs, Waterpocket Fold, and Muley Point. They are also common where Navajo, Kayenta, Cedar Mesa, and White Rim sandstone exposures dominate the landscape, including areas below the mesa top in the Orange Cliffs, the Escalante drainage/canyon system, the San Juan arm of the lake, and on Wilson Mesa. These woodlands occur on a variety of substrates and with a high diversity of shrubs and grasses in the understory. They occupy a variety of available habitats, from wash channels and narrow canyon bottoms where rain water is concentrated, to high elevation slopes, mesa tops, and rims, and most commonly in areas where slickrock and fractured slickrock is exposed. Canopy density is generally controlled by the availability of soil moisture or

rooting sites. A number of classification plots with woodland associations had tree cover below the 10% cover threshold for woodlands. This was often because they represented communities growing in slickrock fractures, not in continuous habitat, and in these cases, shrub cover was also low. The most commonly sampled woodland plant association within GLCA/RABR was the *Pinus edulis - Juniperus osteosperma / Ephedra viridis - Gutierrezia sarothrae* Woodland.

Upland Shrubland Associations

Shrublands are the most diverse community type within the GLCA/RABR mapping area. About 56% of classification plots sampled at GLCA/RABR belong to upland shrubland, dwarf-shrubland or sparse shrubland associations, and 51% of classified associations belong to upland shrubland communities. Some badland communities are extremely sparse, while others on deep soils with good water holding capacity are relatively densely vegetated. The most commonly sampled upland shrubland plant association within GLCA/RABR was the *Coleogyne ramosissima* Shrubland. Other common shrublands encountered are dominated by species of *Atriplex* and/or *Ephedra*. Ninety-eight upland shrubland associations were documented at GLCA/RABR (Table 7).

Shrublands in GLCA/RABR occupy a wide variety of habitats, including terraces along river corridors, tributary wash channels and terraces, broad valley bottoms, alluvial canyon bottoms, sand dunes and sandsheets, talus slopes, rolling plains, badlands, and high mesa tops. Desert shrublands are the most common type within GLCA/RABR, occupying areas of shallow, rocky and/or sandy soils. Blackbrush, shadscale, Torrey's joint-fir, rayless goldenhead, spiny hopsage, and Fremont's dalea characterize the sparse canopy, often in a mixed community of several species. Badlands of the Chinle, Moenkopi, and Tropic Shale formations support a characteristic sparse community that may include Gardner's saltbush, mat saltbush, siltbush, and/or crispleaf buckwheat. Intermittently-flooded wash channels support rubber rabbitbrush, sand sagebrush, fourwing saltbush, longleaf brickellbush, and Apache plume. Floodplains and terraces with alkaline soils support greasewood or shrubby seepweed where an impermeable layer slows infiltration keeping the water table high; basin big sagebrush, sand sagebrush, winterfat, rubber rabbitbrush, fourwing saltbush, or desert Oregon-grape shrublands occur nearby on sandy, well-drained, higher terraces or floodplain valley floors. Deep, loose sands support unusual communities containing hoary rosemarymint, pillar false gumweed, sand buckwheat, sand sagebrush, Cutler Mormon-tea, and/or shinnery oak. More stable sand sheets have sand sagebrush, Cutler Mormon-tea, Torrey's joint-fir, and/or blackbrush communities. Relatively flat sites on plateaus or in broad valley bottoms with deep soils support Mormon-tea, winterfat, or rayless goldenhead, and in more disturbed areas, snakeweed or prickly-pear shrublands dominate. Talus-covered canyon walls have diverse, mixed shrublands that may include Bigelow sage, rabbitbrush species, shadscale, mound saltbush, Torrey's joint-fir, skunkbush sumac, Utah serviceberry, Mormon-tea, and/or single-leaf ash. Higher elevation mesa tops support shrublands of Wyoming big sagebrush, yellow rabbitbrush, black sagebrush, Stansbury's cliffrose, and Gambel oak. Gambel oak, skunkbush sumac, and Utah serviceberry shrublands occur in sheltered, cooler sites or areas where rain water is concentrated, including wash terraces, alcoves, and heads of ravines.

Upland Herbaceous Associations

Upland herbaceous communities are uncommon; only about 5% of the classification plots and 7% of the associations sampled at GLCA/RABR were upland herbaceous communities. They are restricted in distribution to areas of deeper soils on plateaus, plains, and canyon and valley bottoms. “Ruderal” types indicate dominance by one or more species not native to North America. Thirteen upland herbaceous associations were documented in GLCA/RABR (Table 7).

Native grasslands of Indian ricegrass, blue grama, needle-and-thread, and James’ galleta occur on soils of fine, windblown silt and sand or older alluvium on broad plateaus, plains, benches, or in valley bottoms. Flat sites or swales in degraded areas of overgrazed valley bottoms or plains, lakeshores, and tributary terraces support non-native grasslands and exotic forb-dominated communities, as well as communities characterized by a few native grass and forb species mixed with a variety of exotic species. Herbaceous species typical of disturbed or degraded sites include cheatgrass, Russian thistle, sand dropseed, red brome, golden dock, and gray molly. North-facing, cool-aspect, talus slopes support grasslands of salina wildrye and more rarely, muttongrass. Forb-dominated communities are rare; the only forb type sampled in more than one or two plots was *Salsola* spp. Ruderal Grassland.

Riparian and Wetland Forest and Woodland Associations

Riparian woodlands are restricted in distribution to the major tributary drainages of the Colorado and San Juan rivers (especially the Escalante River drainage system), near seeps and springs in other tributary canyons, and below pour-offs in alcoves and other sheltered locations. About 6.5% of classification plots and 11% of the associations sampled at GLCA/RABR belong to riparian and wetland forest and woodland associations. These woodlands are characterized by Fremont cottonwood, often in association with Goodding’s willow, and may have upland or mesic understories depending on the availability of groundwater. Less common are riparian woodlands dominated by Knowlton’s hophornbeam, box-elder, singleleaf ash, or netleaf hackberry. Six riparian forests and 15 riparian woodland associations were documented in GLCA/RABR (Table 7).

Fremont cottonwood woodlands (with or without Goodding’s willow) within GLCA/RABR generally have an open canopy and occur on intermittent and perennial streams in tributary canyons. Because flood events are frequent, stands of many ages occur. In the older (mostly relict) cottonwood stands established on higher floodplains of the Escalante River, the understory may have been crowded out by the invasive shrub tamarisk. Otherwise, the understory may consist of mesic herbaceous species (younger cottonwood stands near seeps/springs in tributary drainages), or upland shrubs and herbaceous species (older stands on higher terraces). Box-elder woodlands are rare, and are found primarily in small stands along the Escalante River and its tributaries. Single-leaf ash sparse woodlands occur along dry wash channels throughout GLCA/RABR. Woodlands of Knowlton’s hophornbeam, Douglas-fir, and netleaf hackberry occur in cool, sheltered locations, often near seeps or springs, including in narrow canyon bottoms, alcoves, and at the heads of ravines on north-facing slopes.

Riparian and Wetland Shrubland Associations

Wetland and riparian shrublands are the most common vegetation types established along the two major river corridors in GLCA/RABR (San Juan and Colorado rivers), and are characterized by dense and homogenous stands of non-native tamarisk and/or smaller stands of native coyote willow. Other riparian and wetland shrubland communities occur in tributary drainages, dry wash channels, and near seeps and springs in alcoves. About 9% of classification plots and 6% of the associations sampled at GLCA/RABR belong to riparian and wetland shrubland associations; 77% of these classification plots were dominated by the invasive, non-native shrub tamarisk. Twelve riparian and wetland shrubland associations were documented in GLCA/RABR (Table 6).

Coyote willow shrublands are rare within GLCA and occur on sand bars and seasonally flooded banks or terraces of the Colorado, Escalante, and San Juan rivers. Tamarisk has become established in many parts of GLCA/RABR, but is especially common on banks and terraces of the major rivers, where it forms impenetrable thickets, and along the lakeshore in bands demarcating higher water levels. Tamarisk shrubs also occur in tributary drainages as sparse, scattered, or small isolated stands. Other riparian or wetland shrublands within GLCA/RABR are rare, and occur almost exclusively as small, isolated stands near seeps and springs, in alcoves, or at the heads of ravines.

Riparian and Wetland Herbaceous Associations

Riparian and wetland herbaceous associations in GLCA/RABR are very rare and limited in distribution, restricted to areas with water at or near the surface for some or all of the growing season. Diversity is high in these typically small stands; most occur in patches smaller than the minimum mapping unit and in areas invisible to a photointerpreter, such as hanging gardens on cliff faces or under overhanging rocks. Fourteen riparian and wetland herbaceous associations occur in GLCA/RABR, eight of which were only documented by unpublished springs and seeps data. The remaining six associations account for 1% of classification plots, but 7% of the associations sampled at GLCA/RABR. Fourteen riparian and wetland herbaceous associations were documented in GLCA/RABR (Table 7).

Hanging gardens develop where water moving through porous sandstone intercepts impermeable layers, forcing the water to emerge from canyon walls with a steady, year-round flow. Over time, alcoves form as water dissolves the calcareous cement holding the sandstone together. Well-developed hanging gardens are found in these alcoves and smaller gardens are sometimes found along seeping horizontal cracks on cliff faces at the junctions of geologic layers. At GLCA/RABR, hanging gardens tend to form at the contact of the Navajo Sandstone with the underlying Kayenta Formation. The availability of water from a seep and the gradual building of soil caught and held by the moist rock surface are keys to the survival of hanging garden vegetation; these communities are vulnerable to changes and fluctuations in water availability due to drought. Hanging gardens support a unique assemblage of plants within the alcove and in the saturated soils and talus downslope. Many species are endemic to the Colorado Plateau and are found only rarely, if at all, outside of hanging gardens. Although vegetation is dense within the gardens, stands are usually long and narrow; they may extend for more than 100m along a horizontal crack, but may be no more than 1 or 2m wide (Tendick et al. 2012). Hanging gardens support communities of Mancos columbine, common

maidenhair fern, ditch reed grass, cave-dwelling primrose, Rydberg's thistle, Kaibab sedge, and Eastwood's monkey-flower. Seeps along tributary wash channels or on colluvial or shale slopes, and the banks of perennial streams support patches of reed canary grass, inland saltgrass, alkali muhly, southern cattail, and/or common reed grass. Small to large patches of common reed grass also occur growing on high terraces of the major rivers. Small stands of alkali sacaton grasslands intermixed with or adjacent to greasewood and/or seepweed shrublands are restricted to alkali floodplains along tributary drainages.

Field Key Preparation

An illustrated, dichotomous field key to plant associations of the GLCA/RABR mapping area was developed for this project (Appendix G). The key is designed to assist users in identifying plant associations in the field. Every effort was made to limit ambiguity in choosing the appropriate vegetation type. The key has two levels; the first level is defined by the physiognomy of the vegetation, i.e., forest, woodland, tall shrubland, shrubland, dwarf-shrubland, graminoid, or forb. The second level focuses on the dominant species' canopy cover. Brief environmental descriptions are included with the floristic descriptions to aid in identifying plant associations.

The association field key was constructed from data collected during the classification phase of the mapping project and revised following accuracy assessment of the map. Because the key is based on a sample of the vegetation, it probably does not account for all plant associations occurring within GLCA/RABR, nor does it explain the full range of variation of all associations or describe ecotonal situations.

The field key was tested by the Project Manager using GLCA/RABR vegetation plot data prior to its use by AA field crews. This was done by selecting random plots representing each association, removing the association identifier from the data, and attempting to run each plot through the field key using information contained in the plots database. Additional testing of the key occurred in the field during the accuracy assessment phase of this project. Areas where the key was confusing or unclear were identified and solutions proposed. The field key in Appendix G is the final version containing revisions based on these suggestions. It also contains the new associations discovered during the AA phase of the project. The field key is illustrated with one to two photographs (taken by field crew members) per plant association; photographs were chosen to show the most representative appearance of a vegetation association as it was found in GLCA/RABR and can be used as an additional aid in identifying plant associations in the field.

Assessment of Global Rarity

GLCA and RABR occur within the Canyon Lands section the Colorado Plateau physiographic province in southeast Utah. Elevations in GLCA/RABR span nearly 4,400 feet and encompass the boundary between pinyon-juniper woodlands and sparsely vegetated semi-desert vegetation. Bisected by long reaches of three major rivers (Colorado, San Juan, and Escalante), as well as by many small and large tributaries, GLCA/RABR supports a variety of riparian species, a few of which are regionally and even globally rare. Particularly rare are the plant species associated with hanging gardens. Few plant associations in GLCA/RABR are considered globally rare; however, not enough

is known about the global distribution of more than half of the plant associations in GLCA/RABR to evaluate their rarity.

NatureServe and the network of state natural heritage programs indicate the rarity and degree of imperilment of plant communities by assigning state and global conservation status ranks to each. The rank scale ranges from 1 to 5; a rank of 1 indicates critical imperilment due to rarity, endemism, and/or threats, while a rank of 5 indicates little or no risk of extirpation of the plant community (Faber-Langendoen et al. 2012). No plant associations classified as occurring within GLCA/RABR are considered critically imperiled (G1). Two associations are considered imperiled (G2): *Populus fremontii - Salix gooddingii / Salix exigua* Riparian Forest and *Populus fremontii - Salix gooddingii* Riparian Woodland. One association is considered imperiled though the taxonomic distinctiveness of this entity at the current level, is questionable (G2Q): *Populus fremontii / Acer negundo* Riparian Forest. Three associations are considered imperiled to vulnerable (G2G3): *Aquilegia micrantha - Mimulus eastwoodiae* Hanging Garden, *Pleuraphis jamesii - Sporobolus airoides* Grassland, and *Populus fremontii* / Sparse Riparian Forest. Three associations are considered imperiled to apparently secure (G2G4): *Achnatherum hymenoides - Sporobolus contractus* Grassland, *Hesperostipa comata* Great Basin Grassland, and *Pleuraphis jamesii* Grassland. Twelve associations are ranked vulnerable, three of which have questionable taxonomic distinctiveness (G3 and G3Q); three possibly vulnerable (G3?); five are ranked vulnerable to apparently secure (G3G4); five are ranked vulnerable to secure (G3G5); and 35 are ranked, apparently, to possibly secure to secure (G4, G4?, G4Q, G5, and G5?). Fourteen associations are invasive or ruderal types that are not applicable for ranking because “the species is not a suitable target for conservation activities (GNA).” Five associations could not be ranked due to lack of information or to substantially conflicting information about status or trends, and two of those have questionable taxonomic distinctiveness (GU and GUQ). The remaining 105 associations are not yet ranked or are new to the NVC. The high number of unranked associations reflects current uncertainty about the relative vulnerability of plant associations to extirpation both in GLCA/RABR and throughout much of the Colorado Plateau. Further review is needed to rank recent associations and improve confidence of existing global ranks (Coles et al. 2009).

All vegetation communities within GLCA/RABR are subject to change over time; drought and insect outbreaks are the most likely agents of change in woodland communities, whereas encroachment of exotic plants, livestock grazing, and climate change threaten many of the other vegetation types. Fire is not a significant factor in establishing or maintaining any of the natural plant associations in GLCA/RABR. Because of recent regional droughts and a predicted change over time to a warmer and drier climate, all riparian, hanging garden, and wetland plant communities within GLCA/RABR are threatened to some degree. This threat is heightened due to the introduction of non-native plant species that invade mesic habitats more readily than dry upland habitats (Coles et al. 2009).

Vegetation Mapping

Introduction

According to Daubenmire (1974), the classification and description of plant associations provides a framework for understanding the ecological composition and structure of a landscape because plant communities integrate all of the influences of their associated environment. Defining map units based on their component plant associations provides the "information linkage between a vegetation community's spatial distribution and its ecology. The outcome is that by grouping land areas based on their ability to support similar associations, general management observations and recommendations can be made for each grouping. In addition, resource managers have found that the classification of vegetation into plant associations has provided insight and the ability to predict vegetation changes in response to various disturbance processes" (Muldavin et al. 2011).

The process of mapping vegetation and land use in the GLCA/RABR project area occurred in stages. Mapping tools and techniques used included remotely sensed digital airborne NAIP imagery, ancillary data, photo interpretation, and field reconnaissance. This section of the report summarizes the methods used by the primary photo-interpreter (PI) and a mapping assistant to map the vegetation of the project area. Each stage built upon information created during the previous stage. Field reconnaissance was intended to familiarize the photo-interpreters with GLCA patterns of vegetation distribution and environmental factors useful for developing mapping models. Map class development followed reconnaissance and a review of ancillary data, and was based on intensive review of the aerial imagery in concert with data from the vegetation plot sampling. Using aerial imagery and ancillary information to map vegetation type is effective only because a high correlation exists between variation in the imagery and ancillary data, and variation in the classified vegetation types. Determining how the imagery and ancillary information represent the variations in the vegetation on the ground was the primary purpose of this stage. The interpretation and mapping phase applied the map class concepts in order to draw consistent, homogenous polygons on the base orthoimagery (Kearsely et al. 2015).

Methods

Imagery selection

The mapping component of the GLCA/RABR project utilized four image data sets:

1. National Agriculture Image Program (NAIP) 2010 for the Arizona portion of the NRA
2. National Agriculture Image Program (NAIP) 2009 for the Utah portion of the NRA
3. National Agriculture Image Program (NAIP) 2011 for the Utah portion of the NRA
4. ArcGIS Basemap layer.

This project relied on the 2009 NAIP imagery as the primary/baseline dataset for delineating features that varied between data sets, including lake level, river shoreline and islands, cliff breaks, etc. This imagery was preferred by the PI over the more current dataset (NAIP 2011) because it had superior color balance and picture clarity. However, during manual interpretation, some of the available

image sets were used interchangeably. Often one image data set would reveal clues to the vegetation that were hidden, in shadow, or otherwise obscured in the other image data set.

Ancillary data sets

Photo interpreters traditionally rely on color, tone, texture, location, context, height, and shape clues available in imagery to identify vegetation types (Spurr 1948). Many of these indicators can be derived from remotely sensed data (e.g., color, tone, texture, shape, and height), others (i.e., as location and context), must be derived from ancillary data. Ancillary data are critical to vegetation mapping because they may capture causes of vegetation variability that are not obvious from the imagery (Kearsely et al. 2015). Ancillary data sets acquired and used for the mapping portion of this project included digital elevation models (hillshade), spatial data for the geology map of GLCA, and later in the process, spatial data for the soils map of GLCA. Other ancillary data used included legacy vegetation data (i.e., the 1988 vegetation map of Glen Canyon NRA [Tuhy and MacMahon 1988]) and park plot data collected at 82 upland vegetation sites.

Field Reconnaissance

Field reconnaissance and map verification occurred at the same time as vegetation plot data collection from the spring of 2012 to the fall of 2013. The Project Manager visited several areas of GLCA both to conduct field crew trainings and to verify aerial imagery signatures. These trips included visiting remote canyons north of Bullfrog and Bull and Imperial Valleys in one of the more remote corners of GLCA. Because GLCA encompasses such a large area, much of which is difficult to access, additional field visits by the photo-interpreters were determined to be too time-consuming. In place of a thorough review of the vegetation on the ground, the project ecologist relied heavily on co-author expertise. Understanding the environmental drivers influencing vegetation patterns was an important part of these discussions.

Map Class Development

The goal of map class development was to identify project-specific, meaningful units to represent existing vegetation types and land uses for the GLCA/RABR vegetation mapping project area. Standard land-use map classes (Anderson et al. 2002) were used to map developed parts of the project area including facilities and roads. In unvegetated portions of the project area, map classes were defined by the exposed geologic substrate or land-use class.

The lead PI developed a preliminary set of map class concepts in the summer of 2012 based on map classes that were used for the CANY and CARE vegetation mapping projects. These two neighboring parks had completed vegetation maps and shared similar vegetation, soils, geology, and climate characteristics. Mapping was first initiated in the Orange Cliffs section of GLCA, where vegetation is similar to that of neighboring CANY. Edge matching was done for the entirety of the GLCA-CANY boundary, where map class concepts and polygon delineation were compatible. The GLCA-CARE boundary was not entirely edge-matched, due to some incompatible map class concepts and polygon delineation, though much of the boundary was similar enough to be broadly conjoined. As mapping moved into more southern portions of GLCA, a few additional map classes were defined based on data from the vegetation classification plot sampling and personal communication with the GLCA Chief Scientist.

The current standard for NPS Vegetation Mapping Inventory Program projects is to map to the plant association level of the NVC. However, because a majority of vegetation associations in GLCA/RABR are sparse shrublands differentiated by small cover differences in indicator or diagnostic species; and/or shrublands with different grasses dominant in the understory; and/or pinyon-juniper woodlands with low shrub cover in the understory, it is often difficult to map to the association level. The difficulty in distinguishing floristic relationships on aerial photography results in similar plant associations being grouped into a single map class; these are generally map classes that correspond with a higher level of the NVC (i.e., alliance or group level).

At GLCA/RABR, the relationships between map classes and plant associations are complex. In some cases, landscape setting and substrate were more defining characteristics of the map class concept than the vegetation, resulting in a map class that was often quite vegetatively heterogeneous and having distinct plant associations (e.g., *Quercus havardii* var. *tuckeri* Shrubland and *Poliomintha incana - Artemisia filifolia - Vanclevea stylosa* Shrubland) grouped together, because they could not be distinguished consistently or accurately using NAIP imagery. In a few other cases, plant associations that occur on a variety of substrates and/or environmental settings (e.g., *Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland and *Pinus edulis - Juniperus osteosperma /* Sparse Understory Woodland), were assigned to more than one map class.

Manual Editing to Produce the Draft and Final Maps

The PI team used a combination of methods to interpret and delineate vegetation polygons for GLCA/RABR. At the outset, the lead photo-interpreter employed a semi-automated technique (Feature Analyst) to generate an initial set of polygons. However, after more than a dozen runs, the results were deemed too unreliable and messy. The main problem was that boundary lines between polygons were jagged and inconsistent and would require extensive “cleaning up,” including cutting/splitting, merging, and redrawing. The lead PI decided that the remainder of vegetation mapping would be done manually, through heads-up digitizing using ArcGIS editing tools. Manual editing generally used scales between 1:5,000 and 1:10,000; however, work in riparian areas along narrow canyon bottoms often required a much finer scale of focus, such as a 1:2,000 scale.

A part-time assistant PI was hired in the late fall of 2012 and worked through the fall of 2014. Photo-interpreters were aided by ancillary datasets, including classification plots, geology and soils layers, digital elevation models, and legacy vegetation maps and data. The mapping effort was split between sections of the park south and north of the confluence of the Colorado River and the San Juan River. The assistant mapper started by mapping obvious landscape breaks (e.g., lake shores, cliff bands, bases of talus slopes, etc.), then drew in more detailed polygons distinguishing unique vegetation types or spectral images as he grew more familiar with recognizing photo-signatures. For the production of the draft map, the two mapping areas were merged and some additional editing was done to clean up the seam lines, fix topology errors, and pull out more detail wherever possible. Each polygon was assigned a map class attribute and sometimes other descriptive attributes by the lead PI.

Polygon Attribute Development

Polygon labeling and attribution procedures were standardized for all park vegetation mapping projects (Evenden 2004). All map polygons were assigned to a land cover/land use (LC/LU) type

(Anderson et al. 2002). In addition, all polygons were assigned to higher levels of the NVC hierarchy, with the exception of non-vegetated map classes, which were coded as 'unclassified' or 'unvegetated' in the NVC columns. Vegetation density, pattern, and height attributes (Table 8) were assigned only when a polygon differed from what was typical for that map class (e.g., stands of saltbush with greater than 40% shrub cover were noted) or to differentiate one polygon from a neighboring polygon of the same map class (e.g., a dense cottonwood woodland that borders on an open cottonwood woodland with a drier understory).

Table 8. Physiognomic attributes of polygons*.

Category	Attribute	Description
Vegetation Canopy Density (Applied to forest, woodland, and shrub-dominated map classes)	A	Closed Tree Canopy/Continuous (> 60% cover)
	B	Open Tree Canopy/Discontinuous (25– 60% cover)
	C	Dispersed – Sparse Tree Canopy (10–25% cover)
	D	Dense Shrub Canopy (> 40% cover)
	E	Light Shrub Canopy (10–40% cover)
Vegetation Pattern (Applied to all vegetation map classes)	1	Clumped/Bunched
	2	Linear
	3	Gradational/Transitional
	4	Regularly Alternating
	5	Homogenous
Vegetation Height (Applied to woody terrestrial vegetation map classes only)	F	Forest and Woodlands > 30 meters tall
	G	Forest and Woodlands 15–30 meters
	H	Forest and Woodlands 5–15 meters
	I	Forest and Woodlands 1–5 meters
	J	Forest and Woodlands < 0.5 meters
	K	Shrublands 1–5 meters
	L	Shrublands 0.5–1 meters
	M	Shrublands 0–0.5 meters

*In some cases, these attributes were assigned to individual polygons. Otherwise, they were assigned to an entire map class.

We defined a suite of polygon modifiers to describe altered vegetation, unique plant species, landforms, transportation and utilities, and other situations. These modifiers were estimated through aerial photo-interpretation and have not been ground-truthed. Their purpose was to help guide the mapping of vegetation patterns, but they should be considered provisional and their use corroborated with additional data (Muldavin et al. 2011). Table 9 is a list of the modifiers used in the GLCA/RABR project.

Table 9. Vegetation modifiers used to provide additional information for map polygons in the GLCA/RABR vegetation mapping project area.

Code	Name	Description
AN	Acer negundo	*Acer negundo* present to co-dominant in polygons mapped as cottonwood woodlands or spring-supported shrublands and woodlands.
b	Burn evidence	Applies to systems disturbed by burns more than one year old (as seen in the 2009 aerial photography).
BS	Baccharis salicina	Applies to polygons mapped as *Salix exigua* Shrublands (map class 2), where *Baccharis salicina* was noted as co-dominant to dominant.
CM	Cercocarpus montanus	Pinyon - juniper shale scarps with *Cercocarpus montanus* present to dominant in the understory. Applies to polygons formerly mapped as map class 24 (P-J/CERMON) which are now combined with map class 29 (P-J Shale Scarps).
e	Eolian	Blackbrush or Mormon-tea shrublands or wooded shrublands or native grasslands on eolian soils (somewhat active to fairly stabilized), and with a duney topography.
EA	Elaeagnus angustifolia	*Elaeagnus angustifolia* present to co-dominant in polygons mapped as cottonwood woodlands.
g	Grassy	Shrublands or woodlands with considerable (usually native) grass cover.
i	Invasives	Applies to systems where invasive graminoid and/or forb species are a component, sometimes dominant component, of the system.
m	Mesic understory	Woodlands or shrublands with mixed mesic herbaceous species in the understory.
QG	Quercus gambelii	Alcoves or shale slopes where *Quercus gambelii* has notable to dominant cover.
QW	Quercus welshii	Dunes or wash channels where *Quercus welshii* has notable to dominant cover.
p	Paved road	A transportation corridor (travel lanes, median strips, interchanges, shoulders, borrow ditches & right-of-way). Roadbed overtopped by asphalt or concrete surface. Right-of-way typically extends to limit of cut and fill slopes associated with construction.
pj	Pinyon-juniper	Pinyon-juniper trees as a subcanopy in cottonwood woodlands.
r	Rocky	Bedrock exposures noted in vegetation types not typical of bedrock habitats (grasslands, dunes, etc.).
s	Shrubby	Stands of native or non-native herbaceous vegetation that have a noticeable shrub component (shrub-herbaceous types)
SE	Salix exigua	*Salix exigua* dominant to co-dominant in polygons mapped as tamarisk shrublands.
SG	Salix gooddingii	*Salix gooddingii* dominant to co-dominant in polygons mapped as cottonwood woodlands.
su	Submerged	Tamarisk shrublands that are partially submerged under lake level. These were defined by 2009 imagery and the associated lake level at that time.
t	Treed	Shrublands with notable tree cover present (wooded shrublands). Tree species is not distinguished with this modifier.
u	Gravel/dirt Road	A transportation corridor (travel lanes, borrow ditches, and right-of-way) consisting of a roadbed of imported gravel or graded native soil and subsoil. Cut and fill slopes associated with construction may or may not be present.
x	Tamarisk	Shrublands or woodlands with tamarisk *(Tamarix chinensis)* shrubs present in the under- or overstory

Map classes were named for the association they represented if there was a 1:1 relationship; map classes representing complexes of associations followed the convention of being named for the unifying botanical and/or environmental factors (e.g., Blackbrush Shrublands or Talus Escarpments Mixed Sparse Vegetation Complex).

Spatial Database Development

In order to improve the utility of the map and all related data, the spatial database was migrated into a geodatabase format, the general structure of which is illustrated in Figure 40. This format allows text and image information to be incorporated and linked to spatial coordinates. A detailed description of the geodatabase is provided in Appendix C.

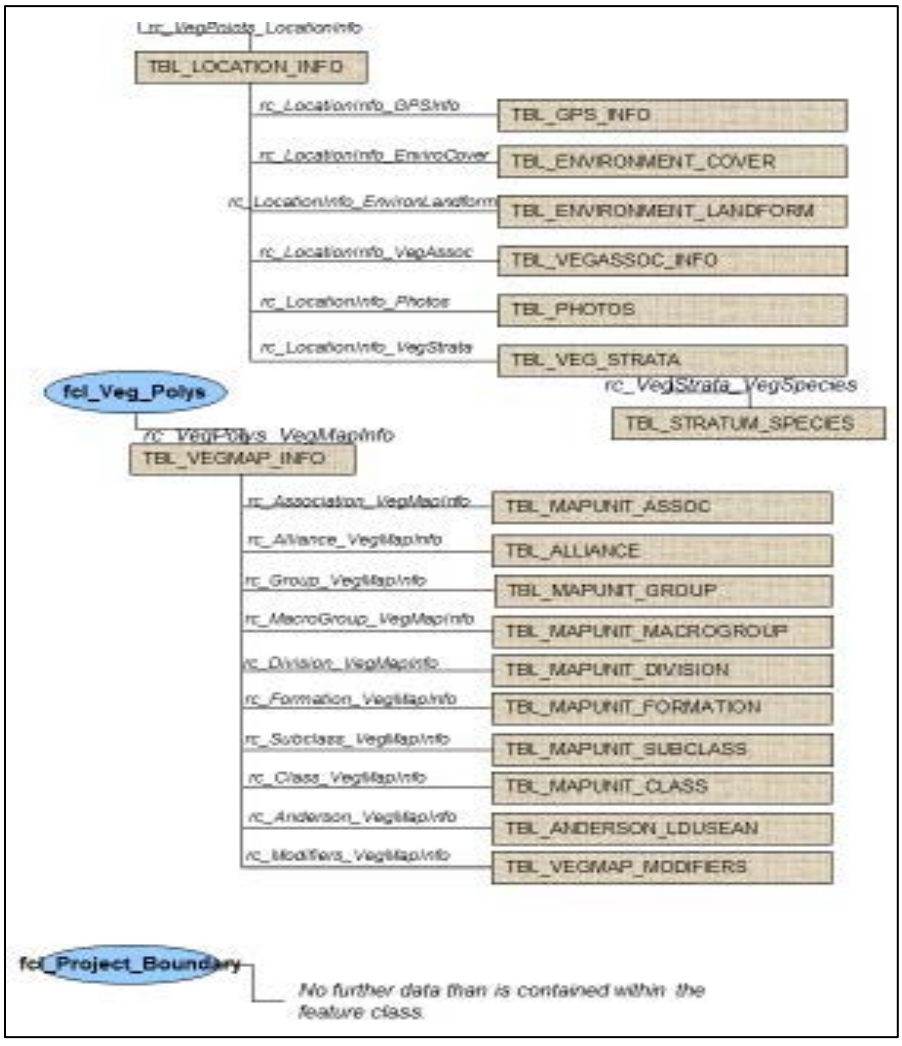


Figure 40. Structure of the GLCA/RABR geodatabase.

Results

Map Classes

The final map for GLCA/RABR (Figure 41a) includes 48 map classes. Thirty-seven are vegetation map classes, three are unvegetated map classes, and eight are land-use map classes (Table 10). Of the 37 vegetation map classes, five represent single NVC plant associations (1:1 relationship), and the remaining 32 represent complexes of multiple plant associations.

The Group level of the National Vegetation Classification hierarchy is used to organize vegetation map classes. The Group level was developed by NatureServe to complement the NVC by creating a mappable classification unit representing groups of biologic communities in similar environments and shaped by similar ecologic processes. Table 11 shows the relationship of vegetation map classes to Groups, ordered roughly by physiognomy: upland woodlands, riparian woodlands, upland shrublands, riparian shrublands, upland herbaceous vegetation, wet meadow herbaceous vegetation, and sparse vegetation. In cases where map classes were more vegetatively heterogeneous, both in physiognomy and species dominance, the Groups for that map class were numerous and failed to create a single mappable classification unit for that map class. Map classes with more than one associated Group are noted (i.e., “Multiple Groups”). “Minor Groups” are Groups that correspond with associations which are a minor part of the map class concept but are included in that map class because they are found in similar habitats and have similar spectral signatures. Appendix A provides summary descriptions for each Group. The geologic and land use map classes could not be placed within the Group system classification.

Map Class Descriptions

Appendix I provides detailed descriptions of all the vegetation map classes used in the final version of the GLCA/RABR vegetation mapping project. Each map class description includes:

- summary of the ecological concept of the map class; reference is made to the abundance and distribution of the map class within GLCA/RABR;
- list of plant associations and common plant species occurring within the map class;
- qualitative description of the photographic signature along with representative samples from the orthophotography;
- ground photographs; and,
- statistics and accuracy assessment results.

Map Polygons

The GLCA/RABR vegetation map consists of 33,691 polygons totaling 505,642 hectares (1,249,468 acres) Average polygon size across all map classes is 23.1 ha (57.2 acres). Forty-eight map classes represented by were developed for GLCA/RABR. A total of 31,058 polygons represent 37 natural or semi-natural vegetation map classes covering 75% of the mapping project area. Eleven map classes representing non-vegetated or developed land use areas account for the remaining 2,633 polygons, covering 25% of the project area.

The polygon count includes adjacent polygons that have the same map code but different density or pattern attributes. Blackbrush Shrublands had the highest number of polygons (5,560) covering 14.5% of the total vegetated mapping area (55,022 hectares). The Pinyon - Juniper Sandstone Woodland Complex is the most extensive map class, delineated on 76,373 ha (188,722 acres) or 20.1% of the vegetated mapping area. The largest average polygon size belongs to the Rivers and Lakes land use map class with 637 hectares (1,574 acres) per polygon.

Figure 41 is a generalized map of the vegetation of GLCA/RABR at the Group level created from the GIS spatial database. Because a geodatabase format was used to store and organize spatial information, there are far more data in the spatial database than can be conveyed in a two-dimensional map. Maps can be produced with vegetation polygons labeled in many different ways at different levels of resolution. Table 11 provides summary statistics for GLCA/RABR vegetation map polygons. Included data are map class number and name, number of polygons interpreted within GLCA/RABR, and the area occupied by interpreted polygons per each mapping unit.

Discussion

Although the goals of the NPS Vegetation Mapping Inventory Program (VMI) are to employ a mapping model that is as close as possible to defining each map class by one corresponding association, mapping a park as large and sparsely vegetated as GLCA/RABR presents challenges to the association-scale of mapping and to mapping consistently to one level of the NVC. Many of the map classes defined for GLCA/RABR were complexes based on a combination of factors including landscape setting, substrate, and vegetation composition. For some map classes, landscape setting and substrate were more key determinants than the vegetation; these were vegetatively quite heterogeneous. In such cases, a variety of plant associations were cross-walked to that map class, including associations from different physiognomic classes (i.e., shrublands and herbaceous vegetation) and sometimes different NVC groups. In other cases, many map classes were created out of one NVC group (i.e., pinyon-juniper woodlands with different understories and different landscape settings) or several map classes with distinct landscape settings and substrates shared very similar diagnostic plant species (i.e., rolling shale badlands on the Moenkopi Formation (map class 33), talus slopes with warm aspects on a variety of geologic formations (map class 30), and slickrock outcrops with sparse vegetation (map class 34)).

In the sparsest settings, map classes were interpreted almost entirely by geologic substrate (as the vegetation signature was barely discernable) and defined by field data which corroborated that the geology supported a unique assemblage of plants compared with neighboring stands of vegetation on different geologic substrates. In these cases, the park’s geology map was a critical tool in delineating polygon boundaries. Other sparse settings such as slickrock habitats and talus/colluvial slopes often supported a diversity of vegetation types and physiognomic classes at finer scales, complicating the determination of representative sites and the appropriate vegetation association for the site based on indicator or diagnostic species. Microtopography, aspect, slope, boulder size, slickrock joint depth, soil depth atop slickrock, and neighboring vegetation are some of the factors influencing the vegetation composition and patterns in these landscape settings. All of these factors contribute to the difficulties in mapping to the vegetation association or even Group levels of the NVC.

Riparian areas and spring-associated sites were similarly difficult to map to an association or alliance level but for different reasons. Unlike the sparse types discussed above, these areas typically supported dense stands of vegetation defined less by substrate than by proximity to water or depth to the water table. Because of their recognizable dark green photo signature they were easy to map at scales well below the MMU, and because of their significance to park resource managers, mapping was accomplished at very fine scales. Polygons were mapped as narrow bands paralleling streams or drainages or small patches surrounding springs or seeps and often represented a diversity of vegetation types (and sometimes physiognomic classes) at even finer scales and growing mosaicked or intertwined to such a degree as to be nearly impossible to map separately. For these reasons, there are nearly a dozen associations assigned to the cottonwood woodlands class (map class 3) and spring-supported mixed deciduous woodlands and shrublands class (map class 5). Additional field work and further review of plot data collected as part of this project may reveal opportunities for refinement of these map classes potentially based on substrate or geology, latitude, aspect, elevation, etc.

Finally, mapping a National Recreation Area vs. a National Park presented some challenges associated with drafting the final classification and map class concepts due to authorized uses not typically found in parks. Nearly 85% of GLCA is subject to grazing use by domestic livestock. The impacts from over a century of livestock grazing on a semi-arid region maladapted to the pressures of livestock grazing can be seen in the vegetation dominating the landscape today. Most notable was the abundance of *Ephedra cutleri*, *Chrysothamnus* spp., *Opuntia* spp., and *Gutierrezia* spp. as co-dominant species in many other vegetation associations, and in some cases, as dominant vegetation types requiring the creation of new association names and new map class concepts. Additionally, exotic, annual understory grasses and forbs were common in many shrubland associations. Though there are conflicting studies and it may not be possible to state that the abundance of these species is related to sustained livestock grazing pressure, or whether climate, precipitation patterns, or drought explain their abundance better, it appeared that there were distinctions in vegetation composition, especially when compared to neighboring Canyonlands NP, that could be attributed to land use (specifically permitted livestock grazing). Also notable was the scarcity of winterfat in the Waterhole Flat area of the Orange Cliffs as compared to more abundant stands nearby in Canyonlands NP (i.e., Ernie's Country) (Tendick et al. 2012). Fluctuating reservoir levels have resulted in shoreline communities dominated by exotic species and in the establishment of tamarisk in upland vegetation communities that would not otherwise support it. Over half of the new vegetation associations created for non-riparian areas in GLCA had *Ephedra cutleri* as a co-dominant or dominant shrub species or were new disturbed/ruderal types.

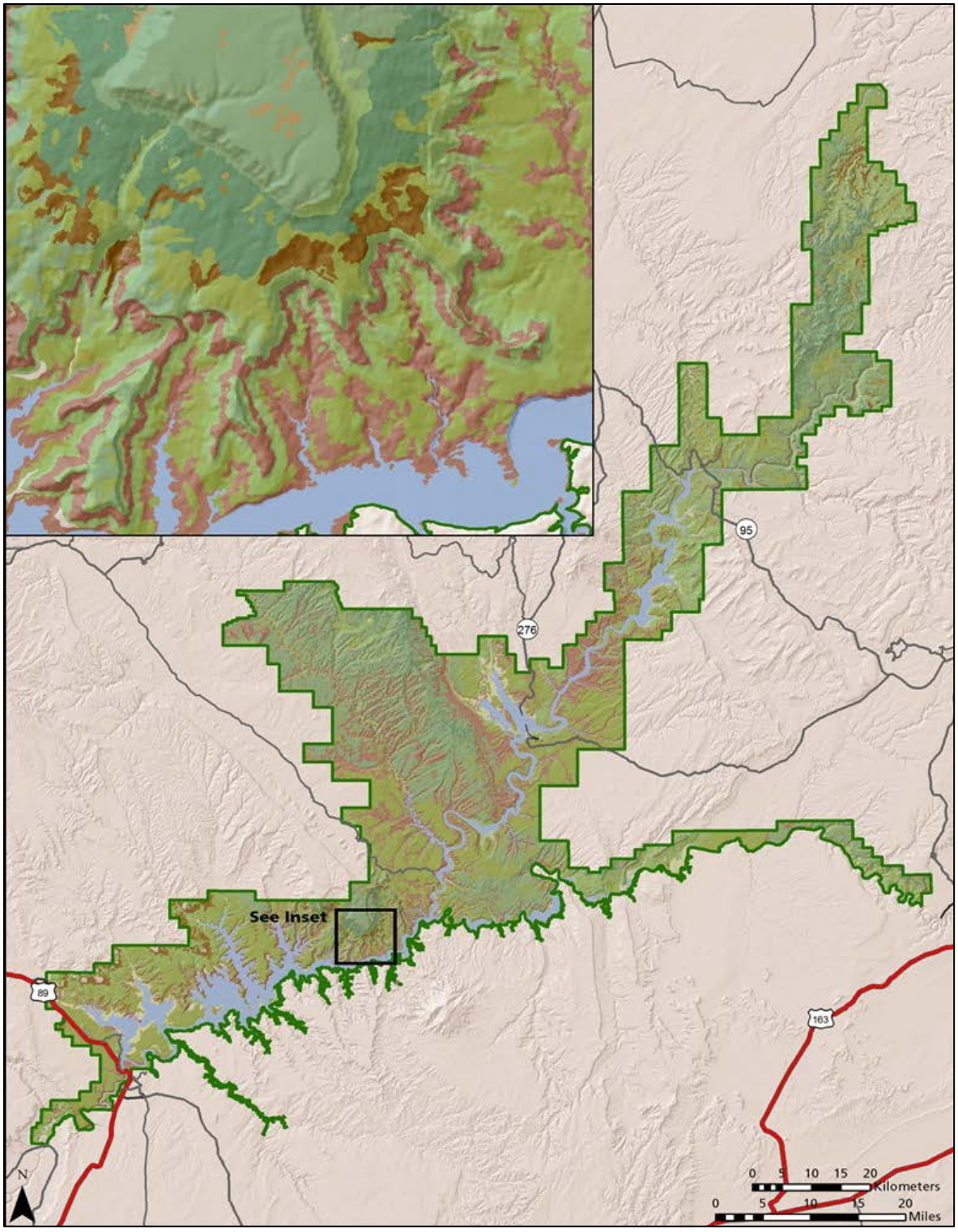


Figure 41a. The GLCA/RABR Group level vegetation map.



Figure 41b. Legend for the GLCA/RABR Group level vegetation map.

Table 10. Map classes used in the final GLCA/RABR vegetation map. GLCA/RABR map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations are shown. Vegetation map classes are arranged using the NatureServe Group classification. *Minor groups are those that correspond with associations which are uncommon and not generally representative of the map class as a whole.

NatureServe		Map	Map Class			
Group	**Minor Group**	**Class #**	**Code**	**Map Class Name**	**Description or Associations Assigned to Map Class**	**Relation**
Colorado Plateau Pinyon-Juniper Woodland (G250)	–	20	W-PJCO	Pinyon - Juniper / Blackbrush Woodland	Juniperus osteosperma / Coleogyne ramosissima Woodland Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland	1 : many
		21	W-MEPJ	Pinyon - Juniper High Elevation Mesa Top Woodland	Pinus edulis - Juniperus osteosperma / Artemisia bigelovii Woodland Pinus edulis - Juniperus osteosperma / Artemisia nova Woodland Pinus edulis - Juniperus spp. / Poa fendleriana Woodland Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia Woodland Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	1 : many
		28	W-PJEP	Pinyon - Juniper / Green Mormon-tea - Snakeweed Woodland	Pinus edulis - Juniperus osteosperma / Ephedra viridis - Gutierrezia sarothrae Woodland	1 : 1
Multiple Groups: Colorado Plateau Pinyon-Juniper Woodland (G250) Colorado Plateau-Great Basin Juniper Open Woodland (G246)	–	22	W-PJGR	Juniper - (Pinyon) Woodland Savannas	Juniperus osteosperma / Hesperostipa comata Open Woodland Juniperus osteosperma / Leymus salinus Open Woodland Juniperus osteosperma / Pleuraphis jamesii Open Woodland Juniperus osteosperma / Sparse Understory Woodland Pinus edulis - Juniperus osteosperma / Achnatherum hymenoides Woodland Pinus edulis - Juniperus osteosperma / Pleuraphis jamesii Woodland Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	1 : many
		23	W-PJAR	Pinyon - Juniper / Wyoming Sagebrush Woodland	Juniperus osteosperma / Artemisia tridentata Woodland Pinus edulis - Juniperus osteosperma / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland	1 : many
		24	W-PJSA	Pinyon - Juniper Sandstone Woodland Complex	Juniperus osteosperma / Cercocarpus intricatus Woodland Juniperus osteosperma / Coleogyne ramosissima Woodland Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Wooded Shrubland Juniperus osteosperma / Sparse Understory Woodland Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland	1 : many
		25	W-PJDU	Pinyon - Juniper Semi-Desert Sand Woodland	Juniperus osteosperma / Quercus havardii - Artemisia filifolia - Ephedra cutleri Sandsheet Scrub Juniperus osteosperma / Sparse Understory Woodland Pinus edulis - Juniperus osteosperma / Muhlenbergia pungens Woodland Pinus edulis - Juniperus osteosperma / Quercus havardii var. tuckeri Woodland	1 : many

Table 10 (continued). Map classes used in the final GLCA/RABR vegetation map. GLCA/RABR map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations are shown. Vegetation map classes are arranged using the NatureServe Group classification. *Minor groups are those that correspond with associations which are uncommon and not generally representative of the map class as a whole.

NatureServe		Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
Group	**Minor Group**					
Multiple Groups: Colorado Plateau Pinyon-Juniper Woodland (G250) Colorado Plateau-Great Basin Juniper Open Woodland (G246) (continued)	–	26	W-PJWA	Pinyon - Juniper / Mixed Shrubland Wash Woodland	Juniperus osteosperma / Mahonia fremontii Woodland Juniperus osteosperma / Quercus gambelii Woodland Pinus edulis - Juniperus osteosperma / Quercus gambelii Woodland Pinus edulis - Juniperus osteosperma / Quercus havardii var. tuckeri Woodland Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland Pinus edulis - Juniperus osteosperma / Symphoricarpos longiflorus Woodland	1 : many
		27	W-PJQU	Pinyon - Juniper / Gambel Oak Woodland	Juniperus osteosperma / Quercus gambelii Woodland Pinus edulis - Juniperus osteosperma / Quercus gambelii Woodland	1 : many
	Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570), Intermountain Mountain Big Sagebrush Steppe & Shrubland (G304), Southern Rocky Mountain Mountain-mahogany - Mixed Foothill Shrubland (G276), Western Madrean Chaparral (G281)	29	C-PJSC	Pinyon - Juniper Shale Scarps Complex	Amelanchier utahensis Shrubland Amelanchier utahensis - Artemisia tridentata (ssp. vaseyana, ssp. wyomingensis) Shrubland Juniperus osteosperma / Leymus salinus Open Woodland Juniperus osteosperma / Mixed Shrubs Talus Woodland Leymus salinus Shale Sparse Vegetation Pinus edulis - Juniperus osteosperma / Amelanchier utahensis Woodland Pinus edulis - Juniperus osteosperma / Cercocarpus montanus - Mixed Shrubs Woodland Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia Woodland Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia - Amelanchier utahensis) Woodland Pinus edulis - Juniperus spp. / Leymus salinus Woodland Quercus turbinella - (Rhus trilobata, Artemisia tridentata) Shrubland	1 : many
Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)	–	96	W-PSME	Douglas-fir Scree Slope Woodland	Pseudotsuga menziesii Scree Woodland	1 : 1

Table 10 (continued). Map classes used in the final GLCA/RABR vegetation map. GLCA/RABR map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations are shown. Vegetation map classes are arranged using the NatureServe Group classification. *Minor groups are those that correspond with associations which are uncommon and not generally representative of the map class as a whole.

NatureServe		Map	Map Class			
Group	**Minor Group**	**Class #**	**Code**	**Map Class Name**	**Description or Associations Assigned to Map Class**	**Relation**
Western Interior Riparian Forest & Woodland (G797)	Interior West Ruderal Riparian Forest & Scrub (G510)	3	W-COTT	Fremont Cottonwood Woodland	Acer negundo / Disturbed Understory Riparian Woodland Elaeagnus angustifolia Ruderal Riparian Woodland Populus fremontii - Salix gooddingii Riparian Woodland Populus fremontii - Salix gooddingii / Salix exigua Riparian Forest Populus fremontii / Acer negundo Riparian Forest Populus fremontii / Baccharis (emoryi, salicina) Riparian Woodland Populus fremontii / Ericameria nauseosa Riparian Woodland Populus fremontii / Mesic Forbs Riparian Woodland Populus fremontii / Mesic Graminoids Riparian Woodland Populus fremontii / Salix exigua Riparian Forest Populus fremontii / Scour Riparian Forest Populus fremontii / Sparse Riparian Forest Populus fremontii / Tamarix sp. Ruderal Riparian Woodland Salix gooddingii / Salix exigua Riparian Woodland	1 : many
Multiple Groups: Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277) Western Interior Riparian Forest & Woodland (G797)	North American Warm Desert Riparian Low Bosque & Shrubland (G533), Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (G506), Rocky Mountain Subalpine-Montane Aspen Forest & Woodland (G222), Western Montane-Subalpine Riparian & Seep Shrubland (G527)	5	W-SPRI	Relict Spring-supported Mixed Deciduous Woodlands & Shrublands	Acer grandidentatum / Quercus gambelii Forest Betula occidentalis Desert Spring Shrubland Celtis laevigata var. reticulata - Quercus gambelii - Cercis orbiculata Slickrock Canyon Spring & Riparian Woodland Frangula betulifolia Wet Shrubland Ostrya knowltonii Riparian Woodland Populus fremontii / Frangula betulifolia - Quercus gambelii Spring & Riparian Woodland Quercus gambelii / Amelanchier utahensis Shrubland Quercus gambelii Shrubland Quercus gambelii / Artemisia tridentata Shrubland Quercus gambelii / Rhus trilobata Shrubland	1 : many
North American Desert Alkaline-Saline Wet Scrub (G537)	–	6	S-SARV	Greasewood Shrublands	Sarcobatus vermiculatus Disturbed Wet Shrubland Sarcobatus vermiculatus / Atriplex gardneri Wet Shrubland Sarcobatus vermiculatus / Sporobolus airoides Wet Shrubland Sarcobatus vermiculatus / Suaeda moquinii Wet Shrubland	1 : many
		91	S-SEEP	Seepweed Sparse Vegetation	Suaeda moquinii Wet Shrubland	1 : 1

Table 10 (continued). Map classes used in the final GLCA/RABR vegetation map. GLCA/RABR map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations are shown. Vegetation map classes are arranged using the NatureServe Group classification. *Minor groups are those that correspond with associations which are uncommon and not generally representative of the map class as a whole.

NatureServe		Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
Group	**Minor Group**					
Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)	Rocky Mountain-Great Basin Lowland-Foothill Riparian Shrubland (G526) and Western Interior Riparian Forest & Woodland (G797)	7	S-WASH	Ephemeral Wash Tall Shrublands	Fallugia paradoxa Colorado Plateau Desert Wash Shrubland Fraxinus anomala Riparian Woodland Rhus trilobata Moist Wet Shrubland	1 : many
Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600)	Intermountain Dry Tall Sagebrush Steppe & Shrubland (G303), Intermountain Semi-Desert Steppe & Shrubland (G310), and Intermountain Shadscale - Saltbush Scrub (G300)	8	S-SAGE	Basin Big Sagebrush Shrublands	Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Ruderal Shrubland Artemisia tridentata Shrubland Atriplex canescens - Artemisia tridentata Shrubland Mahonia fremontii Shrubland	1 : many
Intermountain Dry Tall Sagebrush Steppe & Shrubland (G303)	Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600) and Mojave Mid-Elevation Mixed Desert Scrub (G296)	9	S-WYSA	Wyoming Big Sagebrush Shrublands	Artemisia tridentata ssp. wyomingensis / Achnatherum hymenoides Shrubland Artemisia tridentata ssp. wyomingensis / Bouteloua gracilis Shrubland Artemisia tridentata ssp. wyomingensis / Disturbed Understory Ruderal Shrubland Artemisia tridentata ssp. wyomingensis / Hesperostipa comata Colorado Plateau Shrubland Artemisia tridentata ssp. wyomingensis / Poa fendleriana Shrubland Artemisia tridentata ssp. wyomingensis / Sparse Understory Shrubland Purshia stansburiana Shrubland	1 : many
Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)	Intermountain Shadscale - Saltbush Scrub (G300) and Mojave Mid-Elevation Mixed Desert Scrub (G296)	10	S-BLAC	Blackbrush Shrublands	Coleogyne ramosissima - Acamptopappus sphaerocephalus - Ephedra torreyana Shrubland Coleogyne ramosissima - Ephedra cutleri Sandsheet Shrubland Coleogyne ramosissima - Ephedra spp. Warm Desert Shrubland Coleogyne ramosissima / Pleuraphis jamesii Shrubland Coleogyne ramosissima Shrubland Grayia spinosa Shrubland Polygala acanthoclada - Mixed Scrub	1 : many

Table 10 (continued). Map classes used in the final GLCA/RABR vegetation map. GLCA/RABR map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations are shown. Vegetation map classes are arranged using the NatureServe Group classification. *Minor groups are those that correspond with associations which are uncommon and not generally representative of the map class as a whole.

NatureServe		Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
Group	**Minor Group**					
Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312) (continued)	Intermountain Semi-Desert Grassland (G311), Intermountain Sparsely Vegetated Dune Scrub & Grassland (G775), and Chihuahuan Desert Sand Scrub (G287)	13	C-DUNE	Desert and Semi-desert Sand / Coppice Dunes Complex	Artemisia filifolia - Ephedra cutleri Sandsheet Shrubland Artemisia filifolia Colorado Plateau Shrubland Artemisia filifolia / Sporobolus flexuosus Shrubland Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Shrubland Ephedra (torreyana, viridis) - Psorothamnus fremontii Shrubland Ephedra cutleri / Achnatherum hymenoides - Muhlenbergia pungens - Oenothera pallida Sandsheet Shrubland Ericameria nauseosa Sand Deposit Sparse Shrubland Muhlenbergia pungens Grassland Poliomintha incana - Artemisia filifolia - Vanclevea stylosa Shrubland Quercus havardii var. tuckeri - Eriogonum leptocladon - Artemisia filifolia Sandsheet Shrubland Quercus havardii var. tuckeri Shrubland	1 : many
	Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600) and Intermountain Semi-Desert Steppe & Shrubland (G310)	14	S-EPVI	Green Mormon Tea Shrub Herbaceous Vegetation	Acamptopappus sphaerocephalus - Ephedra spp. Shrubland Chrysothamnus viscidiflorus / Disturbed Understory Shrubland Chrysothamnus viscidiflorus / Hesperostipa comata Shrubland Ephedra (torreyana, viridis) - Psorothamnus fremontii Shrubland Ephedra cutleri Shrubland Ephedra cutleri - Opuntia spp. / Mixed Grass Shrub-Steppe Ephedra viridis / (Achnatherum hymenoides - Hesperostipa comata) Shrubland Ephedra viridis / Bouteloua gracilis Shrubland Ephedra viridis / Bromus tectorum Ruderal Shrubland Ephedra viridis / Pleuraphis jamesii Shrubland	1 : many
Multiple Groups: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312) Great Basin-Intermountain Shrub & Herb Wash-Arroyo (G559)	Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600), Intermountain Semi-Desert Steppe & Shrubland (G310), Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)	11	S-RABB	Rabbitbrush Wash and Sandsheet Shrublands	Artemisia filifolia - Ephedra (torreyana, viridis) Shrubland Artemisia filifolia Colorado Plateau Shrubland Atriplex canescens Desert Wash Shrubland Brickellia longifolia Shrubland Ericameria nauseosa Desert Wash Shrubland Ericameria nauseosa / Bromus tectorum Ruderal Shrubland Ericameria nauseosa / Sporobolus airoides Shrubland	1 : many

Table 10 (continued). Map classes used in the final GLCA/RABR vegetation map. GLCA/RABR map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations are shown. Vegetation map classes are arranged using the NatureServe Group classification. *Minor groups are those that correspond with associations which are uncommon and not generally representative of the map class as a whole.

NatureServe		Map	Map Class			
Group	**Minor Group**	**Class #**	**Code**	**Map Class Name**	**Description or Associations Assigned to Map Class**	**Relation**
Intermountain S**emi-Desert Steppe & Shrub**land (G310)	–	12	S-WINT	Winterfat Dwarf-shrublands	Krascheninnikovia lanata Dwarf-shrubland Krascheninnikovia lanata / Hesperostipa comata Dwarf-shrubland Krascheninnikovia lanata / Pleuraphis jamesii Dwarf-shrubland	1 : many
		19	C-CACT	Snakeweed - Prickly Pear Shrub Herbaceous Vegetation	Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii Dwarf-shrubland Gutierrezia (microcephala, sarothrae) Dwarf-shrubland Opuntia (fragilis, polyacantha, phaeacantha) Shrubland Opuntia polyacantha / Pleuraphis jamesii Dwarf-shrubland	1 : many
Intermountain Shadscale - Saltbush Scrub (G300)	Great Basin-Intermountain Shrub & Herb Wash-Arroyo (G559)	18	S-SALT	Saltbush Shrub Herbaceous Vegetation	Atriplex canescens - Ephedra viridis Shrubland Atriplex canescens Desert Wash Shrubland Atriplex canescens Shrubland Atriplex canescens / Achnatherum hymenoides Shrubland Atriplex canescens / Pleuraphis jamesii Shrubland	1 : many
Interior West Ruderal Riparian Forest & Scrub (G510)	–	1	S-TAMX	Tamarisk Shrublands	Tamarix spp. Ruderal Riparian Shrubland Tamarix chinensis Ruderal Lakeshore Scrub	1 : many
Multiple Groups: Rocky Mountain-Great Basin Lowland-Foothill Riparian Shrubland (G526) Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)	North American Desert Alkaline-Saline Wet Scrub (G537) and North American Warm Desert Riparian Low Bosque & Shrubland (G533)	2	S-WILL	Coyote Willow Shrublands	Baccharis (emoryi, salicina) - Salix exigua Wet Shrubland Baccharis salicifolia Riparian Shrubland Baccharis salicina Shrubland Pluchea sericea Wet Shrubland Salix exigua / Gravel Bar Wet Shrubland Salix exigua / Mesic Graminoids Western Wet Shrubland	1 : many
Intermountain Semi-Desert Grassland (G311)	North American Desert Alkaline-Saline Marsh & Playa (G538), Southern Rocky Mountain Montane-Subalpine Grassland (G268), Intermountain Sparsely Vegetated Dune Scrub & Grassland (G775)	16	H-GRAS	Native Grasslands	Achnatherum hymenoides Colorado Plateau Grassland Achnatherum hymenoides - Psoralidium lanceolatum Grassland Achnatherum hymenoides - Sporobolus contractus Grassland Bouteloua gracilis Grassland Hesperostipa comata Great Basin Grassland Pleuraphis jamesii Grassland Pleuraphis jamesii - Sporobolus airoides Grassland Poa fendleriana Grassland Sporobolus airoides Southern Plains Wet Meadow Sporobolus cryptandrus Great Basin Grassland	1 : many

Table 10 (continued). Map classes used in the final GLCA/RABR vegetation map. GLCA/RABR map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations are shown. Vegetation map classes are arranged using the NatureServe Group classification. *Minor groups are those that correspond with associations which are uncommon and not generally representative of the map class as a whole.

NatureServe		Map	Map Class			
Group	**Minor Group**	**Class #**	**Code**	**Map Class Name**	**Description or Associations Assigned to Map Class**	**Relation**
Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600)	Interior West Ruderal Riparian Forest & Scrub (G510)	17	C-WEED	Weedy Herbaceous Complex	Salsola spp. Ruderal Grassland Alhagi maurorum Ruderal Scrub Bromus tectorum Ruderal Grassland Tamarix chinensis Ruderal Lakeshore Scrub	1 : many
Multiple Groups: North American Desert Alkaline-Saline Marsh & Playa (G538) Western North American Ruderal Marsh, Wet Meadow & Shrubland (G524)	Arid West Interior Freshwater Marsh (G531) and North American Warm Desert Riparian Low Bosque & Shrubland (G533)	15	H-HERB	Spring-supported Herbaceous Vegetation	Distichlis spicata Alkaline Wet Meadow Muhlenbergia asperifolia Wet Meadow Phalaris arundinacea Western Marsh Phragmites australis Western Ruderal Wet Meadow Toxicodendron rydbergii / Mixed Forb Hanging Garden Scrub Typha domingensis Western Marsh	1 : many
Multiple Groups: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312) Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)	Intermountain Shadscale - Saltbush Scrub (G300), Mojave Mid-Elevation Mixed Desert Scrub (G296), Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277), Southern Rocky Mountain Montane-Subalpine Grassland (G268)	30	C-TALU	Talus Escarpments Mixed Sparse Vegetation Complex	Artemisia bigelovii - Ephedra (viridis, torreyana) Talus Shrubland Atriplex obovata Talus Dwarf-shrubland Atriplex canescens - Ephedra viridis Talus Shrubland Chrysothamnus viscidiflorus Talus Shrubland Coleogyne ramosissima - Acamptopappus sphaerocephalus - Ephedra torreyana Shrubland Ericameria nauseosa - (Xylorhiza tortifolia) Talus Sparse Shrubland Fraxinus anomala - Rhus trilobata Dry Talus and Slickrock Shrubland Leymus salinus Shale Sparse Vegetation Lycium andersonii - Ephedra (torreyana, viridis) Shrubland Poa fendleriana Grassland Rhus trilobata - Ephedra (viridis, torreyana) Talus and Slickrock Shrubland	1 : many
	Mojave Mid-Elevation Mixed Desert Scrub (G296) and Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)	33	S-SCRU	Torrey's Joint-fir Shale Barrens Desert Scrub	Coleogyne ramosissima - Ephedra spp. Warm Desert Shrubland Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation Ephedra torreyana - (Atriplex spp.) / Nonvascular Gypsum Sparse Vegetation Ephedra torreyana / Achnatherum hymenoides - Pleuraphis jamesii Shrubland Ephedra torreyana / Pleuraphis jamesii Shrubland Ephedra torreyana Sparse Vegetation Ericameria nauseosa - (Xylorhiza tortifolia) Talus Sparse Shrubland Eriogonum corymbosum Badlands Sparse Vegetation Psorothamnus fremontii Shrubland	1 : many

Table 10 (continued). Map classes used in the final GLCA/RABR vegetation map. GLCA/RABR map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations are shown. Vegetation map classes are arranged using the NatureServe Group classification. *Minor groups are those that correspond with associations which are uncommon and not generally representative of the map class as a whole.

NatureServe		Map	Map Class			
Group	**Minor Group**	**Class #**	**Code**	**Map Class Name**	**Description or Associations Assigned to Map Class**	**Relation**
Multiple Groups: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312) Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570) (continued)	Intermountain Low & Black Sagebrush Steppe & Shrubland (G308), Intermountain Semi-Desert Steppe & Shrubland (G310), Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277)	34	S-SLIC	Slickrock Sparse Shrubland	Artemisia bigelovii Shrubland Cercocarpus intricatus Slickrock Sparse Vegetation Coleogyne ramosissima Sparse Shrubland Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Shrubland Gutierrezia (microcephala, sarothrae) - (Encelia frutescens, Brickellia microphylla) / Stephanomeria pauciflora Dwarf-shrubland Fraxinus anomala - Rhus trilobata Dry Talus and Slickrock Shrubland Rhus trilobata - Ephedra (viridis, torreyana) Talus and Slickrock Shrubland	1 : many
Intermountain Dwarf Saltbush - Sagebrush Scrub (G301)	–	31	S-TROP	Tropic Shale Badlands Mat Saltbush Sparse Vegetation	Atriplex corrugata Dwarf-shrubland	1 : 1
		35	S-GARD	Gardner Saltbush Sparse Vegetation	Atriplex gardneri Dwarf-Shrubland Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland	1 : many
Intermountain Shadscale - Saltbush Scrub (G300)	–	32	S-GOLD	Shadscale - Goldenhead Scrub	Atriplex confertifolia - (Acamptopappus sphaerocephalus, Picrothamnus desertorum) / (Pleuraphis jamesii) Scrub	1 : 1
	Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)	36	S-SHAD	Chinle Badlands Shadscale Scrub	Atriplex confertifolia Great Basin Shrubland Atriplex confertifolia Sparse Shrubland Atriplex confertifolia / Achnatherum hymenoides Shrubland Atriplex confertifolia / Pleuraphis jamesii Shrubland Zuckia brandegeei Sparse Vegetation	1 : many
Non-Vegetated and Anderson Land Use Map Classes	–	111	L-RIVR	Rivers / Lakes	Colorado, Green, Dirty Devil, Escalante, San Juan, Paria Rivers and Lake Powell	N/A
		113	L-POND	Stock Ponds	Small catchments along minor drainages designed to hold runoff for livestock use or groundwater amendment	N/A
		114	L-PDAM	Dam	Glen Canyon Dam	N/A
		136	G-ROCK	Bare Sandstone / Slickrock	Mesas, domes, joints, buttes, cliffbands, and pour-offs of sandstone of any geologic formation. Essentially unvegetated.	N/A
		200	L-BARE	Sand Bar, Sand Islands, Badlands, and other Bare Dirt Areas	Bars and islands of seasonally scoured and/or deposited sand, essentially unvegetated, and subject to change over time (disappear, move up or down stream, or become more stable and vegetated), very clayey badlands devoid of vegetation, as well as bare dirt areas just above the receding lake level or near roads and other developments	N/A

Table 10 (continued). Map classes used in the final GLCA/RABR vegetation map. GLCA/RABR map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations are shown. Vegetation map classes are arranged using the NatureServe Group classification. *Minor groups are those that correspond with associations which are uncommon and not generally representative of the map class as a whole.

NatureServe		Map	Map Class			
Group	**Minor Group**	**Class #**	**Code**	**Map Class Name**	**Description or Associations Assigned to Map Class**	**Relation**
Non-Vegetated and Anderson Land Use Map Classes (continued)	–	212	L-HOUS	Park Housing, Other Housing, and Campgrounds	Housing units built in the park for employee residences, neighborhoods, RV parks and campgrounds	N/A
		213	L-FACI	Park Facilities	Park facilities including: Visitor Centers, maintenance shops/buildings, offices, and supply caches	N/A
		226	L-ROAD	Roadways	Paved (modifier p) and unpaved (modifier u) roadways	N/A
		310	L-MAIN	Maintenance Yards	Areas where equipment and rocks, gravel, etc. are stored for park maintenance projects	N/A
		320	L-HELI	Helicopter Pad	Landing pad for helicopters	N/A
		4131	L-ORCH	Orchard	Fruit trees planted by a residence area	N/A

Table 11. Summary statistics for polygons of each map class developed for the GLCA/RABR vegetation mapping project. Vegetation map classes are arranged using the NatureServe Group classification. *Minor groups are those that correspond with associations which are uncommon and not generally representative of the map class as a whole.

NatureServe		Map Class	Map Class			
Group	**Minor Group**	**Code**	**Number**	**Map Class Common Name**	**Polygons**	**Area (hectares)**
Colorado Plateau Pinyon-Juniper Woodland (G250)	–	W-PJCO	20	Pinyon - Juniper / Blackbrush Woodland	1,134	10,964
		W-MEPJ	21	Pinyon - Juniper High Elevation Mesa Top Woodland	322	7,328
		W-PJEP	28	Pinyon - Juniper / Green Mormon Tea - Snakeweed Woodland	94	1,380
		Subtotal	–	–	1,550	19,672
Multiple Groups: Colorado Plateau Pinyon-Juniper Woodland (G250) Colorado Plateau-Great Basin Juniper Open Woodland (G246)	–	W-PJGR	22	Juniper - (Pinyon) Woodland Savannas	630	3,091
		W-PJAR	23	Pinyon - Juniper / Wyoming Sagebrush Woodland	64	2,300
		W-PJSA	24	Pinyon - Juniper Sandstone Woodland Complex	2,071	76,373
		W-PJDU	25	Pinyon - Juniper Semi-Desert Sand Woodland	721	5,553
		W-PJWA	26	Pinyon - Juniper / Mixed Shrubland Wash Woodland	859	1,959
		W-PJQU	27	Pinyon - Juniper / Gambel Oak Woodland	257	395
		Subtotal	–	–	4,602	89,671
	Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570), Intermountain Mountain Big Sagebrush Steppe & Shrubland (G304), Southern Rocky Mountain Mountain-mahogany - Mixed Foothill Shrubland (G276), Western Madrean Chaparral (G281)	C-PJSC	29	Pinyon - Juniper Shale Scarps Complex	846	11,575
		Subtotal	–	–	846	11,575
Southern Rocky Mountain White Fir - Douglas Fir Dry Forest (G226)	–	W-PSME	96	Douglas-fir Scree Slope Woodland	4	9
		Subtotal	–	–	4	9
Western Interior Riparian Forest & Woodland (G797)	Interior West Ruderal Riparian Forest & Scrub (G510)	W-COTT	3	Fremont Cottonwood Woodland	480	2,006
		–	–	*Subtotal*	480	2,006
Multiple Groups: Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277) Western Interior Riparian Forest & Woodland (G797)	North American Warm Desert Riparian Low Bosque & Shrubland (G533), Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (G506), Rocky Mountain Subalpine-Montane Aspen Forest & Woodland (G222), Western Montane-Subalpine Riparian & Seep Shrubland (G527)	W-SPRI	5	Relict Spring-supported Mixed Deciduous Woodlands & Shrublands	1,059	1,596
		Subtotal	–	–	1,059	1,596

Table 11 (continued). Summary statistics for polygons of each map class developed for the GLCA/RABR vegetation mapping project. Vegetation map classes are arranged using the NatureServe Group classification. *Minor groups are those that correspond with associations which are uncommon and not generally representative of the map class as a whole.

NatureServe		Map Class	Map Class			Area
Group	**Minor Group**	**Code**	**Number**	**Map Class Common Name**	**Polygons**	**(hectares)**
North American Desert Alkaline-Saline Wet Scrub (G537)	–	S-SARV	6	Greasewood Shrublands	15	29
		S-SEEP	91	Seepweed Sparse Vegetation	6	11
		Subtotal	–	–	21	40
Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)	Rocky Mountain-Great Basin Lowland-Foothill Riparian Shrubland (G526) and Western Interior Riparian Forest & Woodland (G797)	S-WASH	7	Ephemeral Wash Tall Shrublands	472	1,102
		Subtotal	–	–	472	1,102
Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600)	Intermountain Shadscale - Saltbush Scrub (G300) and Intermountain Dry Tall Sagebrush Steppe & Shrubland (G303)	S-SAGE	8	Basin Big Sagebrush Shrublands	46	53
		Subtotal	–	–	46	53
Intermountain Dry Tall Sagebrush Steppe & Shrubland (G303)	Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600) and Mojave Mid-Elevation Mixed Desert Scrub (G296)	S-WYSA	9	Wyoming Big Sagebrush Shrublands	88	568
		Subtotal	–	–	88	568
Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)	Intermountain Shadscale - Saltbush Scrub (G300) and Mojave Mid-Elevation Mixed Desert Scrub (G296)	S-BLAC	10	Blackbrush Shrublands	5,560	55,022
		Subtotal	–	–	5,560	55,022
	Intermountain Semi-Desert Grassland (G311)	C-DUNE	13	Desert and Semi-desert Sand / Coppice Dunes Complex	2,071	11,990
		Subtotal	–	–	2,071	11,990
	Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600) and Intermountain Semi-Desert Steppe & Shrubland (G310)	S-EPVI	14	Green Mormon Tea Shrub Herbaceous Vegetation	1,948	18,924
		Subtotal	–	–	1,948	18,924
Multiple Groups: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312) Great Basin-Intermountain Shrub & Herb Wash-Arroyo (G559)	Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600), Intermountain Semi-Desert Steppe & Shrubland (G310), Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)	S-RABB	11	Rabbitbrush Wash and Sandsheet Shrublands	824	2,406
		Subtotal	–	–	824	2,406
Intermountain Semi-Desert Steppe & Shrubland (G310)	–	S-WINT	12	Winterfat Dwarf-shrublands	102	312
		C-CACT	19	Snakeweed - Prickly Pear Shrub Herbaceous Vegetation	41	248
		Subtotal	–	–	143	560

Table 11 (continued). Summary statistics for polygons of each map class developed for the GLCA/RABR vegetation mapping project. Vegetation map classes are arranged using the NatureServe Group classification. *Minor groups are those that correspond with associations which are uncommon and not generally representative of the map class as a whole.

NatureServe		Map Class	Map Class			Area
Group	**Minor Group**	**Code**	**Number**	**Map Class Common Name**	**Polygons**	**(hectares)**
Intermountain Shadscale - Saltbush Scrub (G300) (Minor Group: Great Basin-Intermountain Shrub & Herb Wash-Arroyo (G559))	–	S-SALT	18	Saltbush Shrub Herbaceous Vegetation	297	738
		Subtotal	–	–	297	738
Interior West Ruderal Riparian Forest & Scrub (G510)	–	S-TAMX	1	Tamarisk Shrublands	1,397	10,658
		Subtotal	–	–	1,397	10,658
Multiple Groups: Rocky Mountain-Great Basin Lowland-Foothill Riparian Shrubland (G526) Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)	North American Desert Alkaline-Saline Wet Scrub (G537) and North American Warm Desert Riparian Low Bosque & Shrubland (G533)	S-WILL	2	Coyote Willow Shrublands	38	104
		Subtotal	–	–	38	104
Intermountain Semi-Desert Grassland (G311)	Intermountain Sparsely Vegetated Dune Scrub & Grassland (G775), North American Desert Alkaline-Saline Marsh & Playa (G538), Southern Rocky Mountain Montane-Subalpine Grassland (G268)	H-GRAS	16	Native Grasslands	1,412	4,269
		Subtotal	–	–	1,412	4,269
Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600)	Interior West Ruderal Riparian Forest & Scrub (G510)	C-WEED	17	Weedy Herbaceous Complex	656	1,841
		Subtotal	–	–	656	1,841
Multiple Groups: North American Desert Alkaline-Saline Marsh & Playa (G538) Western North American Ruderal Marsh, Wet Meadow & Shrubland (G524)	Arid West Interior Freshwater Marsh (G531)	H-HERB	15	Spring-supported Herbaceous Vegetation	29	23
		Subtotal	–	–	29	23
Multiple Groups: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312) Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)	Intermountain Shadscale - Saltbush Scrub (G300), Mojave Mid-Elevation Mixed Desert Scrub (G296), Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277), Southern Rocky Mountain Montane-Subalpine Grassland (G268)	C-TALU	30	Talus Escarpments Mixed Sparse Vegetation Complex	2,995	51,484
		Subtotal	–	–	2,995	51,484
	Mojave Mid-Elevation Mixed Desert Scrub (G296) and Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)	S-SCRU	33	Torrey's Joint-fir Shale Barrens Desert Scrub	1,741	22,817
		Subtotal	–	–	1,741	22,817

Table 11 (continued). Summary statistics for polygons of each map class developed for the GLCA/RABR vegetation mapping project. Vegetation map classes are arranged using the NatureServe Group classification. *Minor groups are those that correspond with associations which are uncommon and not generally representative of the map class as a whole.

NatureServe		Map Class	Map Class			
Group	**Minor Group**	**Code**	**Number**	**Map Class Common Name**	**Polygons**	**Area (hectares)**
Multiple Groups: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312) Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570) (continued)	Intermountain Low & Black Sagebrush Steppe & Shrubland (G308), Intermountain Semi-Desert Steppe & Shrubland (G310), Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277)	S-SLIC	34	Slickrock Sparse Shrubland	1,528	48,777
		Subtotal	–	–	1,528	48,777
Intermountain Dwarf Saltbush - Sagebrush Scrub (G301)	–	S-TROP	31	Tropic Shale Badlands Mat Saltbush Sparse Vegetation	110	4,877
		S-GARD	35	Gardner Saltbush Sparse Vegetation	78	1,952
		Subtotal	–	–	188	6,829
Intermountain Shadscale - Saltbush Scrub (G300)	–	S-GOLD	32	Shadscale - Goldenhead Scrub	626	9446
		Subtotal	–	–	626	9446
	Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)	S-SHAD	36	Chinle Badlands Shadscale Scrub	437	7,368
		Subtotal	–	–	437	7,368
Total All Vegetated Map Classes	–	–	–	–	31,058	379,552
Non-Vegetated and Anderson Land Use Map Classes	–	L-RIVR	111	Rivers / Lakes	75	47,785
		L-POND	113	Stock Ponds	6	3
		L-PDAM	114	Dam	1	5
		G-ROCK	136	Bare Sandstone / Slickrock	2,023	74,339
		L-BARE	200	Sand Bar, Sand Islands, Badlands, and other Bare Dirt Areas	441	3,104
		L-HOUS	212	Park Housing, Other Housing, and Campgrounds	22	78
		L-FACI	213	Park Facilities	10	7
		L-ROAD	226	Roadways	49	739
		L-MAIN	310	Maintenance Yards	3	12
		L-HELI	320	Helicopter Pad	2	17
		L-ORCH	4131	Orchard	1	1
		Subtotal	–	–	2,633	126,090
TOTAL ALL MAP CLASSES	–	–	–	–	**33,691**	**505,642**

Accuracy Assessment

Methods

Introduction

Accuracy assessment (AA) is a statistical test of how well polygon map class attributes represent vegetation on the ground. The AA compares field observations with the map class assignment of the sampled polygon. Errors occur when mapped polygon labels differ from field observations. Results of the AA allow users to evaluate the utility of the vegetation mapping data for particular applications. Accuracy assessment results come in two forms (Hop et al. 2005): "producer's accuracy" (the probability that an AA point was mapped correctly, also referred to as "errors of omission"), and "user's accuracy" (the probability that the map represents what was found on the ground, also referred to as "errors of commission"). High producer's accuracy combined with low user's accuracy indicates that the map class is under-mapped. Conversely, low producer's accuracy combined with high user's accuracy indicates that a type is over-mapped.

Users' and producers' accuracies both have value to users of the vegetation map. Users' accuracies suggest the probability that a field visit to a particular map unit polygon will reveal that the mapped vegetation type(s) is what is actually present. Producers' accuracies may be of value to map users, and especially to Park managers, who wish to understand the true extent of a vegetation type that may be of management or conservation interest, since the producers' accuracies will estimate how much of the type may have been missed by the mappers. These users will often not be visiting a site. All users of the map should note that both types of accuracy reflect only probabilities of error and do not identify which site-specific polygons may be mapped incorrectly (Lea and Curtis 2010). Ideally, both user's and producer's accuracy are high.

Sampling Site Considerations/Inference Areas

Glen Canyon NRA is a very large national park unit, at over half a million hectares, and contains vast expanses of lands that are difficult to access. Field sampling was complicated by a variety of factors including significant driving distances, extremely rough 4WD roads, boating distance/time and boat fuel costs, multi-day whitewater river rafting trips, cliff bands that blocked access to or from canyon bottoms, extreme summer heat, steep terrain, long hiking distances (and a lack of established trails) from the nearest road, trail, or lakeshore. Thus, a "cost surface" in the form of a maximum distance for sampling from a road was used to modify the accuracy assessment inference area. The revised NPS accuracy assessment guidelines 2010 (Lea and Curtis 2010) allow for the use of cost-surface layers "on the grounds of access cost or difficulty." Whereas, other parks (i.e., SHEN) have used a cost-surface layer in which they calculated maximum distance from roads at 250 meters, for GLCA we had to set this buffer much higher and ended up using a buffer of 8km from roads. This meant that our inference area was very large, but also that we had to build in longer travel/accessibility times and therefore, lower our expectations of the number of points that could be sampled per day. Project guidelines (Lea and Curtis 2010) recommend a minimum of 8 points per day, whereas our crews averaged about 6 points per day (ranging from 3–10+ points per day).

Sampling Design

A stratified random sampling design was used to determine AA sampling locations. The AA included all vegetation map classes, but excluded eleven non-vegetated or land-use map classes (L-XXXX or G-XXXX), and employed a minimum-mapping unit based response design. Sample sizes for each evaluated map class were determined, prior to any reduction of map class inference area to accommodate access (cost-surface), using scenarios A through C of the revised AA guidelines (Lea and Curtis 2010). We allocated 30 sample sites to each map class with more than 50 hectares of total area. This was the case for the majority of map classes in GLCA/RABR. Only five (6, 12, 91, 94, 96) map classes had fewer than 50 hectares of total area; these received the minimum of five sample sites each, and in a few cases even fewer than five after buffering criteria were applied.

Accuracy assessment sampling points were selected for each vegetation map class using guidelines A through C and employing a cost-surface (buffering) layer to define the inference area. The project area was divided into two sampling frames in order to keep the project within the established timeline. The Orange Cliffs section of GLCA, which had classification plot work done in 2004, and was included in the final classification data analysis for the Canyonlands NP vegetation mapping project, was also the first area of GLCA to have a completed draft map. Field sampling in this area was guided by an edited version of the Canyonlands Field Key to Plant Associations, which captured most of the vegetation types present in the Orange Cliffs. This area of the park was separated from the rest of the park (i.e., treated as if it were its own unique park) for purposes of the sampling design and approach. However, when the criteria for recommended samples per map class (based on map class total area) were not met after applying the buffering techniques used in the cost-surface layer, lower targets were accepted with the expectation that the map class would meet the target once the remainder of the park was sampled. The primary set of 672 AA sample sites for the Orange Cliffs section of GLCA was created in late summer 2014. A secondary set of AA sample sites was created in early 2015 for the remainder of the park, using the same criteria as were used for point generation in the Orange Cliffs. While a handful of map classes failed to meet the criteria for minimum points per map class (based on map class total area), once points from both rounds of sampling were combined, none of the abundant map classes (> 50 ha) had fewer than 30 sample sites in them and many had two to three times that number. Eleven abundant map classes were over-sampled (with 60 or more AA points allocated to each); therefore, they may “unduly weight the accuracy assessment (Kearsely et al. 2015).” The secondary set of AA sample sites created for the remainder of the park included 1,172 points, for a total of 1,844 points created for the entire park.

Inference Area Selection

The recommended 44 m (131 ft) interior buffer from polygon edges was attempted for the map coverage to help ensure that 0.5 ha sampling points would fall cleanly within the polygon; however, the small and narrow size of many polygons made this buffer size too restrictive to meet the requirements of samples per map class for every map class. A 30 m (98 ft) buffer was selected, instead, and worked in most situations; however, for map classes that primarily occurred as especially small or narrow stands, the buffer was reduced or eliminated altogether in order to distribute points in these types for which the buffer would have entirely screened out. The 30-meter buffer inside the boundary of polygons of all other map classes was created. Then a union theme of

the original map classes and this buffer theme was created. All portions of all polygons that were within the 30-meter buffer were then deleted from this union theme, resulting in a sampling population (inference area) that was comprised of the interiors of all polygons (all areas more than 30 meters from a boundary with a different map class). A MMU-sized (80 m diameter circle) buffer was also created around all classification plots, which further reduced our sampling population size (inference area). Though the guidelines state that it is unnecessary to buffer around classification plots (Lea and Curtis 2010), we felt that it was important in a park as large as GLCA to avoid duplication of efforts as much as possible. Additionally, a cost-surface buffer was created at 8 km horizontal distance from all roads. This distance was chosen after several iterations using different buffer distances. A 250-meter buffer from the road, which has been employed in other national park units, would have meant that 94% of the park was excluded from our sampling population/inference area. With an 8-km buffer from the road, only 16% of the park was excluded from our inference area. Because some map classes occur primarily at greater distances from access routes (specifically riparian woodlands), we felt that extending our buffer to 8 km was the best way to capture 30–50% of all map classes. No cost-surface buffers were created from the lake shore or established trails and no slope masks were applied. The guidelines (Lea and Curtis 2010) recommend that the "most accessible 50% of every abundant map class should be included in the inference population, with a minimum of 30% for the most difficult of access situations," and this target was achieved for most of our map classes, with the few exceptions noted below.

Field Data Collection/Response Design

Field Methodology

For accuracy assessment field sampling at GLCA/RABR, we employed field method #3: "Field observation and class assignments made in the field by a qualified and trained, but non-expert observer. The observer also collects supplemental data on species composition and cover and other parameters that would aid in identification of the type. The field calls are assessed for matches to the map data. Supplemental data for the mismatches are evaluated in the office by an expert and the field call is modified, as necessary. The inherent assumption is that the field call is accurate, unless superseded by the office call."

Field method #4 is similar to #3 except that only "minimal amounts of supplemental data (i.e., species cover estimates) are collected," with the express purpose that this minimal "data would not enable a post hoc review of observer determinations" (Lea and Curtis 2010). Lea and Curtis (2010) recommend using method #4 primarily because it reduces bias or the use of fuzzy logic when data are reviewed post hoc by an expert in the office, and AA results are thus adjusted. Our justification for choosing method #3 was the belief that the effort required to get field crews to remote, widely dispersed sampling locations was so great that the majority of field time was spent accessing plots and the time required to collect more supplemental data at each point was trivial by comparison to the more general field data forms suggested for method #4.

The supplemental data collected in the field with method #3 is of great value to both the vegetation classification (which was revised post-AA field data collection) and accuracy assessment portions of this project. Because many of the map classes defined for GLCA/RABR were complexes of

associations, identifying AA sites in the field to the association level, with the species data to support that call, helped to refine map class association assignments, which "provides the map user with useful information about the relative contributions of each of the finer vegetation classes to the coarser map class (Czaplewski 2003)." Furthermore, a lack of species cover data may unfairly lower the accuracy assessment results based on an assumption that field crew members consistently arrived at the most appropriate field call. However, there are a variety of reasons why this may not be the case, including: 1) unfamiliarity with the NVC and the concept of "diagnostic species," 2) confusion with the field key, and 3) lack of training or experience (see Appendix H for more examples of potential error).

An office review of accuracy assessment plot vegetation data was only performed if: 1) a new name was recorded and vegetation data were reviewed to confirm no existing name would reasonably fit as an alternative choice, 2) representativeness of plot to polygon or representativeness of association to description were marked as "fair" or "poor" and reference data were a mismatch with the mapped data, or 3) reference data were a mismatch with the mapped data and was a glaring or significant error (i.e., was confused with a map class very dissimilar from it).

Universal Transverse Mercator (UTM) location coordinates for all AA points were downloaded to Global Positioning System (GPS) receivers for field sampling. The points and polygons were printed on paper maps with an orthophotograph background or with a topographic background to guide the field crews. Crews were provided with maps delineating polygon boundaries for the purpose of assessing the representativeness of the point (MMU-sized) to the polygon. Though the revised guidelines (Lea and Curtis 2010) mention the possibility of the polygon lines influencing/biasing the field call, we felt that the value in providing that information outweighed the potential for bias. Field crews were trained to only record data for the circular 0.5 hectare area around plot center, not for the entire polygon. They did not have training in the map class concepts, which were often complexes of multiple closely-related vegetation associations, and therefore, would not know that two points in the same polygon should or should not be keyed out to the same association. Additionally, it is valuable for post-hoc review of the field data to have a record of observed differences between plot vegetation and that of surrounding areas in the polygon (that were visible to and noted by the field person), especially when a plot is a mismatch with the mapped data.

Field Data Collection

Accuracy assessment point data were collected in the fall of 2014 (all areas north of Hite), the spring of 2015, and the fall of 2015. The crews evaluated an MMU-sized area, approximately 5,000 m^2, centered on the AA point coordinates. MMU-sized circular plots were standard except when field maps showed they were sampling a polygon smaller than 0.5 ha or a long, narrow polygon where circular plots were not appropriate, in which case plot shapes were adapted to fit polygon widths (Appendix B). Environmental data collected in the field included elevation, slope, aspect, topographic position, landform, unvegetated surface elements, and descriptive comments. Vegetation data included leaf type and physiognomic class, stratum height and cover, and canopy cover for the dominant species in each stratum. The illustrated field key was used to identify the plant association that best described the plot. In most cases, only one plant association name was recorded. When

vegetation relationships were less clear, a secondary or tertiary plant association name was also recorded. Plant associations occurring within 50 m of the AA point boundary, but within the same polygon, were also recorded if they represented an association type that was distinctly different from the type recorded for the AA point. Two digital photographs were taken in opposite directions from plot center at each AA point to provide visual documentation of the site.

The field team collected data at 1,668 AA points (Figure 42); 176 points that were generated for field data collection were not sampled. Most of these fell in areas too remote to access without significant travel costs and included areas along the San Juan River; a large area from Mike's Mesa west to the Great Bend; the southern end of Grand Bench; a long section of the Escalante River from Coyote Gulch north to Twentyfive Mile Wash; Choprock Bench; the mesa south of North Wash; and Bull and Imperial Valleys. Map classes that may have been underrepresented in our final sampling inference area include: Fremont Cottonwood Woodlands, Relict Spring-supported Mixed Deciduous Woodlands and Shrublands, Pinyon-Juniper/Gambel Oak Woodlands, and Winterfat Shrublands. These are areas and map classes that could be targeted for future data collection efforts.

The species data and other descriptive data were manually entered into the plots database, after data from the GPS units were uploaded to the database. A thorough quality assurance/quality check (QA/QC) was performed on the data prior to analysis and nomenclature standards and other data management procedures were the same as for the classification plot data (see Vegetation Classification and Description section). All photographs were labeled and filed to facilitate linkage with the final project geodatabase.

Data Analysis

Of the 1,668 AA points collected, 1,623 were used in the final AA data analysis. Two points were eliminated from the final analysis because they fell in unvegetated areas mapped as bare slickrock or barren salt or mud flats; the other 43 rejected points were excluded from the final AA data analysis because they represented very rare map classes that were only mapped where they were found in the field (see Results and Discussion section below). However, all 1,668 AA plots were assessed in the initial analyses, prior to the AA meeting with park staff. The field data were converted into a spatial data layer with coordinates and attributes. The first step in the AA analysis intersected the AA point data with the map polygon data. The primary, secondary, and tertiary plant association names (and associations within 50 m, if recorded) assigned in the field to each AA point were cross-walked to their corresponding map class and then compared to the map class code for that polygon. If any of the three names agreed with the labeled map class for a given polygon, the point was considered correct. All other points were considered mismatches and marked incorrect.

The results of the initial analysis were arrayed in a preliminary contingency table in which producer's and user's accuracy were calculated for each map class. Producer's accuracy is computed by dividing the number of samples that agreed with the corresponding map class by the total number of samples in that class. User's accuracy was calculated by dividing the number of samples that agreed with their corresponding map class by the total number of samples whose field call belonged to that category.

The Project Manager analyzed the map errors revealed in the preliminary contingency table prior to the AA analysis meeting with park staff. AA point mismatches (disagreement between field call and polygon label) were evaluated for the type of error (true or false) when: 1) a new association name was given to the point, 2) representativeness of plot to polygon or representativeness of association to description were marked as “fair” or “poor,” and/or 3) it appeared to be a glaring or significant error (i.e., confused with a map class very dissimilar from it). Sources of “false” error include GPS position error, questionable field determinations, edge or ecotonal error, and inclusions (small patches of vegetation within larger map polygons). The majority of false errors identified in the GLCA/RABR vegetation map were questionable field determinations. In some cases, a second or third map class call was added for the plot based on a thorough review of the association names listed, environmental descriptions, plant species lists, and ground photos (see Appendix H for a detailed review of AA analysis results). The original field calls were not replaced or deleted. Mismatches were corrected when a false error was identified; all other mismatches were deemed true errors.

On April 28–29, 2016, a meeting was held to complete the AA analysis review process. Patterns of error were analyzed and possible solutions for raising individual map class accuracy formulated (Appendix H). The goal was to formulate the best solutions for the purposes of natural resource management. In some cases, combining certain map classes to achieve higher levels of accuracy and more meaningful vegetation map classes was recommended. In other cases, splitting map classes into more meaningful map classes or retaining map classes with lower accuracy was recommended. Final edits were made to the vegetation map to reflect the decisions made at the AA analysis meeting. A final sample contingency table was produced by project cartographers (Table 12). The spatial database was revised to reflect the final list of map classes. Results of these efforts raised the overall map accuracy from 70.2% (original accuracy) to 81.5%.

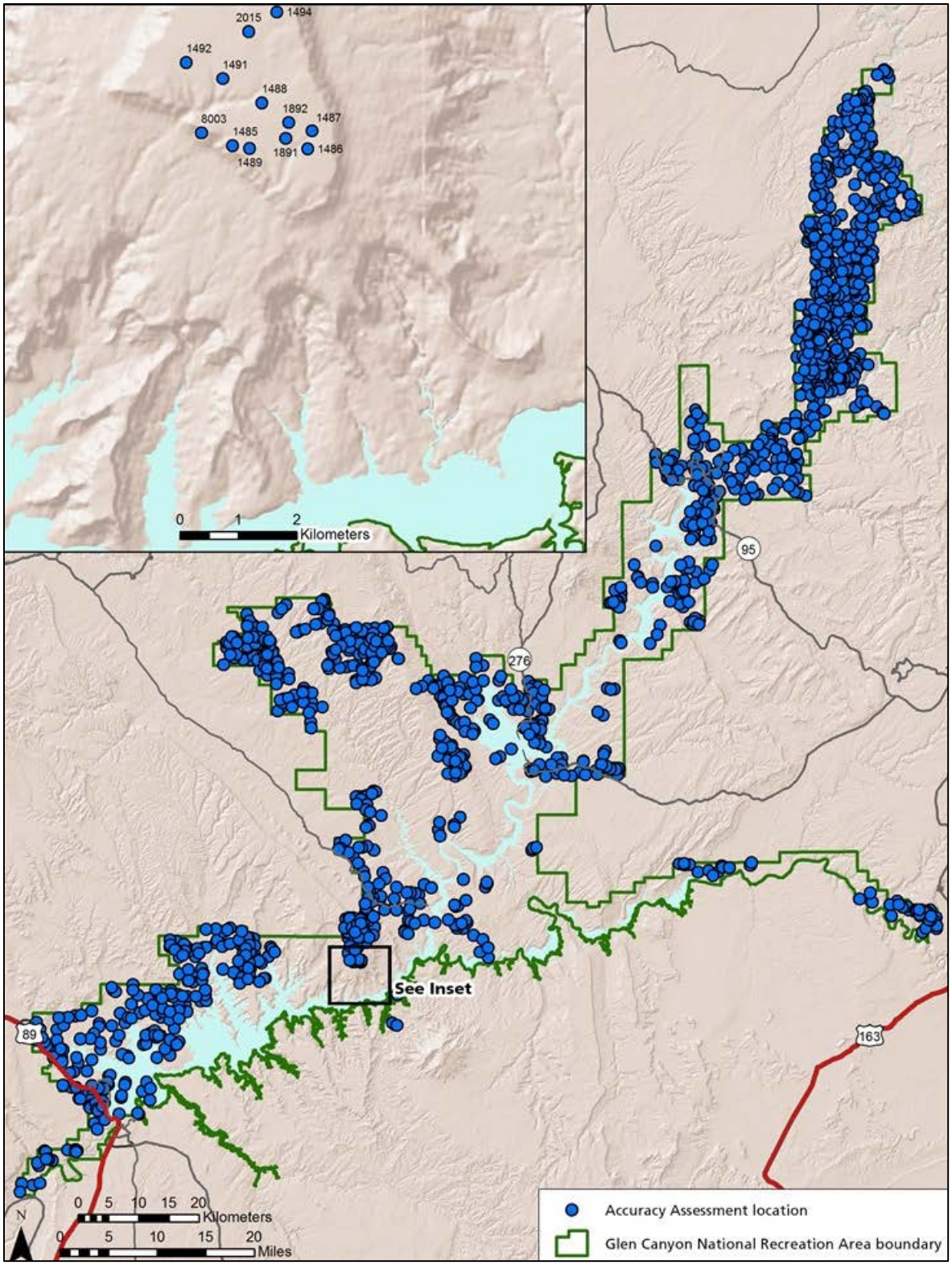


Figure 42. Locations of the 1,668 accuracy assessment points sampled within GLCA/RABR.

Table 12. Final sample contingency table for GLCA/RABR.

Mapped Data - Omission (Producer's) Error		Accuracy Assessment Field Plot Data - Commission (User's) Error																												Correct		90% C.I.	
		1	3	5	7	9	10	11	13	14	16	17	18	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	#	%	-	+
	1	53						1				1																			55	96%	91%	101%
	3	2	49													1															52	94%	88%	101%
	5		1	53				1													2									57	93%	87%	99%
	7		1	1	18			1	2		1									1				2			1				28	64%	48%	81%
	9					31	1										2						1								35	89%	78%	99%
	10						114	2	1	1				2				5									2	1		1	129	88%	83%	93%
	11					1	1	38	2	1	2		2											1			3				51	75%	63%	86%
	13						6	2	73	6																	1				88	83%	76%	90%
	14						3		6	79	4		3											2			6				103	77%	69%	84%
	16						3	1		3	49	2												2			4				64	77%	67%	86%
	17	4			1		1				1	28											1				1				37	76%	63%	89%
	18						1	4	2	4	2		43										1				3				60	72%	61%	82%
	20						2							58		3		1	1			2	2								69	84%	76%	92%
	21														62		2	1					5								70	89%	82%	96%
	22										1			2	1	30	1		2	1		2	5				1				46	65%	53%	78%
	23			1											9		47					1	5								63	75%	65%	84%
	24				1									2	1			85				1	1	2				5			98	87%	81%	93%
	25						1			1				1	1	2			31			2									39	79%	68%	91%
	26		2	1				1						2						29	1	1	2								39	74%	62%	87%
	27			5						1		1				2	3			1	18		3								34	53%	37%	68%
	28													1		4						20									25	80%	65%	95%
	29																	3			1		79	1							84	94%	89%	99%
	30						3																2	31			2		1	3	42	74%	61%	86%
	31																								5						5	100%	90%	110%
	32						3			1			1													27	1	1		3	37	73%	60%	86%
	33						4			2	1	1			1								1	2		1	69			4	86	80%	73%	88%
	34	1			1		5																	1			3	51			62	82%	73%	91%
	35						3									3											2		12	1	21	57%	37%	77%
	36																	1									2		1	40	44	91%	83%	99%
correct	#	60	53	61	21	32	151	51	86	99	61	33	49	68	75	45	55	96	34	32	22	29	108	44	5	28	101	58	14	52	1623	–	–	–
	%	88%	92%	87%	86%	97%	75%	75%	85%	80%	80%	85%	88%	85%	83%	67%	85%	89%	91%	91%	82%	69%	73%	70%	100%	96%	68%	88%	86%	77%	–	81.5%	–	–
90% C.I.	-	81%	86%	79%	71%	90%	69%	63%	78%	73%	71%	73%	79%	77%	75%	54%	77%	83%	82%	81%	66%	53%	66%	58%	90%	89%	60%	80%	67%	66%	–	–	–	–
	+	96%	99%	95%	101%	103%	82%	86%	92%	87%	90%	97%	96%	93%	91%	79%	94%	94%	101%	101%	98%	85%	81%	83%	110%	104%	76%	96%	105%	87%	–	–	–	–

This table represents 29 polygon map classes retained following AA and revision whose accuracy was assessed. Shaded boxes indicate the number of AA points that agree with the assigned map class. To read the table, columns represent the map class observed in the field, while the rows represent the map class assigned by the class photointerpreter.

Overall accuracy is 81.5% (Kappa statistic = 80.6%)

Results and Discussion

Individual producer's and user's accuracy values for the 29 map classes evaluated in the final accuracy assessment contingency table are shown in tables 13, 14, and 15 with corresponding 90% confidence intervals. See Appendix H for a more thorough review, including which original map classes were combined or split in the final map. The width of each confidence interval is affected by sample size (which is determined by abundance or rarity of a map class); larger sample sizes result in narrower confidence intervals, and rarer map classes will almost always have larger confidence intervals. Individual map class accuracy ranges from 53% to 100% (Tables 13, 14, and 15). Following each table is a brief discussion of the errors and issues for each map class that failed to meet the 80% program standard. This discussion is meant to inform users of the map about the limitations of individual map classes, which may be a result of a weakness in the map class concept or an error in mapping the class consistently. Final overall map accuracy is 81.5% (Kappa correction = 80.6%). Ten map classes met or exceeded the 80% program standard for both user's and producer's accuracy (Table 13).

Table 13. Final GLCA/RABR vegetation map classes that met or exceeded the 80% program standard for both user's and producer's accuracy.

Map Class Code	Map Class #	Map Class Name	Producer's Accuracy (±90% CI)	User's Accuracy (±90% CI)
S-TAMX	1	Tamarisk Shrublands	96% ± 5%	88% ± 6%
W-COTT	3	Fremont Cottonwood Woodlands	94% ± 7%	92% ± 7%
W-SPRI	5	Relict Spring-supported Mixed Deciduous Woodlands & Shrublands	93% ± 6%	87% ± 8%
S-WYSA	9	Wyoming Big Sagebrush Shrublands	89% ± 11%	97% ± 7%
C-DUNE	13	Desert and Semi-desert Sand/Coppice Dunes Complex	83% ± 7%	85% ± 7%
W-PJCO	20	Pinyon - Juniper / Blackbrush Woodlands	84% ± 8%	85% ± 8%
W-MEPJ	21	Pinyon - Juniper High Elevation Mesa Top Woodlands	89% ± 7%	83% ± 8%
W-PJSA	24	Pinyon - Juniper Sandstone Woodland Complex	87% ± 6%	89% ± 6%
S-TROP	31	Tropic Shale Badlands Mat Saltbush Sparse Vegetation	100%	100%
S-SLIC	34	Slickrock Sparse Shrublands	82% ± 9%	88% ± 8%

Sixteen map classes were retained in the final vegetation map for GLCA/RABR even though user's or producer's accuracy did not meet the 80% program standard (Table 14). A high producer's accuracy but low user's accuracy can mean that a particular map class was under-mapped by the PI and found to be more common by field crew members. Conversely, a high user's accuracy but low producer's accuracy can mean that a particular map class was over-mapped by the PI and not found to be as common by field crew members. In most cases, the 90% confidence interval includes 80%.

Table 14. GLCA/RABR vegetation map classes where either the user's or producer's accuracy did not meet the 80% program standard.

Map Class Code	Map Class #	Map Class Name	Producer's Accuracy (±90% CI)	User's Accuracy (±90% CI)	Confused with Map Class #
S-WASH	7	Ephemeral Wash Tall Shrublands	64% ± 17%	86% ± 15%	many
S-BLAC	10	Blackbrush Shrublands	88% ± 5%	75% ± 7%	13, 24, 33, 34
S-EPVI	14	Green Mormon Tea Shrub Herbaceous Vegetation	77% ± 8%	80% ± 7%	10, 13, 16, 18, 33
H-GRAS	16	Native Grasslands	77% ± 10%	80% ± 10%	10, 11, 14, 33
C-WEED	17	Weedy Herbaceous Complex	76% ± 13%	85% ± 12%	1, 16
S-SALT	18	Saltbush Shrub Herbaceous Vegetation	72% ± 11%	88% ± 9%	11, 14
W-PJSA	23	Pinyon - Juniper / Wyoming Sagebrush Woodlands	75% ± 10%	85% ± 9%	21, 29
W-PJDU	25	Pinyon - Juniper Semi-Desert Sand Woodlands	79% ± 11%	91% ± 10%	22, 28
W-PJWA	26	Pinyon - Juniper / Mixed Shrubland Wash Woodlands	74% ± 13%	91% ± 10%	3, 20, 29
W-PJQU	27	Pinyon - Juniper / Gambel Oak Woodlands	53% ± 15%	82% ± 16%	3, 5, 23, 29
W-PJEP	28	Pinyon - Juniper / Green Mormon-tea - Snakeweed Woodlands	80% ± 15%	69% ± 16%	22, 25
C-PJSC	29	Pinyon - Juniper Shale Scarps Complex	94% ± 5%	73% ± 8%	21, 22, 23, 24, 27
S-GOLD	32	Shadscale - Goldenhead Scrub	73% ± 13%	96% ± 8%	10, 36
S-SCRU	33	Torrey's Joint-fir Shale Barrens Desert Scrub	80% ± 8%	69% ± 8%	10, 14, 16, 36
S-GARD	35	Gardner Saltbush Sparse Vegetation	57% ± 20%	86% ± 19%	10, 22, 33
S-SHAD	36	Chinle Badlands Shadscale Scrub	91% ± 8%	77% ± 11%	30, 32, 33

Five map classes were under-mapped (high producer's accuracy, low user's accuracy).

Map class 10 (Blackbrush Shrublands) was under-mapped where it occurred on duney substrates (more active sand sheets/coppice dunes) and slickrock substrates (smaller patches on soil deposits in a sandstone mosaic). It was also confused with map class 33, which occurs on shaley substrates, and which is a closely related type and may have blackbrush as a co-dominant in the shrub canopy layer.

Map class 28 (Pinyon - Juniper / Green Mormon-tea - Snakeweed Woodlands) was slightly under-mapped where it was mosaicked with pinyon-juniper savannas or pinyon-juniper dunes; also, because the understory in this map class may be a result of disturbance (e.g., overgrazing), this type may occur as small inclusions in many other pinyon-juniper woodland types.

Map class 29 (Pinyon - Juniper Shale Scarps Complex) is a complex of many pinyon-juniper woodland associations; as such, it was a commonly assigned map class to pinyon-juniper plots that were a mismatch with their mapped polygon (i.e., “mixed shrub talus” name used even though the site was not on talus). In many cases, the site was not on a shale scarp but on flat rimrock or a mesatop, and the concept for map class 29 was not a good fit even though the vegetation data supported that assignment. In an effort to avoid sharing associations across many map classes, these errors were deemed acceptable and this map class was retained with lower accuracy because the overall map class concept was sound.

Map classes 33 (Torrey’s Joint-fir Shale Barrens Desert Scrub) and 36 (Chinle Badlands Shadscale Scrub) were defined principally by substrate/geology; they were both under-mapped and confused with each other and with several other closely related map classes, growing on the same or neighboring substrates with sparse vegetation cover, and which generally lacked a distinct photo signature. While geology is a defining element in the distribution of vegetation on the Colorado Plateau, many other factors including elevation, aspect, soil type, soil depth, soil water-holding capacity, and distance to ground water contribute to vegetation distribution patterns. Basing vegetation map classes on the underlying geology can be problematic; in some cases, the geology is more varied than the vegetation, but in many cases the vegetation is more diverse than the mapped geologic formations. In GLCA the prevalence of blackbrush and shadscale communities across a variety of geologic types demonstrates that the underlying geology is not always a reliable predictor of vegetation.

Eleven map classes were over-mapped (high user’ accuracy, low producer’s accuracy).

Map class 7 (Ephemeral Wash Tall Shrublands) was confused with a variety of other map classes. The majority of errors resulted from pulling out wash channels separately from surrounding polygons/vegetation, because the bare wash channel has a recognizable photo signature, but the shrub composition along the wash channel was, in many cases, less unique or distinct than expected by the mapper. Many of these wash channels should be merged in with surrounding polygons to more accurately represent what the field crews found on the ground.

Map classes 14 (Green Mormon Tea Shrub Herbaceous Vegetation) and 16 (Native Grasslnads) were both slightly over-mapped and slightly under-mapped. They were confused with each other, as well as with neighboring shrublands, partly due to the landscape dynamics of these communities where ecotones may be broad and patchiness is common. This makes it difficult for a mapper to confidently place a line between vegetation patches without consistently mapping below the MMU-scale. In many cases, errors were the result of differences of just a few percent shrub cover, making one shrub dominant over the other or making a shrub herbaceous type vs. an herbaceous type the final call. Many remaining polygons of native grasslands may appear on the ground as shrub-herbaceous communities and not true grasslands, but the map class is still useful to a map user and/or Park Resource Manager wanting to identify areas where native grasses have high (and generally dominant) cover.

Map class 17 (Weedy Herbaceous Complex) was slightly over-mapped along the lake shores where *Tamarix chinensis* saplings actually dominated, as well as in native grasslands that had not been thoroughly invaded by exotic species, but appeared darker on the photo-signature resembling the spectral signature for this map class.

Map class 18 (Saltbush Shrub Herbaceous Vegetation) was over-mapped near wash channels that were actually dominated by rabbitbrush and on higher wash terraces that were actually dominated by green Mormon-tea. Even though saltbush was a component in these other shrubland communities, it was rarely the dominant shrub species and was found to be a less common shrubland type than was originally mapped.

Map class 23 (Pinyon - Juniper / Wyoming Sagebrush Woodlands) was slightly over-mapped and confused with neighboring pinyon-juniper woodlands with sparse or mixed shrub understories (sometimes a difference of just a few percent cover of a diagnostic shrub species).

Map class 25 (Pinyon - Juniper Semi-Desert Sand Woodlands) was slightly over-mapped and confused with other pinyon-juniper woodlands with a sparse, grassy, or *Ephedra*-dominated understory on sites that may have appeared “duney” on the imagery (brighter sand signatures) but were generally more stabilized (though may have contained pockets of active sands). Some of the mapping errors could be attributed to the imagery used; a newer imagery set helped clarify bright vs. smooth understory signatures much better.

Map class 26 (Pinyon - Juniper / Mixed Shrubland Wash Woodlands) was confused with a variety of other map classes. The majority of errors resulted from pinyon-juniper wash channels that were mapped separately from surrounding polygons/vegetation, because the bare wash channel has a recognizable photo signature. But the shrub composition along the wash channel was, in many cases, less unique or distinct than expected by the mapper. Many of these wash channels should be merged in with surrounding polygons to more accurately represent what the field crews found on the ground. Additionally, some mapping errors were due to confusion with other wash channel map classes (cottonwood woodlands, spring-supported deciduous woodlands and shrublands, and rabbitbrush desert washes) that did not contain pinyon-juniper trees.

Map class 27 (Pinyon - Juniper / Gambel Oak Woodlands) was over-mapped and confused primarily with polygons of Gambel oak that did not have pinyon-juniper as a dominant canopy component. There was also some confusion with other pinyon-juniper woodlands that had sparse or mixed shrub understories (not dominated by *Quercus gambelii* or *Mahonia fremontii*) but which occurred in similar “pour-off” locations below cliff bands.

Map classes 32 (Shadscale - Goldenhead Scrub) and 35 (Gardner Saltbush Sparse Vegetation) were both defined principally by substrate/geology; they was slightly over-mapped and confused with several closely related map classes, growing on the same or neighboring substrates with sparse vegetation types, which generally lacked a distinct photo signature. Several polygons of map class 35 had enough tree cover to be given a “t” modifier; when sampled in the field, they were keyed to a pinyon-juniper/sparse understory vegetation type.

The remaining three map classes were retained in the final vegetation map for GLCA/RABR although both user's and producer's accuracy did not meet the 80% program standard (Table 15). In most cases, the 90% confidence interval includes 80%.

Table 15. GLCA/RABR vegetation map classes where both the user's and producer's accuracy did not meet the 80% program standard.

Map Class Code	Map Class #	Map Class Name	Producer's Accuracy (±90% CI)	User's Accuracy (±90% CI)	Confused with Map Class #
S-RABB	11	Rabbitbrush Wash and Sandsheet Shrublands	75% ± 12%	75% ± 12%	13, 16, 18, 33
W-PJGR	22	Juniper - (Pinyon) Woodland Savannas	65% ± 13%	67% ± 13%	20, 28, 29
C-TALU	30	Talus Escarpments Mixed Sparse Vegetation Complex	74% ± 13%	70% ± 13%	10, 33, 36

Map class 11 (Rabbitbrush Wash and Sandsheet Shrublands) had problems similar to the other wash channel types (map classes 7 and 26) due to being somewhat over-mapped where the wash channel did not support vegetation distinct from surrounding polygons/vegetation, and therefore, had errors across a variety of other map classes. Some of the confusion with map class 33 was due to a subspecies distinction between *Ericameria nauseosa* that occur primarily on shaley (often scree) substrates vs. those that occur on sandy substrates. Additionally, this map class shared some overlapping sand sagebrush associations with map class 13 and occurred on similar sandy substrates differentiated as being wash-associated vs. upland. In an effort to avoid sharing multiple associations, these errors were deemed acceptable and this map class was retained with lower accuracy because the overall map class concept was sound.

Map class 22 (Juniper - (Pinyon) Woodland Savannas) was somewhat poorly defined and inconsistently mapped. It was supposed to represent open juniper (sometimes pinyon-juniper) woodland savannas but was often mapped where there was little grass cover in the understory and total understory cover was sparse. There was overlap with the concepts of map classes 21 and 28, as well as over-mapping where the photo-signature looked smooth (grassy signature) on one set of the aerial imagery (the one primarily use for mapping), but shrub signatures could be seen on a newer set of aerial imagery. In many cases, sparse understory stands were dominated by shrubs, not grasses, and when the total understory cover exceeded the threshold for "sparse", the plots were keyed to pinyon-juniper woodlands with shrubs dominant in the understory.

Map class 30 (Talus Escarpments Mixed Sparse Vegetation Complex) is a vegetatively heterogeneous map class. Talus/scree slopes often support a diverse number of shrubs, all with fairly low cover, and dominance by one shrub or another can change based on aspect, substrate, and closest neighboring vegetation. In an effort to avoid lumping all of the sparse vegetation types into this map class, distinctions were made in the association crosswalks from the other sparse vegetation types. This resulted in many errors based on final association name(s), even though, in many cases, the environmental data and plot photos showed that the point occurred in the correct map class

(moderately steep to steep talus slopes lacking tree cover), proving that the overall map class concept was sound.

Eight map classes were left out of the final contingency table (Table 16). Some of these map classes occupied less than 50 total hectares within GLCA, and therefore only required 5 AA points per type. These are all rare to very rare types that often occur in stands less than MMU in size. Several of these map classes were found to be rarer than originally mapped after the initial AA results were calculated. In some cases, they were remapped to even smaller total areas and retained as "mapped only where know[n] to occur" from field sample data. Thus, a true accuracy of these types has not been assessed.

Table 16. GLCA/RABR vegetation map classes that were not included in the final contingency table.

Map Class Code	Map Class #	Map Class Name	Total AA Points	Total Polygons	Total Hectares
S-WILL	2	Coyote Willow Shrublands	3	38	104
S-SARV	6	Greasewood Shrublands	8	15	29
S-SAGE	8	Basin Big Sagebrush Shrublands	7	46	53
S-WINT	12	Winterfat Dwarf-shrublands	9	102	314
H-HERB	15	Spring-supported Herbaceous Vegetation	5	29	23
C-CACT	19	Snakeweed - Prickly Pear Shrub Herbaceous Vegetation	7	41	248
S-SEEP	91	Seepweed Sparse Vegetation	2	6	11
W-PSME	96	Douglas-fir Scree Slope Woodlands	2	4	9
Sum Totals			43	281	791

Stands of map class 2 (Coyote Willow Shrublands) consistently occur in patches too small to pull out using the MMU-standard or in polygons too narrow and intertwined with neighboring stands of *Tamarix chinensis* shrublands or *Populus fremontii* woodlands to be separated out accurately. *Salix exigua* is a common understory species in riparian woodlands, but is rarely found in homogenous patches larger than 0.5 hectare in size. Initial accuracy assessment results showed that it was over-mapped in what should have been polygons of map classes 1 or 3, and under-mapped in polygons that were mapped as 15 (which have a similar photo-signature). After some minor remapping (involving merging with surrounding larger polygons), some polygons remain in areas that were not accessed by field crews; the accuracy of these polygons has not been assessed. Otherwise, this class was mapped only where known to occur from field data.

Map class 6 (Greasewood Shrublands) was so rare that only 6 AA points were generated for it. Initial accuracy assessment results showed that it was only mapped correctly 50% of the time. Some minor remapping was done and this map class is now mapped only where known to occur from field data.

Map class 8 (Basin Big Sagebrush Shrublands) was originally over-mapped on high terraces that were actually dominated by rabbitbrush or sand sagebrush (map class 11), saltbush (map class 18), or

weedy herbaceous vegetation (map class 17). Stands of basin big sagebrush were found to even more rare than originally mapped, and were almost entirely sampled in the upper reaches of the Escalante River corridor. After some minor remapping (relabeling polygons across broad areas where no sagebrush was documented by field crews, not just relabeling polygons that had an AA point in them), a few polygons of this map class remain in areas that were not accessed by field crews; the accuracy of these polygons has not been assessed. Otherwise, this class was mapped only where known to occur from field data.

Map class 12 (Winterfat Dwarf-shrublands) was somewhat over-mapped in the Waterhole Flat portion of GLCA and primarily confused with neighboring saltbush shrublands (map class 18). This map class was removed from the AA contingency table because the majority of AA points (and the majority of polygons) for this type occurred in a very remote section of GLCA (Bull and Imperial valleys) that neither classification nor AA field crews were able to access. The area was visited on a map verification field trip in 2013 and noted significant stands of winterfat, but there were no classification plots or AA points done to further describe this map class or properly assess its accuracy.

Stands of map class 15 (Spring-supported Herbaceous Vegetation) consistently occur in patches too small to pull out using the MMU-standard and in a mosaic with other wetland woodland or shrubland communities. Initial accuracy assessment results showed that was over-mapped in polygons that were actually coyote willow shrublands (map class 2) or a mix of Gambel oak and other spring-associated shrubs and trees (map class 5). After some minor remapping (involving merging with surrounding larger polygons), a few polygons remain in areas that were not accessed by field crews; the accuracy of these polygons has not been assessed. Otherwise, this class was mapped only where known to occur from field data.

The concept for map class 19 (Snakeweed - Prickly Pear Shrub Herbaceous Vegetation) evolved after initial analyses of the AA data that was collected in the Orange Cliffs section of GLCA in 2014. It was originally mapped as a disturbed form of either map class 14 (Green Mormon Tea Shrub Herbaceous Vegetation) or map class 16 (Native Grasslands) and was meant to capture stands dominated by some combination of *Ephedra viridis, Opuntia* spp., *Gutierrezia* spp., native grasses, and weedy annuals. This concept proved to be too broad and contained too many overlapping associations with those related map classes. It was revised to capture stands dominated by *Opuntia* spp. and/or *Gutierrezia* spp. that occurred on the Chinle Formation. Some minor remapping was done in areas with sandier substrates (e.g., the Cedar Mesa Formation around the Waterhole Flat area) and polygons were relabeled as map classes 14 or 16 (often with a modifier “i” for weedy understories). This map class is now only mapped where known to occur from field data.

Map classes 91 (Seepweed Sparse Vegetation) and 96 (Douglas-fir Scree Slope Woodlands) are the rarest types in GLCA and also occur in very small stands. They could not be properly accuracy assessed and were only mapped where known to occur from field data.

The results of the accuracy assessment provide the park managers with detailed knowledge of the strengths and weaknesses of our mapping effort and specific map types. The retention of the less than

80% accuracy map units strongly supports park needs, and was a joint decision to maximize the utility of the products. The lower values typically involve confused types (e.g. pinyon-juniper and associated shrub or herbaceous layers) that have very similar signatures and life zones. The attempt to provide the greatest detail was balanced with the goal of 80%. The GLCA/RABR staff are happy with the results and the details of our effort.

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Appendix A. Group Descriptions for Glen Canyon National Recreation Area and Rainbow Bridge National Monument

Introduction

This appendix contains summary descriptions of the 35 Groups occurring at Glen Canyon National Recreation Area and Rainbow Bridge National Monument. Groups are one level above Alliances in the NVC hierarchy and are combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), with broadly similar composition, and diagnostic growth forms that reflect regional mesoclimate, geology, substrates, hydrology and disturbance regimes (NatureServe website: http://explorer.natureserve.org/classeco.htm). Each Group represents one or more National Vegetation Classification (NVC) plant associations or alliances. Map classes were also crosswalked to Groups (Table 10 within the main report).

The Group classification was developed in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. One purpose of Groups is to provide a coarse-scale mapping unit that can be applied across management boundaries.

INTERNATIONAL ECOLOGICAL CLASSIFICATION STANDARD:

TERRESTRIAL ECOLOGICAL CLASSIFICATIONS

Groups and Macrogroups of
Glen Canyon National Recreation Area and Rainbow Bridge National Monument

28 September 2016

by

NatureServe

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This subset of the International Ecological Classification Standard covers vegetation groups and macrogroups of Glen Canyon National Recreation Area. This classification has been developed in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. Comments and suggestions regarding the contents of this subset should be directed to Mary J. Russo, Central Ecology Data Manager, NC <mary_russo@natureserve.org> and Marion Reid, Senior Regional Ecologist, Boulder, CO <marion_reid@natureserve.org>.



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Elkins, WV; Wisconsin Natural Heritage Program, Madison, WI; Wyoming Natural Diversity Database, Laramie, WY

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1.B.2.Nb. Rocky Mountain Forest & Woodland (D194)

M022. Southern Rocky Mountain Lower Montane Forest

1. Forest & Woodland; 1.B. Temperate & Boreal Forest & Woodland; 1.B.2. Cool Temperate Forest & Woodland; 1.B.2.Nb. Rocky Mountain Forest & Woodland; M022. Southern Rocky Mountain Lower Montane Forest

G226. Southern Rocky Mountain White Fir - Douglas-fir Dry Forest

Scientific Name: *Abies concolor - Pseudotsuga menziesii* Southern Rocky Mountain Dry Forest Group

Common Name (Translated Scientific Name): White Fir - Douglas-fir Southern Rocky Mountain Dry Forest Group (Southern Rocky Mountain White Fir - Douglas-fir Dry Forest)

Classifiers: Transition between this group and Middle Rocky Mountain Montane Douglas-fir Forest & Woodland Group (G215) in Wyoming needs to be further clarified, both in terms of floristics and distribution details. For now, it is assumed that this group does not occur in the Bighorn Range or in the Yellowstone region, but its occurrence in isolated ranges of central and western Wyoming is possible.

Similar NVC Types: G202 Madrean Upper Montane Conifer - Oak Forest & Woodland; G225 Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest; G215 Middle Rocky Mountain Montane Douglas-fir Forest & Woodland.

Concept Summary: This group consists of dry mixed-conifer forests of mainly *Pseudotsuga menziesii* and *Abies concolor*, although as many as seven conifers can be found growing in the same occurrence, and there are a number of cold-deciduous shrub, forb and graminoid species common. It occurs throughout the southern Rocky Mountains and Great Basin and east into Texas, and has a mixed-severity fire regime.

Range: This is a group of the southern Rocky Mountains and Great Basin. It occurs from Nevada extending east into the Trans-Pecos plateaus of Texas, south to the Chihuahuan Desert, and throughout the Four Corners region. These are mixed-conifer forests occurring on all aspects at elevations ranging from 1200 to 3300 m. The composition and structure of the overstory are dependent upon the temperature and moisture relationships of the site and the successional status of the occurrence. *Pseudotsuga menziesii* and *Abies concolor* are most frequent, but *Pinus ponderosa* may be present to codominant. *Pinus flexilis* is common in Nevada. *Pseudotsuga menziesii* forests occupy drier sites, and *Pinus ponderosa* is a common codominant. *Abies concolor*-dominated forests occupy cooler sites, such as upper slopes at higher elevations, canyon sideslopes, ridgetops, and north- and east-facing slopes which burn somewhat infrequently. *Picea pungens* is uncommon in this group but does occur in cool, moist locations, often as smaller patches within a matrix of other associations. As many as seven conifers can be found growing in the same occurrence, and there are a number of cold-deciduous shrub, forb and graminoid species common, including *Juniperus communis, Cercocarpus ledifolius, Artemisia tridentata, Arctostaphylos uva-ursi, Mahonia repens, Paxistima myrsinites, Symphoricarpos oreophilus, Jamesia americana, Quercus gambelii, Galium*

triflorum, Muhlenbergia virescens, and *Festuca arizonica*. Forests in this group were undoubtedly characterized by a mixed-severity fire regime under "natural conditions," characterized by a high degree of variability in lethality and return interval.

Diagnostic Characteristics: The tree canopy is often dominated by the widespread *Pseudotsuga menziesii*, whereas *Abies concolor* is an indicator species that may be present to dominant in stands in the southern half of Colorado and northern New Mexico west into Arizona, Utah and Nevada. Diagnostic understory species are dry-mesic site indicators such as *Arctostaphylos patula, Arctostaphylos uva-ursi, Arnica cordifolia, Carex rossii, Cercocarpus ledifolius, Cercocarpus montanus, Danthonia parryi, Festuca arizonica, Juniperus communis, Mahonia repens, Poa fendleriana, Physocarpus monogynus, Pseudoroegneria spicata, Quercus gambelii, Quercus x pauciloba*, and *Vaccinium myrtillus*.

Physiognomy and Structure: **Rationale for Physiognomic Features:** *Pseudotsuga menziesii* is a widespread dominant or codominant tree species, whereas *Abies concolor* is an indicator species that may be present to dominant in stands in the southern half of Colorado and northern New Mexico west into Arizona, Utah and Nevada.

Mixed conifer-dominated woodlands and forests with shrub, grass or sparse understories. Occasionally broad-leaved deciduous trees are intermixed with the conifers in mesic environments.

Floristics: This highly variable ecological group comprises mixed-conifer forests at montane elevations throughout the Intermountain West region. *Abies concolor* dominates at higher, colder locations; *Picea pungens* represents mesic conditions; and *Pseudotsuga menziesii* dominates intermediate zones. As many as seven conifers can be found growing in the same occurrence, with the successful reproduction of the diagnostic species determining the association type. Common conifers include *Pinus ponderosa, Pinus flexilis, Abies lasiocarpa var. lasiocarpa, Abies lasiocarpa var. arizonica, Juniperus scopulorum*, and *Picea engelmannii*. *Populus tremuloides* is often present as intermingled individuals in remnant aspen clones or in adjacent patches. The composition and structure of the overstory are dependent upon the temperature and moisture relationships of the site and the successional status of the occurrence (DeVelice et al. 1986, Muldavin et al. 1996).

A number of cold-deciduous shrub and graminoid species are found in many occurrences (e.g., *Arctostaphylos uva-ursi, Mahonia repens, Paxistima myrsinites, Symphoricarpos oreophilus, Jamesia americana, Quercus gambelii*, and *Festuca arizonica*). Other important species include *Amelanchier alnifolia, Arctostaphylos patula, Holodiscus dumosus, Jamesia americana, Juniperus communis, Physocarpus monogynus, Quercus x pauciloba, Robinia neomexicana, Rubus parviflorus*, and *Vaccinium myrtillus*. Where soil moisture is favorable, the herbaceous layer may be quite diverse, including graminoids *Bromus ciliatus (= Bromus canadensis), Calamagrostis rubescens, Carex geyeri, Carex rossii, Carex siccata (= Carex foenea), Festuca occidentalis, Koeleria macrantha, Muhlenbergia montana, Muhlenbergia virescens, Poa fendleriana, Pseudoroegneria spicata*, and forbs *Achillea millefolium, Arnica cordifolia, Erigeron eximius, Fragaria virginiana, Linnaea borealis, Luzula parviflora, Osmorhiza berteroi, Packera cardamine (= Senecio cardamine), Thalictrum occidentale, Thalictrum fendleri, Thermopsis rhombifolia, Viola adunca*, and

species of many other genera, including *Lathyrus, Penstemon, Lupinus, Vicia, Arenaria, Galium*, and others.

Environmental Description: This group is widespread throughout the southern Rocky Mountains, occurring mostly on northerly and cooler aspects and less commonly westerly and southerly aspects at elevations ranging from 1200-3300 m. Landforms are variable and can include canyons, plateaus, draws, benches, hills, mesas, ravines, shoulder, sideslopes and toeslopes. Slopes can be gentle to extremely steep. *Climate:* Rainfall averages less than 75 cm per year (40-60 cm), with summer "monsoons" during the growing season contributing substantial moisture. *Soil/substrate/hydrology:* Geologic substrates include volcanic andesite, rhyolite, rhyolitic tuffs, colluvium, shale gneiss, granite, sandstone and limestone. Soils are variable from cobbles, clay loam, silt loam, sandy loam, sand, and gravel.

Geographic Range: This widespread group occurs throughout the southern Rocky Mountains, but extends west into the Great Basin in Nevada and east into the Trans-Pecos plateaus of Texas.

Nations [incomplete except for CA and US]: US

States/Provinces: AZ, CO, NM, NV, TX, UT, WY

M020. Rocky Mountain Subalpine-High Montane Conifer Forest

1. Forest & Woodland; 1.B. Temperate & Boreal Forest & Woodland; 1.B.2. Cool Temperate Forest & Woodland; 1.B.2.Nb. Rocky Mountain Forest & Woodland; M020. Rocky Mountain Subalpine-High Montane Conifer Forest

G222. Rocky Mountain Subalpine-Montane Aspen Forest & Woodland

Scientific Name: *Populus tremuloides* Rocky Mountain Forest & Woodland Group

Common Name (Translated Scientific Name): Quaking Aspen Rocky Mountain Forest & Woodland Group (Rocky Mountain Subalpine-Montane Aspen Forest & Woodland)

Classifiers: This group differs from Northwestern Great Plains Aspen Woodland Group (G328), which is limited to plains environments. The scattered occurrences in the Trans-Pecos of Texas are of interest as they represent disjunct outliers of the type occurring under highly limited circumstances. In Alberta and interior British Columbia, these forests transition to Alaskan-Yukon Boreal Dry Aspen Forest Group (G349). Associations where aspen is mixed with one or more Rocky Mountain conifers in the canopy, or even in the undergrowth, are placed into their respective conifer forest groups (e.g., into a spruce-fir group, or a mixed montane conifer group). Typically, in those associations, the floristics and species richness are more similar to conifer forest groups, than to the aspen group.

Similar NVC Types: G328 Northwestern Great Plains Aspen Woodland.

Concept Summary: This group consists of upland forests dominated by *Populus tremuloides* without significant conifer cover and an understory structure of complex multiple shrub and herbaceous layers, or simply just an herbaceous layer. It is widespread in the southern and central

Rocky Mountains but occurs in the montane and subalpine zones throughout much of the western U.S., south into northern Mexico and north into Canada.

Range: This widespread group is more common in the southern and central Rocky Mountains but occurs in the montane and subalpine zones throughout much of the western U.S., south into northern Mexico and north into Canada. An eastern extension occurs along the Rocky Mountains foothill front, in mountain "islands" in Montana (Big Snowy and Highwood mountains), and the Black Hills of South Dakota. In California, this group is in the Sierra Nevada adjacent to the Great Basin. Large stands are found in the Inyo and White mountains, while small stands occur on the Modoc Plateau. Elevations generally range from 1525 to 3050 m (5000-10,000 feet), but occurrences can be found at lower elevations in some regions. Distribution of this group is primarily limited by adequate soil moisture required to meet its high evapotranspiration demand. Secondarily, it is limited by the length of the growing season or low temperatures. These are upland forests and woodlands dominated by *Populus tremuloides* without a significant conifer component (<25% relative tree cover). The understory structure may be complex with multiple shrub and herbaceous layers, or simple with just an herbaceous layer. The herbaceous layer may be dense or sparse, dominated by graminoids and/or forbs. Associated shrub species include *Symphoricarpos* spp. (*Symphoricarpos oreophilus* being the most widespread and *Symphoricarpos albus* and *Symphoricarpos mollis* having limited distribution), *Rubus parviflorus, Amelanchier alnifolia, Prunus virginiana*, and *Arctostaphylos uva-ursi*.

Diagnostic Characteristics: Open to dense canopies of broad-leaved deciduous trees dominated by *Populus tremuloides*. It has Rocky Mountain floristics associated with it, as opposed to boreal floristics. The herbaceous layer may be dense or sparse, dominated by graminoids or forbs. Common shrubs include *Acer glabrum, Amelanchier alnifolia, Artemisia tridentata, Juniperus communis, Prunus virginiana, Rosa woodsii, Rhamnus alnifolia, Lonicera utahensis, Shepherdia canadensis, Symphoricarpos oreophilus,* and the dwarf-shrubs *Mahonia repens* and *Vaccinium* spp. The herbaceous layers may be lush and diverse. Common graminoids may include *Bromus carinatus, Calamagrostis rubescens, Carex siccata (= Carex foenea), Carex geyeri, Carex rossii, Elymus glaucus, Elymus trachycaulus, Festuca thurberi*, and *Hesperostipa comata*. Associated forbs may include *Achillea millefolium, Eucephalus engelmannii (= Aster engelmannii), Delphinium* spp., *Aconitum columbianum, Geranium viscosissimum, Heracleum sphondylium, Ligusticum filicinum, Lupinus argenteus, Osmorhiza berteroi (= Osmorhiza chilensis), Pteridium aquilinum, Rudbeckia occidentalis, Thalictrum fendleri, Valeriana occidentalis, Wyethia amplexicaulis*, and many others.

Physiognomy and Structure: **Rationale for Physiognomic Features:** *Populus tremuloides* is widely distributed in North America. In the Rocky Mountains and Intermountain West, it forms significant patches of deciduous forest with floristics distinctive of the Rockies, and indicative of particular fire or disturbance history.

Occurrences typically have a somewhat closed canopy of trees 5-20 m tall that is dominated by the cold-deciduous, broad-leaved tree *Populus tremuloides*. Conifers may contribute up to 15% of the canopy cover. The open-spaced stems of *Populus tremuloides* often give way to a lush understory consisting of complex multiple shrub and herbaceous layers, or just an herbaceous layer.

Floristics: Occurrences have a somewhat closed canopy of trees of 5-20 m tall that is dominated by the cold-deciduous, broad-leaved tree *Populus tremuloides*. Conifers that may be present but typically in minor amounts include *Abies concolor, Abies lasiocarpa, Picea engelmannii, Picea pungens, Pinus contorta, Pinus ponderosa*, and *Pseudotsuga menziesii*. Conifer species may contribute up to 15% of the tree canopy before the occurrence is reclassified as a mixed occurrence. Because of the open growth form of *Populus tremuloides*, enough light can penetrate for lush understory development. Depending on available soil moisture and other factors such as disturbance, the understory structure may be complex with multiple shrub and herbaceous layers, or simple with just an herbaceous layer. The herbaceous layer may be dense or sparse, dominated by graminoids or forbs. Common shrubs include *Acer glabrum, Amelanchier alnifolia, Artemisia tridentata, Juniperus communis, Prunus virginiana, Rosa woodsii, Rhamnus alnifolia, Lonicera utahensis, Shepherdia canadensis, Symphoricarpos oreophilus*, and the dwarf-shrubs *Mahonia repens* and *Vaccinium* spp. The herbaceous layers may be lush and diverse. Common graminoids may include *Bromus carinatus, Calamagrostis rubescens, Carex siccata (= Carex foenea), Carex geyeri, Carex rossii, Elymus glaucus, Elymus trachycaulus, Festuca thurberi*, and *Hesperostipa comata*. Associated forbs may include *Achillea millefolium, Eucephalus engelmannii (= Aster engelmannii), Delphinium* spp., *Aconitum columbianum, Geranium viscosissimum, Heracleum sphondylium, Ligusticum filicinum, Lupinus argenteus, Osmorhiza berteroi (= Osmorhiza chilensis), Pteridium aquilinum, Rudbeckia occidentalis, Thalictrum fendleri, Valeriana occidentalis, Wyethia amplexicaulis*, and many others. In California, *Symphyotrichum spathulatum (= Aster occidentalis)* is a common forb. Exotic grasses such as the perennials *Poa pratensis* and *Bromus inermis* and the annual *Bromus tectorum* are often common in occurrences due to grazing disturbance.

Environmental Description: Topography is variable; sites range from level to steep slopes. Aspect varies according to the limiting factors. Occurrences at high elevations are restricted by cold temperatures and are found on warmer southern aspects. At lower elevations, occurrences are restricted by lack of moisture and are found on cooler north aspects and mesic microsites.

Climate: Climate is temperate with a relatively long growing season, typically cold winters and deep snow. Mean annual precipitation is greater than 38 cm (15 inches) and typically greater than 51 cm (20 inches), except in semi-arid environments where occurrences are restricted to mesic microsites such as seeps or where large snow drifts develop. Distribution of this group is primarily limited by adequate soil moisture required to meet its high evapotranspiration demand (Mueggler 1988). Secondarily, its range is limited by the length of the growing season or low temperatures (Mueggler 1988).

Soil/substrate/hydrology: The soils are typically deep and well-developed with rock often absent from the soil. Soil texture ranges from sandy loam to clay loam. Parent materials are variable and may include sedimentary, metamorphic or igneous rocks, but it appears to grow best on limestone, basalt, and calcareous or neutral shales (Mueggler 1988).

Geographic Range: This group is more common in the southern and central Rocky Mountains but occurs in the montane and subalpine zones throughout much of the western U.S., south into northern Mexico and north into Canada. An eastern extension occurs along the Rocky Mountains foothill

front, in mountain "islands" in Montana (Big Snowy and Highwood mountains), and the Black Hills of South Dakota. In California, this group is in the Sierra Nevada adjacent to the Great Basin. Large stands are found in the Inyo and White mountains, while small stands occur on the Modoc Plateau. Very small occurrences may be found in a few scattered locations of the Trans-Pecos of Texas.

Nations [incomplete except for CA and US]: CA, MX, US

States/Provinces: AB, AZ, BC, CA, CO, ID, MT, NM, NV, OR, SD, TX, UT, WA, WY

1.B.2.Nc. Western North American Pinyon - Juniper Woodland & Scrub (D010)

M026. Intermountain Singleleaf Pinyon - Juniper Woodland

1. Forest & Woodland; 1.B. Temperate & Boreal Forest & Woodland; 1.B.2. Cool Temperate Forest & Woodland; 1.B.2.Nc. Western North American Pinyon - Juniper Woodland & Scrub; M026. Intermountain Singleleaf Pinyon - Juniper Woodland

G246. Colorado Plateau-Great Basin Juniper Open Woodland

Scientific Name: *Juniperus osteosperma* Open Woodland Group

Common Name (Translated Scientific Name): Utah Juniper Open Woodland Group (Colorado Plateau-Great Basin Juniper Open Woodland)

Classifiers: *Juniperus californica* savannas in the Central Valley of California and around the fringes of the Mojave Desert are not part of this group. In many cases, they are the result of some disturbance removing an oak component from one of the several oak woodland and savanna systems of California. This group does not extend north into the Columbia Plateau where *Juniperus occidentalis var. occidentalis* dominates the Columbia Plateau Western Juniper Open Woodland Group (G248). This Utah juniper savanna and woodland group does not include sparse juniper stands on rock outcrops or woodlands. It corresponds to both the *Juniperus osteosperma*-dominated portion of the *pinyon-juniper savanna* type (low to moderate cover of trees, well-developed graminoid understory, generally a minor shrub component, growing on deeper soils) and well as the *Juniperus osteosperma*-dominated portion of the *persistent pinyon-juniper woodland* type (occurs on rocky uplands with shallow, coarse-textured, and often skeletal soils that support relatively sparse herbaceous cover and rarely burn) described in Romme et al. (2009).

Similar NVC Types: G250 Colorado Plateau Pinyon - Juniper Woodland; G247 Great Basin Pinyon - Juniper Woodland.

Concept Summary: This widespread juniper woodland and savanna group occurs in the Colorado Plateau and Great Basin and is characterized by dominance of *Juniperus osteosperma* trees in an open tree canopy with high cover of perennial bunchgrasses and forbs (savannas) or an open to closed canopy often with a shrub understory (woodlands) and the lack of pinyon trees *Pinus edulis* and *Pinus monophylla*, which occur outside the ecological or geographic range of this type.

Range: This widespread juniper woodland and savanna group occupies dry foothills and sandsheets of the Colorado Plateau and eastern Great Basin from the western Colorado to Nevada and southern Idaho, and south to northwestern New Mexico and northern Arizona. The vegetation ranges from savanna, often with inclusions of denser patches of juniper, to open to dense woodland. The savanna stands are characterized by an open tree canopy of *Juniperus osteosperma* trees with high cover of perennial bunchgrasses and forbs, with *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Leymus salinus*, and *Pleuraphis jamesii* being most common. Woodland stands are generally open, but range from an open to closed canopy often with shrubs between trees depending on size of

gaps. Characteristic shrubs include *Artemisia nova, Artemisia tridentata, Cercocarpus intricatus, Coleogyne ramosissima,* and *Ephedra* spp. Pinyon trees are typically not present because sites are outside the ecological or geographic range of *Pinus edulis* and *Pinus monophylla*. These juniper woodlands and wooded grasslands are generally found at lower elevations and on more xeric sites than Great Basin Pinyon - Juniper Woodland Group (G247) or Colorado Plateau Pinyon - Juniper Woodland Group (G250). Elevation ranges from 1500-2300 m. Stands occur on lower mountain slopes, hills, plateaus, basins and more recently on flats where juniper is expanding into semi-desert grasslands and steppe.

Diagnostic Characteristics: These woodlands and savannas are characterized by the dominance of *Juniperus osteosperma* in the tree layer and absence of *Pinus monophylla* and *Pinus edulis*. If stand is a savanna, then there is a lush perennial grass layer with scattered *Juniperus osteosperma* trees. Characteristic grasses include *Achnatherum hymenoides, Hesperostipa comata, Leymus salinus*, and *Pleuraphis jamesii*. *Juniperus occidentalis var. occidentalis* is absent (or accidental) as it is restricted to Columbia Plateau Western Juniper Woodland & Savanna Group (G248).

Physiognomy and Structure: Rationale for Physiognomic Features: *Juniperus osteosperma* is the diagnostic and dominant tree species. The grass species are variable and too numerous to name, but are typical of the Great Basin and Colorado Plateau, such as *Leymus salinus, Pleuraphis jamesii*, and *Pleuraphis mutica*.

This group includes both open to closed woodlands dominated by the evergreen sclerophyllous tree *Juniperus osteosperma*, as well as savannas characterized by a lush perennial grass layer (20-90% cover) with tree layer dominated by *Juniperus osteosperma*. Woodland stands may have shrubs present to dense forming a layer.

Floristics: The vegetation is typically open savanna, although there may be inclusions of denser patches of juniper. This savanna is typically dominated by *Juniperus osteosperma* trees with high cover of perennial bunchgrasses and forbs, with *Bouteloua gracilis, Hesperostipa comata, Leymus salinus, Pleuraphis jamesii, Pleuraphis mutica,* and *Pseudoroegneria spicata* being most common. Pinyon trees are typically not present because sites are outside the ecological or geographic range of *Pinus edulis* and *Pinus monophylla*. Scattered shrubs may be present with low cover relative to the perennial herbaceous layer. Characteristic shrubs include *Artemisia arbuscula, Artemisia nova, Artemisia tridentata, Cercocarpus intricatus, Cercocarpus montanus, Coleogyne ramosissima, Ephedra* viridis, *Mahonia fremontii, Purshia tridentata,* and *Symphoricarpos oreophilus*. *Juniperus scopulorum* may codominate or replace *Juniperus osteosperma* in upper elevation stands, near washes, and in the cooler northern extent.

Environmental Description: This widespread juniper woodland and savanna group occupies dry foothills and sandsheets of the Colorado Plateau and eastern Great Basin. These wooded grasslands are generally found at lower elevations and on more xeric sites than Great Basin Pinyon - Juniper Woodland Group (G247) or Colorado Plateau Pinyon - Juniper Woodland Group (G250). Elevation ranges from 1500-2300 m. Stands occur on lower mountain slopes, hills, plateaus, basins and more

recently on flats where juniper is expanding into semi-desert grasslands and steppe. Soils are generally calcareous and alkaline, and often shallow and rocky, but may be acidic.

Geographic Range: This *Juniperus osteosperma* woodland and savanna group occupies dry foothills and sandsheets of the Colorado Plateau and Great Basin from western Colorado to Nevada and southern Idaho, and south to northwestern New Mexico and northern Arizona. Where it occurs in California, it is found only in the far eastern edges of the state within or adjacent to the Great Basin.

Nations [incomplete except for CA and US]: US

States/Provinces: AZ, CA, CO, ID, NM, NV, UT

M027. Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland

1. Forest & Woodland; 1.B. Temperate & Boreal Forest & Woodland; 1.B.2. Cool Temperate Forest & Woodland; 1.B.2.Nc. Western North American Pinyon - Juniper Woodland & Scrub; M027. Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland

G250. Colorado Plateau Pinyon - Juniper Woodland

Scientific Name: *Pinus edulis - Juniperus osteosperma* Woodland Group

Common Name (Translated Scientific Name): Two-needle Pinyon - Utah Juniper Woodland Group (Colorado Plateau Pinyon - Juniper Woodland)

Classifiers: This group corresponds to the *Pinus edulis*-dominated portion of the *persistent pinyon-juniper woodland* type from Romme et al. (2009) that occurs in the Colorado Plateau on rocky uplands with shallow, coarse-textured, and often skeletal soils that support relatively sparse herbaceous cover and rarely burn. The similar Great Basin Pinyon - Juniper Woodland Group (G247) is dominated or codominated by *Pinus monophylla*, not *Pinus edulis*. Hybrid pinyon stands are evaluated by overall floristics and environment with *Juniperus monosperma* more prevalent on more xeric, lower-elevation sites. Another similar group, Southern Rocky Mountain Pinyon - Juniper Woodland Group (G253), which is defined by the range of *Juniperus monosperma* and *Pinus edulis* in the southern Rocky Mountains, transitions into this group in the northwestern corner of New Mexico.

Similar NVC Types: G253 Southern Rocky Mountain Pinyon - Juniper Woodland; G247 Great Basin Pinyon - Juniper Woodland; G246 Colorado Plateau-Great Basin Juniper Open Woodland

Concept Summary: This woodland group is centered in the Colorado Plateau region and is composed of *Pinus edulis* often with *Juniperus osteosperma* or *Juniperus scopulorum* codominant in the tree canopy and a variable understory.

Range: This woodland group occurs in dry mountains and foothills of the Colorado Plateau region, including the Western Slope of Colorado and the Wasatch Range, south to the Mogollon Rim, and east into the northwestern corner of New Mexico. These woodlands are typically composed of a mix of *Pinus edulis* and *Juniperus osteosperma* in the tree canopy. Either tree may dominate as long as

there is significant presence of *Pinus edulis* (not accidental) to characterize the stand as a pinyon-juniper stand and not the typically more xeric lower-elevation *Juniperus osteosperma* woodland and savanna. *Juniperus scopulorum* may replace *Juniperus osteosperma* and codominate at higher-elevation/less xeric sites.

In the southern portion of the Colorado Plateau in northern Arizona and northwestern New Mexico, hybrids of *Juniperus monosperma* and *Juniperus osteosperma* or both juniper species may dominate or codominate the tree canopy. Understory layers are variable and may be dominated by shrubs, graminoids, or be absent. Associated species include *Arctostaphylos patula, Artemisia tridentata, Cercocarpus intricatus, Cercocarpus montanus, Coleogyne ramosissima, Purshia stansburiana, Purshia tridentata, Quercus gambelii, Bouteloua gracilis, Pleuraphis jamesii, Pseudoroegneria spicata, Poa secunda,* or *Poa fendleriana*. This group occurs at higher elevations than Great Basin Pinyon - Juniper Woodland Group (G247) where sympatric on the Colorado Plateau.

Stands are typically found at lower elevations but ranges from 1500-2440 m. These woodlands occur on warm, dry sites on mountain slopes, mesas, plateaus, and ridges. Severe climatic events occurring during the growing season, such as frosts and drought, are thought to limit the distribution of pinyon-juniper woodlands to relatively narrow altitudinal belts on mountainsides. Soils supporting this group vary in texture, ranging from stony, cobbly, gravelly, or sandy loams to clay loam or clay.

Diagnostic Characteristics: *Pinus edulis* and *Juniperus osteosperma* typically codominate the tree canopy in this group. However, either tree may dominate as long as there is significant presence of *Pinus edulis* (not accidental) to characterize the stand as a pinyon-juniper stand and not the typically more xeric lower-elevation *Juniperus osteosperma* woodland and savanna. This group is restricted to where the ranges of *Pinus edulis* and *Juniperus osteosperma* overlap and includes areas where hybrids between *Juniperus monosperma* and *Juniperus osteosperma* or mixed stands occur in northern Arizona and northwestern New Mexico. Understory diagnostic species are more characteristic of the Great Basin than Rocky Mountains, such as *Arctostaphylos patula, Artemisia nova, Artemisia tridentata, Cercocarpus intricatus, Coleogyne ramosissima, Purshia stansburiana, Purshia tridentata, Pleuraphis jamesii, Pseudoroegneria spicata, Poa secunda,* or *Poa fendleriana*.

Physiognomy and Structure: **Rationale for Physiognomic Features:** *Pinus edulis* and *Juniperus osteosperma* are diagnostic of this woodland group and typically dominate the tree canopy.

These woodlands are characterized by diagnostic tree species *Pinus edulis* and *Juniperus osteosperma* that form an open to dense tree layer 3-10 m tall. Shrub and herbaceous layers are variable and may be sparse to dense or absent. On extremely xeric sites, diagnostic trees species may only attain 2 m in height and have more of shrub form.

Floristics: This woodland group is dominated by *Pinus edulis* and/or *Juniperus osteosperma* in the tree canopy. *Juniperus scopulorum* may codominate at higher elevations. In the southern portion of the Colorado Plateau in northern Arizona and northwestern New Mexico, hybrids between *Juniperus monosperma* and of *Juniperus osteosperma* or both may dominate or codominate the tree canopy. *Juniperus scopulorum* may codominate with *Juniperus osteosperma* at higher elevations. Understory

layers are variable and may be dominated by shrubs, graminoids, or be absent. Associated species include *Arctostaphylos patula, Artemisia tridentata, Cercocarpus intricatus, Cercocarpus montanus, Coleogyne ramosissima, Purshia stansburiana, Purshia tridentata, Quercus gambelii, Bouteloua gracilis, Pleuraphis jamesii, Pseudoroegneria spicata, Poa secunda,* or *Poa fendleriana*.

Environmental Description: This woodland group occurs in dry mountains and foothills of the Colorado Plateau region and is typically found at lower elevations but ranges from 1500-2440 m. These woodlands occur on warm, dry sites on mountain slopes, mesas, plateaus, and ridges. Severe climatic events occurring during the growing season, such as frosts and drought, are thought to limit the distribution of pinyon-juniper woodlands to relatively narrow altitudinal belts on mountainsides. Soils supporting this group vary in texture, ranging from stony, cobbly, gravelly, or sandy loams to clay loam or clay.

Geographic Range: This group occurs on dry mountains and foothills of the Colorado Plateau region from the Western Slope of Colorado to the Wasatch Range, south to the Mogollon Rim, and east into the northwestern corner of New Mexico.

Nations [incomplete except for CA and US]: US

States/Provinces: AZ, CO, NM, UT, WY?

1.B.3.Nc. Rocky Mountain-Great Basin Montane Flooded & Swamp Forest (D195)

M034. Rocky Mountain-Great Basin Montane Riparian & Swamp Forest

1. Forest & Woodland; 1.B. Temperate & Boreal Forest & Woodland; 1.B.3. Temperate Flooded & Swamp Forest; 1.B.3.Nc. Rocky Mountain-Great Basin Montane Flooded & Swamp Forest; M034. Rocky Mountain-Great Basin Montane Riparian & Swamp Forest

G506. Rocky Mountain-Great Basin Montane Riparian & Swamp Forest

Scientific Name: *Picea engelmannii - Picea pungens - Populus angustifolia* Riparian & Swamp Forest Group

Common Name (Translated Scientific Name): Engelmann Spruce - Blue Spruce - Narrowleaf Cottonwood Riparian & Swamp Forest Group (Rocky Mountain-Great Basin Montane Riparian & Swamp Forest)

Classifiers: This group is restricted to montane riparian areas and avalanche chutes between lower and upper treeline.

Similar NVC Types: G505 Rocky Mountain-Great Basin Swamp Forest: occurs on saturated, extremely poorly drained soil; G507 North Pacific Montane Riparian Woodland.

Concept Summary: This riparian forest group includes seasonally flooded conifer-dominated forests found at montane to subalpine elevations of the Rocky Mountain cordillera, from southern New Mexico north into Montana, and west into the Intermountain West region and the Colorado Plateau. Picea engelmannii, Picea pungens, and/or Populus angustifolia dominate, and the understory is often dominated by forbs or graminoids with only a few shrubs. Soils are mineral and very well-oxygenated.

Range: This group contains woodlands dominated by cottonwood, conifer and aspen that line montane streams. Dominant tree species usually include Abies lasiocarpa, Picea engelmannii, Pinus ponderosa, Juniperus scopulorum, and/or Populus angustifolia; other important species include Pseudotsuga menziesii, Picea pungens, Picea engelmannii x glauca, and Populus tremuloides. Other trees possibly present but not usually dominant include Alnus incana, Abies concolor, Abies grandis, Pinus contorta, and Juniperus osteosperma. Shrub cover tends to be limited but may include Alnus incana, Betula occidentalis, Cornus sericea, Crataegus rivularis, Forestiera pubescens var. pubescens, Ribes spp., Rosa woodsii, Salix spp., and others. The herbaceous undergrowth can be lush to depauperate. Herbaceous species include Calamagrostis canadensis, Carex aquatilis var. aquatilis, Carex obnupta, Carex pellita, Equisetum arvense, Heracleum maximum, Ranunculus alismifolius, Senecio bigelovii var. bigelovii, Streptopus amplexifolius, and Veratrum californicum. This riparian group includes seasonally flooded forests found at montane to subalpine elevations of the Rocky Mountain cordillera, from southern New Mexico north into Montana, and west into the Intermountain West region and the Colorado Plateau. It occurs throughout the interior of British Columbia and the eastern slopes of the Cascade Range. These are communities tolerant of periodic

flooding and high water tables. Snowmelt moisture may create shallow water tables or seeps for a portion of the growing season. Stands typically occur at elevations between 1500 and 3300 m (4920-10,830 feet); farther north, elevation ranges between 900 and 2000 m. This is confined to specific riparian environments occurring on floodplains or terraces of rivers and streams, in V-shaped, narrow valleys and canyons (where there is cold-air drainage). Less frequently, occurrences are found in moderately wide valley bottoms on large floodplains along broad, meandering rivers, and on pond or lake margins.

Diagnostic Characteristics: This group contains the conifer and aspen woodlands that line montane streams. These are communities tolerant of periodic flooding and high water tables.

Physiognomy and Structure: Open to closed woodlands of tall conifer or deciduous trees with or without an understory of deciduous shrubs, generally forming linear bands following streams. These can blend into the surrounding upland forest, and often only the understory herbaceous species indicate the wet nature of the soils.

Floristics: Dominant tree species usually include Abies lasiocarpa, Abies grandis, Picea engelmannii, Picea pungens, Populus angustifolia, Pinus ponderosa, Pinus contorta, and/or Juniperus scopulorum; other important species include Pseudotsuga menziesii, Picea engelmannii x glauca, and Populus tremuloides. Other trees possibly present and dominant or codominant include Abies concolor, Abies grandis, Pinus contorta, and Juniperus osteosperma. Shrub cover tends to be limited but may include Alnus incana, Betula occidentalis, Cornus sericea, Crataegus rivularis, Forestiera pubescens var. pubescens, Ribes spp., Rosa woodsii, Salix spp., and others. The herbaceous undergrowth can be lush to depauperate. Herbaceous species include Calamagrostis canadensis, Carex aquatilis var. aquatilis, Carex obnupta, Carex pellita, Equisetum arvense, Heracleum maximum, Ranunculus alismifolius, Senecio bigelovii var. bigelovii, Streptopus amplexifolius, and Veratrum californicum. Floristic information is compiled from several sources for eastern Washington and Oregon (Kovalchik 1987, 1993, Crowe and Clausnitzer 1997), Nevada (Manning and Padgett 1995), Colorado (Kittel et al. 1999b), Montana (Butler 1979, 1985, Malanson and Butler 1984, Hansen et al. 1989), British Columbia (MacKenzie and Moran 2004), Utah (Padgett et al. 1989, Tuhy et al. 2002), New Mexico and Arizona (Szaro 1989, Muldavin et al. 2000a), and Wyoming (Walford 1996, Walford et al. 2001).

Environmental Description: Climate: Temperate cold. Soil/substrate/hydrology: Stands typically occur at elevations between 1500 and 3300 m (4920-10,830 feet); farther north, elevation ranges between 900 and 2000 m. This group is confined to specific riparian environments occurring on floodplains or terraces of rivers and streams, in V-shaped, narrow valleys and canyons (where there is cold-air drainage). Less frequently, occurrences are found in moderately wide valley bottoms on large floodplains along broad, meandering rivers, on pond or lake margins, and seeps on gentle slopes. Environmental information is compiled from several sources: for eastern Washington and Oregon (Kovalchik 1987, 1992, 2001, Crowe and Clausnitzer 1997); for Nevada (Manning and Padgett 1995); for Colorado (Baker 1988, 1989a, 1989b, 1990, Kittel et al. 1994, 1995, 1999a, 1999b); for Montana (Butler 1979, 1985, Malanson and Butler 1984, Hansen et al. 1989); for British Columbia (MacKenzie and Moran 2004); for Utah (Padgett et al. 1989, Tuhy et al. 2002); for New

Mexico and Arizona (Szaro 1989, Muldavin et al. 2000a); and for Wyoming (Walford 1996, Walford et al. 2001).

Geographic Range: This group is found at montane to subalpine elevations of the Rocky Mountain cordillera, from southern New Mexico north into Montana, Alberta and British Columbia, and west into the Intermountain West region and the Colorado Plateau.

Nations [incomplete except for CA and US]: CA, US

States/Provinces: AB, AZ, BC, CA, CO, ID, MT, NM, NV, OR, SD, UT, WA, WY

1.B.3.Nd. Western North American Interior Flooded Forest (D013)

M036. Interior Warm & Cool Desert Riparian Forest

1. Forest & Woodland; 1.B. Temperate & Boreal Forest & Woodland; 1.B.3. Temperate Flooded & Swamp Forest; 1.B.3.Nd. Western North American Interior Flooded Forest; M036. Interior Warm & Cool Desert Riparian Forest

G797. Western Interior Riparian Forest & Woodland

Scientific Name: Western Interior Riparian Forest & Woodland Group

Common Name (Translated Scientific Name): Western Interior Riparian Forest & Woodland Group (Western Interior Riparian Forest & Woodland)

Classifiers: This group combine warm southwestern deserts with cool interior lower elevation rivers, and occurs from sea level, but does not include montane elevations.

Similar NVC Types: G510 Interior West Ruderal Riparian Forest & Scrub; G533 North American Warm Desert Riparian Low Bosque & Shrubland; G541 Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope.

Concept Summary: This group consists of riparian woodlands dominated by trees and tall arborescent shrubs, with species such as *Acer negundo, Celtis laevigata var. reticulata, Cephalanthus occidentalis, Fraxinus velutina, Juglans major, Platanus wrightii, Populus deltoides, Populus fremontii, Platanus racemosa, Quercus lobata, Salix gooddingii, Salix laevigata, Sapindus saponaria,* and *Washingtonia filifera*. It is found throughout lowlands of the Interior West, including southwestern warm and cool deserts and Mediterranean California.

Range: This group consists of riparian woody vegetation. Dominant trees may include *Acer negundo, Celtis laevigata var. reticulata, Cephalanthus occidentalis, Fraxinus velutina, Juglans major, Platanus wrightii, Populus deltoides ssp. wislizeni, Populus deltoides ssp. monilifera, Populus fremontii, Platanus racemosa, Quercus lobata, Salix gooddingii, Salix laevigata, Sapindus saponaria,* and *Washingtonia filifera*. Dominant shrubs include *Alnus oblongifolia, Baccharis salicifolia, Prunus* spp., *Salix exigua, Salix lasiolepis, Shepherdia argentea,* and *Vitis californica*. Other dominants on serpentine substrates include *Aquilegia eximia, Carex serratodens, Cirsium fontinale, Cupressus sargentii, Frangula californica ssp. tomentella (= Rhamnus tomentella), Mimulus glaucescens, Mimulus guttatus, Packera clevelandii (= Senecio clevelandii), Salix breweri, Solidago* spp., *Stachys albens,* and *Umbellularia californica*. The variety of plant associations within this group reflects elevation, stream gradient, floodplain width, and flooding events. It also includes springs, seeps, and perennial and intermittent streams and riparian areas found on serpentine substrates. These are disturbance-driven systems that require flooding, scour and deposition for germination and maintenance. Periodic flooding and associated sediment scour are necessary to maintain growth and reproduction of vegetation. Flooding regimes have been significantly altered in all but a few tributaries that support this group. This group occurs throughout lowlands of the interior

west, including southwest warm and cool deserts and Mediterranean California, generally below about 1800 m (6000 feet) elevation. Known occurrences include the following rivers and their tributaries: Colorado, Gila, Pecos, Rio Grande, Sacramento, San Joaquin, Santa Cruz, Salt, San Pedro, Truckee rivers, and others.

Diagnostic Characteristics: This group occurs in the warm desert regions (Sonoran and Mojave) of the southwestern U.S. and adjacent Mexico, Mediterranean California, and the cool desert interior in riparian corridors along perennial and seasonally intermittent streams and spring-fed depressions. Diagnostic tree species trees include *Juglans major*, *Platanus racemosa, Platanus wrightii, Populus deltoides ssp. monilifera, Populus deltoides ssp. wislizeni, Populus fremontii, Salix laevigata,* and *Washingtonia filifera*. Shrubs are rich and varied. Stands are always adjacent to streams or their floodplains and have been observed to follow narrow tributaries. Seasonal flooding and soil saturation by a rising water table are necessary to maintain growth and reproduction of vegetation.

Physiognomy and Structure: Open to closed woodlands of tall cold-deciduous trees and shrubs, forming linear bands following stream and river courses and alluvial floodplains. Herbaceous undergrowth is variable depending on the amount of shading in the overstory.

Floristics: The vegetation is a mix of riparian woodlands dominated by trees and tall arborescent shrubs. Dominant trees include *Acer macrophyllum, Acer negundo, Alnus rhombifolia, Alnus rubra, Celtis laevigata var. reticulata, Cephalanthus occidentalis, Fraxinus velutina, Juglans major, Platanus racemosa, Platanus wrightii, Populus deltoides ssp. wislizeni, Populus deltoides ssp. monilifera, Populus fremontii, Pseudotsuga menziesii, Quercus agrifolia, Quercus lobata, Salix gooddingii, Salix laevigata, Salix lasiolepis, Sapindus saponaria,* and *Washingtonia filifera*. Shrub dominants include *Alnus oblongifolia, Baccharis salicifolia, Prunus* spp., *Salix exigua, Salix geyeriana, Salix lasiolepis,* and *Vitis californica*. Other dominants on serpentine substrates include *Aquilegia eximia, Carex serratodens, Cirsium fontinale, Cupressus sargentii, Frangula californica ssp. tomentella (= Rhamnus tomentella), Mimulus glaucescens, Mimulus guttatus, Packera clevelandii (= Senecio clevelandii), Salix breweri, Solidago* spp., *Stachys albens,* and *Umbellularia californica*. These are disturbance-driven systems that require flooding, scour and deposition for germination and maintenance. Exotic species that may be present include *Ailanthus altissima, Eucalyptus* spp., and *Tamarix* spp., and herbs such as *Arundo donax*.

Environmental Description: Stands occur on streambanks and floodplains. The variety of plant associations within this group reflects elevation, stream gradient, floodplain width, and flooding events. It also includes springs, seeps, and perennial and intermittent streams on serpentine substrates.

Geographic Range: The group occurs throughout Mediterranean California, California's Central Valley, the southern Coast Ranges of Oregon, the lower valleys of Nevada and the Colorado Plateau south into the canyons and desert valleys of the Sonoran and Mojave deserts of southwestern United States and adjacent Mexico. Specifically, it is known in California, southern Oregon, Nevada, Utah, Colorado, southern Arizona, New Mexico, adjacent Mexico (Baja California, Baja California del Sur, Chihuahua), and western Texas. Elevation ranges from sea level up to 1800 m.

Nations [incomplete except for CA and US]: MX, US

States/Provinces: AZ, CA, CO, MXBC?, MXBS, MXCH, MXSO, NM, NV, OR, UT

M298. Interior West Ruderal Flooded & Swamp Forest & Woodland

1. Forest & Woodland; 1.B. Temperate & Boreal Forest & Woodland; 1.B.3. Temperate Flooded & Swamp Forest; 1.B.3.Nd. Western North American Interior Flooded Forest; M298. Interior West Ruderal Flooded & Swamp Forest & Woodland

G510. Interior West Ruderal Riparian Forest & Scrub

Scientific Name: *Tamarix* spp. - *Elaeagnus angustifolia* Ruderal Riparian Forest & Scrub Group

Common Name (Translated Scientific Name): Tamarisk species - Russian-olive Ruderal Riparian Forest & Scrub Group (Interior West Ruderal Riparian Forest & Scrub)

Classifiers: The name is "scrub" rather than forest or woodland to capture lower heights and more open canopy densities and the fact that some dominant species are multi-stemmed and may not meet "forest" or "woodland" criteria. Planted stands of *Washingtonia robusta, Washingtonia filifera,* and *Phoenix canariensis* are not part of this group but would be considered "cultural" vegetation. *Washingtonia robusta* is native to Mexico, so only naturalized stands within the U.S. belong to this group. **Similar NVC Type:** G797 Western Interior Riparian Forest & Woodland.

Concept Summary: Stands of *Tamarix* spp., *Elaeagnus angustifolia,* or other introduced facultative wet-tolerant species in low-elevation riparian areas throughout the western U.S. and into Mexico.

Range: This group consists of low-elevation riparian areas, seeps and springs throughout the southwestern U.S. and into Mexico that are dominated by non-native invasive woody species. Present to abundant species include *Elaeagnus angustifolia, Myoporum laetum, Phoenix canariensis, Prunus mahaleb, Robinia pseudoacacia, Schinus molle, Schinus terebinthifolius, Tamarix* spp., *Ulmus pumila,* or *Washingtonia robusta*. Salt-cedar habitats tend to support fewer species and individuals than native habitats. If present, native species contribute less than 10% relative cover. Elevation ranges from sea level to above 2135 m (7000 feet). Sites are typically streambanks and benches, floodplains and canyons with permanent, intermittent or temporary waterflow.

Diagnostic Characteristics: Tall, deciduous trees dominated by naturalized, invasive species not considered native to North America or, if native to North America, naturalized beyond their native ranges.

Physiognomy and Structure: Open- to closed-canopy riparian woodlands that can have a scrubby appearance (multi-stemmed, 1-20 m tall) dominated by non-native woody species, generally following linear paths of adjacent streams, rivers and floodplains.

Floristics: Present to abundant species include *Elaeagnus angustifolia, Myoporum laetum, Phoenix canariensis, Prunus mahaleb, Robinia pseudoacacia, Schinus molle, Schinus terebinthifolius, Tamarix* spp., *Ulmus pumila,* or *Washingtonia robusta*. Some of these are not necessarily restricted to riparian/wetland settings. Salt-cedar habitats tend to support fewer species and individuals than

native habitats (Smith and Douglas 1989, Barbour et al. 2007, Sogge et al. 2008, Sawyer et al. 2009). Non-native understory species may include *Acroptilon repens, Aegilops* sp., *Agrostis gigantea, Agrostis stolonifera, Alopecurus geniculatus, Alopecurus pratensis, Arundo donax, Conyza canadensis, Cirsium arvense, Echinochloa crus-galli, Eichhornia crassipes, Hordeum murinum, Phalaris arundinacea, Phleum pratense, Phragmites australis, Poa palustris, Poa pratensis, Rumex crispus*, and *Sonchus arvensis.*

Environmental Description: Elevation ranges from sea level to above 2135 m (7000 feet). *Climate:* Warm Temperate. *Soil/substrate/hydrology:* Sites are typically alluvial streambanks and floodplains, with slightly alkaline soils and water heavy in agricultural runoff (Smith and Douglas 1989, Barbour et al. 2007, Sogge et al. 2008, Sawyer et al. 2009).

Geographic Range: This group is found throughout the western interior of the U.S. and into Mexico.

Nations [incomplete except for CA and US]: MX, US

States/Provinces: AZ, CA, NM, NV, OK, TX

2.B.2.Na. Western North American Grassland & Shrubland (D022)

M049. Southern Rocky Mountain Montane Shrubland

2. Shrub & Herb Vegetation; 2.B. Temperate & Boreal Grassland & Shrubland; 2.B.2. Temperate Grassland & Shrubland; 2.B.2.Na. Western North American Grassland & Shrubland; M049. Southern Rocky Mountain Montane Shrubland

G277. Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland

Scientific Name: *Quercus gambelii - Amelanchier* spp. - *Prunus virginiana* Southern Rocky Mountain Montane Shrubland Group

Common Name (Translated Scientific Name): Gambel Oak - Serviceberry species - Chokecherry Southern Rocky Mountain Montane Shrubland Group (Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland)

Classifiers: Disjunct *Quercus gambelii*-dominated shrublands found in the Davis Mountains and probably the Guadalupe Range in the Trans-Pecos of Texas are included in the concept of Eastern Madrean Chaparral Group (G280). *Quercus gambelii* apparently occurs as a significant component of a shrubland of the Trans-Pecos of Texas; however, most of the other species that codominate in this group do not occur in the Trans-Pecos. This group is not currently attributed to Texas, and it seems more appropriate to modify the description of Eastern Madrean Chaparral Group (G280) to allow for the presence of *Quercus gambelii* as a significant component of some occurrences. However, *Quercus gambelii / Symphoricarpos oreophilus* Shrubland (CEGL001117) is an association found in the Trans-Pecos. Also, there is a need to clarify the concept of Southern Rocky Mountain Mountain-mahogany - Mixed Foothill Shrubland Group (G276).

Similar NVC Types: G272 Central Rocky Mountain Montane-Foothill Deciduous Shrubland; G276 Southern Rocky Mountain Mountain-mahogany - Mixed Foothill Shrubland.

Concept Summary: This group occurs in the mountains, plateaus and foothills of the southern Rocky Mountains and Colorado Plateau, and is typically dominated by *Quercus gambelii* alone or codominant with *Amelanchier alnifolia, Amelanchier utahensis, Artemisia tridentata, Cercocarpus montanus, Fraxinus anomala, Prunus virginiana, Purshia stansburiana, Purshia tridentata, Robinia neomexicana, Symphoricarpos oreophilus,* or *Symphoricarpos rotundifolius*.

Range: This group occurs in the mountains, plateaus and foothills of the southern Rocky Mountains and Colorado Plateau, including the Uinta and Wasatch ranges and the Mogollon Rim. The vegetation is typically dominated by *Quercus gambelii* alone or codominant with *Amelanchier alnifolia, Amelanchier utahensis, Artemisia tridentata, Cercocarpus montanus, Fendlera rupicola, Fraxinus anomala, Holodiscus dumosus, Jamesia americana, Prunus virginiana, Purshia stansburiana, Purshia tridentata, Robinia neomexicana, Symphoricarpos oreophilus,* or *Symphoricarpos rotundifolius*. There may be inclusions of other mesic montane shrublands with *Quercus gambelii* absent or as a relatively minor component. These shrublands are most commonly

found along dry foothills, lower mountain slopes, and at the edge of the western Great Plains from approximately 2000 to 2900 m in elevation, and are often situated above pinyon-juniper woodlands. Substrates are variable and include soil types ranging from calcareous, heavy, fine-grained loams to sandy loams, gravelly loams, clay loams, deep alluvial sand, or coarse gravel. This group intergrades with Southern Rocky Mountain Mountain-mahogany - Mixed Foothill Shrubland Group (G276) and shares many of the same site characteristics. However, this group includes more mesic communities. Density and cover of *Quercus gambelii* and *Amelanchier* spp. often increase after fire.

Diagnostic Characteristics: Stands of this group are typically dominated by broad-leaved, deciduous shrubs, which are typical of the montane zones of the southern Rocky Mountains. *Quercus gambelii* is the main species in most occurrences, although some may have equal amounts of (or only) *Amelanchier alnifolia, Amelanchier utahensis, Artemisia tridentata, Cercocarpus montanus, Ceanothus fendleri, Fendlera rupicola, Fraxinus anomala, Holodiscus dumosus, Jamesia americana, Prunus virginiana, Purshia stansburiana, Purshia tridentata, Rhus trilobata, Robinia neomexicana, Symphoricarpos oreophilus*, or *Symphoricarpos rotundifolius*. The herbaceous layer is not consistent, having sparse to moderately dense cover and mostly composed of graminoids, including *Carex geyeri, Carex inops, Festuca thurberi, Hesperostipa comata, Muhlenbergia montana*, and *Poa fendleriana*.

Physiognomy and Structure: **Rationale for Physiognomic Features:** The primary nominal species in this mesic montane shrubland group is *Quercus gambelii*, which is the diagnostic and typically the dominant or codominant tall-shrub species. *Amelanchier alnifolia* and to a lesser extent (drier) *Amelanchier utahensis* are diagnostic shrub species and may also be dominant. *Prunus virginiana* is more widespread but is a good indicator of mesic conditions and is included as a nominal species. *Robinia neomexicana* is also a good diagnostic species but has a limited distribution. Other species not chosen, such as *Artemisia tridentata, Cercocarpus montanus, Purshia stansburiana, Purshia tridentata, Robinia neomexicana, Symphoricarpos oreophilus*, or *Symphoricarpos rotundifolius*, are characteristic of the group, but occur in a variety of dry and mesic shrub communities.

The vegetation may occur as sparse to dense broad-leaved deciduous shrublands composed of moderate to tall shrubs, or occasionally small trees. Occurrences may be multi-layered, with some short shrubby species occurring in the understory of the dominant overstory species. They can range from dense thickets with little understory to relatively mesic mixed shrublands with a rich understory of shrubs, grasses and forbs. These shrubs often have a patchy distribution with grass growing in between. Scattered trees are occasionally present in stands.

Floristics: In many occurrences of this group, the canopy is dominated by the broad-leaved deciduous shrub *Quercus gambelii*, which occasionally reaches small tree size. It may form dense thickets with little understory or be relatively open with a rich understory of shrubs, grasses and forbs. Scattered trees are occasionally present and typically include species of *Juniperus* or *Pinus*. Characteristic shrubs that may co-occur, or be singularly dominant, include *Amelanchier alnifolia, Amelanchier utahensis, Arctostaphylos patula, Artemisia tridentata, Ceanothus fendleri, Cercocarpus montanus, Fendlera rupicola, Fraxinus anomala, Holodiscus dumosus, Jamesia americana, Ptelea trifoliata, Prunus virginiana, Purshia stansburiana, Robinia neomexicana, Rosa*

spp., *Symphoricarpos oreophilus*, and *Symphoricarpos rotundifolius*. The herbaceous layer is sparse to moderately dense, ranging from 1-40% cover. Perennial graminoids are the most abundant species, particularly *Bouteloua curtipendula, Bouteloua eriopoda, Bouteloua gracilis, Aristida* spp., *Carex inops, Carex geyeri, Elymus arizonicus, Eragrostis* spp., *Festuca* spp., *Koeleria macrantha, Muhlenbergia* spp., and *Hesperostipa* spp. Many forb and fern species can occur, but none have much cover. Commonly present forbs include *Achillea millefolium, Artemisia* spp., *Geranium* spp., *Maianthemum stellatum, Thalictrum fendleri*, and *Vicia americana*. Ferns include species of *Cheilanthes* and *Woodsia*. Annual grasses and forbs are seasonally present, and weedy annuals are often present, at least seasonally.

Environmental Description: This group typically occupies the lower slope positions of the foothill and lower montane zones. Stands may occur on level to steep slopes, cliffs, escarpments, rimrock slopes, rocky outcrops, and scree slopes. Climate is semi-arid and characterized by mostly hot-dry summers with mild to cold winters and annual precipitation of 25 to 70 cm. Precipitation mostly occurs as winter snows but may also consist of some late-summer rains. Soils are typically poorly developed, rocky to very rocky, and well-drained. Parent materials include alluvium, colluvium, and residuum derived from igneous, metamorphic or sedimentary rocks such as granite, gneiss, limestone, quartz, monzonite, rhyolite, sandstone, schist, and shale.

Climate: Climate is semi-arid and characterized by mostly hot-dry summers with mild to cold winters and annual precipitation of 25 to 70 cm. Precipitation mostly occurs as winter snows but may also consist of some late-summer or monsoonal rains. *Soil/substrate/hydrology:* Soils are typically poorly developed, rocky to very rocky, and well-drained. Parent materials include alluvium, colluvium, and residuum derived from igneous, metamorphic or sedimentary rocks such as granite, gneiss, limestone, quartz, monzonite, rhyolite, sandstone, schist, and shale.

Geographic Range: This group occurs in the mountains, plateaus and foothills of the southern Rocky Mountains and Colorado Plateau, including the Uinta and Wasatch ranges and the Mogollon Rim.

Nations [incomplete except for CA and US]: US

States/Provinces: AZ, CO, NM, NV?, UT, WY

G276. Southern Rocky Mountain Mountain-mahogany - Mixed Foothill Shrubland
Scientific Name: *Cercocarpus montanus - Quercus x pauciloba - Rhus trilobata* Foothill Shrubland Group

Common Name (Translated Scientific Name): Alderleaf Mountain-mahogany - Wavyleaf Oak - Skunkbush Sumac Foothill Shrubland Group (Southern Rocky Mountain Mountain-mahogany - Mixed Foothill Shrubland)

Classifiers: While *Cercocarpus montanus* is the common dominant shrub in this group, it is not the only dominant, and in many occurrences is not found at all. In addition, in some occurrences, shrub cover is low, which allows for some stands to be graminoid-dominated. In Wyoming, stands where

Cercocarpus montanus is a component of mixed shrublands are placed in Central Rocky Mountain Montane-Foothill Deciduous Shrubland Group (G272).

Similar NVC Types: G277 Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland; G272 Central Rocky Mountain Montane-Foothill Deciduous Shrubland.

Concept Summary: This foothills shrubland group occurs in the Rocky Mountains and Colorado Plateau from lower montane zone to canyons and breaks in the western Great Plains and is characterized by an open to closed shrub layer of nearly pure *Cercocarpus montanus* or a mixed shrub layer with *Amelanchier utahensis, Quercus x pauciloba, Purshia tridentata, Rhus trilobata, Ribes cereum,* or *Symphoricarpos oreophilus.*

Range: This Rocky Mountain foothill shrubland group ranges from southern New Mexico north into Wyoming, and west into the Intermountain West region. *Cercocarpus montanus* dominates pure stands in parts of Wyoming and Colorado. The vegetation is typically dominated by a variety of shrubs, including *Amelanchier utahensis, Cercocarpus montanus, Quercus x pauciloba, Purshia tridentata, Rhus trilobata, Ribes cereum, Symphoricarpos oreophilus,* or *Yucca glauca*. Grasses and sedges are dominant in the understory and may include *Achnatherum scribneri, Bouteloua curtipendula, Carex geyeri, Elymus lanceolatus, Hesperostipa comata, Hesperostipa neomexicana, Leymus ambiguus, Muhlenbergia montana,* and *Pseudoroegneria spicata*. Scattered trees or inclusions of grassland patches or steppe may be present. Stands are found in the foothills, canyon slopes and lower mountains of the Rocky Mountains and on outcrops and canyon slopes in the western Great Plains. These shrublands occur between 1500 and 2900 m elevation and are usually associated with exposed sites, rocky substrates, and dry conditions, which limit tree growth. It is common where *Quercus gambelii* is absent, such as the northern Colorado Front Range and in drier foothills and prairie hills. This group is generally drier than Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland Group (G277), but may include mesic montane shrublands where *Quercus gambelii* does not occur. Fires play an important role in this group as the dominant shrubs usually have a severe die-back, although some plants will stump sprout. *Cercocarpus montanus* requires a disturbance such as fire to reproduce, either by seed sprout or root-crown sprouting. Fire suppression may have allowed an invasion of trees into some of these shrublands, but in many cases, sites are too xeric for tree growth.

Diagnostic Characteristics: Open to dense broadleaf shrublands or shrub-grasslands where *Cercocarpus montanus* occurs as the most often dominant shrub, but may be a codominant or be absent in some stands. Other characteristic shrubs include *Amelanchier utahensis, Artemisia tridentata, Cercocarpus intricatus, Fallugia paradoxa, Fendlera rupicola, Glossopetalon spinescens, Purshia tridentata, Quercus x pauciloba, Ribes cereum,* and *Rhus trilobata*. The herbaceous layer is characterized by an open to dense layer of grasses and sedges. Typical species include *Achnatherum scribneri, Bouteloua curtipendula, Carex geyeri, Elymus lanceolatus, Hesperostipa comata, Hesperostipa neomexicana, Leymus ambiguus, Muhlenbergia montana,* and *Pseudoroegneria spicata*.

Physiognomy and Structure: **Rationale for Physiognomic Features:** *Cercocarpus montanus* is frequently the dominant or codominant shrub species in this group. *Amelanchier utahensis* and *Ribes cereum* are common codominant or sometimes dominant shrubs. *Purshia tridentata* and *Rhus trilobata* also may codominate or dominate, but are less diagnostic as these species occur widely throughout much of the Rocky Mountain and Intermountain West.

Open to dense, broadleaf deciduous shrublands or shrub-grasslands with canopies 1-2 m tall. Occurrences are typically multi-layered shrub-dominated stands where grasses occur in canopy openings. In occurrences where shrub cover is open, grasses may attain higher cover than overstory shrubs.

Floristics: This group consists of two major cover types: those most commonly dominated by *Cercocarpus montanus* or by *Purshia tridentata*. Within these communities, either nominal may be dominant, codominant or absent. Other shrubs include *Amelanchier utahensis, Artemisia tridentata, Cercocarpus intricatus, Fallugia paradoxa, Fendlera rupicola, Glossopetalon spinescens, Quercus x pauciloba, Rhus trilobata, Ribes cereum, Symphoricarpos oreophilus,* or *Yucca glauca*. Grasses are prominent and include *Andropogon gerardii, Achnatherum scribneri, Bouteloua curtipendula, Elymus lanceolatus ssp. lanceolatus, Hesperostipa comata, Hesperostipa neomexicana, Muhlenbergia montana,* and *Pseudoroegneria spicata*.

Environmental Description: This group is found on gentle to extremely steep slopes (5-60%) on slopes, ridges, canyons, mesas, and less often sand dunes. Sites are often subject to drought stress. Elevations range from 1500 to 2700 m. Geologic substrates can include sandstone, shale, basalt, and limestone. Soils are generally poorly developed, rapidly drained and include sand, sandy loam, coarse gravels, loams, and clay loams.

Geographic Range: This group is found in the foothills, canyon slopes and lower mountains of the southern Rocky Mountains and on outcrops and canyon slopes in the western and southern Great Plains. It ranges from southern New Mexico, extending north into Wyoming, and west into the Intermountain West region.

Nations [incomplete except for CA and US]: US

States/Provinces: CO, MT, NE?, NM, NV?, SD, TX, UT, WY

M168. Rocky Mountain-Vancouverian Subalpine-High Montane Mesic Meadow

2. Shrub & Herb Vegetation; 2.B. Temperate & Boreal Grassland & Shrubland; 2.B.2. Temperate Grassland & Shrubland; 2.B.2.Na. Western North American Grassland & Shrubland; M168. Rocky Mountain-Vancouverian Subalpine-High Montane Mesic Meadow

G268. Southern Rocky Mountain Montane-Subalpine Grassland

Scientific Name: *Festuca arizonica - Festuca thurberi - Muhlenbergia montana* Grassland Group

Common Name (Translated Scientific Name): Arizona Fescue - Thurber's Fescue - Mountain Muhly Grassland Group (Southern Rocky Mountain Montane-Subalpine Grassland)

Classifiers: Montane grasslands are very similar and intergrade with their montane and subalpine counterparts. The transition of this group to Central Rocky Mountain Montane Grassland Group (G267) probably occurs somewhere in central Colorado or southern Wyoming. This Southern Rockies grassland group may co-occur with patches of the more mesic Rocky Mountain Subalpine-Montane Mesic Grassland & Meadow Group (G271), which is distinguished by dominance of mesic forb and grass species such as *Deschampsia caespitosa* and *Mertensia ciliata*. *Pascopyrum smithii*-dominated grasslands tend to be restricted to mesic swales within drier upland types.

Similar NVC Types: G271 Rocky Mountain-North Pacific Subalpine-Montane Mesic Grassland & Meadow; G267 Central Rocky Mountain Montane Grassland.

Concept Summary: This southern Rocky Mountains grassland group typically occurs between 2200 and 3000 m elevation on flat to rolling plains and parks or on lower sideslopes that are dry, and is characterized by an open to dense perennial graminoid layer dominated by *Blepharoneuron tricholepis, Danthonia intermedia, Danthonia parryi, Festuca arizonica, Festuca idahoensis, Festuca thurberi, Muhlenbergia filiculmis, Muhlenbergia montana, Pascopyrum smithii*, or *Pseudoroegneria spicata*.

Range: This southern Rocky Mountains group extends west to high plateaus and mountains in the Colorado Plateau. Vegetation is characterized by an open to dense perennial graminoid layer. Larger occurrences usually consist of a mosaic of two or three plant associations with one of the following dominant grasses: *Blepharoneuron tricholepis, Danthonia parryi, Festuca arizonica, Muhlenbergia montana, Pascopyrum smithii*, or *Pseudoroegneria spicata* at lower elevation / warmer aspects, or *Danthonia intermedia, Festuca idahoensis, Festuca thurberi*, or *Muhlenbergia filiculmis* at subalpine elevation / cooler aspects. The common subdominants include *Bouteloua gracilis, Hesperostipa comata*, or *Poa secunda*. *Bouteloua gracilis* often dominates sites with warm aspects and heavy grazing history. Forb species such as *Potentilla hippiana* may be present to codominant. These large-patch grasslands are intermixed with matrix stands of spruce-fir, lodgepole pine, ponderosa pine, and aspen forests. In limited circumstances (e.g., South Park in Colorado), they form the "matrix" of high-elevation plateaus and inter-montane valleys. Stands typically occur between 2200 and 3000 m elevation on flat to rolling plains and parks or on lower sideslopes that are dry, but may extend up to 3350 m on warm aspects. Soils resemble prairie soils in that the A-horizon is dark brown, relatively high in organic matter, slightly acidic, and usually well-drained. Small-patch representations of this group do occur at high elevations of the Trans-Pecos where they present as occurrences of *Festuca arizonica - Blepharoneuron tricholepis* Grassland (CEGL004508). These occurrences often occupy sites adjacent to Eastern Madrean Chaparral Group (G280).

Diagnostic Characteristics: Vegetation is composed of an open to dense perennial graminoid layer that is generally less than 1 m tall. *Danthonia parryi, Festuca arizonica*, and *Muhlenbergia montana* are important species and typically dominate montane grasslands; *Danthonia intermedia* and *Festuca thurberi* are typical of subalpine grasslands in the southern Rocky Mountains. Other characteristic graminoid species that may be present to dominant include *Achnatherum lettermanii, Blepharoneuron tricholepis, Bouteloua gracilis, Carex duriuscula, Carex rossii, Carex siccata,*

Elymus lanceolatus, Festuca calligera, Festuca idahoensis, Hesperostipa comata, Muhlenbergia filiculmis, Poa fendleriana, Poa nervosa, Poa lettermanii, and *Pseudoroegneria spicata*.

Physiognomy and Structure: **Rationale for Physiognomic Features:** *Danthonia parryi, Festuca arizonica*, and *Muhlenbergia montana* are important species in montane grasslands, and *Danthonia intermedia* and *Festuca thurberi* are typical of subalpine grasslands in the Southern Rocky Mountains. However, *Festuca idahoensis* and *Pseudoroegneria spicata* are more characteristic of the Northern Rocky Mountains and Columbia Plateau, and *Blepharoneuron tricholepis* and *Muhlenbergia filiculmis* are relatively minor species with limited distribution.

Vegetation is composed of an open to dense perennial graminoid layer that is generally less than 1 m tall. Forb cover is variable and may be present to codominant.

Floristics: Vegetation in this group is characterized by an open to dense perennial graminoid layer. Larger occurrences usually consist of a mosaic of two or three plant associations with one of the following dominant grasses: *Blepharoneuron tricholepis, Danthonia parryi, Festuca arizonica, Muhlenbergia montana, Pascopyrum smithii*, or *Pseudoroegneria spicata* at lower elevation / warmer aspects, or *Danthonia intermedia, Festuca idahoensis, Festuca thurberi*, or *Muhlenbergia filiculmis* at subalpine elevation / cooler aspects. Other characteristic graminoid species that may be present to dominant include *Achnatherum lettermanii, Blepharoneuron tricholepis, Bouteloua gracilis, Carex duriuscula, Carex rossii, Carex siccata, Elymus lanceolatus, Festuca calligera, Hesperostipa comata, Poa fendleriana, Poa nervosa*, and *Poa lettermanii*. The common subdominants include *Bouteloua gracilis, Hesperostipa comata*, or *Poa secunda*. *Bouteloua gracilis* often dominates sites with warm aspects and heavy grazing history. Forb species such as *Achillea millefolium, Castilleja* spp., *Erigeron simplex, Erigeron ursinus, Eriogonum umbellatum, Geranium viscosissimum, Hymenoxys richardsonii, Lathyrus lanszwertii, Oxytropis oreophila, Penstemon secundiflorus, Potentilla hippiana, Solidago multiradiata*, and *Symphyotrichum foliaceum (= Aster foliaceus)* may be present to codominant. In disturbed stands, species such as Heterotheca villosa may codominant. These large-patch grasslands are intermixed with matrix stands of spruce-fir, lodgepole pine, ponderosa pine, and aspen forests. In limited circumstances (e.g., South Park in Colorado), they form the "matrix" of high-elevation plateaus and inter-montane valleys. Small-patch representations of this group do occur at high elevations of the Trans-Pecos where they present as occurrences of *Festuca arizonica - Blepharoneuron tricholepis* Grassland (CEGL004508). These occurrences often occupy sites adjacent to Eastern Madrean Chaparral Group (G280).

Environmental Description: This Rocky Mountain grassland group typically occurs between 2200 and 3000 m elevation on flat to rolling plains and inter-montane parks or on lower sideslopes that are dry, but it may extend up to 3350 m on warm aspects. Soils resemble prairie soils in that the A-horizon is dark brown, relatively high in organic matter, slightly acidic, and usually well-drained.

Geographic Range: This grassland group occurs between 2200 and 3000 m elevation in the southern Rocky Mountains and extends west to high plateaus and mountains in the Colorado Plateau.

Nations [incomplete except for CA and US]: US

States/Provinces: AZ, CO, NM, NV, SD, UT, WY

2.B.2.Nd. Western North American Interior Chaparral (D061)

M091. Warm Interior Chaparral

2. Shrub & Herb Vegetation; 2.B. Temperate & Boreal Grassland & Shrubland; 2.B.2. Temperate Grassland & Shrubland; 2.B.2.Nd. Western North American Interior Chaparral; M091. Warm Interior Chaparral

G281. Western Madrean Chaparral

Scientific Name: *Quercus turbinella - Ceanothus greggii - Arctostaphylos pungens* Chaparral Group

Common Name (Translated Scientific Name): Sonoran Scrub Oak - Desert Ceanothus - Mexican Manzanita Chaparral Group (Western Madrean Chaparral)

Classifiers: The similar Eastern Madrean Chaparral Group (G280) has floristics mostly derived from the Sierra Madre Oriental, whereas floristics of this group are derived from the Sierra Madre Occidentale. For now, this group includes warm-desert interior chaparrals found in the western Mojave and western Sonoran regions of southern California, but review may suggest splitting it into two groups. Relatively little is known of the "Mogollon Rim" or "Arizona" chaparral types (Carmichael et al. 1978, Brown 1982), so that it's hard to ascertain the floristic patterns adequately. While the main oaks are different in California, the important associated species are more widely distributed, from California east into New Mexico.

Similar NVC Types: G261 Californian Mesic & Pre-montane Chaparral; G280 Eastern Madrean Chaparral.

Concept Summary: This interior chaparral group is found across the southwestern U.S. from central New Mexico and southern Utah west to California and is characterized by a moderate to dense evergreen shrub layer dominated by sclerophyllous shrubs, especially *Adenostoma sparsifolium, Arctostaphylos pungens, Ceanothus greggii, Cercocarpus montanus, Garrya wrightii, Mortonia utahensis, Quercus cornelius-mulleri, Quercus john-tuckeri,* and *Quercus turbinella,* that occurs in foothills, xeric mountain slopes and canyons.

Range: This interior chaparral group is found across the southwestern U.S. from central New Mexico and southern Utah west to California. The moderate to dense evergreen shrub layer is dominated by sclerophyllous shrubs, especially *Ceanothus greggii* and *Quercus turbinella*. Other common shrubs from the eastern portion of its range (Arizona and New Mexico) include *Arctostaphylos pringlei* (higher elevations), *Arctostaphylos pungens, Cercocarpus montanus, Garrya wrightii, Purshia stansburiana, Quercus toumeyi,* and *Rhus trilobata*. In desert chaparral stands in the western extent *Arctostaphylos patula* (not dominant), *Arctostaphylos glauca, Cercocarpus montanus var. glaber (= Cercocarpus betuloides), Garrya flavescens, Juniperus californica, Nolina parryi, Quercus john-tuckeri, Quercus cornelius-mulleri, Quercus berberidifolia,* and *Rhus ovata* characterize this shrubland. Scattered remnant pinyon and juniper trees may be present; however, in the western Mojave, *Juniperus californica* sometimes forms an open, shrubby tree layer with the evergreen oaks and other shrubs. Stands occur prominently across central Arizona (Mogollon Rim) and western New Mexico, south into mountains in the northwestern Chihuahuan region and Madrean

Occidentale in northern Mexico, and north into extreme southwestern Utah and southern Nevada. It also occurs in mountains in the Sonora and western Mojave deserts, and extends from northeast Kern County, California, and south into Baja Norte, Mexico. Stands are found on foothills, xeric mountain slopes and canyons in hotter and drier habitats and often dominate along the mid-elevation transition zone between desert scrub and montane woodlands (1000-2200 m). Sites are often steep and rocky. Parent materials are varied and include basalt, diabases, gneiss, schist, shales, slates, sandstones and, more commonly, limestone and coarse-textured granitic substrates. Occasional desert scrub species may be present in drier, rockier, more open transition sites. Most chaparral species are fire-adapted, sprouting vigorously after burning or producing abundant fire-resistant seeds. Stands occurring within montane woodlands are seral and a result of recent fires.

The similar Eastern Madrean Chaparral Group (G280) has floristics mostly derived from the Sierra Madre Oriental, whereas floristics of this group are derived from the Sierra Madre Occidentale. However, this group is not mattoral (thornscrub) as it is typically dominated by shrubby evergreen oaks and chaparral species, not thornscrub species. More survey is needed to determine if *Quercus turbinella*, common in this group, also codominates in Eastern Madrean Chaparral Group (G280).

Diagnostic Characteristics: This upland shrubland is characterized by Sierra Madre Occidentale evergreen sclerophyllous indicator species that may be present to dominant. These diagnostic species include evergreen shrubby oaks such as *Quercus turbinella, Quercus toumeyi* and, in western Mojave stands, *Quercus cornelius-mulleri* and *Quercus john-tuckeri*, as well as many other diagnostic species, including *Arctostaphylos glauca, Arctostaphylos pringlei, Cercocarpus montanus var. glaber (= Cercocarpus betuloides), Cercocarpus montanus var. paucidentatus, Ceanothus greggii, Garrya flavescens, Garrya wrightii*, and *Rhus ovata*. Additional characteristic species include *Arctostaphylos patula, Juniperus californica, Nolina parryi*, and *Rhus trilobata*.

Physiognomy and Structure: This upland shrubland is characterized by a very diverse list of diagnostic Sierra Madre Occidentale shrub species. *Quercus john-tuckeri, Quercus cornelius-mulleri*, and *Quercus turbinella, Ceanothus greggii*, and *Arctostaphylos pungens* were chosen as nominal species to indicate this very diverse group. *Quercus turbinella* is the most widespread and often dominant diagnostic shrub. *Quercus john-tuckeri* and *Quercus cornelius-mulleri* are indicators for the western portion of this group. *Ceanothus greggii* is a common desert chaparral species, and *Arctostaphylos pungens* is often dominant within higher-elevation standsThis upland shrubland is typically dominated by a moderate to dense evergreen sclerophyllous shrub canopy usually less than 3 m tall. Herbaceous layers may be present and are typically dominated by perennial graminoids.

Floristics: The vegetation is characterized by a moderate to dense evergreen shrub layer dominated by sclerophyllous shrubs such as *Quercus turbinella* and *Ceanothus greggii*. Other common shrubs from the eastern portion of its range (Arizona and New Mexico) include *Cercocarpus montanus var. paucidentatus, Garrya wrightii, Purshia stansburiana, Quercus toumeyi, Rhus trilobata* with *Arctostaphylos pringlei* and *Arctostaphylos pungens* at higher elevations. In desert chaparral stands in the western extent, *Adenostoma sparsifolium, Arctostaphylos glauca, Cercocarpus montanus var. glaber (= Cercocarpus betuloides), Fremontodendron californicum, Garrya flavescens, Juniperus californica, Quercus berberidifolia, Quercus cornelius-mulleri, Quercus john-tuckeri, Rhus virens*

var. choriophylla, and *Rhus ovata* characterize this shrubland. Scattered remnant pinyon and juniper trees may be present; however, in the western Mojave, *Juniperus californica* sometimes forms an open, shrubby tree layer over the evergreen oaks and other shrubs. Occasional desert scrub species may be present in drier, rockier, more open transition sites. The herbaceous layer is generally composed of grasses, such as *Bouteloua curtipendula, Bouteloua hirsuta, Bothriochloa barbinodis, Eragrostis intermedia, Lycurus phleoides, Muhlenbergia emersleyi, Muhlenbergia pauciflora,* and several species of *Aristida,* which are largely restricted to rocky, protected areas because of past heavy livestock grazing (Brown 1982a).

Environmental Description: Stands are found on foothills, xeric mountain slopes and canyons in hotter and drier habitats and often dominate along the mid-elevation (1000-2200 m) transition zone between desert scrub and montane woodlands (encinal, pine-oak, and ponderosa pine). Sites are variable but often steep and rocky. Sometimes this group occurs in thickets along upper canyon watercourses and northerly upland slopes within the pinyon-juniper woodland zone. *Climate:* This is a group of warm semi-desert regions in the southwestern U.S. The climate is hot and may have a somewhat bi-modal precipitation regime with spring rains and warm-season monsoonal rains as well. Frosts occur in winter, and even sometime snows, which will melt rapidly. *Soil/substrate/hydrology:* Parent materials are varied and include basalt, diabases, gneiss, schist, shales, slates, sandstones and, more commonly, limestone and coarse-textured granitic substrates.

Geographic Range: This group occurs prominently across central Arizona (Mogollon Rim) and western New Mexico, south into mountains in the northwestern Chihuahuan region and Madrean Occidentale in northern Mexico. It also occurs in mountains in the Sonora and western Mojave deserts, extends from northeast Kern County, California, into Baja Norte, Mexico, and often dominates along the mid-elevation (1000-2200 m) transition zone between desert scrub and montane woodlands.

Nations [incomplete except for CA and US]: MX, US

States/Provinces: AZ, CA, MXBC, MXSO, NM, NV, TX, UT

2.C.4.Nb. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (D031)

M888. Arid West Interior Freshwater Marsh

2. Shrub & Herb Vegetation; 2.C. Shrub & Herb Wetland; 2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland; 2.C.4.Nb. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland; M888. Arid West Interior Freshwater Marsh

G531. Arid West Interior Freshwater Marsh

Scientific Name: *Schoenoplectus* spp. - *Typha* spp. Interior Freshwater Marsh Group

Common Name (Translated Scientific Name): Clubrush species - Cattail species Interior Freshwater Marsh Group (Arid West Interior Freshwater Marsh)

Classifiers: This group does not include oceanic saline-influenced tidal areas (coastal saline marshes and brackish marshes) which belong to Temperate Pacific Salt Marsh Group (G499). Marshes in saline waters located at the edge of the Great Salt Lake are included in North American Desert Alkaline-Saline Marsh & Playa Group (G538).

Similar NVC Types: G521 Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh; G524 Western North American Ruderal Marsh, Wet Meadow & Shrubland; G538 North American Desert Alkaline-Saline Marsh & Playa; G544 Western North American Temperate Freshwater Aquatic Vegetation.

Concept Summary: These arid west freshwater marshes are found at all elevations below alpine throughout the western interior basins and mountains of western North America, with dominant species such as *Carex pellita (= Carex lanuginosa), Carex praegracilis, Eleocharis palustris, Juncus balticus, Paspalum distichum, Schoenoplectus americanus, Schoenoplectus pungens, Typha domingensis, Typha latifolia*, and species of *Bidens, Cicuta, Cyperus, Mimulus*, and *Phalaris*.

Range: These arid west freshwater marshes are found at all elevations below timberline throughout the western interior basins and mountains of western North America. Vegetation is characterized by a lush, dense herbaceous layer with low diversity, sometimes occurring as a monoculture. Structure varies from emergent forbs which barely reach the water surface to tall graminoids that reach as tall as 4 m high. Dominant species include *Carex pellita (= Carex lanuginosa), Carex praegracilis, Eleocharis palustris, Juncus balticus, Paspalum distichum, Schoenoplectus americanus, Schoenoplectus pungens, Typha domingensis, Typha latifolia,* and species of *Bidens, Cicuta, Cyperus, Mimulus,* and *Phalaris*. This group includes shallow freshwater to brackish waterbodies found in bottomlands along drainages, in river floodplain depressions, cienegas, oxbow lakes, below seeps, frequently flooded gravel bars, low-lying sidebars, in-fill side channels, small ponds, stockponds, ditches and slow-moving streams, perennial streams in valleys and mountain foothills, as well as in small depressions gouged into basalt by Pleistocene floods, channeled scablands of the Columbia Plateau and within dune fields in the intermountain western U.S. These wetlands are mostly small-patch, confined to limited areas in suitable floodplain or basin topography. They are

mostly semipermanently flooded, but some marshes have seasonal hydrologic flooding. Water is on or above the surface for most of the growing season. A consistent source of freshwater is essential to the function of these communities. Soils are muck or mineral or muck over a mineral soil, and water is high-nutrient. It is often found along the borders of ponds, lakes or reservoirs that have more open water. Some occurrences are interdunal wetlands in wind deflation areas, where sands are scoured down to the water table. The water table may be perched over an impermeable layer of caliche or clay or, in the case of the Great Sand Dunes of Colorado, a geologic dike that creates a closed basin that traps water.

Diagnostic Characteristics: Temperate continental, permanently saturated to seasonally flooded wetlands, often with standing water for much of the year, dominated by emergent graminoid herbaceous vegetation. Characteristic dominant species include *Typha* spp., *Schoenoplectus* spp., *Eleocharis palustris, Carex praegracilis, Carex pellita (= Carex lanuginosa),* and *Cyperus* spp.

Physiognomy and Structure: Vegetation is characterized by a lush, dense to open emergent herbaceous layer. The emergent vegetation is characterized by graminoids, annual or perennial forbs or a mixture of all three. Heights varies from low forbs that barely breaking the water surface to tall graminoids up to 4 m high. Sites are permanently or seasonally inundated which prevents the establishment of woody species. Ponds typically have concentric rings or zones of vegetation.

Floristics: These arid west interior marshes are dominated by emergent herbaceous species, mostly graminoids (*Carex, Scirpus* and/or *Schoenoplectus, Eleocharis, Juncus, Typha,*) but also some forbs. Stands vary in diversity, with some stands occurring as a monoculture of one of the dominant genera. Dominant species include *Carex pellita (= Carex lanuginosa), Carex praegracilis, Eleocharis palustris, Juncus balticus, Paspalum distichum, Schoenoplectus americanus, Schoenoplectus pungens, Typha domingensis, Typha latifolia,* and species of *Bidens, Cicuta, Cyperus, Mimulus,* and *Phalaris.*

Environmental Description: *Climate:* Temperate Continental climate. Environmental settings include bottomlands along drainages, in river floodplain depressions, cienegas, oxbow lakes, below seeps, frequently flooded gravel bars, low-lying sidebars, infilled side channels, small ponds, stockponds, ditches and slow-moving streams, perennial streams in valleys and mountain foothills. Elevations range from 890 to 1560 m (2930-5120 feet). *Soil/substrate/hydrology:* Substrates are variable but are generally fine-textured, alkaline, alluvial soil, coarse loam, sandy loam, sand, silt or peat. Hydrologic regimes vary from seasonal inundation followed by complete soil desiccation to year-round standing water. Water may be poorly oxygenated and nitrogen-rich. They are mostly semipermanently flooded, but some marshes have seasonal hydrologic flooding. Water is at or above the surface for most of the growing season. A consistent source of freshwater is essential to the function of these systems. Soils are muck or mineral or muck over a mineral soil, and water is high-nutrient. Environmental information compiled from Bowers (1982, 1984, 1986), Banner et al. (1986, 1993), Lloyd et al. (1990), MacKinnon et al. (1990), Cooper and Severn (1992), Viereck et al. (1992), Shiflet (1994), Holland and Keil (1995), Shephard (1995), Steen and Coupe (1997), Hammond (1998), Pineada et al. (1999), Boggs (2000), Pineda (2000), Rondeau (2001), Brand and Sanderson (2002), and Chappell and Christy (2004).

Geographic Range: This group is found throughout the temperate western North America interior (Columbia Basin, Great Basin, Colorado Plateau, and higher intermountain basins of western North America). It is also know to occur in dune fields across the intermountain western U.S., including the Great Sand Dunes in southern Colorado and the Pink Coral Dunes in Utah, and may also occur in dune fields in northeastern Arizona and the Great Basin, as well as in southwestern Wyoming in the Killpecker Dunes and Ferris Dunes, and southern Idaho.

Nations [incomplete except for CA and US]: CA, MX, US

States/Provinces: AK, AZ, BC, CA, CO, ID, KS, NM, NV, OK, OR, SD, TX, UT, WA, WY

M075. Western North American Montane-Subalpine-Boreal Marsh, Wet Meadow & Shrubland

2. Shrub & Herb Vegetation; 2.C. Shrub & Herb Wetland; 2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland; 2.C.4.Nb. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland; M075. Western North American Montane-Subalpine-Boreal Marsh, Wet Meadow & Shrubland

G526. Rocky Mountain-Great Basin Lowland-Foothill Riparian Shrubland

Scientific Name: *Salix exigua* - *Crataegus* spp. - *Forestiera pubescens* Rocky Mountain-Great Basin Riparian Shrubland Group

Common Name (Translated Scientific Name): Narrowleaf Willow - Hawthorn species - Stretchberry Rocky Mountain-Great Basin Riparian Shrubland Group (Rocky Mountain-Great Basin Lowland-Foothill Riparian Shrubland)

Classifiers: This group represents a range of short to tall shrubs (0.5-5 m in height). This group also represents lower elevation and foothill elevations shrublands. Higher elevation shrublands belong to Western Montane-Subalpine Riparian & Seep Shrubland Group (G527).

Similar NVC Types: G322 Vancouverian Wet Shrubland; G527 Western Montane-Subalpine Riparian & Seep Shrubland: includes riparian shrublands that occur at high elevations and are dominated by more montane species, for example *Salix monticola*; G545 Colorado Plateau Hanging Garden Seep; G568 Great Plains Riverscour Vegetation; G337 Great Plains Riparian Wet Meadow & Shrubland.

Concept Summary: This group consists of riparian shrublands dominated by low to tall shrubs such as *Acer glabrum, Artemisia* spp., *Cornus sericea, Crataegus* spp., *Dasiphora fruticosa ssp. floribunda, Forestiera pubescens, Oplopanax horridus, Philadelphus lewisii, Prunus virginiana, Rhus trilobata, Rosa* spp., *Salix* spp., *Shepherdia argentea*, and *Symphoricarpos* spp. They do not occur up in the mountains, but rather in between mountain valleys and lowlands of the Interior West.

Range: These short to tall shrublands (0.5-5 m in height) occur along streams at and below lower treeline, that is, not up in the mountains, but in between mountain valleys and lowlands of the Interior West. Dominant shrubs include *Acer glabrum, Artemisia cana, Artemisia cana ssp.*

bolanderi, Artemisia cana ssp. viscidula, Artemisia tridentata ssp. tridentata, Cornus sericea, Crataegus douglasii, Crataegus rivularis, Dasiphora fruticosa ssp. floribunda, Forestiera pubescens, Oplopanax horridus, Philadelphus lewisii, Prunus virginiana, Rhus trilobata, Rosa nutkana, Rosa woodsii, Salix exigua, Salix irrorata, Salix melanopsis, Shepherdia argentea, and *Symphoricarpos* spp. Herbaceous layers are often dominated by *Athyrium filix-femina, Carex flava (= Carex nevadensis), Carex* spp., *Elymus trachycaulus, Equisetum arvense, Deschampsia caespitosa, Festuca idahoensis, Galium triflorum, Glyceria striata, Gymnocarpium dryopteris, Heracleum maximum, Iris missouriensis, Juncus balticus, Juncus* spp., *Leymus cinereus, Maianthemum stellatum, Muhlenbergia filiformis, Muhlenbergia richardsonis, Pascopyrum smithii, Poa cusickii,* and *Poa secunda (= Poa nevadensis)*. Introduced forage species such as *Agrostis stolonifera, Poa pratensis, Phleum pratense,* and the invasive annual *Bromus tectorum* are often present in disturbed stands. Streams are permanent, intermittent and ephemeral. Stands occur in steep-sided canyons or in broad flat valleys. They can be large, wide occurrences on mid-channel islands in larger rivers or narrow bands on small, rocky canyon tributaries and well-drained benches. They also are typically found in backwater channels and other perennially wet but less scoured sites, such as floodplain swales and irrigation ditches, and they can occur in depressional wetlands and non-alkaline playas. Stands may also occur on upper benches away from active channel movement. Willow-dominated shrublands require flooding and bare gravels for reestablishment. Stands are maintained by annual flooding and hydric soils throughout the growing season. Sites are subject to temporary flooding during spring runoff. The water table is often just below the ground surface. Occurrences are found within the flood zone of rivers, on islands, sand or cobble bars, and immediate streambanks and upper benches, and occasionally on hillslope springs. This group occurs throughout the Rocky Mountain and Colorado Plateau regions from approximately 780 to 1850 m (2560-6000 feet) in elevation, around the edges and between the mountain ranges of the Great Basin and along the lower eastern slope of the Sierra Nevada at about 1220 m (4000 feet) in elevation, at lowland and montane elevations in the Columbia Plateau, on the periphery of the mountains surrounding the Columbia River Basin, and along major tributaries and the main stem of the Columbia at relatively low elevations. It also occurs in the foothills of the northern Rocky Mountains and the east slopes of the Cascades in the lower montane and foothill zones. Climate is generally semi-arid.

Diagnostic Characteristics: Short to tall (0.5-5 m) riparian and wetland shrublands at foothill and lower elevations of the temperate interior West.

Physiognomy and Structure: Wetland and mesic shrublands dominated by short to tall shrubs (0.5-5 m).

Floristics: Dominant shrubs include *Acer glabrum, Amelanchier alnifolia, Artemisia cana ssp. bolanderi, Artemisia cana ssp. viscidula, Artemisia cana, Artemisia tridentata ssp. tridentata, Cornus sericea, Crataegus douglasii, Crataegus rivularis, Dasiphora fruticosa ssp. floribunda, Forestiera pubescens, Oplopanax horridus, Philadelphus lewisii, Prunus virginiana, Rhus trilobata, Rosa nutkana, Rosa woodsii, Salix exigua (= ssp. exigua), Salix irrorata, Salix melanopsis, Shepherdia argentea,* and *Symphoricarpos* spp. Herbaceous layers are often dominated by *Athyrium filix-femina, Carex flava (= Carex nevadensis), Carex* spp., *Elymus trachycaulus, Equisetum arvense,*

Deschampsia caespitosa, Festuca idahoensis, Galium triflorum, Glyceria striata, Gymnocarpium dryopteris, Heracleum maximum, Iris missouriensis, Juncus balticus, Juncus spp., *Leymus cinereus, Maianthemum stellatum, Muhlenbergia filiformis, Muhlenbergia richardsonis, Pascopyrum smithii, Poa cusickii,* and *Poa secunda (= Poa nevadensis).* Introduced forage species such as *Agrostis stolonifera, Poa pratensis, Phleum pratense,* and the invasive annual *Bromus tectorum* are often present in disturbed stands. Floristic information was compiled from the following sources: Daubenmire (1952), Johnson and Simon (1985), Kovalchik (1987, 1992), Hansen et al. (1989), Manning and Padgett (1989, 1995), Padgett et al. (1989), Szaro (1989), MacKinnon et al. (1990), Banner et al. (1993), Delong et al. (1993), Sawyer and Keeler-Wolf (1995), Walford (1996), Crowe and Clausnitzer (1997), Steen and Coupe (1997), Walford et al. (1997, 2001), Kittel et al. (1999b), Muldavin et al. (2000a), Delong (2003), MacKenzie and Moran (2004), and Sawyer et al. (2009).

Environmental Description: *Climate:* Climate is generally semi-arid continental with typically cold winters and hot summers. *Soil/substrate/hydrology:* These shrublands occur along all streams at and below lower treeline, that is, not up in the mountains, but in the between- mountain valleys and lowlands of the interior west. Streams are permanent, intermittent and ephemeral. Stands occur in steep-sided canyons or in broad flat valleys. They can be large, wide occurrences on mid-channel islands in larger rivers or narrow bands on small, rocky canyon tributaries and well-drained benches. They also are typically found in backwater channels and other perennially wet but less scoured sites, such as floodplain swales and irrigation ditches, and they can occur in depressional wetlands and non-alkaline playas, on hillside seeps and springs. These shrublands require flooding and bare gravels for reestablishment. Willow-dominated stands are maintained by annual flooding and hydric soils throughout the growing season. Sites are subject to temporary flooding during spring runoff. The water table is often just below the ground surface. Occurrences are found within the flood zone of rivers, on islands, sand or cobble bars, immediate streambanks and upper benches. Soils are typically alluvial deposits of sand, clays, silts and cobbles that are highly stratified with depth due to flood scour and deposition. Highly stratified profiles consist of alternating layers of clay loam and organic material with coarser sand or thin layers of sandy loam over very coarse alluvium. Soils are fine-textured with organic material over coarser alluvium. Some soils are more developed due to a slightly more stable environment and greater input of organic matter. Environmental information was compiled from the following sources: Daubenmire (1952), Johnson and Simon (1985), Kovalchik (1987, 1992), Hansen et al. (1989), Manning and Padgett (1989, 1995), Padgett et al. (1989), Szaro (1989), MacKinnon et al. (1990), Banner et al. (1993), Delong et al. (1993), Sawyer and Keeler-Wolf (1995), Walford (1996), Crowe and Clausnitzer (1997), Steen and Coupe (1997), Walford et al. (1997, 2001), Kittel et al. (1999b), Muldavin et al. (2000a), Delong (2003), MacKenzie and Moran (2004), and Sawyer et al. (2009).

Geographic Range: This group is found throughout the Rocky Mountain and Colorado Plateau regions from approximately 900 to 1850 m (3000-6000 feet) in elevation, in the mountain ranges of the Great Basin and along the eastern slope of the Sierra Nevada from about 1220 m (4000 feet) in elevation, at lowland and montane elevations in the Columbia Plateau, on the periphery of the mountains surrounding the Columbia River Basin, and along major tributaries and the main stem of

the Columbia at relatively low elevations. It also occurs in the northern Rocky Mountains and east slopes of the Cascades in the lower montane and foothill zones.

Nations [incomplete except for CA and US]: CA, US

States/Provinces: AB, AZ, BC, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

G521. Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh
Scientific Name: *Carex* spp. - *Calamagrostis* spp. Montane Wet Meadow & Marsh Group

Common Name (Translated Scientific Name): Sedge species - Reedgrass species Montane Wet Meadow & Marsh Group (Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh)

Classifiers:

Similar NVC Types: G520 Vancouverian-Rocky Mountain Subalpine-Alpine Snowbed, Wet Meadow & Dwarf-shrubland: is more or less a strictly alpine group that occurs at higher elevations with different dominant species, and is restricted to alpine or upper subalpine environments; however, it may be adjacent to or even overlap with G521 in some areas; G517 Vancouverian Freshwater Wet Meadow & Marsh: occurs at lower elevations within 2 miles of coast; G524 Western North American Ruderal Marsh, Wet Meadow & Shrubland; G531 Arid West Interior Freshwater Marsh; G545 Colorado Plateau Hanging Garden Seep.

Concept Summary: This group consists of wet meadows dominated by graminoids such as *Calamagrostis canadensis, Carex aquatilis, Carex utriculata,* and *Eleocharis palustris* or forbs such as *Camassia quamash, Cardamine cordifolia, Dodecatheon jeffreyi, Phippsia algida, Rorippa alpina, Senecio triangularis,* and *Veratrum californicum* found throughout montane altitudes of the western U.S. and Canada.

Range: This group contains the wet meadows found in montane and subalpine elevations, occasionally reaching into the lower edges of the alpine elevations (about 1000-3600 m), from California's Transverse and Peninsular ranges north to British Columbia's Coastal Mountains and from throughout the Rocky Mountains of Canada and the U.S. (including the Black Hills of South Dakota) and mountain ranges of the intermountain Interior West. Varying dominant herbaceous species include graminoids *Calamagrostis canadensis, Calamagrostis stricta, Carex bolanderi, Carex exsiccata, Carex illota, Carex microptera, Carex scopulorum, Carex utriculata, Carex vernacula, Deschampsia caespitosa, Eleocharis quinqueflora, Glyceria striata (= Glyceria elata), Juncus drummondii, Juncus nevadensis,* and *Scirpus* and/or *Schoenoplectus* spp. Forb species include *Camassia quamash, Cardamine cordifolia, Dodecatheon jeffreyi, Phippsia algida, Rorippa alpina, Senecio triangularis, Trifolium parryi,* and *Veratrum californicum*. Common but sparse shrubs may include *Betula glandulosa, Salix* spp., *Vaccinium macrocarpon,* and *Vaccinium uliginosum*. Wet meadows occur in open wet depressions, basins and flats with low-velocity surface and subsurface flows. They can be large meadows in montane or subalpine valleys, or occur as narrow strips bordering ponds, lakes and streams, and along toeslope seeps. They are typically found on flat areas or gentle slopes, but may also occur on subirrigated sites with slopes up to 10%. In alpine regions,

sites typically are small depressions located below late-melting snow patches. Sites are usually seasonally wet, often drying by late summer, and many occur in a tension zone between perennial wetlands and uplands, where water tables fluctuate in response to long-term climatic cycles. They may have surface water for part of the year, but depths rarely exceed a few centimeters. Wet meadows can be tightly associated with snowmelt and typically are not subjected to high velocity disturbance, but can be flooded by slow-moving waters. Soils are mostly mineral and show typical hydric soil characteristics such as low chroma and redoximorphic features; some areas may have high organic content as inclusions or pockets. Vegetation of this group can manifest as a mosaic of several plant associations, or be a monotypic stand of a single association which is dominated by graminoids or forbs.

Diagnostic Characteristics: Perennial herbaceous wet meadows found in the montane, subalpine and lower alpine elevations (about 1000-3600 m) of western mountain ranges. Sites are usually seasonally wet, often drying by late summer, and many occur in a tension zone between perennial wetlands and uplands, where water tables fluctuate in response to long-term climatic cycles.

Physiognomy and Structure: Open wet meadows dominated by perennial cold-dormant graminoids or forbs, usually less than 1 m in height, often a pocket surrounded by forests. Wet meadows may be large and carpet an entire valley floor, or they can be very small patches or narrow linear strips. They can also occur in complex mosaics of meadows intermixed with patches of dwarf- or tall shrublands.

Floristics: Vegetation of this group can manifest as a mosaic of several plant associations, or be a monotypic stand of a single association which is dominated by graminoids or forbs. Varying dominant herbaceous species include graminoids *Calamagrostis canadensis, Calamagrostis stricta, Carex bolanderi, Carex utriculata, Carex illota, Carex exsiccata, Carex nigricans, Carex microptera, Carex scopulorum, Carex vernacula, Deschampsia caespitosa, Eleocharis quinqueflora, Glyceria striata (= Glyceria elata), Juncus drummondii, Juncus nevadensis,* and *Scirpus* and/or *Schoenoplectus* spp. Forb species may include *Camassia quamash, Cardamine cordifolia, Caltha leptosepala, Dodecatheon jeffreyi, Phippsia algida, Rorippa alpina, Senecio triangularis, Trifolium parryi, Trollius laxus,* and *Veratrum californicum*. Common but sparse shrubs may include *Salix* spp., *Vaccinium uliginosum, Betula glandulosa,* and *Vaccinium macrocarpon*. Floristic information compiled from Komarkova (1976, 1986), Nachlinger (1985), Kovalchik (1987, 1993), Barbour and Major (1988), Meidinger et al. (1988), Padgett et al. (1988a), Lloyd et al. (1990), Banner et al. (1993), DeLong et al. (1993), Manning and Padgett (1995), Sawyer and Keeler-Wolf (1995), Sanderson and Kettler (1996), Crowe and Clausnitzer (1997), Steen and Coupe (1997), Kittel et al. (1999b), and MacKenzie and Moran (2004).

Environmental Description: *Soil/substrate/hydrology:* Wet meadows are typically found on flat areas or gentle slopes, but may also occur on subirrigated sites with slopes up to 10%. In alpine regions, sites typically are small depressions located below late-melting snow patches. Sites are usually seasonally wet, often drying by late summer, and many occur in a tension zone between perennial wetlands and uplands, where water tables fluctuate in response to long-term climatic cycles. They may have surface water for part of the year, but depths rarely exceed a few centimeters. Wet meadows can be tightly associated with snowmelt and typically are not subjected to high

velocity disturbance, but can be flooded by slow-moving waters. Moisture for these wet meadow community types is acquired from groundwater, stream discharge, overland flow, overbank flow, and on-site precipitation. Salinity and alkalinity are generally low due to the frequent flushing of moisture through the meadow. Depending on the slope, topography, hydrology, soils and substrate, intermittent, ephemeral, or permanent pools may be present.

These areas may support species more representative of purely aquatic environments. Standing water may be present during some or all of the growing season, with water tables typically remaining at or near the soil surface. Fluctuations of the water table throughout the growing season are not uncommon, however. On drier sites supporting the less mesic types, the late-season water table may be 1 m or more below the surface.

Soils are mostly mineral and show typical hydric soil characteristics such as low chroma and redoximorphic features; some areas may have high organic content as inclusions or pockets. Soils may have organic soils inclusions. The presence and amount of organic matter may vary considerably depending on the frequency and magnitude of alluvial deposition (Kittel et. al. 1999b). Organic composition of the soil may include a thin layer near the soil surface or accumulations of highly sapric material of up to 120 cm thick. Soils may exhibit gleying and/or mottling throughout the profile. Wet meadows provide important water filtration, flow attenuation, and wildlife habitat functions. Environmental information compiled from Komarkova (1976, 1986), Nachlinger (1985), Kovalchik (1987, 1993), Barbour and Major (1988), Meidinger et al. (1988), Padgett et al. (1988a), Lloyd et al. (1990), Banner et al. (1993), DeLong et al. (1993), Manning and Padgett (1995), Sawyer and Keeler-Wolf (1995), Sanderson and Kettler (1996), Crowe and Clausnitzer (1997), Steen and Coupe (1997), Kittel et al. (1999b), and MacKenzie and Moran (2004).

Geographic Range: This group occurs in the mountains in California's Transverse and Peninsular ranges north to British Columbia's coastal ranges and is found throughout the Rocky Mountains (including the Black Hills of South Dakota) of the U.S. and Canada as well as the intermountain ranges of the interior west, ranging in elevation from montane to alpine (1000-3600 m).

Nations [incomplete except for CA and US]: CA, MX?, US

States/Provinces: AB, AK?, AZ, BC, CA, CO, ID, MT, NM, NV, OR, SD, UT, WA, WY

G527. Western Montane-Subalpine Riparian & Seep Shrubland
Scientific Name: *Salix* spp. - *Alnus* spp. - *Betula occidentalis* Riparian & Seep Shrubland Group

Common Name (Translated Scientific Name): Willow species - Alder species - Water Birch Riparian & Seep Shrubland Group (Western Montane-Subalpine Riparian & Seep Shrubland)

Classifiers:

Similar NVC Types: G507 North Pacific Montane Riparian Woodland; G322 Vancouverian Wet Shrubland: occurs at lower elevations along the Pacific Northwest coast; G526 Rocky Mountain-

Great Basin Lowland-Foothill Riparian Shrubland: occurs at lower elevations and may overlap with G527.

Concept Summary: These are montane to subalpine riparian shrublands ranging from short to tall (0.5-15 m) that occur in steep and narrow to wide, low-gradient valley bottoms and floodplains as well as steep moist avalanche chutes. They are generally dominated by any or a mix of the following: *Alnus incana, Alnus oblongifolia, Alnus viridis, Betula occidentalis, Betula glandulosa, Betula occidentalis, Cornus sericea, Salix bebbiana, Salix boothii, Salix brachycarpa, Salix drummondiana, Salix eriocephala, Salix geyeriana, Salix monticola, Salix planifolia,* and/or *Salix wolfii*.

Range: These are montane to subalpine riparian shrublands occurring as narrow bands or broad shrublands and are found throughout the Rocky Mountain cordillera from New Mexico north into Montana and northwestern Alberta. They also occur in mountainous areas of the interior Intermountain West and on the Colorado Plateau. This group often occurs as part of a mosaic of multiple communities that are shrub- and herb-dominated and includes above-treeline, willow-dominated, snowmelt-fed basins that feed into streams. Shrubs range from short to tall (0.5-15 m). The shrub species that can be dominant reflect the large elevational gradient of this group and include *Alnus incana, Alnus oblongifolia, Alnus viridis, Betula occidentalis, Betula glandulosa, Betula occidentalis, Cornus sericea, Salix bebbiana, Salix boothii, Salix brachycarpa, Salix drummondiana, Salix eriocephala, Salix geyeriana, Salix monticola, Salix planifolia,* and *Salix wolfii*. Generally the upland vegetation surrounding these wet shrublands is either conifer or aspen forest. Stands occur on streambanks, stream benches and alluvial terraces in steep narrow to wide, low-gradient valley bottoms and floodplains with sinuous stream channels, as well as steep moist avalanche chutes. This group is generally found at higher elevations, but can be found anywhere from 1500-3475 m, and may occur at even lower elevations in the Canadian Rockies. Occurrences can also be found around seeps, fens, and isolated springs on hillslopes away from valley bottoms. Many of the plant associations found within this group are associated with beaver activity.

Diagnostic Characteristics: Montane wet shrublands of the Rocky Mountains of Canada and the U.S., and mountain ranges in the Intermountain West. These shrublands line streams and valley bottoms and are often associated with beaver activity.

Physiognomy and Structure: Montane wetlands dominated by short to tall (0.5-15 m) cold-deciduous shrubs with multiple stems, occurring as narrow bands of shrubs lining streambanks and alluvial terraces in narrow to wide, low-gradient valley bottoms and floodplains with sinuous stream channels.

Floristics: The dominant shrubs reflect the large elevational gradient and include *Alnus incana, Betula glandulosa, Betula occidentalis, Cornus sericea, Salix bebbiana, Salix boothii, Salix brachycarpa, Salix drummondiana, Salix eriocephala, Salix geyeriana, Salix monticola, Salix planifolia,* and *Salix wolfii*. Generally the upland vegetation surrounding these riparian systems is either conifer or aspen forest. Floristic information was compiled from Padgett (1982), Kovalchik (1987, 1993, 2001), Baker (1988, 1989a, 1989b, 1990), Padgett et al. (1988a, 1988b), Kittel (1993,

1994), Manning and Padgett (1995), Kittel et al. (1996, 1999a, 1999b), Walford (1996), Crowe and Clausnitzer (1997), Steen and Coupe (1997), and Muldavin et al. (2000a).

Environmental Description: *Soil/substrate/hydrology:* These are montane to subalpine riparian shrublands occurring as narrow bands lining streambanks and alluvial terraces in narrow to wide, low-gradient valley bottoms and floodplains with sinuous stream channels. Generally, the group is found at higher elevations, but can be found anywhere from 1500-3475 m, and may occur at even lower elevations in the Canadian Rockies. Occurrences can also be found around seeps, fens, and isolated springs on hillslopes away from valley bottoms. They occur on mineral soils or, if on organic soil, these are not deep (not >30-40 cm). Environmental information was compiled from Padgett (1982), Kovalchik (1987, 1993, 2001), Baker (1988, 1989a, 1989b, 1990), Padgett et al. (1988a, 1988b), Kittel (1993, 1994), Manning and Padgett (1995), Kittel et al. (1996, 1999a, 1999b), Walford (1996), Crowe and Clausnitzer (1997), Steen and Coupe (1997), and Muldavin et al. (2000a).

Geographic Range: This group is found throughout the Rocky Mountain cordillera from New Mexico north into Montana and the Canadian Rockies of Alberta and British Columbia (including the isolated "island" mountain ranges of central and eastern Montana), and in mountainous areas of the Intermountain West and on the Colorado Plateau.

Nations [incomplete except for CA and US]: CA, US

States/Provinces: AB, AZ, BC, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

M301. Western North American Ruderal Marsh, Wet Meadow & Shrubland

2. Shrub & Herb Vegetation; 2.C. Shrub & Herb Wetland; 2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland; 2.C.4.Nb. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland; M301. Western North American Ruderal Marsh, Wet Meadow & Shrubland

G524. Western North American Ruderal Marsh, Wet Meadow & Shrubland

Scientific Name: *Poa pratensis - Conyza canadensis - Cirsium arvense* Ruderal Marsh, Wet Meadow & Shrubland Group

Common Name (Translated Scientific Name): Kentucky Bluegrass - Canadian Horseweed - Canada Thistle Ruderal Marsh, Wet Meadow & Shrubland Group (Western North American Ruderal Marsh, Wet Meadow & Shrubland)

Classifiers: This group may be difficult to tease apart from its native counterpart. The test is that the non-native species far outweigh native species in abundance and richness, such that a well-trained observer cannot tell what the native counterpart may have been or to do so is only speculation. This group does not include actively managed irrigated hay meadows that have been historically seeded. Those belong under Class 7 Agricultural & Developed Vegetation.

Similar NVC Types: G517 Vancouverian Freshwater Wet Meadow & Marsh: is dominated by native species; G521 Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh: is dominated

by native species; G531 Arid West Interior Freshwater Marsh; G819 North American Warm Desert Ruderal Scrub; G677 North American Warm Desert Ruderal Grassland; G600 Great Basin-Intermountain Ruderal Dry Shrubland & Grassland.

Concept Summary: This group contains wet meadows dominated by non-native species such as *Agrostis gigantea, Agrostis stolonifera, Alopecurus pratensis, Conyza canadensis, Cirsium arvense, Sonchus* spp., *Lactuca serriola, Phalaris arundinacea, Phragmites australis, Poa palustris,* and/or *Poa pratensis* that occur in the same physical settings as native wet meadows found throughout the western U.S. and Canada.

Range: This group contains disturbed wet meadows found in lowland, montane and subalpine elevations, occasionally reaching into the lower edges of the alpine elevations (sea level to 3600 m) throughout the western U.S. and Canada. Vegetation is dominated by non-native species such as *Agrostis gigantea, Agrostis stolonifera, Alopecurus pratensis, Conyza canadensis, Cirsium arvense, Sonchus* spp., *Lactuca serriola, Phalaris arundinacea, Phragmites australis, Poa palustris,* and *Poa pratensis*. Native species may be present but are so low in abundance that the original native plant association is impossible to determine. These can be wet meadows, wet emergent marshes, coastal backwater dunes, sloughs, open wet depressions, basins and flats with low-velocity surface and subsurface flows. They can be large meadows in montane or subalpine valleys, or occur as narrow strips bordering ponds, lakes, and streams, and along toeslope seeps. They are typically found on flat areas or gentle slopes, but may also occur on subirrigated sites with slopes up to 10%. Sites are usually seasonally wet, often drying by late summer, and many occur in a tension zone between perennial wetlands and uplands, where water tables fluctuate in response to long-term climatic cycles. They may have surface water for part of the year, but depths rarely exceed a few centimeters. Soils are mostly mineral and show typical hydric soil characteristics such as low chroma and redoximorphic features; some areas may have high organic content as inclusions or pockets. Due to disturbance, soils may be compacted.

Diagnostic Characteristics: Wet graminoid and forb meadow or marsh dominated by non-native species.

Physiognomy and Structure: Herbaceous wet meadow dominated by perennial herbs introduced to North America.

Floristics: Vegetation of this group is dominated by non-native species such as *Agrostis gigantea, Agrostis stolonifera, Alopecurus pratensis, Conyza canadensis, Lactuca serriola, Cirsium arvense, Iris pseudacorus, Phalaris arundinacea, Phragmites australis, Poa palustris, Poa pratensis, Poa trivialis*, and *Scirpus cyperinus*. Native species may be present but are so low in abundance that the original native plant association is impossible to determine. Floristic information was compiled from Whitson et al. (1996), Rondeau (2001), Faber-Langendoen et al. (2008), and Sawyer et al. (2009).

Environmental Description: *Soil/substrate/hydrology:* These wet meadows occur in open wet depressions, basins and flats with low-velocity surface and subsurface flows. They can be large meadows in montane or subalpine valleys, or occur as narrow strips bordering ponds, lakes, and

streams, and along toeslope seeps. They are typically found on flat areas or gentle slopes, but may also occur on subirrigated sites with slopes up to 10%. Sites are usually seasonally wet, often drying by late summer, and many occur in a tension zone between perennial wetlands and uplands, where water tables fluctuate in response to long-term climatic cycles. Some sites occur under an agricultural management regime of seasonal sheet irrigation for grazing or haying purposes, and may bear no resemblance to historical types of the area. They may have surface water for part of the year, but depths rarely exceed a few centimeters. Soils are mostly mineral and show typical hydric soil characteristics such as low chroma and redoximorphic features; some areas may have high organic content as inclusions or pockets. Due to disturbance, soils may be compacted.

This group occurs in the same environmental settings as Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh Group (G521), Vancouverian Freshwater Wet Meadow & Marsh Group (G517), and Arid West Interior Freshwater Marsh Group (G531).

Geographic Range: This group is found throughout the entire western U.S. and Canada.

Nations [incomplete except for CA and US]: CA, US

States/Provinces: AB, AK, BC, CA, CO, ID, MT, NM, NV, OR, SD, TX, WA, WY

2.C.4.Nc. Southwestern North American Warm Desert Freshwater Marsh & Bosque (D032)

M076. Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland

2. Shrub & Herb Vegetation; 2.C. Shrub & Herb Wetland; 2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland; 2.C.4.Nc. Southwestern North American Warm Desert Freshwater Marsh & Bosque; M076. Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland

G545. Colorado Plateau Hanging Garden Seep

Scientific Name: *Adiantum* spp. - *Mimulus* spp. - *Aquilegia* spp. Colorado Plateau Seep Group

Common Name (Translated Scientific Name): Maidenhair species - Monkeyflower species - Columbine species Colorado Plateau Seep Group (Colorado Plateau Hanging Garden Seep)

Classifiers: More literature and data are available and need to be incorporated (e.g., Spence (2008) and Keate (1996)). "Hanging gardens" along wet cliff faces also occur in other areas of the Arid West, including Death Valley National Park, where taxa such as *Andropogon glomeratus, Cladium californicum, Muhlenbergia utilis, Schoenus nigricans, Solidago spectabilis var. confinis (= Solidago confinis),* and *Solidago spectabilis var. spectabilis (= Solidago spectabilis)* along with a variety of other forbs occur; thus, other related groups and alliances in the Southwest will need to be addressed and defined. Additional floristic and environmental information will be added from data supplied by John Spence in 2015.

Similar NVC Types: G521 Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh: can have similar vegetation species; G526 Rocky Mountain-Great Basin Lowland-Foothill Riparian Shrubland: can have similar vegetation species, but Hanging Gardens occur in special cliff-based spring settings.

Concept Summary: These herbaceous-dominated perennial water sources (seeps) form pocketed wetlands and draping vegetation across wet cliff faces, with species such as *Adiantum capillus-veneris, Aquilegia micrantha,* and/or *Mimulus eastwoodiae,* although there are many other representative species. They are found on cliffs in the Colorado Plateau region.

Range: This group consists of the herbaceous vegetation found in "hanging gardens" in the Colorado Plateau region that are surrounded by an arid environment associated with canyon country. These highly localized environments occur in canyonlands with perennial water sources (seeps) forming pocketed wetlands and draping vegetation across wet cliff faces. Three main garden types exist: alcove, terrace, or windowblind. Each is determined by the nature of the geological formation and the presence or absence of joint systems. They tend to occur at all exposures of the canyon walls, but they are always shaded for much to most of each day. Temperature and humidity are relatively stable compared to the surrounding environment. Most hanging gardens are dominated by herbaceous plants, and a number of these are endemic to this region. Common species include *Adiantum capillus-veneris, Adiantum aleuticum, Cirsium rydbergii, Mimulus eastwoodiae, Mimulus guttatus,*

Sullivantia hapemanii, and several species of *Aquilegia*, including *Aquilegia micrantha*. Larger alcoves may have shrubby species as well, such as *Frangula betulifolia (= Rhamnus betulifolia), Quercus gambelii*, and even *Pseudotsuga menziesii* in some north-facing alcoves.

Diagnostic Characteristics: These highly localized environments occur in canyonlands with perennial water sources (seeps) forming pocketed wetlands and draping herbaceous vegetation across wet cliff faces. Some shrubs may be present in the larger alcove seep areas.

Physiognomy and Structure: Wetland seeps in cliff faces with drooping and hanging cold-deciduous fern and forb herbaceous vegetation.

Floristics: The vegetation of the hanging gardens group is often composed of few species, although the diversity of vegetation is much greater in the gardens on the Colorado Plateau than those of the Utah High Plateaus. The vegetation may overlap with nearby riparian vegetation, but there are a series of species that are unique to hanging gardens (Welsh 1989). Several species of algae are restricted to these hanging gardens. The back and face walls support clinging plants of *Adiantum capillus-veneris, Mimulus eastwoodiae, Petrophyton caespitosum, Primula specuicola*, and several other species. The wet, sandy detritus supports *Aquilegia micrantha, Calamagrostis scopulorum, Carex aurea, Cirsium rydbergii, Dichanthelium acuminatum (= Panicum acuminatum), Epipactis gigantea, Perityle specuicola*, and *Zigadenus vaginatus*. A fringing margin of *Cercis canadensis var. texensis (= Cercis occidentalis), Celtis laevigata var. reticulata (= Celtis reticulata)*, and *Quercus gambelii* often occurs outward from the footslope where the plants tend to conceal the alcove base. The outer and drier edges support grasses typical of the prairies and plains of the western U.S. In the Utah High Plateaus gardens, the dominants are usually *Sullivantia hapemanii var. purpusii* and *Aquilegia barnebyi* with *Mimulus guttatus* common.

Variation in hanging garden vegetation varies from canyon to canyon as well as separate alcoves within a canyon. The vegetation of hanging gardens generally has some common species that are found at most of the hanging gardens, e.g., *Adiantum capillus-veneris, Adiantum pedatum, Maianthemum stellatum*, and *Mimulus* spp., but numerous endemics occur of which some may be represented by just one or two sites. The following species are endemic to hanging gardens of the Colorado Plateau region: *Aquilegia micrantha, Carex curatorum, Cirsium rydbergii, Erigeron kachinensis* (one occurrence outside of hanging gardens in the Abajo Mountains), *Erigeron sionis, Erigeron zothecinus, Platanthera zothecina (= Habenaria zothecina), Mimulus eastwoodiae, Perityle specuicola*, and *Primula specuicola*. Other species include *Andropogon glomeratus, Cladium californicum, Muhlenbergia utilis, Schoenus nigricans, Solidago spectabilis var. confinis (= Solidago confinis)*, and *Solidago spectabilis var. spectabilis (= Solidago spectabilis)*. Floristic information compiled from Keammerer and Keammerer (1978), Malanson (1980, 1982), Malanson and Kay (1980), Welsh and Toft (1981), Welsh (1989), and Romme et al. (1993).

Environmental Description: *Climate:* Hanging gardens in the Colorado Plateau ecoregion are surrounded by an arid environment and associated with canyon country. Annual precipitation is low and varies from 127 to 356 mm (5-14 inches). While mean annual temperatures are high, extreme

temperatures are probably more important than means to the survival of plants. Summer temperatures greater than 100°F are common.

Soil/substrate/hydrology: The classic alcove type of hanging garden in the Canyonlands of southeastern Utah consists of an overhanging back wall, a vaulted face wall, a detrital slope, and a plunge basin. Complexity of the plant community within a hanging garden is a function of the quantity and quality of water, developmental aspects, and accessibility of plant species to it. They tend to occur at all exposures of the canyon walls, but they are always shaded for much to most of each day. Temperature and humidity are relatively stable compared to the surrounding environment. They vary in size, aspect, exposure to the elements, water quantity and quality, number of bedding planes, and amount of light received. Water quality, in some degree, controls the kinds of plants in hanging gardens. Quality of water is dictated by the nature of the formations through which the water passes. Water is often of drinkable quality; however, water may be saline or laden with calcium, which results in tufa deposits in the gardens. Generally, however, water from the gardens is potable.

In the Utah High Plateaus, the hanging garden group is associated with springs, seeps and waterfalls. The waterfall vegetation grows in the cracks behind and beside the waterfall and is best described as hanging gardens. In the seeps adjacent to waterfalls and in the splash zones at the base of waterfalls, the substrate is saturated during most of the growing season. The vegetation is continually wet, at least near the bases of the plants, and water can very commonly be seen dripping from leaves, exposed roots and old stems. Suitable growing sites are limited on the steep rock walls such that each of the available ledges has an abundance of plants which grow on it. Most of the hanging gardens in the Utah High Plateaus are associated with calcareous shales of the Green River Formation. Although large occurrences of hanging gardens are primarily associated with waterfalls, smaller occurrences occur along cliff seeps above the streams, especially in the Roan Plateau area. Environmental description compiled from Keammerer and Keammerer (1978), Malanson (1980, 1982), Malanson and Kay (1980), Welsh and Toft (1981), Welsh (1989), and Romme et al. (1993).

Geographic Range: This group is found on the Colorado Plateau.

Nations [incomplete except for CA and US]: US

States/Provinces: AZ, CO, NV?, UT

G533. North American Warm Desert Riparian Low Bosque & Shrubland

Scientific Name: *Prosopis glandulosa* - *Prosopis velutina* - *Baccharis* spp. North American Warm Desert Riparian Low Bosque & Shrubland Group

Common Name (Translated Scientific Name): Honey Mesquite - Velvet Mesquite - False Willow species North American Warm Desert Riparian Low Bosque & Shrubland Group (North American Warm Desert Riparian Low Bosque & Shrubland)

Classifiers: Addition characteristic taxa to be added.

Similar NVC Types: G797 Western Interior Riparian Forest & Woodland.

Concept Summary: This low-elevation (<1100 m) desert riparian vegetation is dominated by scrub *Prosopis glandulosa* and/or *Prosopis velutina*, and/or shrubs *Baccharis salicifolia, Pluchea sericea, Salix geyeriana, Shepherdia argentea*, and/or *Salix exigua*. It is found along perennial and intermittent streams and rivers of the southwestern U.S. and adjacent Mexico.

Range: This group consists of riparian scrub found along low-elevation (<1100 m) perennial or intermittent streams and rivers throughout the warm desert regions of the southwestern U.S. and adjacent Mexico. The vegetation is low scrub or shrubland, not tall trees. Dominants include scrub *Prosopis glandulosa* and *Prosopis velutina*, and shrubs *Baccharis salicifolia, Pluchea sericea, Salix geyeriana, Shepherdia argentea*, and/or *Salix exigua*. Woody cover is relatively dense, especially when compared to drier washes. Dominant species, especially the mesquites, tap groundwater below the streambed when surface flows stop. Vegetation is dependent upon annual rise in the water table or annual/periodic flooding and associated sediment scour for growth and reproduction.

Diagnostic Characteristics: Desert climes of the southwestern U.S., intermittent and perennial streambanks, riverbanks and floodplains with native woody tree and shrub species.

Physiognomy and Structure: Scrubby growth of short bosque or thickets of shrubs that are winter-deciduous along lower elevation stream courses.

Floristics: Dominant scrub/trees include *Prosopis glandulosa* and *Prosopis velutina*. Dominants of shrub communities include *Baccharis salicifolia, Pluchea sericea, Salix geyeriana, Shepherdia argentea*, and *Salix exigua*. Understory species include low shrubs *Celtis pallida* or *Prunus serotina*; forbs *Amaranthus palmeri* and *Eustoma exaltatum*; and graminoid species such as *Bouteloua curtipendula, Distichlis spicata, Juncus balticus, Leymus condensatus, Muhlenbergia asperifolia, Muhlenbergia rigens, Phragmites australis, Schoenoplectus pungens, Sorghum halepense*, and *Sporobolus airoides*. Floristic information was compiled from Eyre (1980), Brown (1982), Barbour and Major (1988), Szaro (1989), Dick-Peddie (1993), Holland and Heil (1995), Muldavin et al. (2000a, 2000b), and Griffith et al. (2004).

Environmental Description: *Climate:* Low-elevation arid southwestern deserts. *Soil/substrate/hydrology:* Low-elevation (<1100 m) riparian corridors along small, medium and large perennial and intermittent streams and rivers throughout canyons and desert valleys with alluvial soils. Environmental information was compiled from Eyre (1980), Brown (1982), Barbour and Major (1988), Szaro (1989), Dick-Peddie (1993), Holland and Heil (1995), Muldavin et al. (2000a, 2000b), and Griffith et al. (2004).

Geographic Range: This group encompasses riparian corridors along small, medium and large perennial and intermittent streams and rivers throughout canyons and desert valleys of the warm desert regions of the southwestern U.S. and adjacent Mexico. Rivers include the lower Colorado (into the Grand Canyon), Gila, Santa Cruz, Salt, lower Rio Grande (below Elephant Butte Reservoir in New Mexico to the Coastal Plain of Texas), and the lower Pecos (up to near its confluence with Rio Hondo in southeastern New Mexico) and their tributaries that occur in the desert portions of their range.

Nations [incomplete except for CA and US]: MX, US

States/Provinces: AZ, CA, MXBC, MXCH, MXSO, NM, NV, TX, UT

2.C.5.Nd. North American Western Interior Brackish Marsh, Playa & Shrubland (D036)

M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland

2. Shrub & Herb Vegetation; 2.C. Shrub & Herb Wetland; 2.C.5. Salt Marsh; 2.C.5.Nd. North American Western Interior Brackish; Marsh, Playa & Shrubland; M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland

G538. North American Desert Alkaline-Saline Marsh & Playa

Scientific Name: *Distichlis spicata - Puccinellia lemmonii - Salicornia* spp. Alkaline-Saline Marsh & Playa Group

Common Name (Translated Scientific Name): Saltgrass - Lemmon's Alkali Grass - Saltwort species Alkaline-Saline Marsh & Playa Group (North American Desert Alkaline-Saline Marsh & Playa)

Classifiers:

Similar NVC Types: G531 Arid West Interior Freshwater Marsh; G324 Great Plains Saline Wet Meadow & Marsh: also includes salt-tolerant herbaceous wetlands, but occurs east of the Continental Divide on the Great Plains; G537 North American Desert Alkaline-Saline Wet Scrub: also occurs in cold desert regions but is dominated by shrub species.

Concept Summary: This group contains alkaline-saline marshes found in non-coastal and non-tidal areas of the Intermountain West. Marshes can be densely vegetated emergent or barren and sparsely vegetated playas where soils and water (if present) are alkaline. Characteristic species may include *Allenrolfea occidentalis, Atriplex* spp., *Distichlis spicata, Grayia spinosa, Leymus cinereus, Leymus triticoides (= Elymus triticoides), Muhlenbergia* spp., *Poa secunda, Puccinellia lemmonii, Salicornia* spp., *Sarcobatus vermiculatus,* and *Triglochin maritima*.

Range: This group is found in the intermountain western U.S. Associations are composed of densely vegetated seasonal wetlands, saltwater emergent marshes to barren and sparsely vegetated playas (generally <10% plant cover). Characteristic species may include *Allenrolfea occidentalis, Atriplex* spp., *Distichlis spicata, Grayia spinosa, Leymus cinereus, Leymus triticoides (= Elymus triticoides), Muhlenbergia* spp., *Poa secunda, Puccinellia lemmonii, Salicornia* spp., *Sarcobatus vermiculatus,* and *Triglochin maritima*. Soils and standing water (if present) are alkaline. Salt crusts are common where there are actively drying ponds, that can have saltgrass beds in depressions and sparse shrubs around the margins. Playa flats are intermittently, seasonally to semipermanently flooded, usually retaining water into the growing season and drying completely only in drought years. Many are associated with hot and cold springs, located in basins with internal drainage. Soils are alkaline to saline clays with hardpans. Seasonal drying exposes mudflats colonized by annual wetland vegetation. Water is prevented from percolating through the soil by an impermeable soil subhorizon and is left to evaporate. Soil salinity varies greatly with soil moisture and greatly affects species composition. During exceptionally wet years, increased precipitation can dilute soil salt

concentrations which may allow less salt-tolerant species to become established or more abundant. Some stands occur on floodplains, along the margins of perennial lakes, and in alkaline closed basins, with extremely low-gradient shorelines.

Diagnostic Characteristics: Salt-tolerant herbs that are seasonally or intermittently wet on barren to sparsely vegetated playas, lake margins, closed basins, and low-gradient shorelines.

Physiognomy and Structure: Open shrub and/or herb vegetation.

Floristics: Characteristic species may include *Allenrolfea occidentalis, Atriplex* spp., *Distichlis spicata, Grayia spinosa, Leymus cinereus, Leymus triticoides (= Elymus triticoides), Muhlenbergia* spp., *Poa secunda, Puccinellia lemmonii, Salicornia* spp., *Schoenoplectus americanus, Schoenoplectus maritimus,* and *Triglochin maritima*.

Environmental Description: *Climate:* Cold desert. *Soil/substrate/hydrology:* This group is found on barren and sparsely vegetated playas (generally <10% plant cover). Salt crusts are common throughout, with small saltgrass beds in depressions and sparse shrubs around the margins. The flats are intermittently, seasonally to semipermanently flooded, usually retaining water into the growing season and drying completely only in drought years. Many are associated with hot and cold springs, located in basins with internal drainage. Soils are alkaline to saline clays with hardpans. Seasonal drying exposes mudflats colonized by annual wetland vegetation. Water is prevented from percolating through the soil by an impermeable soil subhorizon and is left to evaporate. Soil salinity varies greatly with soil moisture and greatly affects species composition. During exceptionally wet years, increased precipitation can dilute soil salt concentrations which may allow less salt-tolerant species to become established or more abundant. Some stands occur on floodplains, along the margins of perennial lakes, and in alkaline closed basins, with extremely low-gradient shorelines. Environmental information compiled from individual associations and Knight (1994).

Geographic Range: This group is found throughout the intermountain western U.S.

Nations [incomplete except for CA and US]: CA, MX, US

States/Provinces: CA, CO, ID, MT, NM, NV, OR, TX, UT, WA?, WY

G537. North American Desert Alkaline-Saline Wet Scrub
Scientific Name: *Sarcobatus vermiculatus* - *Atriplex* spp. Alkaline-Saline Wet Scrub Group

Common Name (Translated Scientific Name): Greasewood - Saltbush species Alkaline-Saline Wet Scrub Group (North American Desert Alkaline-Saline Wet Scrub)

Classifiers:

Similar NVC Types: G534 Western Great Plains Saline Wet Meadow: occurs in the northern and western Great Plains and is also dominated by *Sarcobatus vermiculatus* with more Great Plains herbaceous species; G538 North American Desert Alkaline-Saline Marsh & Playa: includes salt communities in the cold desert that are dominated by herbaceous species.

Concept Summary: This group consists of saline scrub wetlands of the Intermountain West. Characteristic species include *Atriplex* spp., *Allenrolfea occidentalis, Salicornia rubra, Sarcobatus vermiculatus, Sesuvium verrucosum,* and/or *Suaeda moquinii*.

Range: This group occurs throughout much of the western U.S. in intermountain basins. Stands typically occur near drainages on stream terraces and flats or may form rings around more sparsely vegetated playas. Sites typically have saline soils, a shallow water table and flood intermittently, but remain dry for most growing seasons. The water table remains high enough to maintain vegetation, despite salt accumulations. This group consists of open to moderately dense shrublands dominated by *Atriplex lentiformis, Atriplex parryi, Atriplex polycarpa, Atriplex spinifera, Allenrolfea occidentalis, Salicornia rubra, Sarcobatus vermiculatus, Sesuvium verrucosum,* and/or *Suaeda moquinii*. Stands may be monotypic or have lesser abundance of other shrubs such as *Atriplex canescens, Atriplex confertifolia, Atriplex gardneri, Artemisia tridentata ssp. wyomingensis, Artemisia tridentata ssp. tridentata, Artemisia cana ssp. cana, Baccharis* spp., *Krascheninnikovia lanata,* and others. The herbaceous layer, if present, is usually dominated by graminoids. There may be inclusions of *Calamovilfa longifolia, Distichlis spicata* (where water remains ponded the longest), *Eleocharis palustris, Pascopyrum smithii, Poa pratensis, Puccinellia nuttalliana,* or *Sporobolus airoides* herbaceous types.

Diagnostic Characteristics: Salt-tolerant shrublands with a shallow water table.

Physiognomy and Structure: Shrubland.

Floristics: These shrublands are dominated by *Atriplex lentiformis, Atriplex parryi, Atriplex polycarpa, Atriplex spinifera, Allenrolfea occidentalis, Salicornia rubra, Sarcobatus vermiculatus, Sesuvium verrucosum,* and/or *Suaeda moquinii*. Codominant shrubs include *Ambrosia dumosa, Artemisia californica, Atriplex canescens, Baccharis pilularis, Baccharis salicifolia, Encelia californica, Eriogonum fasciculatum, Gutierrezia sarothrae, Hymenoclea salsola, Kochia americana, Larrea tridentata, Malosma laurina, Myoporum laetum, Pluchea sericea, Prosopis glandulosa, Rhus integrifolia,* and/or *Suaeda taxifolia* plus several others. The herbaceous layer, if present, is usually dominated by graminoids. There may be inclusions of *Calamovilfa longifolia, Distichlis spicata* (where water remains ponded the longest), *Eleocharis palustris, Pascopyrum smithii, Poa pratensis, Puccinellia nuttalliana,* or *Sporobolus airoides* herbaceous types (West 1983b, Knight 1994).

Environmental Description: *Climate:* Cold interior desert. *Soil/substrate/hydrology:* Sites are generally flat to gently sloping and moderately saline, but some sites do occur on rolling to hilly fans and slopes. Sites typically have saline soils, a shallow water table and flood intermittently, on margins of intermittently flooded desert playas, and usually remain dry for most growing seasons. The water table remains high enough to maintain vegetation, despite salt accumulations, often with fine soils such as clays (West 1983b, Knight 1994).

Geographic Range: This group occurs throughout much of the western U.S. in intermountain basins.

Nations [incomplete except for CA and US]: US

States/Provinces: AZ, CA, CO, ID, MT, NM, NV, OR, TX, UT, WA, WY

3.A.2.Na. North American Warm Desert Scrub & Grassland (D039)

M086. Chihuahuan Desert Scrub

3. Desert & Semi-Desert; 3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland; 3.A.2. Warm Desert & Semi-Desert Scrub & Grassland; 3.A.2.Na. North American Warm Desert Scrub & Grassland; M086. Chihuahuan Desert Scrub

G287. Chihuahuan Desert Sand Scrub

Scientific Name: *Artemisia filifolia - Psorothamnus scoparius* Sand Scrub Group

Common Name (Translated Scientific Name): Sand Sagebrush - Broom Smokebush Sand Scrub Group (Chihuahuan Desert Sand Scrub)

Classifiers: Heavy grazing in the late 1800s and early 1900s may have caused this shrubland to increase through degradation of semi-desert grassland on sandy plains. *Artemisia filifolia*, a dominant and diagnostic species of this group, is a widespread psammophilous shrub that extends into other biogeographic regions, including the Western Great Plains and the Colorado Plateau. Occurrence within the Chihuahuan Desert biogeographic area or presence of Chihuahuan Desert indicator species is diagnostic of stands in this group.

Similar NVC Types: G819 North American Warm Desert Ruderal Scrub; G491 Chihuahuan Sandy Plains Semi-Desert Grassland.

Concept Summary: This scrub group occurs on sandsheets and sandy plains in the Chihuahuan Desert and has an open canopy (10-30% total vegetation cover) that is frequently dominated by *Artemisia filifolia* or *Psorothamnus scoparius* often with *Atriplex canescens, Ephedra torreyana, Ephedra trifurca, Poliomintha incana, Rhus microphylla,* or *Larrea tridentata* present to codominant.

Range: This group includes the open desert scrub of vegetated coppice dunes and sandy plains found in the Chihuahuan Desert. Stands are usually dominated by *Artemisia filifolia* or *Psorothamnus scoparius* that anchor coppice dunes or occur on open sandsheet flats. They may also be dominated or codominated by *Atriplex canescens, Ephedra torreyana, Ephedra trifurca, Poliomintha incana, Rhus microphylla,* and *Larrea tridentata,* usually with 10-30% total vegetation cover. *Yucca elata, Gutierrezia sarothrae, Bouteloua eriopoda,* and *Sporobolus flexuosus* are commonly present. This group includes degraded sandy desert plains grasslands now dominated by *Artemisia filifolia* and *Prosopis glandulosa*.

Diagnostic Characteristics: A sparse to moderately dense (5-30% cover), low-statured shrubland (<2 m tall) dominated by *Psorothamnus scoparius* or *Artemisia filifolia* on sandy substrate. *Atriplex canescens, Ephedra torreyana, Ephedra trifurca, Poliomintha incana,* and *Rhus microphylla* may also dominate or codominate this coppice dune and sandsheet scrub.

Physiognomy and Structure: **Rationale for Physiognomic Features:** *Prosopis glandulosa* is the dominant and diagnostic shrub on southern stands and declines northward. *Artemisia filifolia* is

common on northern stands and is less prevalent going southward. *Prosopis* is an indicator of the desert flora and *Artemisia filifolia* is an indicator of sand substrates. *Poliomintha incana* and *Psorothamnus scoparius* are also indicators of desert sand habitats but have more restricted distribution. The other sometimes dominant shrub species (*Atriplex canescens, Ephedra torreyana, Ephedra trifurca,* and *Rhus microphylla*) also occur in other habitats.

This group is an extremely xeromorphic, deciduous, desert shrubland generally without succulents. It has a sparse to moderately dense (5-30% cover), short-shrub layer (<2 m tall). The understory and inter-shrub spaces are generally sparse or absent of vegetation, but perennial grasses may be moderately abundant on stable sandsheets.

Floristics: Vegetation in this group is usually dominated by *Artemisia filifolia* or *Psorothamnus scoparius* that anchor coppice dunes or occur on sandsheets or sandy flats. They may also be dominated or codominated by *Atriplex canescens, Ephedra torreyana, Ephedra trifurca, Poliomintha incana, Rhus microphylla,* and *Larrea tridentata,* usually with 10-30% total vegetation cover. *Yucca elata, Gutierrezia sarothrae, Bouteloua eriopoda,* and *Sporobolus flexuosus* are commonly present. Other common herbaceous species include *Abronia* spp., *Achnatherum hymenoides, Heliotropium convolvulaceum, Muhlenbergia pungens,* and *Penstemon ambiguus*. In northern stands, *Prosopis glandulosa* becomes less common or absent. This group includes degraded sandy desert plains grasslands now dominated by *Artemisia filifolia* and *Prosopis glandulosa*.

Environmental Description: This group includes the open desert scrub of vegetated coppice dunes and sandsheets found in the Chihuahuan Desert. It often occurs on the lee sides of large playas in basins where sand accumulates, but may include deep sandy plains.

Geographic Range: This desert scrub group occurs on dunes and sandsheets found in the Chihuahuan Desert.

Nations [incomplete except for CA and US]: MX, US

States/Provinces: MXCH, NM, TX

M092. North American Warm-Desert Xeric-Riparian Scrub

3. Desert & Semi-Desert; 3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland; 3.A.2. Warm Desert & Semi-Desert Scrub & Grassland; 3.A.2.Na. North American Warm Desert Scrub & Grassland; M092. North American Warm-Desert Xeric-Riparian Scrub

G541. Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope

Scientific Name: *Chilopsis linearis - Fallugia paradoxa - Prunus fasciculata* Desert Wash & Colluvial Slope Group

Common Name (Translated Scientific Name): Desert-willow - Apache Plume - Desert Almond Desert Wash & Colluvial Slope Group (Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope)

Classifiers: This intermittently flooded desert wash group is wide-ranging with diverse species. There is some species overlap with desert riparian groups that are seasonally or permanently flooded, although cover of these riparian species such as *Juglans microcarpa* is lower in dry washes than in riparian shrublands and woodlands. Stands may also be dominated by denser cover of upland and facultative wetland (semi-riparian) species such as *Acacia greggii, Fallugia paradoxa, Psorothamnus spinosus, Rhus microphylla*, and *Salazaria mexicana.* Also complicating the species composition of this group is the wide soil moisture gradients across its range. In extremely dry area such as found in the Lower Colorado Desert, uplands are sparsely vegetated with non-sparse upland vegetation restricted to dendritic intermittently flooded drainage channels. In other areas, upland dry washes flood so infrequently that they have only upland vegetation present (although sometime denser and more robust). However, if there is no floristic difference between upland area and a dry wash that bisects it, then it is not a distinct wash community.

Similar NVC Types: G797 Western Interior Riparian Forest & Woodland; G559 Great Basin-Intermountain Shrub & Herb Wash-Arroyo.

Concept Summary: These are fluvial-driven shrublands and herbaceous communities that line washes in the warm deserts of the western U.S. and northwestern Mexico and may be dominated by *Chilopsis linearis, Fallugia paradoxa, Prunus fasciculata,* or other shrub species.

Range: This group is restricted to intermittently flooded washes or arroyos that dissect bajadas, mesas, plains and basin floors throughout the warm deserts of the western U.S. and northwestern Mexico. A woody layer is usually present and is typically scattered clumps to very open and may be dominated by shrubs and small trees such as *Acacia greggii, Brickellia laciniata, Baccharis sarothroides, Chilopsis linearis, Ephedra californica, Ericameria paniculata, Fallugia paradoxa, Forestiera pubescens, Hymenoclea salsola, Hymenoclea monogyra, Hyptis emoryi, Juglans microcarpa, Lepidospartum squamatum, Olneya tesota, Parkinsonia florida, Prosopis* spp., *Psorothamnus spinosus, Prunus fasciculata, Rhus microphylla, Salazaria mexicana, Sarcobatus vermiculatus*, or *Viguiera reticulata*. A few known herbaceous communities dominate intermittent drainages and washes with woody vegetation absent or only with scattered individuals present. Dominant species include *Panicum bulbosum, Alopecurus aequalis*, or *Lycurus phleoides*. Although often dry, the intermittent fluvial processes are characteristic of this group, which are often associated with rapid sheet and gully flow. This group is restricted to drainages in upland areas or ramaderos that are intermittently flooded and occur as linear or sometimes broader braided strips within desert scrub-or desert grassland-dominated landscapes. The vegetation of desert washes is quite variable in species composition and structure, ranging from sparse and patchy to moderately dense, and typically occurs along the banks, but may occur within the channel.

Diagnostic Characteristics: Characteristic species of shrubs and small trees may include *Acacia greggii, Brickellia laciniata, Baccharis sarothroides, Chilopsis linearis, Ephedra californica, Ericameria paniculata, Fallugia paradoxa, Forestiera pubescens, Hymenoclea salsola, Hymenoclea monogyra, Hyptis emoryi, Juglans microcarpa, Lepidospartum squamatum, Olneya tesota, Parkinsonia florida, Prosopis* spp., *Psorothamnus spinosus, Prunus fasciculata, Rhus microphylla, Salazaria mexicana, Sarcobatus vermiculatus*, and *Viguiera reticulata*.

Physiognomy and Structure: **Rationale for Physiognomic Features:** This intermittently flooded wash type is wide-ranging with diverse species. Characteristic desert wash species were included from the Chihuahuan, Sonoran and Mojave deserts (*Chilopsis linearis, Hymenoclea* spp., *Rhus microphylla*), and tropical Central America (*Haematoxylum brasiletto*) washes.

This group is typically characterized by an intermittently open to dense woody layer, but includes stands lacking a woody layer that may be dominated by herbaceous vegetation or sparsely vegetated.

Floristics: The vegetation of this group is quite variable in species composition and structure, ranging from sparse and patchy to moderately dense, and typically occurs along the banks, but may occur within the channel. A woody layer is usually present and is typically intermittent to open and may be dominated by shrubs and small trees such as *Acacia greggii, Brickellia laciniata, Baccharis sarothroides, Chilopsis linearis, Ephedra californica, Ericameria paniculata, Fallugia paradoxa, Forestiera pubescens, Hymenoclea salsola, Hymenoclea monogyra, Hyptis emoryi, Juglans microcarpa, Lepidospartum squamatum, Olneya tesota, Parkinsonia florida, Prosopis pubescens, Psorothamnus spinosus, Prunus fasciculata, Rhus microphylla, Salazaria mexicana, Sarcobatus vermiculatus,* or *Viguiera reticulata*. Additional species characteristic of Tamaulipan stands are *Acacia farnesiana, Celtis pallida, Haematoxylum brasiletto, Prosopis glandulosa,* or *Tecoma stans*. *Prosopis glandulosa* is not dominant. Sometimes herbaceous vegetation dominates the wash with woody vegetation absent or only with scattered individuals present. Dominance by *Panicum bulbosum, Alopecurus aequalis*, or *Lycurus phleoides* is typical of some herbaceous stands, although it is variable. Floristic information was compiled from Shreve and Wiggins (1964), Brown (1982a), Barbour and Major (1988), Jahrsdoerfer and Leslie (1988), MacMahon (1988), Szaro (1989), Dick-Peddie (1993), Sawyer and Keeler-Wolf (1995), Barbour et al. (2007), Schoenherr and Burk (2007), and Sawyer et al. (2009).

Environmental Description: This group is restricted to intermittently flooded washes or arroyos that dissect bajadas, mesas, plains and basin floors throughout the warm deserts and subtropical Tamaulipan region of North and Central America. Although often dry, the intermittent fluvial processes are characteristic of this group, which are often associated with rapid sheet and gully flow. This group is restricted to drainages in upland areas or ramaderos that are intermittently flooded and occur as linear or sometimes broader braided strips within desert scrub-or desert grassland-dominated landscapes. *Soil/substrate/hydrology:* This group is restricted to drainages in upland areas or ramaderos (isolated strips of dense brush associated with arroyos) that are intermittently flooded.

Geographic Range: This group is restricted to intermittently flooded washes or arroyos that dissect bajadas, mesas, plains and basin floors throughout the warm deserts of North America and northern Central America.

Nations [incomplete except for CA and US]: MX, US

States/Provinces: AZ, CA, MXBC, MXCH, MXCO, MXNU, MXSO, MXTM, NM, NV, TX

3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland (D040)

M171. Great Basin-Intermountain Dry Shrubland & Grassland

3. Desert & Semi-Desert; 3.B. Cool Semi-Desert Scrub & Grassland; 3.B.1. Cool Semi-Desert Scrub & Grassland; 3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland; M171. Great Basin-Intermountain Dry Shrubland & Grassland

G296. Mojave Mid-Elevation Mixed Desert Scrub

Database Code: G296

Scientific Name: *Yucca brevifolia - Eriogonum fasciculatum - Ephedra fasciculata* Mixed Desert Scrub Group

Common Name (Translated Scientific Name): Joshua Tree - Eastern Mojave Buckwheat - Arizona Joint-fir Mixed Desert Scrub Group (Mojave Mid-Elevation Mixed Desert Scrub)

Classifiers: Diagnostics needs to be rewritten to solidify how this group differs from Colorado Plateau Blackbrush - Mormon-tea Shrubland Group (G312) (T. Keeler-Wolf pers. comm. 2013). TKW recommends the following species be removed from diagnostics: *Coleogyne ramosissima, Peucephyllum schottii*. Former Sonoran Mid-elevation Desert Scrub Group (G291) was merged into this group. TKW recommends moving *Chrysothamnus albidus / Puccinellia nuttalliana* Shrubland (CEGL001328) to an "alkali" group, perhaps G537 or G672. Colloquial name of the group changed per TKW recommendation, from Mojave Mid-Elevation Mixed Desert Scrub Group to Mojavean-Sonoran Rocky Upland Desert Scrub Group. Also, need to revisit placement of the *Grayia spinosa* associations; *Grayia* alliance is generally considered in this group in California, but may belong in a Great Basin group (cold desert) in Nevada Idaho, Utah, and elsewhere in Great Basin (T. Keeler-Wolf pers. comm. 2013).

Similar NVC Types: G312 Colorado Plateau Blackbrush - Mormon-tea Shrubland: shares several dominant species such as *Coleogyne ramosissima* and species of *Ephedra*.

Concept Summary: This group represents the extensive desert scrub in the transition zone above *Larrea tridentata - Ambrosia dumosa* desert scrub and below the lower montane woodlands (at mid-elevations of 700-1800 m) that occurs in the eastern and central Mojave Desert and transition zone into the southern Great Basin. Stands are dominated by a variety characteristic species such as *Coleogyne ramosissima, Ericameria cooperi, Eriogonum fasciculatum, Ephedra* spp., *Eriogonum corymbosum, Grayia spinosa, Lycium andersonii, Menodora spinescens, Nolina* spp., *Opuntia acanthocarpa, Purshia glandulosa, Purshia stansburiana, Salazaria mexicana, Thamnosma montana, Yucca brevifolia*, or *Yucca schidigera*.

Range: This group represents the extensive desert scrub in the transition zone above *Larrea tridentata - Ambrosia dumosa* desert scrub and below the lower montane woodlands at mid-elevations in the eastern and central Mojave Desert. It is also common on lower piedmont slopes in the transition zone into the southern Great Basin. The vegetation in this group is quite variable.

Larrea tridentata may be absent or present to codominant in some examples, but typically does not dominate. Characteristic and dominant species include *Ambrosia eriocentra, Arctostaphylos patula, Coleogyne ramosissima, Ericameria cooperi, Eriogonum fasciculatum, Ephedra californica, Ephedra nevadensis, Ephedra torreyana, Ephedra viridis, Eriogonum corymbosum, Grayia spinosa, Lycium andersonii, Menodora spinescens, Nolina bigelovii, Nolina microcarpa, Nolina parryi, Opuntia acanthocarpa, Purshia glandulosa, Purshia stansburiana, Salazaria mexicana, Thamnosma montana, Viguiera parishii, Yucca brevifolia,* or *Yucca schidigera*. Less common are stands with scattered *Yucca brevifolia* and a saltbush short-shrub layer dominated by *Atriplex canescens, Atriplex confertifolia,* or *Artemisia tridentata*. In some areas in the western Mojave, shrubby *Juniperus californica* is common with the yuccas. *Grayia spinosa* is a common codominant shrub in disturbed stands. Desert grasses, including *Achnatherum hymenoides, Achnatherum speciosum, Muhlenbergia porteri, Pleuraphis jamesii, Pleuraphis rigida, Poa secunda,* or *Pseudoroegneria spicata*, may form an herbaceous layer. Scattered *Juniperus osteosperma* or warm desert scrub species may also be present. This shrubland group is found in the Mojave Desert of southeastern California and southern Nevada and forms a cool-temperate elevational belt on desert ranges (700-1800 m) elevation. It also occurs at the longitudinal transition zone between the Mojave and southern Great Basin, generally at mid-elevations. Landforms include valleys, bajadas, mountain slopes, ridges, mesas or alluvial fans bordering intermountain basins. The climate is semi-arid and characterized by hot, dry summers and cold winters with precipitation ranging from 5-30 cm annually. Temperatures are continental, with large annual and diurnal ranges. Soils are highly variable across the large range of this vegetation type and are generally shallow, well-drained, coarse-textured loams or sand with rock fragments, but include finer-textured substrates such as silt.

Diagnostic Characteristics: The presence of *Eriogonum fasciculatum, Ephedra fasciculata, Yucca brevifolia,* or *Yucca schidigera* is diagnostic of this type, as is *Coleogyne ramosissima,* which is often a dominant species. The widespread desert shrub *Larrea tridentata* may be absent or present to codominant in some stands, but typically does not dominate here as it does at lower elevations. This is a diverse group, and stands may also be dominated or codominated by *Ambrosia eriocentra, Ericameria cooperi, Ephedra californica, Ephedra nevadensis, Ephedra torreyana, Ephedra viridis, Grayia spinosa, Lycium andersonii, Juniperus californica, Menodora spinescens, Nolina bigelovii, Nolina microcarpa, Nolina parryi, Opuntia acanthocarpa, Purshia glandulosa, Purshia stansburiana,* and *Salazaria mexicana*.

Physiognomy and Structure: **Rationale for Physiognomic Features:** *Yucca brevifolia, Eriogonum fasciculatum,* and *Ephedra fasciculata* are characteristic and either conspicuous (tree yucca) or often dominant in this mixed desert scrub group. Many other species may dominate, but few are consistent indicators of this group.

This group is an extremely xeromorphic evergreen shrubland sometimes with a sparse tree layer of evergreen sclerophyllous trees. The herbaceous layer is generally sparse, but may have significant perennial grass cover.

Floristics: The vegetation in this group is quite variable. *Larrea tridentata* may be absent or present to codominant in some stands, but typically does not dominate. Characteristic and dominant species

include *Ambrosia eriocentra, Arctostaphylos patula, Coleogyne ramosissima, Ericameria cooperi, Eriogonum fasciculatum, Ephedra californica, Ephedra nevadensis, Ephedra torreyana, Ephedra viridis, Eriogonum corymbosum, Grayia spinosa, Lycium andersonii, Menodora spinescens, Nolina bigelovii, Nolina microcarpa, Nolina parryi, Opuntia acanthocarpa, Purshia glandulosa, Purshia stansburiana, Salazaria mexicana, Thamnosma montana, Viguiera parishii, Yucca brevifolia,* or *Yucca schidigera*. Less common are stands with scattered *Yucca brevifolia* and a saltbush short-shrub layer dominated by *Atriplex canescens, Atriplex confertifolia,* or *Artemisia tridentata*. In some areas in the western Mojave, shrubby *Juniperus californica* is common with the yuccas. *Grayia spinosa* is a common codominant shrub in disturbed stands. Desert grasses, including *Achnatherum hymenoides, Achnatherum speciosum, Muhlenbergia porteri*, *Pleuraphis jamesii, Pleuraphis rigida, Poa secunda, Pseudoroegneria spicata*, or *Sporobolus cryptandrus,* may form an herbaceous layer. Scattered *Juniperus osteosperma* or warm desert scrub species may also be present.

Environmental Description: This shrubland group is found in the Mojave Desert of southeastern California and southern Nevada and forms a cool-temperate elevational belt on desert ranges. It also occurs at the longitudinal transition zone between the Mojave and southern Great Basin at mid-elevation (800-1800 m) (Sawyer et al. 2009). Landforms include valleys, bajadas, mountain slopes, ridges, mesas or alluvial fans bordering intermountain basins. Some authors regard this group as delimiting the upper elevational boundary of the Mojave Desert in the transition between the Mojave and Great Basin deserts (Mozingo 1987). Full elevation ranges from 50-2500 m, with stands regularly occurring above 900 m. The climate is semi-arid and characterized by hot, dry summers and cold winters with precipitation ranging from 5-30 cm annually. Winter precipitation dominates in the western portions, with summer rain becoming more important eastward. Year-to-year precipitation variability can be quite large. Temperatures are continental, with large annual and diurnal ranges. Soils are highly variable across the large range of this vegetation type and are generally shallow, well-drained, coarse-textured loams or sand with rock fragments, but include finer-textured substrates such as silt. Soils are derived from bedrock or alluvial deposits from granitic and sedimentary rocks (Keeler-Wolf and Thomas 2000, Thomas et al. 2004, Sawyer et al. 2009). These communities are more drought-tolerant than *Artemisia tridentata*-dominated communities of the Great Basin but less tolerant of drought than either *Larrea tridentata* or *Atriplex* spp. shrublands. Adjacent vegetation is typically *Artemisia* shrublands at the upper elevational margin and *Larrea tridentata* or *Atriplex* - *Sarcobatus* shrublands where these communities grade into lower-elevation deserts or heavy alkaline soils.

Geographic Range: This desert scrub group is found in the eastern and central Mojave Desert and on lower piedmont slopes in the transition zone into the southern Great Basin.

Nations [incomplete except for CA and US]: MX?, US

States/Provinces: AZ, CA, NV, UT

G312. Colorado Plateau Blackbrush - Mormon-tea Shrubland

Scientific Name: *Coleogyne ramosissima - Ephedra cutleri - Ephedra torreyana* Colorado Plateau Shrubland Group

Common Name (Translated Scientific Name): Blackbrush - Cutler's Joint-fir - Torrey's Joint-fir Colorado Plateau Shrubland Group (Colorado Plateau Blackbrush - Mormon-tea Shrubland)

Classifiers:

Similar NVC Types: G296 Mojave Mid-Elevation Mixed Desert Scrub.

Concept Summary: This semi-arid shrubland group occurs in the Colorado Plateau on sandy substrates and is characterized by extensive, typically open shrublands dominated by *Artemisia filifolia, Coleogyne ramosissima, Ephedra cutleri, Ephedra torreyana, Ephedra viridis, Poliomintha incana, Quercus havardii var. tuckeri*, or *Vanclevea stylosa*.

Range: This semi-arid Colorado Plateau shrubland group is characterized by extensive, typically open shrublands dominated by *Coleogyne ramosissima* or one of three species of *Ephedra*: *Ephedra cutleri, Ephedra torreyana*, or *Ephedra viridis*. *Ephedra cutleri* and *Ephedra viridis* often assume a distinctive matty growth form. Other dominant /diagnostic shrubs that occur either singly or in mixed stands include *Artemisia filifolia* (often on deep-sand sites), *Poliomintha incana, Quercus havardii var. tuckeri*, and *Vanclevea stylosa*. Other more widespread shrubs, such as *Ericameria nauseosa* and *Grayia spinosa*, may be present to dominant locally. The herbaceous layer is sparse and composed of graminoids such as *Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii*, or *Sporobolus cryptandrus*. The general aspect of occurrences is an open low shrubland but may include small blowouts and dunes. Occasionally grasses may be moderately abundant locally and form a distinct layer. Stands occur on windswept mesas, benchlands, colluvial slopes, pediments, alluvial fans, broad basins and plains. Elevation ranges from 560-1800 m. Substrates are shallow, typically calcareous, non-saline and gravelly or sandy soils over sandstone bedrock or limestone bedrock (less common), caliche or limestone alluvium. It also occurs in deeper soils on sandy plains and stabilized sandsheets and may form small hummocks or small coppice dunes. Disturbance may be important in maintaining the woody component. Eolian processes are evident, such as pediceled plants, occasional blowouts or small dunes, but the generally higher vegetative cover and less prominent geomorphic features distinguish this group from active and stabilized dune complexes.

Diagnostic Characteristics: *Coleogyne ramosissima* is an indicator species for this shrubland group in the northern portion of its range and often dominates or codominates with species of *Ephedra*. *Ephedra* species are typically present to dominant throughout the range of this group with *Ephedra cutleri* largely restricted to the southern portions. *Artemisia filifolia* may also be present to dominant, but is a widespread western shrub on sandy substrates and is not a good indicator of this Colorado Plateau group.

Physiognomy and Structure: **Rationale for Physiognomic Features:** *Coleogyne ramosissima* is a common dominant or codominant shrub in the northern extent, whereas the *Ephedra* species are common all throughout the range, with *Ephedra cutleri* largely restricted to the southern portion of the range. *Artemisia filifolia* is a very common western shrub on sand deposits and not a good indicator of this Colorado Plateau group.

This group is composed of a typically open evergreen, microphyllous semi-desert scrub with succulents, half-shrubs, and scattered deciduous shrubs. Occasionally shrub cover can be moderately dense. Herbaceous species are typically sparse and composed of perennial graminoids.

Floristics: This semi-arid shrubland group is characterized by extensive, typically open shrublands dominated by *Coleogyne ramosissima* or one of several different species of *Ephedra*: *Ephedra cutleri, Ephedra torreyana*, or *Ephedra viridis*. *Ephedra cutleri* and *Ephedra viridis* often assume a distinctive matty growth form. *Artemisia filifolia* is often present and may be codominant to dominant on deep-sand sites. *Poliomintha incana, Quercus havardii var. tuckeri*, and *Vanclevea stylosa* may also dominant stands in either singly or in mixed stands. Other more widespread shrubs may be present, including *Atriplex canescens, Atriplex confertifolia*, *Ericameria nauseosa*, and *Grayia spinosa*, but not dominant. The herbaceous layer is sparse and composed of perennial graminoids such as *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata*, *Pleuraphis jamesii*, or *Sporobolus cryptandrus*. The general aspect of occurrences is an open low shrubland but may include small blowouts and dunes. Occasionally grasses may be moderately abundant locally and form a distinct layer.

Environmental Description: This semi-arid shrubland group occurs in the Colorado Plateau on windswept mesas, benchlands, colluvial slopes, pediments, alluvial fans, broad basins and plains. Elevation ranges from 560-1800 m. Substrates are shallow, typically calcareous, non-saline and gravelly or sandy soils over sandstone bedrock and, less commonly, limestone bedrock (regolith), caliche (petrocalcic layer) or limestone alluvium. Stands also occur in deeper soils on extensive sandy plains and stabilized sandsheets and may form small hummocks or small coppice dunes. Disturbance may be important in maintaining the woody component. Eolian processes are evident, such as pediceled plants, occasional blowouts or small dunes, but the generally higher vegetative cover and less prominent geomorphic features distinguish this group from active and stabilized dune complexes.

Climate: This shrubland group occurs in an arid to semi-arid climate with annual precipitation in the form of summer monsoons and winter storms averaging approximately 20 cm.
Soil/substrate/hydrology: This group typically occurs on gentle to steep, bouldery or rocky slopes of mountains, canyons, and mesas with varying aspects, but includes extensive sandy plains and basin in the southern portion of the Colorado Plateau. Soils are highly variable, and parent materials may include shale, sandstone, limestone, quartzites, and igneous rocks. Soils are generally coarse-textured, often rocky, shallow and well-drained. Effective soil moisture appears to be primarily controlled by depth of regolith (layer of loose, heterogeneous material covering solid rock) and position in relation to the water table. In most sites the regolith is uniformly shallow. In association with blackbrush (*Coleogyne ramosissima*) sites, the soil moisture is concentrated on top of impermeable bedrock at a shallow depth. This perching effect allows for gradual uptake of moisture by the plants roots (Loope and West 1979). This permits growth of plants with more mesic habitat requirements (Warren et al. 1982). On sites with deep soil, blackbrush may occur in almost pure stands with only a few associated species (Warren et al. 1982). Dark-colored cryptogamic soil crusts, composed of lichens, mosses, fungi, and algae, are often present in this group in fairly undisturbed

areas. Sandy soils may have more cryptogamic crusts than clayish or silty soil surfaces. This group also occurs in deeper soils on sandy plains and stabilized sandsheets and may form small hummocks or small coppice dunes. Eolian processes are evident, such as pediceled plants, occasional blowouts or small dunes, but the generally higher vegetative cover and less prominent geomorphic features distinguish this group from active and stabilized dune complexes.

Geographic Range: This group occurs in the Colorado Plateau on benchlands, colluvial slopes, pediments or alluvial fans common in Canyonlands portion in central Utah and extends south into southern Utah and northeastern Arizona where it occurs on vast sandy plains and mesatops.

Nations [incomplete except for CA and US]: US

States/Provinces: AZ, CO, NM, NV, UT

G311. Intermountain Semi-Desert Grassland

Scientific Name: *Pleuraphis jamesii - Achnatherum hymenoides - Hesperostipa comata* Semi-Desert Grassland Group

Common Name (Translated Scientific Name): James' Galleta - Indian Ricegrass - Needle-and-Thread Semi-Desert Grassland Group (Intermountain Semi-Desert Grassland)

Classifiers: This group was merged with former Columbia Basin Foothill & Canyon Dry Grassland Group (G274), which was very similar compositionally and a northern variant of this intermountain group. Communities dominated by *Achnatherum lettermanii, Achnatherum nelsonii*, and *Agrostis variabilis* are poorly understood and require further documentation. The only occurrence of a community dominated by *Agrostis variabilis* is known from Utah and may be the result of disturbance. *Achnatherum speciosum* is a southern Great Basin species, which extends in distribution into the Mojave and Colorado deserts, for now its communities are included here. Occurrences of this semi-desert grassland group in the relatively high-elevation basins of Wyoming and south-central Montana resemble in species composition the foothill grasslands that grow at slightly higher elevations and in the Columbia Plateau.

Similar NVC Types: G273 Central Rocky Mountain Lower Montane, Foothill & Valley Grassland.

Concept Summary: This widespread semi-arid to arid grassland group occurs throughout the intermountain western U.S. that are composed of dominant drought-resistant perennial bunchgrasses such as *Achnatherum* spp., *Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii, Poa cusickii, Poa secunda*, and *Pseudoroegneria spicata* often with scattered shrubs, especially *Artemisia tridentata, Atriplex* spp., *Coleogyne ramosissima, Ephedra* spp., *Gutierrezia sarothrae*, and *Krascheninnikovia lanata*.

Range: This widespread group includes semi-arid to arid grasslands found throughout the intermountain western U.S. The dominant perennial bunchgrasses and shrubs within this group are all drought-resistant plants. Dominant or codominant species are *Achnatherum hymenoides, Achnatherum lettermanii, Achnatherum nelsonii, Achnatherum speciosum, Bouteloua gracilis,*

Hesperostipa comata, Pleuraphis jamesii, Poa cusickii, Poa secunda, Pseudoroegneria spicata, and *Sporobolus cryptandrus*. Scattered shrubs and dwarf-shrubs often are present, especially *Artemisia tridentata ssp. tridentata, Artemisia tridentata ssp. wyomingensis, Atriplex* spp., *Coleogyne ramosissima, Ephedra* spp., *Gutierrezia sarothrae*, and *Kraschenninnikovia lanata,* which are the typical dominant species of adjacent shrublands. Stands occur on sites on a variety of landforms, including swales, playas, mesas, alluvial flats, and plains over an elevational range of approximately 1100 to 3290 m in most of its range and 350 to 425 m in the Columbia Basin. This group may constitute the matrix over large areas of intermountain basins, and also may occur as large patches in mosaics with semi-desert shrublands. Grasslands in areas of higher precipitation, at higher elevation, typically belong to other groups. Substrates are often well-drained sandy or loam soils derived from sedimentary parent materials but are quite variable and may include fine-textured soils derived from igneous and metamorphic rocks.

Diagnostic Characteristics: This group consists of semi-arid to arid grasslands often creating the matrix over large areas. Characteristic graminoids include *Achnatherum hymenoides, Bouteloua eriopoda, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii, Poa cusickii, Poa secunda,* and *Pseudoroegneria spicata*.

Physiognomy and Structure: **Rationale for Physiognomic Features:** *Pleuraphis jamesii* is both drought- and grazing-resistant (USFS 1937, Weaver and Albertson 1956, West et al. 1972), while *Achnatherum hymenoides* is one of the most drought-tolerant grasses in the western U.S. (USFS 1937).

Medium to tall bunchgrass-dominated group occurring with scattered shrubs as a matrix community or interspersed among shrub-dominated communities. Cover within this group is variable from dense to less than 25% cover.

Floristics: The dominant perennial bunchgrasses and shrubs within this group are all drought-resistant plants. Dominant or codominant species are *Achnatherum hymenoides, Achnatherum lettermanii, Achnatherum nelsonii, Achnatherum speciosum, Bouteloua eriopoda, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii, Poa cusickii, Poa secunda,* and *Pseudoroegneria spicata*. Other graminoids may include *Aristida purpurea, Carex filifolia, Elymus elymoides, Koeleria macrantha, Leymus salinus,* or *Sporobolus cryptandrus*. Scattered shrubs and dwarf-shrubs often are present, especially *Artemisia tridentata ssp. tridentata, Artemisia tridentata ssp. wyomingensis, Atriplex* spp., *Coleogyne ramosissima, Ephedra* spp., *Gutierrezia sarothrae*, and *Kraschenninnikovia lanata*. Forb cover is also sparse but can be relatively diverse. Common forbs are *Gaura coccinea, Balsamorhiza sagittata, Hymenopappus filifolius, Machaeranthera canescens, Sphaeralcea coccinea, Vicia americana, Lappula occidentalis (= Lappula redowskii), Lithophragma glabrum, Lupinus pusillus, Opuntia aurea (= Opuntia basilaris var. aurea), Opuntia polyacantha, Plantago patagonica, Pediomelum argophyllum, Artemisia campestris, Artemisia dracunculus, Artemisia ludoviciana,* and species of *Antennaria, Astragalus, Cryptantha, Eriogonum, Gilia,* and *Lappula*. Cryptogams are important in some stands with up to 40% ground cover on sites in the Colorado Plateau. Exotic species such as *Bromus tectorum, Draba verna, Lactuca serriola, Salsola tragus,*

Bassia scoparia (= Kochia scoparia), Poa pratensis, Sisymbrium altissimum, and *Tragopogon dubius* are present in many of these stands.

Environmental Description: Low-elevation grasslands in the Intermountain West region occur in semi-arid to arid climates at approximately 1450 to 2320 m (4750-7610 feet) elevation, but can reach as low as 350 m in the Columbia Basin. These grasslands occur in lowland and upland areas and may occupy swales, playas, mesatops, plateau parks, alluvial flats, plains and extend into dry foothills. In the Columbia Plateau stands extend up into the Columbia and Snake river canyons on stream terraces and dry, rocky slopes. These grasslands typically occur on relatively xeric sites. This group experiences cold temperate conditions. Hot summers and cold winters with freezing temperatures and snow are common. Annual precipitation is usually from 20-40 cm (7.9-15.7 inches). A significant portion of the precipitation falls in July through October during the summer monsoon storms, with the rest falling as snow during the winter and early spring months. These grasslands occur on a variety of aspects and slopes. Sites may range from flat to moderately steep. Soils supporting this group also vary from deep to shallow, and from sandy to finer-textured. The substrate is typically derived from sandstone or shale. Some occurrences on sandy soils have a high cover of cryptogams on the soil surface. These cryptogams tend to increase the stability of the highly erodible sandy soils of these grasslands during torrential summer rains and heavy wind storms (Kleiner and Harper 1977).

Geographic Range: This group occurs throughout the intermountain western U.S. on dry plains, foothills and mesas, at approximately 1450 to 2320 m (4750-7610 feet) elevation. Stands extend up into the Columbia and Snake river canyons on stream terraces and dry, rocky slopes. In the Bighorn Basin of north-central Wyoming, there may be some semi-desert grasslands, but this is uncertain.

Nations [incomplete except for CA and US]: MX?, US

States/Provinces: AZ, CA, CO, ID, MT?, NM, NV, OR, UT, WA, WY

G310. Intermountain Semi-Desert Steppe & Shrubland
Scientific Name: *Chrysothamnus viscidiflorus - Ericameria nauseosa - Krascheninnikovia lanata* Steppe & Shrubland Group

Common Name (Translated Scientific Name): Yellow Rabbitbrush - Rubber Rabbitbrush - Winterfat Steppe & Shrubland Group (Intermountain Semi-Desert Steppe & Shrubland)

Classifiers: This group encompasses a somewhat broad range of semi-desert shrublands in the Intermountain West. Many of these communities are somewhat disturbance-maintained, early-seral types. Additional data and analysis are needed to clarify the associations that should be placed here. Shrub communities occurring over talus included in this group are part of a continuum and can be highly variable, and some dwarf-shrub communities can technically be defined as herbaceous types.

Concept Summary: This widespread dwarf-shrubland, shrubland and shrub-steppe group occurs throughout the semi-arid western U.S. on a variety of sites and disturbance regimes and is characterized by an open to moderately dense woody layer composed of diverse woody species such as *Chamaebatiaria millefolium, Chrysothamnus albidus, Chrysothamnus viscidiflorus, Ericameria*

nauseosa, Ephedra viridis, Ephedra torreyana, Glossopetalon spinescens, Gutierrezia sarothrae, Gutierrezia microcephala, Ericameria nana, Ericameria parryi, Ericameria teretifolia, Krascheninnikovia lanata, Mahonia fremontii, Opuntia polyacantha, and *Tetradymia canescens* with or without an herbaceous layer.

Range: This group occurs throughout the semi-arid western U.S., including areas in the western Great Plains. This group can either be shrub-, dwarf-shrub-, or grass-dominated with an open (5-25% cover) woody layer. Stands dominated by *Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia microcephala,* and *Gutierrezia sarothrae* are often associated with disturbance. Other common shrubs may include *Chamaebatiaria millefolium, Chrysothamnus albidus, Ephedra viridis, Ephedra torreyana, Glossopetalon spinescens, Ericameria nana, Ericameria parryi, Ericameria teretifolia, Krascheninnikovia lanata, Mahonia fremontii, Opuntia fragilis, Opuntia polyacantha, Opuntia phaeacantha,* and *Tetradymia canescens*. Herbaceous species include *Achnatherum hymenoides, Aristida purpurea, Hesperostipa comata,* and *Pleuraphis jamesii*. Scattered *Juniperus* spp. are common, but rarely attain more than 5% cover. Landforms include alluvial flats and fans, talus slopes, plateaus, and bluffs. Slopes range from gentle to steep, and substrates are variable and include sandstone talus, fine-textured alluvium, sand, clay, loams, cinder, cobbles, and coarse gravels. Disturbance and grazing have impacted many occurrences, and in some cases may be important in maintaining these communities.

Diagnostic Characteristics: This group occurs as open shrub, dwarf-shrub, or shrub herbaceous communities. Shrub canopy ranges from 10-60% shrub cover with herbaceous layer usually sparse but ranging from dense to absent. Dominant/diagnostic shrubs in this group include *Chamaebatiaria millefolium, Chrysothamnus albidus, Chrysothamnus viscidiflorus, Ephedra viridis, Ephedra torreyana, Ericameria nauseosa, Ericameria nana, Ericameria parryi, Ericameria teretifolia, Glossopetalon spinescens, Gutierrezia sarothrae, Gutierrezia microcephala, Krascheninnikovia lanata, Mahonia fremontii, Opuntia fragilis, Opuntia phaeacantha, Opuntia polyacantha, Tetradymia canescens,* and *Tetradymia tetrameres*. Characteristic herbaceous species may include *Achnatherum hymenoides, Aristida purpurea, Bouteloua curtipendula, Bouteloua eriopoda, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii, Poa secunda, Sphaeralcea coccinea,* and *Sporobolus cryptandrus*. Scattered *Juniperus* spp. are common, but rarely attain more than 5% cover.

Physiognomy and Structure: **Rationale for Physiognomic Features:** *Chrysothamnus viscidiflorus, Ericameria nauseosa,* and *Krascheninnikovia lanata* are the dominant shrubs of most of the associations placed in this tentative group. Other important shrubs, such as the Ephedras, are found in this group, but are not the primary components of these communities.

Open shrub, dwarf-shrub, or shrub herbaceous communities dominated by cold-deciduous, broad-leaved shrub, dwarf-shrub species, or perennial grasses with an open shrub layer.

Floristics: The most important, widespread shrubs in this group include *Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae, Gutierrezia microcephala, Krascheninnikovia lanata, Opuntia polyacantha,* and *Opuntia phaeacantha*. Other

dominant/diagnostic shrubs with narrower ranges are *Chrysothamnus albidus, Chamaebatiaria millefolium, Ericameria nana, Ericameria parryi, Ericameria teretifolia, Glossopetalon spinescens, Mahonia fremontii, Opuntia phaeacantha,* and *Opuntia polyacantha*. Other commonly present to codominant species include *Artemisia* spp., *Ephedra torreyana, Ephedra viridis , Coleogyne ramosissima, Fallugia paradoxa, Isocoma drummondii, Eriogonum* spp., *Grayia spinosa, Holodiscus dumosus, Lycium pallidum, Opuntia* fragilis, *Purshia tridentata, Tetradymia canescens,* and *Tetradymia tetrameres*. Semi-desert grasses are common, including *Achnatherum hymenoides, Aristida purpurea, Aristida purpurea, Bouteloua curtipendula, Bouteloua eriopoda, Bouteloua gracilis, Elymus elymoides, Hesperostipa comata, Leymus salinus, Muhlenbergia pungens, Pascopyrum smithii, Pleuraphis jamesii, Poa secunda, Pseudoroegneria spicata, Sporobolus airoides,* and *Sporobolus cryptandrus*. Perennial forbs may include *Achillea millefolium, Astragalus purshii, Calochortus macrocarpus, Chamaesyce* spp., *Erigeron* spp., *Penstemon deustus, Phlox hoodii, Sphaeralcea coccinea,* and *Sphaeralcea munroana*. Annuals may be seasonally present to abundant depending on precipitation and disturbance. Exotic annuals such as *Bromus tectorum* or *Salsola kali* can be abundant.

Environmental Description: This group occurs throughout the Intermountain West from the western Great Basin to the Northern Rocky Mountains and Colorado Plateau at elevations ranging from 300 m up to 2500 m. The climate where this group occurs is generally hot in summers and cold in winters with low annual precipitation, ranging from 18-40 cm and high inter-annual variation. Much of the precipitation falls as snow, and growing-season drought is characteristic. Temperatures are continental with large annual and diurnal variations. Sites are generally alluvial fans and flats with moderate to deep soils. Some sites can be flat, poorly drained and intermittently flooded with a shallow or perched water table often within 1 m depth (West 1983e). Substrates are generally shallow, calcareous, fine-textured soils (clays to silt-loams), derived from alluvium; deep, fine to medium-textured alluvial soils with some source of subirrigation during the summer season, or sandstone talus over shale. Soils may be alkaline and typically moderately saline (West 1983e).

Geographic Range: This group occurs throughout the semi-arid western U.S., including areas in the western Great Plains.

Nations [incomplete except for CA and US]: CA?, US

States/Provinces: AZ, CA, CO, ID, KS, MT, NM, NV, OR, SD, TX, UT, WY

G775. Intermountain Sparsely Vegetated Dune Scrub & Grassland
Scientific Name: Intermountain Sparsely Vegetated Dune Scrub & Grassland Group

Common Name (Translated Scientific Name): Intermountain Sparsely Vegetated Dune Scrub & Grassland Group (Intermountain Sparsely Vegetated Dune Scrub & Grassland)

Classifiers: The majority of this group occurs in the intermountain western U.S.; however, two of the associations may extend out into the shortgrass region of the western Great Plains. These associations need further review as far as floristic composition and range such as on "blowout" sites

where sandy plains or stabilized dunes have been disturbed (Ramaley 1939b). Shrubby semi-arid dune communities in this group need further review.

Similar NVC Types: G675 North American Warm Semi-Desert Dune & Sand Flats: also occurs on dunes and sandsheets, but in warm, semi-arid climate.

Concept Summary: This shrubby and herbaceous group occurs on sandy sites in the intermountain western U.S. and is characterized by a sparse to open vegetation layer composed of shrubs *Ericameria nauseosa, Eriogonum leptocladon,* or *Tetradymia tetrameres* and herbaceous species *Achnatherum hymenoides, Leymus flavescens, Psoralidium lanceolatum,* and *Redfieldia flexuosa,* which may dominate solely or in a combination on active and stable dunes and sandsheets.

Range: This group occurs on sandy sites in the intermountain western U.S. from the Columbia Basin, Great Basin, and Centennial Valley in Montana, Wyoming Basins, Colorado Plateau and the San Luis Valley of southern Colorado. This group is characterized by open to sparse (<15% total cover) shrub and/or herbaceous vegetation. Characteristic shrubs include *Ericameria nauseosa, Eriogonum leptocladon,* or *Tetradymia tetrameres*. Diagnostic herbaceous species are *Achnatherum hymenoides, Leymus flavescens, Muhlenbergia pungens, Psoralidium lanceolatum,* and *Redfieldia flexuosa,* which may dominate solely or in a combination. There are several associated species, including graminoids such as *Calamovilfa gigantea, Hesperostipa comata (= Stipa comata), Schizachyrium scoparium,* and forbs *Heliotropium convolvulaceum, Machaeranthera canescens (= Aster canescens), Oxytheca dendroidea (= Eriogonum dendroideum), Polanisia dodecandra ssp. trachysperma, Polanisia jamesii, Reverchonia arenaria, Sophora stenophylla, Wyethia scabra,* and the annual forb *Eriogonum deflexum.* Stands occur on active and stable dunes and sandsheets. Elevations range from 1500-2400 m. All sites have cool, semi-arid continental climates. Substrates are eolian sand.

Diagnostic Characteristics: This group is characterized by a sparse to open shrub and/or herbaceous layer composed of shrubs *Ericameria nauseosa, Eriogonum leptocladon, Tetradymia tetrameres,* and perennial grasses and forbs *Achnatherum hymenoides, Leymus flavescens, Psoralidium lanceolatum,* and *Redfieldia flexuosa,* which may dominate solely or in a combination on rapidly drained sands.

Physiognomy and Structure: Vegetation has a sparse cover of xeromorphic shrubs and dwarf-shrubs less than 2 m tall and/or a short herbaceous layer that is typically sparse and is dominated by perennial graminoids, with ephemeral forbs and grasses present seasonally.

Floristics: This group occurs on sandy sites in the intermountain western U.S. from the Columbia Basin, Great Basin, and Centennial Valley in Montana, Wyoming Basins, Colorado Plateau and the San Luis Valley of southern Colorado. This group is characterized by open to sparse (<15% total cover) shrub and/or herbaceous vegetation. Dominant shrubs include *Ericameria nauseosa, Eriogonum leptocladon,* or *Tetradymia tetrameres*. Diagnostic herbaceous species are *Achnatherum hymenoides, Leymus flavescens, Muhlenbergia pungens, Psoralidium lanceolatum,* and *Redfieldia flexuosa,* which may dominate solely or in a combination. There are several associated species, including graminoids such as *Calamovilfa gigantea, Hesperostipa comata (= Stipa comata),*

Schizachyrium scoparium, and forbs *Heliotropium convolvulaceum, Machaeranthera canescens (= Aster canescens), Oxytheca dendroidea (= Eriogonum dendroideum), Polanisia dodecandra ssp. trachysperma, Polanisia jamesii, Reverchonia arenaria, Sophora stenophylla, Wyethia scabra*, and the annual forb *Eriogonum deflexum*. On the Colorado Plateau, active dune sites have codominants such as *Calamovilfa gigantea, Psoralidium lanceolatum, Reverchonia arenaria, Sophora stenophylla*, and *Wyethia scabra* (Castle 1954, Bowers 1982).

Environmental Description: This group occurs on sandy sites in the intermountain western U.S. from the Columbia Basin, Great Basin, and Centennial Valley in Montana, Wyoming Basins, Colorado Plateau and the San Luis Valley of southern Colorado. Elevations range from 1500-2400 m. Stands occur on active and stable dunes and sandsheets. In the San Luis Valley in Colorado, at approximately 2400 m elevation, stands occur on a sandsheet on the windward side of dunes (R. Rondeau, CONHP, pers. comm.). In semi-arid dune systems in the Colorado Plateau and Great Basin, stands occur in active dunes (Van Pelt 1978, Bowers 1982). They are early-seral communities that colonize bare sand in interdune valleys. The plants adapt to sand deposition by stem elongation but eventually will be buried or dug up as the dunes move. On dune margins, stabilization may occur as other sand-adapted species colonize, eventually succeeding into the adjacent desert scrub community. In the Colorado Plateau of southeastern Utah and western Colorado, this vegetation is often limited to small stands on sandy point bars, islands or terraces in the beds of intermittent streams. These stands are subject to periodic flooding but are usually isolated from the water table. A few Colorado Plateau stands occupy unconsolidated sands in areas with active dunes. Additional review is needed to characterize the environments in its full range.

Climate: This group occurs in a cool, semi-arid continental climate. *Soil/substrate/hydrology:* Substrates are eolian sands.

Geographic Range: This group occurs on sandy sites in the intermountain western U.S. from the Columbia Basin, Great Basin, Centennial Valley in Montana, Wyoming Basins, Colorado Plateau and the San Luis Valley of southern Colorado.

Nations [incomplete except for CA and US]: US

States/Provinces: AZ, CO, ID, MT, NV, OR, UT, WA, WY

M170. Great Basin-Intermountain Dwarf Sagebrush Steppe & Shrubland

3. Desert & Semi-Desert; 3.B. Cool Semi-Desert Scrub & Grassland; 3.B.1. Cool Semi-Desert Scrub & Grassland; 3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland; M170. Great Basin-Intermountain Dwarf Sagebrush Steppe & Shrubland

G308. Intermountain Low & Black Sagebrush Steppe & Shrubland

Scientific Name: *Artemisia arbuscula - Artemisia bigelovii - Artemisia nova* Steppe & Shrubland Group

Common Name (Translated Scientific Name): Little Sagebrush - Bigelow's Sagebrush - Black Sagebrush Steppe & Shrubland Group (Intermountain Low & Black Sagebrush Steppe & Shrubland)

Classifiers: Alliances in this group are distinguished largely by the predominant species: *Artemisia nova, Artemisia bigelovii*, and the nominal subspecies of *Artemisia arbuscula*, and by the importance of the perennial graminoid layer (>20% cover) in the shrub herbaceous alliances. The *Artemisia arbuscula* subspecies are distinguished by the nominal subspecies taxonomically and by the different environments which they occupy. *Artemisia arbuscula ssp. longicaulis* Shrubland Alliance (A2548) occurs in more alkaline and less stony settings than *Artemisia arbuscula ssp. arbuscula* Steppe & Shrubland Alliance (A3219). *Artemisia arbuscula ssp. thermopola - Artemisia papposa / Festuca idahoensis* Steppe & Shrubland Alliance (A4122) occurs in more calcareous soils and has a restricted distribution. Beetle and Johnson (1982) report that *Artemisia arbuscula ssp. arbuscula* grows in soils with a high volume of gravel (even though soil may be in clay textural class, or contain a clay-rich layer that impedes drainage), and that *Artemisia arbuscula ssp. longiloba* grows in clay soils, often alkaline, that contain no gravels.

Concept Summary: This broadly defined semi-arid sagebrush dwarf-shrubland and steppe occurs throughout much of the intermountain western U.S. and is characterized by an open to moderately dense shrub or dwarf-shrub layer that is typically dominated by one of the following: *Artemisia arbuscula ssp. arbuscula, Artemisia arbuscula ssp. longicaulis, Artemisia arbuscula ssp. longiloba, Artemisia arbuscula ssp. thermopola, Artemisia bigelovii, Artemisia frigida, Artemisia nova,* or *Artemisia tripartita ssp. rupicola* depending on environment and range of species.

Range: This broadly defined semi-arid dwarf-shrubland and steppe occurs throughout much of the intermountain western U.S. The vegetation in this broadly defined shrubland and steppe group includes an open to moderately dense shrub or dwarf-shrub layer with a sparse to dense herbaceous layer. Several different taxa of sagebrush may dominate depending on location and by habitat. *Artemisia nova* is most widespread, occurring throughout most of the region on mid- to low-elevation, gravelly, calcareous soils. *Artemisia arbuscula ssp. arbuscula* occurs on low- to high-elevation sites often on shallow, fine-textured soils with a dense clay layer that impedes drainage in spring. *Artemisia arbuscula ssp. longiloba* is widespread in the Columbia Basin and Great Basin into southwestern Wyoming and badlands in the western Great Plains. It occurs on shallow, alkaline, calcareous soils derived from shale. *Artemisia bigelovii* occurs throughout much of the Colorado Plateau and extends across northern New Mexico and southeastern Colorado on shallow soils on limestone hills and shale outcrops. Several other more restricted taxa include *Artemisia tripartita ssp. rupicola, Artemisia arbuscula ssp. longicaulis, Artemisia arbuscula ssp. thermopola,* and *Artemisia frigida*. Other shrubs present to codominant may include *Artemisia tridentata ssp. wyomingensis, Artemisia tridentata ssp. vaseyana, Ephedra torreyana, Ephedra viridis, Grayia spinosa*, or *Purshia tridentata,* depending on habitat. The herbaceous layer, if present, ranges from sparse cushion plants such as *Arenaria hookeri, Eriogonum brevicaule,* and *Phlox hoodii* to moderate to dense cover of perennial grasses. Characteristic grasses include *Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus, Festuca idahoensis, Hesperostipa comata, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana, Poa secunda,* and *Pseudoroegneria spicata*. Some stands have significant biological crust formation on the soil surface. Sites are generally xeric and may be wind-blown ridges and benches, gravelly alluvial fans, hilltops, canyons, gravelly draws, and dry flats. Substrates are typically shallow, gravelly or finer-textured alkaline, calcareous soils. Most stands occur from

1000 to 3000 m elevation with some extending to 3800 m in subalpine and alpine habitats of the Sierra Nevada. Substrates are variable, but are typically alluvium derived from limestone, shale, basalt, rhyolite or volcanics.

Diagnostic Characteristics: This group has an open to moderately dense shrub or dwarf-shrub layer with a sparse to dense herbaceous layer. Several different taxa of sagebrush are diagnostic depending on location and by habitat: *Artemisia nova, Artemisia arbuscula ssp. arbuscula, Artemisia arbuscula ssp. longiloba, Artemisia arbuscula ssp. longicaulis, Artemisia bigelovii, Artemisia tripartita ssp. rupicola, Artemisia arbuscula ssp. longicaulis, Artemisia arbuscula ssp. thermopola,* and *Artemisia frigida*. In all cases, these sagebrush taxa tend to occur in shallow, rocky, calcareous or alkaline soils, often fine-textured and sometimes with a claypan impeding drainage. Associated herbaceous taxa are semi-desert grasses and forbs.

Physiognomy and Structure: **Rationale for Physiognomic Features:** The nominal species *Artemisia arbuscula, Artemisia bigelovii,* and *Artemisia nova* are the three most common dominant and diagnostic species of this shrubland and steppe group. The other dominant species are relatively minor as they have restricted distributions.

The vegetation is this broadly defined shrubland and steppe group includes an open to moderately dense shrub or dwarf-shrub layer dominated by microphyllous evergreen shrubs with a sparse to dense herbaceous layer usually dominated by perennial graminoids (often bunch grasses).

Floristics: This broadly defined shrubland and steppe group includes an open to moderately dense shrub or dwarf-shrub layer with a sparse to dense herbaceous layer. Several different taxa of sagebrush may dominate depending on location and by habitat. *Artemisia nova* is most widespread, occurring throughout most of the region on mid- to low-elevation, gravelly, calcareous soils. *Artemisia arbuscula ssp. arbuscula* occurs on low- to high-elevation sites often on shallow, fine-textured soils with a dense clay layer that impedes drainage in spring. *Artemisia arbuscula ssp. longiloba* is widespread in the Columbia Basin and Great Basin into southwestern Wyoming and badlands in the western Great Plains. It occurs on shallow, alkaline, calcareous soils derived from shale. *Artemisia bigelovii* occurs throughout much of the Colorado Plateau and extends across northern New Mexico and southeastern Colorado on shallow soils on limestone hill and shale outcrops. Several other more restricted taxa may dominate, including *Artemisia tripartita ssp. rupicola* (central Wyoming), *Artemisia arbuscula ssp. longicaulis* (Lahontan Basin of northwestern Nevada, southeastern Oregon, and northeastern California), *Artemisia arbuscula ssp. thermopola* (ridgetops and benches in mountains at 1830 to 2690 m in southern Idaho), and *Artemisia frigida* (described from sites in the Rocky Mountains). Other shrubs present to codominant may include *Artemisia tridentata ssp. wyomingensis, Artemisia tridentata ssp. vaseyana, Ephedra torreyana, Ephedra viridis, Grayia spinosa*, or *Purshia tridentata*, depending on habitat. The herbaceous layer is variable. If present, it ranges from sparse cushion plants such as *Arenaria hookeri, Astragalus bisulcatus, Astragalus jejunus, Eriogonum brevicaule, Minuartia nuttallii (= Arenaria nuttallii), Phlox hoodii, Stenotus acaulis*, and *Trifolium gymnocarpon* to moderate to dense cover of perennial grasses. Characteristic grasses may include *Achnatherum hymenoides, Achnatherum thurberianum, Bouteloua gracilis, Elymus elymoides, Elymus lanceolatus, Festuca idahoensis, Hesperostipa*

comata, Leymus salinus, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana, Poa secunda, and *Pseudoroegneria spicata*. Some stands have significant biological crust formation on soil surface.

Environmental Description: This broadly defined semi-arid dwarf-shrubland and steppe group occurs throughout much of the intermountain western U.S. Sites are generally xeric and may be on wind-blown, shallow, gravelly or finer-textured alkaline soils. Throughout eastern Oregon, northern Nevada, southern Idaho, western Montana, western Wyoming, and western Colorado, stands typically occur on mountain ridges and flanks and broad terraces, ranging from 1000 to 3000 m in elevation with stands extending to 3800 m elevation in subalpine and alpine habitats of the Sierra Nevada. Substrates are shallow, fine-textured soils, poorly drained clays, shallow-soiled areas, almost always very stony, characterized by recent rhyolite or basalt or are alkaline soils derived from shale (Zamora and Tueller 1973, Baker and Kennedy 1985). In central and southern Wyoming, typical sites are very windy, gently rolling hills and long, gently sloping pediments and fans with shallow, often rocky soils where this group forms the matrix vegetation and large patches on the margins of high-elevation basins. In higher elevation areas, it forms a mosaic with Intermountain Mountain Big Sagebrush Steppe & Shrubland Group (G304) and is restricted to wind-blown ridges. In the Colorado Plateau, Tavaputs Plateau and Uinta Basin, stands occur in canyons, gravelly draws, hilltops, and dry flats at elevations generally below 1800 m. Soils are often rocky, shallow, and alkaline. This group also extends across northern New Mexico and Wyoming into the western Great Plains on limestone hills and shale outcrops.

Geographic Range: This broadly defined semi-arid dwarf-shrubland and steppe group occurs throughout much of the intermountain western U.S.

Nations [incomplete except for CA and US]: US

States/Provinces: AZ, CA, CO, ID, MT, NM, NV, OR, UT, WY

M169. Great Basin-Intermountain Tall Sagebrush Steppe & Shrubland

3. Desert & Semi-Desert; 3.B. Cool Semi-Desert Scrub & Grassland; 3.B.1. Cool Semi-Desert Scrub & Grassland; 3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland; M169. Great Basin-Intermountain Tall Sagebrush Steppe & Shrubland

G303. Intermountain Dry Tall Sagebrush Steppe & Shrubland

Scientific Name: *Artemisia tridentata ssp. wyomingensis - Artemisia tridentata ssp. tridentata* Steppe & Shrubland Group

Common Name (Translated Scientific Name): Wyoming Big Sagebrush - Basin Big Sagebrush Steppe & Shrubland Group (Intermountain Dry Tall Sagebrush Steppe & Shrubland)

Classifiers: This group tends to occur in drier biophysical settings than the two similar tall sagebrush groups (G302, G304). Hence, it tends to have a less abundant herbaceous component, with the predominant grasses being more adapted to drier conditions. In addition, the co-occurring shrub taxa will include more desert species as well as cacti. This is a slid group in concept, but the specific associations included in it need to be reviewed and will require some adjustment.

Similar NVC Types: G302 Intermountain Mesic Tall Sagebrush Steppe & Shrubland; G304 Intermountain Mountain Big Sagebrush Steppe & Shrubland.

Concept Summary: This widely distributed, matrix-forming shrubland group is concentrated in the drier, more southerly portions of the interior western U.S., but extends into more xeric portions of the Columbia Plateau, Rocky Mountains, across Wyoming, then northeast into the northwestern Great Plains. Vegetation is typically dominated by *Artemisia tridentata ssp. wyomingensis* and *Artemisia tridentata ssp. tridentata*, sometimes codominated by xeric shrubs such as *Atriplex* spp., with a typically sparse to open herbaceous layer dominated by dry-site graminoids.

Range: This widely distributed, matrix-forming shrubland group is concentrated in the drier, more southerly portions of the interior western U.S., especially in the Great Basin and Colorado Plateau, but extends into more xeric portions of the Columbia Plateau, Wyoming steppe, Rocky Mountains, and northeast into the northwestern Great Plains. Stands are dominated by *Artemisia tridentata ssp. wyomingensis* and *Artemisia tridentata ssp. tridentata* and, in some cases, codominated by xeric shrubs such as *Atriplex canescens, Atriplex confertifolia, Ephedra nevadensis, Ephedra viridis, Ericameria nauseosa, Grayia spinosa*, or *Sarcobatus vermiculatus*. Other common shrubs include *Amelanchier utahensis, Artemisia frigida, Atriplex gardneri, Chrysothamnus* spp., *Ericameria* spp., *Peraphyllum ramosissimum, Purshia tridentata*, and *Tetradymia* spp. If present, the herbaceous layer ranges from sparse and patchy to moderately dense and is typically dominated by dry-site graminoids with low cover of forbs. Characteristic graminoids include *Achnatherum hymenoides, Achnatherum lettermanii (= Stipa lettermanii), Achnatherum pinetorum, Achnatherum thurberianum, Bouteloua gracilis, Bromus tectorum, Carex filifolia, Distichlis spicata, Elymus albicans, Elymus elymoides, Hesperostipa comata (= Stipa comata), Leymus ambiguus, Leymus salinus, Pleuraphis jamesii, Poa fendleriana, Poa secunda, Pseudoroegneria spicata, Sporobolus airoides*, and *Sporobolus cryptandrus*. A sparse layer of cold-deciduous needle-leaved or scale-leaved evergreen trees may occasionally be emergent over the shrubs. This group occurs on flat to steeply sloping upland slopes on alluvial fans and terraces, toeslopes, lower and middle slopes, draws, badlands, and foothills. Stands are found at elevations as low as 500 m in the northwestern Great Plains to 2500 m in the Rocky Mountains and Colorado Plateau. Sites with little slope tend to have deep soils, while those with steeper slopes have shallow to moderately deep soils. Climate is mostly semi-arid but ranges from semi-arid in the western Great Basin to subhumid in the northern Great Plains and Rocky Mountains with much of the precipitation falling primarily as snow. The amount and reliability of growing-season moisture increase eastward and with increasing elevation.

Diagnostic Characteristics: Stands are dominated by *Artemisia tridentata ssp. wyomingensis* or *Artemisia tridentata ssp. tridentata* and, in some cases, codominated by dry-site shrubs such as *Atriplex canescens, Ephedra nevadensis, Ephedra viridis, Ericameria nauseosa*, or *Sarcobatus vermiculatus*. If present, the herbaceous component layer ranges from sparse and patchy to moderately dense and is typically dominated by dry-site graminoids with low cover of forbs. Characteristic graminoids include *Achnatherum hymenoides, Achnatherum lettermanii, Achnatherum pinetorum, Achnatherum thurberianum, Bouteloua gracilis, Bromus tectorum, Carex filifolia, Distichlis spicata, Elymus albicans, Elymus elymoides, Hesperostipa comata, Leymus ambiguus,*

Leymus salinus, Pleuraphis jamesii, Poa fendleriana, Poa secunda, Pseudoroegneria spicata, Sporobolus airoides, and *Sporobolus cryptandrus*. Associated species tend to include more semi-desert taxa with core distribution in the Great Basin and Colorado Plateau regions. Warm-season grasses are common in the southern and eastern portions of its range.

Physiognomy and Structure: **Rationale for Physiognomic Features:** Although this is a wide-ranging group with highly variable understory species, *Artemisia tridentata ssp. wyomingensis* and *Artemisia tridentata ssp. tridentata* are the most constant matrix-forming overstory dominants.

This deciduous scrub and grassland group is structurally characterized by open to dense sagebrush with associated shrubs interspersed and/or a moderately dense understory of perennial grasses.

Floristics: Stands are dominated by *Artemisia tridentata ssp. wyomingensis* and *Artemisia tridentata ssp. tridentata* and, in some cases, codominated by *Atriplex canescens, Atriplex confertifolia, Ephedra nevadensis, Ephedra viridis, Ericameria nauseosa, Grayia spinosa*, or *Sarcobatus vermiculatus*. Other common shrubs include *Artemisia frigida, Atriplex gardneri, Chrysothamnus* spp., *Ericameria* spp., *Krascheninnikovia lanata, Peraphyllum ramosissimum, Prunus virginiana, Purshia tridentata, Symphoricarpos longiflorus*, and *Tetradymia* spp. A sparse layer of cold-deciduous needle-leaved or scale-leaved evergreen trees may occasionally be emergent over the shrubs. The herbaceous layer may be sparse to strongly dominated by graminoids, including *Achnatherum hymenoides, Achnatherum lettermanii (= Stipa lettermanii), Achnatherum pinetorum, Achnatherum thurberianum, Bouteloua gracilis, Bromus tectorum, Carex filifolia, Elymus albicans, Elymus elymoides, Elymus lanceolatus, Festuca idahoensis, Hesperostipa comata (= Stipa comata), Leymus ambiguus, Pleuraphis jamesii, Poa fendleriana, Poa secunda, Pseudoroegneria spicata, Sporobolus airoides*, and *Sporobolus cryptandrus*. Trees found across the range include *Cercocarpus ledifolius, Juniperus monosperma, Juniperus occidentalis, Juniperus osteosperma, Juniperus scopulorum, Pinus edulis, Pinus flexilis, Pinus jeffreyi, Pinus monophylla, Pinus ponderosa, Populus tremuloides, Quercus gambelii, Quercus garryana*, and *Yucca brevifolia*.

Environmental Description: This shrubland group is widely distributed in the western U.S., at elevations as low as 500 m in the northwestern Great Plains to 2500 m in the Rocky Mountains and Colorado Plateau. This group occurs on flat to steeply sloping upland slopes on alluvial fans and terraces, toeslopes, lower and middle slopes, draws, badlands, and foothills. *Climate:* Climate ranges from arid in the western Great Basin to subhumid in the northern plains and Rocky Mountains with much of the precipitation falling primarily as snow. The amount and reliability of growing-season moisture increase eastward and with increasing elevation. *Soil/substrate/hydrology:* Sites with little slope tend to have deep soils while those with steeper slopes have shallow to moderately deep soils. Soil texture is loamy sand, loam, sandy loam, or clay loam (Hansen and Hoffman 1988), and there is often a significant amount of coarse fragments in the soil profile.

Geographic Range: This widely distributed, matrix-forming shrubland group is concentrated in the drier, more southerly portions of the interior western U.S., especially in the Great Basin and Colorado Plateau, but extends into more xeric portions of the Columbia Plateau, Wyoming steppe, Rocky Mountains, and northeast into the northwestern Great Plains.

Nations [incomplete except for CA and US]: CA, US

States/Provinces: BC, CA, CO, ID, MT, ND, NV, OR, SD?, UT, WY

G304. Intermountain Mountain Big Sagebrush Steppe & Shrubland
Scientific Name: *Artemisia tridentata ssp. spiciformis - Artemisia tridentata ssp. vaseyana - Artemisia cana ssp. viscidula* Steppe & Shrubland Group

Common Name (Translated Scientific Name): Spiked Big Sagebrush - Mountain Big Sagebrush - Mountain Silver Sagebrush Steppe & Shrubland Group (Intermountain Mountain Big Sagebrush Steppe & Shrubland)

Classifiers: *Artemisia cana* is often found in mesic to wet swales and toeslopes. Some *Artemisia cana ssp. viscidula* communities are included in this group, when they are not composed of more obligate wetland taxa, such as *Juncus*, wetland Carices, and such.

Similar NVC Types: G303 Intermountain Dry Tall Sagebrush Steppe & Shrubland; G302 Intermountain Mesic Tall Sagebrush Steppe & Shrubland.

Concept Summary: This sagebrush shrubland and shrub-steppe group is found at montane and subalpine elevations across the western U.S. where the open to dense shrub layer is composed primarily of *Artemisia tridentata ssp. vaseyana, Artemisia cana ssp. bolanderi, Artemisia cana ssp. viscidula*, and related taxa such as *Artemisia tridentata ssp. spiciformis* and *Artemisia rothrockii* with *Symphoricarpos* spp. often codominant and there is usually an abundant perennial herbaceous layer (over 25% cover).

Range: This group includes sagebrush communities occurring at foothills (in Wyoming) to montane and subalpine elevations across the western U.S. from 1000 m in eastern Oregon and Washington to over 3000 m in the Southern Rockies. In Montana, it occurs on mountain "islands" in the north-central portion of the state and possibly along the Boulder River south of Absarokee and at higher elevations. In British Columbia, it occurs between 450 and 1650 m in the southern Fraser Plateau and the Thompson and Okanagan basins. Across its range of distribution, this is a compositionally diverse group. It is composed primarily of *Artemisia tridentata ssp. vaseyana*, and related taxon *Artemisia tridentata ssp. spiciformis* often with *Symphoricarpos* spp. present to codominant. Also included, but less common, are stands dominated by *Artemisia cana ssp. bolanderi, Artemisia cana ssp. viscidula*, and *Artemisia rothrockii* (a California endemic). Additionally there are mixed shrub stands codominated by *Amelanchier* spp., *Chamaebatiaria millefolium, Chrysothamnus viscidiflorus, Ericameria nauseosa, Peraphyllum ramosissimum, Purshia tridentata*, and *Ribes cereum*. *Artemisia tridentata ssp. wyomingensis* may be present to codominant if the stand is clearly montane as indicated by montane indicator species such as *Artemisia tridentata ssp. vaseyana, Danthonia intermedia, Festuca thurberi*, or *Leucopoa kingii*.

Most stands have an abundant perennial herbaceous layer (over 25% cover, and in many cases over 50% cover), but this group also includes *Artemisia tridentata ssp. vaseyana* shrublands that lack a significant herbaceous layer. Other common graminoids include *Achnatherum lettermanii,*

Achnatherum occidentale, Achnatherum pinetorum, Bromus carinatus, Calamagrostis rubescens, Carex geyeri, *Elymus trachycaulus, Festuca arizonica, Festuca campestris, Festuca idahoensis, Hesperostipa comata, Leucopoa kingii, Muhlenbergia montana, Pascopyrum smithii, Poa fendleriana, Poa secunda,* and *Pseudoroegneria spicata*. In many areas, wildfires can maintain an open herbaceous-rich steppe condition, although at most sites, shrub cover can be unusually high for a steppe system (>40%), with the moisture providing equally high grass and forb cover.

Diagnostic Characteristics: This montane and subalpine sagebrush shrubland and shrub-steppe group is dominated by diagnostic shrub species *Artemisia tridentata ssp. vaseyana, Artemisia cana ssp. bolanderi, Artemisia cana ssp. viscidula*, and related taxa such as *Artemisia tridentata ssp. spiciformis* and *Artemisia rothrockii* (a California endemic). *Symphoricarpos* spp. are often codominant, but other shrubs may be present, forming a mixed canopy. There is usually an abundant perennial herbaceous layer (over 25% cover). Characteristic montane and subalpine herbaceous species include *Achnatherum lettermanii, Achnatherum occidentale, Achnatherum pinetorum, Bromus carinatus, Calamagrostis rubescens, Carex geyeri, Carex exserta, Danthonia intermedia, Danthonia parryi, Elymus trachycaulus, Festuca arizonica, Festuca campestris, Festuca idahoensis, Festuca thurberi, Leucopoa kingii,* and *Muhlenbergia montana*.

Physiognomy and Structure: Microphyllous-leaved evergreen and broad-leaved, cold-deciduous shrub-steppe group with open to dense cover of sagebrush species and an abundant perennial herbaceous layer of graminoid and forb species.

Floristics: Vegetation types within this group are usually less than 1.5 m tall and dominated by *Artemisia tridentata ssp. vaseyana, Artemisia tridentata ssp. spiciformis,* or *Artemisia cana ssp. viscidula*, often with *Symphoricarpos* spp. present to codominant. Also included, but less common, are stands dominated by *Artemisia cana ssp. bolanderi, Artemisia cana ssp. viscidula*, and *Artemisia rothrockii* (a California endemic). Additionally, there are mixed shrub stands codominated by *Amelanchier* spp., *Chamaebatiaria millefolium, Peraphyllum ramosissimum,* and *Purshia tridentata*. A variety of other shrubs can be found in some occurrences, but these are seldom dominant. They include *Amelanchier alnifolia, Artemisia arbuscula, Ceanothus velutinus, Chrysothamnus viscidiflorus, Ericameria nauseosa, Ribes cereum,* and *Rosa woodsii*. *Artemisia tridentata ssp. wyomingensis* may be present to codominant if the stand is clearly montane to subalpine as indicated by montane indicator species such as *Artemisia tridentata ssp. vaseyana, Danthonia intermedia, Festuca thurberi,* or *Leucopoa kingii*. The shrub canopy cover ranges from 10 to 80%. The herbaceous layer is usually well-represented (over 25% cover, and in many cases over 50% cover), but bare ground may be common in particularly arid or disturbed occurrences. Additional characteristic graminoids may include *Achnatherum lettermanii, Achnatherum occidentale, Achnatherum pinetorum, Bromus carinatus, Calamagrostis rubescens, Carex geyeri, Carex exserta, Danthonia parryi, Elymus trachycaulus, Festuca arizonica, Festuca campestris, Festuca idahoensis, Hesperostipa comata, Muhlenbergia montana, Pascopyrum smithii, Poa fendleriana, Poa secunda,* and *Pseudoroegneria spicata*. Forbs are often numerous and an important indicator of health. Common forbs include *Achillea millefolium, Antennaria rosea, Artemisia ludoviciana, Balsamorhiza sagittata, Eriogonum umbellatum, Fragaria virginiana, Hymenoxys hoopesii (= Helenium hoopesii),*

and several species of *Astragalus, Castilleja, Erigeron, Geum, Lupinus, Penstemon, Phlox*, and *Potentilla*.

Environmental Description: This group occurs in many of the western United States, usually at middle elevations (1000-2500 m). The climate regime is cool, semi-arid to subhumid, with yearly precipitation ranging from 25 to 90 cm/year. Much of this precipitation falls as snow. Temperatures are continental with large annual and diurnal variation. In general, this group shows an affinity for mild topography, fine soils, and some source of subsurface moisture. Soils generally are moderately deep to deep, well-drained, and of loam, sandy loam, clay loam, or gravelly loam textural classes; soils often have a substantial volume of coarse fragments, and are derived from a variety of parent materials. This group primarily occurs on deep-soiled to stony flats, ridges, nearly flat ridgetops, and mountain slopes. All aspects are represented, but the higher elevation occurrences may be restricted to south- or west-facing slopes.

Geographic Range: This group is found at montane and subalpine elevations across the western U.S. from 1000 m in eastern Oregon and Washington to over 3000 m in the Southern Rockies. In British Columbia, it occurs in the southern Fraser Plateau and the Thompson and Okanagan basins. This group also occurs in central Montana in the Rocky Mountain island ranges

Nations [incomplete except for CA and US]: CA, US

States/Provinces: AZ?, BC, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

M095. Great Basin-Intermountain Xeric-Riparian Scrub

3. Desert & Semi-Desert; 3.B. Cool Semi-Desert Scrub & Grassland; 3.B.1. Cool Semi-Desert Scrub & Grassland; 3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland; M095. Great Basin-Intermountain Xeric-Riparian Scrub

G559. Great Basin-Intermountain Shrub & Herb Wash-Arroyo

Scientific Name: *Atriplex canescens - Ericameria nauseosa* Shrub & Herb Wash-Arroyo Group

Common Name (Translated Scientific Name): Fourwing Saltbush - Rubber Rabbitbrush Shrub & Herb Wash-Arroyo Group (Great Basin-Intermountain Shrub & Herb Wash-Arroyo)

Classifiers: These associations can be difficult to differentiate from surrounding upland communities.

Similar NVC Types: G541 Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope: occurs in warmer regions of the West.

Concept Summary: This group includes sparsely to densely vegetated shrublands that occur along dry watercourses that experience periodic flash flooding, and is dominated by *Atriplex canescens, Atriplex confertifolia, Brickellia* spp., *Ephedra* spp., *Ericameria nauseosa*, and/or *Fraxinus anomala*, found throughout interior western deserts.

Range: This is a sparsely to densely vegetated group that occurs along dry watercourses that experience periodic flash flooding. These are shrublands dominated by *Atriplex canescens, Atriplex confertifolia, Brickellia* spp., *Ephedra* spp., *Ericameria nauseosa*, and/or *Fraxinus anomala*. Other associated shrubs include *Artemisia filifolia, Artemisia tridentata, Atriplex gardneri, Gutierrezia sarothrae, Lycium andersonii, Purshia stansburiana, Quercus havardii, Rhus trilobata, Sarcobatus vermiculatus*, and/or *Suaeda moquinii (= Suaeda torreyana)*. Herbaceous cover is sparse (<10% cover) with a variety of grasses and forbs; non-native annuals can be abundant. This group is known from eastern Washington, eastern Oregon, the Columbia Basin, and throughout the Great Basin. Elevations range from 500-2500 m. Stands occur along the banks or edges of, in or near temporary watercourses (aka washes, dry streambeds, gullies and the like). Surfaces occupied include sandy terraces, wash bottoms, point bars, as well as basin floors that are flat or gently sloping. Substrates are rapidly drained and coarse, such as sandy or gravelly soils derived from alluvium, gneiss, shale, cinder and sandstone, which are often very rocky as well.

Diagnostic Characteristics: This shrubland group is characterized by a sparse to dense (1-65% cover) shrub layer dominated by *Atriplex canescens, Atriplex confertifolia, Brickellia* spp., *Ephedra* spp., *Ericameria nauseosa*, and/or *Fraxinus anomala*. Stands occur in or near temporary watercourses on sandy terraces, wash bottoms, point bars, and basin floors that are flat or gently sloping.

Physiognomy and Structure: **Rationale for Physiognomic Features:** This group is defined by two associations, one of which is dominated by *Ericameria nauseosa*, the other by *Atriplex canescens*.

This group is defined as a broadleaf deciduous shrubland with 1-65% cover. Herbaceous cover is generally low to sparse and characterized by a mixed composition of graminoids.

Floristics: Stands are sparse to dense (1-65% cover) and dominated by *Atriplex canescens, Atriplex confertifolia, Brickellia* spp., *Ephedra* spp., *Ericameria nauseosa*, and/or *Fraxinus anomala*. Associated shrubs include *Artemisia filifolia, Artemisia tridentata, Atriplex gardneri, Gutierrezia sarothrae, Lycium andersonii, Purshia stansburiana, Quercus havardii, Rhus trilobata, Sarcobatus vermiculatus*, and/or *Suaeda moquinii (= Suaeda torreyana)*. Herbaceous cover is sparse (<10% cover) with a variety of grasses and forbs such as *Achnatherum hymenoides, Artemisia dracunculus, Descurainia pinnata, Elymus elymoides, Glycyrrhiza lepidota, Hesperostipa comata, Hordeum jubatum, Muhlenbergia porteri, Pleuraphis jamesii, Sphaeralcea parvifolia, Sporobolus contractus, Sporobolus cryptandrus, Stanleya pinnata*, and *Wyethia scabra*. Non-native annuals such as *Bromus tectorum* and *Salsola tragus* are sometimes present to abundant.

Environmental Description: *Soil/substrate/hydrology:* Substrates are rapidly drained, sandy or gravelly soils derived from alluvium, gneiss, shale, cinder and sandstone. Scattered large rocks, gravel and bare ground cover most of the unvegetated surface, although some litter is typically present.

Geographic Range: This group is known from eastern Washington, eastern Oregon, the Columbia Basin, and throughout the Great Basin.

Nations [incomplete except for CA and US]: US

States/Provinces: AZ, CA, CO, ID, MT, NV, OR, UT, WA, WY

M093. Great Basin Saltbush Scrub

G301. Intermountain Dwarf Saltbush - Sagebrush Scrub

Scientific Name: *Atriplex corrugata - Atriplex gardneri - Artemisia pedatifida* Dwarf-Scrub Group

Common Name (Translated Scientific Name): Mat Saltbush - Gardner's Saltbush - Birdfoot Sagebrush Dwarf-Scrub Group (Intermountain Dwarf Saltbush - Sagebrush Scrub)

Classifiers: This group is more broadly defined than just low, mat-forming saltbush on shaly sites (*Atriplex corrugata, Atriplex gardneri*), but includes few dwarf sagebrush species that occur with similar habits and in similar habitats. Generally, it does not include stands mixed with taller species of saltbush or sagebrush. Stands in this group may grade into sparse vegetation groups on shale barrens/badlands. Welsh (1957) observed that *Atriplex corrugata* stands were restricted to north and east aspects on Mancos shale, with south and west aspects nearly barren. In Montana, *Atriplex gardneri* also occurs associated with badlands, and determining which group it falls into may be difficult. Scrub stands dominated by *Picrothamnus desertorum* are placed in Intermountain Shadscale - Saltbush Scrub Group (G300) because they often codominant with the widespread shrub *Atriplex confertifolia*. However, *Picrothamnus desertorum* is often short (10-25 cm tall) so it could also be classified as a dwarf-shrubland.

Concept Summary: This dwarf-shrub scrub group occurs on gentle slopes and rolling plains in the Colorado Plateau and Uinta Basin on Mancos shale and arid, windswept basins and plains across parts of Wyoming and Montana. It is characterized by an open canopy of dwarf-shrubs composed of relatively pure stands of *Artemisia pedatifida, Atriplex corrugata*, or *Atriplex gardneri* sometimes with *Artemisia longifolia, Artemisia pygmaea*, or *Picrothamnus desertorum* dominant or codominant.

Range: This semi-arid dwarf-shrub scrub group occurs in the interior western U.S. and is found on windswept basins and plains, often on marine shales. The vegetation is characterized by an open canopy of dwarf-shrubs composed of relatively pure stands of *Artemisia pedatifida* (important in Wyoming), *Atriplex corrugata* (western Colorado and Utah), or *Atriplex gardneri* (Wyoming and Montana into Canada). Other dominant or codominant dwarf-shrubs may include *Artemisia longifolia, Artemisia pygmaea,* or *Picrothamnus desertorum,* sometimes with a mix of other low shrubs, such as *Krascheninnikovia lanata* or *Tetradymia spinosa*. Occasional individuals or small clumps of *Atriplex confertifolia, Atriplex canescens*, or *Artemisia tridentata ssp. wyomingensis* may be present in some stands within this group but do not codominate. The herbaceous layer is typically sparse. Scattered perennial forbs occur, such as *Xylorhiza glabriuscula* and *Sphaeralcea grossulariifolia*; perennial grasses *Achnatherum hymenoides, Bouteloua gracilis* (not in Wyoming), *Elymus elymoides, Elymus lanceolatus ssp. lanceolatus, Pascopyrum smithii, Poa secunda,* or *Sporobolus airoides* may dominate the herbaceous layer. In less saline areas, there may be inclusions of grasslands dominated by *Hesperostipa comata, Leymus salinus, Pascopyrum smithii,* or *Pseudoroegneria spicata*. Stands occur on gentle slopes and rolling plains. Substrates are shallow,

typically saline, alkaline, fine-textured soils developed from shale or alluvium that may be associated with shale badlands. Infiltration rate is typically low. In Wyoming and possibly elsewhere, inclusions of non-saline, gravelly barrens or rock outcrops dominated by cushion plants such as *Arenaria hookeri* and *Phlox hoodii* without dwarf-shrubs may be present (these are not restricted to this group and larger patches would likely be classified in a sparse vegetation group).

Diagnostic Characteristics: This open dwarf-shrubland is typically dominated by relatively pure stands of *Atriplex corrugata* (in Colorado and Utah) or *Atriplex gardneri* (Wyoming and Montana into Canada). Other dominant or codominant dwarf-shrubs may include *Artemisia longifolia, Artemisia pedatifida* (very important in Wyoming, rare in Colorado stands), or *Artemisia pygmaea*, sometimes with a mix of other low shrubs, such as *Krascheninnikovia lanata* or *Tetradymia spinosa*. Occasional individuals or small clumps of *Atriplex confertifolia, Atriplex canescens,* or *Artemisia tridentata ssp. wyomingensis* may be present in some stands within this group but do not codominate.

Physiognomy and Structure: **Rationale for Physiognomic Features:** This dwarf-shrubland group typically supports stands of *Atriplex corrugata, Atriplex gardneri, Artemisia pedatifida*, or *Picrothamnus desertorum*. *Artemisia longifolia* may codominate, but is more characteristic of shale badlands in the Great Plains, and is not included as a nominal species.

This group is a facultatively deciduous, subdesert dwarf-shrubland. It typically has an open woody canopy of clumps of low, mat-forming dwarf-shrubs and a sparse herbaceous layer.

Floristics: This dwarf-shrubland group is characterized by an open canopy of dwarf-shrubs typically composed of relatively pure stands of *Atriplex* spp., such as *Atriplex corrugata* (in Colorado and Utah), *Atriplex gardneri* (Wyoming and Montana into Canada), or *Artemisia pedatifida* (very important in Wyoming, rare in Colorado stands). Other dominant or codominant dwarf-shrubs may include *Artemisia longifolia, Artemisia pygmaea,* or *Picrothamnus desertorum*, sometimes with a mix of other low shrubs, such as *Krascheninnikovia lanata* or *Tetradymia spinosa*. Occasional individuals or small clumps of *Atriplex confertifolia, Atriplex canescens,* or *Artemisia tridentata ssp. wyomingensis* may be present in some stands within this group but do not codominate. The herbaceous layer is typically sparse. Scattered perennial forbs occur, such as *Xylorhiza glabriuscula* and *Sphaeralcea grossulariifolia*; perennial grasses *Achnatherum hymenoides, Bouteloua gracilis* (not in Wyoming), *Elymus elymoides, Elymus lanceolatus ssp. lanceolatus, Pascopyrum smithii, Poa secunda*, or *Sporobolus airoides* may dominate the herbaceous layer. In less saline areas, there may be inclusions of grasslands dominated by *Hesperostipa comata, Leymus salinus, Pascopyrum smithii*, or *Pseudoroegneria spicata*. In Wyoming and possibly elsewhere, inclusions of non-saline, gravelly barrens or rock outcrops dominated by cushion plants such as *Arenaria hookeri* and *Phlox hoodii* without dwarf-shrubs may be present (these are not restricted to this group and larger patches would likely be classified in a sparse vegetation group). Annuals are seasonally present and may include *Eriogonum inflatum, Plantago tweedyi, Monolepis nuttalliana,* and the introduced annual grass *Bromus tectorum*.

Environmental Description: This group occurs on gentle slopes and rolling plains in the northern Colorado Plateau and Uinta Basin on Mancos shale and arid, windswept plains and basins across

parts of Wyoming. On Mancos shale (and possibly other saline marine shales), stands may be restricted to gentler slopes and cooler north and east aspects, with steeper south and west aspects nearly barren (Welsh 1957). *Climate:* Climate is temperate and semi-arid. Summers are generally hot, and freezing temperatures are common in the winter. Mean annual precipitation ranges from 13-33 cm. In Montana and Wyoming, approximately two-thirds of the annual precipitation falls in spring and early summer. In Colorado and Utah, over half the precipitation occurs in the late-summer monsoons as high-intensity thunderstorms. *Soil/substrate/hydrology:* Substrates are typically saline, alkaline, fine-textured soils developed from shale or alluvium and may be associated with shale badlands. Infiltration rate is typically low. In Wyoming and possibly elsewhere, inclusions of non-saline, gravelly barrens or rock outcrops may be present.

Geographic Range: This group occurs on gentle slopes and rolling plains in the Colorado Plateau and Uinta Basin on Mancos shale and arid, windswept basins and plains across parts of Wyoming and Montana, and into Canada.

Nations [incomplete except for CA and US]: CA, US

States/Provinces: AZ, CO, MT, NM, NV, UT, WY

G300. Intermountain Shadscale - Saltbush Scrub
Scientific Name: *Atriplex confertifolia - Atriplex canescens - Grayia spinosa* Scrub Group

Common Name (Translated Scientific Name): Shadscale Saltbush - Fourwing Saltbush - Spiny Hopsage Scrub Group (Intermountain Shadscale - Saltbush Scrub)

Classifiers: Some *Grayia spinosa*-dominated stands tends to occur on coppice dunes that have a silty component to them. If they occur on deep sand or dunes, then consider a dune group. Scrub stands dominated by *Picrothamnus desertorum* are placed in this group because *Picrothamnus desertorum* is frequently present to codominant with the widespread shrub *Atriplex confertifolia* in the Great Basin (Mozingo 1987). However, *Picrothamnus desertorum* is often short (10-25 cm tall) so could also be classified as Intermountain Dwarf Saltbush - Sagebrush Scrub Group (G301). **Similar NVC Types:** G299 Chihuahuan Desert Lowland Basin Scrub.

Concept Summary: This widespread semi-arid scrub group is found in basins, plains, alluvial flats and slopes in the intermountain western U.S. and western Great Plains and is characterized by a typically open to moderately dense shrub layer dominated or codominated by *Atriplex canescens, Atriplex confertifolia, Atriplex cuneata, Atriplex hymenelytra, Atriplex obovata, Atriplex polycarpa, Grayia spinosa,* and/or *Picrothamnus desertorum* often with other shrubs present to codominant.

Range: This extensive group includes open-canopied shrublands of typically saline basins, alluvial slopes and plains across the intermountain western U.S. and western Great Plains. The vegetation is characterized by a typically open to moderately dense shrubland composed of one or more *Atriplex* species, such as *Atriplex canescens, Atriplex confertifolia, Atriplex cuneata, Atriplex hymenelytra, Atriplex obovata,* or *Atriplex polycarpa*. Other shrubs present to codominant may include *Artemisia tridentata ssp. wyomingensis, Chrysothamnus viscidiflorus, Ericameria nauseosa, Ephedra*

nevadensis, Krascheninnikovia lanata, Grayia spinosa, Lycium spp., *Picrothamnus desertorum,* or *Tetradymia* spp. Northern occurrences lack *Atriplex* species and are typically dominated by *Grayia spinosa*. In Wyoming, occurrences are typically a mix of *Artemisia tridentata ssp. wyomingensis, Atriplex confertifolia, Grayia spinosa, Krascheninnikovia lanata, Sarcobatus vermiculatus,* and various *Ericameria* or *Chrysothamnus* species. Some places are a mix of *Atriplex confertifolia* and *Artemisia tridentata ssp. wyomingensis*. In the Great Basin, *Sarcobatus vermiculatus* is generally absent but, if present, does not codominate. The herbaceous layer varies from sparse to moderately dense and is dominated by perennial graminoids such as *Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus ssp. lanceolatus, Pascopyrum smithii, Pleuraphis jamesii, Pleuraphis rigida, Poa secunda,* or *Sporobolus airoides.* Various forbs are also present. Substrates are often saline and calcareous, medium- to fine-textured, alkaline soils, but include some coarser-textured soils.

Diagnostic Characteristics: The vegetation is characterized by a typically open to moderately dense shrubland composed of one or more shrub species, such as *Atriplex canescens, Atriplex confertifolia, Atriplex cuneata, Atriplex hymenelytra, Atriplex obovata, Atriplex polycarpa, Grayia spinosa,* and/or *Picrothamnus desertorum*.

Physiognomy and Structure: **Rationale for Physiognomic Features:** This is a diverse group with many possible dominant shrub species; however, there are two major types: shadscale and saltbush shrublands that dominate vast areas in the intermountain western U.S. *Atriplex confertifolia* is shadscale and *Atriplex canescens* is a common saltbush species that is representative of the many shrubby *Atriplex* spp. included in this group. *Krascheninnikovia lanata* is also a common western species that frequently dominates saline basins in the Great Basin. *Grayia spinosa* is also often dominant or codominant in warm semi-desert scrub, but is less diagnostic.

This group is a facultatively deciduous, extremely xeromorphic, subdesert short shrubland with a typically open shrub canopy and sparse to moderately dense herbaceous layer dominated by perennial graminoids.

Floristics: This widespread cool semi-desert scrub group is highly variable and ranges from almost pure occurrences of a single species to fairly complex mixtures. The characteristic mix of low shrubs and grasses is sparse, with large open spaces between the plants (Blaisdell and Holmgren 1984). Occurrences have a sparse to moderately dense cover of woody species that is often dominated by one of several shrubs such as *Atriplex canescens* (also codominated by *Artemisia tridentata, Ephedra viridis,* or *Krascheninnikovia lanata*), *Atriplex confertifolia* (also codominated by several species of *Lycium* and *Ephedra, Picrothamnus desertorum,* or *Sarcobatus vermiculatus*), *Atriplex cuneata, Atriplex obovata, Atriplex hymenelytra, Atriplex polycarpa, Grayia spinosa,* or *Picrothamnus desertorum (= Artemisia spinescens)*. Other shrubs may be present, especially in transition areas with desert or montane scrub. Species include *Acacia greggii, Artemisia frigida, Chrysothamnus* spp., *Encelia frutescens, Ericameria nauseosa, Ephedra nevadensis, Frankenia salina, Larrea tridentata, Lycium andersonii, Lycium pallidum, Parthenium confertum, Psorothamnus polydenius, Purshia stansburiana, Suaeda* spp., *Tetradymia glabrata, Tetradymia spinosa, Tiquilia latior,* and *Yucca*

glauca. Dwarf-shrubs include *Gutierrezia sarothrae* and several species of *Eriogonum*, but generally do not form a distinct layer as the main shrub layer is often >0.5 m tall.

Warm-season medium-tall and short perennial grasses dominate in the sparse to moderately dense graminoid layer. The species present depend on the geographic range of the grasses, soil alkalinity/salinity, and past land use. Species may include *Achnatherum hymenoides, Bouteloua gracilis, Distichlis spicata, Elymus elymoides, Hesperostipa comata, Leymus ambiguus, Leymus salinus, Muhlenbergia torreyi, Pascopyrum smithii, Pleuraphis jamesii, Poa secunda, Pseudoroegneria spicata, Sporobolus airoides,* and *Sporobolus cryptandrus*. A number of annual species may also grow in association with the shrubs and grasses, although they are usually rare and confined to areas of recent disturbance (Blaisdell and Holmgren 1984). Forb cover is generally sparse. Perennial forbs that might occur include *Chaetopappa ericoides, Descurainia* spp., *Mentzelia* spp., *Sphaeralcea coccinea,* and *Xylorhiza venusta*. Annual natives include *Monolepis nuttalliana, Plantago* spp., or *Vulpia octoflora*. Associated halophytic annuals include *Salicornia bigelovii, Salicornia rubra,* and *Suaeda* species. Exotic annuals that may occur include *Salsola kali, Bromus rubens,* and *Bromus tectorum*. Cacti such as species of *Opuntia* and *Echinocereus* may be present in some occurrences. Trees are not usually present but some scattered *Juniperus* spp. may be found.

Environmental Description: This salt-desert shrubland group is matrix-forming in the Intermountain West. This group composes arid to semi-arid shrublands on lowland and upland sites usually at elevations between 1520 and 2200 m (4987-7218 feet). Sites can be found on all aspects and include valley bottoms, alluvial and alkaline flats, mesas and plateaus, playas, drainage terraces, washes and interdune basins, bluffs, and gentle to moderately steep sandy or rocky slopes. Slopes are typically gentle to moderately steep but are sometimes unstable and prone to surface movement. Many areas within this group are degraded due to erosion and may resemble "badlands." Soil surface is often very barren and interspaces between the characteristic plant clusters are commonly covered by a microphytic crust (West 1982).

Climate: This is typically a vegetation group of extreme climatic conditions, with warm to hot summers and freezing winters. Annual precipitation ranges from approximately 13-33 cm. In much of the group, the period of greatest moisture will be mid to late summer, although in the more northern areas, a moist period is to be expected in the cold part of the year. However, plotted seasonality of occurrence is probably of less importance on this desert vegetation than in other types because desert precipitation comes with an extreme irregularity that does not appear in graphs of long-term seasonal or monthly averages (Blaisdell and Holmgren 1984). *Soil/substrate/hydrology:* Soils are shallow to moderately deep, poorly developed, and a product of an arid climate and little precipitation. Soils are often alkaline or saline. Vegetation within this group is tolerant of these soil conditions but not restricted to it. The shallow soils of much of the area are poorly developed Entisols. Vegetation within this group can occur on level pediment remnants where coarse-textured and well-developed soil profiles have been derived from sandstone gravel and are alkaline, or on Mancos shale badlands, where soil profiles are typically fine-textured and non-alkaline throughout (West and Ibrahim 1968). They can also occur in alluvial basins where parent materials from the

other habitats have been deposited over Mancos shale and the soils are heavy-textured and saline-alkaline throughout the profile (West and Ibrahim 1968).

Geographic Range: The distribution of this widespread group centers in the Intermountain West of the U.S., and extends in limited distribution across northern New Mexico into the southern Great Plains. In Wyoming, this group occurs in the Great Divide and Bighorn basins.

Nations [incomplete except for CA and US]: MX?, US

States/Provinces: AZ, CA, CO, ID, KS, MT, NM, NV, OR, TX, UT, WA, WY

M118. Intermountain Basins Cliff, Scree & Badland Sparse Vegetation

3. Desert & Semi-Desert; 3.B. Cool Semi-Desert Scrub & Grassland; 3.B.1. Cool Semi-Desert Scrub & Grassland; 3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland; M118. Intermountain Basins Cliff, Scree & Badland Sparse Vegetation

G570. Intermountain Basins Cliff, Scree & Badland Sparse Vegetation

Scientific Name: *Atriplex* spp. - *Cercocarpus* spp. - *Ephedra* spp. Intermountain Basins Sparse Vegetation Group

Common Name (Translated Scientific Name): Saltbush species - Mountain-mahogany species - Joint-fir species Intermountain Basins Sparse Vegetation Group (Intermountain Basins Cliff, Scree & Badland Sparse Vegetation)

Classifiers: This group is very diverse floristically and so it is difficult to determine indicator species. More diagnostic is the sparse cover of vascular plants and/or presence and sometimes dominance of nonvascular (lichen) species. This broadly defined lithomorphic group was developed by NatureServe. M. Reid (9-13): I am removing dune communities from this group; they are now placed in Intermountain Sparsely Vegetated Dune Scrub & Grassland Group (G775). We need to revisit and get clear on criteria for differentiating this group from other vegetated groups. Generally this group is conceived of as sparsely vegetated associations occurring on rocky or badland substrates.

Similar NVC Types: G569 North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation; G567 Great Plains Cliff, Scree & Rock Vegetation; G565 Rocky Mountain Cliff, Scree & Rock Vegetation.

Concept Summary: This group consists of barren and sparsely vegetated cliffs, scree slopes, badlands and other similar harsh habitats from low to high elevations, with a wide variety of trees or shrubs, such as species of *Artemisia, Atriplex, Cercocarpus, Eriogonum, Fallugia, Grayia, Juniperus, Pinus, Purshia*, and others, distributed throughout the interior western U.S.

Range: This group consists of barren and sparsely vegetated cliffs, scree slopes, badlands and other similar areas from a variety of landscapes in the interior western U.S. from eastern Washington and Oregon, the Columbia Plateau south to the Great Basin and Colorado Plateau, east into Wyoming basins and plains. Characteristic shrub species in lower elevation semi-desert, lava field, and badland

areas include *Artemisia pedatifida, Artemisia tridentata, Atriplex canescens, Atriplex confertifolia, Atriplex corrugata, Atriplex gardneri, Ephedra* spp., *Eriogonum corymbosum, Eriogonum heermannii, Eriogonum ovalifolium, Fallugia paradoxa, Grayia spinosa, Purshia tridentata, Salvia dorrii*, and *Sarcobatus vermiculatus*. Characteristic herbs include species of *Achnatherum, Camissonia, Cleome, Eriogonum*, and *Mentzelia*. Foothill sites include *Pinus edulis* and *Pinus ponderosa* (Colorado Plateau), *Pinus monophylla, Pinus longaeva* (Great Basin), *Juniperus osteosperma, Cercocarpus intricatus*, and *Cercocarpus ledifolius*. At montane and subalpine elevations, scattered trees may be present, such as *Abies concolor, Picea engelmannii, Pinus flexilis, Pinus ponderosa*, and *Pseudotsuga menziesii*. Shrubs may include *Arctostaphylos patula, Artemisia tridentata, Cercocarpus ledifolius, Ephedra* spp., *Holodiscus* spp., *Ivesia* sp., and *Purshia tridentata*. Landforms include cliffs and canyon sides, mesas and plateaus, and mountains. Sparse vegetation also occurs on special substrates such as shale outcrops, badlands and volcanic deposits such as lava, cinder, ash, tuff and basalt dikes. Rock substrates include bedrock, slickrock, and unstable talus and scree slopes. Some substrates, such as marine shales, are strongly alkaline and/or saline which chemically limits plant growth. Active substrates such as scree slopes are difficult sites for plants to grow. Physical properties of substrates may also limit plant growth. Some massive rock substrates lack cracks where vascular plants can root. Badland sites often have heavy clay soils that reduce water infiltration increasing erosion rates and reducing soil moisture for plants. Vegetation is variable depending on environmental variables of the sites, which range from relatively low-elevation semi-desert to subalpine cliffs and rock outcrops. Lower elevation sites often have herbaceous or shrub species present, whereas foothill, montane and subalpine sites may also include trees. Most of the species also occur in non-sparse vegetation groups. However, some of the sites with harsh soil properties have a high number of endemic perennial species.

Diagnostic Characteristics: Diagnostic characteristics of this lithomorphic group are barren to sparsely vegetation substrates and its geographic location, which is the intermountain western U.S. However, it is often composed of a mix of woody vegetation, especially shrubs and herbs (particularly cushion plants), although either may be absent on a given site.

Physiognomy and Structure: **Rationale for Physiognomic Features:** This group is very diverse floristically and so it is difficult to determine indicator species. Four genera of shrubs were chosen, i.e., *Atriplex, Cercocarpus, Ephedra*, and *Eriogonum*, because they are characteristic of many of the sparsely vegetated stands in this lithomorphic group.

This lithomorphic group may be composed of woody plants, including both trees and shrubs, herbaceous plants, and/or nonvascular plants. Shrubs are especially common and were chosen as indicator species, however, herbs, especially cushion plants, and nonvasculars such as mosses or lichens may be more common.

Floristics: This group consists of sparsely vegetated substrates which are variable depending on environmental factors of the sites. Sites range from relatively low-elevation semi-desert to subalpine cliffs and rock outcrops. Lower elevation sites often have herbaceous or shrub species present, whereas foothill, montane and subalpine sites may also include trees. Most of the species also occur in non-sparse vegetation groups. However, some of the sites with harsh soil properties have a high

number of endemic perennial species (Welsh 1979, Welsh and Chatterly 1985). Characteristic shrub species in lower elevation semi-desert, lava field, and badland areas include *Artemisia pedatifida, Artemisia tridentata, Atriplex canescens, Atriplex confertifolia, Atriplex corrugata, Atriplex gardneri, Ephedra* spp., *Eriogonum corymbosum, Eriogonum heermannii, Eriogonum ovalifolium, Fallugia paradoxa, Grayia spinosa, Purshia tridentata, Salvia dorrii*, and *Sarcobatus vermiculatus*. Characteristic herbs include species of *Achnatherum, Camissonia, Cleome, Eriogonum*, and *Mentzelia*. Foothill sites include *Pinus edulis* and *Pinus ponderosa* (Colorado Plateau), *Pinus monophylla, Pinus longaeva* (Great Basin), *Juniperus osteosperma, Cercocarpus intricatus, Cercocarpus ledifolius*, and *Ephedra* spp. At montane and subalpine elevations, scattered trees may be present, such as *Pinus ponderosa, Pinus flexilis, Abies concolor, Pseudotsuga menziesii*, and *Picea engelmannii*. Shrubs may include *Arctostaphylos patula, Artemisia tridentata, Cercocarpus ledifolius, Ephedra* spp., *Holodiscus* spp., and *Purshia tridentata*.

Environmental Description: This group consists of barren and sparsely vegetated substrates from a variety of landscapes in the interior western U.S. from the Columbia Plateau south to the Great Basin and Colorado Plateau, east into Wyoming basins and plains. Landforms include cliffs and canyon sides, mesas and plateaus, and mountains. Sparse vegetation also occurs on special substrates such as shale outcrops, active sand dunes, badlands and volcanic deposits such as lava, cinder, ash, tuff and basalt dikes. Rock substrates include bedrock and unstable talus and scree slopes. Some substrates, such as marine shales, are strongly alkaline and/or saline which chemically limits plant growth. Active substrates such as scree slopes are difficult sites for plants to grow. Physical properties of substrates may also limit plant growth. Some massive rock substrates lack cracks where vascular plants can root. Badland sites often have heavy clay soils that reduce water infiltration increasing erosion rates and reducing soil moisture for plants.

Geographic Range: This sparsely vegetated group occurs in the interior western U.S. from the Columbia Plateau south to the Great Basin and Colorado Plateau, east into Wyoming basins and plains.

Nations [incomplete except for CA and US]: US

States/Provinces: AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

M499. Western North American Cool Semi-Desert Ruderal Scrub & Grassland

3. Desert & Semi-Desert; 3.B. Cool Semi-Desert Scrub & Grassland; 3.B.1. Cool Semi-Desert Scrub & Grassland; 3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland; M499. Western North American Cool Semi-Desert Ruderal Scrub & Grassland

G600. Great Basin-Intermountain Ruderal Dry Shrubland & Grassland

Scientific Name: Great Basin-Intermountain Ruderal Dry Shrubland & Grassland Group

Common Name (Translated Scientific Name): Great Basin-Intermountain Ruderal Dry Shrubland & Grassland Group (Great Basin-Intermountain Ruderal Dry Shrubland & Grassland)

Classifiers: This group may be difficult to determine from native degraded shrublands and grasslands when non-native species codominate. The test is that the non-native species, especially invasive species, far outweigh (>90% relative cover) native species in abundance and richness, such that a well-trained observer cannot tell what the native counterpart may have been or to do so is only speculation. Dominant and diagnostic semi-arid exotic species *Agropyron cristatum* can be present to codominant in Western North American Interior Ruderal Grassland & Shrubland Group (G624) when codominated by relatively mesic species such as *Bromus inermis* or exotic forage grasses such as *Agrostis stolonifera, Dactylis glomerata, Phleum pratense,* and *Poa pratensis* that are characteristic of more temperate climates.

This group may grade into wetter areas and may have transition zones where mesic forbs intermix with wetter forbs and graminoids found in Western North American Ruderal Marsh, Wet Meadow & Shrubland Group (G524). This group does not include the mesic introduced hay grasses such as *Bromus inermis, Dactylis glomerata,* and *Phleum pratense* that have escaped from improved pasture and irrigated meadow to invade montane grasslands. These grasslands are classified in the more temperate Western North American Interior Ruderal Grassland & Shrubland Group (G624).

Similar NVC Types: G648 Southern Vancouverian Lowland Ruderal Grassland & Shrubland: may include similar alliances, but is restricted to lowlands west of the Cascade Range; G624 Western North American Interior Ruderal Grassland & Shrubland: has similar ruderal alliances but rather than occurring in cool, semi-arid sites, stands occur in cool, temperate regions and include montane, subalpine and alpine areas. Vegetation lacks obligate wetland species and is not dominated by facultative wetland species; G524 Western North American Ruderal Marsh, Wet Meadow & Shrubland: has similar ruderal alliances but occurs on mesic to wet sites and vegetation either includes obligate wetland species or is dominated by facultative wetland species; G819 North American Warm Desert Ruderal Scrub; G677 North American Warm Desert Ruderal Grassland: may include similar alliances, but is restricted warm, semi-arid desert regions.

Concept Summary: This semi-desert interior western U.S. ruderal shrubland and grassland group includes shrubland, shrub-steppe and grassland stands that are strongly dominated (>90% relative canopy cover) by invasive, exotic species. Additionally, this group contains shrubland and shrub-steppe that are dominated or codominated by native shrub species (>10% relative cover) with a significant herbaceous understory (>10% absolute cover) that is strongly dominated (>90% relative canopy cover) by exotic herbaceous species.

Range: This semi-desert interior western U.S. ruderal shrubland and grassland group includes shrubland, shrub-steppe and grassland stands that are strongly dominated (>90% relative canopy cover) by invasive, exotic species. Diagnostic invasive shrubs include *Alhagi maurorum, Cytisus striatus, Zygophyllum fabago*, or other exotic shrubs. Herbaceous stands include open to dense grasslands and forblands composed of either exotic annual or biennial grasses or forbs with low cover of perennial species (<10% absolute cover) or stands with a significant perennial herbaceous layer (>10% absolute cover) strongly dominated by exotics (>90% relative cover) with or without annuals and biennials present to dominant. There are relatively few cool, semi-arid invasive perennial graminoids such as *Agropyron cristatum*. Relatively mesic, invasive perennial hay grasses such as

Bromus inermis, Dactylis glomerata, and *Phleum pratense* are typically absent or have low cover and are restricted to mesic microsites as they are more common in higher elevation or higher latitude, temperate climates or relatively mesic sites. Numerous exotic perennial herbaceous species may compose these stands, such as *Acroptilon repens, Cardaria draba, Centaurea calcitrapa, Centaurea diffusa, Centaurea iberica, Centaurea biebersteinii (= Centaurea stoebe ssp. micranthos), Centaurea triumfettii (= Centaurea virgata), Euphorbia esula, Hypericum perforatum, Lepidium latifolium, Peganum harmala,* or a mixture of other exotic forbs and graminoids. Stands dominated by annuals may be composed of annual grasses such as *Bromus arvensis (= Bromus japonicus), Bromus hordeaceus, Bromus madritensis, Bromus tectorum, Taeniatherum caput-medusae,* or annual forbs, including *Bassia scoparia (= Kochia scoparia), Brassica nigra, Centaurea melitensis, Centaurea solstitialis, Crupina vulgaris, Cynoglossum officinale, Descurainia sophia, Erodium cicutarium, Hyoscyamus niger, Isatis tinctoria, Salsola tragus, Sisymbrium altissimum, Taraxacum officinale*, or a mixture of other exotic annual forbs and grasses. Additionally, this group contains semi-desert shrublands and shrub-steppe that are dominated or codominated by native shrub species such as *Artemisia tridentata* with a significant herbaceous understory (>10% absolute cover) that is strongly dominated (>90% relative canopy cover) by exotic herbaceous species such as *Agropyron cristatum* or *Bromus tectorum*. Stands occur in disturbed dry to mesic basins, alluvial fans, and foothills elevations up to 2200 m and are restricted to areas with the cool, semi-arid climate found in the intermountain western U.S. region. Stands can be large areas or narrow strips adjacent to roadsides or under powerlines and other disturbed areas. Soils are mostly mineral and well-drained. Due to disturbance, soils may be compacted. It is an early-successional type that may occur in areas disturbed by fire, grazing or mining. This group may grade into wetter areas and may have transition zones where mesic forbs intermix with wetter forbs and graminoids found in Western North American Ruderal Marsh, Wet Meadow & Shrubland Group (G524). This group does not include the mesic introduced hay grasses such as *Bromus inermis, Dactylis glomerata,* and *Phleum pratense* that have escaped from improved pasture and irrigated meadow to invade montane grasslands. These grasslands are classified in the more temperate Western North American Interior Ruderal Grassland & Shrubland Group (G624).

Diagnostic Characteristics: This ruderal shrubland and grassland group occurs in the semi-arid interior western U.S. and includes shrubland, shrub-steppe and grassland stands that are strongly dominated (>90% relative canopy cover) by invasive, exotic species. Additionally, this group contains shrubland and shrub-steppe that is dominated or codominated by native shrub species (>10% relative cover) with a significant herbaceous understory (>10% absolute cover) that is strongly dominated (>90% relative canopy cover) by exotic herbaceous species.

Physiognomy and Structure: This group includes shrubland and shrub-steppe stands that have an open to dense shrub canopy, and annual and perennial grasslands and forblands with an open to dense herbaceous layer.

Floristics: This ruderal shrubland and grassland group includes shrubland and shrub-steppe stands that have an open to dense shrub canopy (>10% absolute cover) that is strongly dominated (>90% relative canopy cover) by invasive, introduced shrub species such as *Alhagi maurorum, Cytisus*

striatus, Zygophyllum fabago, or other exotic shrubs. Additionally, this group includes shrubland and shrub-steppe that is dominated or codominated by native shrub species (>10% relative cover) with a significant herbaceous understory (>10% absolute cover) that is strongly dominated (>90% relative canopy cover) by exotic herbaceous species. Herbaceous layers are composed of either exotic annuals with low cover of perennial species, or high cover of exotic perennials. Also included in this group are open to dense ruderal herbaceous stands without a shrub layer (<10% absolute cover). The herbaceous understory (>10% absolute cover) is strongly dominated (>90% relative canopy cover) by exotic herbaceous species. Herbaceous layers are composed of either exotic annuals with low cover of perennial species (<5% absolute cover), or moderate perennial cover (>10% absolute cover) dominated by of exotic perennials, either graminoids or forbs or a combination. There are relatively few cool, semi-arid perennial graminoids such as *Agropyron cristatum* (which has frequently been purposefully seeded to prevent soil erosion or provide livestock forage). The relatively mesic, invasive perennial hay grasses such as *Bromus inermis, Dactylis glomerata,* and *Phleum pratense* are typically absent or have low cover and are restricted to mesic microsites as they are more common in higher elevation or higher latitude, temperate climates or relatively mesic sites. Numerous exotic perennial herbaceous species may compose these stands such as *Acroptilon repens, Cardaria draba, Centaurea calcitrapa, Centaurea diffusa, Centaurea iberica, Centaurea biebersteinii (= Centaurea stoebe ssp. micranthos), Centaurea triumfettii (= Centaurea virgata), Hypericum perforatum, Lepidium latifolium, Peganum harmala,* or a mixture of other exotic forbs and graminoids. Stands dominated by annuals may be composed of annual grasses such as *Bromus arvensis (= Bromus japonicus), Bromus hordeaceus, Bromus madritensis, Bromus tectorum, Taeniatherum caput-medusae*, or annual forbs, including *Bassia scoparia (= Kochia scoparia), Brassica nigra, Centaurea melitensis, Centaurea solstitialis, Crupina vulgaris, Cynoglossum officinale, Descurainia sophia, Erodium cicutarium, Hyoscyamus niger, Isatis tinctoria, Lepidium perfoliatum, Salsola tragus, Sisymbrium altissimum, Taraxacum officinale*, or a mixture of other exotic annual forbs and grasses.

Environmental Description: This interior western U.S. ruderal shrubland and grassland group is found on disturbed dry to mesic, basins, alluvial fans, and foothills elevations (up to 2200 m). Stands can be large areas or narrow strips adjacent to roadsides or under powerlines, in waste places such as abandoned agricultural fields that are no longer irrigated, oil and gas development areas, and other disturbed areas. *Climate:* This group occurs in the cool, semi-arid, continental, climate found intermountain western U.S. region. *Soil/substrate/hydrology:* Soils are mostly mineral and well-drained. Due to disturbance, soils may be compacted. It is an early-successional type that may occur in areas disturbed by fire, grazing or mining. However, it also occurs over vast acres of heavily overgrazed lands in the arid west, where livestock such as cows and horses have broken soil biotic crust, compacted soil and reduced native plant vigor.

Animals [optional]: In general, crested wheatgrass seedings are characterized by low plant diversity, and thus by low wildlife diversity. With appropriate soils, the Great Basin spadefoot (*Spea intermontana*) may breed and forage in this habitat type. Pronghorn (*Antilocapra americana*), western rattlesnake (*Crotalus oreganus*), common raven (*Corvus corax*), horned lark (*Eremophila alpestris*), and grasshopper sparrow (*Ammodramus savannarum*) breed and forage as well. A variety of generalist wildlife species may forage in this plant community, including turkey vulture

(*Cathartes aura*), prairie falcon (*Falco mexicanus*), barn swallow (*Hirundo rustica*), western meadowlark (*Sturnella neglecta*), and black-tailed jackrabbit (*Lepus californicus*).

Geographic Range: This ruderal group contains disturbed semi-arid grasslands, meadows, shrublands and shrub-steppe found in the interior western U.S. on disturbed dry to mesic, basins, alluvial fans, and foothills elevations (up to 2200 m). Stands do not extend up into the cool, temperate zone in included mountain ranges. This group does not extend south to the warm deserts or east into the Great Plains or west into cismontane California or the west side of the Cascades.

Nations [incomplete except for CA and US]: CA, US

States/Provinces: AZ, CA, CO, ID, MT, ND, NV, OR, SD, SK, UT, WY

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Appendix B. Plot, Observation Point, Accuracy Assessment Point Instructions and Data Forms

Introduction

This appendix contains the forms and instruction manuals used in collecting field data for the Vegetation Mapping Project at Glen Canyon National Recreation Area and Rainbow Bridge National Monument. Two types of data were collected: vegetation plot (or observation point for larger, undefined plot area) and accuracy assessment point. Vegetation plots were used primarily in developing the NVC classification for the mapped area. They were also used by photointerpreters to help recognize aerial photo signatures. Observation points were used primarily for assisting with photointerpretation, and secondarily for supporting NVC association descriptions and documenting non-standard vegetation types. Accuracy assessment data were used primarily for testing the thematic accuracy of the vegetation map, and secondarily to support NVC association descriptions.

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Plot and Observation Point Field Sampling Manual, Vegetation Mapping at Glen Canyon NRA & Rainbow Bridge NM

This document is intended to assist you in conducting vegetation mapping at Glen Canyon National Recreation Area (GLCA) and Rainbow Bridge National Monument (RABR) during the 2012-2103 field seasons. Detailed, field-by-field instructions for data collection are provided. These are abbreviated on a 'cheat sheet' at the end of this document.

Vegetation Data Collection Instructions

Navigating to a Plot

Navigate toward each selected segment using park maps, topographic maps, handheld GPS receivers and DOQQ maps of the imagery with segments printed on them.

- Segment maps will identify location, size and shape of the polygon.
- Topography (Topo) maps are useful in identifying the landscape through which navigation will take place, and in determining the elevation of a plot. Additionally, you will find them more legible than the segment maps in reading the names of features.
- GPS receivers indicate the direction and the distance (as the crow flies) to the segment
- ***Note***: *In very homogenous terrain, GPS the location of your vehicle or track your route, which is also useful in writing the directions to your plot.*

Along the way...look around. Context is everything – you will have a much better sense of how your plots represent the landscape if you are always in analysis mode. Keep in mind that the goal of this field work is to sample **all** the different vegetation types that occur at the park. If, on the way to a Segment or plot, you see an assemblage of plants that seems unique and is not included on the list of vegetation types, **please** sample, if time allows. A list of potential plant associations for the parks will be provided at the beginning of the field season. As the season progresses, this list will be updated in order to recognize new plant alliances and associations more easily.

GLCA and RABR are working on documenting all vascular plants in each park with specimen vouchers. Field crews will be supplied a working vascular plant species list for each park at the beginning of the field season. This list will indicate which plants are presently vouchered. Field crews are being requested to collect herbarium quality specimens of park vascular plant species that are presently not represented in the collection. Please be careful not to collect extremely rare plants. In this case, a photographic voucher would be in order.

Establishing a Plot

1. Placement of Plot

Figuring out where to place your plot is a subjective process. Place your plots in areas that seem to be both relatively **homogenous** and **representative** of the vegetation of the polygon as a whole. In other words, avoid areas where the vegetation appears to be transitioning from one type to another and areas with anomalous or heterogeneous structure or species composition. Photos will help identify

the different vegetation types available in each segment for sampling – similar colors, patterns and textures usually indicate similar vegetation. Look at *all* the vegetation layers to determine if the area is structurally and floristically uniform. Generally, try to place your plots **at least** 30 m (100 feet) from what you see as the "boundary" between a vegetation type and neighboring different types. The exception to this rule is when you are sampling a unique type that is always going to occur in small patches, such as a spring seep, or a narrow vegetation type following a wash channel. ***Note***: In cases where a polygon is very heterogeneous, more than one plot may be needed. Again, look around; use your acquired knowledge and judgment.

2. Size and Shape of Plot

The chart below indicates what size plot should be used for each vegetation type. Circular plots are the standard plot shape employed in this project. In limited circumstances, where vegetation occurs in linear patterns, a rectangular plot may be required. For example, rectangles are ideal for ridgelines, hillsides, and riparian zones while circles are well suited to very large, homogenous vegetative stands. Selecting the shape of the plot to fit into a given sample area is fine, but please do not make a plot smaller than the sizes listed below. The standard plot is about the size of a pencil point to the photo interpreter – even ½ hectare is only the size of a pea. Lay one tape out 22.6 meters and cross at 11.3 meters with the second tape to make an X; record all species within the circle outlined by the tapes. For rectangular plots, run one tape the length of the long end and one across for the length of the short end.

If you're in a ...	**… in most situations use this plot size (heterogeneous)**	**…. In special situations w/extremely uniform (homogenous) conditions consider using this plot size**
Forest (i.e., trees have their crowns overlapping, usually 60-100% total cover)	400 m2 11.3 m radius	--
Woodland (i.e., stands of trees with crowns usually not touching. Canopy tree cover is 10-60% or exceeds total shrub, dwarf-shrub, herb, and nonvascular cover)	400 m2 11.3 m radius	--
Shrubland (i.e., shrubs greater than 0.5 m tall are dominant, usually with more than 25% cover or exceeding tree, dwarf-shrub, herb, and nonvascular cover)	400 m2 11.3 m radius	100 m2 5.65 m radius
Dwarf-shrubland (i.e., shrubs less than 0.5 m tall are dominant, usually with more than 25% cover or exceeding tree, shrub, herb, and nonvascular cover)	400 m2 11.3 m radius	100 m2 5.65 m radius
Shrub Herbaceous (i.e., forb and/or grass cover roughly equal to shrubs or dwarf shrubs)	400 m2 11.3 m radius	100 m2 5.65 m radius
Herbaceous (i.e., herbs or grasses dominant, usually forming more than 25 percent cover)	400 m2 11.3 m radius	100 m2 5.65 m radius

Vegetation Plot Survey Form Instructions – 2012

Identifiers/Locators Section

Plot Code

This is a unique identifier given to each sample plot using the format "PARK.XXX." Each field crew will be assigned a set of numbers to use (e.g., 100-299, 300-499, etc.). Write the plot number on the blank line.

SID Code

Record the segment identifier from the segment map. If you encounter a unique or new vegetative community that is not in a designated segment, enter "None."

County

Enter name of the county.

State

This field is already completed as 'UT' on all data sheets. Enter AZ for the plots in that state.

Site Name

This is best determined from a topo map. Select a nearby feature as an obvious waypoint, such as the name of a canyon, road or mesa top (e.g., White Canyon).

Quad Name

Record the **full name** of the 7.5-minute quadrangle. Locate your plot on the map.

GPS Unit

Record the name and model of the GPS unit being used to record data for the plot. If a GPS unit was not used to determine UTMs, record "None" here and be sure to complete the "GPS Comments" field below.

UTM Zone

This value is already entered on datasheets as "12S," and will remain the same throughout the project area.

GPS Comments

VERY IMPORTANT: If you resorted estimating the plot location's UTM on the topo map, note that in this field. If you left the plot to get a reading from a higher point, record that here, also.

Field UTM X

Record UTM numbers of the easting as shown on the GPS, or determined from the topo map.

Field UTM Y

Record UTM numbers of the northing as shown on the GPS, or determined from the topo map.

GPS Error (PDOP)

Note the "Estimated Position Error" (EPE) displayed on your GPS unit. The longer you wait to mark the waypoint, the longer GPS has to gather satellite information and determine your location more

accurately. Using the antenna will also help get a more accurate reading. The lower the number, the more accurate the reading.

Directions to Plot

Give precise directions to the plot beginning with a landmark (e.g., a named point on the topo map, a major highway) readily locatable on a 7.5 minute topo map as the starting point. Use clear sentences that will be understandable to someone who is unfamiliar with the area and has only your directions to follow. Give estimates of distances and use compass directions. Again, using the GPS unit to give distances may be very helpful.

Survey Date

Record the date the plot was sampled. Please use the following format: Month - Day - Year.

Surveyors

List the full last names and first initial of all field team members present.

Plot Diameter, Length, Width and Azimuth

Enter diameter for circular plots OR width and length dimensions for rectangular plots. Record the azimuth for the long side of rectangular plots.

Photos Taken

Circle Y or N, accordingly.

Camera Name and Model

Record name and model of camera used.

Photos: Type/Roll Number/Frame Number/Photographer/Direction and Comments

For each photo taken at the plot, record the following: *Photo type* - indicate whether photo is a "plot," "landscape," or "biological crust" photo. *Photographer*: record last name of person taking the photograph. *Directions/Comments*: record the direction the photos were taken (e.g., →NW) and any other comments to clarify contents of the photo (especially landscape/scenery photos).

Taking photographs

Take two to four photos of each plot. The purpose is to get a good representation of the plot vegetation, but not individual species. Take photos in opposite directions from plot center or from the corner of a plot. Photos at rectangular plots should be taken from opposite ends of the long side. Use a chalkboard to record the plot number and the direction of photo taken. Thus, for plot 241, the board in the photo taken from the SE side of the plot, facing NW will read "CP241, SE→NW." If plot is on a steep slope, take the photo looking across the contour.



If you are in a particularly nice, rare or representative stand, please take a third slide, without the signboard in it, from any position as long as it illustrates the community well.

Please take a biological soil crust photo at each plot, where appropriate. Take the photo with a 6" ruler for scale in it, and position yourself so that the photo encompasses an area that is ½ meter squared.

Plot Representativeness

***Representativeness of plot in stand**:* Does the sample represent the vegetative community within the surrounding area or polygon? If not, were additional sample plots taken? Note additional species occurring outside the plot, but characteristic of the stand.

1. An example could be: "This BPU is relatively large and very homogenous in species composition, although species density varies slightly. Pinyons are sparsely scattered throughout BPU but none are located inside the plot."

2. Another example: "This polygon encompasses a variety of elevations and aspects, with similar slopes. Multiple plots will be done in this stand. This plot represents a predominantly herbaceous community on a northern aspect."

3. ***Note**: Sometimes variation within a polygon is not large enough to sample, in which case you would describe surrounding communities in the "Other Comments" field on the back of the first data sheet.*

Environmental Description Section

Elevation of Plot

Take the measurement either from the GPS unit or from the topo map. The reading from a topo map, provided you are certain of where you are, is often more accurate than the average reading from the GPS unit. Specify whether measurement is in feet (topo map) or meters (GPS unit).

Slope

Measure the slope in degrees using a clinometer.

Aspect

Measure the plot aspect in degrees using a compass (set for local magnetic declination).

Topographic Position

This is the position of the plot on its related landform. Determining this requires you to think of the landform in cross-section, which is roughly diagramed on the back of your cheat sheet. You **must** use the descriptions listed below:

Interfluve (crest, summit, ridge). Linear top of ridge, hill, or mountain; the elevated area between two fluve drainages that sheds water to the drainages.

High slope (shoulder slope, upper slope, convex creep slope). The uppermost inclined surface at the top of a slope. Includes the transition zone from backslope to summit. Surface is dominantly convex in profile and erosional in origin.

High level (mesa, summit). Level top of a plateau.

Midslope (transportational midslope). Intermediate slope position.

Backslope (dipslope). Subset of midslopes that are steep, linear, and may include cliff segments.

Step in slope (ledge, terracette). Nearly level shelf interrupting a steep slope, rock wall, or cliff face.

Lowslope (lower slope, foot slope, colluvial footslope). Inner gently inclined surface at the base of a slope. Surface profile is generally concave and a transition between midslope or backslope, and toeslope.

Toeslope (alluvial toeslope). Outermost gently inclined surface at base of a slope. In profile, usually gentle, linear and characterized by alluvial deposition.

Low level (terrace). Valley floor or shoreline representing the former position of an alluvial plain, lake, or shore.

Landform

Enter the landform(s) that describes the site where the plot was sampled. Referring to the topo map for the landscape context may help determine what landform(s) to choose. Note that landform choices may describe different scales, or a landform feature can be described by more than one term. For example, your plot may be on a ledge on the rim of a canyon, and, in this case, you may need to record multiple landforms. A suggested list of landforms and definitions is provided in **APPENDIX 1.** ***Note:*** *The topographic position selected above should relate to the scale of the landform chosen.*

Surficial Geology

Note the geologic substrate where plant community occurs. The geology map should help, but if you can't determine or do not have the geology map with you, put in a general description (e.g., coarse sandstone, green shale, aeolian sands or obscured by soils).

Cowardin System

The majority of the conducted plots will be “Uplands.” Any wetland plots will be one of the three following categories:

Riverine: “Riverine” includes all wetlands and deepwater habitats contained within a channel. Characterized by unidirectional flow from upstream to downstream, with vegetation and habitats contained within that channel (www.mip.Berkele.edu).

Palustrine: "Palustrine" comes from the Latin word "Palus" or marsh. These systems include any inland, freshwater wetland that lacks flowing water (www.ecn.purdue.edu).

Lacustrine: "Lacustrine" is related to the word "lake," meaning that the wetland is associated with a lake and is situated in a depression or damned river channel.

Hydrology

This field will be completed if you are in a wetland; however, some areas considered uplands may also be subject to intermittent flooding. Select from the following definitions (from Cowardin et al. 1979):

Permanently flooded. Water covers the land surface at all times of the year, in all years.

Semipermanently flooded. Surface water persists throughout growing season in most years except during periods of drought. Land surface is normally saturated when water level drops below soil surface.

Seasonally flooded. Surface water is present for extended periods during the growing season, but is absent by the end of the growing season, in most years. The water table, after flooding ceases, is very variable, extending from saturated to a water table well below the ground surface.

Saturated. Surface water is seldom present, but substrate is saturated to surface for extended periods during the growing season.

Temporarily flooded. Surface water present for brief periods during growing season, but water table usually lies well below soil surface. Often characterizes flood-plain wetlands.

Intermittently flooded. Substrate is usually exposed, but surface water can be present for variable periods without detectable seasonal periodicity. Inundation is not predictable to a given season and is dependent upon highly localized rain storms. This modifier was developed for use in the arid West for water regimes of playa lakes, intermittent streams, and dry washes but can be used in other parts of the U.S., where appropriate. This modifier can be applied to both wetland and non-wetland situations.

Unknown. The water regime of the area is not known. The unit is labeled a non-tidal wetland.

Environmental Comments

Enter any additional noteworthy comments on the environmental setting and its effect on the vegetation. Examples include: “stunted trees due to shallow soils, vegetation only where pockets of soil occur, or large colluvial boulders and small rocks litter surface of soil.” This field can also be used to describe site history such as fire events. This is an important field for crews to document. Please, take the time to do a thorough job, looking at soils, geology, ground cover, patterns of vegetation, etc.

Ground Cover

Estimate the approximate percentage of the *total* surface area covered by each category. One helpful hint in making ocular estimates is that in a 200 square meter plot, 2 square meters is equal to 1%. The sum of the cover values should equal 100%. *Note*: For estimating live litter and live wood, visualize cutting the vegetation off at ground level. The percent ground cover is how much space the stems take up. Estimating lichens, dark cyanobacteria and moss also take an extra step in visualization. Lichens often are growing on dark cyano mounds or on exposed bedrock, but your estimate needs to reflect the percentage of ground covered by lichens, and your estimates for dark cyano or bedrock

will be for non-lichen-covered surfaces. Also note, it is possible to have bare soil and sand in a plot if sand has blown in, or to have sand on the surface of the plot even though the soil test results in a texture other than sand because you are sampling below the surface.

Soil Texture

Use a trowel to dig a hole a few inches deep (of course, this will vary with soil depth) to expose the soil at root level and take a small handful of soil to sample. **APPENDIX 2** is a key to use when sampling soil texture. An abbreviated version is on the cheat sheet.

Soil Drainage

Soil drainage classes are defined in terms of (1) actual moisture content in excess of field moisture capacity and (2) the extent of the period during which excess water is present in the plant-root zone. Permeability, level of groundwater, and seepage are factors affecting moisture status. However, because these are not easily observed or measured in the field, they cannot generally be used as criteria of moisture status. Use the following definitions to determine soil drainage at your plot:

Rapidly drained. The soil moisture content seldom exceeds field capacity in any horizon except immediately after precipitation. Nearly all of the soils outside of wetlands, springs and floodplains will fall into this category. Rapidly drained soils are commonly coarse textured or soils on steep slopes located well above the water table. ***These soils are characterized by strictly upland species.***

Well drained. The soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant part of the year. Soils are usually free from mottling in the upper three feet, but may be mottled below this depth. B horizons, if present, are reddish, brownish, or yellowish. ***Look for species that indicate periodic saturation, such as western wheatgrass, Great Basin wildrye, arctic rush or black greasewood.***

Moderately well drained. The soil moisture in excess of field capacity remains for a small but significant period of the year. Soils are commonly mottled (chroma < 2) in the lower B and C horizons or below a depth of two feet. The Ae horizon, if present, may be faintly mottled in fine-textured soils and in medium-textured soils that have a slowly permeable layer below the solum. In grassland soils the B and C horizons may be only faintly mottled and the A horizon may be relatively thick and dark. ***Soils in this category and the next three will typically support wetland plants.***

Somewhat poorly drained. The soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year. Soils are commonly mottled in the B and C horizons; the Ae horizon, if present, may be mottled. The matrix generally has a lower chroma than in the well-drained soil on similar parent material.

Poorly drained. The soil moisture in excess of field capacity remains in all horizons for a large part of the year. The soils are usually very strongly gleyed. Except in high-chroma parent materials, the B, if present, and upper C horizons usually have matrix colors of low chroma. Faint mottling may occur throughout.

Very poorly drained. Free water remains at or within 12 inches of the surface most of the year. The soils are usually very strongly gleyed. Subsurface horizons usually are of low chroma and yellowish to bluish hues. Mottling may be present but at the depth in the profile. Very poorly drained soils usually have a mucky or peaty surface horizon.

Animal Use Evidence

Comment on any evidence of use of the plot and BPU by non-domestic animals (i.e., tracks, scat, burrows, etc.). Notes on domestic animals should be made in the next field.

Natural and Anthropogenic Disturbance

Comment on any evidence of natural or anthropogenic disturbance and specify the source, severity and effects on the vegetation. Common disturbances are water gullies, colluvial deposition of rocks on slopes and sometimes old tin cans from cowboys or miners.

Other Comments

Record any other comments. Describe the landscape context of the community. What are the adjacent plant communities in all directions from the plot? Are there any other landscape features or processes influencing this community? Is there a species that occurs in the sample community but is not within your plot? Is there a large amount of a dead species in the plot?

Vegetation Description Section

Leaf Phenology

Select the best description for the leaf phenology of the **dominant** stratum. The dominant stratum is the tallest stratum that contains at least 10% cover. Leave blank for non-vascular plots.

Evergreen. Greater than 75% of the total woody cover and is never without green foliage.

Cold deciduous. Greater than 75% of the total woody cover and sheds its foliage in connection with an unfavorable season mainly characterized by winter frost.

Mixed evergreen - cold deciduous. Evergreen and deciduous species mixed within the type and generally contribute 25-75% of the total woody cover.

Perennial. Herbaceous vegetation composed of more than 50% perennial species.

Annual. Herbaceous vegetation composed of more than 50% annual species.

Leaf Type

Select the best description for the leaf form of the dominant stratum. The dominant stratum is the uppermost stratum that contains at least 10% total plot coverage. Within that dominant stratum, the species that makes up greater than 50% of cover defines the leaf type.

Broad-leaved. Woody vegetation that is primarily broad-leaved (Sagebrush, oak, mountain mahogany).

Needle-leaved. Woody vegetation that is primarily needle-leaved (Juniper, pinyon).

Microphyllous. Woody cover primarily microphyllous (Ephedra).

Graminoid. Herbaceous vegetation composed of more than 50 percent graminoid species (grasses, sedges, rushes, etc).

Forb (broad-leaf-herbaceous). Herbaceous vegetation composed of more than 50% broad-leaf forb species (Phlox, Astragalus, Erigeron, etc).

Pteridophyte. Herbaceous vegetation composed of more than 50 percent ferns or fern allies (scouring rushes).

Non-vascular. Dominated by lichens or mosses.

Mixed. As with leaf phenology, the dominant stratum may be composed approximately equally of species with several different leaf types. Describe the mix briefly or circle leaf types that apply.

Physiognomic Class

This represents what you see when standing in the plot looking across at the vegetation. The following definitions may be used as guidelines, but may not always apply in desert locals. For example, areas with scattered pinyon and juniper may not fit the cover classes below, but they would best be described as a woodland.

Forest. Trees with crowns overlapping (generally forming 60-100% cover).

Woodland. Open stands of trees with crowns not usually touching (generally forming 25-60% cover). Canopy tree cover may be less than 25% in cases where it exceeds shrub, dwarf-shrub, herb, and nonvascular cover, respectively.

Shrubland. Shrubs generally greater than 0.5 m tall with individuals or clumps overlapping to not touching (generally forming more than 25% cover; trees generally less than 10% cover). Shrub cover may be less than 25% where it exceeds tree, dwarf-shrub, herb, and nonvascular cover, respectively. Vegetation composed of woody vines is included in this class.

Dwarf-Shrubland. Low-growing shrubs usually under 0.5 m tall. Individuals or clumps overlapping to not touching (generally forming more than 25% cover; trees and tall shrubs generally less than 10% cover). Dwarf-shrub cover may be less than 25% where it exceeds tree, shrub, herb, and nonvascular cover, respectively.

Shrub Herbaceous. Low or taller shrubs forming approximately equal cover with a grass or forb component. Individuals or clumps of shrubs generally not touching (usually forming more than 25% cover; trees less than 10% cover). Spaces between shrubs are generally occupied by grasses and/or forbs.

Herbaceous. Perennial herbs (graminoids or forbs) dominant (generally forming at least 25% cover; trees, shrubs, and dwarf-shrubs generally with less than 10% cover). Herb cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and nonvascular cover, respectively.

Nonvascular. Nonvascular cover (bryophytes, non-crustose lichens, and algae) dominant (generally forming at least 25% cover). Nonvascular perennial vegetation cover may be less than 25%, as long as it exceeds tree, shrub, dwarf-shrub, and herb cover.

Sparsely Vegetated. Abiotic substrate features dominant. Perennial vegetation is scattered to nearly absent and generally restricted to areas of concentrated resources. Total vegetation cover is typically less than 5% and greater than 0%. Badlands or sand dunes supporting communities of annual plants should be included in this category, regardless of cover.

Plant Species List Form

Provisional Community Name

If you were provided a list of potential Alliances and Associations, assign the name of the vegetation type which most closely resembles this type. If a list has not been made for the park you are working in, write what you think is appropriate. To do this, identify the dominant species of the dominant strata, and indicate the physiognomic class (this must match the physiognomic class checked on the back side the datasheet). This "provisional community name" will be used in tallying how many of each plant community has been sampled.

Plot Code

Write the plot number on the blank line. This field is a **must** in the event that the two data sheets get separated, they can be paired up again.

Species/Percent Cover Table

This table is composed of the following columns, three duplicated to allow for many plant names:

1. **Dead:** Record "dead" in the Specm column if the plant listed is dead or next to the plant name in parentheses, if there is room.

2. **Species Name:** Refer to the provided plant list for plant names used in this area (from *Utah Flora*). Always record the full scientific name for each species – required nomenclature is: Welch et al. – Utah Flora. This is especially critical for forb species, but less so for shrub species.

3. '*' **–** This Column is used to indicate whether a particular species has been identified as a "diagnostic" species for defining a particular stratum.

4. **Cover Class:** Estimate the aerial/crown cover of **each** plant listed, using the codes listed in the upper right hand corner of the table.

5. **% Cover:** Record continuous cover value used to make cover class estimates.

Height Class, Cover Class, Continuous Cover and Dominant/Diagnostic Species

Begin by assessing the plot strata. Pinyon and juniper make up the majority of Canyonlands' "canopy," but where they are absent, begin with the shrubs, or herbaceous species, if no shrubs are present. If the plot tree crowns are mostly touching and similar in height, but a given tree species is much taller, that species would be an "emergent," which is not typical of vegetative communities in this area. Occasionally, sample an area where there may be several tall, scattered cottonwoods and then shorter scattered junipers. In this case, the cottonwoods would be your "canopy" and the junipers would be the "subcanopy." ***Note:*** *Trees are defined as single-stemmed woody plants, generally 5 m in height or greater at maturity and under optimal growing conditions. Shrubs are defined as multiple-stemmed woody plants generally less than 5 m in height at maturity and under optimal growing conditions. The exception is mature pinyon and juniper plants, which are considered trees regardless of their height.*

The remaining vegetative strata are as follows (check with plant list for consistency):

S1 Tall Shrub. >2 meters tall. Examples, *Fraxinus anomalous* and *Purshia mexicana*.

S2 Short Shrub. <2 meters tall. Example, *Coleogyne ramosissimum*.

S3 Dwarf Shrub. <0.5 meters tall. Example, *Opuntia polycantha*.

H1 Graminoid. All grass species, including *Juncus arcticus*.

H2 Forb. All forbs.

H3 Fern or Fern Ally. All ferns, including *Equisetum hyemale*.

H4 Tree Seedlings. Seedlings are trees with vertical stems less than 1.5 m tall, but that may vary by species.

N Nonvascular. This is mainly dark cyanobacteria, mosses and lichens.

V Vine/liana. All vine species.

E Epiphyte. All epiphytic species.

Once your strata have been identified, write the uppermost strata code in the corresponding column. List all plant species in that strata, as well as their class cover code. Then list the next strata. Skipping several lines between strata allows you to fill in plant names and cover classes as you move through the plot and identify more plants. Be thorough in looking for plant species, but do not spend excessive amounts of time looking for new or different plants. Remember these plot data are to be used to classify the vegetation of the Park, not make a complete species list for it. If you spend much more than 20 minutes to *find* a species, it probably isn't going to be important in characterizing the vegetation type.

Before completing this section, first complete the overall species lists and cover estimates and then return to complete this section.

1. Indicate the average height class of the stratum in the first column, using the Height Scale in the upper right hand corner of the form.

2. Enter the total percent cover class of the whole stratum in the second column, using the Cover Scale in the upper right hand corner of the form.

ALWAYS fill in the Height Class and Cover Class for "Ht Herbaceous," which represents total herbaceous species in plot (H1, H2, H3 and H4).

Unknowns.

If you can't identify or easily key out the plant at the plot, assign a name to it and record it on your data sheet. For example, if you know what family it is in or its genus, label it "unknown Asteraceae sp." or "Unk. Erigeron sp." If there are more than one unknown in a family, add a number to the name you assign. If you do not know the family, label the plant "Unknown 1," using consecutive numbers for additional unknowns. Record the cover class and other data for the unknown as you would for any other species. Then, take a sample of the species with as much of the plant as possible, especially intact sexual parts, if present. Place the sample in a plastic baggie, and either label the plant (if you are putting more than one plant in the baggie) or label the baggie with the plot code, the date and the name you gave it on the data form. Plant samples in baggies can be stored in coolers or refrigerators for short periods. If you are not able to key the plant out soon after collecting it, or you intend to keep the sample for the park collection, press the plant and with a label stating the plot or location of its collection (include UTMs if the sample is not from a plot), date, collectors name and assigned plant name. Also, thoroughly label any plant specimens collected as proof of plant occurrence for plants not listed on park plant list. Once identification of unknown specimens has been completed, record the scientific name in the "final determination" column on the field form.

Tree Stem Diameters

This portion of the form is used to record obtained information on the size (biomass) of trees in a given plot. Record the scientific name of the species on the form and check whether the measurement is DBH or DRC. Please see instructions below to determine which measure should be used.

Diameter Breast Height (DBH) - all tree species except Pinyon/Juniper

In plots containing single bole trees such as Douglas Fir, Ponderosa Pine, and Cottonwood, record the species name and diameter (in cm) of the tree stem/trunk at breast height (4.5) using a DBH tape. Often this measurement will involve only a single tree trunk, however on some occasions there may be multiple stems. In this case record all diameters associated with a given individual on the same line, separated by a comma or commas. Given the propensity of pinyon and juniper to grow in large multi-stemmed clumps, measure the diameter of the root crown (see section below). If there are more than 25 trees over 4.5 feet tall, divide the plot into quarters and measure the DRC of trees in the southeast quarter/quadrant. NOTE on the form that this is what you have done.

Diameter Root Crown (DRC) - Pinyon/Juniper

In plots containing pinyon and/or juniper trees, record the species and diameter at root crown (ground level) of all stems belonging to trees taller than 4.5 feet. This measurement typically requires crawling under the low tree branches to hook the DBH/DRC measuring tape and wrap it around the trunk to read the diameter. Record this value, in centimeters, on an individual line on the field form that is labeled with the appropriate tree species. Should multiple stems emerge from the ground level, measure the DRC of each stem and record the diameters on the same line of the field form, separated by a comma or commas. If there are more than about 25 trees more than 4.5 feet tall, divide the plot into quarters and measure the DRC of trees in the southeast quarter/quadrant. NOTE on the form that this is what you did. Use caution when performing this measurement, as there may be pinyon pine pitch, sharp needles, sharp branch tips, cacti, and/or poisonous animals (spiders, scorpions, snakes, etc.) under these short-stature tree species or under the bark covering the lower portion of the tree. Always look up prior to standing to avoid collision with overhead branches.

Pinyon-juniper Age Class

If you are in a plot that contains pinyon and/or juniper trees (whether or not you have placed the plot in a P-J alliance/association), check the box that best describes the age class of the stand based on the following criteria:

Old-growth (>500 years). Ancient trees with flat crowns, much dead wood, dead trees on ground, some younger trees occupying canopy gaps. "You know it when you're in it." Generally, this occurs only in locations protected from fire.

Mature (350-500 years). Large old trees with flat crowns, some with gnarled trunks, lightning scars and dead wood, others without. Tends not to have much understory, depending on soils.

Young (100-500 years). Developed canopy of large trees, but some or all junipers have pointed crowns. Generally, there tends to be a well-developed understory of shrubs and sometimes forbs and grasses.

Invasive (<80 years). Scattered smaller trees, all with pointed crowns, in a community clearly dominated by shrubs or grasses.

Appendix 1: Landforms

Source: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054230

Aeolian deposit. Sand, silt or clay-sized material transported and deposited primarily by wind, commonly in the form of a dune or a sheet of sand or loess.

Alluvial. Having stream deposits and sediments formed by the action of running water.

Alluvial fan. A low, outspread mass of loose and/or rock material, commonly with gentle slopes, shaped like an open fan or a segment of a cone, deposited by a stream at the place where it issues from a narrow mountain or upland valley or where a tributary stream is near or at its junction with the main stream. It is steepest near its apex which points upstream and slopes gently and convexly outward (downstream) with a gradual decrease in gradient.

Alluvial flat. A nearly level, graded, alluvial surface in a closed or nearly-closed basin which commonly does not manifest traceable channels, terraces or floodplain levels.

Arroyo. The channel of a flat-floored, ephemeral stream, commonly with very steep banks cut in unconsolidated material, sometimes called a wash. It is usually dry but can be transformed into a temporary watercourse or short-lived torrent after heavy rain within the watershed. Where arroyos intersect zones of ground-water discharge, they are classed as intermittent stream channels.

Badlands. A landscape which is intricately dissected and characterized by a very fine drainage network with high drainage densities and short, steep slopes with narrow interfluves. Badlands develop on surfaces with little or no vegetative cover, overlying unconsolidated or poorly cemented materials (usually clays and silts) sometimes with soluble minerals such as gypsum or halite.

Backbar channel. A channel formed behind a bar connected to the main channel but usually at a higher bed elevation than the main channel. Backbar channels may or may not contain flowing or standing water.

Bajada. A broad, gently inclined, alluvial piedmont slope extending from the base of a mountain range out into a basin and formed by the lateral coalescence of a series of alluvial fans. Typically, it has a broadly undulating transverse profile, parallel to the mountain front, resulting from the convexities of component fans.

Bank. The steep outer edge of an active channel system *OR* the portion of the channel cross section that restricts lateral movement of water at normal levels.

Basin. A general term for the nearly level to gently sloping bottom of an intermontane basin (bolson). Landforms include playas, broad alluvial flats containing ephemeral drainageways, and relict alluvial and lacustrine surfaces that rarely, if ever, are subject to flooding. Where through-

drainage systems are well developed, floodplains are dominant and lake plains are absent or of limited extent. Basin floors grade mountainward to outer piedmont slopes.

Bench. A platform-like, nearly level to gentle incline erosional surface developed on resistant strata in areas where valleys are cut in alternating strong and weak layers with an essentially horizontal attitude. Structural benches are bedrock controlled, and in contrast to stream terraces, and do not represent a stage of flood-plain development following an episode of valley trenching.

Blowout. A saucer-, cup-, or trough-shaped depression formed by wind erosion on a preexisting dune or other sand deposit, especially in an area of shifting sand, loose soil, or where vegetation is disturbed or destroyed; the adjoining accumulation of sand derived from the depression, where recognizable, is commonly included.

Bluff. A high bank or bold headland, presenting a precipitous front; a steep cliff.

Box canyon. a) A narrow gorge or canyon containing an intermittent stream following a zigzag course, characterized by high, steep rock walls and typically closed upstream by a wall, thus giving the impression, as viewed from its bottom, of being surrounded or "boxed in" by almost vertical walls. b) A steep-walled canyon heading against a cliff; a dead-end canyon.

Butte. An isolated, generally flat-topped hill or mountain with relatively steep slopes and talus or precipitous cliffs and characterized by summit width that is less than the height of bounding escarpments, commonly topped by a caprock of resistant material and representing an erosion remnant carved from flat-lying strata.

Canyon. A long, deep, narrow, very steep-sided valley cut primarily in bedrock with high and precipitous walls in mountainous terrain or in a high plateau, often with a perennial stream at the bottom; larger than a gorge.

Channel. The bed of a single or braided watercourse that is generally barren of vegetation and formed of modern alluvium. Channels may be enclosed by banks or splayed across and slightly mounded above a fan surface and include bars and mounds of cobbles and stones.

Channel bank. The sloping land bordering a channel. The bank has steeper slope than the bottom of the channel and is usually steeper than the land surrounding the channel.

Cliff. Any high, very steep to perpendicular or overhanging face of rock or earth; a precipice.

Colluvial Slope. A slope formed of material or by processes associated with transportation and/or deposition by mass movement and local, unconcentrated runoff.

Cuesta. An asymmetric ridge capped by resistant rock layers of slight to moderate dip (usually less than 15 percent) produced by differential erosion of interbedded resistant and weak rocks. A cuesta has a long, gentle slope on one side (dip slope), that roughly parallels the inclined beds, and on the other side has a relatively short and steep or cliff-like slope (scarp) that cuts through the tilted rocks.

Debris flow. The process, associated sediments (debris flow deposit) or resultant landform characterized by a very rapid type of flow dominated by a sudden downslope movement of a mass of rock, soil, and mud (more than 50% of the particles are > 2mm), and whether saturated or comparatively dry, behaves much as a viscous fluid when moving.

Deflation basin. A topographic basin excavated and maintained by wind erosion which removes unconsolidated material and commonly leaves a rim of resistant material surrounding the depression. Unlike a blowout, a deflation basin does not include adjacent deposits derived from the basin.

Depression. Any relatively sunken part of the Earth's surface; especially a low-lying area surrounded by higher ground. A closed depression has no natural outlet for surface drainage (e.g., a sinkhole). An open depression has a natural outlet for surface drainage.

Dike. A tabular igneous intrusion that cuts across the bedding or grain of the country rock.

Ditch. A long, narrow excavation artificially dug in the ground; especially an open and usually unpaved waterway, channel, or trench for conveying water for drainage or irrigation, and usually smaller than a canal. Some ditches may be natural watercourses.

Dune. A low mound, ridge, bank or hill of loose, windblown, granular material (generally sand), either barren and capable of movement from place to place, or covered and stabilized with vegetation, but retaining its characteristic shape.

Dune swale. A low place among sand dunes, typically moister and having distinctive vegetation differing from the surrounding sand environment.

Escarpment. A continuous and steep slope or cliff produced by erosion or faulting that topographically interrupts the general continuity of more gently sloping land surfaces.

Fan remnant. A general term for landforms that are the remaining parts of older landforms such as alluvial fans, fan aprons, inset fans, and fan skirts, that either have been dissected or partially buried. An erosional fan remnant must have a relatively flat summit that is a relict fan-surface. A nonburied fan-remnant is a relict surface in its entirety.

Floodplain. The nearly level plain that borders a stream and is subject to inundation under flood-stage conditions unless protected artificially. It is usually a constructional landform built of alluvium deposited during overflow and lateral migration of the streams.

Gap. A break or opening in a mountain ridge, or a short pass through a mountain range.

Gorge. A narrow, deep valley with nearly vertical, rocky walls, smaller than a canyon and more steep-sided than a ravine; a restricted, steep-walled part of a canyon.

Hill. A generic term for an area of the land surface rising at least 30 m to as much as 300 meters above surrounding lowlands, usually with a nominal summit area relative to bounding slopes, a

well-defined, rounded outline and slopes that generally exceed 15 percent. A hill can occur as a single, isolated mass or in a group. Informal distinctions between a hill and a mountain are often arbitrary.

Hogback. A sharp-crested ridge or highly tilted resistant rock layers; produced by differential erosion of interlayered resistant and weak rocks with dips greater than about 25°.

Interfluve. A landform composed of the relatively undissected upland or ridge between two adjacent valleys containing streams flowing in the same general direction. An elevated area between two drainageways that sheds water to those drainageways.

Intermittent stream. A stream, or reach of a stream, that does not flow year-round and whose channel is generally below the local water table; it flows only a) during wet periods, or b) as a result of ground-water discharge or protracted contributions from melting snow or other erratic surface and shallow subsurface sources.

Knob. A peak or other projection from the top of a hill or mountain. Also, a boulder or group of boulders or an area of resistant rocks protruding from the side of a hill or mountain.

Knoll. A small, low, rounded hill rising above adjacent landforms.

Landslide. A general term for most types of mass movement landforms and processes involving the downslope transport and outward deposition of soil and rock materials, caused by gravitational forces and which may or may not involve saturated materials. Landslide types generally reflect the dominant process and/or the resultant landform. The main operational categories of mass movement are *fall* (rockfall), *slide* (rotational landslide, debris slide), *flow* (especially debris avalanche, debris flow), and *complex landslides*.

Ledge. A narrow shelf of rock, much longer than wider, formed on a rock wall or cliff face.

Meander scroll. One of a series of long, parallel, close fitting, crescent-shaped ridges and troughs formed along the inner bank of a stream meander as the channel migrated laterally down-valley and toward the outer bank.

Mesa. A broad, nearly flat-topped, and usually isolated landmass bounded by steep slopes or precipitous cliff and capped by layers of resistant, nearly horizontal, rocky summit width greater than the height of bounding escarpments.

Mountain. A generic term for an elevated area of the land surface, rising more than 300 meters above surrounding lowlands, usually with a nominal summit area relative to bounding slopes and generally with steep sides (greater than 25 percent slope) with or without considerable bedrock exposed. A mountain can occur as a single, isolated mass or in a group forming a chain or range. Mountains are primarily formed by tectonic activity and/or volcanic action and secondarily by differential erosion.

Mud flat. A level area of fine grained material (e.g., silt) along a shore or around an island, alternately covered and uncovered by shallow water, and barren of vegetation.

Overflow stream channel. A watercourse that is generally dry but conducts flood waters that have overflowed the banks of a river during large storms or meltwater events.

Peak. Sharp or rugged upward extension of a ridge chain, usually at the junction of two or more ridges; the prominent highest point of a summit area.

Pediment. A gently sloping erosional surface developed at the foot of a receding hill or mountain slope. The surface may be essentially bare, exposing earth material that extends beneath adjacent uplands or it may be thinly mantled with alluvium and colluvium, ultimately in transit from upland front to basin or valley lowland.

Piedmont. (Noun) An area, plain, slope, or another feature at the base of a mountain (e.g., a foothill or a bajada). (Adj.) Lying or formed at the base of a mountain or mountain range (e.g., a piedmont terrace or a piedmont pediment).

Plain. A general term referring to any flat lowland area at a low elevation. Specifically, any extensive region of comparatively level to gently undulating land. A plain has few or no prominent hills or valleys but sometimes has considerable slope. Where dissected, remnants of a plain can form the local uplands. A plain may be forested or bare of trees and may be formed by deposition or erosion.

Plateau. A comparatively flat area of great extent and elevation; specifically, an extensive land region considerably elevated (more than 100 meters) above adjacent lower-lying terrain, and commonly limited on at least one side by an abrupt descent; has a flat or nearly level surface. A comparatively large part of a plateau surface is near summit level.

Platform. Any level or nearly level surface, ranging in size from a terrace or bench to a plateau.

Playa. The usually dry and nearly level lake plain that occupies the lowest parts of closed depressions. Temporary flooding occurs in response to precipitation-runoff events. Playa deposits are fine grained and may or may not have a high water table and saline conditions.

Ramp. The steepened segment of a thrust fault, especially where a bedding thrust changes from a stratigraphically lower to a higher bed.

Ravine. A small stream channel; narrow, steep-sided, commonly V-shaped in cross section and larger than a gully, cut in unconsolidated materials.

Ridge. A long elevation of the land surface forming an extended upland between valleys, usually sharp crested with steep sides. The term is used in both hill and mountain areas.

Rim. The border, margin or edge of a landform; specifically, the rim of a plateau or canyon.

River. A general term for a natural surface stream of some volume and generally with a permanent base flow, moving in a defined channel toward a larger river or lake.

Rockfall. The process, associated sediments or resultant landform characterized by a very rapid type of *fall* dominated by downslope movement of detached rock bodies which fall freely through the air or by leaps and bounds. Lacks an underlying slip face.

Rotational slide. The process, associated sediments (rotational landslide deposit) or resultant landforms characterized by an extremely slow to moderately rapid type of slide, composed of comparatively dry and largely soil-rock materials, portions of which remain largely intact and in which movement occurs along a well-defined, concave shear surface and resulting in a backward rotation of the displaced mass.

Saddle. A low point on a ridge or interfluve, generally a divide (pass, col) between the heads of streams flowing in opposite directions.

Scree slope. A portion of a hillside or mountain slope mantled by scree and lacking an up-slope rockfall source (i.e., cliff).

Seep. An area, generally small, where water percolates slowly to the land surface.

Slide. A category of mass movement processes, associated sediments (slide deposit) or resultant landforms (e.g., rotational slide, translational slide, and snowslide) characterized by a failure of earth or rock under shear stress along one or several surfaces that are either visible or may reasonably be inferred. The moving mass may or may not be greatly deformed, and movement may be rotational (rotational slide) or planar (translational slide). A slide can result from lateral erosion, lateral pressure, weight of overlying material, accumulation of moisture, earthquakes, expansion owing to freeze-thaw of water in cracks, regional tilting, undermining, fire, or human agencies.

Slot canyon. A long, narrow, deep and tortuous channel or drainageway with sheer rock walls eroded into sandstone or other sedimentary rocks subject to flash flood events; depth to width ratios exceed 10:1 over most of its length and can approach 100:1.

Slough. A small marsh, or marshy area lying in a local, shallow, closed depression on a piece of dry land.

Stream bed. Class in the Cowardin et al. wetland classification referring to wetlands contained within the intermittent subsystem of the riverine system and all channels of the estuarine system.

Stream channel. The bed where a natural stream of water runs or may run; the long narrow depression shaped by the concentrated flow of a stream and covered continuously or periodically by water.

Stream terrace. One or a series of platforms in a stream valley, flanking and more or less parallel to the stream channel, originally formed near the level of the stream, and representing the remnants

of an abandoned floodplain, stream bed, or valley floor produced during a former state of fluvial erosion or deposition (i.e., now rarely or never floods). Remnants of constructional valley floors thickly mantled with alluvium are called alluvial terraces.

Swale. A shallow, open depression in unconsolidated materials which lacks a defined channel but can funnel overland or subsurface flow into a drainageway. Soils in swales tend to be moister and thicker (cumulic) compared to surrounding soils.

Talus slope. A portion of a hill slope or mountain slope mantled by talus and lying below a rockfall source (e.g., cliff).

Terrace. A relatively level bench or step-like surface breaking the continuity of a slope.

Upland. The ground level above a floodplain that zone sufficiently above and/or away from transported waters as to be dependent upon local precipitation for its water supplies.

Valley floor. A general term for the nearly level to gently sloping, lowest surface of a valley. Landforms include axial stream channels, the floodplain, floodplain steps, and, in some areas, low terrace surfaces.

Valley side. The sloping to very steep surfaces between the valley floor and summits of adjacent uplands.

Washes. A watercourse associated with an alluvial fan, stream, or river channel. Washes are often associated with arid environments and are characterized by large, high energy discharges with high bed material load transport. Washes are often intermittent and their beds sparsely vegetated.

Appendix 2: Soil Texture Key
(Modified from Brewer and McCann 1982)

Soil primarily organic:

0a. Soil is black, saturated with water, and often smells of rotten eggs..... **muck**

0b. Soil is dark brown, usually saturated, and consists of clearly identifiable plant parts .....**peat**

Soil primarily mineral:

1a. Soil does not remain in a ball when squeezed, leaves fingers clean ..... **sand**

1b. Soil remains in a ball when squeezed..... 2

Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you push up over your finger:

2a. Soil makes no ribbon but leaves your fingers dirty.....**loamy sand**

2b. Soil makes at least a very short ribbon..... 3

3a. Ribbon extends less than 1 inch before breaking 4

3b. Ribbon extends 1 inch or more before breaking 5

4a. Add excess water to small amount of soil. Soil feels slightly gritty .....**loam**

4b. Soil fees very gritty .....**sandy loam**

4c. Soil feels smooth ..... **silt loam**

5a. Soil makes a ribbon that breaks when 1-2 inches long; cracks if bent into a ring 6

5b. Soil makes a ribbon 2+ inches long; does not crack when bent into a ring..... 7

6a. Add excess water to small amount of soil; soil feels slightly gritty .....**clay loam**

6b. Soil feels very gritty and slightly sticky .....**sandy clay loam**

6c. Soil feels very smooth but not at all sticky.....**silt**

6d. Soil feels slightly gritty and slightly sticky .....**silty clay loam**

7a. Add excess water to a small amount of soil; soil feels gritty ..... **sandy clay**

7b. Soil feels smooth and sometimes sticky 8

8a. Soil feels smooth but leaves a gritty taste in the mouth ..... **silty clay**

8b. Soil leaves a smooth taste in the mouth, not at all gritty ..... **clay**

Considerations for Planning

Planning for the day

1. Safety and sustenance: Bring plenty of food, water, first-aid kit, raingear, sunscreen.
2. Field communications:
    a) Develop a plan with other team(s) for radio check-in time.
    b) Does your radio have charged batteries? Do you have extra batteries for your walkie-talkie?
    c) Does park staff know the area in which you will be working?
3. Make sure you have the right maps and photos.
4. Check your GPS (Datum set to NAD83? Does it need new batteries?).
5. Plan the day's mission before departing using:
    a) USGS quads,
    b) aerial photo,
    c) park/BLM maps.

Considerations for mission planning

1. Plan travel based on topography, best access routes, density and complexity of vegetation (allow more time for forest and woodland plots, less for herbaceous and scrub).
2. Plan data collection based on priority needs; new types get higher priority.
3. Communicate with other team(s) to make sure you are not duplicating efforts.

Planning for the week (do this on the first day of the trip):

1. Do you have all appropriate maps, photos?
2. Develop a reasonable estimate of the number of plots for each team broken up by day and based on an estimate of individual team's travel logistics for the week.
3. Develop a plan of attack for the week to capture all essential associations in the work area.
4. Balance points two and three above with the expected work schedule of the teams and ensure adequate time-off and reduce over-time concerns.
5. Do you have all necessary information and backups for the week's planning? (e.g., blank field forms, film, extra AA batteries).

Wrap-up (do this on the last day of the trip, after you have returned to base):

1. Clean, recharge and repair equipment.
2. Hold brief meeting to discuss data collection issues, things that came up during the work week, and plan for next work hitch.
3. Edit field forms and file them systematically. File observation points separately.

4. Key unknown plants.
5. Enter field data into database.

Communicate among teams/topics for wrap-up meetings:

1. What were your questions about the polygons visited during the week?
2. Do you have any questions about the forms or fields?
3. What was accomplished, what was not accomplished?
4. Pass on developments and questions after every trip. Don't let them build up. For example, should we sample the new types we saw? Were there problems with interpreting the aerial photos, or are there personnel issues, problems in consistency in interpreting forms, or with park-related logistics?

Materials Checklist

- Park research permit
- Topo maps
- Park and BLM maps for general navigation
- Maps of BPU locations
- Geology map
- Aerial photos
- DBH tape and two tape measures
- Trowel or U-dig-it, soil water bottle
- Compass with adjustable declination
- Clinometer
- GPS unit
- Extra AA batteries for GPS and walkie-talkie
- Radio or walkie-talkie and/or cell phone
- 35 mm camera and film (allow at least two exposures per plot, plus general and scenic photos)
- Baggies for temporary storage of unknown plants, and masking tape for labeling
- Plant press and paper
- Plant Keys/Flora(s)
- Pens/sharpies/dry erase markers
- Forms: plot survey (both pages) and observation point

- Clipboard/forms holder and clear page protector sleeves
- Pens, pencils, pencil lead, chalk (for slate board), and chalkboard eraser
- Stapler and extra staples
- Most recent version of provisional classification of the park, with number of plots still needed per type (updated approximately every two weeks)
- All ancillary information (cheat sheet(s), species list, floras, sampling priority list for zone, main sampling protocol)
- First aid kit, personal gear (food, water, rain gear, etc.)

Code List – Cheatsheet

Landform
Alluvial fan
Alluvial flat
Arroyo
Badlands
Bajada
Bank
Basin
Bench
Blowout
Box canyon
Butte
Canyon
Channel
Cliff
Colluvial Slope
Cuesta
Debris flow
Deflation basin
Depression
Dike
Dune
Eolian deposit
Escarpment
Fan remnant
Floodplain
Gap
Gorge
Hill
Hogback

Interfluve
Intermitt. stream
Knob
Knoll
Landslide
Meander scroll
Mountain
Mud flat
Overflow channel
Peak
Piedmont
Plain
Plateau
Playa
Ravine
Ridge
Rim
River
Rockfall
Rotational slide
Saddle
Scree slope
Seep
Slide
Slot canyon
Slough
Stream terrace
Swale
Talus slope
Terrace
Valley floor
Valley side
Wash

Aspect
Flat
Azimuth (deg.)
Variable

Plot size

Plot size	Community type(s)
25m^2 (2.8m r)	Non vascular
100m^2 (5.6 m r)	Dwarf Shrublands Shrub-Herbaceous Herbaceous
400m^2 (11.3m r)	Forests Woodlands Shrublands

You may adapt plot size and shape to fit the situation; but never choose a plot size smaller than identified here.

Topographic position

Designation	Synonym(s)
Interfluve	crest, summit, ridge
High slope	shoulder slope, upper slope, convex creep slope
High level	mesa, plateau
Midslope	transportational midslope
Backslope	dipslope, cliff
Step in slope	ledge, terracette, bench
Lowslope	lower slope, foot slope, colluvial footslope
Toeslope	alluvial toeslope
Low level	terrace, valley floor, floodplain

ALSO SEE DIAGRAM BELOW

Vegetative strata

Code	Vegetation type
T1	emergent tree
T2	tree canopy
T3	tree sub-canopy
S1	tall shrub, > 2m
S2	short shrub, < 2m
S3	dwarf shrub. < 0.5m
H1	graminoid
H2	forb
H3	fern or fern ally
H4	tree seedlings
N	nonvascular other than ferns
V	vine/liana
E	epiphyte

Park specials (keep an eye out for)

Rare plants

Raptor nesting sites

Upland springs and seeps or Hanging Gardens

Flammable historic/archaeologic sites

Invasive weeds (ignore cheatgrass, dandelions)
Abandoned agricultural fields (e.g., old alfalfa)

Physiognomic Class	Description
Forest	Crowns touching
Woodland	Trees>25%, crowns not touching
Shrubland	Shrubs> grass, forbs or trees
Dwarf Shrubland	Shrubland <0.5 m tall
Shrub Herbaceous	Shrubs = Forbs/grasses
Herbaceous	Grass/forbs > trees or shrubs

Soil texture

Texture	Description
Sand	clean, no ball
Loamy sand	ball, no ribbon
Sandy loam	gritty, weak ribbon
Silt loam	smooth, weak ribbon
Clay loam	long ribbon, no ring
Clay	smooth ribbon/ring, edible
Sandy Clay	gritty ribbon & ring
Silty Clay	smooth ribbon/ring
Peat	still has plant parts
Muck	smelly black ooze

Surficial geology
SEE GEOLOGY MAP

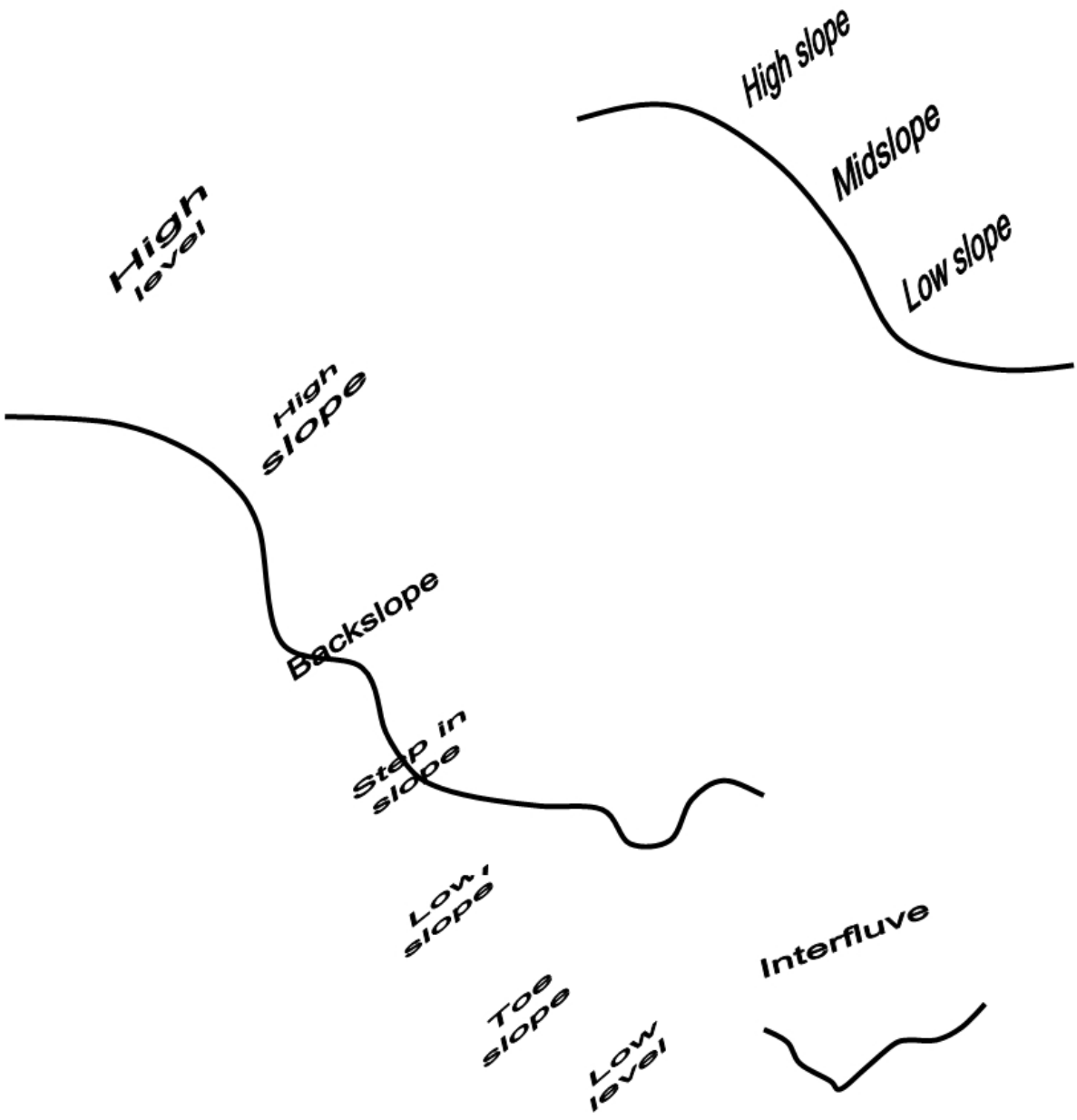
Obscured by soil
Aeolian sands
New Alluvium or Older
Alluvium
Talus/Colluvium/Landslides

Canyonlands
Entrada Sandstone
Dewey Bridge
Navajo Sandstone
Kayenta Formation
Wingate Sandstone
Chinle Formation
Moenkopi Formation
Cutler Group-undifferentiated
Kaibab limestone
Cutler Group-White Rim

Cutler Group-Organ Rock
Cedar Mesa Sandstone
Elephant Canyon Formation
Halgaito Shale
Honaker Trail Formation
Paradox Formation

Impacts
Fire or fire suppression activity
Mountain pine beetle damage
Mistletoe (specify tree species)
Grazing evidence
Development, historic structures
ORV use or Recreation (camp site, etc.)
Wildlife concentration

Topographic Position – Cheatsheet



B.2. Accuracy Assessment Point Field Sampling Manual, Accuracy Assessment at Glen Canyon NRA

Project Manual – 2014-2015

This document is intended to assist you in conducting accuracy assessment data collection at Glen Canyon NRA during the 2014-15 field seasons. Detailed, field-by-field instructions for data collection are provided. These are abbreviated on 'cheat sheets' at the end of each section. This project is being directed by the Northern Colorado Plateau Network (NCPN) Inventory and Monitoring Program with assistance from NAU, John Spence (GLCA), and NatureServe.

Introduction

The primary purpose of Accuracy Assessment fieldwork is to supply data that will test the accuracy of vegetation maps. It is also a continuation of the sampling of vegetation communities. The following are the main uses for the collected data:

- Verify accuracy of polygons drawn on the map (map units)
- Verify relationships between associations and mapping units
- Verify that field key works well to classify vegetation to association
- Check for classification completeness –undescribed associations not sampled during inventory
- Clarify concepts and augment descriptions of existing associations and possibly develop new associations

A number of factors can contribute to error on vegetation maps. Be particularly aware of those sources over which you have some influence, and those sources that may affect you when you are collecting data. For example:

- Locational error (when you can't get a good GPS point, the AA point data you collect may look like it's in another polygon, or if the polygons are small/narrow and your GPS isn't working well, it may be difficult for you to know which polygon you're supposed to be sampling).
- Field key is difficult to use, leading you to assign your point to the wrong association.
- Field key does not include all plant associations in the park, also leads to confusion in what association to assign to a point.
- Field data error - either by misidentifying diagnostic species, or by not reading the key carefully, resulting in a bad field call when the map is actually accurate.
- AA point falls within an ecotone, which is impossible to classify but still has to be mapped as something.

- Relationships between plant associations and map units (modeling) are flawed.

- The polygon is heterogeneous, including patches of varying vegetation that are too small to map individually. Your AA point may happen to fall in a part of the polygon with a different community than what the photo interpreter saw in the bigger picture.

Navigating to a Point

Navigate towards each selected Accuracy Assessment (AA) point using Digital Ortho photos (DOQQ maps) with AA points/vegetation mapping polygons printed on them, topographic maps, and handheld GPS receivers.

- DOQQ identifies the location of the AA point, as well as the location, size and shape of map polygons.

- Topo maps are useful in identifying the landscape through which you will be navigating, and in determining the elevation of a point. Also use them to obtain names of local topographic features (for site names, etc.).

- GPS receivers indicate the direction and the distance (as the crow flies) to the AA point. This can obviously get you into trouble if you navigate as the crow flies to your AA points, not being aware of cliffs or other obstacles in your way. Use the DOQQ and topo maps to plan your route! ***Note***: *It's often a good idea to GPS the location of your vehicle so you can find your way back!*

  Use your GPS unit to locate the point within 5-10 m of coordinates, but do not spend a lot of time trying to be exact. You will be evaluating a 5000 m^2 area (or half a hectare or ~2.5 acres) around the point, which is the size of the Minimum Mapping Unit (MMU). The MMU is the smallest area the photo interpreters are required to map to vegetation class. (Mappers can choose to delineate smaller polygons if the map class is distinctive).

  Attempt to key the vegetation within a half a hectare around the AA point to plant association, and if a key is available, to map unit. The MMU is a relatively large area - approximately the size of a football field with end zones (50m x100m rectangle, 71m x71m square, 80m diameter circle). The shape of the MMU may need to vary depending on the shape of the mapping polygon, but for large polygons, an 80m diameter circle may be easiest. If the polygon is smaller than the MMU, evaluate the whole polygon.

  Along the way... Identify the mapping polygons that the target AA points are in and if possible walk through part of the polygons on the way to the points, noting polygon boundaries. Is the map polygon uniform or variable? Is the AA point representative of the polygon? Record these observations on the AA form when you stop to sample.

  A word about safety… As with all fieldwork, you will be navigating through rough terrain, often off-trail, to reach your destination. However, particularly in AA work, there is a desire to reach as many points as you can in a day, and to get as close as you can to each point. No

AA point is worth your life! Use good judgment, and if a point cannot be reached safely, take data as close to the point as you can (hopefully within the target polygon) and document that the point was not actually reached in the comments field. If you can't reach a primary point because of difficult terrain (or other reasons), PLEASE note this so that anyone who comes after you will not repeat the effort.

AA Point Form Instructions

Important: When you reach an AA point location, log a waypoint with your GPS unit and, if you are using a Trimble unit, fill in the appropriate fields in the data dictionary. Make sure your GPS unit is set for NAD83, and that the WAAS is on (see 3D differential, below). Although we do have a data dictionary for recording several fields associated with data sheets, please enter all data manually on the paper forms as well (as a backup).

Identifiers/Locators Section

AA Point Code

Accuracy assessment point codes are derived from the codes assigned to points on the DOQQ photo map you have, with the letters "AA" inserted between the 4-letter park code and point number. For example, an AA point for Glen Canyon would be GLCA.AA.0101. Be sure to log a new point with your true coordinates in your GPS receiver.

Quad name

Leave blank. This will be completed in the office.

AA Point Shape

Are you observing a circular area around the point (all contained within the target polygon) or are you observing a narrow wash channel? Mark long, narrow wash channels as "other."

Park Site Name

This is best determined from your topo map. Select a nearby feature that is an obvious waypoint, such as the name of a canyon, road, arch, etc. This name does not need to be unique. If you sample a number of plots in a small area, you can use the same site name for all of them.

Survey Date

Date the AA point was sampled. Please use the following format: Month- Day- Year.

Surveyor

Full last name(s) of the field team member(s) collecting data.

GPS file name

You only need to fill this in if you are using a unit other than the Trimble GeoXM. For instance, if you are using a Garmin unit, enter the name you give to the waypoint when you mark the AA point in your GPS unit.

Field UTMX, Field UTMY

Record the UTM easting and northing you saved as a waypoint in your GPS. Please double check to make sure the easting is six digits and the northing is seven digits.

In deep canyon country it is often difficult to get a GPS reading (your machine has to be able to see at least three or four satellites). If you are unable to get a GPS reading in the plot, or if the PDOP is greater than 8 (or EPE is greater than ±50m), first try to get a signal from a higher point outside (but still close to) the plot. If that fails, you will need to estimate the UTM coordinates from the topo map, and manually enter these UTMs into the GPS unit.

Use a map that is in NAD 83 if at all possible, since the project standard is the NAD83 datum. However, USGS 7.5 minute maps use the NAD27 datum. The difference in this part of the world is that the NAD83 grid is shifted about 60m west and 200m north of NAD27. To ensure that all your plots show up in the right place, please use this procedure when estimating UTM coordinates from a NAD27 topo map:

1. Locate your plot as accurately as possible on the topo map, using triangulation or climbing to a high point.

2. Use the topo map, straightedge, pencil and a transparent overlay grid to obtain UTM coordinates in NAD27 (done carefully, you should be able to get to the nearest 10m). Write these coordinates down in the GPS Comments Field with the note "UTM coordinates derived from NAD27 topo map." DO NOT enter these in the UTM X and UTM Y fields.

3. Update the settings in your GPS unit to the NAD27 datum.

4. Create a new waypoint, give it the name of your plot, and enter the UTM coordinates you recorded.

5. Update the settings in your GPS unit to the NAD83 datum. This will convert the NAD27 coordinates to NAD83 without messing up the coordinates you already had in your machine (there may be rounding error). Enter the converted coordinates (now in NAD 83) into the UTM X and UTM Y fields.

6. Try to do this only once per hitch, because the more often you do it, the more likely it is that the rounding error will change the coordinates of your other (non-topo-derived) plots. You can do it in the office during datasheet cleanup and entry time.

GPS Unit

Record the name and model of the GPS unit being used to record data for the plot. If a GPS unit was not used to determine UTMs record “none” here and be sure to complete the “GPS Comments” field below.

GPS Error

Note the PDOP (or “Estimated Position Error" (EPE), if you’re using a Garmin unit) displayed on your GPS unit. The lower the number, the more accurate your reading.

3D Differential

3D differential is obtained when your GPS unit can "see" a satellite that does nothing but correct the tiny errors in the positioning or clocks of other GPS satellites. This satellite broadcasts a real-time

differential correction so that your location coordinates are as accurate as possible. It is in geosynchronous orbit in the southern sky, so if you can see the southern sky, you will generally be able to get 3D differential. This system is known as the Wide-Area Augmentation System, or WAAS. The Garmin and Trimble units have a field in their setup pages for turning WAAS on or off. Please make sure that WAAS is **always** on.

GPS Comments

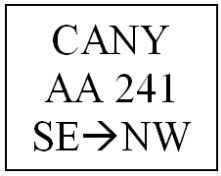
VERY IMPORTANT: If you resorted to estimating the plot location UTMs on the topo map, note that in this field. If your usual GPS croaked and you had to borrow an old Magellan from a friend, note that. Also, if you left the point to get a reading from a high point, record that here, along with the compass bearing and distance of the GPS location from the plot center (unless you used the offset function on the Trimble GeoXM) - in that case, enter "point offset."

Camera

Circle the appropriate camera name and model or ID number, or enter it next to "other" if it is not on the datasheet.

Taking photographs

Take two color slides of each plot. The purpose is to get a good representation accurately captures the vegetative stand of the point. If the area is heterogeneous, represent this in the photos. Try to include a little sky for perspective. Use a chalkboard to record the point number and the direction the photo is taken. Thus, for AA point 241, the board in the photo taken from the SE looking NW across the point will read "CANY AA 241, SE→NW". Take the photograph looking across the contour if point is on a steep slope.



Photos: Type/Roll Number/Frame Number/Photographer/Direction and Comments

For each photo taken at the plot record the following: *Trip number*: record trip number (Trip numbers should be a team member's initials plus the trip number.) *Frame number*: record frame number of photo. *Photographer*: record last name of person taking photograph. *Directions/Comments*: record the direction the photos were taken from and towards (SE→NW) and any other comments to clarify the photo.

Association Information Section

Primary Name, Secondary Name

Fill out this section last, after all the vegetation information has been collected. Using the environmental, stratum and cover data, key the vegetation in the half-hectare area around the AA point to association. Choose carefully! Write the name of the association in the primary name field. If the situation is borderline between two associations (e.g., some sagebrush, but also some muttongrass), write other association names in the secondary name or even tertiary name fields. List

other associations that are within 50m of the outside border of the half-hectare AA point you are evaluating. This is only important to include if these other associations are within the target polygon not in a neighboring polygon.

If vegetation near point does not key well, try your best to fit it into one or two of the associations listed in the manual, then make detailed comments in the "Classification Comments" field to justify your reasoning. **If vegetation near point does not fit the key at all,** enter "Y" under New Association and create a new name using the dominant species of each stratum. Add additional useful information to characterize new association in "Classification Comments" field and list additional species on strata form.

Representativeness of AA point

Because the AA points are randomly located within a polygon, there is no guarantee that they will land in a spot that is representative of either the polygon or of the associations included within the polygon's map unit. The point could easily land in a small gully or an inclusion that is too small to map, or an ecotone where trees are invading a shrubland, for instance. Because of this, it is important that you pay attention not only to the vegetation within the ½ hectare sample area, but the larger area as well. Rank the representativeness of this AA point for the polygon (Good,

Fair, or Poor). If you are unable to observe most of the polygon and are therefore having a difficult time determining representativeness, mark "Unk" for unknown. Please note in the Classification Comments field if the AA point falls in an ecotone or inclusion, or in an anomalous situation such as a gully or rock outcrop.

The key you are using does not give a lot of descriptive information for each association, and is likely not to contain all the associations you may encounter. Rank the representativeness of your AA point's association to the description in the key (Good, Fair, Poor). Please describe briefly the difficulty you had with the key in the Classification Comments field. This is important! It will help others write a better key.

Environmental Description Section

Elevation

Elevation of the plot. Take this measurement from the GPS unit (if you are using the Trimble GeoXM), in meters. If you are using a different GPS unit, estimate the elevation from the topographic map. Specify on the data sheet whether the measurement is in feet or meters.

Slope

Measure the slope in degrees using a clinometer. The degree scale is the left-hand scale as you look through the clinometer. If the slope varies in your plot, estimate an average. If the plot is on rolling microtopography, enter "variable." Describe these further under the Environmental Comments section.

Aspect

Measure the plot aspect in degrees using a compass (set for local magnetic declination, which is given in the lower left hand corner of every USGS topo map). If the slope is flat, enter "n/a" for

aspect. If the plot wraps around different aspects on a slope, enter “variable” and describe further under the Environmental Comments section.

Topographic Position

This is the position of the plot on its related landform. Determining this requires you to think of the landform in cross-section, which is roughly diagramed on the back of your cheat sheet. You **must** use one of the terms listed below:

Interfluve (crest, summit, ridge). Linear top of ridge, hill, or mountain; the elevated area between two drainages that sheds water to the drainages.

High slope (shoulder slope, upper slope, convex creep slope). The uppermost inclined surface at the top of a slope. Includes the transition zone from backslope to summit. Surface is dominantly convex in profile and erosional in origin.

High level (mesa, summit). Level top of a plateau.

Midslope (transportational midslope). Intermediate slope position.

Backslope (dipslope). Subset of midslopes that are steep, linear, and may include cliff segments.

Step in slope (ledge, terracette). Nearly level shelf interrupting a steep slope, rock wall, or cliff face.

Lowslope (lower slope, foot slope, colluvial footslope). Inner gently inclined surface at the base of a slope. Surface profile is generally concave and a transition between midslope or backslope, and toeslope.

Toeslope (alluvial toeslope). Outermost gently inclined surface at base of a slope. In profile, usually gentle, linear and characterized by alluvial deposition.

Low level (terrace). Valley floor or shoreline representing the former position of an alluvial plain, lake, or shore.

Landform

Enter the landform(s) that describes the site where the plot was sampled. Referring to the topo map for the landscape context may help you decide what landform(s) to choose. Note that the landform choices may describe different scales, or that a landform feature can be described by more than one term. For example, your plot may be on a ledge on the rim of a canyon. A suggested list of landforms and definitions is provided in APPENDIX 1. ***Note:*** *The topographic position selected should relate to the scale of the landform chosen here.*

Geology

Note the geologic substrate where plant community occurs. The geology map should help, but if you can't tell the geology at all or you do not have the geology map with you at the plot, put a general description (e.g., coarse sandstone, green shale, eolian sands or obscured by soils).

Environmental Comments

Enter any additional noteworthy comments on the environmental setting and its effect on the vegetation. Examples include: "stunted trees due to shallow soils," "vegetation only where pockets of soil occur," or "large colluvial boulders and small rocks litter surface of soil." This field can also be used to describe site history such as fire events. This is an extremely important field for crews to document so please take the time to do a thorough job. Information from this field is used to prepare local descriptions of the plant communities, and to help assign AA points to associations not previously recorded in the park.

Unvegetated Surface

This field is an ocular estimate of ground cover (totaling 100% cover). For this estimation, you must use the cover classes/scale listed on the data sheet, under the Vegetation Description section. If an unvegetated surface category is not present in your observation point area, leave the corresponding line blank.

Vegetation Description Section

Leaf Phenology

Select the best description for the leaf phenology of the **dominant** stratum. The dominant stratum is the tallest stratum that contains at least 10% cover. Leave blank for non-vascular plots.

Evergreen. Greater than 75% of the total woody cover is never without green foliage. (Some tricky examples: most Artemisia, Coleogyne, Ephedra and all Atriplex except canescens, all Chrysothamnus except nauseosus var. junceus).

Cold deciduous. Greater than 75% of the total woody cover sheds its foliage in connection with an unfavorable season mainly characterized by winter frost (tricky ones: Sarcobatus vermiculatus, Tamarix).

Mixed evergreen - cold deciduous. Evergreen and deciduous species are mixed within the type and generally contribute 25-75% of the total woody cover.
Perennial. Herbaceous vegetation composed of more than 50% perennial species.
Annual. Herbaceous vegetation composed of more than 50% annual species.

Leaf Type

Select the best description for the leaf form of the **dominant** stratum. The dominant stratum is the uppermost stratum that contains at least 10% total plot coverage. Within that dominant stratum, the species that makes up greater than 50% of cover defines the leaf type.

Broad-leaved. Woody vegetation that is primarily broad-leaved (Sagebrush, oak, mountain mahogany).

Needle-leaved. Woody vegetation that is primarily needle-leaved (Juniper, pinyon, tamarisk).

Microphyllous. Woody cover that is primarily microphyllous (*Ephedra*).

Graminoid. Herbaceous vegetation composed of more than 50 percent graminoid species (grasses, sedges, rushes, etc).

Forb (broad-leaf-herbaceous). Herbaceous vegetation composed of more than 50% broad-leaf forb species (*Phlox, Astragalus, Erigeron*, etc.).

Pteridophyte. Herbaceous vegetation composed of more than 50 percent ferns or scouring rushes.

Non-vascular. Dominated by lichens or mosses.

Mixed. As with leaf phenology, the dominant stratum may be composed approximately equally of species with several different leaf types. Describe the mix briefly or circle leaf types that apply.

Physiognomic Class

This represents what you see when you are standing in the plot looking across at the vegetation. The following definitions can be used as guidelines, but may not always apply in desert locales. For example, areas with scattered pinyon and juniper may not fit the cover classes below but they would best be described as a woodland.

Forest. Trees with their crowns overlapping (generally forming 60-100% cover).

Woodland. Open stands of trees with crowns not usually touching (generally forming 10-60% cover). Canopy tree cover may be less than 10% in cases where it exceeds shrub, dwarf-shrub, herb, and nonvascular cover, respectively.

Shrubland. Shrubs generally greater than 0.5 m tall with individuals or clumps overlapping to not touching (generally forming more than 25% cover, trees generally less than 10% cover). Shrub cover may be less than 25% where it exceeds tree, dwarf-shrub, herb, and nonvascular cover, respectively. Vegetation composed of woody vines is included this class.

Dwarf-Shrubland. Low-growing shrubs usually under 0.5 m tall. Individuals or clumps overlapping to not touching (generally forming more than 25% cover, trees and tall shrubs generally less than 10% cover). Dwarf-shrub cover may be less than 25% where it exceeds tree, shrub, herb, and nonvascular cover, respectively.

Shrub Herbaceous. Low or taller shrubs forming approximately equal cover with a grass or forb component. Individuals or clumps of shrubs (generally not touching and usually forming more than 25% cover; trees less than 10% cover). Spaces between shrubs are generally mostly occupied by grasses and/or forbs.

Wooded Herbaceous. Trees forming approximately equal cover with a grass or forb component.

Herbaceous. Perennial herbs (graminoids or forbs) dominant (generally forming at least 25% cover; trees, shrubs, and dwarf-shrubs generally with less than 10% cover). Herb cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and nonvascular cover, respectively.

Nonvascular. Nonvascular cover (bryophytes, lichens, and algae) dominant (generally forming at least 25% cover). Nonvascular perennial vegetation cover may be less than 25%, as long as it exceeds tree, shrub, dwarf-shrub, and herb cover.

Sparsely Vegetated. Abiotic substrate features dominant. Perennial vegetation is scattered to nearly absent and generally restricted to areas of concentrated resources. Total vegetation cover is typically less than 10% and greater than 2%. Badlands of sand dunes supporting communities of annual plants should be included in this category, regardless of cover.

Dominant Plant Species List

Record information on ***dominant species only***. Do not record species with trace cover or those with very low cover which do not define the community.

Strata: Species names will be recorded within the appropriate stratum. It is important that all crew members are consistent in assignment of species to strata throughout this project. Following are some guidelines to use in determining strata. The 'working draft' plant list for each park will be used as a guide for assigning species to the appropriate stratum. Field crew members are expected to help 'improve' this list and associated categorization as the field season progresses.

Begin by assessing the strata at your plot. Trees are defined as single-stemmed woody plants, generally 5 m in height or greater at maturity and under optimal growing conditions. Shrubs are defined as multiple-stemmed woody plants generally less than 5 m in height at maturity and under optimal growing conditions. The exception is mature pinyon and juniper plants, which are considered trees regardless of their height.

T1 Emergent, T2 Canopy, T3 Subcanopy. A uniform stand of pinyon or cottonwood trees would be a good example of T2"canopy", but where they are absent you would begin with the shrub stratum, or herbaceous stratum if no shrubs are present. If the tree crowns in your plot are mostly touching and similar in height, but one tree species is much taller, that species would be a T1"emergent." Occasionally, you will sample an area where there may be several tall, scattered cottonwoods and then shorter scattered junipers. In this case, the cottonwoods would be your "canopy" and the junipers would be the "subcanopy." You may also have cottonwoods listed in the "subcanopy" layer, if there are a number of saplings in addition to mature tall trees.

The remaining vegetative strata are (remember to check with plant list for consistency):

S1 Tall Shrub. >2 meters tall. For example, *Fraxinus anomala* and *Purshia mexicana.*

S2 Short Shrub. <2 meters tall. For example, *Coleogyne ramosissima,* all *Atriplex* except *cuneata, corrugata, gardneri* (which are dwarf).

S3 Dwarf Shrub. <0.5 meters tall. For example, *Opuntia polyacantha.*

H1 Graminoid. All grass species, including *Juncus arcticus.*

H2 Forb. All forbs. (*Typha* is a forb.)

H3 Fern or Fern Ally. All ferns, including *Equisetum hyemale.*

H4 Tree Seedlings. Seedlings are trees with vertical stems < 1.5 m tall, but that may vary by species.

N Nonvascular. This is mainly dark cyanobacteria, mosses and lichens.

V Vine/liana. All vine species.

E Epiphyte. All epiphytic species.

Height can be used to define strata, but is not how species should be placed in strata. Species characteristically belong to one stratum or another (e.g., pinyon and juniper are canopy (T2), Utah serviceberry is a tall shrub (S1), blackbrush is a short shrub (S2), snakeweed is a dwarf shrub (S3), etc.), EVEN when unusual environmental circumstances dictate that the plants have an unusually tall (e.g., 3' PLEJAM in burned areas at MEVE) or unusually short growth form. So even if the junipers growing in cracks are only 1.5 m tall, as long as they are mature trees, they get put in the T2 category. About the only rule regarding height should be that the tree layer is (usually) higher than the tall shrub layer, is taller than the short shrub layer, etc.

*The second thing is to avoid splitting species between strata. If a few mountain mahogany have been browsed to <1m tall, but most are 2m tall, they all get rolled into the tall shrub stratum. There are two exceptions: (1) each height class covers more than 10% of plot, or (2) there is a reproductive layer of baby shrubs or young trees.

The third thing is how to define some of the "borderline/confusing" species. What we want to avoid is some folks calling *Leptodactylon* a forb and some calling it a dwarf shrub. Ditto snakeweed. Ditto *Eriogonum microthecum*, fringed sage, *Brickellia* and any number of other species. Consult your plant lists, which you should keep updated as the crew discusses which species go in which stratum.

Completing the Species/Strata Table:

1. **Height.** Use the number code that best describes the heights of all plant species within a given stratum. The number codes are listed in the bottom left had corner of the data sheet.

2. **Cover Class.** For this ocular estimation you are looking at the aerial cover of **all** plants within a given stratum. Use the cover class codes listed in the bottom right hand corner of the data sheet (note: these are broader cover classes than used on the plot form).

3. **Dominant Species (Mark species that characterize the stand with a "*").** List the plant species using the full scientific name. You may find that there are not enough lines, in which case you can write in the blank area under the stratum name and number codes.

4. **% Cover.** An ocular estimate of the percent aerial cover (1-100%) for each plant species listed.

If your point is on the border between two types - (and both types are at least MMU-size), make two species lists, one for each type, on the back of your AA point form. These will both be entered into the database for that AA point.

Glen Canyon AA – Cheatsheet

Landform
alluvial fan
alluvial flat
alluvial plain
alluvial terrace
alluvium
backslope
badlands
bajada
basin
basin floor
bench
blowout
bluff
borrow pit
bottomland
box canyon
braided stream
break
butte
canyon
channel
cliff
climbing dune
closed depression
colluvium
crest
cuesta
debris flow
deflation basin
depression
desert pavement
dip
divide
drainageway
draw
dune
dune field
eolian deposit
eolian sands
ephemeral stream

escarpment
falling dune
finger ridge
flat
floodplain
gulch
gully
hill
hillslope
interdune
interfluve
intermittent stream
island
knob
knoll
ledge
meander belt
mesa
natural levee
overflow channel
oxbow
perennial stream
plain
plateau
playa
point bar
pool
quarry
ravine
ridge
rise
rim
rockfall
saddle
sand ramp
sand sheet
scarp
scree slope
shoulder
side slope
slope
slope alluvium

slope wash
slot canyon
stream terrace
swale
talus slope
tank
terrace
toeslope
valley
valley floor
valley side
was

Topographic position
See diagram below

Vegetative strata

Code	Vegetation Type
T1	emergent tree
T2	tree canopy
T3	tree sub-canopy
S1	tall shrub, > 2m
S2	short shrub, < 2m
S3	dwarf shrub < 0.5m
H1	graminoid
H2	forb
H3	fern or fern ally
H4	tree seedlings
N	nonvascular other than ferns
V	vine/liana
E	epiphyte

Park specials
Invasive weeds (ignore cheatgrass, dandelions)

Physiognomic Class	Description
Forest	Crowns touching
Woodland	Trees>10%, crowns not touching
Shrubland	Shrubs> grass, forbs or trees
Dwarf Shrubland	Shrubland <0.5 m tall
Shrub Herbaceous	Shrubs = Forbs/grasses
Herbaceous	Grass/forbs > trees or shrubs

Aspect
Flat
Azimuth (deg.)

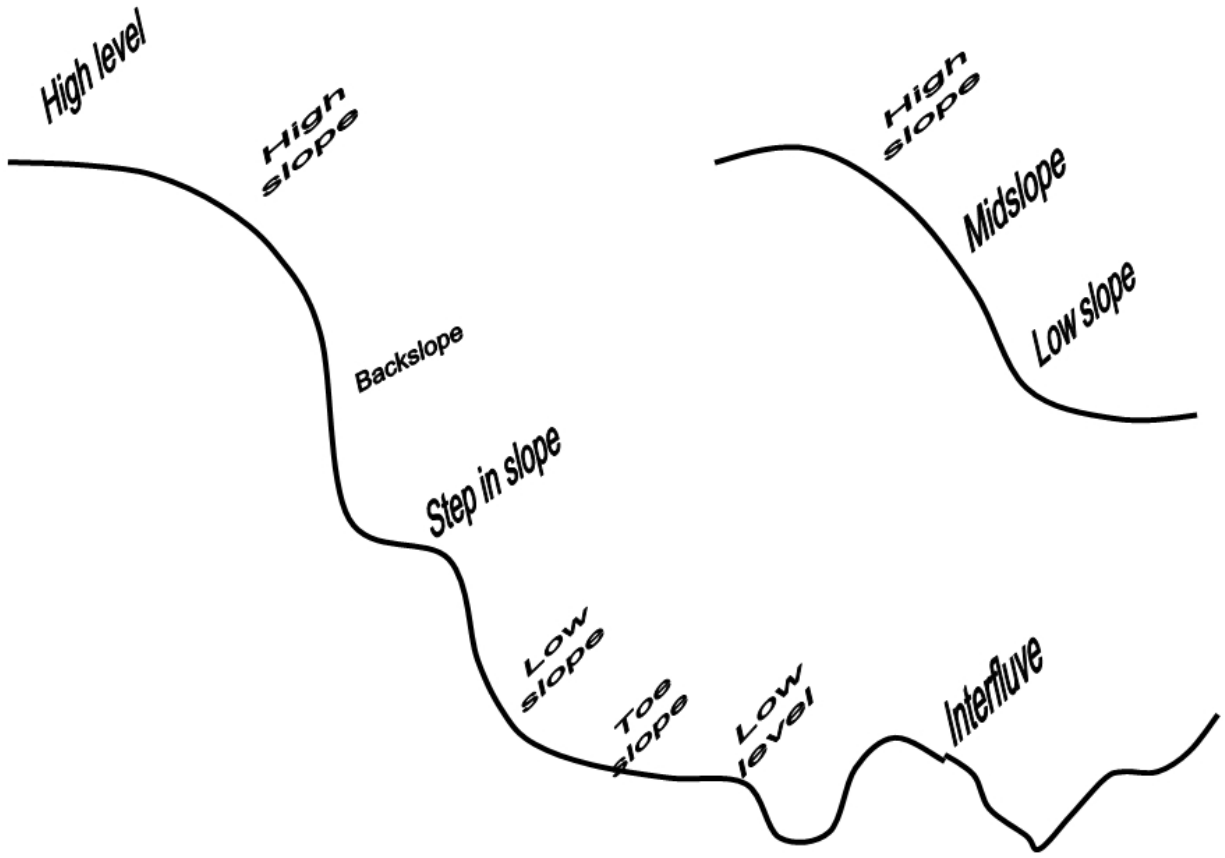
Variable

Plot size
71m × 71m square
10m × 50m rectangle
40m radius circle
80m diameter circle
You may adapt plot shape to fit the polygon. NEVER overlap with another polygon.

Surficial geology
Obscured by soil
Eolian sands
New Alluvium (Holocene)
Older Alluvium (pre-Holocene)
Talus / Colluvium / Landslides
Navajo Sandstone
Kayenta Formation
Wingate Sandstone
Chinle Fm
Mossback Member
Moenkopi Formation
White Rim Sandstone
Cutler Group-undiff or
Organ Rock Shale
Cedar Mesa Sandstone
Elephant Canyon Formation
Halgaito Shale
Honaker Trail Formation
Paradox Formation

Disturbance
Water gullies
Mass wasting
Tamarisk beetle defoliation
Flash flooding
Grazing evidence
Human development
Historic structures
Agriculture
ORV use or recreation
Concentrated wildlife use
Fire
Drought

Topographic Position – Cheatsheet



Appendix 1: Landform Glossary
(https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054230)

alluvial cone - A semi-conical type of alluvial fan with very steep slopes; it is higher, narrower, and steeper (e.g., > 40% slopes) than a fan, and composed of coarser, and thicker layers of material deposited by a combination of alluvial episodes and to a much lesser degree, landslides (e.g., debris flow). Compare - alluvial fan, talus cone.

alluvial fan - A low, outspread mass of loose materials and/or rock material, commonly with gentle slopes, shaped like an open fan or a segment of a cone, deposited by a stream (best expressed in semiarid regions) at the place where it issues from a narrow mountain or upland valley; or where a tributary stream is near or at its junction with the main stream. It is steepest near its apex which points upstream and slopes gently and convexly outward (downstream) with a gradual decrease in gradient.

alluvial flat - (a) (Colloquial: western US) - A nearly level, graded, alluvial surface in bolsons and semi-bolsons which commonly does not manifest traceable channels, terraces or floodplain levels. Compare - flood-plain step, terrace, valley flat.

alluvial plain - (a) A large assemblage of fluvial landforms (braided streams, terraces, etc.,) that form low gradient, regional ramps along the flanks of mountains and extend great distances from their sources (e.g., High Plains of North America, SW.) (b) (Not recommended, use floodplain.) - A general, informal term for a broad floodplain or a low-gradient delta. Compare - alluvial flat.

alluvial terrace - (Not preferred) - Refer to stream terrace.

alluvium - Unconsolidated, clastic material subaerially deposited by running water, including gravel, sand, silt, clay, and various mixtures of these. Compare - colluvium, slope alluvium.

anticline - (a) A unit of folded strata that is convex upward and whose core contains the stratigraphically oldest rocks, and occurs at the earth's surface. In a single anticline, beds forming the opposing limbs of the fold dip away from its axial plane. Compare - monocline, syncline, fold. (b) A fold, at any depth, generally convex upward whose core contains the stratigraphically older rocks.

arroyo - (Colloquial: southwest A.) - The channel of a flat-floored, ephemeral stream, commonly with very steep to vertical banks cut in unconsolidated material; sometimes called a wash. It is usually dry but can be transformed into a temporary watercourse or short-lived torrent after heavy rain within the watershed. Where arroyos intersect zones of ground-water discharge, they are more properly classed as intermittent stream channels.

backslope - The hillslope profile position that forms the steepest and generally linear, middle portion of the slope. In profile, backslopes are commonly bounded by a convex shoulder above and a concave footslope below. They may or may not include cliff segments (i.e., free faces).

Backslopes are commonly erosional forms produced by mass movement, colluvial action, and running water. Compare - summit, shoulder, footslope, toeslope.

badlands - A landscape which is intricately dissected and characterized by a very fine drainage network with high drainage densities and short, steep slopes with narrow interfluves. Badlands develop on surfaces with little or no vegetative cover, overlying unconsolidated or poorly cemented materials (clays, silts, or in some cases sandstones) sometimes with soluble minerals such as gypsum or halite.

bajada - (Colloquial: southwestern US.) - A broad, gently inclined, alluvial piedmont slope extending from the base of a mountain range out into a basin and formed by the lateral coalescence of a series of alluvial fans. Typically it has a broadly undulating transverse profile, parallel to the mountain front, resulting from the convexities of component fans. The term is generally restricted to constructional slopes of intermontane basins. Synonym - coalescent fan piedmont.

bar - A general term for a ridge-like accumulation of sand, gravel, or other alluvial material formed in the channel, along the banks, or at the mouth of a stream where a decrease in velocity induces deposition (e.g,, a channel bar or a meander bar). A generic term for any of various elongate offshore ridges, banks, or mounds of sand, gravel, or other unconsolidated material submerged at least at high tide, and built up by the action of waves or currents, especially at the mouth of a river or estuary, or at a slight distance offshore from the beach.

base slope - A geomorphic component of hills consisting of the concave to linear slope (perpendicular to the contour) which, regardless of the lateral shape is an area that forms an apron or wedge at the bottom of a hillside dominated by colluvial and slope wash processes and sediments (e.g., colluvium and slope alluvium). Distal base slope sediments commonly grade to, or interfinger with, alluvial fills, or gradually thin to form pedisediment over residuum.

basin - (a) Drainage basin. (b) A low area in the Earth's crust, of tectonic origin, in which sediments have accumulated. (c) (Colloquial: western US) - A general term for the nearly level to gently sloping, bottom surface of an intermontane basin (bolson). Landforms include playas, broad alluvial flats containing ephemeral drainageways, and relict alluvial and lacustrine surfaces that rarely, if ever, are subject to flooding. Where through-drainage systems are well developed, floodplains are dominant and lake plains are absent or of limited extent. Basin floors grade mountainward to distal parts of piedmont slopes.

basin floor - A general term for the nearly level, lower-most part of intermontane basins (i.e., bolsons, semi-bolsons). The floor includes all of the alluvial, eolian, and erosional landforms below the piedmont slope.

bench - (Not preferred) - Refer to structural bench.

blowout - A saucer-, cup-, or trough-shaped depression formed by wind erosion on a preexisting dune or other sand deposit, especially in an area of shifting sand, loose soil, or where protective

vegetation is disturbed or destroyed; the adjoining accumulation of sand derived from the depression, where recognizable, is commonly included. Commonly small, some blowouts may be large (kilometers in diameter). Compare - deflation basin.

bluff - (a) A high bank or bold headland, with a broad, precipitous, sometimes rounded cliff face overlooking a plain or body of water, especially on the outside of a stream meander; ex. a river bluff. (b) (Not preferred) - Use cliff. Any cliff with a steep, broad face.

bottomland - (Not recommended) - Use floodplain. An obsolete, informal term loosely applied to varying portions of a floodplain.

box canyon - a) A narrow gorge or canyon containing an intermittent stream following a zigzag course, characterized by high, steep rock walls and typically closed upstream by a similar wall, giving the impression, as viewed from its bottom, of being surrounded or “boxed in” by almost vertical walls. b) A steep-walled canyon heading against a cliff a dead-end canyon.

braided stream - A channel or stream with multiple channels that interweave as a result of repeated bifurcation and convergence of flow around inter-channel bars, resembling (in plain view) the strands of a complex braid. Braiding is generally confined to broad, shallow streams of low sinuosity, high bedload, non-cohesive bank material, and a steep gradient. At bank-full discharge, braided streams have steeper slopes and shallower, broader, and less stable channel cross sections than meandering streams. Compare - meandering channel, flood-plain landforms.

breaks - (Colloquial: western US) - A landscape or large tract of steep, rough or broken land dissected by ravines and gullies and marks a sudden change in topography as from an elevated plain to lower hilly terrain, or a line of irregular cliffs at the edge of a mesa or a river (e.g., the Missouri River breaks).

butte - An isolated, generally flat-topped hill or mountain with relatively steep slopes and talus or precipitous cliffs and characterized by summit width that is less than the height of bounding escarpments, commonly topped by a caprock of resistant material and representing an erosion remnant carved from flat-lying rocks.

canyon - A long, deep, narrow, very steep-sided valley cut primarily in bedrock with high and precipitous walls in an area of high local relief (e.g., mountain or high plateau terrain), often with a perennial stream at the bottom; similar to but larger than a gorge. Compare - gorge, box canyon, slot canyon.

canyon bench - One of a series of relatively narrow, flat landforms occurring along a canyon wall and caused by differential erosion of alternating strong and weak horizontal strata; a type of structural bench.

channel - (a) The hollow bed where a natural body of surface water flows or may flow. The deepest or central part of the bed of a stream, containing the main current and occupied more or less continuously by water. (b) (Colloquial: western US.) - The bed of a single or braided watercourse

that commonly is barren of vegetation and is formed of modern alluvium. Channels may be enclosed by banks or splayed across and slightly mounded above a fan surface and include bars and mounds of cobbles and stones. (c) Small, trough-like, arcuate or sinuous channels separated by small bars or ridges, caused by fluvial processes; common to floodplains and young alluvial terraces; a constituent part of *bar and channel* topography.

cliff - Any high, very steep to perpendicular or overhanging face of rock or earth; a precipice.

climbing dune - A dune formed by the piling-up of sand by wind against a cliff or mountain slope; very common in arid regions with substantial local relief and strong winds. Compare - sand ramp.

colluvium - Unconsolidated, unsorted material being transported or deposited on sideslopes and/or at the base of slopes by mass movement (e.g., direct gravitational action) and by local, unconcentrated runoff.

complex landslide - A category of mass movement processes, associated sediments (complex landslide deposit) or resultant landforms characterized by a composite of several mass movement processes none of which dominates or leaves a prevailing landform. Numerous types of complex landslides can be specified by naming the constituent processes evident (e.g., a complex earth spread - earth flow landslide).

crest - (a) The commonly linear, narrow top of a ridge, hill, or mountain. It is appropriately applied to elevated areas where retreating backslopes are converging such that these high areas are almost exclusively composed of convex shoulders. (b) (Not preferred) - Sometimes used as an alternative for the hillslope component *summit*.

cuesta - An asymmetric, homoclinal ridge capped by resistant rock layers of slight to moderate dip (commonly less than 15 percent); produced by differential erosion of interbedded resistant and weak rocks. A cuesta has a long, gentle slope on one side (dip slope), that roughly parallels the inclined beds, and on the other side has a relatively short and steep or cliff-like slope (scarp) that cuts through the tilted rocks.

debris fall - The process, associated sediments (debris fall deposit) or resultant landform characterized by a rapid type of *fall* involving the relatively free, downslope movement or collapse of detached, unconsolidated material which falls freely through the air (lacks an underlying slip face); sediments have substantial proportions of both fine earth and coarse fragments; common along undercut stream banks. Compare - rock fall, soil fall, landslide.

debris flow - The process, associated sediments (debris flow deposit) or landform resulting from a very rapid type of *flow* dominated by a sudden downslope movement of a mass of rock, soil, and mud (more than 50% of the particles are > 2mm), and whether saturated or comparatively dry, behaves much as a viscous fluid when moving.

depression - Any relatively sunken part of the Earth's surface; especially a low-lying area surrounded by higher ground. A closed depression has no natural outlet for surface drainage (e.g.,

a sinkhole). An open depression has a natural outlet for surface drainage. Compare - closed depression, open depression.

desert pavement - A natural, residual concentration or layer of wind-polished, closely packed gravel, boulders, and other rock fragments, mantling a desert surface. It is formed where wind action and sheetwash have removed all smaller particles or where coarse fragments have migrated upward through sediments to the surface. It usually protects the underlying, finer-grained material from further deflation. The coarse fragments commonly are cemented by mineral matter. Compare - erosion pavement, stone line.

dip - A geomorphic component (characteristic piece) of flat plains (e.g., lake plain, low coastal plain, low-relief till plain) consisting of a shallow and typically closed depression that tends to be an area of focused groundwater recharge but not a permanent water body and that lies slightly lower and is wetter than the adjacent talf, and favors the accumulation of fine sediments and organic materials.

divide - (a) The line of separation. (b) The summit area, or narrow tract of higher ground that constitutes the watershed boundary between two adjacent drainage basins; it divides the surface waters that flow naturally in one direction from those that flow in the opposite direction. Compare – interfluve.

drainageway - (a) A general term for a course or channel along which water moves in draining an area. (b) A term restricted to relatively small, roughly linear or arcuate depressions that move concentrated water at some time, and either lack a defined channel (e.g., head slope, swale) or have a small, defined channel (e.g., low order streams).

draw - A small, natural watercourse cut in unconsolidated materials, generally more open with a broader floor and more gently sloping sides than an arroyo, ravine or gulch, and whose present stream channel may appear inadequate to have cut the drainageway that it occupies.

dune - A low mound, ridge, bank or hill of loose, windblown, subaerially deposited granular material (generally sand), either barren and capable of movement from place to place, or covered and stabilized with vegetation, but retaining its characteristic shape.

dune field - An assemblage of moving and/or stabilized dunes, together with sand plains, interdune areas, and the ponds, lakes, or swamps produced by the blocking of steams by the sand. See dune lake.

eolian deposit - Sand, silt or clay-sized clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sheet of sand or loess. Conventionally, primary volcanic deposits (e.g., tephra) are handled separately. Compare - loess, parna, beach sands.

ephemeral stream - Generally a small stream, or upper reach of a stream, that flows only in direct response to precipitation. It receives no protracted water supply from melting snow or other sources and its channel is above the water table at all times.

eroded fan remnant - All, or a portion of an alluvial fan that is much more extensively eroded and dissected than a fan remnant; sometimes called an *erosional fan remnant*. It consists primarily of a) eroded and highly dissected sides (*eroded fan-remnant sideslopes*) dominated by hillslope positions (shoulder, backslope, etc.), and b) to a lesser extent an intact, relatively planar, relict alluvial fan "summit" area best described as a tread.

escarpment - A continuous, steep slope or cliff produced by erosion or faulting and that topographically interrupts or breaks the general continuity of more gently sloping land surfaces. The term is most commonly applied to cliffs produced by differential erosion. Synonym = scarp.

falling dune - An accumulation of sand that is formed as sand is blown off a mesa top or over a cliff face or steep slope, forming a solid wall, sloping at the angle of repose of dry sand, or a fan extending downward from a re-entrant in the mesa wall. Compare - climbing dune, sand ramp.

fan - (a) A gently sloping, fan-shaped mass of detritus forming a section of a low-angle cone commonly at a place where there is a notable decrease in gradient; specifically an alluvial fan (not preferred – use alluvial fan). (b) A fan-shaped mass of congealed lava that formed on a steep slope by the continually changing direction of flow.

fault-line scarp - (a) A steep slope or cliff formed by differential erosion along a fault line, as by the more rapid erosion of soft rock on the side of a fault as compared to that of more resistant rock on the other side; e.g., the east face of the Sierra Nevada in California. (b) (Not recommended) - A fault scarp that has been modified by erosion. This usage is not recommended because the scarp is usually not located on the fault line.

finger ridge - One in a group of small, tertiary spur ridges that form crudely palmate extensions of erosional remnants along the flanks or nose of larger ridges. Compare - ballena, rib.

flat - (a) (Adjective) - Said of an area characterized by a continuous surface or stretch of land that is smooth, even, or horizontal, or nearly so, and that lacks any significant curvature, slope, elevations, or depressions. (b) (Noun) An informal, generic term for a level or nearly level surface or small area of land marked by little or no local relief.

floodplain - The nearly level plain that borders a stream and is subject to inundation under flood-stage conditions unless protected artificially. It is usually a constructional landform built of sediment deposited during overflow and lateral migration of the streams.

foothills - A steeply sloping upland composed of hills with relief of 30 up to 300 meters and fringes a mountain range or high-plateau escarpment. Compare - hill, mountain, plateau.

footslope - The hillslope profile position that forms the concave surface at the base of a hillslope. It is a transition zone between upslope sites of erosion and transport (shoulder, backslope) and downslope sites of deposition (toeslope). Compare - summit, shoulder, backslope, and toeslope.

gorge - (a) A narrow, deep valley with nearly vertical, rocky walls, smaller than a canyon, and more steep-sided than a ravine; especially a restricted, steep-walled part of a canyon. (b) A narrow defile or passage between hills or mountains.

graben - An elongate trough or basin bounded on both sides by high-angle, normal faults that dip towards the interior of the trough. It is a structural form that may or may not be geomorphically expressed as a rift valley.

gulch - (Colloquial: western US.; not preferred - refer to ravine) - A small stream channel, narrow and steep-sided in cross section, and larger than a gully, cut in unconsolidated materials. General synonym - ravine.

gully - A small channel with steep sides caused by erosion and cut in unconsolidated materials by concentrated but intermittent flow of water usually during and immediately following heavy rains or ice / snow melt. A gully generally is an obstacle to wheeled vehicles and too deep (e.g., > 0.5 m) to be obliterated by ordinary tillage; (a rill is of lesser depth and can be smoothed over by ordinary tillage). Compare - rill, ravine, arroyo, swale, draw.

hill - A generic term for an elevated area of the land surface, rising at least 30 m (100 ft.) to as much as 300 meters (approx. 1000 ft.) above surrounding lowlands, usually with a nominal summit area relative to bounding slopes, a well-defined, rounded outline and slopes that generally exceed 15 percent. A hill can occur as a single, isolated mass or in a group. Informal distinctions between a hill and a mountain are often arbitrary and dependent on local use.

hillslope - A generic term for the steeper part of a hill between its summit and the drainage line, valley flat, or depression floor at the base of the hill. Compare - mountain slope.

hogback - A sharp-crested, symmetric (homoclinal) ridge formed by highly tilted resistant rock layers; produced by differential erosion of interlayered resistant and weak rocks with dips greater than about 25 degrees (45 percent).

hummock - (a) (Not preferred - see hillock) - An imprecise, general term for a rounded or conical mound or other small elevation. (b) (Not preferred) - A slight rise of ground above a level surface.

interdune - The relatively flat surface, whether sand-free or sand-covered, between dunes. GG

interfluve - A landform composed of the relatively undissected upland or ridge between two adjacent valleys containing streams flowing in the same general direction. An elevated area between two drainageways that sheds water to those drainageways. Compare - divide.

intermittent stream - A stream, or reach of a stream, that does not flow year-round (commonly dry for 3 or more months out of 12) and whose channel is generally below the local water table; it flows only when it receives a) base flow (i.e., solely during wet periods), or b) ground-water discharge or protracted contributions from melting snow or other erratic surface and shallow subsurface sources. Compare - ephemeral stream.

island - (a) Land completely surrounded by water. (b) An elevated area of land surrounded by swamp, or marsh, or isolated at high water or during floods. Compare - barrier island.

knob - (a) A rounded eminence, a small hill or mountain; especially a prominent or isolated hill with steep sides, commonly found in the Southern United States. (b) A peak or other projection from the top of a hill or mountain. Also, a boulder or group of boulders or an area of resistant rocks protruding from the side of a hill or mountain.

knoll - A small, low, rounded hill rising above adjacent landforms.

landslide - A general, encompassing term for most types of mass movement landforms and processes involving the downslope transport and outward deposition of soil and rock materials, caused by gravitational forces and which may or may not involve saturated materials. Names of landslide types generally reflect the dominant process and/or the resultant landform. The main operational categories of mass movement are *fall* (rockfall, soil fall, topple), *slide* (rotational landslide, block glide, debris slide, lateral spread), *flow* [rock fragment flow (especially rockfall avalanche), debris avalanche, debris flow (e.g., lahar), earthflow, (creep, mudflow)], and *complex landslides*.

ledge - (a) A narrow shelf or projection of rock, much longer than wide, formed on a rock wall or cliff face, as along a coast by differential wave action on softer rocks; erosion is by combined biological and chemical weathering. (b) A rocky outcrop; solid rock. (c) A shelf-like quarry exposure or natural rock outcrop. Compare - structural bench.

lowland - (a) A generic, imprecise term for low-lying land or an extensive region of low-lying land, especially near a coast and including the extended plains or country lying not far above tide level. (b) (Not preferred) - A generic, imprecise term for a landscape of low, comparatively level ground of a region or local area, in contrast with the adjacent higher country. (c) (Not recommended - use valley, bolson, etc.) - A generic term for a large valley.

marsh - Periodically wet or continually flooded areas with the surface not deeply submerged. Covered dominantly with sedges, cattails, rushes, or other hydrophytic plants. Compare - salt marsh, swamp, bog, fen.

meander belt - The zone within which migration of a meandering channel occurs; the flood-plain area included between two imaginary lines drawn tangential to the outer bends of active channel loops. Landform components of the meander-belt surface are produced by a combination of gradual (lateral and down-valley) migration of meander loops and avulsive channel shifts causing abrupt cut-offs of loop segments. Landforms flanking the sinuous stream channel include: point bars, abandoned meanders, meander scrolls, oxbow lakes, natural levees, and flood-plain splays. Meander belts may not exhibit prominent natural levee or splay forms. Floodplains of broad valleys may contain one or more abandoned meander belts in addition to the zone flanking the active stream channel.

mesa - A broad, nearly flat-topped, and usually isolated landmass bounded by steep slopes or precipitous cliff and capped by layers of resistant, nearly horizontal, rocky summit width greater

than the height of bounding escarpments. (Colloquial: western US; not preferred) - Also used to designate broad structural benches and alluvial terraces that occupy intermediate levels in stepped sequences of platforms bordering canyons and valleys.

monocline - (a) A unit of folded strata that dips from the horizontal in one direction only, is not part of an anticline or syncline, and occurs at the earth's surface. This structure is typically present in plateau areas where nearly flat strata locally assume steep dips caused by differential vertical movements without faulting. Compare - anticline, syncline, fold. (b) A local steepening in an otherwise uniform gentle dip.

overbank deposit - Fine-grained sediments (silt and clay) deposited from suspension on a floodplain by floodwaters that cannot be contained within the stream channel.

overflow stream channel - A watercourse that is generally dry but conducts flood waters that have overflowed the banks of a river, commonly from large storms or annual meltwater.

oxbow - A closely looping stream meander having an extreme curvature such that only a neck of land is left between the two parts of the stream. (Colloquial: northeastern A.) - The land enclosed, or partly enclosed, within an oxbow.

peak - Sharp or rugged upward extension of a ridge chain, usually at the junction of two or more ridges; the prominent highest point of a summit area.

pediment - A gently sloping erosional surface at the foot of a receding hill or mountain slope. The surface may be essentially bare, exposing earth material that extends beneath adjacent uplands; or it may be thinly mantled with alluvium and colluvium, ultimately in transit from upland front to basin or valley lowland. In hill-foot slope terrain the mantle is designated “pedisediment.” The term has been used in several geomorphic contexts: Pediments may be classed with respect to (a) landscape positions, for example, intermontane-basin piedmont or valley-border footslope surfaces (respectively, apron and terrace pediments); (b) Type of material eroded, bedrock or regolith; or (c) combinations of the above. Compare - Piedmont slope.

perennial stream - A stream or reach of a stream that flows continuously throughout the year and whose surface is generally lower than the water table adjacent to the region adjoining the stream.

plain - A general term referring to any flat, lowland area, large or small, at a low elevation. Specifically, any extensive region of comparatively smooth and level gently undulating land. A plain has few or no prominent hills or valleys but sometimes has considerable slope, and usually occurs at low elevation relative to surrounding areas. Where dissected, remnants of a plain can form the local uplands. A plain may be forested or bare of trees and may be formed by deposition or erosion. Compare - lowland, plateau.

plateau - A comparatively flat area of great extent and elevation; specifically, an extensive land region considerably elevated (more than 100 meters) above adjacent lower-lying terrain, and is commonly limited on at least one side by an abrupt descent, has a flat or nearly level surface. A

comparatively large part of a plateau surface is near summit level. Compare - hill, foothill, mountain, mesa, plain.

playa - The usually dry and nearly level lake plain that occupies the lowest parts of closed depressions, such as those occurring on intermontane basin floors. Temporary flooding occurs primarily in response to precipitation-runoff events. Playa deposits are fine grained and may or may not have high water table and saline conditions.

point bar - One of a series of low, arcuate ridges of sand and gravel developed on the inside of a growing meander by the slow addition of individual accretions accompanying migration of the channel toward the outer bank.

pool - A small, natural body of standing water, usually fresh; e.g., a stagnant body of water in a marsh, or a transient puddle in a depression following a rain.

ravine - A small stream channel; narrow, steep-sided, commonly V-shaped in cross section and larger than a gully, cut in unconsolidated materials. General synonym (not preferred) - gulch. Compare - arroyo, draw, gully.

ridge - A long, narrow elevation of the land, usually sharp crested with steep sides and forming an extended upland between valleys. The term is used in areas of both hill and mountain relief.

rill - A very small channel with steep sides caused by erosion and cut in unconsolidated materials by concentrated but intermittent flow of water, usually during and immediately following moderate rains or after ice/snow melt. Generally, a rill is not an obstacle to wheeled vehicles and is shallow enough to be obliterated by ordinary tillage.

rim - The border, margin, edge, or face of a landform, such as the curved brim surrounding the top part of a crater or caldera; specifically, the rimrock of a plateau or canyon.

river - (a) A general term for a natural, freshwater surface stream of considerable volume and generally with a permanent base flow, moving in a defined channel toward a larger river, lake, or sea. (b) (Not recommended: colloquial - New England, US) - A small watercourse which elsewhere in the US is known as a *creek*.

river valley - An elongate depression of the Earth's surface; carved by a river during the course of its development. Compare - valley side, valley floor.

rockfall - The process, associated sediments (rockfall deposit) or resultant landform characterized by a very rapid type of *fall* dominated by downslope movement of detached rock bodies which fall freely through the air or by leaps and bounds (lacks an underlying slip face); also spelled rock fall. Compare - debris fall, soil fall, landslide.

saddle - A low point on a ridge or interfluve, generally a divide (pass, col) between the heads of streams flowing in opposite directions. Compare - summit, crest.

sand ramp - A sand sheet blown up onto the lower slopes of a bedrock hill or mountain and forming an inclined plane, sometimes filling small mountain-side valleys and even crossing low passes.

sand sheet - A large, irregularly shaped, commonly thin, surficial mantle of eolian sand, lacking the discernible slip faces that are common on dunes.

scarp - An escarpment, cliff, or steep slope of some extent along the margin of a plateau, mesa, terrace, or structural bench. A scarp may be of any height. Compare - escarpment.

scree slope - A portion of a hillside or mountainslope mantled by scree and lacking an up-slope rockfall source (i.e. cliff). Compare - talus slope, scree, talus.

seep - (noun) An area, generally small, where water or oil percolates slowly to the land surface. For water, it may be considered as a seepage spring, but it is used by some for flows too small to be considered as springs.

shoulder - The hillslope profile position that forms the convex, erosional surface near the top of a hillslope. If present, it comprises the transition zone from summit to backslope. Compare - summit, crest, backslope, footslope, and toeslope.

shrub-coppice dune - A small, streamlined dune that forms around brush and clump vegetation.

side slope - A laterally planar area of a hillside, resulting in predominantly parallel overland water flow (e.g., sheet wash); contour lines generally form straight lines. Side slopes are dominated by colluvium and slope wash sediments. Slope complexity (downslope shape) can range from simple to complex. Compare - head slope, nose slope, free face, interfluve, crest, base slope. The slope bounding a drainageway and lying between the drainageway and the adjacent interfluve. It is generally linear along the slope width.

slide - (a) Mass movement processes, associated sediments (slide deposit) or resultant landforms (e.g., rotational, translational, and snow slide) characterized by a failure of earth, snow, or rock under shear stress along one or several surfaces that are either visible or may reasonably be inferred. The moving mass may or may not be greatly deformed, and movement may be rotational (rotational slide) or planar (translational slide). A slide can result from lateral erosion, lateral pressure, weight of overlying material, accumulation of moisture, earthquakes, expansion owing to freeze-thaw of water in cracks, regional tilting, undermining, fire, and human agencies. Compare -fall, topple, lateral spread, flow, complex landslide. (b) The track of bare rock or furrowed earth left by a slide. (c) The mass of material moved by or deposited by a slide.

slope - (Also called slope gradient or gradient) - The inclination of the land surface from the horizontal. Percent slope is the vertical distance divided by the horizontal distance, then multiplied by 100.

slot canyon - A long, narrow, deep and tortuous channel or drainageway with sheer rock walls eroded into sandstone or other sedimentary rocks, especially in the semi-arid western US (e.g., Colorado Plateau); subject to flash flood events; depth to width ratios exceed 10:1 over most of

its length and can approach 100:1; commonly containing unique ecological communities distinct from the adjacent, drier uplands.

stream - (a) A body of running water that moves under gravity to progressively lower levels, in a relatively narrow but clearly defined channel on the ground surface, in a subterranean cavern, or beneath or in a glacier. It is a mixture of water and dissolved, suspended, or entrained matter. (b) A term used in quantitative geomorphology interchangeably with channel. Compare - river.

stream terrace - One or a series of platforms in a stream valley, flanking and more or less parallel to the stream channel, originally formed near the level of the stream, and representing the remnants of an abandoned floodplain, stream bed, or valley floor produced during a former state of fluvial erosion or deposition (i.e., currently very rarely or never floods; inactive cut and fill and/or scour and fill processes). Erosional surfaces cut into bedrock and thinly mantled with stream deposits (alluvium) are called “strath terraces.” Remnants of constructional valley floors thickly mantled with alluvium are called alluvial terraces. Compare - alluvial terrace, flood-plain step, strath terrace, terrace.

structural bench - A platform-like, nearly level to gently inclined erosional surface developed on resistant strata in areas where valleys are cut in alternating strong and weak layers with an essentially horizontal attitude. Structural benches are bedrock controlled, and in contrast to stream terraces, have no geomorphic implication of former, partial erosion cycles and base-level controls, nor do they represent a stage of flood-plain development following an episode of valley trenching. Compare - pediment, ledge; see scarp.

swale - (a) A shallow, open depression in unconsolidated materials which lacks a defined channel but can funnel overland or subsurface flow into a drainageway. Soils in swales tend to be more moist and thicker (cummulic) compared to surrounding soils. (b) A small, shallow, typically closed depression in an undulating ground moraine formed by uneven glacial deposition; Compare - swell-and-swale topography. (c) (Not preferred; refer to interdune) - A long, narrow, generally shallow, trough-like depression between two beach ridges, and aligned roughly parallel to the coastline.

tableland - A term for a broad upland with an extensive, nearly level or undulating summit area and steep side slopes descending to surrounding lowlands. Compare - plateau, mesa, cuesta.

talus - Rock fragments of any size or shape (usually coarse and angular) derived from and lying at the base of a cliff or very steep rock slope. The accumulated mass of loose broken rock formed chiefly by falling, rolling, or sliding.

talus slope - A portion of a hillslope or mountainslope mantled by talus and lying below a rockfall source (e.g., cliff). Compare - scree slope, scree, talus. Compare - beveled base.

terrace - A step-like surface, bordering a valley floor or shoreline, that represents the former position of a floodplain, or lake or sea shore. The term is usually applied to both the relatively flat summit surface (tread), cut or built by stream or wave action, and the steeper slope (scarp, riser),

descending to a lower base level. Compare - stream terrace, flood-plain step. Practically, terraces are considered to be generally flat alluvial areas above the 100 yr. flood stage.

toeslope - The hillslope position that forms the gently inclined surface at the base of a hillslope. Toeslopes in profile are commonly gentle and linear, and are constructional surfaces forming the lower part of a hill-slope continuum that grades to valley or closed-depression floors. Compare - summit, shoulder, backslope, footslope, valley floor.

valley floor - A general term for the nearly level to gently sloping, lowest surface of a valley. Landforms include axial stream channels, the floodplain, flood-plain steps, and, in some areas, low terrace surfaces. Compare - flood-plain landforms, meander, braided channel, valley side.

valley side - The sloping to very steep surfaces between the valley floor and summits of adjacent uplands. Well-defined, steep valley sides have been termed valley walls (not recommended). *Note:* Scale, relief, and perspective may require use of closely related terms such as hill slope or mountain slope.

wash (dry wash) - (Colloquial: western US.) The broad, flat- floored channel of an ephemeral stream, commonly with very steep to vertical banks cut in alluvium. *Note:* When channels reach intersect zones of ground-water discharge they are more properly classed as “intermittent stream” channels. Synonym - arroyo. Compare - gully.

Considerations for Planning

Planning for the day

1. Safety and sustenance: Plenty of food, water, first-aid kit, raingear, sunscreen.
2. Field communications:
    a. Develop a plan with other team(s) for radio check-in times.
    b. Do you have a radio and are batteries charged? If you have a walkie-talkie, do you have extra batteries for it? Does park staff know the area in which you will be working?
3. Make sure you have the right maps and photos.
4. Check your GPS (Datum set to NAD83? WAAS on? Needs new batteries?).
5. Plan the day’s mission before departing using: a) USGS quads, b) aerial photos, c) BLM maps.
6. Considerations for mission planning:
    a. Plan travel based on topography, best access routes, density and complexity of vegetation
    b. Communicate with the other team member(s) to make sure you aren't duplicating effort.
7. Go over master map after each day so every crew member can cross off AA points they completed.

Planning for the week (do this on the first day of the trip)

1. Do you have all appropriate maps, photos?
2. Develop a reasonable estimate of the number of points for each team broken up by day and based on an estimate of individual team's travel logistics for the week.
3. Do you have all necessary information and backups for the week's planning? (e.g., blank field forms, film, plenty of batteries).

Wrap-up (Do this on the last day of the trip, after you have returned to base)

1. Clean, recharge and repair equipment.
2. Hold brief meeting to discuss data collection issues, things that came up during the work week, and plan for next work hitch.
3. Edit field forms and file them systematically.
4. Re-file the aerial photos and maps.
5. Download all photos from the cameras.
6. Key unknown plants.
7. Upload all data from the GPS units.

Communicate among teams / Topics for wrap-up meetings

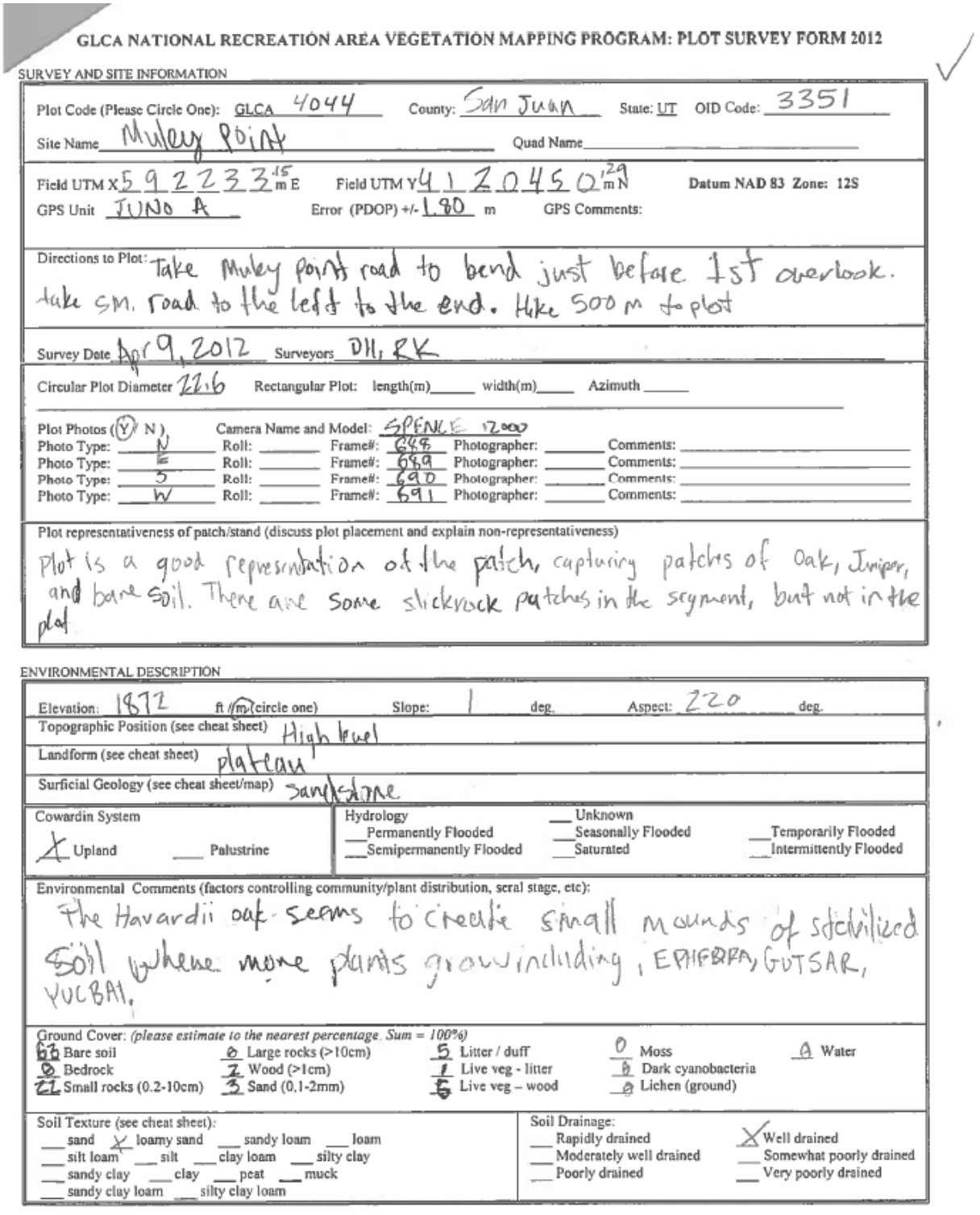
1. What were your questions about the points visited during the week?
2. Do you have any questions about the forms or fields?
3. What was accomplished, what was not accomplished?
4. Pass on developments and questions after every trip. Don't let them build up. For example, should we sample the new types we saw? Were there problems with interpreting the aerial photos, or are there personnel issues, problems in consistency in interpreting the forms, or with park-related logistics?

Materials Checklist

- Topo maps
- Park and BLM maps for general navigation (Trails Illustrated maps for Canyonlands)
- Compass with adjustable declination
- Clinometer
- GPS unit
- Extra AA batteries for walkie-talkie
- Radio or walkie-talkie and/or cell phone
- Cameras and SD cards
- Baggies for temporary storage of unknown plants, and masking tape for labeling

- Plant press and paper
- Plant Keys/Flora(s)
- Pencils/sharpies
- Forms: AA point
- Clipboard/forms holder
- Pens, pencils, dry erase boards, markers
- Key to the plant associations of the park
- Notebook of association local descriptions
- All ancillary information (cheat sheet, species list, floras, sampling priority list for zone, main sampling protocol).
- First aid kit, personal gear (food, water, rain gear, etc.)

B.3. Example of a Vegetation Plot Data Form



GLCA NATIONAL RECREATION AREA VEGETATION MAPPING PROGRAM: PLOT SURVEY FORM 2012

SURVEY AND SITE INFORMATION

Plot Code (Please Circle One): GLCA 4044 County: San Juan State: UT OID Code: 3351

Site Name Muley Point Quad Name

Field UTM X 592233.15 m E Field UTM Y 4120450.29 m N Datum NAD 83 Zone: 12S

GPS Unit JUNO A Error (PDOP) +/- 1.80 m GPS Comments:

Directions to Plot: Take Muley point road to bend just before 1st overlook. take sm. road to the left to the end. Hike 500 m to plot

Survey Date Apr 9, 2012 Surveyors DH, RK

Circular Plot Diameter 22.6 Rectangular Plot: length(m)_____ width(m)_____ Azimuth _____

Plot Photos (Y) N) Camera Name and Model: SPENCE 12000

Photo Type: N Roll: _____ Frame#: 688 Photographer: _____ Comments: _____

Photo Type: E Roll: _____ Frame#: 689 Photographer: _____ Comments: _____

Photo Type: S Roll: _____ Frame#: 690 Photographer: _____ Comments: _____

Photo Type: W Roll: _____ Frame#: 691 Photographer: _____ Comments: _____

Plot representativeness of patch/stand (discuss plot placement and explain non-representativeness)

Plot is a good representation of the patch, capturing patches of Oak, Juniper, and bare soil. There are some slickrock patches in the segment, but not in the plot

ENVIRONMENTAL DESCRIPTION

Elevation: 1872 ft /(m) (circle one) Slope: 1 deg. Aspect: 220 deg.

Topographic Position (see cheat sheet) High level

Landform (see cheat sheet) plateau

Surficial Geology (see cheat sheet/map) sandstone

Cowardin System: X Upland ___ Palustrine

Hydrology: ___ Unknown; ___ Permanently Flooded; ___ Seasonally Flooded; ___ Temporarily Flooded; ___ Semipermanently Flooded; ___ Saturated; ___ Intermittently Flooded

Environmental Comments (factors controlling community/plant distribution, seral stage, etc):

The Havardii oak seems to create small mounds of stabilized soil where more plants grow including, EPHEDRA, GUTSAR, YUCBAT.

Ground Cover: *(please estimate to the nearest percentage. Sum = 100%)*

63 Bare soil	0 Large rocks (>10cm)	5 Litter / duff	0 Moss	A Water
0 Bedrock	2 Wood (>1cm)	1 Live veg - litter	0 Dark cyanobacteria	
21 Small rocks (0.2-10cm)	3 Sand (0.1-2mm)	5 Live veg – wood	0 Lichen (ground)	

Soil Texture (see cheat sheet):

___ sand X loamy sand ___ sandy loam ___ loam

___ silt loam ___ silt ___ clay loam ___ silty clay

___ sandy clay ___ clay ___ peat ___ muck

___ sandy clay loam ___ silty clay loam

Soil Drainage:

___ Rapidly drained X Well drained

___ Moderately well drained ___ Somewhat poorly drained

___ Poorly drained ___ Very poorly drained

GLCA NATIONAL RECREATION AREA VEGETATION MAPPING PROGRAM: PLOT SURVEY FORM 2012

GLCA 4044

ENVIRONMENTAL DESCRIPTION (Continued)

Animal Use Evidence (including scat, browse, burrows, bedding sites, etc)

Rabbit tracks

Natural and Anthropogenic Disturbance Comments (see cheat sheet for examples; describe intensity and effect on the vegetation, also whether disturbance is current, chronic, episodic or historic)

None evident

Other Comments. **Describe surrounding communities (in all directions) and how they relate to the plot.**

N, S, W, - Slick rock communities w/ PJ, COLRAM, Lithospermum subincisum. until the cliff.

E - veg looks similar

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic Class
Trees and Shrubs		
X Evergreen		
__ Cold-deciduous		
__ Mixed evergreen-cold-deciduous		
Herbs		
__ Annual		
__ Perennial		
	__ Broad-leaved	__ Forest
	X Needle-leaved	X Woodland
	__ Microphyllous	__ Shrubland
	__ Graminoid	__ Dwarf Shrubland
	__ Forb	__ Shrub Herbaceous
	__ Pteridophyte	__ Herbaceous
	__ Non-vascular	__ Nonvascular
	__ Mixed (describe)	__ Sparsely Vegetated

Tree DBH and DRC. Record the species of each individual tree in the full plot or subplot. Check appropriate measure for each species (see instructions) and use check mark accordingly. Separate measurements of multi-stemmed trees with commas.

Supplemental Form (Please Check if Used): ☐ Plot (circle one): Full Plot / Subplot

SPECIES	DBH ✓	DRC ✓	DIAMETERS (cm)	SPECIES	DBH ✓	DRC ✓	DIAMETERS (cm)

Pinyon-juniper age classes (*check one*)

__ Not PJ
__ Old-growth (>500 years old)
X Mature (350-500 years old; shrub layer absent)
__ Young (100-350 years old)
__ Invasive (< 80 years old)

GLCA NATIONAL PARK VEGETATION MAPPING PROGRAM: PLOT SURVEY FORM - 2012

ATION DESCRIPTION

Plot Code: [GLCA 4044]

Provisional Community Name: Pinus edulis-Juniperus osteosperma / Quercus havardii Woodland

Species/Strata: Starting with the uppermost stratum list all species with full scientific names, cover class and % cover for each species in the stratum. For each tree species estimate seedling, sapling, total cover in appropriate stratum. Once species level information is completed, then complete height class and cover class for each strata (shaded blocks). Indicate with an asterix ('*') diagnostic species for each stratum and check whether a specimen has been collected. Trees and shrubs are on the front portion of this form. Herbaceous species and non-vascular plants are on the back of this form. **List species outside the plot with a 0 in the Cover Class Column.**

SPECIES/STRATA TABLE / TREES & SHRUBS Strata / Species Scientific Name	*	Cover Class	% Cover	Specm ✓
T1 EMERGENT Strata Height ____ Strata Cover ____				
T2 CANOPY Strata Height 04 Strata Cover 1A				
PIED		P	5	
JUOS		P	4	
T3 SUBCANOPY Strata Height 0.3 Strata Cover 1A				
Quercus havardii		1A	7	
S1 TALL SHRUB (> 2m) Strata Height ____ Strata Cover ____				
S2 SHORT SHRUB (< 2m) Strata Height 02 Strata Cover P				
EPHEDRA VIRIDIS		P	1	
S3 DWARF SHRUB (< 0.5m) Strata Height 01 Strata Cover P				
Ostrotus arizonicus		P	1	✓
Gutierrezia microcephala		T	1	
Opuntia erinacea		T		
Artemesia bigelovii		T		
Yucca bigelovii		X	X	
Sclerocactus parviflorus		X	X	

SPECIES/STRATA TABLE / HERBACEOUS & NON-VASCULAR Strata / Species Scientific Name	*	Cover Class	% Cover	Specm ✓
Ht HERBACEOUS Sum of H1, H2, H3, H4 Strata Height ____ Strata Cover ____				
H1 GRAMINOIDS Strata Height ____ Strata Cover ____				
H2 FORBS Strata Height 01 Strata Cover T				
Lithospermum incisum		T		
Streptanthella longirostris		T		
Cymopterus acaulis var. fendleri		T		✓
Hymenoppus f.l. foliosus		T		✓
Eriogonum shockleyi		T		
Cryptantha flava		T		
Lotidium montanum		T		
Senecio multilobatus		X	X	✓
Streptanthus cord. foliosus		T		
H3 FERNS & ALLIES Strata Height ____ Strata Cover ____				
H4 TREE SEEDLINGS Strata Height ____ Strata Cover ____				
N NON-VASCULAR Strata Height 01 Strata Cover T				
MOSS		T		
V VINE/LIANA Strata Height ____ Strata Cover ____				

Cover Scale for Species and Strata

X = few; T = 0-1%; P = 1-5%; 1A = 5-10%; 1B = 10-15%; 2 = 15-25%; 3 = 25-35%; 4 = 35-45%; 5A = 45-50%; 5B = 50-55%; 6 = 55-65%; 7 = 65-75%; 8 = 75-85%; 9 = 85-95%; 10 = > 95%

Height Scale for Strata

01	< 0.5 m	03	1 – 2 m	05	5 – 10 m	07	15-20 m	09	35 – 50 m
02	0.5 – 1 m	04	2 – 5 m	06	10 – 15 m	08	20 35 m	10	> 50 m

Supplemental Form on Next Page (Please Check if Used): ☐

B.4. Example of an Accuracy Assessment Data Form

2014-15 ACCURACY ASSESSMENT POINT FORM – GLEN CANYON NATIONAL RECREATION AREA

IDENTIFIERS/LOCATORS

AA Point Code: GLCA_AA. 1537 Quad name: _____ AA Point Shape: (circle) other

Park Site Name W. SIT DOWN BENCH

Survey Date 3/22/15 Surveyor(s) S. TILL

GPS file name_____ Field UTM Y 4110558 m N Field UTM X 469321 m E

Coordinates from USGS NAD27 Quad Map (if checked enter coordinates under GPS comments)

GPS Unit: (circle one): Juno 3B/ Juno ST/Juno SB/ Garmin Flat /None/ Other: _____ PDOP: 1.80

3D Differential? (Yes) No Error +/-: _____ m (Flat Garmin only) Datum NAD 83 Zone: 12

GPS Comments:

Camera Name and Model (circle one): Olympus Stylus Tough / Other: _____

Trip #	Frame #	Photographer	Direction/Comments
1	82	ST	260°
1	0083	ST	60°

ENVIRONMENTAL DESCRIPTION

Elevation 1444 (m)/ft From: (GPS) / Map (circle one) Slope 4 Aspect 320°

Topographic Position: Midslope

Landform: Mesa Geology: Straight cliffs

Environmental Comments:

Unvegetated Surface Cover: *(use the cover classes listed below under Vegetation Description heading)*

—	Bedrock	T	Large rocks (cobbles, boulders > 10 cm)	—	Sand (0.1-2 mm)
1a	Litter, duff	06	Small rocks (gravel, 0.2-10 cm)	02	Bare soil
T	Wood (> 1 cm)			Pc	Other: CRYPTO

VEGETATION DESCRIPTION

Leaf phenology (dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic Class	Height Class (m)	Cover Class
Trees and Shrubs				
x Evergreen	x Broad-leaved	___ Forest	01 - <0.5	T - <1%
___ Cold-deciduous	___ Needle-leaved	___ Woodland	02 - 0.5-1	P - 1-5%
___ Mixed evergreen - cold-deciduous	___ Microphyllous	___ Shrubland	03 - 1-2	1a - 6-10%
	___ Graminoid	x Dwarf- shrubland	04 - 2-5	1b- 11-15%
Herbs			05 - 5-10	02 - 16-25%
___ Perennial	___ Forb	___ Shrub herbaceous	06 - 10-15	03 - 26-35%
	___ Pteridophyte	___ Wooded herbaceous	07 - 15-20	04 - 36-45%
___ Annual		___ Wooded Shrubland	08 - 20-35	05 - 46-55%
	___ Non Vascular	___ Herbaceous	09 - 35-50	06 - 56-65%
	___ Mixed	___ Nonvascular	10 - >50	07 - 66-75%
		___ Sparsely vegetated		08 - 76-85%
				09 - 86-95%
				10 - >95%

2006: Feb 9

2014-15 ACCURACY ASSESSMENT POINT FORM – GLEN CANYON NATIONAL RECREATION AREA

VEGETATION DESCRIPTION cont.

Strata	Height Class	Cover Class	Dominant species (mark any known diagnostic species with a *)	% Cover
T1 Emergent				
T2 Canopy				
T3 Sub-canopy				
S1 Tall shrub				
S2 Short Shrub	01	P	COLRAM SHATOR SUEDA SUEDA	T T
S3 Dwarf-shrub	01	02	ATRCON ★ ARTSP1 ★	11 6
H Herbaceous	01	P	Calochortus sp. EVONUT	1 T
H4 Tree Seedlings				
N Non-vascular	01	P	CRYPTO	2

☐ Please check this box if AA point has more than one plant association (e.g. two unique species lists are recorded on this form)

ASSOCIATIONS AT AA POINT	New?	OTHER ASSOCIATIONS WITHIN 50 M OF AA POINT
Primary Name ATRCON-ACAC.PH-ARTSP1 D. shrub		1.
Secondary Name ATRCON-ARTSP1 dwarf shr.		2.
Tertiary Name		3.

Representativeness of point within polygon: (Good) Fair Poor Unk **.....of association to description:** (Good) Fair Poor

Classification Comments: (complications, uncertainties, explanation of fair/poor representativeness)

Good, except again A. sphaerocephalus is absent

2006 Feb 0

Appendix C. Plots Database Documentation

Background

This database, designed for data resulting from fieldwork related to vegetation mapping projects, was developed by the Northern Colorado Plateau Network (NCPN). The Plots Database System, developed by The Nature Conservancy, was the starting point for this database. From this starting point, NCPN normalized the data structure, added fields and lookup tables, and developed an extensive user interface. Similar versions of this database, subsequently referred to as the GLCA VegMapDB, have been used for all vegetation mapping projects conducted by the NCPN. GLCA VegMapDB contains plot, observation point, and accuracy assessment data collected during project field work.

Two database files are required to use GLCA VegMapDB:

- *GLCA_Plots.mdb.* This "frontend" file contains all queries, forms, reports, associated modules and Visual Basic code.
- *GLCA_Plots_be.mdb*. This "backend" file contains the database tables.

The frontend/backend file structure allows multiple users to enter data in a network environment, and allows for easy backup and transfer of the data tables. Users typically launch the frontend file, and a utility will prompt them to establish a link to the backend file. The contents of the backend file, however, can be used independently of the frontend.

Entity Relationship Diagram

The primary tables and relationships from the backend file (GLCA_Plots_be.mdb) are illustrated below. The database follows the design structure of the National Park Service Natural Resource Database Template, which is based on a location record, one or more related event records, and observation data elements linked to each event.

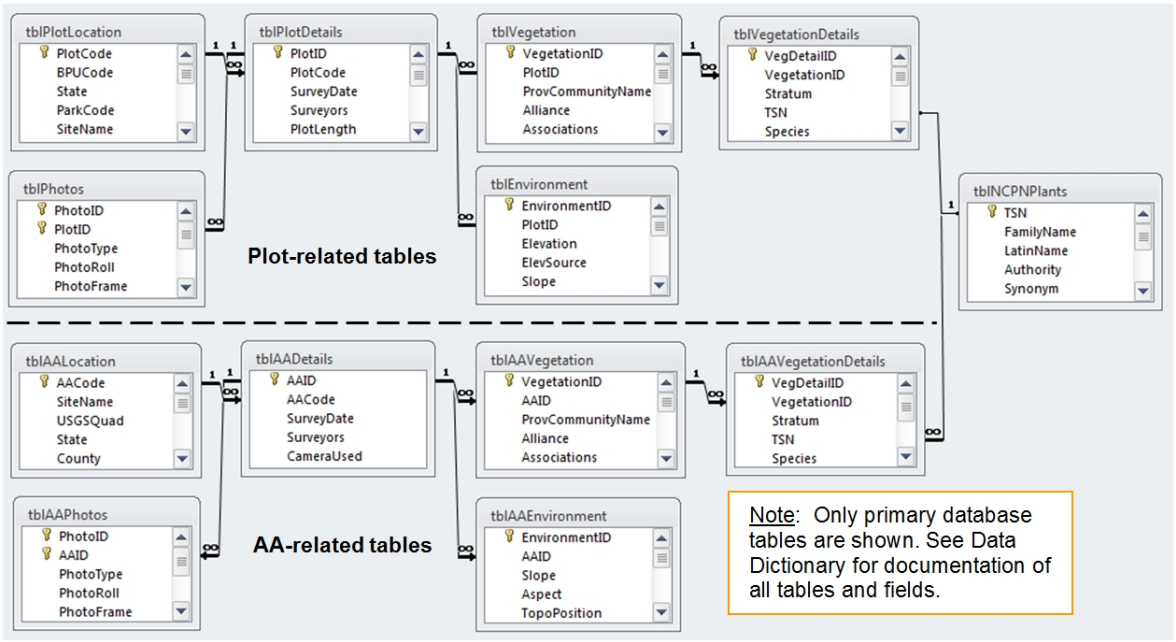


Figure 1. Entity Relationship Diagram for GLCA VegMapDB.

Data Dictionary

The database consists of three types of tables: plot data, accuracy assessment data, and lookup tables that provide a standardized list of values to be used for certain data fields. Tables appear in alphabetical order within each of these three categories.

Plot-related tables

Table Name: tblBPU
Description: Location/UTMs of Biophysical Units visited during sampling effort

Field Name	Field Description	Field Type	Field Width
BPU_record_ID	Unique record ID	dbLong	4
centroid_x	X coordinate of approximate BPU centroid	dbDouble	8
centroid_y	Y coordinate of approximate BPU centroid	dbDouble	8
hectares	Number of hectares of BPU	dbDouble	8
BPU_code	ID Number for BPU	dbText	50
district	District in which BPU occurs	dbText	75
gradsect_year	Year gradsect analysis was performed to derive the BPU	dbLong	4
BPU_comments	Comments on BPU sampling effort	dbText	250

Table Name: tblDataMgmtLog

Description: Table containing a log of data set manipulations or database object alterations

Field Name	Field Description	Field Type	Field Width
ActionDate	The date on which the data set was changed or manipulated.	dbDate	8
ActionMonth	If ActionDate known to month only, use this field and the ActionYear field.	dbText	50
ActionYear	If ActionDate known to year only, use this field.	dbText	50
Action	What was done with the data set. How was it altered, manipulated, etc. Include changes to data and changes to database objects or structures.	dbMemo	0
Who	The name of the person who performed the action with the data set.	dbText	50

Table Name: tblEnvironment

Description: Table containing values on environmental features and conditions of plot or observation point

Field Name	Field Description	Field Type	Field Width
EnvironmentID	Unique record identifier	dbLong	4
PlotID	Foreign key; links record to tblPlotDetails	dbLong	4
Elevation	Elevation of plot in meters as estimated from either map or GPS unit	dbLong	4
ElevSource	How elevation was derived in the field (GPS or Quad Map)	dbText	50
Slope	Slope of plot measured in degrees	dbText	50
Aspect	Aspect of plot	dbText	50
TopoPosition	Topographic position of plot; value selected from tlkpTopography	dbText	50
Landform	Landform on which plot is located, any landform could be entered by crew	dbText	50
Geology	Geologic substrate influencing the plant community; value selected from tlkpGeology	dbText	75
CowardinSystem	If the plot is in a wetland system, select term that best describes its hydrology; value selected from tlkpCowardin	dbText	12
Hydrology	Select value that best describes hydrology of plot from tlkpHydrology	dbText	50
Soil_Moisture	Select value that best describes soil moisture of plot from tlkpSoilMoisture	dbText	50
Surface_Water	Select value that best describes surface water at plot from tlkpSurfaceWater	dbText	50
EnvironmentalComments	Comments on environmental setting and its effect on the vegetation; also comments on any disturbance or reproduction factors	dbMemo	0
BareSoil	Estimate to the nearest percentage of bare soil ground cover	dbText	3
Bedrock	Estimate to the nearest percentage of bedrock ground cover	dbText	3
Sand	Estimate to the nearest percentage of sand (particle size 0.1-2mm) ground cover	dbText	3
Moss	Estimate to the nearest percentage of moss ground cover	dbText	3

Field Name	Field Description	Field Type	Field Width
Other	Estimate to the nearest percentage of other type of ground cover	dbText	3
OtherPctDesc	Text field to describe the other type of ground cover	dbText	255
Litter	Estimate to the nearest percentage of litter ground cover	dbText	3
Rocks	Estimate to the nearest percentage of rocks >10cm wide ground cover	dbText	3
Lichen	Estimate to the nearest percentage of lichen ground cover	dbText	3
Wood	Estimate to the nearest percentage of wood >1cm ground cover	dbText	3
Gravel	Estimate to the nearest percentage of rocks <10cm wide ground cover	dbText	3
Water	Estimate to the nearest percentage of water ground cover	dbText	3
Cryptogam	Estimate to the nearest percentage of cryptogram ground cover	dbText	3
SoilTexture	Assessment of average soil texture from sample taken a few inches below the surface; values selected from tlkpSoilTexture	dbText	50
SoilDrainage	Soil drainage class based on actual moisture content and extent period; values selected from tlkpSoilDrainage	dbText	30
AnimalUseComments	Comments on evidence of use by non-domestic animals in plot area	dbMemo	0
DisturbanceComments	Comments on evidence of natural or anthropogenic disturbance in plot area, severity and effects on vegetation	dbMemo	0
OtherComments	Other general comments	dbMemo	0
LandscapeComments	Description of landscape context of plot, including any important landscape features influencing the community	dbMemo	0
SoilTaxonDesc	Field used for either identifying soils keyed, or to describe if large rocks or outcrops are present on the surface	dbText	255
LiveVegLitter	Estimate to the nearest percentage of live veg litter ground cover	dbText	3
LiveVegWood	Estimate to the nearest percentage of live veg wood ground cover	dbText	3
LichenRocks	Estimate to the nearest percentage of lichen covering rocks	dbText	3
LichenGround	Estimate to the nearest percentage of lichen ground cover (on the soil, associated with cryptogams)	dbText	3
DarkCyanobacteria	Estimate to the nearest percentage of dark cyanobacteria ground cover	dbText	3
TotalPct	Total percentage reported covered - calculated as QC check	dbInteger	2

Table Name: tblEnvironmentDetails

Description: Table containing values on environmental features and conditions of plot or observation point

Field Name	Field Description	Field Type	Field Width
EnvDetailID	Unique record identifier	dbLong	4
EnvironmentID	Foreign key; links to tblEnvironment	dbLong	4
Landform	One or more landform values corresponding to plot location; any value may be entered by crew	dbText	50

Table Name: tblFuels

Description: Table containing details on fuels characteristics of plot

Field Name	Field Description	Field Type	Field Width
FuelsID	Unique record ID	dbLong	4
PlotID	Foreign key; links to tblPlotDetails	dbLong	4
PPDFPhotoGuide	n/a for GLCA plots	dbText	3
PJPhotoGuide	n/a for GLCA plots	dbText	3
SBPhotoGuide	n/a for GLCA plots	dbText	3
PJAgeClass	If plot contains pinyon and/or juniper, enter value that best describes the age class of the stand; values stored in tlkpPJAge	dbText	15
LitterOrigin	n/a for GLCA plots	dbText	3
LitterNorth	n/a for GLCA plots	dbText	3
LitterEast	n/a for GLCA plots	dbText	3
LitterSouth	n/a for GLCA plots	dbText	3
LitterWest	n/a for GLCA plots	dbText	3
DuffOrigin	n/a for GLCA plots	dbText	3
DuffNorth	n/a for GLCA plots	dbText	3
DuffEast	n/a for GLCA plots	dbText	3
DuffSouth	n/a for GLCA plots	dbText	3
DuffWest	n/a for GLCA plots	dbText	3
IsSubplot	Indicate if measurements are for subplot (if plot has >25 trees, one quadrant (subplot) of plot can be measured for fuels	dbBoolean	1

Table Name: tblFuelsDetails

Description: Details on stems, height, crown width, and other attributes of trees within plot

Field Name	Field Description	Field Type	Field Width
FuelsDetailID	Unique identifier for record	dbLong	4
FuelsID	Foreign key, links to tblFuels	dbLong	4
StemCount	Number of stems measured. Value will be 1 if forest species; >=1 if woodland species.	dbInteger	2

Field Name	Field Description	Field Type	Field Width
StemDiameter	Diameter in cm of stem(s). If stem count =1 for a forest species, diameter represents dbh. If stem count is >1 for a woodland species, diameter represents the average diameter of all stems measured at crown base.	dbDouble	8
DBH	Check if diameter is DBH	dbBoolean	1
DRC	Check if diameter is DRC	dbBoolean	1
AVG	Check if diameter is average of multiple stems	dbBoolean	1
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
WoodlandCrownWidth	n/a for GLCA plots	dbDouble	8
WoodlandCrownHeight	n/a for GLCA plots	dbDouble	8
ForestCrownBaseHeight	n/a for GLCA plots	dbDouble	8
ForestCrownHeight	n/a for GLCA plots	dbDouble	8
CrownRatio	n/a for GLCA plots	dbText	12
StructureStage	n/a for GLCA plots	dbText	12
Comments	n/a for GLCA plots	dbText	255

Table Name: tblGeneralPhotos

Description: Information pertaining to photos not associated with plots

Field Name	Field Description	Field Type	Field Width
GenPhotoID	Unique record identifier	dbLong	4
GenPhotoParkCode	Four-letter abbreviation of park where photo was taken (if applicable)	dbText	50
GenPhotoDate	Date photo taken	dbDate	8
GenPhotographer	Name of photographer	dbText	75
GenPhotoDesc	General description of photo contents	dbText	250
GenPhotoUTME	UTME of photo	dbLong	4
GenPhotoUTMN	UTMN of photo	dbLong	4
GenUTMZone	UTMZone of photo UTM coordinates	dbLong	4
GenPhotoRoll10	Roll number of photo	dbText	50
GenPhotoFrame	Frame number of photo	dbText	10
GenPhotoDigFile	Digital file name of photo	dbText	50
GenPhotoComments	General comments	dbText	250

Table Name: tblGeneralSpecimens

Description: Table used to enter data on specimens collected outside of plots or observation points

Field Name	Field Description	Field Type	Field Width
GenSpecimenID	Unique record ID	dbLong	4
GenSpecFamily	Family name of species collected	dbText	50
GenSpecLatinName	Latin name of species collected	dbText	120

Field Name	Field Description	Field Type	Field Width
GenSpecCollector	Name of person collecting specimen	dbText	50
GenSpecCollectNum	Reference of specimen assigned by collector	dbText	50
GenSpecAccNumber	NPS Accession Number of specimen	dbText	15
GenSpecCatNumber	NPS Catalog Number of specimen	dbText	15
GenSpecDate	Date collection made	dbDate	8
GenSpecUTMN	Northing of collection location	dbLong	4
GenSpecUTME	Easting of collection location	dbLong	4
GenSpecCounty	County of collection location	dbText	50
GenSpecElev	Elevation (ft) of collection location	dbLong	4
GenSpecLocality	Description of locality where specimen was collected	dbText	250
GenSpecHabitat	Description of habitat where specimen was collected	dbText	250
GenSpecAssocSpec	Associated species where specimen was collected	dbText	250
GenSpecComments	Comments associated with specimen	dbText	250

Table Name: tblPhotos

Description: Details on individual photos taken of plot or observation point

Field Name	Field Description	Field Type	Field Width
PhotoID	Unique record identifer	dbLong	4
PlotID	Foreign key, links to tblPlotDetails	dbLong	4
PhotoType	Type of photo being referenced (tlkpPhotoTypes)	dbText	16
PhotoRoll	Reference number for film roll of photo	dbText	12
PhotoFrame	Frame number of photo within roll	dbLong	4
PhotoOther	Other unique identifier or reference number for digital photo or name of movie file	dbText	30
Photographer	Name of photographer	dbText	50
Direction	Direction photograph was taken	dbText	12
PhotoComments	Brief description of photo	dbText	255
NCPNImageFileID	NCPN Photo database image file ID	dbText	50

Table Name: tblPlotDetails

Description: Information on a plot that is specific to a visit

Field Name	Field Description	Field Type	Field Width
PlotID	Unique identifier for record	dbLong	4
PlotCode	Foreign key, links to tblPlotLocation	dbText	10
SurveyDate	Date plot was visited and data collected	dbDate	8
Surveyors	Names of persons collecting data at plot (last names)	dbText	75
PlotLength	Length of plot, in meters	dbText	5
PlotAzimuth	Azimuth of plot; synonymous with aspect. One or the other, or both, can be used	dbText	5

Field Name	Field Description	Field Type	Field Width
PlotWidth	Width of plot, in meters	dbText	5
PlotDiam	Diameter of plot, in meters, if plot is circular	dbText	5
PlotHasPhotos	Yes if photos are taken of plot	dbBoolean	1
PlotRepresentation	Description or discussion of representativeness of plot in stand, and in comparison to associations outside the park (if known)	dbMemo	0
PlotShape	Shape of plot	dbText	15
CameraUsed	Make and model of camera used to photograph plot	dbText	50
ObsPointArea	Estimated size of observation point	dbText	50

Table Name: tblPlotLocation

Description: Basic and unchanging information on plot or observation point location

Field Name	Field Description	Field Type	Field Width
PlotCode	Identifier assigned to plot by survey crew	dbText	10
BPUCode	Biophysical unit code where plot is located	dbText	25
State	State where plot is located	dbText	2
ParkCode	Park unit where plot is located	dbText	4
SiteName	Short, descriptive name of site where plot is located	dbText	100
USGSQuad	USGS quadrangle (1:24K) where plot is located	dbText	50
AerialPhotoNo	Aerial photo number corresponding to plot location	dbText	10
Waypoint	Garmin plot code	dbText	7
UTMEasting	UTM easting of plot	dbLong	4
UTMNorthing	UTM northing of plot	dbLong	4
Datum	Datum of UTM coordinates	dbText	10
UTMZone	UTM zone of coordinates	dbText	4
UTM Error	Error, in meters, of location data (based on reading from Garmin GPS unit)	dbText	5
PDOP	Satellite Precision Dilution of Position (based on reading from Trimble GPS unit)	dbText	50
DiffCorrected	Indicate if coordinates have been differentially corrected	dbText	3
DirectionsToPlot	Precise directions to plot	dbMemo	0
County	County where plot is located	dbText	50
GPSUnit	Manufacturer and model of GPS unit (e.g., Trimble GeoExplorer 3)	dbText	25
GPSComments	Any brief comments on GPS data collection at plot	dbText	255
InPark	Select Yes if plot is within park boundaries	dbBoolean	1
IsObservationPt	Yes if observation point	dbBoolean	1

Table Name: tblVegetation

Description: Overall vegetation characteristics of a plot or observation point

Field Name	Field Description	Field Type	Field Width
VegetationID	Unique record ID	dbLong	4
PlotID	Foreign key, links to tblPlotDetails	dbLong	4
ProvCommunityName	Community name (provisional) assigned by field crews by following naming protocols as described in field manual and training 04/04	dbText	120
Alliance	Alliance corresponding to provisional community name	dbText	100
Associations	Association corresponding to provisional community name	dbText	250
CEGLCode	CEGL (association) code	dbText	50
Phenology	Leaf phenology of the dominant stratum. Field is blank for non-vascular plots	dbText	35
LeafType	Leaf form of the dominant stratum	dbText	35
LeafTypeComments	If Leaf Type is "mixed," this field describes the multiple leaf types found in the dominant stratum	dbText	255
Physiognom	Physiognomic class of plot (from tlkpPhysiogClass)	dbText	20
EmergHt	Height class of emergent stratum (classes are in tlkpHeightClass)	dbText	2
EmergCovTot	Cover class of emergent stratum (classes are in tlkpCover)	dbText	15
EmergCovPercent	[not used]	dbText	50
CanHt	Height class of canopy stratum	dbText	2
CanCovTot	Cover class of canopy stratum	dbText	15
CanCovPercent	[not used]	dbText	50
SubHt	Height class of sub-canopy stratum	dbText	2
SubCovTot	Cover class of sub-canopy stratum	dbText	15
SubCovPercent	[not used]	dbText	50
TallShHt	Height class of tall shrub stratum	dbText	2
TallShCovTot	Cover class of tall shrub stratum	dbText	15
TallShCovPercent	[not used]	dbText	50
ShrubHt	Height class of short shrub stratum	dbText	2
ShrubCovTot	Cover class of short shrub stratum	dbText	15
ShrubCovPercent	[not used]	dbText	50
DwarfHt	Height class of dwarf shrub stratum	dbText	2
DwarfCovTot	Cover class of dwarf shrub stratum	dbText	15
SwarfCovPercent	[not used]	dbText	50
HerbHt	Height class of herbaceous stratum (all H layers)	dbText	2
HerbCovTot	Cover class of herbaceous stratum (all H layers)	dbText	15
HerbCovPercent	[not used]	dbText	50
GramHt	Height class of graminoid stratum	dbText	2
GramCovTot	Cover class of graminoid stratum	dbText	15
GramCovPercent	[not used]	dbText	50

Field Name	Field Description	Field Type	Field Width
ForbHt	Height class of forb stratum	dbText	2
ForbCovTot	Cover class of forb stratum	dbText	15
ForbCovPercent	[not used]	dbText	50
FernHt	Height class of fern and fern ally stratum	dbText	2
FernCovTot	Cover class of fern and fern ally stratum	dbText	15
FernCovPercent	[not used]	dbText	50
SeedlHt	Height class of seedling stratum	dbText	2
SeedlCovTot	Cover class of seedling stratum	dbText	15
SeedCovPercent	[not used]	dbText	50
NonvasHt	Height class of nonvascular stratum	dbText	2
NonvasCovTot	Cover class of nonvascular stratum	dbText	15
NonvasCovPercent	[not used]	dbText	50
VineHt	Height class of vine stratum	dbText	2
VineTotCov	Cover class of vine stratum	dbText	15
VineTotPercent	[not used]	dbText	50
EpiHt	Height class of epiphyte stratum	dbText	2
EpiTotCov	Cover class of epiphyte stratum	dbText	15
EpiTotPercent	[not used]	dbText	50
OutsidePlotHt	Height class of species occurring outside plot	dbText	50
OutsidePlotTotCov	Cover class of species occurring outside plot	dbText	50
OutsidePlotTotPercent	[not used]	dbText	50
PlantSpeciesComments	Comments on plant species list, particularly for species whose ID is not 100% sure	dbMemo	0

Table Name: tblVegetationDetails

Description: Species and strata-specific data related to a plot or observation point

Field Name	Field Description	Field Type	Field Width
VegDetailID	Unique record ID	dbLong	4
VegetationID	Foreign key, links to tblVegetation	dbLong	4
Stratum	Strata class from tlkpStrata	dbText	2
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
Species	Latin names of species, from tblNCPNPlants	dbText	100
CoverClass	Cover class to describe species and strata (from tlkpCover)	dbText	5
ObsPointCoverClass	Cover class for observation points (different scale than cover classes for plots: 01=0-10%, 02=10-25%, 03=25-60%, 04=60-100%)	dbText	50
PercentCover	Percent (0-100) cover of each species	dbText	5
IsDead	Check yes if the species being documented was dead	dbBoolean	1

Field Name	Field Description	Field Type	Field Width
Diagnostic	Check yes if the species is known to be diagnostic of the vegetation type	dbBoolean	1
SpecimenCollected	Check yes if a specimen of the species was collected	dbBoolean	1
CollectedBy	Name of person collecting specimen	dbText	120
NPSAccessionNumber	Accession number corresponding to all collections made under research permit assigned by park curator	dbText	50
NPSCatalogNumber	Unique reference number for individual specimen assigned by park curator	dbText	50
SpecimenNumber	Enter the collector's reference number for the specimen collected	dbText	20
SpecimenLocality	Brief description of collection location, suitable for specimen label	dbText	240
SpecimenHabitat	Brief description of collection habitat, suitable for specimen label	dbText	240
SpecimenAssocSpecies	Brief description of associated species in collection area, suitable for specimen label	dbText	240

Accuracy assessment-related tables

Table Name: tblAADetails
Description: Information on an AA point that is specific to a visit

Field Name	Field Description	Field Type	Field Width
AAID	Unique identifier for record	dbLong	4
AACode	Identifier of AA record; assigned by field crew	dbText	13
SurveyDate	Date AA point was visited and data was collected	dbDate	8
Surveyors	Name(s) of persons who collected data at an AA point (last name and first initial)	dbText	75
CameraUsed	Make and model of camera used to photograph plot	dbText	50

Table Name: tblAAEnvironment
Description: Table containing values on environmental features and conditions of an AA point

Field Name	Field Description	Field Type	Field Width
EnvironmentID	Unique record identifier	dbLong	4
AAID	Foreign key; links to tblAADetails	dbLong	4
Slope	Slope of AA point measured in degrees	dbText	50
Aspect	Aspect of AA point	dbText	50
TopoPosition	Topographic position of AA point; value selected from tlkpTopography	dbText	50
Elevation	Elevation of AA point in meters as estimated from either map or GPS unit	dbLong	4
ElevSource	How elevation was derived in the field (GPS or Quad Map)	dbText	50

Field Name	Field Description	Field Type	Field Width
EnvironmentalComments	Comments on environmental setting and its effect on the vegetation; also comments on any disturbance or reproduction factors	dbMemo	0
Geology	Geologic substrate influencing the plant community; value selected from tlkpGeology	dbText	75
BareSoil	Estimate to the nearest percentage of bare soil ground cover	dbText	3
Bedrock	Estimate to the nearest percentage of bedrock ground cover	dbText	3
Sand	Estimate to the nearest percentage of sand (particle size 0.1-2mm) ground cover	dbText	3
Moss	[not used]	dbText	3
Other	Estimate to the nearest percentage of other type of ground cover	dbText	3
OtherPctDesc	Description of other type of ground cover if "Other" percentage field contains a value	dbText	255
Litter	Estimate to the nearest percentage of litter ground cover	dbText	3
Rocks	Estimate to the nearest percentage of rocks >10cm wide ground cover	dbText	3
Lichen	[not used]	dbText	3
Gravel	Estimate to the nearest percentage of gravel <10cm wide ground cover	dbText	3
LiveVegLitter	[not used]	dbText	3
LiveVegWood	[not used]	dbText	3
Wood	Estimate to the nearest percentage of wood >1cm ground cover	dbText	3
LichenRocks	[not used]	dbText	3
LichenGround	[not used]	dbText	3
DarkCyanobacteria	[not used]	dbText	3
Water	[not used]	dbText	3

Table Name: tblAAEnvironmentDetails

Description: Table containing values on environmental features and conditions of an AA point

Field Name	Field Description	Field Type	Field Width
EnvDetailID	Unique record identifier	dbLong	4
EnvironmentID	Foreign key; provides link to tblAAEnvironment	dbLong	4
Landform	One or more landform values corresponding to AA point location; any value may be entered by crew	dbText	50

Table Name: tblAALocation

Description: Basic and unchanging information on AA point location

Field Name	Field Description	Field Type	Field Width
AACode	Identifier assigned to AA point by survey crew	dbText	13
SiteName	Short, descriptive name of site where point is located	dbText	100
USGSQuad	USGS quadrangle (1:24K) where point is located	dbText	50
State	State where point is located	dbText	2
County	County where plot is located	dbText	50
ParkCode	Park unit where point is located	dbText	4
GPSFileName	Name of corresponding GPS file	dbText	50
GPSUnit	Manufacturer and model of GPS unit (e.g., Trimble GeoExplorer 3)	dbText	25
UTMEasting	UTM easting of point	dbLong	4
UTMNorthing	UTM northing of point	dbLong	4
UTMZone	UTM zone of coordinates	dbText	4
DiffCorrected	Indicate if coordinates have been differentially corrected	dbText	3
Datum	Datum of UTM coordinates	dbText	10
PDOP	Satellite Precision Dilution of Position (based on reading from Trimble GPS unit)	dbText	50
UTM Error	Error, in meters, of location data (based on reading from Garmin GPS unit)	dbText	5
InPark	Select Yes if plot is within park boundaries	dbBoolean	1
GPSComments	Any brief comments on GPS data collection	dbText	255
RepresentPWP	Representativeness of point within polygon: Good, Fair, or Poor (on association page)	dbText	7
RepresentATD	Representativeness of association to ***description:*** Good, Fair, or Poor (on association page)	dbText	4
ClassificationComments	Classification comments (on association page)	dbMemo	0
PlotShape	Plot shape: Circular, Other	dbText	10
PMU	Primary Map Unit	dbText	5
SMU	Secondary Map Unit	dbText	5
TMU	Tertiary Map Unit	dbText	5

Table Name: tblAAPhotos

Description: Details on individual photos taken of an AA point

Field Name	Field Description	Field Type	Field Width
PhotoID	Unique record identifier	dbLong	4
AAID	Foreign key; provides link to tblAADetails	dbLong	4
PhotoType	Type of photo being referenced (tlkpPhotoTypes)	dbText	16
PhotoRoll	Reference number for film roll of photo	dbText	12
PhotoFrame	Frame number of photo within roll	dbText	50
PhotoOther	Other unique identifier or reference number for digital photo or name of movie file	dbText	50
Photographer	Name of photographer	dbText	50
PhotoComments	Brief description of photo	dbText	255
NCPNImageFileID	NCPN Photo Database Image File ID	dbText	50

Table Name: tblAAVegAssociation

Description: Vegetation association at AA location

Field Name	Field Description	Field Type	Field Width
VegAssocID	Unique record identifier	dbLong	4
AAID	Foreign key; provides link to tblAADetails	dbLong	4
VegAssocCode	Identification code of vegetation association; provided by NatureServe	dbText	25
VegAssocRank	Rank of vegetation association (primary, secondary, tertiary)	dbText	15
FieldKey	Was name obtained from field key?	dbBoolean	1
NewName	Is it a new classification name?	dbBoolean	1
Post_Field_Name	Post-field name?	dbBoolean	1
OtherAssocCode	Other associations within 50 meters	dbText	255

Table Name: tblAAVegetation

Description: Overall vegetation characteristics of an AA point

Field Name	Field Description	Field Type	Field Width
VegetationID	Unique record identifier	dbLong	4
AAID	Foreign key; provides link to tblAADetails	dbLong	4
ProvCommunityName	Community name (provisional) assigned by field crews by following naming protocols as described in field manual and training 04/04	dbText	120
Alliance	Alliance corresponding to provisional community name	dbText	100
Associations	Association corresponding to provisional community name	dbText	100
Phenology	Leaf phenology of the dominant stratum	dbText	35
LeafType	Leaf form of the dominant stratum	dbText	35

Field Name	Field Description	Field Type	Field Width
LeafTypeComments	If Leaf Type is "mixed," this field describes the multiple leaf types found in the dominant stratum	dbText	255
Physiognom	Physiognomic class of plot (from tlkpPhysiogClass)	dbText	20
EmergHt	Height class of emergent stratum (from tlkpHeightClass)	dbText	2
EmergCovTot	Cover class of emergent stratum (from tlkpCoverAA)	dbText	15
EmergCovPercent	[not used]	dbText	50
CanHt	Height class of canopy stratum	dbText	2
CanCovTot	Cover class of canopy stratum	dbText	15
CanCovPercent	[not used]	dbText	50
SubHt	Height class of subcanopy stratum	dbText	2
SubCovTot	Cover class of subcanopy stratum	dbText	15
SubCovPercent	[not used]	dbText	50
TallShHt	Height class of tall shrub stratum	dbText	2
TallShCovTot	Cover class of tall shrub stratum	dbText	15
TallShCovPercent	[not used]	dbText	50
ShrubHt	Height class of shrub stratum	dbText	2
ShrubCovTot	Cover class of shrub stratum	dbText	15
ShrubCovPercent	[not used]	dbText	50
DwarfHt	Height class of dwarf shrub stratum	dbText	2
DwarfCovTot	Cover class of dwarf shrub stratum	dbText	15
DwarfCovPercent	[not used]	dbText	50
HTotalHt	Height class of total herbaceous stratum	dbText	2
HTotalCover	Cover class of total herbaceous stratum	dbText	15
HTotalCoverPercent	[not used]	dbText	50
H4Ht	Height class of tree seedling stratum	dbText	2
H4Cover	Cover class of tree seedling stratum	dbText	15
H4CoverPercent	[not used]	dbText	50
NonvasHt	Height class of nonvascular stratum	dbText	2
NonvasCovTot	Cover class of nonvascular stratum	dbText	15
NonvasCovPercent	[not used]	dbText	50
VineHt	Height class of vine stratum	dbText	2
VineTotCov	Cover class of vine stratum	dbText	15
VineTotPercent	[not used]	dbText	50
EpiHt	Height class of epiphyte stratum	dbText	2
EpiTotCov	Cover class of epiphyte stratum	dbText	15
EpiTotPercent	[not used]	dbText	50
PlantSpeciesComments	Comments on plant species list	dbMemo	0
MultipleAssoc	Does list represent more than one association?	dbBoolean	1

Table Name: tblAAVegetationDetails
Description: Species and strata-specific data related to an AA point

Field Name	Field Description	Field Type	Field Width
VegDetailID	Unique record ID	dbLong	4
VegetationID	Foreign key; links to tblAAVegetation	dbLong	4
Stratum	Strata class from tlkpStrata	dbText	2
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
Species	Latin names of species, from tblNCPNPlants	dbText	100
CoverClass	[not used]	dbText	5
CoverPct	Percent (0-100) cover to describe species and strata	dbText	5
Diagnostic	Check if species is known to be diagnostic of the vegetation type	dbBoolean	1
Dead	Check if the species is dead	dbBoolean	1

Lookup tables

Table Name: tblNCPNPlants
Description: Master lookup table for plant species names and taxonomic information. Derived from ITIS (Integrated Taxonomic Information System)

Field Name	Field Description	Field Type	Field Width
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
FamilyName	Family name of taxon	dbText	255
LatinName	Latin name of taxon	dbText	255
Authority	Authority of Latin name	dbText	255
Synonym	Accepted synonyms of taxon	dbText	255
CommonName	Locally accepted common name for taxon	dbText	255
Exotic	Check yes if species is exotic	dbBoolean	1
Sensitive	Check yes if species is threatened, endangered, or sensitive	dbBoolean	1
GrowthHabit	Select GrowthHabit for species -- habit can vary based on region; edit as needed to reflect habit in park	dbText	255
PLANTSCode	Code for taxonomic unit assigned by USDA PLANTS	dbText	255
FullName	Temporary field; concatenation of Latin name and authority	dbText	255

Table Name: tlkpAAVegAssociation
Description: Lookup of vegetation association codes (CEGL codes from NatureServe) and vegetation association name

Field Name	Field Description	Field Type	Field Width
VegAssocCode	Vegetation association code (CEGL code); assigned by NatureServe	dbText	255
VegAssocName	Final vegetation association name; assigned by NatureServe	dbText	255

Table Name: tlkpAAVegAssocRanks
Description: Lookup of rank of vegetation association (primary, secondary, tertiary)

Field Name	Field Description	Field Type	Field Width
VegAssocRank	Indicates whether the vegetation association represents a primary, secondary, or tertiary collection by field crews	dbText	255

Table Name: tlkpAlliances
Description: Lookup of provisional community names

Field Name	Field Description	Field Type	Field Width
Alliance	Alliance name from NatureServe classification	dbText	100

Table Name: tlkpAssociations
Description: Lookup of association names

Field Name	Field Description	Field Type	Field Width
Associations	Association names from NatureServe classification	dbText	100

Table Name: tlkpCamera
Description: Lookup of camera make/models used for plot photos

Field Name	Field Description	Field Type	Field Width
CameraType	Model and make of camera used for photographs of plot	dbText	50
CameraComments	Additional comments on camera, including default focal length	dbText	50

Table Name: tlkpCover
Description: Lookup of cover classes assigned to species and strata in tblVegetationDetails

Field Name	Field Description	Field Type	Field Width
CoverClass	Code for cover class	dbText	50
CoverClassPercent	Percent value of each class: x=0.1, T=0.5, P=1-5, 1a=6-10, 1b=11-15, 2=16-25, 3=26-35, 4=36-45, 5a=46-50, 5b=51-55, 6=56-65, 7=66-75, 8=76-85, 9=86-95, 10=96-100	dbText	50

Table Name: tlkpCoverAA
Description: Lookup of cover classes assigned to strata in tblAAVegetation

Field Name	Field Description	Field Type	Field Width
CoverClass	T<1%, P=1-5%, 1a=6-10%, 1b=11-15%, 2=16-25%, 3=26-35%, 4=36-45%, 5=46-55%, 6=56-65%, 7=66-75%, 8=76-85%, 9=86-95%, 10>95%	dbText	50

Table Name: tlkpCowardin
Description: Lookup of Cowardin system categories for environment descriptions

Field Name	Field Description	Field Type	Field Width
CowardinSystem	Cowardin system descriptors for environmental description of plot	dbText	50

Table Name: tlkpElevSource
Description: Lookup of options for source of elevation data

Field Name	Field Description	Field Type	Field Width
ElevSource	Source of elevation data entered on field forms	dbText	50

Table Name: tlkpGeology
Description: Lookup of geology types to describe substrate of plot

Field Name	Field Description	Field Type	Field Width
Geology	Geology types used to describe substrate of plot or observation point	dbText	75

Table Name: tlkpHeightClass
Description: Lookup of height classes assigned to strata in tblVegetation and tblAAVegetation

Field Name	Field Description	Field Type	Field Width
HeightClass	Height class code: 01, 02, 03, 04, 05, 06, 07, 08, 09, 10	dbText	2
HeightClassRange	Range of each height class: 01<.5m 02=.5-1m 03=1-2m 04=2-5m 05=5-10m 06=10-15m 07=15-20m 08=20-35m 09=35-50m 10=>50m	dbText	20

Table Name: tlkpHydrology
Description: Lookup of hydrology types from Cowardin et al. 1979

Field Name	Field Description	Field Type	Field Width
Hydrology	Hydrology descriptors for plots that are in a wetland or upland with intermittent flooding (dry wash).	dbText	50

Table Name: tlkpLandForm
Description: Lookup of landforms in Veg Mapping Manual (from http://soils.usda.gov/technical/handbook/contents/part629glossary1.html)

Field Name	Field Description	Field Type	Field Width
Field1	Landforms from appendix 1 of field manual	dbText	255

Table Name: tlkpLeafPhen
Description: Lookup of phenology types to describe dominant stratum (from VegMapping Manual 04/04.)

Field Name	Field Description	Field Type	Field Width
Phenology	Leaf phenology descriptors to describe dominant stratum	dbText	40

Table Name: tlkpLeafType
Description: Lookup of leaf form of dominant stratum (from VegMapping Manual 04/04)

Field Name	Field Description	Field Type	Field Width
LeafType	Leaf form description of the dominant stratum	dbText	35

Table Name: tlkpParks
Description: Lookup of parks surveyed

Field Name	Field Description	Field Type	Field Width
ParkCode	Four-letter abbreviation for park code	dbText	4
ParkName	Full name of park where data were collected	dbText	50

Table Name: tlkpPhotoComments
Description: Lookup table of photo comments

Field Name	Field Description	Field Type	Field Width
PhotoComments	Photograph comments	dbText	50

Table Name: tlkpPhotographer
Description: Lookup table of photographer names

Field Name	Field Description	Field Type	Field Width
Photographer	Photographer name	dbText	50

Table Name: tlkpPhotoTypes
Description: Lookup of types of photos taken during data collection

Field Name	Field Description	Field Type	Field Width
PhotoType	Type of photo taken, associated with plot	dbText	50

Table Name: tlkpPhysiogClass
Description: Lookup of physiognomic types to describe each plot or observation point

Field Name	Field Description	Field Type	Field Width
Physiognom	Physiognomic class used to describe plot	dbText	50

Table Name: tlkpPJAge
Description: Lookup of Pinyon-Juniper age classes

Field Name	Field Description	Field Type	Field Width
PJAgeClass	Pinyon- Juniper age class, if plot contains either of these two species	dbText	15

Table Name: tlkpPlotDiameter
Description: Lookup of diameters used for circular plots

Field Name	Field Description	Field Type	Field Width
PlotDiameter	Diameter, in meters, of circular plot	dbText	50

Table Name: tlkpPlotShapes
Description: Lookup of shapes of plots

Field Name	Field Description	Field Type	Field Width
PlotShape	Shapes of plots	dbText	15

Table Name: tlkpProvisionalCommunities
Description: Lookup of provisional names assigned by crews to each plot or observation point during data collection

Field Name	Field Description	Field Type	Field Width
ID	Unique record ID	dbLong	4
NVC Elcode	Unique identifier for association name, assigned by NatureServe	dbText	255
NVC Association Name	Names assigned through NatureServe preliminary classification, and communities named by crews (following naming protocol in field manual)	dbText	255
CARE plots	Totals for each community type at Capitol Reef NP	dbDouble	8
COLM plots	Totals for each community type at Colorado National Monument	dbDouble	8
NABR plots	Totals for each community type at Natural Bridges NM	dbDouble	8
HOVE plots	Totals for each community type at Hovenweep NM	dbDouble	8
ARCH plots	Totals for each community type at Arches NP	dbDouble	8

Table Name: tlkpSoilDrainage
Description: Lookup of soil drainage classes to describe plot or observation point

Field Name	Field Description	Field Type	Field Width
SoilDrainage	Soil drainage classes used to describe soil where plot is located	dbText	30

Table Name: tlkpSoilMoisture
Description: Lookup of soil moisture descriptors

Field Name	Field Description	Field Type	Field Width
SoilMoisture	Soil moisture descriptor	dbText	50

Table Name: tlkpSoilTexture
Description: Lookup of soil textures based on Bowker 2003 field key for CANY, ARCH, and NABR

Field Name	Field Description	Field Type	Field Width
SoilTexture	Soil texture based on Bowker 2003 field key for CANY, ARCH, and NABR.	dbText	15

Table Name: tlkpStates
Description: Lookup of all states in the USA

Field Name	Field Description	Field Type	Field Width
StateCode	Two-letter abbreviation for each state	dbText	2
StateName	Full name of each state in the USA	dbText	50

Table Name: tlkpStrata
Description: Lookup of strata classes in tblVegetationDetails and tblAAVegetationDetails (from VegMapping Manual 04/04)

Field Name	Field Description	Field Type	Field Width
Stratum	Stratum class code	dbText	3
StratumDefinition	Stratum class definition	dbText	20

Table Name: tlkpStructureStages
Description: Lookup of vegetation structure stages

Field Name	Field Description	Field Type	Field Width
StructureStage	Standard fuel model classes for forest and woodland trees indicating their position in the canopy	dbText	12

Table Name: tlkpSurfaceWater
Description: Lookup of surface water descriptors

Field Name	Field Description	Field Type	Field Width
SurfaceWater	Surface water type if within 25 meters of plot.	dbText	50

Table Name: tlkpSurveyors
Description: Lookup of data collection teams

Field Name	Field Description	Field Type	Field Width
SurveyorName	Last names of crew members on each data collection team.	dbText	75

Table Name: tlkpTopography
Description: Lookup of topographic positions to describe where plot or observation point is located on its related landform

Field Name	Field Description	Field Type	Field Width
TopoPosition	Topographic positions used to describe where plot or observation point is located on its related landform.	dbText	50

Table Name: tlkpUSGS_Quad
Description: Lookup of all 7.5 minute USGS quads for CANY and GLCA Orange Cliffs district

Field Name	Field Description	Field Type	Field Width
USGSQuad	Names of all 7.5 minute USGS quads for CANY and GLCA Orange Cliffs district.	dbText	50
USGSQuadCode	n/a for CANY and GLCA plots	dbText	7

Table Name: tlkpUTMZone
Description: Lookup for UTM zone of CANY and GLCA

Field Name	Field Description	Field Type	Field Width
UTMZone	UTM zone where all CANY and GLCA plots were collected	dbText	5

Table Name: tlu_MU_Codes
Description: Lookup table for map unit codes

Field Name	Field Description	Field Type	Field Width
MU_CODE	Map unit code	dbText	5
MU_NAME	Map unit name	dbText	255

Table Name: tlu_Photo_Direction
Description: Lookup of photo direction values

Field Name	Field Description	Field Type	Field Width
Direction	Direction photo was taken	dbText	12

Geodatabase Documentation

Background

The geodatabase was designed to consolidate all spatial and non-spatial (i.e., tabular) data from the GLCA vegetation mapping project. In the geodatabase, feature classes were created for the spatial datasets, including plots, observation points, AA points, and polygons. These feature classes were then linked to the tables in the Plots database via relationship classes.

Entity Relationship Diagram

The primary tables and relationships for the geodatabase are illustrated below.

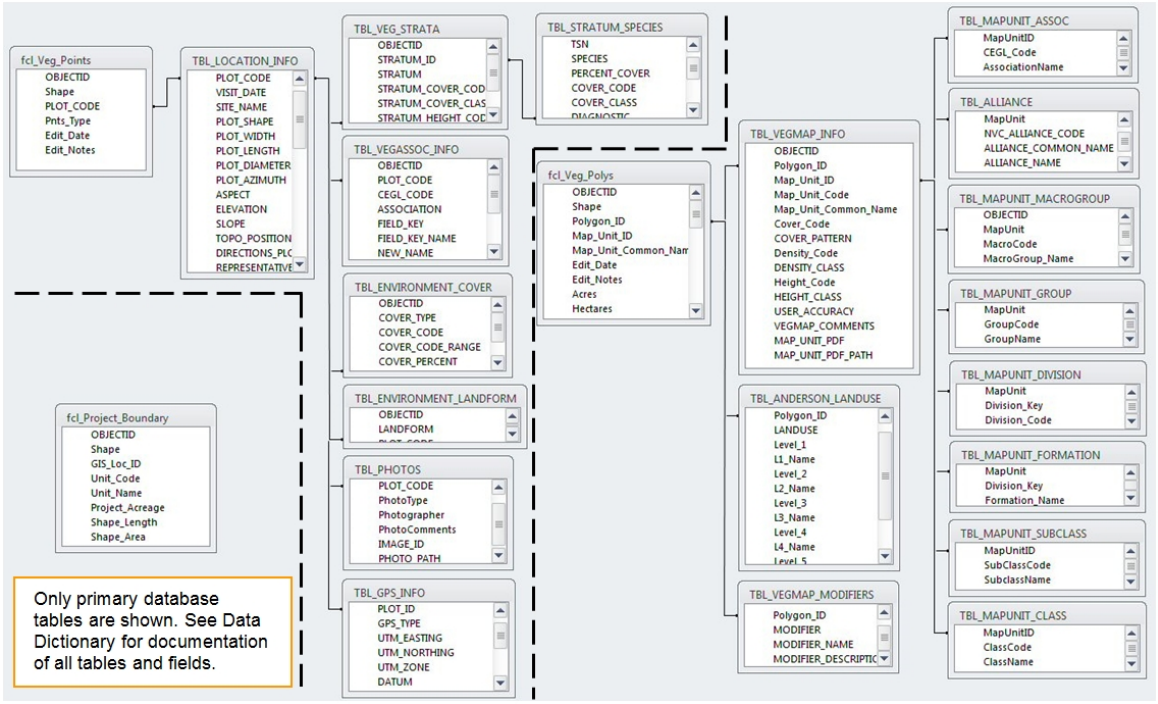


Figure 2. Entity Relationship Diagram for GLCA Geodatabase

Data Dictionary

The geodatabase consists of two types of tables: spatial (i.e., feature classes), and non-spatial tables. Tables appear in alphabetical order within these two categories.

Spatial tables

Table Name: fcl_Project_Boundary

Description: The feature class of the boundary of the vegetation mapping project area

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
SHAPE	ESRI generated	dbLongBinary	0
GIS_Loc_ID	Unique ID	dbText	128
Unit_Code	Four-letter park code (GLCA)	dbText	10
Unit_Name	Full name of national park (Glen Canyon National Recreation Area)	dbText	255
Project_Acreage	Acreage of project area	dbLong	4
SHAPE_Length	ESRI generated	dbDouble	8
SHAPE_Area	ESRI generated	dbDouble	8

Table Name: fcl_Veg_Points

Description: The feature class containing all point data associated with the vegetation project (Plots, Observations, Fuels, AA)

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
SHAPE	ESRI generated	dbLongBinary	0
PLOT_CODE	Unique Plot code, used for relating tables and feature class (TBL_LOCATION_INFO)	dbText	20
Pnts_Type	Type of point (fuels, plot, observation, aa, misc)	dbLong	4
Edit_Date	Date of any edits to the point or data	dbText	10
Edit_Notes	Notes regarding any edits	dbText	255

Table Name: fcl_Veg_Polys

Description: The feature class displaying the vegetation mapping units for the park

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
SHAPE	ESRI generated	dbLongBinary	0
Polygon_ID	Unique polygon code, used for relating tables (TBL_VEGMAP_INFO)	dbText	128
Map_Unit_ID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10
Map_Unit_Common_Name	The name of the map unit (or map class)	dbText	250
Edit_Date	Date of any edits to the polygon or its attributes	dbDate	8

Field Name	Field Description	Field Type	Field Width
Edit_Notes	Notes regarding any edits to the polygon or its attributes	dbText	250
Acres	Acres per polygon, generated using ArcMap	dbDouble	8
Hectares	Hectares per polygon, generated using ArcMap	dbDouble	8
SHAPE_Length	ESRI generated	dbDouble	8
SHAPE_Area	ESRI generated	dbDouble	8

Non-spatial tables

Table Name: TBL_ALLIANCE

Description: Contains the alliances for the vegetation polygons by map unit ID

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MapUnit	The map unit identifier, used by the mappers (aka: grid_code or map class code, usually a number)	dbText	12
NVC_ALLIANCE_CODE	The NVC alliance code	dbText	20
ALLIANCE_COMMON_NAME	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition. NVC alliance common name	dbText	250
ALLIANCE_NAME	NVC alliance Latin name	dbText	250

Table Name: TBL_ANDERSON_LANDUSE

Description: Contains the Anderson Landuse classes for the vegetation polygons

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
Polygon_ID	Unique polygon code, used for relating tables (TBL_VEGMAP_INFO)	dbText	20
LANDUSE	The Anderson landuse classes of the polygon (version 1.5, January 2002)	dbDouble	8
Level_1	Anderson landuse code for level one	dbText	255
L1_Name	Anderson landuse name for level one	dbText	255
Level_2	Anderson landuse code for level two	dbText	50
L2_Name	Anderson landuse name for level two	dbText	255
Level_3	Anderson landuse code for level three	dbText	255
L3_Name	Anderson landuse name for level three	dbText	255
Level_4	Anderson landuse code for level four	dbText	255
L4_Name	Anderson landuse name for level four	dbText	255
Level_5	Anderson landuse code for level five	dbText	255
L5_Name	Anderson landuse name for level five	dbText	255
Level_6	Anderson landuse code for level six	dbText	255
L6_Name	Anderson landuse name for level six	dbText	255

Table Name: TBL_ENVIRONMENT_COVER

Description: Contains ground cover data for the veg points feature class

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
COVER_TYPE	Ground cover type	dbText	30
COVER_CODE	Cover code from field sheet - AA only	dbText	5
COVER_PERCENT	Field estimate to the nearest percentage of ground cover type (plots only).	dbDouble	8
COVER_CODE_RANGE	Cover code range - for plots with non-integer percentages.	dbText	50
COVER_PERCENT_DESC	Description of cover, if "other"	dbText	255
PLOT_CODE	Unique Plot code, used for relating tables	dbText	20

Table Name: TBL_ENVIRONMENT_LANDFORM

Description: Contains landform data for the veg points feature class

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
LANDFORM	Landform on which plot is located, any landform could be entered by crew.	dbText	100
PLOT_CODE	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	20

Table Name: TBL_GPS_INFO

Description: Contains information about the GPS unit and accuracies of data collected for the veg points feature class

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
PLOT_ID	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	20
GPS_TYPE	Manufacturer / model of GPS unit (e.g., Garmin Etrex or Trimble XM)	dbText	30
UTM_EASTING	UTM easting of plot	dbDouble	8
UTM_NORTHING	UTM northing of plot	dbDouble	8
UTM_ZONE	UTM zone of coordinates	dbText	3
DATUM	Datum of UTM coordinates (NAD83)	dbText	10
GPS_ERROR	Error, in meters, of location data (based on reading from Garmin GPS unit)	dbText	5
DIFF_CORRECTED	Indicates if coordinates have been differentially corrected (from Garmin screen)	dbText	3
GPS_COMMENTS	Any brief comments on GPS data collection at plot	dbText	255
GPS_QUALITY	Indicates the quality of the GPS unit used (recreational, mapping grade)	dbText	35
PDOP	Positional Dilution Of Precision reading (from Garmin screen)	dbText	30

Field Name	Field Description	Field Type	Field Width
ERROR_RANGE	General error range, in meters, of the type of GPS unit used.	dbText	20

Table Name: TBL_LOCATION_INFO

Description: Contains data about the location of the point and general observations about the area for the veg points feature class

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
PLOT_CODE	Unique Plot code, used for relating tables & feature class (fcl_Veg_Points)	dbText	20
VISIT_DATE	Date the location was visited	dbText	10
SITE_NAME	General Site name given by field crew	dbText	180
PLOT_SHAPE	The shape of the area observed as a point	dbText	20
PLOT_WIDTH	The width of the point (plot and obs only)	dbText	3
PLOT_LENGTH	The length of the point (plot and obs only)	dbText	3
PLOT_DIAMETER	The diameter of the point (plot and obs only)	dbText	5
PLOT_AZIMUTH	The azimuth of the point (plot and obs only)	dbText	5
ASPECT	Aspect of plot	dbText	10
ELEVATION	Elevation of plot in meters, generated by GPS unit	dbDouble	8
SLOPE	Slope of plot measured in degrees	dbText	15
TOPO_POSITION	Topographic position of plot	dbText	50
DIRECTIONS_PLOT	Directions to the location of the plot (plot and obs only)	dbText	255
REPRESENTATIVENESS	The representativeness of the vegetation (at plots and obs only)	dbText	255
OBSERVER	The names of the field crew member(s) observing the site.	dbText	50
UNIT_CODE	4 letter park code (GLCA)	dbText	10
STATE_CODE	State (AZ or UT)	dbText	2
USGS_NAME	USGS 1:24k Topo Name	dbText	75
COUNTY_NAME	County where plot is located (Coconino, Garfield, Kane, San Juan, or Wayne)	dbText	80
PHENOLOGY	Leaf phenology of the dominant stratum. Field is blank for non-vascular plots	dbText	50
PHYSIOGNOMIC_NAME	Physiognomic class of plot	dbText	80
LEAF_TYPE	Leaf form of the dominant stratum.	dbText	80
LEAF_TYPE_COMMENTS	If Leaf Type is "mixed," this field describes the multiple leaf types found in the dominant stratum.	dbText	250
PROVISIONAL_COMM_NAME	Community name (provisional) assigned by field crews by following naming protocols as described in field manual & training (plot and obs only).	dbText	220
ALLIANCE	Alliance corresponding to provisional community name (plots and obs only)	dbText	150

Field Name	Field Description	Field Type	Field Width
PLANT_SPECIES_COMMENTS	Comments about the plant species observed	dbText	200
COWARDIN_SYSTEM	If the plot is in a wetland system, select term that best describes its hydrology (Upland, Palustrine, Riverine, Lacustrine); plot and obs only	dbText	40
HYDROLOGY	Describes hydrology of plot (plot and obs only)	dbText	40
GEOLOGY	Geologic substrate influencing the plant community (plot and obs only); Surficial geology (AA points)	dbText	60
ENV_COMMENTS	Comments on environmental setting and its effect on the vegetation; also comments on any disturbance or reproduction factors	dbText	255
LANDSCAPE_COMMENTS	Description of landscape context of plot, including any important landscape features influencing the community (plot and obs only)	dbText	255
ANIMAL_USE_COMMENTS	Comments on evidence of use by non-domestic animals in plot area (plot and obs only)	dbText	255
DISTURBANCE_COMMENTS	Comments on evidence of natural or anthropogenic disturbance in plot area, severity and effects on vegetation (plot and obs only)	dbText	255
OTHER_COMMENTS	Other general comments (plot and obs only)	dbText	255
SOIL_TEXTURE	Assessment of average soil texture from sample taken a few inches below the surface (plot and obs only)	dbText	50
SOIL_DRAINAGE	Soil drainage class based on actual moisture content and extent period (plot and obs only)	dbText	30
SOIL_TAXON_DESC	Field used for either identifying soils keyed, or to describe if large rocks or outcrops are present on the surface (plot and obs only)	dbText	255
SOIL_MOISTURE	Assessment of soil moisture at plot (Dry, Moist, Saturated, Standing water)	dbText	50
SURFACE_WATER	Assessment of surface water at plot (Seep, Spring, Stream, Pothole, River, Lake)	dbText	50

Table Name: TBL_MAPUNIT_ASSOC

Description: Contains association data for the vegetation polygons by map unit ID

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MapUnitID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	20
CEGL_Code	NVC association code	dbText	18
AssociationName	The NVC Association name (scientific)	dbText	250
AssociationCommonName	NVC Association Common name (diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition).	dbText	250
Dominant	Denotes which association is dominant	dbText	3

Table Name: TBL_MAPUNIT_CLASS

Description: Contains class data for the vegetation polygons by map unit ID

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MAPUNIT	The map unit identifier, used by the mappers (aka: grid_code or map class code, usually a number)	dbText	10
ClassCode	Class code value	dbText	10
ClassName	Class name (Broad combinations of general dominant growth forms).	dbText	100
PrimaryCall	Denotes which Class is the dominant or primary class for the map unit.	dbText	5

Table Name: TBL_MAPUNIT_DIVISION

Description: Contains division data for the vegetation polygons by map unit ID

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MAPUNIT	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10
Division_Key	Division key value	dbText	10
Division_Code	Division code value	dbText	10
DivisionName	Division name (Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant species that reflect biogeographic differences.).	dbText	100
PrimaryCall	Denotes which Division is the dominant or primary Division for the map unit.	dbText	5

Table Name: TBL_MAPUNIT_FORMATION

Description: Contains formation data for the vegetation polygons by map unit ID

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MAPUNIT	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10
Division_Key	Formation division key value	dbText	10
FormationName	Formation name (Combinations of dominant and diagnostic growth forms).	dbText	100
PrimaryCall	Denotes which Formation is the dominant or primary Formation for the map unit.	dbText	5

Table Name: TBL_MAPUNIT_GROUP

Description: Contains group data for the vegetation polygons by map unit ID

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MAPUNIT	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10

Field Name	Field Description	Field Type	Field Width
GroupCode	Group code	dbText	10
GroupName	Combinations of relatively narrow sets of diagnostic plant species, including dominants and co-dominants, broadly similar composition, and diagnostic growth forms (mid-scale classification, larger than associations or alliances, smaller than ecoregions).	dbText	100
PrimaryCall	Denotes which Group is the dominant or primary Group for the map unit.	dbText	5

Table Name: TBL_MAPUNIT_MACROGROUP

Description: Contains macrogroup data for the vegetation polygons by map unit ID

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MAPUNIT	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10
MacroCode	MacroGroup code	dbText	10
MacroGroupName	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences.	dbText	100
PrimaryCall	Denotes which MacroGroup is the dominant or primary Macrogroup for the map unit.	dbText	5

Table Name: TBL_MAPUNIT_SUBCLASS

Description: Contains subclass data for the vegetation polygons by map unit ID

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MAPUNIT	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10
SubClassCode	Subclass code	dbText	10
SubclassName	Combinations of general dominant and diagnostic growth forms.	dbText	100
PrimaryCall	Denotes which Subclass is the dominant or primary Subclass for the map unit.	dbText	5

Table Name: TBL_PHOTOS

Description: Details on individual photos taken of a point

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
PLOT_CODE	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	50
PhotoType	Type of photo being referenced.	dbText	16
Photographer	Name of photographer.	dbText	50
Direction	Direction photograph was taken.	dbText	12
PhotoComments	Brief description of photo.	dbText	255

Field Name	Field Description	Field Type	Field Width
IMAGE_ID	Unique image file name.	dbText	50
PHOTO_PATH	Hard-coded path name to photos (update this field).	dbText	200

Table Name: TBL_STRATUM_SPECIES

Description: Contains species level data by stratum

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
SPECIES	Latin names of species	dbText	255
PERCENT_COVER	Applicable to AA data only, percent cover by species	dbText	4
COVER_CODE	Cover class code to describe species and strata	dbText	5
COVER_CLASS	Cover class to describe species and strata	dbText	50
DIAGNOSTIC	Check yes if the species is known to be diagnostic of the vegetation type.	dbInteger	2
SPECIMEN_COLLECTED	"yes" (-1) if a specimen of the species was collected.	dbInteger	2
SPECIMEN_NO	The collector's reference number for the specimen collected.	dbText	10
DEAD	Percent cover of dead species seen at plot. Not completed of every species, but always done if diagnostic species.	dbInteger	2
STRATUM_ID	Unique ID, relates to TBL_VEG_STRATA	dbLong	4

Table Name: TBL_VEG_STRATA

Description: Contains stratum data for the veg points feature class

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
STRATUM_ID	Links to TBL_STRATUM_SPECIES	dbLong	4
STRATUM	Stratum name/type	dbText	20
STRATUM_COVER_CODE	Stratum cover code	dbText	5
STRATUM_COVER_CLASS	Stratum percentage cover class	dbText	50
STRATUM_HEIGHT_CODE	Stratum height code	dbText	5
STRATUM_HEIGHT_CLASS	Stratum height class in meters	dbText	50
PLOT_CODE	Unique Plot code, used for relating tables (TBL_STRATUM_SPECIES)	dbText	15

Table Name: TBL_VEGASSOC_INFO

Description: Contains association data for all points (plots, obs, and AA points) in the veg points feature class

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
PLOT_CODE	Unique Plot code, used for relating tables	dbText	35
CEGL_CODE	CEGL (association) code	dbText	10
ASSOCIATION	Association corresponding to provisional community name	dbText	180
FIELD_KEY_NAME	Yes if association name was chosen from field key	dbText	10
CREATED_NAME	Yes if no name really fits from the field key, the surveyor will create a new name.	dbText	10
POST_AA_FIELD_NAME	Yes if association name was assigned after AA field work, based on species lists and comments fields -- during AA meetings.	dbText	10
ASSOC_RANK	Rank of vegetation association (primary, secondary, tertiary)	dbText	50
OTHER_ASSOC_50M	Other associations noted in a 50meter area beyond plot	dbText	200

Table Name: TBL_VEGMAP_INFO

Description: Contains map unit level data for each vegetation map unit polygon

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
Polygon_ID	Unique polygon code, used for relating tables and feature classes (fcl_Veg_polys)	dbText	30
Map_Unit_ID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10
Map_Unit_Code	NCPN code (e.g., S-BLAC)	dbText	10
Map_Unit_Common_Name	The name of the map unit (or map class)	dbText	250
Cover_Code	Cover pattern value class code	dbText	1
COVER_PATTERN	Characterizes the pattern of vegetation on the landscape (Clumped/Bunched, Linear, Gadational/Transitional, Regularly alternating, Homogenous (default)) per polygon.	dbText	100
Density_Code	Density value code	dbText	1
DENSITY_CLASS	Density of Forest/Woodland vegetation, and density for sagebrush communities per polygon.	dbText	100
Height_Code	Height class value code	dbText	1
HEIGHT_CLASS	Vegetation height classes assigned to each polygon of forest/woodland and/or shrubland types	dbText	100
USER_ACCURACY	User accuracy of the map unit (determined during AA meetings). N/A means the class was not accuracy assessed.	dbText	3
VEGMAP_COMMENTS	Any comments about the particular polygon or map class.	dbText	255
MAP_UNIT_PDF	File name of pdf describing map unit (class)	dbText	50

Field Name	Field Description	Field Type	Field Width
MAP_UNIT_PDF_PATH	Hard-coded link to Map Unit description PDF document - path name (e.g. C:/GLCA/Vegetation/MapClassDescriptions/ s_blac_mu10.pdf)	dbText	250

Table Name: TBL_VEGMAP_MODIFIERS

Description: Contains modifiers for the vegetation map unit polygons

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
Polygon_ID	Unique polygon code, used for relating tables (TBL_VEGMAP_INFO)	dbText	20
MODIFIER	Modifier code (one lower case letter)	dbText	12
MODIFIER_NAME	Name/type of modifier	dbText	50
MODIFIER_DESCRIPTION	Description of modifier	dbText	255

Appendix D. Plant Species List and Crosswalk

Seven hundred and four vascular and nine non-vascular plant species representing 72 (81 with non-vascular) families were noted during plot, observation point and accuracy assessment point data collection at Glen Canyon National Recreation Area (GLCA) and Rainbow Bridge National Monument (RABR). The GLCA/RABR vegetation mapping project used Welsh et al. 2003 as the nomenclatural authority for vascular plants and the project database reflects scientific names as assigned by Welsh. These names are crosswalked to Kartesz 1999, which is the nomenclatural authority used by NatureServe for the National Vegetation Classification. Scientific and common names used by NatureServe are presented in this crosswalk; these names are used throughout the GLCA/RABR vegetation mapping report and in the individual association descriptions in Appendix F. The taxonomic serial number (TSN) assigned by the Integrated Taxonomic Information System (ITIS) is provided for each species.

VASCULAR PLANTS

Family	Scientific Name (Welsh et al. 20013)	Scientific Name (Kartesz 1999)	CommonName	TSN
Aceraceae	Acer glabrum var. glabrum Torr.	Acer glabrum var. glabrum	Rocky Mountain maple	28743
Aceraceae	Acer grandidentatum Nutt.	Acer grandidentatum	bigtooth maple	28760
Aceraceae	Acer negundo L.	Acer negundo	box elder	28749
Agavaceae	Yucca L.	Yucca	yucca, yucca species	43116
Agavaceae	Yucca angustissima Engelm. ex Trel.	Yucca angustissima	narrowleaf yucca	43131
Agavaceae	Yucca baccata Torr.	Yucca baccata	banana yucca, datil yucca	43134
Agavaceae	Yucca baileyi Woot. & Standl.	Yucca baileyi	Navajo yucca	43118
Agavaceae	Yucca harrimaniae Trel.	Yucca harrimaniae	Spanish bayonet	43144
Amaranthaceae	Amaranthus L.	Amaranthus	pigweed	20715
Amaranthaceae	Amaranthus blitoides S. Wats.	Amaranthus blitoides	prostrate amaranth, prostrate pigweed	20723
Anacardiaceae	Rhus aromatica Ait.	Rhus aromatica	fragrant sumac	28779
Anacardiaceae	Rhus aromatica var. simplicifolia (Greene) Cronq.	Rhus trilobata var. simplicifolia	skunkbush sumac	539585
Anacardiaceae	Rhus aromatica var. trilobata (Nutt.) Gray ex. S. Wats.	Rhus trilobata var. trilobata	skunkbush sumac	539586
Anacardiaceae	Toxicodendron rydbergii (Small ex Rydb.) Greene	Toxicodendron rydbergii	western poison-ivy	28822
Apiaceae	Cymopterus acaulis (Pursh) Raf.	Cymopterus acaulis	plains springparsley	29628
Apiaceae	Cymopterus acaulis var. fendleri (Gray) Goodrich	Cymopterus acaulis var. fendleri	Fendler's springparsley	527614
Apiaceae	Cymopterus newberryi (S. Wats.) M.E. Jones	Cymopterus newberryi	sweetroot springparsley	29649
Apiaceae	Cymopterus purpurascens (Gray) M.E. Jones	Cymopterus purpurascens	widewing springparsley	29653
Apiaceae	Cymopterus Raf.	Cymopterus	cymopterus, springparsley	29625
Apiaceae	Lomatium parryi (S. Wats.) J.F. Macbr.	Lomatium parryi	Parry's biscuitroot, Utah desert-parsley	29735
Apocynaceae	Amsonia tomentosa Torr. & Frém.	Amsonia tomentosa	amsonia, bluestar	30130
Apocynaceae	Amsonia tomentosa var. stenophylla Kearney & Peebles	Amsonia tomentosa var. stenophylla	woolly bluestar, wooly amosonia	30150
Apocynaceae	Amsonia Walt.	Amsonia	woolly bluestar	182210
Apocynaceae	Apocynum cannabinum L.	Apocynum cannabinum	dogbane, Indian hemp	30157
Asclepiadaceae	Asclepias L.	Asclepias	milkweed, milkweed spp.	30240
Asclepiadaceae	Asclepias asperula (Dcne.) Woods.	Asclepias asperula	antelope horns, antelopehorn milkweed	30247
Asclepiadaceae	Asclepias involucrata Engelm. ex Torr.	Asclepias involucrata	dwarf milkweed	30275
Asclepiadaceae	Asclepias latifolia (Torr.) Raf.	Asclepias latifolia	broadleaf milkweed	30278
Asclepiadaceae	Asclepias speciosa Torr.	Asclepias speciosa	showy milkweed	30304

Family	Scientific Name (Welsh et al. 20013)	Scientific Name (Kartesz 1999)	CommonName	TSN
Asclepiadaceae	Asclepias subverticillata (Gray) Vail	Asclepias subverticillata	western whorled milkweed	30308
Asteraceae	Acamptopappus sphaerocephalus (Harvey & Gray ex Gray) Gray	Acamptopappus sphaerocephalus	rayless goldenhead	36443
Asteraceae	Acourtia D. Don	Acourtia	desert peony	36452
Asteraceae	Acroptilon repens (L.) DC.	Acroptilon repens	Russian knapweed	36459
Asteraceae	Agoseris Raf.	Agoseris	agoseris, mountain dandylion	36485
Asteraceae	Ambrosia acanthicarpa Hook.	Ambrosia acanthicarpa	bursage, ragweed	36495
Asteraceae	Ambrosia L.	Ambrosia	annual bursage	36497
Asteraceae	Ambrosia tomentosa Nutt.	Ambrosia tomentosa	skeletonleaf bursage	36520
Asteraceae	Antennaria Gaertn.	Antennaria	pussytoes	36716
Asteraceae	Artemisia bigelovii Gray	Artemisia bigelovii	Bigelow's sagebrush	35452
Asteraceae	Artemisia campestris L.	Artemisia campestris	common sagewort, Pacific wormwood	183748
Asteraceae	Artemisia carruthii Wood ex Carruth.	Artemisia carruthii	Carruth's sagewort	35458
Asteraceae	Artemisia dracunculus L.	Artemisia dracunculus	sand sagebrush	35462
Asteraceae	Artemisia filifolia Torr.	Artemisia filifolia	fringed sagebrush, fringed sagewort	35463
Asteraceae	Artemisia frigida Willd.	Artemisia frigida	tarragon, wormwood	35465
Asteraceae	Artemisia L.	Artemisia	sagebrush, sagewort, wormwood	35431
Asteraceae	Artemisia ludoviciana Nutt.	Artemisia ludoviciana	mugwort wormwood, prairie sage	35474
Asteraceae	Artemisia nova A. Nels.	Artemisia nova	black sagebrush	500971
Asteraceae	Artemisia spinescens D.C. Eat.	Picrothamnus desertorum	bud sagebrush	35496
Asteraceae	Artemisia tridentata Nutt.	Artemisia tridentata	big sagebrush	35498
Asteraceae	Artemisia tridentata ssp. tridentata Nutt.	Artemisia tridentata ssp. tridentata	basin big sagebrush	35499
Asteraceae	Artemisia tridentata ssp. wyomingensis Beetle & Young	Artemisia tridentata ssp. wyomingensis	Wyoming big sagebrush	183741
Asteraceae	Aster glaucodes Blake	Eurybia glauca	gray aster	35578
Asteraceae	Aster L.	Aster	aster	35510
Asteraceae	Aster spinosus Benth.	Chloracantha spinosa	spiny chloracantha	35658
Asteraceae	Asteraceae	Asteraceae	sunflowers	35420
Asteraceae	Baccharis L.	Baccharis	baccharis	35681
Asteraceae	Baccharis salicifolia (Ruiz & Pavón) Pers.	Baccharis salicifolia	mule-fat	183763
Asteraceae	Baccharis salicina Torr. & Gray	Baccharis salicina	Great Plains falsewillow, willow baccharis	35698

Family	Scientific Name (Welsh et al. 20013)	Scientific Name (Kartesz 1999)	CommonName	TSN
Asteraceae	Brickellia atractyloides Gray	Brickellia atractyloides	hollyleaf brickellbush, spearleaf brickellbush	36862
Asteraceae	Brickellia californica (Torr. & Gray) Gray	Brickellia californica	California brickellbush	36866
Asteraceae	Brickellia Ell.	Brickellia	brickelbush spp., brickellia species	36859
Asteraceae	Brickellia longifolia S. Wats.	Brickellia longifolia	longleaf brickellbush	36885
Asteraceae	Brickellia microphylla (Nutt.) Gray	Brickellia microphylla	littleleaf brickellbush	36886
Asteraceae	Brickellia microphylla var. scabra Gray	Brickellia microphylla var. scabra	rough brickellbush	526984
Asteraceae	Brickellia oblongifolia Nutt.	Brickellia oblongifolia	Mojave brickellbush	36891
Asteraceae	Chaenactis DC.	Chaenactis	chaenactis, pincushion	36981
Asteraceae	Chaenactis macrantha D.C. Eat.	Chaenactis macrantha	bighead dustymaiden, bighead pincushion	36992
Asteraceae	Chaenactis stevioides Hook. & Arn.	Chaenactis stevioides	Steve's dusty maiden, Steve's pincushion	36998
Asteraceae	Chaetopappa ericoides (Torr.) Nesom	Chaetopappa ericoides	rose heath	501376
Asteraceae	Chorisiva nevadensis (M.E. Jones) Rydb.	Iva nevadensis	Nevada sumpweed	780250
Asteraceae	Chrysopsis villosa (Pursh) Nutt. ex DC	Heterotheca villosa	hairy false goldenaster	510984
Asteraceae	Chrysothamnus depressus Nutt.	Chrysothamnus depressus	dwarf rabbitbrush	37051
Asteraceae	Chrysothamnus greenei (Gray) Greene	Chrysothamnus greenei	Greene's rabbitbrush	37052
Asteraceae	Chrysothamnus linifolius Greene	Chrysothamnus linifolius	spearleaf rabbitbrush	37054
Asteraceae	Chrysothamnus nauseosus (Pallas ex Pursh) Britt.	Ericameria nauseosa	gray rabbitbrush	37055
Asteraceae	Chrysothamnus nauseosus var. junceus (Greene) Hall	Ericameria nauseosa ssp. consimilis var. juncea	rubber rabbitbrush	533557
Asteraceae	Chrysothamnus nauseosus var. leiospermus (A. Gray) H.M. Hall	Ericameria nauseosa ssp. consimilis var. leiosperma	rubber rabbitbrush	533559
Asteraceae	Chrysothamnus Nutt.	Chrysothamnus	rabbitbrush	37048
Asteraceae	Chrysothamnus vaseyi (Gray) Greene	Chrysothamnus vaseyi	Vasey's rabbitbrush	37089
Asteraceae	Chrysothamnus viscidiflorus (Hook.) Nutt.	Chrysothamnus viscidiflorus	green rabbitbrush	37090
Asteraceae	Chrysothamnus viscidiflorus var. stenophyllus (Gray) Hall	Chrysothamnus viscidiflorus var. stenophyllus	yellow rabbitbrush	566624
Asteraceae	Cirsium arizonicum (Gray) Petrak	Cirsium arizonicum	Arizona thistle	36341
Asteraceae	Cirsium calcareum (M.E. Jones) Woot. & Standl.	Cirsium calcareum	Cainville thistle	36346
Asteraceae	Cirsium neomexicanum Gray	Cirsium	thistle	36334
Asteraceae	Cirsium P. Mill.	Cirsium neomexicanum	New Mexico thistle	36388

Family	Scientific Name (Welsh et al. 20013)	Scientific Name (Kartesz 1999)	CommonName	TSN
Asteraceae	Cirsium rydbergii Petrak	Cirsium rydbergii	Rydberg's thistle	36411
Asteraceae	Conyza canadensis (L.) Cronq.	Conyza canadensis	Canada horseweed	37113
Asteraceae	Dicoria brandegeei Gray	Dicoria canescens ssp. brandegeei	desert twinbugs	37233
Asteraceae	Dicoria canescens Gray	Dicoria canescens	desert twinbugs	37234
Asteraceae	Dicoria Torr. ex Gray	Dicoria	twinbugs	37232
Asteraceae	Encelia frutescens (Gray) Gray	Encelia frutescens	bush encelia, button brittlebush	37309
Asteraceae	Enceliopsis (Gray) A. Nels.	Enceliopsis	sunray	37311
Asteraceae	Enceliopsis nudicaulis (Gray) A. Nels.	Enceliopsis nudicaulis	nakedstem sunray	37314
Asteraceae	Erigeron bellidiastrum Nutt.	Erigeron bellidiastrum	western daisy fleabane	35827
Asteraceae	Erigeron concinnus (Hook. & Arn.) Torr. & Gray	Erigeron concinnus	Navajo fleabane	502385
Asteraceae	Erigeron divergens Torr. & Gray	Erigeron divergens	spreading daisy, spreading fleabane	35852
Asteraceae	Erigeron eatonii Gray	Erigeron eatonii	Eaton's daisy, Eaton's fleabane	35853
Asteraceae	Erigeron L.	Erigeron	daisy, fleabane	35803
Asteraceae	Erigeron pumilus Nutt.	Erigeron pumilus	low daisy, low fleabane	35934
Asteraceae	Erigeron religiosus Cronq.	Erigeron religiosus	Clear Creek fleabane	35942
Asteraceae	Erigeron utahensis Gray	Erigeron utahensis	Utah fleabane	35967
Asteraceae	Erigeron utahensis var. sparsifolius (Eastw.) Cronq.	Erigeron utahensis var. sparsifolius	Utah fleabane	527970
Asteraceae	Euthamia Nutt. ex Cass.	Euthamia	goldentop	37349
Asteraceae	Euthamia occidentalis Nutt.	Euthamia occidentalis	western goldenrod	37356
Asteraceae	Gaillardia Foug.	Gaillardia	blanketflower	37395
Asteraceae	Gaillardia pinnatifida Torr.	Gaillardia pinnatifida	red-dome blanketflower	37409
Asteraceae	Gaillardia spathulata Gray	Gaillardia spathulata	western blanketflower	502699
Asteraceae	Glyptopleura marginata D.C. Eat.	Glyptopleura marginata	carveseed	37433
Asteraceae	Grindelia fastigiata Greene	Grindelia	gumweed	37439
Asteraceae	Grindelia squarrosa (Pursh) Dunal	Grindelia fastigiata	pointed gumweed	37446
Asteraceae	Grindelia Willd.	Grindelia squarrosa	curlycup gumweed, curlytop gumweed	37472
Asteraceae	Gutierrezia Lag.	Gutierrezia	snakeweed	37478
Asteraceae	Gutierrezia microcephala (DC.) Gray	Gutierrezia microcephala	threadleaf snakeweed	37482
Asteraceae	Gutierrezia sarothrae (Pursh) Britt. & Rusby	Gutierrezia sarothrae	broom snakeweed, perennial snakeweed	37483
Asteraceae	Haplopappus armerioides (Nutt.) Gray	Stenotus armerioides	thrift mock goldenweed	37506

Family	Scientific Name (Welsh et al. 20013)	Scientific Name (Kartesz 1999)	CommonName	TSN
Asteraceae	Haplopappus rusbyi (Greene) Cronquist	Isocoma rusbyi	Rusby's goldenbush	503208
Asteraceae	Helianthella microcephala (Gray) Gray	Helianthella microcephala	purpledisk helianthella, small-head dwarf-sunflower	37595
Asteraceae	Helianthella Torr. & Gray	Helianthella	helianthella	37592
Asteraceae	Helianthus annuus L.	Helianthus annuus	annual sunflower, wild sunflower	36616
Asteraceae	Helianthus anomalus Blake	Helianthus anomalus	desert sunflower, western sunflower	36617
Asteraceae	Helianthus L.	Helianthus	sunflower	36611
Asteraceae	Helianthus pauciflorus Nutt.	Helianthus pauciflorus	stiff sunflower	502925
Asteraceae	Helianthus petiolaris Nutt.	Helianthus petiolaris	prairie sunflower	36671
Asteraceae	Heterotheca Cass.	Heterotheca	false goldenaster	37652
Asteraceae	Hymenopappus filifolius Hook.	Hymenopappus filifolius	fine-leaf woollywhite, fineleaf hymenopappus	37766
Asteraceae	Hymenoxys acaulis (Pursh) Parker	Tetraneuris acaulis	stemless four-nerve daisy	514991
Asteraceae	Hymenoxys acaulis var. arizonica (Greene) Parker	Tetraneuris acaulis var. arizonica	Arizona four-nerve daisy	536275
Asteraceae	Hymenoxys acaulis var. ivesiana (Greene) Parker	Tetraneuris ivesiana	Ives' four-nerve daisy	536278
Asteraceae	Hymenoxys Cass.	Hymenoxys	rubberweed	37778
Asteraceae	Isocoma Nutt.	Isocoma	goldenbush, jimmyweed	37801
Asteraceae	Iva axillaris Pursh	Iva axillaris	poverty sumpweed, poverty weed	36033
Asteraceae	Lactuca L.	Lactuca	lettuce	36594
Asteraceae	Laennecia schiedeana (Less.) Nesom	Laennecia schiedeana	pineland horseweed	503311
Asteraceae	Lygodesmia arizonica S. Tomb	Lygodesmia arizonica	Arizona skeletonplant	503618
Asteraceae	Machaeranthera canescens (Pursh) Gray	Machaeranthera canescens	hoary tansyaster, purple aster	37984
Asteraceae	Machaeranthera gracilis (Nutt.) Shinners	Machaeranthera gracilis	slender goldenweed	37991
Asteraceae	Machaeranthera grindelioides (Nutt.) Shinners	Machaeranthera grindelioides	rayless aster, rayless tansyaster	37992
Asteraceae	Machaeranthera grindelioides var. grindelioides (Nutt.) Shinners	Machaeranthera grindelioides var. grindelioides	rayless aster, rayless tansyaster	529072
Asteraceae	Machaeranthera Nees	Machaeranthera	goldenweed, tansyaster	37970
Asteraceae	Machaeranthera pinnatifida (Hook.) Shinners	Machaeranthera pinnatifida	lacy tansyaster	38005
Asteraceae	Machaeranthera tanacetifolia (Kunth) Nees	Machaeranthera tanacetifolia	Takhoka-daisy, tanseyleaf aster	38013
Asteraceae	Malacothrix DC.	Malacothrix	desert dandelion	38043
Asteraceae	Malacothrix glabrata (Gray ex D.C. Eat.) Gray	Malacothrix glabrata	smooth desert dandelion	38050
Asteraceae	Malacothrix sonchoides (Nutt.) Torr. & Gray	Malacothrix sonchoides	sowthistle desert dandelion	38055

Family	Scientific Name (Welsh et al. 20013)	Scientific Name (Kartesz 1999)	CommonName	TSN
Asteraceae	Melampodium leucanthum Torr. & Gray	Melampodium leucanthum	plains blackfoot	38085
Asteraceae	Oxytenia acerosa Nutt.	Iva acerosa	copperweed	518080
Asteraceae	Pectis angustifolia Torr.	Pectis angustifolia	lemonscent	38176
Asteraceae	Pectis papposa Harvey & Gray	Pectis papposa	manybristle cinchweed	38187
Asteraceae	Petradoria pumila (Nutt.) Greene	Petradoria pumila	grassy rockgoldenrod, rock goldenrod	38233
Asteraceae	Pluchea sericea (Nutt.) Coville	Pluchea sericea	arrowweed	36069
Asteraceae	Prenanthella exigua (Gray) Rydb.	Prenanthella exigua	brightwhite	38267
Asteraceae	Pseudognaphalium Kirp.	Pseudognaphalium	cudweed, falsecudweed	500903
Asteraceae	Pseudognaphalium stramineum (Kunth) W.A. Weber	Pseudognaphalium stramineum	cottonbatting plant	508110
Asteraceae	Psilostrophe sparsiflora (Gray) A. Nels.	Psilostrophe sparsiflora	greenstem paperflower	38315
Asteraceae	Senecio flaccidus Less.	Senecio flaccidus	threadleaf groundsel	505126
Asteraceae	Senecio L.	Senecio	groundsel, ragwort	36084
Asteraceae	Senecio multilobatus Torr. & Gray ex Gray	Packera multilobata	lobeleaf groundsel	36161
Asteraceae	Senecio neomexicanus A. Gray	Packera neomexicana	New Mexico groundsel	36162
Asteraceae	Senecio spartioides Torr. & Gray	Senecio spartioides	broom groundsel	36184
Asteraceae	Solidago canadensis L.	Solidago canadensis	Canada goldenrod	36224
Asteraceae	Solidago L.	Solidago	goldenrod	36223
Asteraceae	Solidago velutina DC.	Solidago velutina	sparse goldenrod, three-nerve goldenrod	505290
Asteraceae	Sonchus asper (L.) Hill	Sonchus asper	perennial sowthistle, prickly sowthistle	38424
Asteraceae	Sonchus L.	Sonchus	sowthistle	38420
Asteraceae	Stephanomeria exigua Nutt.	Stephanomeria exigua	small wirelettuce	38445
Asteraceae	Stephanomeria Nutt.	Stephanomeria	wirelettuce	38442
Asteraceae	Stephanomeria pauciflora (Torr.) A. Nels.	Stephanomeria pauciflora	brownplume wirelettuce, fewflower wirelettuce	38451
Asteraceae	Stephanomeria tenuifolia (Raf.) Hall	Stephanomeria minor	narrowleaf wirelettuce	38455
Asteraceae	Stylocline micropoides Gray	Stylocline micropoides	desert neststraw, woolly neststraw	38473
Asteraceae	Symphyotrichum lanceolatum (Willd.) Nesom	Symphyotrichum lanceolatum	white panicle aster	522219
Asteraceae	Symphyotrichum Nees	Symphyotrichum	aster	564906
Asteraceae	Taraxacum officinale G.H. Weber ex Wiggers	Taraxacum officinale	dandelion	36213
Asteraceae	Tetradymia canescens DC.	Tetradymia canescens	spineless horsebrush	38494

Family	Scientific Name (Welsh et al. 20013)	Scientific Name (Kartesz 1999)	CommonName	TSN
Asteraceae	Thelesperma megapotamicum (Spreng.) Kuntze	Thelesperma megapotamicum	green threads	38525
Asteraceae	Thelesperma subnudum Gray	Thelesperma subnudum	Navajo tea, sand fringedpod	38528
Asteraceae	Thelesperma subnudum var. subnudum Gray	Thelesperma subnudum var. subnudum	Navajo tea	530642
Asteraceae	Thymophylla acerosa (DC.) Strother	Thymophylla acerosa	pricklyleaf dogweed	505493
Asteraceae	Thymophylla Lag.	Thymophylla	pricklyleaf	500589
Asteraceae	Thymophylla pentachaeta (DC.) Small	Thymophylla pentachaeta	fiveneedle pricklyleaf	505497
Asteraceae	Townsendia annua Beaman	Townsendia annua	annual Townsend daisy	38538
Asteraceae	Townsendia Hook.	Townsendia	Townsend daisy	38536
Asteraceae	Townsendia incana Nutt.	Townsendia incana	hoary Townsend daisy	38549
Asteraceae	Vanclevea stylosa (Eastw.) Greene	Vanclevea stylosa	pillar false gumweed	38587
Asteraceae	Viguiera longifolia (B.L. Rob. & Greenm.) S.F. Blake	Heliomeris longifolia	longleaf false goldeneye	523279
Asteraceae	Viguiera multiflora (Nutt.) Blake	Heliomeris multiflora	showy goldeneye	523280
Asteraceae	Wyethia Nutt.	Wyethia	mule-ears	38673
Asteraceae	Wyethia scabra Hook.	Wyethia scabra	badlands mule-ears	38687
Asteraceae	Xanthium L.	Xanthium	cocklebur	38690
Asteraceae	Xanthium strumarium L.	Xanthium strumarium	cocklebur	38692
Asteraceae	Xylorhiza glabriuscula Nutt.	Xylorhiza glabriuscula	smooth woodyaster	38698
Asteraceae	Xylorhiza glabriuscula var. linearifolia T.J. Wats.	Xylorhiza glabriuscula var. linearifolia	smooth woodyaster	530876
Asteraceae	Xylorhiza tortifolia (Torr. & Gray) Greene	Xylorhiza tortifolia	Mojave woodyaster	38700
Berberidaceae	Mahonia fremontii (Torr.) Fedde	Mahonia fremontii	Fremont's barberry, Fremont's mahonia	195033
Berberidaceae	Mahonia repens (Lindl.) G. Don	Mahonia repens	creeping barberry, Oregongrape	195045
Betulaceae	Betula occidentalis Hook.	Betula occidentalis	water birch	19488
Betulaceae	Ostrya knowltonii Coville	Ostrya knowltonii	Knowlton's hophornbeam	19510
Boraginaceae	Amsinckia Lehm.	Amsinckia	fiddleneck	31700
Boraginaceae	Cryptantha ambigua (Gray) Greene	Cryptantha ambigua	basin cryptantha	31783
Boraginaceae	Cryptantha cinerea (Greene) Cronq.	Cryptantha cinerea	bownut cryptantha	501822
Boraginaceae	Cryptantha circumscissa (Hook. & Arn.) I.M. Johnston	Cryptantha circumscissa	cushion cryptantha, matted cryptantha	31793
Boraginaceae	Cryptantha confertiflora (Greene) Payson	Cryptantha confertiflora	roundleaf cryptantha	31796
Boraginaceae	Cryptantha crassisepala var. elachantha I.M. Johnston	Cryptantha crassisepala var. elachantha	thicksepal cryptantha	527560
Boraginaceae	Cryptantha flava (A. Nels.) Payson	Cryptantha flava	Brenda's yellow cryptantha	31770

Family	Scientific Name (Welsh et al. 20013)	Scientific Name (Kartesz 1999)	CommonName	TSN
Boraginaceae	Cryptantha flavoculata (A. Nels.) Payson	Cryptantha flavoculata	roughseed cryptantha	31809
Boraginaceae	Cryptantha gracilis Osterhout	Cryptantha gracilis	narrowstem cryptantha	31813
Boraginaceae	Cryptantha humilis (Gray) Payson	Cryptantha humilis	roundspike cryptantha	31820
Boraginaceae	Cryptantha Lehm. ex G. Don	Cryptantha	cryptantha	31765
Boraginaceae	Cryptantha micrantha (Torr.) I.M. Johnston	Cryptantha micrantha	redroot cryptantha	31836
Boraginaceae	Cryptantha pterocarya (Torr.) Greene	Cryptantha pterocarya	wingnut cryptantha	31856
Boraginaceae	Cryptantha recurvata Coville	Cryptantha recurvata	curvenut cryptantha	31860
Boraginaceae	Cryptantha tenuis (Eastw.) Payson	Cryptantha tenuis	canyon cryptantha	31777
Boraginaceae	Heliotropium convolvulaceum (Nutt.) Gray	Heliotropium convolvulaceum	bindweed heliotrope, phlox heliotrope	31644
Boraginaceae	Heliotropium curassavicum L.	Heliotropium curassavicum	salt heliotrope, seaside heliotrope	31635
Boraginaceae	Heliotropium L.	Heliotropium	heliotrope	31634
Boraginaceae	Lappula occidentalis (S. Wats.) Greene	Lappula occidentalis	flatspine stickseed, western sticktight	503329
Boraginaceae	Lithospermum incisum Lehm.	Lithospermum incisum	narrowleaf gromwell, narrowleaf stoneseed	31940
Boraginaceae	Lithospermum L.	Lithospermum	stoneseed	31937
Boraginaceae	Tiquilia latior (I.M. Johnston) A. Richards.	Tiquilia latior	mat tiquilia	505519
Boraginaceae	Tiquilia Pers.	Tiquilia	coldenia, crinklemat, tiquilia	500591
Brassicaceae	Alyssum L.	Alyssum	alyssum, madwort	23029
Brassicaceae	Arabis L.	Arabis	rockcress	22671
Brassicaceae	Arabis perennans S. Wats.	Arabis perennans	perennial rockcress	22720
Brassicaceae	Arabis pulchra M.E. Jones ex S. Wats.	Arabis pulchra	beauty rockcress	22725
Brassicaceae	Arabis selbyi Rydb.	Arabis selbyi	Selby's rockcress	22731
Brassicaceae	Brassicaceae	Brassicaceae	mustards	22669
Brassicaceae	Caulanthus crassicaulis (Torr.) S. Wats.	Caulanthus crassicaulis	thickstem wild cabbage	23080
Brassicaceae	Conringia Heister ex Fabr.	Conringia	conringia, hare's ear mustard	23102
Brassicaceae	Conringia orientalis (L.) Dumort.	Conringia orientalis	hare's ear mustard	23103
Brassicaceae	Descurainia incana (Bernh. ex Fisch. & C.A. Mey.) Dorn	Descurainia incana	mountain tansy mustard	502003
Brassicaceae	Descurainia pinnata (Walt.) Britt.	Descurainia pinnata	pinnate tansy mustard	22826
Brassicaceae	Descurainia sophia (L.) Webb ex Prantl	Descurainia sophia	flaxweed tansy mustard	22843
Brassicaceae	Descurainia Webb & Berth.	Descurainia	tansy mustard	22819

Family	Scientific Name (Welsh et al. 20013)	Scientific Name (Kartesz 1999)	CommonName	TSN
Brassicaceae	Dithyrea wislizeni Engelm.	Dimorphocarpa wislizeni	touristplant	512398
Brassicaceae	Draba cuneifolia Nutt. ex Torr. & Gray	Draba cuneifolia	wedgeleaf draba	22874
Brassicaceae	Draba L.	Draba	draba, whitlowgrass	22844
Brassicaceae	Erysimum capitatum (Dougl. ex Hook.) Greene	Erysimum capitatum	sanddune wallflower, western wallflower	22932
Brassicaceae	Lepidium densiflorum Schrad.	Lepidium densiflorum	common pepperweed	22960
Brassicaceae	Lepidium fremontii S. Wats.	Lepidium fremontii	desert pepperweed	22963
Brassicaceae	Lepidium L.	Lepidium	pepperweed	22953
Brassicaceae	Lepidium lasiocarpum Nutt.	Lepidium lasiocarpum	hairypod pepperweed	22967
Brassicaceae	Lepidium lasiocarpum var. lasiocarpum Nutt.	Lepidium lasiocarpum var. lasiocarpum	hairypod pepperweed	22968
Brassicaceae	Lepidium latifolium L.	Lepidium latifolium	broad-leaved pepperweed	503379
Brassicaceae	Lepidium montanum Nutt.	Lepidium montanum	mountain pepperweed	503381
Brassicaceae	Lepidium montanum var. jonesii (Rydb.) C.L. Hitchc.	Lepidium montanum var. jonesii	Jones' pepperweed	528731
Brassicaceae	Malcolmia africana (L.) Ait. f.	Malcolmia africana	African mustard	23243
Brassicaceae	Physaria (Nutt. ex Torr. & Gray) Gray	Physaria	twinpod	23269
Brassicaceae	Physaria acutifolia Rydb.	Physaria acutifolia	sharpleaf twinpod	23270
Brassicaceae	Physaria chambersii Rollins	Physaria chambersii	Chamber's twinpod	23275
Brassicaceae	Physaria ludoviciana Welsh et al.	Lesquerella ludoviciana	Silver bladderpod	823205
Brassicaceae	Physaria newberryi Gray	Physaria newberryi	Newberry's twinpod	23281
Brassicaceae	Physaria rectipes (Wooton & Standl.) O'Kane & Al-Shehbaz	Lesquerella rectipes	Colorado bladderpod	823232
Brassicaceae	Schoenocrambe linifolia (Nutt.) Greene	Schoenocrambe linifolia	flaxleaf plainsmustard, rush mustard	23296
Brassicaceae	Sisymbrium altissimum L.	Sisymbrium altissimum	tall tumblemustard	23312
Brassicaceae	Sisymbrium irio L.	Sisymbrium irio	London rocket	23314
Brassicaceae	Stanleya pinnata (Pursh) Britt.	Stanleya pinnata	desert princes plume	23329
Brassicaceae	Streptanthella longirostris (S. Wats.) Rydb.	Streptanthella longirostris	longbeak fiddle mustard	23333
Brassicaceae	Streptanthus cordatus Nutt.	Streptanthus cordatus	heartleaf twistflower	23348
Brassicaceae	Thelypodium Endl.	Thelypodium	thelypody	23392
Brassicaceae	Thelypodium integrifolium (Nutt.) Endl. ex Walp.	Thelypodium integrifolium	entireleaf thelypody	23398
Brassicaceae	Thelypodium integrifolium var. gracilipes B.L. Robins.	Thelypodium integrifolium ssp. gracilipes	entireleaved thelypody	541249
Brassicaceae	Thelypodium wrightii Gray	Thelypodium wrightii	Wright's thelypody	23416

Family	Scientific Name (Welsh et al. 20013)	Scientific Name (Kartesz 1999)	CommonName	TSN
Cactaceae	Echinocactus polycephalus	Echinocactus polycephalus	cottontop cactus	19820
Cactaceae	Echinocereus Engelm.	Echinocereus	hedgehog cactus	19803
Cactaceae	Echinocereus engelmannii (Parry ex Engelm.) Lem.	Echinocereus engelmannii	Engelmann's hedgehog cactus	19806
Cactaceae	Echinocereus triglochidiatus Engelm.	Echinocereus triglochidiatus	claretcup hedgehog	19815
Cactaceae	Echinocereus triglochidiatus var. mojavensis (Engelm. & Bigelow) L. Benson	Echinocereus triglochidiatus var. mojavensis	Mohave hedgehog cactus	527836
Cactaceae	Opuntia basilaris Engelm. & Bigelow	Opuntia basilaris	beavertail pricklypear	19693
Cactaceae	Opuntia erinacea Engelm. & Bigelow ex Engelm.	Opuntia erinacea	grizzlybear pricklypear	19705
Cactaceae	Opuntia fragilis (Nutt.) Haw.	Opuntia fragilis	fragile cactus, jumping cactus	19707
Cactaceae	Opuntia macrorhiza Engelm.	Opuntia macrorhiza	plains twistspine pricklypear	19718
Cactaceae	Opuntia P. Mill.	Opuntia	cactus spp., prickly pear	19686
Cactaceae	Opuntia phaeacantha Engelm.	Opuntia phaeacantha	brownspine pricklypear	19724
Cactaceae	Opuntia polyacantha Haw.	Opuntia polyacantha	plains pricklypear	19726
Cactaceae	Opuntia whipplei Engelm. & Bigelow	Opuntia whipplei	Whipple's cholla	19745
Cactaceae	Sclerocactus Britt. & Rose	Sclerocactus	fishhook cactus	19758
Cactaceae	Sclerocactus parviflorus Clover & Jotter	Sclerocactus parviflorus	Small flower fishook cactus	19761
Campanulaceae	Lobelia cardinalis L.	Lobelia cardinalis	Cardinal flower	34505
Cannabaceae	Humulus americanus Nutt.	Humulus lupulus var. lupuloides	common hop	514916
Capparaceae	Cleome L.	Cleome	beeplant	22613
Capparaceae	Cleome lutea Hook.	Cleome lutea	yellow beeplant	22620
Capparaceae	Cleome serrulata Pursh	Cleome serrulata	Rocky Mountain beeplant	22626
Caprifoliaceae	Lonicera L.	Lonicera	honeysuckle	35281
Caprifoliaceae	Symphoricarpos Duham.	Symphoricarpos	snowberry	35330
Caprifoliaceae	Symphoricarpos longiflorus Gray	Symphoricarpos longiflorus	desert snowberry	35334
Caryophyllaceae	Arenaria eastwoodiae Rydb.	Arenaria eastwoodiae	Eastwood's sandwort	20244
Caryophyllaceae	Arenaria fendleri Gray	Arenaria fendleri	Fendler's sandwort	20245
Caryophyllaceae	Arenaria fendleri var. fendleri Gray	Arenaria fendleri var. fendleri	Fendler's sandwort	184229
Caryophyllaceae	Arenaria L.	Arenaria	sandwort	20235
Caryophyllaceae	Silene antirrhina L.	Silene antirrhina	catchfly, sleepy silene	20045
Caryophyllaceae	Spergularia salina J.& K. Presl	Spergularia salina	salt sandspurry	507251
Chenopodiaceae	Atriplex argentea Nutt.	Atriplex argentea	silverscale saltbush	20512

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Chenopodiaceae	Atriplex canescens (Pursh) Nutt.	Atriplex canescens	fourwing saltbush	20518
Chenopodiaceae	Atriplex confertifolia (Torr. & Frém.) S. Wats.	Atriplex confertifolia	shadscale	20519
Chenopodiaceae	Atriplex corrugata S. Wats.	Atriplex corrugata	mat saltbush	20522
Chenopodiaceae	Atriplex gardneri (Moq.) D. Dietr.	Atriplex gardneri	Gardner's saltbush	20531
Chenopodiaceae	Atriplex garrettii Rydb.	Atriplex garrettii	Garrett's saltbush	20532
Chenopodiaceae	Atriplex L.	Atriplex	saltbush	20505
Chenopodiaceae	Atriplex obovata Moq.	Atriplex obovata	mound saltbush	20552
Chenopodiaceae	Bassia All.	Bassia	smotherweed	20586
Chenopodiaceae	Bassia americana Welsh et al.	Kochia americana	Gray molly	822853
Chenopodiaceae	Bassia hyssopifolia (Pallas) Kuntz	Bassia hyssopifolia	fivehook bassia, fivehorn smotherweed	20588
Chenopodiaceae	Bassia scoparia (L.) Schrad.	Bassia scoparia	Summer-cypress	565741
Chenopodiaceae	Chenopodium album L.	Chenopodium album	lambsquarters	20592
Chenopodiaceae	Chenopodium capitatum (L.) Ambrosi	Chenopodium capitatum	blite goosefoot	20599
Chenopodiaceae	Chenopodium desiccatum A. Nels.	Chenopodium desiccatum	desert goosefoot	20604
Chenopodiaceae	Chenopodium fremontii S. Wats.	Chenopodium fremontii	Fremont's goosefoot	20607
Chenopodiaceae	Chenopodium L.	Chenopodium	goosefoot	20589
Chenopodiaceae	Chenopodium leptophyllum (Moq.) Nutt. ex S. Wats.	Chenopodium leptophyllum	narrowleaf goosefoot, narrowleaf lambsquarters	20616
Chenopodiaceae	Corispermum americanum (Nutt.) Nutt.	Corispermum americanum	American bugseed	511428
Chenopodiaceae	Corispermum L.	Corispermum	bugseed	500216
Chenopodiaceae	Cycloloma atriplicifolium (Spreng.) Coult.	Cycloloma atriplicifolium	winged pigweed	20685
Chenopodiaceae	Grayia spinosa (Hook.) Moq.	Grayia spinosa	spiny hopsage	20690
Chenopodiaceae	Halogeton glomeratus (Bieb.) C.A. Mey.	Halogeton glomeratus	halogeton, saltlover	20692
Chenopodiaceae	Krascheninnikovia lanata (Pursh) A.D.J. Meeuse & Smit	Krascheninnikovia lanata	winterfat	503290
Chenopodiaceae	Monolepis nuttalliana (J.A. Schultes) Greene	Monolepis nuttalliana	Nuttall's poverty weed	20700
Chenopodiaceae	Salsola L.	Salsola	Russian thistle, tumbleweed	20654
Chenopodiaceae	Salsola paulsenii Litv.	Salsola paulsenii	barbwire Russian thistle	20657
Chenopodiaceae	Salsola tragus L.	Salsola tragus	prickly Russian thistle	520950
Chenopodiaceae	Sarcobatus vermiculatus (Hook.) Torr.	Sarcobatus vermiculatus	greasewood	20707
Chenopodiaceae	Suaeda torreyana S. Wats.	Suaeda moquinii	Mojave seablite	505404

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Chenopodiaceae	Zuckia brandegeei (Gray) Welsh & Stutz ex Welsh	Zuckia brandegeei	siltbush	505810
Chenopodiaceae	Zuckia brandegeei var. brandegeei (Gray) Welsh & Stutz ex Welsh	Zuckia brandegeei	siltbush	530925
Commelinaceae	Tradescantia occidentalis (Britt.) Smyth	Tradescantia occidentalis	prairie spiderwort, spiderwort	39168
Convolvulaceae	Evolvulus nuttallianus J.A. Schultes	Evolvulus nuttallianus	shaggy dwarf morning-glory	502573
Cornaceae	Cornus sericea L.	Cornus sericea	redosier dogwood	501637
Cornaceae	Cornus sericea ssp. sericea L.	Cornus sericea ssp. sericea	redosier dogwood	523904
Crossosomataceae	Glossopetalon spinescens Gray	Glossopetalon spinescens	spiny greasebush	502808
Crossosomataceae	Glossopetalon spinescens var. meionandrum (Koehne) Trel.	Glossopetalon spinescens var. meionandrum	spiny greasebush	528253
Cupressaceae	Juniperus osteosperma (Torr.) Little	Juniperus osteosperma	Utah juniper	194859
Cyperaceae	Carex aurea Nutt.	Carex aurea	golden sedge	39445
Cyperaceae	Carex curatorum Stacey	Carex curatorum	Kaibab sedge	39565
Cyperaceae	Carex hystericina Muhl. ex Willd.	Carex hystericina	bottlebrush sedge, porcupine sedge	39456
Cyperaceae	Carex L.	Carex	sedge	39369
Cyperaceae	Carex pellita Muhl ex Willd.	Carex pellita	woolly sedge	507767
Cyperaceae	Carex pityophila Mackenzie	Carex pityophila	loving sedge	39757
Cyperaceae	Carex praegracilis W. Boott	Carex praegracilis	clustered field sedge, slim sedge	39767
Cyperaceae	Carex rossii Boott	Carex rossii	Ross' sedge	39786
Cyperaceae	Cyperus L.	Cyperus	flatsedge, nutgrass	39882
Cyperaceae	Eleocharis rostellata (Torr.) Torr.	Eleocharis rostellata	beaked spikerush, beaked spikesedge	40022
Cyperaceae	Scirpus americanus Pers.	Schoenoplectus americanus	chairmaker's bulrush	40226
Elaeagnaceae	Elaeagnus angustifolia L.	Elaeagnus angustifolia	Russian olive	27770
Elaeagnaceae	Shepherdia rotundifolia Parry	Shepherdia rotundifolia	roundleaf buffaloberry	27780
Ephedraceae	Ephedra cutleri Peebles	Ephedra cutleri	Cutler Mormon tea	508106
Ephedraceae	Ephedra L.	Ephedra	ephedra, Mormon tea	183496
Ephedraceae	Ephedra torreyana S. Wats.	Ephedra torreyana	Torrey's ephedra, Torrey's jointfir	502318
Ephedraceae	Ephedra viridis Coville	Ephedra viridis	green ephedra, green Mormon tea	502319
Equisetaceae	Equisetum arvense L.	Equisetum arvense	field horsetail	17152
Equisetaceae	Equisetum hyemale L.	Equisetum hyemale	horsetail, scouringrush	17154
Equisetaceae	Equisetum L.	Equisetum	horsetail, scouring rush	17148

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Equisetaceae	Equisetum laevigatum A. Braun	Equisetum laevigatum	horsetail, smooth scouringrush	17156
Euphorbiaceae	Chamaesyce fendleri (Torr. & Gray) Small	Chamaesyce fendleri	Fendler's sandmat	501419
Euphorbiaceae	Chamaesyce glyptosperma (Engelm.) Small	Chamaesyce glyptosperma	ribseed sandmat, ridgeseed spurge	501422
Euphorbiaceae	Chamaesyce parryi (Engelm.) Rydb.	Chamaesyce parryi	Parry's spurge	501448
Euphorbiaceae	Chamaesyce S.F. Gray	Chamaesyce	sandmat	28244
Euphorbiaceae	Chamaesyce serpyllifolia (Pers.) Small	Chamaesyce serpyllifolia	thymeleaf sandmat	501458
Euphorbiaceae	Croton L.	Croton	croton	28260
Euphorbiaceae	Croton texensis (Klotzsch) Muell.-Arg.	Croton texensis	Texas croton	28291
Euphorbiaceae	Euphorbia micromera Boiss. ex Engelm.	Chamaesyce micromera	Sonoran sandmat	28103
Euphorbiaceae	Euphorbia nephradenia Barneby	Euphorbia nephradenia	Paria spurge	28106
Euphorbiaceae	Reverchonia arenaria A. Gray	Reverchonia arenaria	sand reverchonia	28391
Fabaceae	Alhagi maurorum Medik.	Alhagi maurorum	camelthorn	500956
Fabaceae	Astragalus americanus (Hook.) M.E. Jones	Astragalus americanus	American milkvetch	25412
Fabaceae	Astragalus amphioxys Gray	Astragalus amphioxys	Crescent milkvetch	25414
Fabaceae	Astragalus convallarius Greene	Astragalus convallarius	lesser rushy milkvetch	25477
Fabaceae	Astragalus cutleri (Barneby) S.L. Welsh	Astragalus cutleri	Cutler milkvetch	820323
Fabaceae	Astragalus desperatus M.E. Jones	Astragalus desperatus	rimrock milkvetch	25491
Fabaceae	Astragalus L.	Astragalus	locoweed, milkvetch	25392
Fabaceae	Astragalus lentiginosus Dougl. ex Hook.	Astragalus lentiginosus	freckled milkvetch, specklepod milkvetch	25559
Fabaceae	Astragalus moencoppensis M.E. Jones	Astragalus moencoppensis	Moenkopi milkvetch	25586
Fabaceae	Astragalus mollissimus Torr.	Astragalus mollissimus	wooly locoweed, wooly milkvetch	25589
Fabaceae	Astragalus monumentalis Barneby	Astragalus monumentalis	Monument Valley milkvetch	25593
Fabaceae	Astragalus newberryi Gray	Astragalus newberryi	Newberry's milkvetch	25602
Fabaceae	Astragalus nuttallianus DC.	Astragalus nuttallianus	Nuttall milkvetch	25607
Fabaceae	Astragalus oophorus S. Wats.	Astragalus oophorus	egg milkvetch	25616
Fabaceae	Astragalus praelongus Sheldon	Astragalus praelongus	stinking milkvetch	25639
Fabaceae	Astragalus sabulonum Gray	Astragalus sabulonum	gravel milkvetch	25663
Fabaceae	Astragalus sesquiflorus S. Wats.	Astragalus sesquiflorus	sandstone milkvetch	25675
Fabaceae	Astragalus wingatanus S. Wats.	Astragalus wingatanus	Fort Wingate milkvetch	25727
Fabaceae	Caragana arborescens Lam.	Caragana arborescens	Siberian peashrub	26529

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Fabaceae	Cercis occidentalis Torr. ex A. Gray	Cercis canadensis var. texensis	California redbud	25783
Fabaceae	Dalea candida Michx. ex Willd.	Dalea candida	white prairie clover	26603
Fabaceae	Dalea candida var. oligophylla (Torr.) Shinners	Dalea candida var. oligophylla	white prairieclover	192889
Fabaceae	Dalea flavescens var. flavescens	Dalea flavescens	Canyonlands prairie clover	26614
Fabaceae	Dalea L.	Dalea	dalea, prairie clover	26597
Fabaceae	Fabaceae	Fabaceae	pea family	500059
Fabaceae	Glycyrrhiza lepidota Pursh	Glycyrrhiza lepidota	wild licorice	26719
Fabaceae	Lathyrus eucosmus Butters & St. John	Lathyrus eucosmus	bush peavine	503338
Fabaceae	Lathyrus L.	Lathyrus	peavine	25834
Fabaceae	Lupinus L.	Lupinus	lupine	25916
Fabaceae	Lupinus pusillus Pursh	Lupinus pusillus	small lupine	26099
Fabaceae	Medicago sativa L.	Medicago sativa	alfalfa	183623
Fabaceae	Melilotus alba Medikus	Melilotus officinalis	white sweetclover	26149
Fabaceae	Melilotus officinalis (L.) Lam.	Melilotus officinalis	yellow sweetclover	26150
Fabaceae	Melilotus P. Mill.	Melilotus	sweetclover	26148
Fabaceae	Psoralidium junceum	Psoralidium junceum	rush lemonweed	504644
Fabaceae	Psoralidium lanceolatum (Pursh) Rydb.	Psoralidium lanceolatum	dune scurfpea, lemon scurfpea	504645
Fabaceae	Psoralidium Rydb.	Psoralidium	breadroot, scurfpea	500520
Fabaceae	Psorothamnus fremontii (Torr. ex Gray) Barneby	Psorothamnus fremontii	Fremont's dalea	26928
Fabaceae	Psorothamnus Rydb.	Psorothamnus	dalea, smokebush	26925
Fabaceae	Psorothamnus thompsoniae (Vail) Welsh & Atwood	Psorothamnus thompsoniae	Thompson's dalea	26934
Fabaceae	Sophora stenophylla Gray	Sophora stenophylla	fringeleaf necklacepod	26964
Fabaceae	Trifolium fragiferum L.	Trifolium fragiferum	strawberry clover	26251
Fagaceae	Quercus gambelii Nutt.	Quercus gambelii	Gambel oak	19337
Fagaceae	Quercus havardii X gambellii	N/A	hybrid oak	-502814
Fagaceae	Quercus L.	Quercus	oak	19276
Fagaceae	Quercus turbinella Greene	Quercus turbinella	Sonoran scrub oak, turbinella oak	19440
Fagaceae	Quercus welshii Welsh et al.	Quercus havardii var. tuckeri	Shinnery oak	529960
Fagaceae	Quercus X pauciloba Rydb. (pro sp.)	Quercus X pauciloba	wavyleaf oak	19395
Gentianaceae	Swertia albomarginata (S. Wats.) Kuntze	Frasera albomarginata	desert frasera	30109
Gentianaceae	Swertia L.	Swertia	felwort	30107

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Gentianaceae	Swertia utahensis (M.E. Jones) St. John	Frasera paniculata	tufted frasera	30123
Geraniaceae	Erodium cicutarium (L.) L'Hér. ex Ait.	Erodium cicutarium	cutleaf filaree,red-stem stork's-bill	29147
Geraniaceae	Erodium L'Hér. ex Ait.	Erodium	filaree, stork's bill	29144
Geraniaceae	Erodium texanum	Erodium texanum	Texas stork's bill	29153
Grossulariaceae	Ribes cereum Dougl.	Ribes cereum	wax currant	24457
Hydrangeaceae	Fendlera rupicola Gray	Fendlera rupicola	cliff fendlerbush	24331
Hydrangeaceae	Fendlerella utahensis (S. Wats.) Heller	Fendlerella utahensis	Utah fendlerbush	24334
Hydrophyllaceae	Nama L.	Nama	fiddleleaf, nama	31399
Hydrophyllaceae	Phacelia crenulata Torr. ex S. Wats.	Phacelia crenulata	caterpillarweed, notch-leaf scorpion-weed	31478
Hydrophyllaceae	Phacelia heterophylla Pursh	Phacelia heterophylla	variable-leaf scorpion-weed	504271
Hydrophyllaceae	Phacelia integrifolia Torr.	Phacelia integrifolia	gypsum phacelia	504272
Hydrophyllaceae	Phacelia ivesiana Torr.	Phacelia ivesiana	Ives phacelia	504273
Hydrophyllaceae	Phacelia Juss.	Phacelia	phacelia, scorpion-weed	31433
Juncaceae	Juncus articulatus L.	Juncus articulatus	jointleaf rush	39249
Juncaceae	Juncus balticus var. mexicanus (Willd. ex J.A. & J.H. Schultes) Kuntze	Juncus mexicanus	Mexican rush	536414
Juncaceae	Juncus balticus Willd.	Juncus balticus	Baltic rush	39223
Juncaceae	Juncus L.	Juncus	rush	39220
Juncaceae	Juncus tenuis Willd.	Juncus tenuis	field rush	39243
Juncaceae	Juncus torreyi Coville	Juncus torreyi	Torrey's rush	39320
Lamiaceae	Hedeoma drummondii Benth.	Hedeoma drummondii	Drummond's false pennyroyal	32512
Lamiaceae	Mentha arvensis auct. non L.	Mentha arvensis	wild mint	32265
Lamiaceae	Poliomintha incana (Torr.) Gray	Poliomintha incana	hoary rosemarymint	504488
Liliaceae	Allium L.	Allium	Wild onion	42634
Liliaceae	Allium nevadense S. Wats.	Allium nevadense	Nevada onion	42687
Liliaceae	Androstephium breviflorum S. Wats.	Androstephium	funnel lily	42776
Liliaceae	Androstephium Torr.	Androstephium breviflorum	pink funnel lily	42777
Liliaceae	Calochortus aureus S. Wats.	Calochortus aureus	golden mariposa lily	42836
Liliaceae	Calochortus flexuosus S. Wats.	Calochortus flexuosus	straggling mariposa lily	42848
Liliaceae	Calochortus nuttallii Torr. & Gray	Calochortus nuttallii	sego lily	42863

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Liliaceae	Calochortus Pursh	Calochortus	mariposa lily	42823
Liliaceae	Dichelostemma pulchellum (Salisb.) Heller	Dichelostemma capitatum	bluedicks	42916
Liliaceae	Eremocrinum albomarginatum (M.E. Jones) M.E. Jones	Eremocrinum albomarginatum	lonely lily	42925
Liliaceae	Liliaceae	Liliaceae	lily family	42633
Liliaceae	Smilacina stellata (L.) Desf.	Maianthemum stellatum	starry false lily of the valley	43038
Liliaceae	Zigadenus paniculatus (Nutt.) S. Wats.	Zigadenus paniculatus	foothill deathcamas	43167
Linaceae	Linum aristatum Engelm.	Linum aristatum	bristle flax	29231
Linaceae	Linum L.	Linum	flax	29201
Linaceae	Linum subteres (Trel.) Winkl.	Linum subteres	slenderfoot flax	29224
Loasaceae	Mentzelia albicaulis (Dougl. ex Hook.) Dougl. ex Torr. & Gray	Mentzelia albicaulis	whitestem blazingstar	503757
Loasaceae	Mentzelia L.	Mentzelia	blazingstar	202469
Loasaceae	Mentzelia marginata (Osterhout) H.J. Thompson & Prigge	Mentzelia marginata	Colorado blazingstar	503782
Loasaceae	Mentzelia multiflora (Nutt.) Gray	Mentzelia multiflora	desert blazingstar, manyflowered mentzelia	503788
Loasaceae	Mentzelia pumila Nutt. ex Torr. & Gray	Mentzelia pumila	dwarf blazingstar	503800
Malvaceae	Sphaeralcea ambigua Gray	Sphaeralcea ambigua	desert globemallow	21910
Malvaceae	Sphaeralcea coccinea (Nutt.) Rydb.	Sphaeralcea coccinea	orange globemallow, scarlet globemallow	21920
Malvaceae	Sphaeralcea grossulariifolia (Hook. & Arn.) Rydb.	Sphaeralcea grossulariifolia	gooseberryleaf globemallow	21939
Malvaceae	Sphaeralcea janeae (Welsh) Welsh	Sphaeralcea janeae	Jane's globemallow	505320
Malvaceae	Sphaeralcea leptophylla (Gray) Rydb.	Sphaeralcea leptophylla	scaly globemallow	21947
Malvaceae	Sphaeralcea parvifolia A. Nels.	Sphaeralcea parvifolia	smallflower globemallow	21953
Malvaceae	Sphaeralcea St.-Hil.	Sphaeralcea	globemallow	21909
Molluginaceae	Mollugo cerviana (L.) Ser.	Mollugo cerviana	threadstem carpetweed	19900
Nyctaginaceae	Abronia fragrans Nutt. ex Hook.	Abronia fragrans	snowball sand verbena	19557
Nyctaginaceae	Abronia Juss.	Abronia	sand verbena	19550
Nyctaginaceae	Abronia elliptica A. Nelson	Abronia elliptica	fragrant white sand verbena	19556
Nyctaginaceae	Boerhavia L.	Boerhavia	boerhavia, spiderling	19667
Nyctaginaceae	Mirabilis linearis (Pursh) Heimerl	Mirabilis linearis	narrowleaf four o'clock	19651

Family	Scientific Name (Welsh et al. 20013)	Scientific Name (Kartesz 1999)	CommonName	TSN
Nyctaginaceae	Mirabilis multiflora (Torr.) Gray	Mirabilis multiflora	Colorado four o'clock	19654
Nyctaginaceae	Nyctaginaceae	Nyctaginaceae	four o'clocks	19542
Nyctaginaceae	Tripterocalyx Hook. ex Standl.	Tripterocalyx	sandpuffs	19618
Nyctaginaceae	Forestiera pubescens Nutt.	Forestiera pubescens	desert olive	32957
Oleaceae	Fraxinus anomala Torr. ex S. Wats.	Fraxinus anomala	singleleaf ash	32937
Oleaceae	Calylophus lavandulifolius (Torr. & Gray) Raven	Calylophus lavandulifolius	lavendarleaf eveningprimrose, lavender calylophus	501160
Onagraceae	Camissonia Link	Camissonia	camissonia, suncup	27462
Onagraceae	Camissonia multijuga (S. Wats.) Raven	Camissonia multijuga	froststem suncup	27527
Onagraceae	Camissonia scapoidea (Nutt. ex Torr. & Gray) Raven	Camissonia scapoidea	Paiute suncup	27543
Onagraceae	Camissonia walkeri (A. Nels.) Raven	Camissonia walkeri	Walker's suncup	27559
Onagraceae	Epilobium ciliatum Raf.	Epilobium ciliatum	fringed willowherb, hairy willowherb	27293
Onagraceae	Epilobium palustre L.	Epilobium palustre	marsh willowweed	27320
Onagraceae	Gaura coccinea Nutt. ex Pursh	Gaura coccinea	Scarlet guara	27646
Onagraceae	Oenothera albicaulis Pursh	Oenothera albicaulis	white-stem evening-primrose	27373
Onagraceae	Oenothera caespitosa Nutt.	Oenothera caespitosa	tufted evening-primrose	565328
Onagraceae	Oenothera elata Kunth	Oenothera elata	Hooker's evening primrose	27395
Onagraceae	Oenothera elata ssp. hookeri (Torr. & Gray) W. Dietr. & W.L. Wagner	Oenothera elata ssp. hookeri	Hooker's evening primrose	524353
Onagraceae	Oenothera L.	Oenothera	evening primrose	27367
Onagraceae	Oenothera longissima Rydb.	Oenothera longissima	longstem evening primrose	27428
Onagraceae	Oenothera pallida Lindl.	Oenothera pallida	pale evening primrose	27436
Onagraceae	Epipactis gigantea Dougl. ex Hook.	Epipactis gigantea	giant hellebore, stream orchid	43481
Orchidaceae	Habenaria zothecina Higgins & Welsh	Platanthera zothecina	alcove bog orchid	514389
Orchidaceae	Orobanche L.	Orobanche	broomrape	34277
Orobanchaceae	Pinus edulis Engelm.	Pinus edulis	pinyon, two-needle pinyon	183336
Pinaceae	Pseudotsuga menziesii (Mirbel) Franco	Pseudotsuga menziesii	Douglas fir	183424
Pinaceae	Plantago major L.	Plantago major	broadleaf plantain, common plantain	32887
Plantaginaceae	Plantago patagonica Jacq.	Plantago patagonica	woolly plantain	32907
Plantaginaceae	Agropyron cristatum (L.) Gaertn.	Agropyron cristatum	crested wheatgrass	182478
Poaceae	Agrostis stolonifera L.	Agrostis stolonifera	carcreeping bentgrass, redtop, redtop bent	40400

Family	Scientific Name (Welsh et al. 20013)	Scientific Name (Kartesz 1999)	CommonName	TSN
Poaceae	Andropogon gerardii Vitman	Andropogon gerardii	big bluestem	40462
Poaceae	Andropogon glomeratus (Walt.) B.S.P.	Andropogon glomeratus	bushy bluestem	40454
Poaceae	Aristida arizonica Vasey	Aristida arizonica	Arizona threeawn	41410
Poaceae	Aristida L.	Aristida	annual threeawn	41400
Poaceae	Aristida purpurea Nutt.	Aristida purpurea	purple threeawn	41429
Poaceae	Bothriochloa barbinodis (Lag.) Herter	Bothriochloa barbinodis	cane beardgrass, cane bluestem	41483
Poaceae	Bothriochloa Kuntze	Bothriochloa	beardgrass, bothriochloa	41476
Poaceae	Bouteloua aristidoides (Kunth) Griseb.	Bouteloua aristidoides	needle grama	41497
Poaceae	Bouteloua barbata Lag.	Bouteloua barbata	sixweeks grama	41498
Poaceae	Bouteloua curtipendula (Michx.) Torr.	Bouteloua curtipendula	sideoats grama	41500
Poaceae	Bouteloua eriopoda (Torr.) Torr.	Bouteloua eriopoda	black grama	41501
Poaceae	Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths	Bouteloua gracilis	blue grama	41493
Poaceae	Bromus diandrus Roth	Bromus diandrus	ripgut brome	40498
Poaceae	Bromus japonicus Thunb. ex Murr.	Bromus japonicus	Japanese brome	40479
Poaceae	Bromus L.	Bromus	brome	40478
Poaceae	Bromus rubens L.	Bromus rubens	foxtail brome, red brome	40518
Poaceae	Bromus tectorum L.	Bromus tectorum	cheat grass	40524
Poaceae	Calamagrostis Adans.	Calamagrostis	reedgrass	40529
Poaceae	Calamagrostis scopulorum M.E. Jones	Calamagrostis scopulorum	ditch reedgrass	40566
Poaceae	Crypsis Ait.	Crypsis	pricklegrass	41602
Poaceae	Dichanthelium (A.S. Hitchc. & Chase) Gould	Dichanthelium	rosette grass	41645
Poaceae	Distichlis Raf.	Distichlis	saltgrass	40661
Poaceae	Distichlis spicata (L.) Greene	Distichlis spicata	desert saltgrass, inland saltgrass	40662
Poaceae	Echinochloa crus-galli (L.) Beauv.	Echinochloa crus-galli	barnyard grass	502210
Poaceae	Elymus canadensis L.	Elymus canadensis	Canada wildrye	40683
Poaceae	Elymus elymoides (Raf.) Swezey	Elymus elymoides	squirreltail	502264
Poaceae	Elymus L.	Elymus	wildrye	40677
Poaceae	Elymus repens (L.) Gould	Elymus repens	quackgrass	512839
Poaceae	Elymus salinus M.E. Jones	Leymus salinus	saline wildrye	512841
Poaceae	Elymus smithii (Rydb.) Gould	Pascopyrum smithii	western wheatgrass	512844
Poaceae	Elymus spicatus (Pursh) Gould	Pseudoroegneria spicata	bluebunch wheatgrass	512845

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Poaceae	Elymus trachycaulus (Link) Gould ex Shinners	Elymus trachycaulus	slender wheatgrass, slender wild rye	502282
Poaceae	Enneapogon desvauxii Desv. ex Beauv.	Enneapogon desvauxii	feather pappusgrass	41709
Poaceae	Erioneuron pilosum (Buckl.) Nash	Erioneuron pilosum	hairy woollygrass	41731
Poaceae	Erioneuron pulchellum (Kunth) Tateoka	Dasyochloa pulchella	low woollygrass	41732
Poaceae	Festuca octoflora Walt.	Vulpia octoflora	sixweeks fescue	513551
Poaceae	Festuca ovina L.	Festuca brachyphylla ssp. brachyphylla	sheep fescue	40804
Poaceae	Hesperostipa (Elias) Barkworth	Hesperostipa	needle and thread	500937
Poaceae	Hilaria jamesii (Torr.) Benth.	Pleuraphis jamesii	James' galleta	41768
Poaceae	Hilaria rigida (Thurb.) Benth. ex Scribn.	Pleuraphis rigida	big galleta	41770
Poaceae	Hordeum L.	Hordeum	barley	40865
Poaceae	Leptochloa Beauv.	Leptochloa	sprangletop	41817
Poaceae	Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi	Muhlenbergia asperifolia	alkali muhly	41899
Poaceae	Muhlenbergia porteri Scribn. ex Beal	Muhlenbergia porteri	bush muhly	41933
Poaceae	Muhlenbergia pungens Thurb.	Muhlenbergia pungens	sandhill muhly	41934
Poaceae	Muhlenbergia Schreb.	Muhlenbergia	muhly	41883
Poaceae	Munroa squarrosa (Nutt.) Torr.	Munroa squarrosa	false buffalograss	783911
Poaceae	Oryzopsis micrantha (Trin. & Rupr.) Thurb.	Piptatherum micranthum	littleseed ricegrass	41989
Poaceae	Panicum acuminatum Sw.	Dichanthelium acuminatum	tapered rosette grass	518203
Poaceae	Panicum capillare L.	Panicum capillare	annual witchgrass, common panic grass	40914
Poaceae	Panicum L.	Panicum	panicgrass	40901
Poaceae	Phalaris arundinacea L.	Phalaris arundinacea	reed canary grass	41335
Poaceae	Phragmites Adans.	Phragmites	reed	41071
Poaceae	Phragmites australis (Cav.) Trin. ex Steud.	Phragmites australis	common reed	41072
Poaceae	Poa annua L.	Poa annua	annual bluegrass	41107
Poaceae	Poa fendleriana (Steud.) Vasey	Poa fendleriana	muttongrass	504467
Poaceae	Poa L.	Poa	bluegrass	41074
Poaceae	Poa pratensis L.	Poa pratensis	Kentucky bluegrass	41088
Poaceae	Poa secunda J. Presl	Poa secunda	Sandberg bluegrass	41103
Poaceae	Poaceae	Poaceae	grasses	40351

Family	Scientific Name (Welsh et al. 20013)	Scientific Name (Kartesz 1999)	CommonName	TSN
Poaceae	Polypogon monspeliensis (L.) Desf.	Polypogon monspeliensis	annual rabbitsfoot grass	41171
Poaceae	Polypogon viridis (Gouan) Breistr.	Polypogon viridis	beardless rabbitsfoot grass	504522
Poaceae	Saccharum ravennae	Saccharum ravennae	ravennagrass	504934
Poaceae	Schedonnardus paniculatus (Nutt.) Trel.	Schedonnardus paniculatus	tumblegrass	42063
Poaceae	Schismus barbatus (L.) Thell.	Schismus barbatus	common Mediterranean grass	42066
Poaceae	Schizachyrium scoparium (Michx.) Nash	Schizachyrium scoparium	little bluestem	42076
Poaceae	Sorghastrum nutans (L.) Nash	Sorghastrum nutans	Indiangrass	42102
Poaceae	Sorghum halepense (L.) Pers.	Sorghum halepense	Johnsongrass	42111
Poaceae	Spartina gracilis Trin.	Spartina gracilis	alkali cordgrass	41270
Poaceae	Sporobolus airoides (Torr.) Torr.	Sporobolus airoides	alkali sacaton	42128
Poaceae	Sporobolus contractus A.S. Hitchc.	Sporobolus contractus	spike dropseed	42131
Poaceae	Sporobolus cryptandrus (Torr.) Gray	Sporobolus cryptandrus	sand dropseed	42132
Poaceae	Sporobolus flexuosus (Thurb. ex Vasey) Rydb.	Sporobolus flexuosus	mesa dropseed	42137
Poaceae	Sporobolus giganteus Nash	Sporobolus giganteus	giant dropseed	42138
Poaceae	Sporobolus R. Br.	Sporobolus	dropseed	42115
Poaceae	Stipa arida M.E. Jones	Achnatherum aridum	Mormon needlegrass	42159
Poaceae	Stipa comata Trin. & Rupr.	Hesperostipa comata	needle-and-thread	42172
Poaceae	Stipa coronata Thurb.	Achnatherum coronatum	giant ricegrass	42173
Poaceae	Stipa hymenoides Roemer & J.A. Schultes	Achnatherum hymenoides	Indian ricegrass	522063
Poaceae	Stipa L.	N/A	needlegrass	42158
Poaceae	Stipa neomexicana (Thurb.) Scribn.	Hesperostipa neomexicana	New Mexico feathergrass	507976
Poaceae	Stipa speciosa Trin. & Rupr.	Achnatherum speciosum	desert needlegrass	42194
Poaceae	Stipa X bloomeri	Achnatherum X bloomeri	Bloomer's ricegrass	507933
Poaceae	Tridens muticus (Torr.) Nash	Tridens muticus	slim tridens	42228
Poaceae	Vulpia C.C. Gmel.	Vulpia	fescue	42260
Poaceae	Vulpia microstachys (Nutt.) Munro	Vulpia microstachys	little fescue	42262
Polemoniaceae	Eriastrum diffusum (Gray) Mason	Eriastrum diffusum	diffuse woolstar, miniature woollystar	31059
Polemoniaceae	Gilia hutchinsifolia Rydb.	Gilia hutchinsifolia	desert pale gilia	31125
Polemoniaceae	Gilia inconspicua (Sm.) Sweet	Gilia inconspicua	shy gilia	31127
Polemoniaceae	Gilia latifolia S. Wats.	Gilia latifolia	broadleaf gilia	31139
Polemoniaceae	Gilia leptomeria Gray	Gilia leptomeria	sand gilia, slender gilia	31150

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Polemoniaceae	Gilia Ruiz & Pavón	Gilia	gilia, gilia spp.	31075
Polemoniaceae	Ipomopsis aggregata (Pursh) V. Grant	Ipomopsis aggregata	scarlet gilia	31192
Polemoniaceae	Ipomopsis congesta var. frutescens (Rydb.) Day	Ipomopsis congesta ssp. frutescens	Shrubby gilia	31205
Polemoniaceae	Ipomopsis gunnisonii (Torr. & Gray) V. Grant	Ipomopsis gunnisonii	sanddune skyrocket	31210
Polemoniaceae	Ipomopsis longiflora (Torr.) V. Grant	Ipomopsis longiflora	Flaxflowered gilia	31198
Polemoniaceae	Ipomopsis Michx.	Ipomopsis	gilia, ipomopsis	31191
Polemoniaceae	Ipomopsis polycladon (Torr.) V. Grant	Ipomopsis polycladon	manybranched gilia	31216
Polemoniaceae	Ipomopsis pumila (Nutt.) V. Grant	Ipomopsis pumila	dwarf gilia	31217
Polemoniaceae	Ipomopsis roseata (Rydb.) V. Grant	Ipomopsis roseata	rosy ipomopsis	31218
Polemoniaceae	Leptodactylon pungens (Torr.) Torr. ex Nutt.	Leptodactylon pungens	granite prickly phlox	31233
Polemoniaceae	Leptodactylon watsonii (Gray) Rydb.	Leptodactylon watsonii	Watson's prickly phlox	503390
Polemoniaceae	Phlox austromontana Coville	Phlox austromontana	desert mountain phlox	30913
Polemoniaceae	Phlox L.	Phlox	phlox	30897
Polemoniaceae	Polemoniaceae	Polemoniaceae	phlox	30896
Polygalaceae	Polygala acanthoclada	Polygala acanthoclada	desert polygala	29322
Polygalaceae	Polygala L.	Polygala	milkwort	29302
Polygonaceae	Chorizanthe brevicornu	Chorizanthe brevicornu	brittle spineflower	21007
Polygonaceae	Eriogonum alatum Torr.	Eriogonum alatum	winged buckwheat	21057
Polygonaceae	Eriogonum bicolor M.E. Jones	Eriogonum bicolor	pretty buckwheat	21078
Polygonaceae	Eriogonum cernuum Nutt.	Eriogonum cernuum	nodding buckwheat	21090
Polygonaceae	Eriogonum corymbosum Benth.	Eriogonum corymbosum	corymbed buckwheat, crispleaf buckwheat	21103
Polygonaceae	Eriogonum corymbosum var. corymbosum Benth.	Eriogonum corymbosum var. corymbosum	crispleaf buckwheat	195443
Polygonaceae	Eriogonum deflexum Torr.	Eriogonum deflexum	skeletonweed	21111
Polygonaceae	Eriogonum inflatum Torr. & Frém.	Eriogonum inflatum	Native American pipeweed	21163
Polygonaceae	Eriogonum inflatum var. fusiforme (Small) Reveal	Eriogonum fusiforme	Native American pipeweed	195498
Polygonaceae	Eriogonum jamesii Benth.	Eriogonum jamesii	James' buckwheat	21167
Polygonaceae	Eriogonum leptocladon Torr. & Gray	Eriogonum leptocladon	sand buckwheat	21179
Polygonaceae	Eriogonum leptophyllum (Torr. & Gray) Woot. & Standl.	Eriogonum leptophyllum	slenderleaf buckwheat	21180
Polygonaceae	Eriogonum Michx.	Eriogonum	buckwheat, wild buckwheat	21054

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Polygonaceae	Eriogonum microthecum Nutt.	Eriogonum microthecum	slender buckwheat	21192
Polygonaceae	Eriogonum microthecum var. foliosum (Torr. & Gray) Reveal	Eriogonum microthecum var. simpsonii	Simpson's buckwheat	535156
Polygonaceae	Eriogonum palmerianum Reveal	Eriogonum palmerianum	Palmer's buckwheat	502413
Polygonaceae	Eriogonum racemosum Nutt.	Eriogonum racemosum	redroot buckwheat	21230
Polygonaceae	Eriogonum shockleyi S. Wats.	Eriogonum shockleyi	Shockley's buckwheat	21245
Polygonaceae	Eriogonum umbellatum ssp. subaridum (S. Stokes) Munz	Eriogonum umbellatum var. subaridum	sulphur-flower buckwheat	195621
Polygonaceae	Eriogonum umbellatum Torr.	Eriogonum umbellatum	sulfur buckwheat	21266
Polygonaceae	Eriogonum wetherillii Eastw.	Eriogonum wetherillii	Wetherill's buckwheat	21278
Polygonaceae	Polygonum lapathifolium L.	Polygonum lapathifolium	curlytop knotweed	20860
Polygonaceae	Rumex crispus L.	Rumex crispus	curly dock	20937
Polygonaceae	Rumex hymenosepalus Torr.	Rumex hymenosepalus	canaigre	20962
Polygonaceae	Rumex L.	Rumex	dock, dock species	20933
Polygonaceae	Rumex maritimus L.	Rumex maritimus	bristle dock, golden dock	20965
Portulacaceae	Portulaca halimoides L.	Portulaca halimoides	silkcotton purslane	20431
Portulacaceae	Portulaca oleracea L.	Portulaca oleracea	common purslane, wild portulaca	20422
Portulacaceae	Portulaca pilosa L.	Portulaca pilosa	kiss me quick	20425
Portulacaceae	Talinum brevifolium Torr.	Talinum brevifolium	pygmy fameflower	20445
Portulacaceae	Talinum parviflorum Nutt.	Talinum parviflorum	prairie flameflower	20453
Potamogetonaceae	Potamogeton L.	Potamogeton	pondweed	39005
Primulaceae	Primula specuicola Rydb.	Primula specuicola	cave-dwelling primrose	24032
Pteridaceae	Adiantum capillus-veneris L.	Adiantum capillus-veneris	common maidenhair fern	17308
Pteridaceae	Adiantum L.	Adiantum	maidenhair fern	17307
Ranunculaceae	Aquilegia L.	Aquilegia	columbine	18728
Ranunculaceae	Aquilegia micrantha Eastw.	Aquilegia micrantha	Mancos columbine	18743
Ranunculaceae	Clematis ligusticifolia Nutt.	Clematis ligusticifolia	virgins bower, western white clematis	18702
Ranunculaceae	Clematis orientalis L.	Clematis orientalis	Oriental virginsbower	18705
Ranunculaceae	Delphinium L.	Delphinium	larkspur	18457
Ranunculaceae	Delphinium scaposum Greene	Delphinium scaposum	barestem larkspur, tall mountain larkspur	18507
Rhamnaceae	Ceanothus greggii Gray	Ceanothus greggii	desert ceanothus	28473

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Rhamnaceae	Ceanothus greggii var. franklinii Welsh	Ceanothus greggii var. franklinii	desert ceanothus	531448
Rhamnaceae	Rhamnus betulifolia Greene	Frangula betulifolia	birchleaf buckthorn	28563
Rosaceae	Amelanchier utahensis Koehne	Amelanchier utahensis	Utah serviceberry	25121
Rosaceae	Cercocarpus intricatus S. Wats.	Cercocarpus intricatus	littleleaf mountain mahogany	25133
Rosaceae	Cercocarpus montanus Raf.	Cercocarpus montanus	alderleaf mountain mahogany	25136
Rosaceae	Coleogyne ramosissima Torr.	Coleogyne ramosissima	blackbrush	25150
Rosaceae	Fallugia paradoxa (D. Don) Endl. ex Torr.	Fallugia paradoxa	Apache plume	25167
Rosaceae	Petrophyton caespitosum (Nutt.) Rydb.	Petrophyton caespitosum	mat rockspirea	25272
Rosaceae	Prunus fasciculata (Torr.) Gray	Prunus fasciculata	desert almond, desert peach	24777
Rosaceae	Purshia DC. ex Poir.	Purshia	bitterbrush, cliffrose	25288
Rosaceae	Purshia mexicana (D. Don) Henrickson	Purshia mexicana	Mexican cliffrose	195899
Rosaceae	Purshia tridentata (Pursh) DC.	Purshia tridentata	antelope bitterbrush	25290
Rosaceae	Rosa L.	Rosa	rose, wildrose spp.	24807
Rosaceae	Rosa woodsii Lindl.	Rosa woodsii	Woods' rose	24847
Rubiaceae	Galium aparine L.	Galium aparine	bedstraw	34797
Rubiaceae	Galium L.	Galium	bedstraw	34796
Rutaceae	Thamnosma montana	Thamnosma montana	turpentinebroom	29004
Salicaceae	Populus angustifolia James	Populus angustifolia	narrowleaf cottonwood	22452
Salicaceae	Populus fremontii S. Wats.	Populus fremontii	Fremont's cottonwood	22459
Salicaceae	Salix amygdaloides Anderss.	Salix amygdaloides	peachleaf willow	22499
Salicaceae	Salix eriocephala (Michx.)	Salix eriocephala	Missouri willow	22528
Salicaceae	Salix exigua Nutt.	Salix exigua	coyote willow, sandbar willow	22529
Salicaceae	Salix gooddingii Ball	Salix gooddingii	Goodding's willow	22539
Salicaceae	Salix L.	Salix	willow	22476
Santalaceae	Comandra umbellata (L.) Nutt.	Comandra umbellata	bastard toadflax	501614
Santalaceae	Comandra umbellata var. pallida (A. DC.) M.E. Jones	Comandra umbellata ssp. pallida	pale bastard toadflax	533741
Scrophulariaceae	Castilleja chromosa A. Nels.	Castilleja applegatei ssp. martinii	wavyleaf Indian paintbrush	33102
Scrophulariaceae	Castilleja exilis A. Nels.	Castilleja minor	lesser Indian paintbrush	33113
Scrophulariaceae	Castilleja linariifolia Benth.	Castilleja linariifolia	Wyoming Indian paintbrush	33138
Scrophulariaceae	Castilleja Mutis ex L. f.	Castilleja	Indian paintbrush	33049
Scrophulariaceae	Cordylanthus Nutt. ex Benth.	Cordylanthus	bird's beak	33537

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Scrophulariaceae	Cordylanthus parviflorus (Ferris) Wiggins	Cordylanthus parviflorus	purple bird'sbeak	33572
Scrophulariaceae	Cordylanthus wrightii Gray	Cordylanthus wrightii	Wright's bird's beak	33577
Scrophulariaceae	Mimulus cardinalis Eastw., non Dougl. ex Benth.	Mimulus eastwoodiae	crimson monkeyflower	33300
Scrophulariaceae	Orthocarpus Nutt.	Orthocarpus	orthocarpus, owlclover	33430
Scrophulariaceae	Pedicularis centranthera Gray	Pedicularis centranthera	dwarf lousewort	33367
Scrophulariaceae	Penstemon ambiguus Torr.	Penstemon ambiguus	bush penstemon, gilia penstemon	33808
Scrophulariaceae	Penstemon comarrhenus Gray	Penstemon comarrhenus	dusty beardtongue, dusty penstemon	33854
Scrophulariaceae	Penstemon eatonii Gray	Penstemon eatonii	Eaton's penstemon	33686
Scrophulariaceae	Penstemon ophianthus Pennell	Penstemon ophianthus	Arizona beardtongue, coiled anther penstemon	504222
Scrophulariaceae	Penstemon pachyphyllus Gray ex Rydb.	Penstemon pachyphyllus	thickleaf penstemon	33963
Scrophulariaceae	Penstemon palmeri Gray	Penstemon palmeri	Palmer's penstemon	33738
Scrophulariaceae	Penstemon rostriflorus Kellogg	Penstemon rostriflorus	beaked beardtongue, Bridge penstemon	504226
Scrophulariaceae	Penstemon Schmidel	Penstemon	beardtongue, penstemon	33665
Scrophulariaceae	Penstemon utahensis Eastw.	Penstemon utahensis	Utah penstemon	33785
Scrophulariaceae	Veronica anagallis Linnaeus	Veronica anagallis-aquatica	water speedwell	33410
Solanaceae	Datura L.	Datura	datura, jimsonweed	30513
Solanaceae	Datura wrightii Regel	Datura wrightii	sacred datura	30521
Solanaceae	Lycium andersonii Gray	Lycium andersonii	Anderson wolfberry, water jacket	30532
Solanaceae	Lycium pallidum Miers	Lycium pallidum	pale wolfberry	30544
Solanaceae	Nicotiana L.	Nicotiana	tobacco	30562
Solanaceae	Physalis L.	Physalis	ground cherry, groundcherry	30587
Tamaricaceae	Tamarix chinensis Lour.	Tamarix chinensis	Chinese saltcedar, tamarisk, tamarix	22308
Tamaricaceae	Tamarix L.	Tamarix	tamarisk	22303
Typhaceae	Typha domingensis Pers.	Typha domingensis	southern cattail	42327
Typhaceae	Typha L.	Typha	cattail	42324
Ulmaceae	Celtis laevigata var. reticulata (Torr.) L. Benson	Celtis laevigata var. reticulata	netleaf hackberry	527226
Verbenaceae	Verbena L.	Verbena	verbena, vervain	32070
Violaceae	Viola nephrophylla Greene	Viola nephrophylla	northern bog violet, wanderer violet	22117
Vitaceae	Parthenocissus vitacea (Knerr) A.S. Hitchc.	Parthenocissus vitacea	Virginia creeper, woodbine	28605

NON-VASCULAR PLANTS

Family	Scientific Name (Welsh et al. 20013)	Scientific Name (Kartesz 1999)	CommonName	TSN
Bacidiaceae	Squamarina Poelt	N/A	rim lichen	190068
Candelariaceae	Candelariella Mull. Arg.	N/A	eggyolk lichen	190230
Catillariaceae	Toninia A. Massal.	N/A	bruised lichen	190205
Collemataceae	Collema Wigg.	N/A	jelly lichen	191331
Hymeneliaceae	Aspicilia Massal.	N/A	rimmed lichen	189695
Marchantiophytina	Marchantiophytina	N/A	liverworts	846120
Psoraceae	Psora Hoffm.	N/A	fishscale lichen	190026
Teloschistaceae	Fulgensia Massal.and De Not.	N/A	sulphur lichen	191759
Verrucariaceae	Endocarpon Hedwig	N/A	chalice lichen	N/A

Appendix E. Field Plot Crosswalk to NVC Associations

Plots, observation points, and accuracy assessment (AA) points are assigned to National Vegetation Classification associations based on their composition and structure as they were recorded in the field. A total of 183 NVC associations and fourteen “Park Specials” were described for Glen Canyon National Recreation Area and Rainbow Bridge National Monument. Thirty associations in the table below were documented only during accuracy assessment (Plot codes in the rightmost column contain the letters “AA”). Accuracy assessment points assigned to associations already described from plots or observation points are not included in this table unless they comprise the majority of plots sampled in the type and/or were used to inform the local descriptions (see Appendix F). Element codes are used by NatureServe and state Natural Heritage Programs to track nomenclature and status of rare plants, rare animals, and communities (“elements”). Nomenclature used by the NVC follows Kartesz (1999).

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Acamptopappus sphaerocephalus - Ephedra spp. Shrubland	CEPP005684	22	GLCA.1004, GLCA.1063, GLCA.1068, GLCA.1079, GLCA.1081, GLCA.2065, GLCA.2068, GLCA.2074, GLCA.2085, GLCA.4014, GLCA.4225, GLCA.4231, GLCA.4239, GLCA.4241, GLCA.5161, GLCA.5174, GLCA_AA.1405, GLCA_AA.1551, GLCA_AA.1562, GLCA_AA.1567, GLCA_AA.3045, GLCA_AA.8002
Acer grandidentatum / Quercus gambelii Forest	CEGL000559	2	GLCA.4219, GLCA_AA.1882
Acer negundo - Salix gooddingii / Equisetum hyemale Woodland	Park Special	1	GLCA.5210
Acer negundo / Disturbed Understory Riparian Woodland	CEGL002693	2	GLCA.5238, GLCA.5240
Achnatherum hymenoides - Psoralidium lanceolatum Grassland	CEGL001650	1	GLCA.5157
Achnatherum hymenoides - Sporobolus contractus Grassland	CEGL001652	6	GLCA.1074, GLCA.4316, GLCA.4328, GLCA_AA.1208, GLCA_AA.1654, GLCA_AA.1937
Achnatherum hymenoides Colorado Plateau Grassland	CEGL002343	12	GLCA.1062, GLCA.1085, GLCA.2067, GLCA.2095, GLCA.4080, GLCA_AA.0072, GLCA_AA.0256, GLCA_AA.1168, GLCA_AA.1169, GLCA_AA.1367, GLCA_AA.1550, GLCA_AA.3077
Alhagi maurorum Ruderal Scrub	CEGL002784	2	GLCA.5113, GLCA.5123
Amelanchier utahensis - Artemisia tridentata (ssp. vaseyana, ssp. wyomingensis) Shrubland	CEGL002820	4	GLCA_AA.1371, GLCA_AA.1805, GLCA_AA.1885, GLCA_AA.2026
Amelanchier utahensis Shrubland	CEGL001067	7	GLCA.0112, GLCA.0571, GLCA_AA.1189, GLCA_AA.1933, GLCA_AA.1934, GLCA_AA.2045, GLCA_AA.2064
Aquilegia micrantha Herbaceous Vegetation	CEGL002762	2	GLCA.9302, GLCA.9708
Artemisia bigelovii - Ephedra (viridis, torreyana) Talus Shrubland	CEGL003755	7	GLCA.0318, GLCA.0746, GLCA.2037, GLCA.4056, GLCA.4058, GLCA.5014, GLCA.9307
Artemisia bigelovii Shrubland	CEGL000276	4	GLCA.0546, GLCA_AA.1560, GLCA_AA.1828, GLCA_AA.1850
Artemisia filifolia - Ephedra (torreyana, viridis) Shrubland	CEGL002786	9	GLCA.6190, GLCA_AA.0017, GLCA_AA.0018, GLCA_AA.0019, GLCA_AA.0209, GLCA_AA.1134, GLCA_AA.1390, GLCA_AA.2088, GLCA_AA.3065

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Artemisia filifolia - Ephedra cutleri Sandsheet Shrubland	CEPP005686	26	GLCA.1007, GLCA.1053, GLCA.1086, GLCA.1087, GLCA.2033, GLCA.2056, GLCA.2058, GLCA.2059, GLCA.2061, GLCA.2089, GLCA.2091, GLCA.2096, GLCA.4124, GLCA.4226, GLCA.4340, GLCA.5031, GLCA.5038, GLCA.5104, GLCA.5146, GLCA.5215, GLCA.5250, GLCA.5268, GLCA.5558, GLCA.5561, GLCA.5568, GLCA.5572
Artemisia filifolia / Sporobolus flexuosus Shrubland	Park Special	1	GLCA_AA.1989
Artemisia filifolia Colorado Plateau Shrubland	CEGL002697	16	GLCA.0577, GLCA.0579, GLCA.5013, GLCA.5282, GLCA.9509, GLCA_AA.0029, GLCA_AA.0085, GLCA_AA.0483, GLCA_AA.1354, GLCA_AA.1355, GLCA_AA.1870, GLCA_AA.1974, GLCA_AA.2039, GLCA_AA.2041, GLCA_AA.3076, GLCA_AA.3098
Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Ruderal Shrubland	CEGL002699	9	GLCA.0775, GLCA.4322, GLCA.5239, GLCA.5242, GLCA_AA.1764, GLCA_AA.1766, GLCA_AA.1779, GLCA_AA.1988, GLCA_AA.4005
Artemisia tridentata Shrubland	CEGL000991	2	GLCA.4320, GLCA.5302
Artemisia tridentata ssp. wyomingensis / Achnatherum hymenoides Shrubland	CEGL001046	1	GLCA_AA.0578
Artemisia tridentata ssp. wyomingensis / Bouteloua gracilis Shrubland	CEGL001041	15	GLCA.0300, GLCA.0501, GLCA.0518, GLCA_AA.0178, GLCA_AA.0179, GLCA_AA.0180, GLCA_AA.0186, GLCA_AA.0187, GLCA_AA.0188, GLCA_AA.0189, GLCA_AA.0226, GLCA_AA.0231, GLCA_AA.0282, GLCA_AA.0572, GLCA_AA.0575
Artemisia tridentata ssp. wyomingensis / Disturbed Understory Ruderal Shrubland	CEGL002083	6	GLCA.4200, GLCA.4204, GLCA.4214, GLCA.6125, GLCA.6129, GLCA_AA.1816
Artemisia tridentata ssp. wyomingensis / Hesperostipa comata Colorado Plateau Shrubland	CEGL002761	3	GLCA_AA.1852, GLCA_AA.1854, GLCA_AA.1855
Artemisia tridentata ssp. wyomingensis / Poa fendleriana Shrubland	CEGL002775	1	GLCA_AA.0285
Artemisia tridentata ssp. wyomingensis / Sparse Understory Shrubland	CEGL002768	6	GLCA.0508, GLCA.0509, GLCA.4049, GLCA.4050, GLCA.4054, GLCA.4217
Atriplex canescens - Artemisia tridentata Shrubland	CEGL001282	2	GLCA.4318, GLCA.4323

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Atriplex canescens - Ephedra viridis Shrubland	CEGL003828	11	GLCA.4019, GLCA.4267, GLCA.4305, GLCA.5407, GLCA_AA.0047, GLCA_AA.0548, GLCA_AA.1472, GLCA_AA.1585, GLCA_AA.1594, GLCA_AA.1926, GLCA_AA.1991
Atriplex canescens - Ephedra viridis Talus Shrubland	CEGL001287	2	GLCA.0587, GLCA.5223
Atriplex canescens / Achnatherum hymenoides Shrubland	CEGL001289	6	GLCA.2038, GLCA.4247, GLCA.4301, GLCA.4330, GLCA.5023, RABR.5578
Atriplex canescens / Pleuraphis jamesii Shrubland	CEGL001288	6	GLCA.0566, GLCA_AA.0051, GLCA_AA.0631, GLCA_AA.1080, GLCA_AA.1521, GLCA_AA.1569
Atriplex canescens Desert Wash Shrubland	CEGL003470	6	GLCA.6230, GLCA_AA.1584, GLCA_AA.1845, GLCA_AA.1896, GLCA_AA.4020, GLCA_AA.4021
Atriplex canescens Shrubland	CEGL001281	5	GLCA.0580, GLCA.2044, GLCA.4245, GLCA.4296, GLCA.4337
Atriplex confertifolia - (Acamptopappus sphaerocephalus, Picrothamnus desertorum) / (Pleuraphis jamesii) Scrub	CEPP005685	16	GLCA.1003, GLCA.1019, GLCA.2004, GLCA.2016, GLCA.2023, GLCA.2024, GLCA.2026, GLCA.4007, GLCA.4016, GLCA.4023, GLCA.5001, GLCA.5009, GLCA.5011, GLCA.5016, GLCA.5020, GLCA.5022
Atriplex confertifolia / Achnatherum hymenoides Shrubland	CEGL001311	4	GLCA_AA.0529, GLCA_AA.0540, GLCA_AA.1641, GLCA_AA.1642
Atriplex confertifolia / Pleuraphis jamesii Shrubland	CEGL001304	12	GLCA.0120, GLCA.0122, GLCA.0321, GLCA.0542, GLCA.0759, GLCA.2029, GLCA.4060, GLCA.4062, GLCA.4084, GLCA.5044, GLCA.5289, GLCA.9108
Atriplex confertifolia Great Basin Shrubland	CEGL001294	15	GLCA.1020, GLCA.2006, GLCA.5290, GLCA.5507, GLCA_AA.0520, GLCA_AA.0543, GLCA_AA.1034, GLCA_AA.1040, GLCA_AA.1042, GLCA_AA.1120, GLCA_AA.1366, GLCA_AA.1611, GLCA_AA.1685, GLCA_AA.1851, GLCA_AA.2034
Atriplex confertifolia Sparse Shrubland	CEGL003830	16	GLCA.0725, GLCA.1002, GLCA.1013, GLCA.4009, GLCA.4020, GLCA.4066, GLCA.4085, GLCA.4096, GLCA.4266, GLCA.4285, GLCA.5010, GLCA.5021, GLCA.5051, GLCA.5096, GLCA.5107, GLCA.5186
Atriplex corrugata Dwarf-shrubland	CEGL001437	13	GLCA.1005, GLCA.1017, GLCA.2001, GLCA.2005, GLCA.2007, GLCA.2017, GLCA.2025, GLCA.4008, GLCA.4010, GLCA.4011, GLCA.4022, GLCA.5005, GLCA.5019

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Atriplex gardneri / Pleuraphis jamesii Dwarf-Shrubland	CEGL001441	10	GLCA.0115, GLCA_AA.0324, GLCA_AA.0365, GLCA_AA.0369, GLCA_AA.0370, GLCA_AA.0377, GLCA_AA.0380, GLCA_AA.0408, GLCA_AA.0410, GLCA_AA.0624
Atriplex gardneri Dwarf-Shrubland	CEGL001438	7	GLCA.0319, GLCA.0550, GLCA.0730, GLCA_AA.0348, GLCA_AA.0367, GLCA_AA.0409, GLCA_AA.0662
Atriplex obovata Talus Dwarf-shrubland	CEGL001789	8	GLCA.1025, GLCA.2030, GLCA.2069, GLCA.5087, GLCA.5130, GLCA_AA.1066, GLCA_AA.1111, GLCA_AA.1688
Baccharis (emoryi, salicina) - Salix exigua Wet Shrubland	CEGL005947	4	GLCA.4333, GLCA.4339, GLCA.5156, GLCA_AA.1997
Baccharis salicifolia Riparian Shrubland	CEGL003549	1	GLCA.5176
Baccharis salicina Shrubland	CEGL005007	6	GLCA.4253, GLCA.5109, GLCA_AA.1924, GLCA_AA.2062, GLCA_AA.3068, GLCA_AA.3069
Barren/Unvegetated	N/A	13	GLCA.2064, GLCA.4012, GLCA.4021, GLCA.4033, GLCA.4065, GLCA.4073, GLCA.4083, GLCA.5203, GLCA.5204, GLCA_AA.0557, GLCA_AA.1711, GLCA_AA.1865, GLCA_AA.3041
Betula occidentalis Desert Spring Shrubland	CEPP009680	1	GLCA.9300
Boulder pile	N/A	1	GLCA.6191
Bouteloua gracilis Grassland	CEGL001760	3	GLCA.0526, GLCA_AA.0314, GLCA_AA.0577
Brickellia longifolia Shrubland	CEGL005392	3	GLCA.5118, GLCA_AA.0433, GLCA_AA.0434
Bromus tectorum Ruderal Grassland	CEGL003019	16	GLCA.0591, GLCA.0595, GLCA.4206, GLCA.4222, GLCA.4234, GLCA.4235, GLCA.4290, GLCA.5057, GLCA.5084, GLCA.5177, GLCA.5191, GLCA.5192, GLCA.5224, GLCA.5515, GLCA.6127, GLCA.9501
Celtis laevigata var. reticulata - Quercus gambelii - Cercis orbiculata Slickrock Canyon Spring & Riparian Woodland	CEGL002359	11	GLCA.1014, GLCA.5194, GLCA.5408, GLCA.5433, GLCA.5501, GLCA.9510, GLCA_AA.0649, GLCA_AA.1261, GLCA_AA.1913, GLCA_AA.1982, GLCA_AA.8006
Cercocarpus intricatus Slickrock Sparse Vegetation	CEGL002977	4	GLCA.0547, GLCA_AA.0521, GLCA_AA.0556, GLCA_AA.1776
Chrysothamnus greenei - Gutierrezia sarothrae / Bouteloua gracilis - Pleuraphis jamesii Shrubland	Park Special	2	GLCA_AA.1192, GLCA_AA.1723
Chrysothamnus viscidiflorus / Disturbed Understory Shrubland	CEPP005695	6	GLCA.4213, GLCA.5048, GLCA.9503, GLCA.9505, GLCA_AA.1362, GLCA_AA.2043
Chrysothamnus viscidiflorus / Hesperostipa comata Shrubland	CEGL002799	2	GLCA.4205, GLCA_AA.1484

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Chrysothamnus viscidiflorus Talus Shrubland	CEGL002347	1	GLCA.1064
Coleogyne ramosissima - Acamptopappus sphaerocephalus - Ephedra torreyana Shrubland	CEPP005688	19	GLCA.1066, GLCA.1067, GLCA.1069, GLCA.1075, GLCA.2071, GLCA.2075, GLCA.2083, GLCA.2087, GLCA.5006, GLCA.5008, GLCA.5150, GLCA.5155, GLCA.5159, GLCA.5160, GLCA.5162, GLCA.5164, GLCA.5166, GLCA.5254, GLCA.6113
Coleogyne ramosissima - Ephedra cutleri Sandsheet Shrubland	CEPP005687	21	GLCA.1035, GLCA.1036, GLCA.1054, GLCA.1080, GLCA.2050, GLCA.2055, GLCA.2073, GLCA.2093, GLCA.4236, GLCA.4291, GLCA.4345, GLCA.5000, GLCA.5100, GLCA.5227, GLCA.5229, GLCA.5260, GLCA.5271, GLCA.5273, GLCA.5555, GLCA.5560, GLCA.5565
Coleogyne ramosissima - Ephedra spp. Warm Desert Shrubland	CEGL005297	56	GLCA.0116, GLCA.0117, GLCA.0324, GLCA.0325, GLCA.0327, GLCA.0330, GLCA.0739, GLCA.1022, GLCA.1032, GLCA.1065, GLCA.1076, GLCA.4017, GLCA.4018, GLCA.4024, GLCA.4034, GLCA.4036, GLCA.4038, GLCA.4039, GLCA.4040, GLCA.4059, GLCA.4106, GLCA.4122, GLCA.4123, GLCA.4139, GLCA.4143, GLCA.4341, GLCA.4346, GLCA.5025, GLCA.5027, GLCA.5041, GLCA.5042, GLCA.5134, GLCA.5149, GLCA.5154, GLCA.5179, GLCA.5197, GLCA.5209, GLCA.5550, GLCA.5554, GLCA.5557, GLCA.5570, GLCA.5571, GLCA.5575, GLCA.5580, GLCA.5581, GLCA.6102, GLCA.6104, GLCA.6109, GLCA.6112, GLCA.6115, GLCA.6118, GLCA.6121, GLCA.6122, GLCA.9311, GLCA.9702, GLCA.9703
Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Shrubland	CEGL002348	10	GLCA.2019, GLCA.2035, GLCA.4147, GLCA.4348, GLCA.5091, GLCA.5228, GLCA.5258, GLCA.5270, GLCA.5306, GLCA.5319
Coleogyne ramosissima / Pleuraphis jamesii Shrubland	CEGL001334	16	GLCA.0548, GLCA.0596, GLCA.0741, GLCA.2008, GLCA.2043, GLCA.2072, GLCA.2076, GLCA.4004, GLCA.4015, GLCA.4108, GLCA.4308, GLCA.5045, GLCA.5294, GLCA.6100, GLCA.6105, GLCA.9111

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Coleogyne ramosissima Shrubland	CEGL001332	59	GLCA.0310, GLCA.0313, GLCA.0314, GLCA.0336, GLCA.0537, GLCA.0540, GLCA.0551, GLCA.0593, GLCA.0709, GLCA.0720, GLCA.0733, GLCA.0734, GLCA.0736, GLCA.0761, GLCA.0770, GLCA.1006, GLCA.1021, GLCA.1037, GLCA.1038, GLCA.2021, GLCA.2022, GLCA.2036, GLCA.2046, GLCA.2081, GLCA.2097, GLCA.4005, GLCA.4041, GLCA.4141, GLCA.4146, GLCA.4210, GLCA.4212, GLCA.4223, GLCA.4281, GLCA.4284, GLCA.4347, GLCA.5003, GLCA.5007, GLCA.5028, GLCA.5030, GLCA.5043, GLCA.5111, GLCA.5153, GLCA.5252, GLCA.5255, GLCA.5264, GLCA.5269, GLCA.5274, GLCA.5320, GLCA.5321, GLCA.5436, GLCA.5559, GLCA.9103, GLCA.9105, GLCA.9107, GLCA.9513, GLCA.9704, GLCA.9705, GLCA.9706, RABR.5577
Coleogyne ramosissima Sparse Shrubland	CEGL003834	26	GLCA.0322, GLCA.0536, GLCA.0543, GLCA.0544, GLCA.0545, GLCA.0740, GLCA.1033, GLCA.2047, GLCA.2063, GLCA.2092, GLCA.4013, GLCA.4042, GLCA.4093, GLCA.4112, GLCA.4114, GLCA.4118, GLCA.4303, GLCA.4309, GLCA.5082, GLCA.5086, GLCA.5216, GLCA.5257, GLCA.5265, GLCA.9106, GLCA.9308, GLCA.9309
Distichlis spicata Alkaline Wet Meadow	CEGL001770	3	GLCA.4069, GLCA_AA.1157, GLCA_AA.1759
Elaeagnus angustifolia Ruderal Riparian Woodland	CEGL005269	3	GLCA.5237, GLCA.5246, GLCA_AA.3073
Ephedra (torreyana, viridis) - Psorothamnus fremontii Shrubland	CEPP005690	23	GLCA.4109, GLCA.4125, GLCA.4140, GLCA.4244, GLCA.4248, GLCA.4278, GLCA.4335, GLCA.5026, GLCA.5075, GLCA.5200, GLCA.5220, GLCA.5251, GLCA.5256, GLCA.5259, GLCA.5283, GLCA.5401, GLCA.5504, GLCA.5509, GLCA.5551, GLCA.5552, GLCA.6233, GLCA.6234, GLCA.6235
Ephedra cutleri - Opuntia spp. / Mixed Grass Shrub-Steppe	CEPP005691	11	GLCA.1034, GLCA.2009, GLCA.4228, GLCA.4263, GLCA.4264, GLCA.5039, GLCA.5293, GLCA.5310, GLCA.5314, GLCA.6114, GLCA.9313
Ephedra cutleri / Achnatherum hymenoides - Muhlenbergia pungens - Oenothera pallida Sandsheet Shrubland	CEPP005689	8	GLCA_AA.0024, GLCA_AA.0319, GLCA_AA.0321, GLCA_AA.1036, GLCA_AA.1049, GLCA_AA.1055, GLCA_AA.1285, GLCA_AA.1596
Ephedra cutleri Shrubland	CEGL005804	6	GLCA.5317, GLCA.5566, GLCA_AA.1476, GLCA_AA.1601, GLCA_AA.1602, GLCA_AA.3029

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation	CEGL005801	49	GLCA.0114, GLCA.0121, GLCA.0123, GLCA.0124, GLCA.0125, GLCA.0129, GLCA.0320, GLCA.0535, GLCA.0727, GLCA.0731, GLCA.0737, GLCA.1023, GLCA.1024, GLCA.2032, GLCA.4030, GLCA.4031, GLCA.4061, GLCA.4099, GLCA.4100, GLCA.4101, GLCA.4111, GLCA.4113, GLCA.4119, GLCA.4121, GLCA.4144, GLCA.4145, GLCA.5012, GLCA.5073, GLCA.5078, GLCA.5089, GLCA.5090, GLCA.5093, GLCA.5103, GLCA.5131, GLCA.5132, GLCA.5218, GLCA.5402, GLCA.5422, GLCA.5423, GLCA.5427, GLCA.5513, GLCA.6116, GLCA.6117, GLCA.6119, GLCA.6120, GLCA.6123, GLCA.6124, GLCA.6231, GLCA.9109
Ephedra torreyana - (Atriplex spp.) / Nonvascular Gypsum Sparse Vegetation	CEGL002349	1	GLCA_AA.0442
Ephedra torreyana - Psorothamnus thompsoniae Shrubland	Park Special	1	GLCA_AA.1108
Ephedra torreyana / Achnatherum hymenoides - Pleuraphis jamesii Shrubland	CEGL002352	6	GLCA.4115, GLCA.4254, GLCA.5284, GLCA.5285, GLCA.5418, GLCA.5421
Ephedra torreyana / Pleuraphis jamesii Shrubland	CEGL003772	24	GLCA.0118, GLCA.0328, GLCA.0331, GLCA.0742, GLCA.0743, GLCA.1018, GLCA.2078, GLCA.4074, GLCA.4075, GLCA.4076, GLCA.4081, GLCA.4094, GLCA.4107, GLCA.4270, GLCA.4313, GLCA.5040, GLCA.5079, GLCA.5080, GLCA.5088, GLCA.5280, GLCA.5286, GLCA.5322, GLCA.6106, GLCA.6110
Ephedra torreyana / Sporobolus cryptandrus Shrubland	Park Special	1	GLCA_AA.2074
Ephedra torreyana Sparse Vegetation	CEGL002353	12	GLCA.0208, GLCA.0558, GLCA.1028, GLCA.1030, GLCA.4035, GLCA.4068, GLCA.4126, GLCA.4127, GLCA.4142, GLCA.5015, GLCA.5077, GLCA.5425
Ephedra viridis / (Achnatherum hymenoides - Hesperostipa comata) Shrubland	CEGL002354	11	GLCA.0109, GLCA.0529, GLCA.1055, GLCA.1058, GLCA.2060, GLCA.2088, GLCA.5152, GLCA.5169, GLCA.5202, GLCA.5266, GLCA.9306
Ephedra viridis / Bouteloua gracilis Shrubland	CEGL003934	17	GLCA.0106, GLCA.0107, GLCA.0311, GLCA.0525, GLCA.0706, GLCA.0723, GLCA_AA.0259, GLCA_AA.0261, GLCA_AA.0316, GLCA_AA.0318, GLCA_AA.0322, GLCA_AA.0352, GLCA_AA.0353, GLCA_AA.0354, GLCA_AA.0384, GLCA_AA.0571, GLCA_AA.1720
Ephedra viridis / Bromus tectorum Ruderal Shrubland	CEGL002355	4	GLCA.5182, GLCA.5184, GLCA.5195, GLCA_AA.1923
Ephedra viridis / Pleuraphis jamesii Shrubland	CEGL002356	12	GLCA.0767, GLCA.1015, GLCA.1059, GLCA.2042, GLCA.2090, GLCA.5059, GLCA.5231, GLCA.5291, GLCA.5295, GLCA.5297, GLCA.5301, GLCA.5307

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Ericameria nauseosa - (Xylorhiza tortifolia) Talus Sparse Shrubland	CEGL003961	4	GLCA.4272, GLCA.5419, GLCA.9310, GLCA_AA.1041
Ericameria nauseosa / Bromus tectorum Ruderal Shrubland	CEGL002937	5	GLCA.4002, GLCA.4252, GLCA.5185, GLCA.5415, GLCA_AA.3062
Ericameria nauseosa / Pleuraphis jamesii Shrubland	Park Special	1	GLCA.4089
Ericameria nauseosa / Sporobolus airoides Shrubland	CEGL002918	2	GLCA_AA.0252, GLCA_AA.1981
Ericameria nauseosa Desert Wash Shrubland	CEGL002261	25	GLCA.0127, GLCA.0130, GLCA.0559, GLCA.0728, GLCA.1001, GLCA.1011, GLCA.1012, GLCA.1027, GLCA.2011, GLCA.2013, GLCA.2018, GLCA.2034, GLCA.4082, GLCA.4086, GLCA.4220, GLCA.4292, GLCA.4344, GLCA.4349, GLCA.5116, GLCA.5253, GLCA.5424, GLCA.5426, GLCA.5505, GLCA.6236, GLCA.9506
Ericameria nauseosa Sand Deposit Sparse Shrubland	CEGL002980	1	GLCA.0306
Eriogonum corymbosum Badlands Sparse Vegetation	CEGL002979	7	GLCA.0323, GLCA.1031, GLCA.2031, GLCA.6107, GLCA_AA.0211, GLCA_AA.0212, GLCA_AA.1422
Fallugia paradoxa Colorado Plateau Desert Wash Shrubland	CEGL002357	7	GLCA.2028, GLCA.4117, GLCA.5412, GLCA.5420, GLCA.5502, GLCA.6101, GLCA.6103
Frangula betulifolia Wet Shrubland	CEPP009630	2	GLCA.4001, GLCA_AA.3070
Fraxinus anomala - Rhus trilobata Dry Talus and Slickrock Shrubland	CEGL003963	12	GLCA.0119, GLCA.0317, GLCA.0326, GLCA.0329, GLCA.0729, GLCA.4095, GLCA.5081, GLCA.5085, GLCA.5324, GLCA.5416, GLCA.5434, GLCA.5514
Fraxinus anomala Riparian Woodland	CEGL002752	6	GLCA.1016, GLCA.5511, GLCA_AA.0435, GLCA_AA.0544, GLCA_AA.0550, GLCA_AA.1194
Grayia spinosa Shrubland	CEGL002358	3	GLCA.5553, GLCA_AA.1517, GLCA_AA.1559
Gutierrezia (microcephala, sarothrae) - (Encelia frutescens) / Stephanomeria pauciflora Slickrock Dwarf-shrubland	CEPP005693	13	GLCA.1052, GLCA.1060, GLCA.1061, GLCA.1070, GLCA.1082, GLCA.1083, GLCA.2054, GLCA.4256, GLCA.4288, GLCA_AA.1644, GLCA_AA.1647, GLCA_AA.1704, GLCA_AA.1880
Gutierrezia (microcephala, sarothrae) Dwarf-shrubland	CEPP009523	7	GLCA.1008, GLCA.1073, GLCA.2027, GLCA.5017, GLCA.5049, GLCA.5053, GLCA_AA.1574
Gutierrezia sarothrae - Ephedra torreyana / Muhlenbergia porteri Herbaceous Shrubland	Park Special	1	GLCA_AA.0441
Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii Dwarf-shrubland	CEGL002690	9	GLCA.0719, GLCA.0777, GLCA.4300, GLCA.5055, GLCA_AA.1097, GLCA_AA.1102, GLCA_AA.1159, GLCA_AA.1165, GLCA_AA.1179

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Hesperostipa comata Great Basin Grassland	CEGL001705	14	GLCA.0582, GLCA.5243, GLCA.5247, GLCA_AA.0044, GLCA_AA.0060, GLCA_AA.0065, GLCA_AA.0067, GLCA_AA.0074, GLCA_AA.0635, GLCA_AA.0636, GLCA_AA.0637, GLCA_AA.0639, GLCA_AA.0659, GLCA_AA.3032
Juncus tenuis - Solidago canadensis Herbaceous Vegetation	Park Special	1	GLCA.5187
Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Wooded Shrubland	CEGL003774	19	GLCA.0315, GLCA.0316, GLCA.0557, GLCA.0711, GLCA.0722, GLCA.0749, GLCA.4000, GLCA.4314, GLCA.5004, GLCA.5076, GLCA.5083, GLCA.5135, GLCA.5296, GLCA.5556, GLCA.5564, GLCA.5567, GLCA.5569, GLCA.9304, GLCA.9507
Juniperus osteosperma / Achnatherum speciosa Wooded Herbaceous	Park Special	1	GLCA_AA.1216
Juniperus osteosperma / Aristida purpurea Woodland	Park Special	1	GLCA_AA.2005
Juniperus osteosperma / Artemisia tridentata Woodland	CEGL000730	6	GLCA.0590, GLCA.4047, GLCA_AA.1368, GLCA_AA.1427, GLCA_AA.1508, GLCA_AA.1509
Juniperus osteosperma / Cercocarpus intricatus Woodland	CEGL000733	6	GLCA.5325, GLCA_AA.0406, GLCA_AA.0513, GLCA_AA.1768, GLCA_AA.1772, GLCA_AA.1777
Juniperus osteosperma / Coleogyne ramosissima Woodland	CEGL002909	9	GLCA.4120, GLCA.4312, GLCA.5002, GLCA.5092, GLCA.5232, GLCA.5562, GLCA.5563, GLCA.6108, GLCA.9104
Juniperus osteosperma / Ericameria nauseosa / Bromus tectorum Woodland	Park Special	1	GLCA.9700
Juniperus osteosperma / Hesperostipa comata Woodland	CEGL002815	6	GLCA_AA.0042, GLCA_AA.0137, GLCA_AA.0505, GLCA_AA.0566, GLCA_AA.1238, GLCA_AA.2021
Juniperus osteosperma / Leymus salinus Open Woodland	CEGL003109	6	GLCA.0584, GLCA.0703, GLCA.0710, GLCA.0712, GLCA.5056, GLCA.9102
Juniperus osteosperma / Mahonia fremontii Woodland	CEGL003965	3	GLCA.0768, GLCA_AA.0401, GLCA_AA.0604
Juniperus osteosperma / Mixed Herbaceous Woodland	Park Special	1	RABR.5576

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Juniperus osteosperma / Mixed Shrubs Talus Woodland	CEGL002266	27	GLCA.5133, GLCA.6111, GLCA_AA.0195, GLCA_AA.0198, GLCA_AA.0216, GLCA_AA.0609, GLCA_AA.0641, GLCA_AA.0647, GLCA_AA.0660, GLCA_AA.1171, GLCA_AA.1185, GLCA_AA.1186, GLCA_AA.1245, GLCA_AA.1370, GLCA_AA.1373, GLCA_AA.1374, GLCA_AA.1505, GLCA_AA.1507, GLCA_AA.1755, GLCA_AA.1830, GLCA_AA.1960, GLCA_AA.1990, GLCA_AA.2006, GLCA_AA.2014, GLCA_AA.2028, GLCA_AA.2031, GLCA_AA.2033
Juniperus osteosperma / Pleuraphis jamesii Open Woodland	CEGL002362	23	GLCA.4071, GLCA.4091, GLCA.5047, GLCA.5305, GLCA_AA.0115, GLCA_AA.0201, GLCA_AA.0257, GLCA_AA.0597, GLCA_AA.1151, GLCA_AA.1154, GLCA_AA.1163, GLCA_AA.1174, GLCA_AA.1175, GLCA_AA.1191, GLCA_AA.1212, GLCA_AA.1214, GLCA_AA.1217, GLCA_AA.1230, GLCA_AA.1961, GLCA_AA.1963, GLCA_AA.2016, GLCA_AA.2017, GLCA_AA.2019
Juniperus osteosperma / Quercus gambelii Woodland	CEPP005696	9	GLCA.4249, GLCA.5410, GLCA_AA.1928, GLCA_AA.1936, GLCA_AA.1938, GLCA_AA.1969, GLCA_AA.1972, GLCA_AA.1984, GLCA_AA.2083
Juniperus osteosperma / Quercus havardii - Artemisia filifolia - Ephedra cutleri Sandsheet Scrub	CEPP005694	20	GLCA.4311, GLCA.4315, GLCA_AA.1221, GLCA_AA.1237, GLCA_AA.1242, GLCA_AA.1243, GLCA_AA.1248, GLCA_AA.1250, GLCA_AA.1251, GLCA_AA.1252, GLCA_AA.1258, GLCA_AA.1263, GLCA_AA.2025, GLCA_AA.3074, GLCA_AA.3080, GLCA_AA.3093, GLCA_AA.3094, GLCA_AA.3097, GLCA_AA.4000, GLCA_AA.4002
Juniperus osteosperma / Sparse Understory Woodland	CEGL000732	8	GLCA.4092, GLCA.5046, GLCA_AA.0481, GLCA_AA.1257, GLCA_AA.2018, GLCA_AA.3020, GLCA_AA.3050, GLCA_AA.3084
Krascheninnikovia lanata / Hesperostipa comata Dwarf-shrubland	CEGL001327	2	GLCA_AA.0061, GLCA_AA.0498
Krascheninnikovia lanata / Pleuraphis jamesii Dwarf-shrubland	CEGL001322	5	GLCA.0576, GLCA.0763, GLCA_AA.0048, GLCA_AA.0050, GLCA_AA.0077
Krascheninnikovia lanata Dwarf-shrubland	CEGL001320	2	GLCA_AA.0078, GLCA_AA.0547
Leymus salinus Shale Sparse Vegetation	CEGL002745	5	GLCA.0103, GLCA.0113, GLCA.0738, GLCA.0766, GLCA_AA.1148

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Lycium andersonii - Ephedra (torreyana, viridis) Shrubland	CEGL005150	4	GLCA.5117, GLCA_AA.1104, GLCA_AA.1109, GLCA_AA.1687
Mahonia fremontii Shrubland	CEGL003967	3	GLCA.0128, GLCA.4331, GLCA.5236
Muhlenbergia asperifolia Wet Meadow	CEGL001779	1	GLCA.4295
Muhlenbergia pungens Grassland	CEGL002363	2	GLCA.5318, GLCA_AA.0317
Oenothera pallida - Mixed Herbaceous Sand Dune Sparse Vegetation	Park Special	1	GLCA.2010
Opuntia (fragilis, polyacantha, phaeacantha) Shrubland	CEGL004009	1	GLCA.1029
Opuntia polyacantha / Pleuraphis jamesii Shrubland	CEGL002299	7	GLCA.0574, GLCA.0760, GLCA.4078, GLCA.5309, GLCA_AA.0626, GLCA_AA.0628, GLCA_AA.1180
Ostrya knowltonii Riparian Woodland	CEGL003971	3	GLCA.0776, GLCA.5411, GLCA_AA.0100
Phalaris arundinacea Western Marsh	CEGL001474	1	GLCA.5125
Phragmites australis Western Ruderal Wet Meadow	CEGL001475	10	GLCA.0530, GLCA.4246, GLCA.4250, GLCA.4251, GLCA.4268, GLCA.4336, GLCA.4338, GLCA.5413, GLCA_AA.1812, GLCA_AA.1975
Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia - Amelanchier utahensis) Wooded Shrubland	CEGL002334	22	GLCA.0105, GLCA.0133, GLCA.0305, GLCA.0510, GLCA.0554, GLCA.0555, GLCA.0561, GLCA.0564, GLCA.0565, GLCA.0567, GLCA.0569, GLCA.0570, GLCA.0573, GLCA.0747, GLCA.0753, GLCA.0757, GLCA.0758, GLCA.0769, GLCA.4070, GLCA.5037, GLCA.9112, GLCA.9511
Pinus edulis - Juniperus osteosperma / Achnatherum hymenoides Woodland	CEGL002364	3	GLCA.4329, GLCA_AA.0234, GLCA_AA.1241
Pinus edulis - Juniperus osteosperma / Amelanchier utahensis Woodland	CEGL002329	5	GLCA.0132, GLCA.0750, GLCA.4202, GLCA.6135, GLCA.9312
Pinus edulis - Juniperus osteosperma / Artemisia bigelovii Woodland	CEGL002118	8	GLCA.4055, GLCA.6134, GLCA_AA.0182, GLCA_AA.0309, GLCA_AA.1152, GLCA_AA.1732, GLCA_AA.1834, GLCA_AA.5555
Pinus edulis - Juniperus osteosperma / Artemisia nova Woodland	CEGL002331	8	GLCA.0503, GLCA.0520, GLCA_AA.0129, GLCA_AA.0146, GLCA_AA.0150, GLCA_AA.0152, GLCA_AA.1485, GLCA_AA.1495
Pinus edulis - Juniperus osteosperma / Artemisia tridentata (ssp. Wyomingensis, ssp. Vaseyana) Woodland	CEGL005658	8	GLCA.0101, GLCA.0502, GLCA.0568, GLCA.0724, GLCA.4053, GLCA.4201, GLCA.4218, GLCA.5035

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland	CEGL000779	16	GLCA.0302, GLCA.0307, GLCA.0504, GLCA.0505, GLCA.0527, GLCA.0575, GLCA.0581, GLCA.0700, GLCA.0714, GLCA.0764, GLCA.4045, GLCA.4048, GLCA.5034, GLCA.5036, GLCA.5313, GLCA.9301
Pinus edulis - Juniperus osteosperma / Cercocarpus montanus - Mixed Shrubs Woodland	CEGL005657	4	GLCA.0511, GLCA.0531, GLCA_AA.0141, GLCA_AA.0151
Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland	CEGL000781	13	GLCA.0126, GLCA.0308, GLCA.0335, GLCA.0528, GLCA.0563, GLCA.0578, GLCA.0772, GLCA.4105, GLCA.4211, GLCA.5292, GLCA.5299, GLCA.5312, GLCA.9101
Pinus edulis - Juniperus osteosperma / Ephedra viridis - Gutierrezia sarothrae Woodland	CEGL002370	31	GLCA.0717, GLCA.0771, GLCA.5060, GLCA.5061, GLCA.5069, GLCA.5311, GLCA_AA.0041, GLCA_AA.0069, GLCA_AA.0071, GLCA_AA.0088, GLCA_AA.0102, GLCA_AA.0208, GLCA_AA.0296, GLCA_AA.0310, GLCA_AA.0618, GLCA_AA.0655, GLCA_AA.1158, GLCA_AA.1161, GLCA_AA.1231, GLCA_AA.1239, GLCA_AA.1264, GLCA_AA.1281, GLCA_AA.1369, GLCA_AA.1627, GLCA_AA.1721, GLCA_AA.1728, GLCA_AA.1729, GLCA_AA.1730, GLCA_AA.1735, GLCA_AA.3021, GLCA_AA.3036
Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland	CEGL002328	10	GLCA.0131, GLCA.0304, GLCA.0556, GLCA.0572, GLCA.0594, GLCA.0705, GLCA.0708, GLCA.0748, GLCA.4090, GLCA.5303
Pinus edulis - Juniperus osteosperma / Muhlenbergia pungens Woodland	CEGL002373	2	GLCA_AA.0275, GLCA_AA.1722
Pinus edulis - Juniperus osteosperma / Pleuraphis jamesii Woodland	CEGL002379	3	GLCA.4317, GLCA_AA.0135, GLCA_AA.0616
Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland	CEGL000782	19	GLCA.0334, GLCA.0500, GLCA.0514, GLCA.0521, GLCA.0522, GLCA.0524, GLCA.0704, GLCA.0713, GLCA.0716, GLCA.0745, GLCA.4063, GLCA.4067, GLCA.4216, GLCA.5050, GLCA.5052, GLCA.5062, GLCA.5070, GLCA.5323, GLCA.5326
Pinus edulis - Juniperus osteosperma / Quercus gambelii Woodland	CEGL005659	8	GLCA.0303, GLCA.4207, GLCA.4215, GLCA.5063, GLCA.5064, GLCA.5066, GLCA.6126, GLCA.6128
Pinus edulis - Juniperus osteosperma / Quercus havardii var. tuckeri Woodland	CEGL002497	9	GLCA.0108, GLCA.0312, GLCA.4044, GLCA.4046, GLCA.4052, GLCA.9305, GLCA_AA.0621, GLCA_AA.1228, GLCA_AA.2022
Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland	CEGL004007	1	GLCA.5193

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia Woodland	CEGL002335	17	GLCA.0102, GLCA.0104, GLCA.0111, GLCA.0506, GLCA.0515, GLCA.0516, GLCA.0519, GLCA.0523, GLCA.0553, GLCA.0585, GLCA.0586, GLCA.0588, GLCA.0589, GLCA.0752, GLCA.0754, GLCA.0756, GLCA.4072
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	CEGL002148	22	GLCA.0100, GLCA.0110, GLCA.0301, GLCA.0507, GLCA.0512, GLCA.0513, GLCA.0517, GLCA.0532, GLCA.0533, GLCA.0534, GLCA.0560, GLCA.0592, GLCA.0701, GLCA.0718, GLCA.4051, GLCA.5033, GLCA.5067, GLCA.5068, GLCA.5300, GLCA.5308, GLCA.6132, GLCA.9303
Pinus edulis - Juniperus osteosperma / Symphoricarpos longiflorus Woodland	CEPP009635	2	GLCA.0765, GLCA_AA.0495
Pinus edulis - Juniperus spp. / Leymus salinus Woodland	CEGL002340	9	GLCA.0134, GLCA.0309, GLCA.0332, GLCA.0583, GLCA.0707, GLCA.0715, GLCA.0774, GLCA.9100, GLCA.9504
Pinus edulis - Juniperus spp. / Poa fendleriana Woodland	CEGL000787	9	GLCA.6130, GLCA.6131, GLCA.6133, GLCA_AA.1400, GLCA_AA.1401, GLCA_AA.1500, GLCA_AA.1502, GLCA_AA.1762, GLCA_AA.2015
Pleuraphis jamesii - Sporobolus airoides Grassland	CEGL001778	2	GLCA.0735, GLCA_AA.0111
Pleuraphis jamesii Grassland	CEGL001777	14	GLCA.0562, GLCA.0762, GLCA.0778, GLCA.4057, GLCA.4077, GLCA.4079, GLCA.5065, GLCA.5281, GLCA.5298, GLCA.5304, GLCA.5315, GLCA.5316, GLCA.5405, GLCA.5506
Pluchea sericea Wet Shrubland	CEGL003080	6	GLCA.2039, GLCA.4332, GLCA.5188, GLCA.5432, GLCA_AA.1418, GLCA_AA.1610
Poa fendleriana Grassland	CEGL001925	2	GLCA.4088, GLCA.4208
Poliomintha incana - Artemisia filifolia - Vanclevea stylosa Shrubland	CEGL002418	22	GLCA.0721, GLCA.0726, GLCA.1056, GLCA.2041, GLCA.4043, GLCA.4129, GLCA.4131, GLCA.4136, GLCA.4310, GLCA.5024, GLCA.5029, GLCA.5032, GLCA.5097, GLCA.5101, GLCA.5175, GLCA.5199, GLCA.5212, GLCA.5217, GLCA.5230, GLCA.5262, GLCA.5272, GLCA.5437
Polygala acanthoclada - Mixed Scrub	CEPP005698	3	GLCA_AA.1461, GLCA_AA.1860, GLCA_AA.1869
Populus fremontii - Salix gooddingii / Salix exigua Riparian Forest	CEGL002684	10	GLCA.4102, GLCA.4138, GLCA.4297, GLCA.4307, GLCA.4319, GLCA.4326, GLCA.5221, GLCA.5235, GLCA.5263, GLCA.9110
Populus fremontii - Salix gooddingii Riparian Woodland	CEGL0000944	6	GLCA.4289, GLCA.4299, GLCA.4304, GLCA.5213, GLCA_AA.1260, GLCA_AA.1999
Populus fremontii / Acer negundo Riparian Forest	CEGL000662	4	GLCA.5244, GLCA.5245, GLCA_AA.1293, GLCA_AA.3078

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Populus fremontii / Baccharis (emoryi, salicina) Riparian Woodland	CEGL002946	2	GLCA.2040, GLCA.5503
Populus fremontii / Ericameria nauseosa Riparian Woodland	CEGL002465	8	GLCA.2012, GLCA.5181, GLCA.5211, GLCA.5241, GLCA.5249, GLCA.5508, GLCA.6232, GLCA.9707
Populus fremontii / Frangula betulifolia - Quercus gambelii Spring & Riparian Woodland	CEPP005699	11	GLCA.4255, GLCA.4306, GLCA.5219, GLCA.5226, GLCA.5261, GLCA.5409, GLCA.5414, GLCA.5417, GLCA.5431, GLCA.5500, GLCA.5510
Populus fremontii / Mesic Forbs Riparian Woodland	CEGL002470	3	GLCA.5225, GLCA_AA.1126, GLCA_AA.1966
Populus fremontii / Mesic Graminoids Riparian Woodland	CEGL002473	7	GLCA.4087, GLCA.4321, GLCA.5180, GLCA.5435, GLCA_AA.0488, GLCA_AA.1196, GLCA_AA.4023
Populus fremontii / Salix exigua Riparian Forest	CEGL000666	15	GLCA.0552, GLCA.4325, GLCA.4327, GLCA.5234, GLCA_AA.0020, GLCA_AA.0023, GLCA_AA.0493, GLCA_AA.1070, GLCA_AA.1198, GLCA_AA.1206, GLCA_AA.1233, GLCA_AA.1244, GLCA_AA.3082, GLCA_AA.3085, GLCA_AA.4024
Populus fremontii / Scour Riparian Forest	CEGL005978	7	GLCA.4232, GLCA.4334, GLCA.5287, GLCA.5574, GLCA_AA.0648, GLCA_AA.0650, GLCA_AA.1147
Populus fremontii / Sparse Riparian Forest	CEGL005979	3	GLCA.4294, GLCA.5248, GLCA_AA.3072
Populus fremontii / Tamarix sp. Ruderal Riparian Woodland	CEGL005485	4	GLCA_AA.1122, GLCA_AA.1195, GLCA_AA.1234, GLCA_AA.1778
Pseudotsuga menziesii Scree Woodland	CEGL000911	3	GLCA.0702, GLCA_AA.0563, GLCA_AA.0564
Psorothamnus fremontii Shrubland	CEGL005154	2	GLCA_AA.1271, GLCA_AA.1272
Purshia stansburiana Shrubland	CEGL002957	2	GLCA.9500, GLCA.9502
Quercus gambelii / Amelanchier utahensis Shrubland	CEGL001110	10	GLCA.4203, GLCA.5512, GLCA_AA.1372, GLCA_AA.1658, GLCA_AA.1717, GLCA_AA.1718, GLCA_AA.1815, GLCA_AA.1881, GLCA_AA.1884, GLCA_AA.2056
Quercus gambelii / Artemisia tridentata Shrubland	CEGL001111	1	GLCA_AA.1814
Quercus gambelii / Mesic Herbaceous Woodland	Park Special	1	GLCA_AA.1656
Quercus gambelii / Poa fendleriana Shrubland	CEGL002949	1	GLCA_AA.1821
Quercus gambelii / Rhus trilobata Shrubland	CEGL002338	8	GLCA.4324, GLCA.5400, GLCA.5517, RABR.5579, GLCA_AA.2053, GLCA_AA.2061, GLCA_AA.2075, GLCA_AA.2078,
Quercus gambelii / Symphoricarpos oreophilus Shrubland	CEGL001117	1	GLCA_AA.1987

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Quercus gambelii Shrubland	CEGL002477	15	GLCA.5178, GLCA.5189, GLCA.5516, GLCA_AA.0238, GLCA_AA.1127, GLCA_AA.1699, GLCA_AA.1702, GLCA_AA.1719, GLCA_AA.1889, GLCA_AA.2060, GLCA_AA.2073, GLCA_AA.2076, GLCA_AA.3061, GLCA_AA.3063, GLCA_AA.3067
Quercus havardii var. tuckeri - Eriogonum leptocladon - Artemisia filifolia Sandsheet Shrubland	CEPP005692	7	GLCA.4343, GLCA.5233, GLCA.5582, GLCA_AA.1799, GLCA_AA.1803, GLCA_AA.2090, GLCA_AA.3057
Quercus havardii var. tuckeri Shrubland	CEGL002486	5	GLCA.4342, GLCA.5267, GLCA_AA.0397, GLCA_AA.1800, GLCA_AA.1867
Quercus turbinella - (Rhus trilobata, Artemisia tridentata) Shrubland	CEGL005168	1	GLCA.4271
Rhus trilobata - Ephedra (viridis, torreyana) Talus and Slickrock Shrubland	CEGL003776	12	GLCA.0538, GLCA.0539, GLCA.0549, GLCA.0732, GLCA.1077, GLCA.2020, GLCA.2070, GLCA.4003, GLCA.4006, GLCA.4064, GLCA.5112, GLCA.5151
Rhus trilobata Moist Wet Shrubland	CEGL001121	3	GLCA.9047, GLCA_AA.0036, GLCA_AA.0364
Salix exigua / Gravel Bar Wet Shrubland	CEGL005656	5	GLCA.5119, GLCA.5121, GLCA.5122, GLCA_AA.1027, GLCA_AA.1788
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Salix gooddingii / Salix exigua Riparian Woodland	CEGL003778	3	GLCA.4229, GLCA.4258, GLCA_AA.4014
Salsola spp. Ruderal Grassland	CEGL004004	9	GLCA.1050, GLCA.2053, GLCA.4133, GLCA.4224, GLCA.4293, GLCA.4298, GLCA.5148, GLCA.5222, GLCA.5573
Sarcobatus vermiculatus / Atriplex gardneri Wet Shrubland	CEGL001360	1	GLCA_AA.0387
Sarcobatus vermiculatus / Sporobolus airoides Wet Shrubland	CEGL001368	2	GLCA_AA.0015, GLCA_AA.1782
Sarcobatus vermiculatus / Suaeda moquinii Wet Shrubland	CEGL001370	2	GLCA_AA.0030, GLCA_AA.0372
Sarcobatus vermiculatus Disturbed Wet Shrubland	CEGL001357	4	GLCA.5058, GLCA_AA.1784, GLCA_AA.2081, GLCA_AA.3033
Sporobolus airoides Southern Plains Wet Meadow	CEGL001685	7	GLCA.0541, GLCA.0751, GLCA.9512, GLCA_AA.0200, GLCA_AA.0297, GLCA_AA.0335, GLCA_AA.0351
Sporobolus cryptandrus Great Basin Grassland	CEGL002691	3	GLCA_AA.0066, GLCA_AA.1590, GLCA_AA.1660
Suaeda moquinii Wet Shrubland	CEGL001991	4	GLCA.1009, GLCA.2003, GLCA.2014, GLCA_AA.1844

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation, and AA Point Assignments
Tamarix chinensis Ruderal Lakeshore Scrub	CEPP005697	24	GLCA.1039, GLCA.1051, GLCA.1071, GLCA.2052, GLCA.2094, GLCA.4037, GLCA.4230, GLCA.4261, GLCA.4275, GLCA.4277, GLCA.4279, GLCA.4283, GLCA.4287, GLCA.5094, GLCA.5099, GLCA.5105, GLCA.5196, GLCA.5430, GLCA_AA.0506, GLCA_AA.0507, GLCA_AA.1014, GLCA_AA.1098, GLCA_AA.1099, GLCA_AA.1100
Tamarix spp. Ruderal Riparian Shrubland	CEGL003114	92	GLCA.1010, GLCA.1026, GLCA.1057, GLCA.1072, GLCA.1078, GLCA.1084, GLCA.1088, GLCA.2015, GLCA.2045, GLCA.2051, GLCA.2057, GLCA.2062, GLCA.2066, GLCA.2077, GLCA.2079, GLCA.2080, GLCA.2082, GLCA.2084, GLCA.2086, GLCA.4032, GLCA.4097, GLCA.4098, GLCA.4103, GLCA.4116, GLCA.4128, GLCA.4130, GLCA.4132, GLCA.4134, GLCA.4135, GLCA.4137, GLCA.4221, GLCA.4227, GLCA.4233, GLCA.4237, GLCA.4238, GLCA.4240, GLCA.4242, GLCA.4243, GLCA.4257, GLCA.4259, GLCA.4260, GLCA.4262, GLCA.4265, GLCA.4273, GLCA.4274, GLCA.4276, GLCA.4280, GLCA.4282, GLCA.5018, GLCA.5054, GLCA.5071, GLCA.5072, GLCA.5095, GLCA.5098, GLCA.5102, GLCA.5106, GLCA.5108, GLCA.5110, GLCA.5114, GLCA.5115, GLCA.5120, GLCA.5126, GLCA.5127, GLCA.5129, GLCA.5145, GLCA.5147, GLCA.5158, GLCA.5163, GLCA.5165, GLCA.5167, GLCA.5168, GLCA.5170, GLCA.5171, GLCA.5172, GLCA.5173, GLCA.5183, GLCA.5190, GLCA.5198, GLCA.5201, GLCA.5205, GLCA.5206, GLCA.5207, GLCA.5208, GLCA.5214, GLCA.5288, GLCA.5403, GLCA.5404, GLCA.5406, GLCA.5428, GLCA.5429, GLCA.6220, GLCA.9508
Toxicodendron rydbergii / Mixed Forb Hanging Garden Scrub	CEPP005700	1	GLCA.9701
Typha domingensis Western Marsh	CEGL001845	2	GLCA.4269, GLCA.4286
Zuckia brandegeei Sparse Vegetation	CEGL002493	9	GLCA.0333, GLCA.0744, GLCA.0755, GLCA.0773, GLCA_AA.0120, GLCA_AA.0598, GLCA_AA.0601, GLCA_AA.0615, GLCA_AA.1695

Appendix F. Plant Association Descriptions for Glen Canyon National Recreation Area and Rainbow Bridge National Monument

Descriptions of National Vegetation Classification Standard (NVCS) vegetation Associations from the Glen Canyon National Recreation Area and Rainbow Bridge National Monument Vegetation Classification and Mapping Project. Not all vegetation types encountered during sampling were described. Descriptions were written only when associations had been sampled two or more times and when project ecologists felt confident that the samples captured a type of vegetation which represented a unit repeated across the landscape in the project area. Several unique types were named but not described.

INTERNATIONAL ECOLOGICAL CLASSIFICATION STANDARD: TERRESTRIAL ECOLOGICAL CLASSIFICATIONS

Associations and Alliances of Glen Canyon National Recreation Area and Rainbow Bridge National Monument

28 September 2016

by

NatureServe

600 North Fairfax Drive, 7th Floor

Arlington, VA 22203

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Boulder, CO 80301

This subset of the International Ecological Classification Standard covers vegetation associations and alliances of Glen Canyon National Recreation Area. This classification has been developed in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. Comments and suggestions regarding the contents of this subset should be directed to Mary J. Russo, Central Ecology Data Manager, NC <mary_russo@natureserve.org> and Marion Reid, Senior Regional Ecologist, Boulder, CO <marion_reid@natureserve.org>.



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[1] NatureServe is an international organization including NatureServe regional offices, a NatureServe central office, U.S. State Natural Heritage Programs, and Conservation Data Centres (CDC) in Canada and Latin America and the Caribbean. Ecologists from the following organizations have contributed the development of the ecological systems classification:

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1. Forest & Woodland

1.B.2. Cool Temperate Forest & Woodland

1.B.2.Nb. Rocky Mountain Forest & Woodland

M020. Rocky Mountain Subalpine-High Montane Conifer Forest

G222. Rocky Mountain Subalpine-Montane Aspen Forest & Woodland

Group Summary Description: This widespread group is more common in the southern and central Rocky Mountains but occurs in the montane and subalpine zones throughout much of the western U.S., south into northern Mexico and north into Canada. An eastern extension occurs along the Rocky Mountains foothill front, in mountain "islands" in Montana (Big Snowy and Highwood mountains), and the Black Hills of South Dakota. In California, this group is in the Sierra Nevada adjacent to the Great Basin. Large stands are found in the Inyo and White mountains, while small stands occur on the Modoc Plateau. Elevations generally range from 1525 to 3050 m (5000-10,000 feet), but occurrences can be found at lower elevations in some regions. Distribution of this group is primarily limited by adequate soil moisture required to meet its high evapotranspiration demand. Secondarily, it is limited by the length of the growing season or low temperatures. These are upland forests and woodlands dominated by *Populus tremuloides* without a significant conifer component (<25% relative tree cover). The understory structure may be complex with multiple shrub and herbaceous layers, or simple with just an herbaceous layer. The herbaceous layer may be dense or sparse, dominated by graminoids and/or forbs. Associated shrub species include *Symphoricarpos* spp. (*Symphoricarpos oreophilus* being the most widespread and *Symphoricarpos albus* and *Symphoricarpos mollis* having limited distribution), *Rubus parviflorus, Amelanchier alnifolia, Prunus virginiana*, and *Arctostaphylos uva-ursi*.

A3371 Acer grandidentatum Montane Forest Alliance

Alliance Summary Description: This alliance includes mainly deciduous forests dominated by *Acer grandidentatum* occurring in relatively moist lower montane areas of the Utah-Wyoming Rocky Mountains and Columbia Plateau. Forests in this alliance are dominated by a dense canopy of *Acer grandidentatum*, often occurring with *Quercus* spp. and *Juniperus* spp. Shrub and herb strata are relatively sparse throughout the range of the alliance and are composed of short shrubs and annual or perennial graminoids and forbs. Tree and shrub associates include *Amelanchier alnifolia, Artemisia tridentata, Paxistima myrsinites, Physocarpus malvaceus, Populus tremuloides, Prunus virginiana, Quercus gambelii*, and *Symphoricarpos* spp. The alliance can occur on all aspects but is best developed on north-facing valleys or canyons with moderate insolation and favorable soil moisture. In the southern part of the range, these communities are typically associated with protected topographic positions with relatively moist soils and lower fire frequencies than surrounding hillsides. Elevations range from 1200-2600 m.

[CEGL000559] Acer grandidentatum / Quercus gambelii Forest

Translated Name: Bigtooth Maple / Gambel Oak Forest

Common Name:

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USNVC Classification

Division: Rocky Mountain Forest & Woodland (1.B.2.Nb)
Macrogroup: Rocky Mountain Subalpine-High Montane Conifer Forest (M020)
Group: Rocky Mountain Subalpine-Montane Aspen Forest & Woodland (G222)
Alliance: *Acer grandidentatum* Montane Forest Alliance (A3371)

Element Concept

Global Summary: This forest association has been reported from mountains and plateaus of Utah. Elevations range from 1220-2620 m. Sites include moderate to steep, middle and lower slopes with cool northern or eastern aspects, intermittently flooded canyon bottoms, alluvial benches, and shaded colluvial slopes. *Acer grandidentatum* and *Quercus gambelii* codominate the tree canopy. The understory is variable and may be dominated by tall or short shrubs. Species include *Prunus virginiana, Rosa woodsii, Symphoricarpos oreophilus, Physocarpus malvaceus, Mahonia repens*, and seedling trees. The herbaceous layer is generally sparse because of heavy shading. Stands transition to *Quercus gambelii* woodland in the drier uplands.

Environmental Description

Global Environment: This forest association occurs in the mountains and plateaus of Utah. Elevations range from 1220-2620 m. Sites include moderate to steep, middle and lower slopes with cool northern or eastern aspects, intermittently flooded canyon bottoms, alluvial benches, and shaded colluvial slopes. These forests typically occur on these relatively mesic sites, especially at lower latitudes and elevations. However, stands have been reported on dry, open slopes in the northern part of its range in the Wasatch Mountains where fire suppression may be allowing oak-dominated stands to succeed to mixed maple-oak. Substrates are generally calcareous and rocky with soil textures ranging from sand to clay loam.

Vegetation Description

Global Vegetation: This association is characterized by a moderately dense to dense tree canopy of *Acer grandidentatum* that is typically codominated by *Quercus gambelii* with 10-50% cover. *Celtis laevigata var. reticulata, Juniperus scopulorum,* or *Juniperus osteosperma* may also be present to abundant. *Pseudotsuga menziesii* and *Abies concolor* trees may be scattered throughout the stand. The shrub layer is variable, depending on the stand age, elevation and habitat. It ranges from dense *Quercus gambelii*-dominated tall-shrub stratum to a mixed short-shrub layer that includes *Symphoricarpos oreophilus, Prunus virginiana, Amelanchier utahensis, Mahonia repens, Physocarpus malvaceus, Paxistima myrsinites, Acer glabrum, Holodiscus dumosus, Jamesia americana*, and *Rosa woodsii*. The herbaceous layer is generally sparse because of shading. Associates include graminoids such as *Achnatherum hymenoides, Carex hoodii, Elymus glaucus, Poa fendleriana*, and *Pseudoroegneria spicata*, and forbs *Galium multiflorum, Heterotheca villosa, Heuchera parviflora, Thalictrum fendleri, Vicia americana*, and species of *Lathyrus, Osmorhiza, Eriogonum*, and *Polygonum*.

Global Dynamics: This association is closely related to oakbrush types of Utah (*Quercus gambelii*-dominated and -codominated communities), sharing many of the same species (Reem 1960, 1964, Kunzler et al. 1981). Kunzler et al. (1981) suggested that the maple stands sampled by Reem (1960, 1964) in the Wasatch Mountains are likely late-seral stages of the oakbrush types.

Quercus gambelii is a fire-adapted rhizomatous shrub that can form dense clones and will vigorously resprout after a burn (FEIS 2001). *Acer grandidentatum* is also rhizomatous, but resprouts much less vigorously after burning, so Quercus *gambelii* is favored by frequent fires (FEIS 2001). However, throughout much of this association's range, stands are restricted to relatively mesic sites such as along streams, shady canyon bottoms, and on cool northern aspects at higher elevations where fire is less frequent. Where stands are more widespread in the northern part of its range in the Wasatch Mountains, *Acer grandidentatum* has recently been invading *Quercus gambelii* stands growing on open slopes with warm aspects. Harper et al. (1985) suggested these drier sites had greater fire frequency prior to fire suppression that favored the more fire-adapted oak. Now with fire suppression, *Acer grandidentatum* has been slowly colonizing these relatively xeric habitats. Research is needed to verify this hypothesis.

Most Abundant Species

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus scopulorum*
Tree canopy	Broad-leaved deciduous tree	*Acer grandidentatum*, *Quercus gambelii*
Tall shrub/sapling	Broad-leaved deciduous tree	*Acer grandidentatum*, *Quercus gambelii*
Short shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos oreophilus*
Herb (field)	Graminoid	*Poa fendleriana*

Characteristic Species

Global: Acer grandidentatum, Quercus gambelii

Other Noteworthy Species

Global: Invasive/Exotic Plants: *Bromus diandrus*, *Bromus tectorum* (High), *Poa pratensis* (Medium)

Conservation Status Rank

Global Rank & Reasons: G4G5 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Abies concolor / Acer grandidentatum* Forest (CEGL000241)
- *Acer grandidentatum / Calamagrostis rubescens* Forest (CEGL000558)
- *Populus angustifolia / Acer grandidentatum* Riparian Forest (CEGL000646)
- *Pseudotsuga menziesii / Acer grandidentatum* Forest (CEGL000419)

Global Related Concepts:

- *Acer grandidentatum/Quercus gambelii* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:I.B.3.b. (Driscoll et al. 1984) >
- Maple stands (Ream 1964) =
- Mountain Brush Community (Christensen 1955) >
- Oak Communities (Ream 1960) >
- Oakbrush type (Kunzler et al. 1981) **?**

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Classification

Status: Standard
Classification Confidence: 2 - Moderate
Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Global Classification Comments: *Acer grandidentatum* and *Quercus gambelii* both are widespread western species and occur in the understory of several conifer-dominated associations. There are several similar forest associations that are dominated by *Acer grandidentatum* with one of several oak species codominant or in the understory. Both *Acer grandidentatum* and *Quercus gambelii* have shrub and tree forms which complicate the vegetation classification of this mixed type. This association is typically late seral with some large single- or few-stemmed maples and oaks that are over 5 m tall.

Element Distribution

Global Range: This forest association is documented from the Wasatch and Uinta ranges in northeastern Utah and the Markagunt Plateau in southwestern Utah.

Nations: US
States/Provinces: UT:S4S5
TNC Ecoregions: 9:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, M331D:CC, M341C:CC
Federal Lands: NPS (Bryce Canyon, Glen Canyon, Timpanogos Cave, Zion)

Element Sources

Global Description Author(s): K.A. Schulz
References: Allman 1952, Bourgeron and Engelking 1994, Christensen 1955, Cogan et al. 2004, Coles et al. 2009b, Driscoll et al. 1984, FEIS 2001, Harper et al. 1985, Kunzler et al. 1981, Ream 1960, Ream 1964, Tendick et al. 2011b, Western Ecology Working Group n.d.*

M022. Southern Rocky Mountain Lower Montane Forest

G226. Southern Rocky Mountain White Fir - Douglas-fir Dry Forest

Group Summary Description: This is a group of the southern Rocky Mountains and Great Basin. It occurs from Nevada extending east into the Trans-Pecos plateaus of Texas, south to the Chihuahuan Desert, and throughout the Four Corners region. These are mixed-conifer forests occurring on all aspects at elevations ranging from 1200 to 3300 m. The composition and structure of the overstory are dependent upon the temperature and moisture relationships of the site and the successional status of the occurrence. *Pseudotsuga menziesii* and *Abies concolor* are most frequent, but *Pinus ponderosa* may be present to codominant. *Pinus flexilis* is common in Nevada. *Pseudotsuga menziesii* forests occupy drier sites, and *Pinus ponderosa* is a common codominant. *Abies concolor*-dominated forests occupy cooler sites, such as upper slopes at higher elevations, canyon sideslopes, ridgetops, and north- and east-facing slopes which burn somewhat infrequently. *Picea pungens* is uncommon in this group but does occur in cool, moist locations, often as smaller patches within a matrix of other associations. As many as seven conifers can be found growing in the same occurrence, and there are a number of cold-deciduous shrub, forb and graminoid species common, including *Juniperus communis,*

Cercocarpus ledifolius, Artemisia tridentata, Arctostaphylos uva-ursi, Mahonia repens, Paxistima myrsinites, Symphoricarpos oreophilus, Jamesia americana, Quercus gambelii, Galium triflorum, Muhlenbergia virescens, and *Festuca arizonica*. Forests in this group were undoubtedly characterized by a mixed-severity fire regime under "natural conditions," characterized by a high degree of variability in lethality and return interval.

A3454 Pseudotsuga menziesii Southern Rocky Mountain Forest & Woodland Alliance

Alliance Summary Description: These forests and woodlands are primarily distributed in the southern Rocky Mountains, and as far east as Texas. They include evergreen forests dominated by *Pseudotsuga menziesii*. Canopy associates vary widely depending on geographic location and may include *Abies lasiocarpa, Juniperus scopulorum, Pinus contorta, Pinus flexilis, Pinus ponderosa, Pinus strobiformis,* and *Populus tremuloides*. Understories are most often shrub-dominated, but in some associations a layer of graminoids takes prominence. Common dominant shrubs may include *Arctostaphylos patula, Arctostaphylos uva-ursi, Artemisia tridentata, Cercocarpus montanus, Holodiscus dumosus, Juniperus communis, Paxistima myrsinites, Physocarpus monogynus, Quercus gambelii,* and *Quercus x pauciloba*. Herbaceous dominants may include *Festuca arizonica, Jamesia americana, Muhlenbergia montana, Muhlenbergia virescens,* and *Poa fendleriana*. Elevations range from less than 1000 m in the northern Rocky Mountains to nearly 2900 m in the Southern Rockies and plateaus of the southwestern U.S. Lower elevation stands typically occupy protected northern exposures or mesic ravines and canyons, often on steep slopes. At higher elevations, these forests occur primarily on southerly aspects or ridgetops.

[CEGL000911] *Pseudotsuga menziesii* Scree Woodland

Translated Name: Douglas-fir Scree Woodland

Common Name: Douglas-fir Scree Slope

USNVC Classification

Division: Rocky Mountain Forest & Woodland (1.B.2.Nb)
Macrogroup: Southern Rocky Mountain Lower Montane Forest (M022)
Group: Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)
Alliance: *Pseudotsuga menziesii* Southern Rocky Mountain Forest & Woodland Alliance (A3454)

Element Concept

Global Summary: This association occurs throughout the interior western U.S. but is restricted to steep slopes covered by loose rock and colluvium on mountain or canyon slopes and dry alcoves. It has the appearance of scattered trees with a sparse understory. The open canopy of this association is generally mixed and rarely exceeds 50% cover. *Pseudotsuga menziesii* is always present and dominant; other tree species present to codominant may include *Juniperus osteosperma, Juniperus scopulorum, Picea engelmannii, Pinus edulis, Pinus flexilis, Pinus strobiformis, Pinus ponderosa, Populus tremuloides, Abies concolor*, and *Abies lasiocarpa*. Shrub cover is sparse and lacks a diagnostic species or the shrub layer is too poorly developed to be diagnostic. Herbaceous species are sparse and species are inconsistent among sites. The vegetation appears to be limited by the lack of soil development. Slopes generally exceed 60% and are generally unstable, with constantly shifting rocks

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on the slopes as well as additional rockfall from outcrops upslope. Elevations range from 915 to 2560 m (3100-8400 feet). Most of the unvegetated ground surface is covered by rocks and boulders, litter and/or dead wood. Soils are poorly developed, well-drained and rocky. The rocky slope is the dominant visual element of the community.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland was sampled on a colluvial slope at the head of a canyon. Sites are steep to very steep (22-40°), oriented to the west or north, and occur at 1879 m elevation. Most of the unvegetated surface is covered by litter, with moderate cover of bare soil, moss, and large and small rocks. Soils are rapidly drained loamy sands derived from colluvium or Kayenta or Navajo sandstones.

Global Environment: This association occurs throughout the interior western U.S. but is restricted to steep slopes covered by loose rock and colluvium on mountain or canyon slopes. Slopes generally exceed 60% (40-84%) and are generally unstable, with constantly shifting rocks on the slopes as well as additional rockfall from outcrops upslope. Elevations at the northern end of the range (Montana) are from 915 to 2560 m (3100-8400 feet). At the northern end of the range, sites are usually limited to warm, south- to west-facing slopes in canyons. In the southern end of the range in southern Colorado, southern Utah and northern Arizona, stands occur on various aspects, including north-facing alcoves. Most of the unvegetated ground surface is covered by rocks and boulders, litter and/or dead wood. Soils are poorly developed, well-drained and rocky.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Douglas-fir scree woodland is rare within the recreation area. Total vegetation cover ranges from 29 to 48% and is characterized by a tree layer of *Pseudotsuga menziesii* with 4 to 40% cover and between 10 and 20 m tall. Scattered Douglas-fir seedlings are present. The subcanopy layer has moderate cover by both *Pinus edulis* and *Juniperus osteosperma*. The shrub layer includes moderate cover of *Amelanchier utahensis, Quercus gambelii, Mahonia fremontii, Shepherdia rotundifolia, Purshia stansburiana,* and *Ephedra viridis.* The herbaceous layer has sparse to moderate cover and includes *Hesperostipa* and/or *Achnatherum* sp. (= *Stipa* sp.), *Phragmites australis*, and *Leymus salinus.*

Global Vegetation: This association has the appearance of a stand of scattered trees with a sparse understory; the vegetation is limited by the lack of soil development. The rocky slope is the dominant visual element of the community. The sparse to open canopy of this association is generally mixed and rarely exceeds 35% cover. *Pseudotsuga menziesii* is always present and dominant or codominant; other tree species may include *Juniperus osteosperma, Juniperus scopulorum, Picea engelmannii, Pinus edulis, Pinus flexilis, Pinus strobiformis, Pinus ponderosa, Populus tremuloides, Abies concolor,* and *Abies lasiocarpa*. Shrubs are variable depending on the site, but cover is too sparse and the mix either lacks a diagnostic species in the understory or the shrub layer is too poorly developed to be diagnostic. Shrub species present may include *Arctostaphylos uva-ursi, Acer glabrum, Amelanchier utahensis, Dasiphora fruticosa ssp. floribunda, Ephedra viridis, Holodiscus dumosus, Juniperus communis, Mahonia fremontii, Prunus virginiana, Purshia stansburiana, Quercus gambelii, Ribes inerme, Ribes montigenum, Salix scouleriana, Shepherdia canadensis, Shepherdia rotundifolia*, and *Symphoricarpos*

oreophilus. Herbaceous species are sparse and inconsistent among sites and include *Hesperostipa* and/or *Achnatherum* spp. (= *Stipa* spp.), *Phragmites australis*, and *Leymus salinus*.

Global Dynamics: This association is stable; the substrate is constantly shifting so there is little chance of the canopy closing or a dense understory developing.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pseudotsuga menziesii*
Tree subcanopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Shepherdia rotundifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Mahonia fremontii*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pseudotsuga menziesii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Pseudotsuga menziesii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4)
Global: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High); Other Plants: *Abies concolor* (G5), *Abies lasiocarpa* (G5), *Acer glabrum* (G5), *Amelanchier utahensis* (G5), *Holodiscus dumosus* (G5), *Juniperus communis* (G5), *Juniperus osteosperma* (G5), *Juniperus scopulorum* (G5), *Picea engelmannii* (G5), *Pinus edulis* (G5), *Pinus flexilis* (G4), *Pinus ponderosa* (G5), *Pinus strobiformis* (G5?), *Populus tremuloides* (G5), *Prunus virginiana* (G5), *Ribes inerme* (G5), *Ribes montigenum* (G4), *Salix scouleriana* (G5), *Shepherdia canadensis* (G5), *Symphoricarpos oreophilus* (G5)

Conservation Status Rank

Global Rank & Reasons: G5 (23-Feb-1994).

Related Concepts

Global Similar Types:
- *Abies lasiocarpa* Scree Woodland (CEGL000925)
- *Pinus flexilis* Scree Woodland (CEGL000815)
- *Pinus ponderosa* Scree Woodland (CEGL000878)
- *Pseudotsuga menziesii / Holodiscus dumosus* Scree Woodland (CEGL000902)

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Global Related Concepts:
- *Pseudotsuga menziesii / Holodiscus dumosus* (Scree) Habitat Type (Fitzhugh et al. 1987) <
- *Pseudotsuga menziesii / Holodiscus dumosus* Habitat Type (DeVelice et al. 1986) <
- *Pseudotsuga menziesii*/Scree (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.b. (Driscoll et al. 1984) >
- Forested Scree Communities (Pfister et al. 1977) >

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is distinguished from other scree woodland associations by the clear dominance of *Pseudotsuga menziesii* in the canopy and a shrub layer that is too sparse and scattered to be diagnostic. Stands described by Pfister et al. (1977) and MTNHP (2002b) from Montana are currently included in this Southern Rocky Mountain association. Review of Montana plots is needed to determine if they should stay in this association or be moved to a new association within a Central Rocky Mountains macrogroup and group.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland association is extremely rare within the recreation area and was only sampled below Observation Rock in the Orange Cliff section.

Global Range: This association has been documented from sites scattered throughout the Rocky Mountain Cordillera and mountain ranges in the interior western U.S., including Montana, Utah, New Mexico, Arizona and Colorado.

Nations: US
States/Provinces: AZ, CO, MT:S4, NM:S4, UT
TNC Ecoregions: 8:P, 19:C, 20:C, 21:P
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, M313A:CP, M331G:CC, M332B:CP, M332D:CP
Federal Lands: NPS (Black Canyon of the Gunnison, Canyon de Chelly, Capitol Reef, Curecanti, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: The plot is located in a very large alcove/canyon head, with a colluvial (Navajo sandstone-derived) substrate and sheltering, overhanging cliff walls above. *Pseudotsuga menziesii* covers the colluvial slopes here most extensively where the aspect is most northerly and where cliff walls provide the longest shading throughout the day.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2014 field data (1 plot, 2 accuracy assessment points): (Plot: GLCA.0702; AA Points: GLCA_AA.0563, GLCA_AA.0564).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and G. Kittel

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Subset: GLCA; Glen Canyon National Recreation Area

References: Bourgeron and Engelking 1994, Clark et al. 2009, Coles et al. 2010, DeVelice et al. 1986, Driscoll et al. 1984, Fitzhugh et al. 1987, MTNHP 2002b, Pfister et al. 1977, Romme et al. 1993, Tendick et al. 2010, Thomas et al. 2010, Western Ecology Working Group n.d.*

1.B.2.Nc. Western North American Pinyon - Juniper Woodland & Scrub

M026. Intermountain Singleleaf Pinyon - Juniper Woodland

G246. Colorado Plateau-Great Basin Juniper Open Woodland

Group Summary Description: This widespread juniper woodland and savanna group occupies dry foothills and sandsheets of the Colorado Plateau and eastern Great Basin from the western Colorado to Nevada and southern Idaho, and south to northwestern New Mexico and northern Arizona. The vegetation ranges from savanna, often with inclusions of denser patches of juniper, to open to dense woodland. The savanna stands are characterized by an open tree canopy of *Juniperus osteosperma* trees with high cover of perennial bunchgrasses and forbs, with *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Leymus salinus*, and *Pleuraphis jamesii* being most common. Woodland stands are generally open, but range from an open to closed canopy often with shrubs between trees depending on size of gaps. Characteristic shrubs include *Artemisia nova, Artemisia tridentata, Cercocarpus intricatus, Coleogyne ramosissima*, and *Ephedra* spp. Pinyon trees are typically not present because sites are outside the ecological or geographic range of *Pinus edulis* and *Pinus monophylla*. These juniper woodlands and wooded grasslands are generally found at lower elevations and on more xeric sites than Great Basin Pinyon - Juniper Woodland Group (G247) or Colorado Plateau Pinyon - Juniper Woodland Group (G250). Elevation ranges from 1500-2300 m. Stands occur on lower mountain slopes, hills, plateaus, basins and more recently on flats where juniper is expanding into semi-desert grasslands and steppe.

A3497 Juniperus osteosperma / Herbaceous Understory Open Woodland Alliance

Alliance Summary Description: Stands have a typically open to moderately dense tree canopy with an understory characterized by herbaceous vegetation. Tree canopy is dominated by *Juniperus osteosperma* with *Juniperus scopulorum* becoming important at higher elevations and along drainages. *Pinus* species are absent or accidental. Perennial grasses typically dominate the herbaceous layer although forbs are present and can be diverse. Characteristic species include *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Hesperostipa neomexicana, Leymus salinus, Pleuraphis jamesii, Pleuraphis mutica,* and *Pseudoroegneria spicata*. The non-native, invasive annual grass *Bromus tectorum* may be abundant in disturbed stands and dominate the herbaceous layer of highly disturbed stands. The core distribution of this juniper alliance is the Colorado Plateau, but it extends out into adjacent ecoregions primarily west into the Great Basin and north and east into the foothills of the central and southern Rocky Mountains. Stands occur on level to moderately steep alluvial fans and terraces, colluvial slopes, benches, hills, and badlands. Elevation of most stands ranges from 1423 to 1880 m (4670-6165 feet) but may occur as high as 2200 m (7215 feet) on warmer southwest-facing slopes. Sites may be oriented to any aspect. Soils are well-drained sands, sandy clays, or clay loams derived from shales, sandstones, or a mix of the two. Less frequently substrates are derived from eolian sands.

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[CEGL002815] Juniperus osteosperma / Hesperostipa comata Open Woodland

Translated Name: Utah Juniper / Needle-and-Thread Open Woodland

Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)

Macrogroup: Intermountain Singleleaf Pinyon - Juniper Woodland (M026)

Group: Colorado Plateau-Great Basin Juniper Open Woodland (G246)

Alliance: *Juniperus osteosperma* / Herbaceous Understory Open Woodland Alliance (A3497)

Element Concept

Global Summary: This woodland association occurs on slopes, mesatops, hills, benches and alluvial terraces in the Colorado Plateau of western Colorado and eastern Utah, and the Snake River Plain in southern Idaho. The vegetation is characterized by a savanna-like distribution of 2- to 5-m tall *Juniperus osteosperma* trees that range in cover from 5 to 15% and the bunchgrass *Hesperostipa comata* that ranges in cover from 5 to 30%. Shrubs are generally present but too sparse to form a layer. The herbaceous layer is diverse and has up to 30% cover. Sites are on level to moderately sloping terrain that may be oriented to any aspect. Elevation of most stands ranges from 1423 to 2200 m (4670-7215 feet). Soils are generally sandy loams, with a few stands on clay loams. Gravel, bare ground or cryptobiotic crusts cover much of the unvegetated surface.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association is distributed on mesatops, benches, dunes, terraces, and in canyons. Sites are on gentle to moderate slopes (up to 11°), oriented to the south or west, and between 1423 and 1820 m elevation. Sand and bare soil cover most of the unvegetated surface, with moderate cover of biological soil crusts (up to 36% cover), and with lesser cover by litter and bedrock. Soils are rapidly drained and derived from the Shinarump conglomerate, Kayenta Formation, Navajo or Cedar Mesa sandstones, or from eolian deposits.

Global Environment: This woodland association occurs on slopes, hills, mesatops, dunes, canyons, benches and alluvial terraces in the Colorado Plateau of western Colorado and eastern Utah. Sites are on level to moderately sloping terrain that may be oriented to any aspect. Elevation of most stands ranges from 1423 to 1880 m (4670-6165 feet) but may occur as high as 2200 m (7215 feet) on warm southerly exposures that discourage establishment of *Pinus edulis*. Most sites have sandy soils derived from eolian sands, sandstone or alluvium, but some stands occur on barren shale slopes of the Carmel (Capitol Reef National Park) and Chinle formations (Canyonlands National Park). Soils are generally sandy loams, with a few stands on clay loams. Gravel, bare ground or cryptobiotic crusts cover much of the unvegetated surface.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This juniper woodland is uncommon within the recreation area. Total vegetation cover ranges from 24 to 100%. Stands are characterized by scattered *Juniperus osteosperma* (with 4-30% cover), and a shrub-herbaceous understory where *Hesperostipa comata* is generally dominant (with 4-8% cover). Many stands have *Achnatherum*

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hymenoides as a codominant species in the herbaceous understory (with 7-16% cover). The shrub layer often has nearly equal cover to the herbaceous layer and includes *Ephedra cutleri, Ephedra viridis, Ephedra torreyana, Fraxinus anomala, Gutierrezia sarothrae, Atriplex canescens, Shepherdia rotundifolia, Artemisia filifolia, Opuntia* spp. (with 15% cover in one stand), and *Yucca angustissima*. Herbaceous species providing low cover may include *Poa fendleriana, Sporobolus contractus, Sporobolus flexuosus, Muhlenbergia pungens, Bromus tectorum, Cirsium calcareum, Comandra umbellata, Conyza canadensis, Cordylanthus wrightii, Heterotheca villosa (= Chrysopsis villosa), Machaeranthera canescens, Penstemon ambiguus*, and *Solidago* sp. Biological soil crusts are common.

Global Vegetation: This woodland association has total vegetation cover that ranges from 24 to 60%. It is characterized by a savanna-like distribution of 2- to 5-m tall *Juniperus osteosperma* trees that range in cover from 5 to 15% and the tall bunchgrass *Hesperostipa comata* that ranges in cover from 5 to 25%. Shrubs are generally present but too sparse to form a layer. Common species include *Artemisia filifolia, Atriplex canescens, Coleogyne ramosissima, Ephedra cutleri, Ephedra torreyana, Ephedra viridis, Eriogonum microthecum, Ericameria nauseosa, Fraxinus anomala, Krascheninnikovia lanata, Gutierrezia sarothrae, Opuntia erinacea, Opuntia macrorhiza, Opuntia polyacantha, Shepherdia rotundifolia*, and *Yucca angustissima*. The herbaceous layer is diverse and has up to 30% cover, including *Hesperostipa* spp. Other characteristic graminoids include *Poa fendleriana, Bouteloua eriopoda, Bouteloua gracilis, Pleuraphis jamesii, Sporobolus contractus, Sporobolus flexuosus, Muhlenbergia pungens*, and *Achnatherum hymenoides*. Forbs may be diverse but contribute little cover with such species as *Cirsium calcareum, Chaetopappa ericoides, Heterotheca villosa (= Chrysopsis villosa), Comandra umbellata, Cordylanthus wrightii, Hymenoxys richardsonii, Machaeranthera canescens, Machaeranthera grindelioides, Mirabilis multiflora, Penstemon ambiguus, Solidago* sp., *Streptanthella longirostris, Tetraneuris acaulis (= Hymenoxys acaulis)*, and *Townsendia incana*. *Bromus tectorum* may be abundant in plots that have experienced chronic or severe disturbance.

Global Dynamics: Some stands likely result from the invasion by *Juniperus osteosperma* into *Hesperostipa comata* Great Basin Grassland (CEGL001705) or related grasslands. Many stands are too open and sparsely vegetated to carry fire well.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*, *Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Hesperostipa comata*

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Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Herb (field)	Graminoid	*Hesperostipa comata*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Hesperostipa comata*, *Juniperus osteosperma*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (6-Jul-2005).

Related Concepts

Global Similar Types:

- *Juniperus osteosperma / Hesperostipa comata* Wooded Grassland (CEGL001489)
- *Juniperus osteosperma / Pleuraphis jamesii* Open Woodland (CEGL002362)
- *Pinus edulis - Juniperus monosperma / Hesperostipa comata* Open Woodland (CEGL005660)
- *Pinus edulis - Juniperus osteosperma / Hesperostipa comata* Open Woodland (CEGL005652)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland association is uncommon within the recreation area and was sampled in Waterhole Flat, Andy Miller Flats, near the Flint Trail, Observation Rock, Egypt, and on the Escalante River.

Global Range: This association has been described from the Colorado Plateau, specifically from western Colorado and eastern Utah and the Snake River Plain in southern Idaho. It is likely to occur on sandy soils at low to moderate elevations throughout the plateau.

Nations: US
States/Provinces: CO, ID, UT
TNC Ecoregions: 9:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331E:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Canyonlands, Capitol Reef, Colorado, Dinosaur, Glen Canyon); USFWS (Minidoka)

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Element Sources

Glen Canyon National Recreation Area Inventory Notes: There is a mappable polygon of JUNOST with EPHVIR, ACHHYM, HESCOM, Opuntia understory. This would be within a larger polygon of PJ woodland with COLRAM understory upslope and PJ woodland with sparse understory downslope.

Glen Canyon National Recreation Area Plots: The description is based on 2014 and 2015 field data (6 accuracy assessment points): (AA Points: GLCA_AA.0042, GLCA_AA.0137, GLCA_AA.0505, GLCA_AA.0566, GLCA_AA.1238, GLCA_AA. 2021).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: CNHP 2015, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2010, Romme et al. 1993, Von Loh et al. 2007, Western Ecology Working Group n.d.*

[CEGL003109] Juniperus osteosperma / Leymus salinus Open Woodland
Translated Name: Utah Juniper / Saline Wildrye Open Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Intermountain Singleleaf Pinyon - Juniper Woodland (M026)
Group: Colorado Plateau-Great Basin Juniper Open Woodland (G246)
Alliance: *Juniperus osteosperma* / Herbaceous Understory Open Woodland Alliance (A3497)

Element Concept

Global Summary: This sparse woodland association occurs on low- to mid-elevation hogbacks, colluvial slopes and badlands in the Colorado Plateau of western Colorado and eastern Utah. The vegetation is characterized by a sparse to open canopy of *Juniperus osteosperma* with up to 25% cover. *Pinus edulis* may be present in very low amounts in the canopy. There is no shrub layer, but scattered short and dwarf-shrubs may total up to 10% cover in more heavily vegetated stands. The herbaceous layer is dominated by *Leymus salinus* with up to 25% cover. The remainder of the herbaceous cover is sparse but diverse. Elevations range from 1488 to 1997 m (4880-6550 feet), and most sites are on cooler north and east aspects. Slopes may be gentle to moderately steep (3-46% slope). Soils are rapidly drained and may be sandy loams or silty clays.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland is common on canyon rims, talus/colluvial slopes, canyon sides, and midslopes. Sites are on moderate to very steep slopes (10-38°) on cooler north- and east-facing aspects between 1546 and 1858 m elevation. Most of the unvegetated surface is covered by large and small rocks or bare soil, with low cover by litter and dead wood. Soils are rapidly drained loams and sandy loams derived from colluvium, Kayenta Formation, Wingate sandstone, or Chinle Formation.

Global Environment: This sparse woodland association occurs on canyon rims, ledges, low- to mid-elevation hogbacks, colluvial slopes, toeslopes and badlands in the Colorado Plateau of western

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Colorado and eastern Utah. Elevations range from 1488 to 1997 m (4880-6550 feet), and most sites are on cooler north and east aspects, although they are reported from west aspects in the Piceance Basin of northwestern Colorado (Baker 1982b). Slopes may be gentle to moderately steep (3-46% slope) and are generally underlain by Mesozoic marine shales of the Morrison Formation, Chinle Formation or Mancos shale. Other parent materials include Kayenta Formation and Cedar Mesa sandstone. Colluvium from sandstone cliffs or outcrops upslope is common on the ground surface. Soils are rapidly drained and may be sandy loams or silty clays.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Utah juniper woodland is fairly common within the recreation area. Total vegetation cover ranges from 6 to 27%. Stands are characterized by an open canopy, typically 2 to 5 m tall, of *Juniperus osteosperma* with 3 to 11% cover, and an understory dominated by *Leymus salinus* with 2 to 13% cover. Scattered *Pinus edulis* may occur in the canopy with trace cover, and *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. Shrubs are generally present but always with less total cover than the grasses; common species include *Ephedra viridis, Shepherdia rotundifolia, Ericameria nauseosa, Chrysothamnus viscidiflorus var. stenophyllus, Rhus trilobata var. trilobata (= Rhus aromatica var. trilobata),* and *Artemisia bigelovii*. Associated herbaceous species include *Hesperostipa comata* and *Pleuraphis jamesii*.

Global Vegetation: This association has a sparse to open canopy of *Juniperus osteosperma* with between 1 and 25% cover. *Pinus edulis* can be absent or present in very low amounts in the canopy, and *Juniperus osteosperma* and *Pinus edulis* seedlings may also be present. There is no shrub layer, but scattered short and dwarf-shrubs may total up to 10% cover. Common shrub species include *Atriplex confertifolia, Artemisia bigelovii, Artemisia nova, Artemisia tridentata ssp. wyomingensis, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Gutierrezia sarothrae, Glossopetalon spinescens var. meionandrum, Ephedra viridis, Eriogonum microthecum, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia erinacea, Opuntia polyacantha, Rhus trilobata var. trilobata, Shepherdia rotundifolia,* and *Yucca harrimaniae*. The herbaceous layer is dominated by *Leymus salinus* with between 1 and 25% cover. Herbaceous cover is sparse but diverse. Additional graminoids present include *Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii, Poa fendleriana,* and *Poa secunda*. Forbs also provide sparse cover and include *Arenaria hookeri, Arenaria fendleri, Calochortus gunnisonii, Cymopterus bulbosus, Cymopterus purpureus, Eriogonum umbellatum, Leptodactylon pungens, Lepidium montanum, Oenothera pallida, Phlox austromontana, Petradoria pumila, Phlox hoodii, Sphaeralcea coccinea, Streptanthella longirostris, Stenotus acaulis,* and *Xylorhiza venusta*.

Global Dynamics: In some stands, this association is the result of *Leymus salinus* Shale Sparse Vegetation (CEGL002745) grasslands being invaded by *Juniperus osteosperma*. This change may be indicative of shifts in seasonal precipitation rather than fire suppression, since most stands are too sparse to carry fire.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved deciduous shrub	*Shepherdia rotundifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Herb (field)	Graminoid	*Leymus salinus*, *Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Herb (field)	Graminoid	*Leymus salinus*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Atriplex confertifolia, Chrysothamnus viscidiflorus, Juniperus osteosperma, Leymus salinus, Pleuraphis jamesii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4)
Global: Vulnerable Plants: Glossopetalon spinescens var. meionandrum (G5T3), Shepherdia rotundifolia (G3G4)

Conservation Status Rank

Global Rank & Reasons: G3 (26-Jan-2006). The Colorado Natural Heritage Program tracks this association and has given it a rank of S3. It may be somewhat more common in Utah, as there is more potential habitat, but it is unlikely that there are more than 100 viable occurrences worldwide. All stands tend to be small, generally less than five hectares.

Related Concepts

Global Similar Types:

- *Juniperus osteosperma / Leymus salinus ssp. salmonis* Wooded Grassland (CEGL001488)
- *Leymus salinus* Shale Sparse Vegetation (CEGL002745)
- *Pinus edulis - Juniperus* spp. / *Leymus salinus* Woodland (CEGL002340)

Global Related Concepts:

- *Juniperus osteosperma / Elymus salina* (Baker 1982b) =
- *Juniperus osteosperma/Leymus ambiguus* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:V.B.1.e. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 1 - Strong
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. There may be some difficulty in clearly distinguishing *Pinus edulis - Juniperus* spp. / *Leymus salinus* Woodland (CEGL002340) from this association, in which case they may need to be combined. In particularly sparse stands, it may also be difficult to distinguish *Leymus salinus* Shale Sparse Vegetation (CEGL002745) from this association.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is mostly restricted to the Orange Cliffs section of the recreation area and was sampled at Land's End, near Observation Rock, in North Trail Canyon, Upper Millard Canyon, and Moody Canyon.

Global Range: The plant association occurs on low-elevation marine shales in western Colorado and eastern Utah.

Nations: US
States/Provinces: CO:S2, UT
TNC Ecoregions: 9:C, 18:C, 20:C
USFS Ecoregions (1994/95): 341B:CC, M331E:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Canyonlands, Capitol Reef, Dinosaur, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Steep, active colluvial slope with lots of very large boulders. Large boulders shed runoff and north exposure keeps shady microenvironments on their downslope sides moister than elsewhere.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2012 field data (6 plots): (Plots: GLCA.0584, GLCA.0703, GLCA.0710, GLCA.0712, GLCA.5056, GLCA.9102).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Baker 1982b, Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2010, Driscoll et al. 1984, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEGL002362] Juniperus osteosperma / Pleuraphis jamesii Open Woodland
Translated Name: Utah Juniper / James' Galleta Open Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Intermountain Singleleaf Pinyon - Juniper Woodland (M026)

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Group: Colorado Plateau-Great Basin Juniper Open Woodland (G246)
Alliance: *Juniperus osteosperma* / Herbaceous Understory Open Woodland Alliance (A3497)

Element Concept

Global Summary: This woodland association occurs on valley floors, ridges, and benches in northwestern Colorado and eastern Utah. Total vegetation cover rarely exceeds 60%. The tree canopy consists of *Juniperus osteosperma* with up to 40% cover. *Pinus edulis* is generally absent. Scattered shrubs may be present, but there is no developed shrub layer. The herbaceous stratum is sparse to moderately dense and is dominated by graminoids. *Pleuraphis jamesii* is dominant to codominant and is generally accompanied by other grasses such as *Achnatherum hymenoides, Bouteloua gracilis*, or *Hesperostipa comata*. Forbs are sparse in cover and inconsistent in composition among sites. Sites have gentle to moderately steep slopes (2-20%), occur between 1341 and 1860 m elevation, and may be oriented to any aspect. Soils are well-drained sands, sandy clays, or clay loams. Unvegetated surface has bare soil and small rocks or may have a high cover of litter, and biological soil crusts may be well-developed in areas that are protected from grazing. Stands occur in relatively small patches, often in a mosaic with other pinyon-juniper / grass woodland types.

Environmental Description

Glen Canyon National Recreation Area Environment: This association occurs on valley bottoms, canyon bottoms, benches, mesas, slumps, talus slopes, hills, and along washes/drainage channels within the recreation area at elevations ranging from 1583 to 1806 m. Sites have gentle to moderately steep slopes (2-20%) and are oriented to all aspects. Bare soil and sand cover most of the unvegetated surface, with lesser cover by small and large rocks, and with low cover by litter and biological soil crusts. Soils are rapidly drained sands, loams, and sandy loams derived from alluvium, shales of the Moenkopi, Shinarump conglomerate, Chinle, Organ Rock, and Carmel formations, or from Navajo sandstone.

Global Environment: This woodland association occurs on valley floors, ridges, benches, slumps, talus slopes, hills, and along washes/drainage channels. Sites have gentle slopes (3-5%), occur between 1579 and 1860 m elevation, and may be oriented to any aspect. The unvegetated surface has bare soil and small rocks or may have a high cover of litter. Soils are well-drained sands, sandy clays, or clay loams derived from shales, sandstones, or a mix of the two.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This association is characterized by a sparse to open canopy of *Juniperus osteosperma* ranging from 2 to 18% cover, with total cover ranging from 11 to 58%. The understory is generally dominated by the bunchgrass *Pleuraphis jamesii* with 3 to 35% cover. Other native grasses may be present with sparse to low cover, including *Bouteloua gracilis, Leymus salinus, Muhlenbergia pungens, Sporobolus* spp., and *Achnatherum speciosum (= Stipa speciosa)*; *Achnatherum hymenoides* may be codominant in some stands. Shrubs are common, although none clearly dominate over the grass cover. Shrub species occurring include *Artemisia bigelovii, Chrysothamnus greenei, Ephedra cutleri, Ephedra viridis, Ephedra torreyana, Purshia stansburiana, Ericameria nauseosa, Atriplex confertifolia, Atriplex canescens, Zuckia brandegeei,*

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Krascheninnikovia lanata, Gutierrezia sarothrae, Gutierrezia microcephala, Shepherdia rotundifolia, Opuntia spp., *Yucca angustissima,* and *Xylorhiza tortifolia*. *Bromus tectorum* may be present in disturbed stands.

Global Vegetation: This woodland association occurs in relatively small patches, often in a mosaic with other pinyon-juniper woodland types. Total vegetation cover rarely exceeds 60%. The tree canopy consists of *Juniperus osteosperma* with between 20 and 40% cover. *Pinus edulis* is absent or occurs only as scattered individuals. Scattered shrubs such as *Artemisia bigelovii, Artemisia tridentata ssp. wyomingensis, Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Ephedra cutleri, Ephedra viridis, Ephedra torreyana, Ericameria nauseosa, Gutierrezia sarothrae, Gutierrezia microcephala, Opuntia polyacantha, Zuckia brandegeei, Krascheninnikovia lanata,* and *Purshia stansburiana* may be present, but there is no developed shrub layer. The herbaceous stratum is sparse to moderately dense and is dominated by graminoids. *Pleuraphis jamesii* is dominant to codominant and is generally accompanied by other grasses such as *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Muhlenbergia pungens, Sporobolus* spp., and *Achnatherum speciosum (= Stipa speciosa)*. Forbs are sparse in cover and inconsistent in composition among sites. *Bromus tectorum* may be present in disturbed stands.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*, *Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia microcephala*, *Gutierrezia sarothrae*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Juniperus osteosperma*, *Pleuraphis jamesii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (22-Mar-2005).

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Related Concepts

Global Similar Types:

- *Juniperus osteosperma / Bouteloua gracilis* Open Woodland (CEGL002361)
- *Juniperus osteosperma / Hesperostipa comata* Open Woodland (CEGL002815)
- *Pinus edulis - Juniperus osteosperma / Pleuraphis jamesii* Woodland (CEGL002379)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This association is somewhat common within the recreation area and was sampled on Fourmile Bench, Choprock Bench, in the Purple Hills, Circle Cliffs, Cove Canyon, Clearwater Canyon, East Moody Canyon, Middle Moody Canyon, the South Fork of Happy Canyon, Elaterite Basin, near Allen Dump and Egypt.

Global Range: This association has been documented in northwestern Colorado and eastern Utah. It is likely to be widespread throughout the Colorado Plateau, including Arizona and New Mexico.

Nations: US
States/Provinces: AZ, CO, NM?, UT
TNC Ecoregions: 9:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331E:CC
USFS Ecoregions (2007): 341Bj:C
Federal Lands: NPS (Canyonlands, Capitol Reef, Dinosaur, Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Soil is somewhat rocky, but mostly stabilized by crust. Segment is series of drainages and undulating ridges between them.

Glen Canyon National Recreation Area Plots: The description is based on 2012, 2013, 2014, and 2015 field data (4 plots, 19 accuracy assessment points): (Plots: GLCA.4071, GLCA.4091, GLCA.5047, GLCA.5305; AA Points: GLCA_AA.0115, GLCA_AA.0201, GLCA_AA.0257, GLCA_AA.0597, GLCA_AA.1151, GLCA_AA.1154, GLCA_AA.1163, GLCA_AA.1174, GLCA_AA.1175, GLCA_AA.1191, GLCA_AA.1212, GLCA_AA.1214, GLCA_AA.1217, GLCA_AA.1230, GLCA_AA.1961, GLCA_AA.1963, GLCA_AA.2016, GLCA_AA.2017, GLCA_AA.2019).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and G. Kittel
References: Clark et al. 2009, Coles et al. 2008a, Reid and Hall 2010, Romme et al. 1993, Western Ecology Working Group n.d.*

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A3496 Juniperus osteosperma / Shrub Understory Woodland Alliance

Alliance Summary Description: Stands have a short, typically open to moderately dense tree canopy with an understory characterized by shrubs. Tree canopy is dominated by *Juniperus osteosperma* with *Juniperus scopulorum* becoming important and sometimes dominant at higher elevations and on relatively mesic sites such as along drainages. *Pinus* species are absent or accidental with very low cover. Shrubs typically dominate the understory and form an open to moderately dense layer. Scattered shrubs frequently characterize the sparse and rocky understory. Characteristic shrubs are many, including *Artemisia arbuscula, Artemisia nova, Artemisia tridentata, Cercocarpus intricatus, Cercocarpus montanus, Coleogyne ramosissima, Mahonia fremontii, Quercus gambelii*, and *Symphoricarpos oreophilus*. The herbaceous layer is sparse to moderate and composed of grasses and often diverse forbs. Common species may include *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Hesperostipa neomexicana, Leymus salinus, Pleuraphis jamesii*, and *Pseudoroegneria spicata*. The non-native, invasive annual grass *Bromus tectorum* may be abundant and dominate the herbaceous layer of highly disturbed stands. This alliance also includes sparse understory stands often with scattered shrubs and grasses. The core distribution of this juniper alliance is semi-arid canyons, foothills, plateaus and low mountains in the Colorado Plateau, but it extends out into adjacent ecoregions primarily west into the Great Basin and north and east into the foothills of the central and southern Rocky Mountains. Stands occur on a variety of sites, including alluvial fans and stream terraces, colluvial slopes, benches, ledges, hills, ridges, mesas, and badlands. Sites range from level to steep terrain that may be oriented to any aspect. Elevation of most stands ranges from 1220 to 2260 m (4000-7400 feet). Soils are often calcareous, shallow, poorly developed, rapidly to well-drained sands, sandy clays, or clay loams derived from shales, sandstones, or a mix of the two.

[CEGL003774] Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Wooded Shrubland

Translated Name: Utah Juniper - (Two-needle Pinyon) / Blackbrush - Stansbury's Cliffrose - Tucker Sand Shinnery Oak Wooded Shrubland

Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Intermountain Singleleaf Pinyon - Juniper Woodland (M026)
Group: Colorado Plateau-Great Basin Juniper Open Woodland (G246)
Alliance: *Juniperus osteosperma* / Shrub Understory Woodland Alliance (A3496)

Element Concept

Global Summary: This association has been documented from the canyonlands of the Colorado Plateau in eastern Utah. This wooded shrubland association has a mixed shrub canopy, with scattered trees of *Pinus edulis* and/or *Juniperus osteosperma*. Woody plants tend to be rooted in bedrock fractures; herbaceous plants persist in the thin deposits of sand that cover the substrate. Total vegetation cover is variable, ranging from 2 to 65% depending on the degree of fracturing of the underlying bedrock. The vegetation is characterized by an open canopy of stunted *Juniperus osteosperma* or *Pinus edulis* ranging in cover from 1 to 15% and a shrub understory in which

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Coleogyne ramosissima is always present and is always accompanied by either or both *Purshia stansburiana* and *Quercus havardii var. tuckeri*. Shrub cover may often exceed total tree cover. *Pinus edulis*, typically 2-5 m tall, may be present with low cover relative to *Juniperus osteosperma*. The shrub layer may contain as many as ten species, depending on how xeric or mesic the site is. Herbaceous species are rarely important in these stands. This wooded shrubland association occurs where a thin veneer of sand has been deposited in slickrock depressions, on escarpments, plateaus, benches, ridges, hogbacks, valley sides and slopes, dunes, swales, in slot canyons, and washes. Sites are on flat to steep slopes (up to 70%), occur between 1296 and 1890 m elevation, and are oriented to all aspects. Biological soil crust cover is typically low but can be as high as 45%. Soils are derived from eolian deposits and include rapidly drained loams, loamy sands to sandy clays and sands.

Environmental Description

Glen Canyon National Recreation Area Environment: This wooded shrubland occurs on slickrock exposures interrupted by shallow, sand-filled depressions (and more rarely on active dunes and along intermittently flooded drainages) on mesas, canyon rims, plateaus, benches, and terraces. Sites are on flat to moderately steep slopes (up to 10°), oriented to all aspects, and lie between 1189 and 1850 m elevation. Exposed soil, sand, or bedrock makes up most of the unvegetated surface, with low cover by large and small rocks, litter, and biological soils crusts. Soils are rapidly drained sandy loams, loams, silty clay loams, silty clays, clay loams, sands, or loamy sands derived from eolian sources or from sandstone and shale bedrock, including the Morrison Formation, Moenkopi Formation, Cedar Mesa, Navajo, and White Rims sandstones, and the Chinle Formation.

Global Environment: This wooded shrubland association occurs where a thin veneer of sand has been deposited in slickrock depressions, on escarpments, plateaus, benches, ridges, hogbacks, valley sides and slopes, dunes, swales, in slot canyons, and washes. Sites are on flat to steep slopes (up to 70%), occur between 1296 and 1890 m elevation, and are oriented to all aspects. Bedrock and bare soil typically cover most of the unvegetated surface. Litter provides sparse to low cover. Biological soil crust cover is typically low but can be as high as 45%. Soils are rapidly drained sand, sandy loams, sandy clay loams, or loamy sands derived from eolian or alluvium deposits, sandstone and shale bedrock or colluvium. Parent materials are variable and include Cedar Mesa, Wingate, Kayenta, Entrada (including the Dewey Bridge Member), and Navajo sandstone formations, the Moab Tongue of the Curtis Formation, the Chinle Formation and the Salt Wash Member of the Morrison Formation.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: The vegetation is characterized by a sparse to open canopy of stunted *Juniperus osteosperma* ranging in cover from 1 to 12% and a shrub understory in which *Coleogyne ramosissima* is always present, with at least trace cover, and is always accompanied by either or both *Purshia stansburiana* (with 1-5% cover) and *Quercus havardii var. tuckeri* (with trace to 7% cover). Shrub cover generally exceeds total tree cover. *Pinus edulis* may be present with trace to low cover. Total vegetation cover ranges from 3 to 28% depending on the availability of rooting sites, but is generally under 10%. Shrubs dominate the understory. Stands with deeper sands may have *Quercus havardii var. tuckeri* as a codominant. There is often a diversity of associated shrubs with trace to low cover, including *Fraxinus anomala, Cercocarpus intricatus,*

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Ephedra viridis, Ephedra cutleri, Artemisia bigelovii, Rhus trilobata, Ephedra torreyana, Mahonia fremontii, Atriplex canescens, Gutierrezia spp., *Shepherdia rotundifolia, Amelanchier utahensis, Opuntia* spp., and *Yucca angustissima.* Mesic stands include *Amelanchier utahensis*. The herbaceous layer provides only sparse cover and may include *Achnatherum hymenoides, Bouteloua barbata, Rumex hymenosepalus,* and *Lepidium montanum var. jonesii*. Biological soil crust cover is generally present with sparse to low cover, and is usually well-developed.

Global Vegetation: This wooded shrubland association has a mixed shrub canopy, with scattered trees of *Pinus edulis* and/or *Juniperus osteosperma*. Woody plants tend to be rooted in bedrock fractures; herbaceous plants persist in the thin deposits of sand that cover the substrate. Total vegetation cover is variable, ranging from 2 to 65% depending on the degree of fracturing of the underlying bedrock. The vegetation is characterized by an open canopy of stunted *Juniperus osteosperma* or *Pinus edulis* ranging in cover from 1 to 15% and a shrub understory in which *Coleogyne ramosissima* is always present and is always accompanied by either or both *Purshia stansburiana* and *Quercus havardii var. tuckeri*. Shrub cover often exceeds total tree cover. *Pinus edulis*, typically 2-5 m tall, may be present with low cover relative to *Juniperus osteosperma*. The shrub layer may contain as many as ten species, depending on how xeric or mesic the site is. Xeric stands most commonly include *Artemisia bigelovii, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra torreyana, Ephedra cutleri, Ephedra viridis, Fraxinus anomala, Glossopetalon spinescens var. meionandrum, Gutierrezia microcephala, Gutierrezia sarothrae, Opuntia erinacea*. *Opuntia polyacantha, Mahonia fremontii, Rhus trilobata, Shepherdia rotundifolia, Sclerocactus whipplei*, and *Yucca harrimaniae*. In more mesic sites, *Amelanchier utahensis, Cercocarpus intricatus*, or *Cercocarpus montanus* may be present. Herbs are generally too sparse to form a layer but may be diverse. Grasses include *Achnatherum hymenoides, Achnatherum speciosum, Aristida purpurea, Bouteloua barbata, Sporobolus cryptandrus, Vulpia octoflora (= Festuca octoflora),* and exotic *Bromus tectorum.* Forbs include *Arenaria fendleri, Chamaesyce fendleri, Cryptantha flava, Descurainia pinnata, Hedysarum boreale, Lepidium montanum, Lomatium parryi, Machaeranthera grindelioides, Plantago patagonica, Petradoria pumila, Rumex hymenosepalus, Streptanthella longirostris,* and *Tetraneuris acaulis (= Hymenoxys acaulis)*. Exotic forbs are sometimes present and include *Chenopodium album, Erodium cicutarium*, and *Salsola tragus.* Biological soil crust cover is generally sparse (<15%), although some stands have nearly 50% cover, and is usually well-developed.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*, *Quercus havardii* var. *tuckeri*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*, *Ephedra viridis*, *Purshia stansburiana*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia microcephala*, *Gutierrezia sarothrae*
Short shrub/sapling	Succulent shrub	*Opuntia erinacea*

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Global

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Needle-leaved tree	*Juniperus osteosperma*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Purshia stansburiana*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Fraxinus anomala*
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*, *Quercus havardii* var. *tuckeri*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Coleogyne ramosissima*, *Fraxinus anomala*, *Juniperus osteosperma*, *Purshia stansburiana*, *Quercus havardii* var. *tuckeri*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Quercus havardii* var. *tuckeri* (G4T3?Q);

Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Vulnerable Plants: *Quercus havardii* var. *tuckeri* (G4T3?Q), *Sclerocactus whipplei* (G2G3); Invasive/Exotic Plants: *Bromus tectorum* (High), *Chenopodium album*, *Erodium cicutarium* (Medium/Low), *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: GNR (15-Mar-2006).

Related Concepts

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau

Element Distribution

Glen Canyon National Recreation Area Range: This wooded shrubland type is common within the recreation area and was sampled in Big Water Canyon, Clyde's Spring Canyon, on Clyde's Mesa, in Horsethief Canyon, White Canyon, Horse Canyon, Elaterite Basin, below Muley Point, near The Golden Stairs, Egypt, Hite, The Cove, on Grand Bench and Wilson Mesa.

Global Range: This association is known from the canyonlands of the Colorado Plateau in eastern Utah. It is reported from Arches, Canyonlands, and Capitol Reef national parks and Glen Canyon National Recreation Area.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Mostly exposed pale-colored slickrock sandstone with patches of shallow rocky soil stabilized by moss/crust and shrubs, with mature but small *Juniperus, Purshia, Fraxinus*, and *Coleogyne*. Precipitation runs off the slickrock and drains into soil patches.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, and 2013 field data (19 plots): (Plots: GLCA.0315, GLCA.0316, GLCA.0557, GLCA.0711, GLCA.0722, GLCA.0749, GLCA.4000, GLCA.4314, GLCA.5004, GLCA.5076, GLCA.5083, GLCA.5135, GLCA.5296, GLCA.5556, GLCA.5564, GLCA.5567, GLCA.5569, GLCA.9304, GLCA.9507).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): G. Kittel and K.A. Schulz
References: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEGL000730] Juniperus osteosperma / Artemisia tridentata Woodland
Translated Name: Utah Juniper / Basin Big Sagebrush Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Intermountain Singleleaf Pinyon - Juniper Woodland (M026)
Group: Colorado Plateau-Great Basin Juniper Open Woodland (G246)
Alliance: *Juniperus osteosperma* / Shrub Understory Woodland Alliance (A3496)

Element Concept

Global Summary: This sparse woodland association has been reported from semi-arid foothills, plateaus and mountains throughout much of the western Rocky Mountains, Colorado Plateau, and Great Basin. The vegetation is characterized by an open tree canopy dominated by *Juniperus osteosperma* with *Artemisia tridentata ssp. wyomingensis* dominating the short-shrub layer. Other shrubs may be present but generally with low cover. The sparse to moderately dense herbaceous layer is dominated by graminoids. Elevation ranges from 1220 to 2260 m (4000-7400 feet). This community generally occurs on a variety of slopes and aspects, often at the break between foothill and basin. Soils are generally coarse-textured, calcareous alluvial or eolian deposits derived from sandstone and shale. Evidence of erosion such as gullies and rills is not uncommon.

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Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association was found on flat to moderately sloping (up to 8° slopes) mesatops, plateaus, and benches at elevations ranging from 1636 to 1929 m. Bare soil and large and small rocks cover most of the unvegetated surface, with lesser cover by litter, bedrock, and cryptobiotic soil crusts. The soil is a moderately well-drained to rapidly drained loamy sand or silty clay loam derived from Cedar Mesa sandstone or the Straight Cliffs Formation.

Global Environment: This sparse woodland association has been reported from semi-arid foothills, plateaus and mountains throughout much of the western Rocky Mountains, Colorado Plateau, and Great Basin. Elevation ranges from 1220 to 2260 m (4000-7400 feet). This community occurs on a variety of slopes and aspects, often at the break between foothill and basin. Soils are generally coarse-textured, calcareous alluvial or eolian deposits derived from sandstone and shale. Evidence of erosion such as gullies and rills is not uncommon. There are generally significant amounts of bare ground, litter, and desert pavement at the soil surface. Rock cover is variable.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Utah juniper woodland is uncommon within the park. Total vegetation cover ranges from 14 to 38%. The sparse tree canopy of *Juniperus osteosperma* has between 5 and 15% cover, and *Artemisia tridentata ssp. wyomingensis* dominates the shrub understory with 3 to 14% cover. *Pinus edulis* may be present with trace cover. Associated shrub species with low cover may include *Amelanchier utahensis, Artemisia bigelovii, Artemisia nova, Ephedra cutleri, Ephedra viridis, Gutierrezia sarothrae,* and *Shepherdia rotundifolia*. Herbaceous species with low cover may include *Achnatherum hymenoides, Leymus salinus*, and *Pleuraphis jamesii*. Biological soil crusts are a common component in some stands.

Global Vegetation: The vegetation is characterized by an open tree canopy dominated by *Juniperus osteosperma* with *Artemisia tridentata ssp. wyomingensis* dominating the sparse to moderately dense short-shrub layer. Tree canopy cover values are over 5%, but typically less than 20%, and the height of the tree canopy is 2-10 m. Other shrubs such as *Atriplex canescens, Atriplex confertifolia, Artemisia bigelovii, Artemisia nova, Chrysothamnus viscidiflorus, Ephedra cutleri, Ephedra nevadensis, Ephedra viridis, Ericameria nauseosa, Gutierrezia sarothrae, Opuntia* spp., *Shepherdia rotundifolia*, and/or *Purshia* spp. may be present but generally with low cover. The herbaceous layer tends to have sparse to low cover but can range to moderately dense cover in some stands. It is dominated by graminoids such as *Achnatherum hymenoides, Aristida* spp., *Bouteloua* spp., *Carex filifolia, Elymus elymoides, Hesperostipa comata, Leymus salinus, Pleuraphis jamesii (= Hilaria jamesii), Pascopyrum smithii, Poa secunda, Pseudoroegneria spicata, Sporobolus* spp., and introduced annual *Bromus* spp. Associated forbs may include *Artemisia frigida, Eriogonum* spp., *Gayophytum racemosum, Leptodactylon pungens, Phlox hoodii*, and *Plantago patagonica*.

Global Dynamics: Fires in this association are thought to be infrequent because smaller *Juniperus osteosperma* and *Artemisia tridentata* are easily killed by burns and do not resprout (Barney and Frischknecht 1974, Everett 1987). In addition, many stands have an open canopy with insufficient understory to carry fire. *Artemisia tridentata* will re-establish relatively quickly (about 10-20 years) if

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a seed source is nearby (Barney and Frischknecht 1974, Bunting 1987). However, *Juniperus osteosperma* is relatively slow to recover following fire, and sagebrush may dominate the sites for decades (Jameson et al. 1962). If fire-return intervals are more frequent than 10 years then *Artemisia tridentata* has difficulty recovering (Bunting 1987, Everett 1987). This community may be increasing in extent by invading adjacent grasslands and steppe because of reduction of fire frequency due to fire suppression and fine fuels removal by grazing livestock that would allow fires to spread (Johnson and Payne 1968). Fire, drought and competition with grasses are thought to have kept *Juniperus* spp. communities restricted to rocky areas that do not burn frequently (Wright et al. 1979).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *wyomingensis*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *wyomingensis*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Artemisia tridentata* ssp. *wyomingensis*, *Juniperus osteosperma*

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: G5? (1-Feb-1996).

Related Concepts

Global Similar Types:

- *Pinus edulis - Juniperus monosperma / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana)* Woodland (CEGL005650)
- *Pinus edulis - Juniperus osteosperma / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana)* Woodland (CEGL005658) also supports an open canopy of *Juniperus osteosperma* and a shrub layer dominated by *Artemisia tridentata*, but *Pinus edulis* is codominant in the canopy.

Global Related Concepts:

- *Juniperus osteosperma / Artemisia tridentata / Agropyron spicata* Community (Blackburn et al. 1971) =
- *Juniperus osteosperma / Artemisia tridentata / Poa secunda* Community (Blackburn et al. 1969a) =
- *Juniperus osteosperma / Artemisia tridentata / Stipa comata* Community (Blackburn et al. 1971) =
- *Juniperus osteosperma / Artemisia tridentata* Community (Blackburn et al. 1968a) =

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- *Juniperus osteosperma / Artemisia tridentata* Community (Blackburn et al. 1968c) =
- *Juniperus osteosperma / Artemisia tridentata* Community Type (DeVelice and Lesica 1993) =
- *Juniperus osteosperma / Artemisia tridentata* Plant Association (Johnston 1987) =
- *Juniperus osteosperma / Artemisia tridentata* Plant Association (Larson and Moir 1987) =
- *Juniperus osteosperma / Artemisia tridentata* Plant Association (Stuever and Hayden 1997a) =
- *Juniperus osteosperma / Chrysothamnus viscidiflorus / Bromus tectorum* Community (Blackburn et al. 1969e) =
- *Juniperus osteosperma/Artemisia tridentata* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: Although it ranges wider than the Colorado Plateau, this association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands may be similar to open *Artemisia tridentata ssp. wyomingensis* shrublands with scattered pinyon and juniper trees, but they are considered a variation of the woodland type because of the ecological values of the trees.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland association is uncommon within the recreation area and was sampled on Muley Point, Navajo Point (Fiftymile Bench), and in Waterhole Flat.

Global Range: This sparse woodland association occurs throughout much of the western Rocky Mountains, Colorado Plateau, and Great Basin region and extends east to the Bighorn Mountains and hills of central Wyoming.

Nations: US
States/Provinces: AZ:S4, CA:S2?, CO:S1, ID:S1?, MT:S3, NM:S5, NV, UT:S5, WY
TNC Ecoregions: 6:C, 8:C, 9:C, 10:C, 11:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, 341D:CC, 342A:CC, 342B:CC, 342D:CC, 342F:CC, 342G:CC, M331B:CC, M331E:CC, M331G:CC, M332E:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Capitol Reef, Colorado, Dinosaur, Glen Canyon, Grand Canyon, Grand Canyon-Parashant, Hovenweep, Navajo, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: A shallow drainage runs through the center of the plot. Shrubs and trees are growing on the hummocks around the drainage. Soil crust and cyanobacteria are holding the soil together.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012 and 2015 field data (2 plots, 4 accuracy assessment points): (Plots: GLCA.0590, GLCA.4047; AA Points: GLCA_AA.1368, GLCA_AA.1427, GLCA_AA.1508, GLCA_AA.1509).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Drake, J. Coles and G. Kittel
References: Barney and Frischknecht 1974, Blackburn 1967, Blackburn et al. 1968a, Blackburn et al. 1968c, Blackburn et al. 1969a, Blackburn et al. 1969e, Blackburn et al. 1971, Bourgeron and Engelking 1994, Bradley 1964, Brotherson and Evenson 1983, Bunting 1987, CNHP 2003, CNHP 2015, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2010, Dastrup 1963, DeVelice and Lesica 1993, Donart et al. 1978b, Driscoll et al. 1984, Everett 1987, Francis 1986, Isaacson 1967, Jameson et al. 1962, Johnson and Payne 1968, Johnston 1987, Jones 1992b, Larson and Moir 1987, MTNHP 2002b, Milton and Purdy 1983, Moir and Carleton 1987, Reid and Hall 2010, Romme et al. 1993, Salas et al. 2010a, Stuever and Hayden 1997a, USFS 1983a, Von Loh et al. 2007, Von Loh et al. 2008, WNDD unpubl. data, West et al. 1998, Western Ecology Working Group: n.d.*, Wright et al. 1979

[CEGL000733] Juniperus osteosperma / Cercocarpus intricatus Woodland
Translated Name: Utah Juniper / Littleleaf Mountain-mahogany Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Intermountain Singleleaf Pinyon - Juniper Woodland (M026)
Group: Colorado Plateau-Great Basin Juniper Open Woodland (G246)
Alliance: *Juniperus osteosperma* / Shrub Understory Woodland Alliance (A3496)

Element Concept

Global Summary: This woodland association occurs in the Great Basin of Nevada, and on the Colorado Plateau. Total vegetation cover rarely exceeds 35%. The tree canopy is open, with *Juniperus osteosperma* often stunted. There is a well-developed shrub layer in which *Cercocarpus intricatus* is dominant or codominant. Total shrub cover ranges from 5 to 15%. The herbaceous layer is diverse in terms of species composition and provides sparse to low cover. Forbs are diverse but provide sparse cover. Stands are located between 1400 and 1980 m (4600-6500 feet) elevation. Aspect may influence the distribution of stands locally, but rangewide stands may occur on any aspect. It occurs on steep, rocky ridges or gentle to moderate slopes on mesas, benches and canyon floors where bedrock is partially covered by sandy soils. At least half the unvegetated surface is bare ground or sandstone slickrock, with the remainder divided primarily between litter and biological soil crusts. Soils are shallow or skeletal and are rapidly drained sands or sandy loams.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association is found on flat to hummocky to moderately sloping (up to 20°) canyon rims, benches, and mesatops that lie between 1398 and 1553 m elevation. Most of the unvegetated surface is exposed bedrock, with lesser cover by

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sand, bare soil, litter, and cryptobiotic soil crusts. Soil pockets within the sandstone bedrock matrix often support a diverse, lichen-rich biological soil crust community. Soils are rapidly drained sands derived from Navajo, Kayenta, and Cedar Mesa sandstones.

Global Environment: This woodland association occurs on steep, rocky ridges in the Great Basin of Nevada, whereas in the Colorado Plateau of Utah and Colorado it occupies gentle to moderate slopes on mesas, benches and canyon floors where bedrock is partially covered by sandy soils. Stands are located between 1400 and 1980 m (4600-6500 feet) elevation. Aspect may influence the distribution of stands locally, but rangewide stands may occur on any aspect. At least half the unvegetated surface is bare ground or sandstone slickrock, with the remainder divided primarily between litter and biological soil crusts. Soils are shallow or skeletal and are rapidly drained sands or sandy loams.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Utah juniper woodland is rare within the park. Total vegetation cover is sparse (8-14% cover). The dwarfed tree canopy of *Juniperus osteosperma* has between 3 and 4% cover, and *Cercocarpus intricatus* dominates a sparse shrub understory with 1 to 4% cover. Associated species with very low cover include *Fraxinus anomala, Artemisia bigelovii, Ephedra* spp., *Rhus trilobata, Gutierrezia sarothrae, Yucca angustissima, Opuntia* spp., and *Coleogyne ramosissima*. Herbaceous species are diverse but contribute only trace to low cover; *Aristida purpurea, Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii, Sporobolus contractus, Sporobolus flexuosus, Achnatherum speciosum (= Stipa speciosa), Ambrosia acanthicarpa, Cordylanthus wrightii, Cryptantha flava,* and *Tetraneuris acaulis (= Hymenoxys acaulis)* were reported. The cover of biological soil crusts is low because there is little soil in these stands, but the small patches that do occur are often well-developed and diverse.

Global Vegetation: Total vegetation cover rarely exceeds 35% because the high exposure of slickrock limits where plants can grow. The canopy is open, with *Juniperus osteosperma* trees providing between 5 and 25% cover. There is a well-developed shrub layer in which *Cercocarpus intricatus* is dominant or codominant. Total shrub cover ranges from 5 to 15%. Associated shrubs include *Amelanchier utahensis, Artemisia bigelovii, Atriplex confertifolia, Cercocarpus montanus, Chrysothamnus greenei, Coleogyne ramosissima, Echinocereus triglochidiatus, Ephedra viridis, Fraxinus anomala, Glossopetalon spinescens var. meionandrum, Gutierrezia sarothrae, Opuntia erinacea, Philadelphus microphyllus, Quercus havardii var. tuckeri, Rhus trilobata, Symphoricarpos longiflorus,* and *Yucca angustissima*. The herbaceous layer is diverse in terms of species composition and provides sparse to low cover. Graminoids commonly include *Aristida purpurea, Achnatherum hymenoides, Hesperostipa comata, Achnatherum speciosum, Achnatherum coronatum, Achnatherum pinetorum, Bouteloua gracilis, Hesperostipa comata, Muhlenbergia pungens, Pleuraphis jamesii, Sporobolus contractus,* or *Sporobolus flexuosus*. Forbs are diverse but provide sparse cover and include *Stenotus acaulis (= Haplopappus acaulis), Tetraneuris acaulis (= Hymenoxys acaulis), Lepidium montanum,* and *Cryptantha flavoculata*. The cover of biological soil crusts is low because there is little soil in these stands, but where patches occur it is well-developed and diverse.

Global Dynamics: This association is often transitional in areas on mesatops where soils thin as they approach the mesa rim. Deeper soils support juniper woodlands with a more xeric shrub understory

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(such as *Artemisia tridentata* or *Shepherdia rotundifolia*), whereas areas immediately on mesa rims tend to have few trees and sparse cover.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Fraxinus anomala*
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii*, *Cercocarpus intricatus*, *Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Short shrub/sapling	Succulent shrub	*Yucca angustissima*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Cercocarpus intricatus*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Amelanchier utahensis*, *Aristida purpurea*, *Artemisia bigelovii*, *Cercocarpus intricatus*, *Ephedra viridis*, *Fraxinus anomala*, *Juniperus osteosperma*

Other Noteworthy Species

Global: Vulnerable Plants: *Glossopetalon spinescens* var. *meionandrum* (G5T3)

Conservation Status Rank

Global Rank & Reasons: GNR (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus* Woodland (CEGL000779)

Global Related Concepts:

- *Juniperus osteosperma / Cercocarpus intricatus* Woodland (Blackburn et al. 1968c) =
- *Juniperus osteosperma/Cercocarpus intricatus* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. It is unusual for sites as rocky as those occupied by this association not to have *Pinus edulis* in the understory. It is not clear why *Pinus* is absent from these stands, but the sites may be too warm or may be isolated from other woodlands containing *Pinus*.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland association is rare within the park and was sampled on Andy Miller Flats, Mille Crag Bend, near Egypt, above Harris Wash, and on a rim above Horsethief Canyon.

Global Range: This association is known from southeastern Utah, western Colorado and northern Nevada and may also occur in southeastern California. It is likely to occur in scattered stands throughout the Great Basin and Colorado Plateau.

Nations: US
States/Provinces: CA?, CO:S1, NV, UT
TNC Ecoregions: 6:P, 11:C, 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC, 341B:CC, M341:C
Federal Lands: NPS (Canyonlands, Capitol Reef, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: It is mostly exposed bedrock here, so plant life only occurs in the sandy pockets between the slickrock bedrock.

Glen Canyon National Recreation Area Plots: The description is based on 2012, 2014, and 2015 field data (1 plot, 5 accuracy assessment points): (Plots: GLCA.5325; AA Points: GLCA_AA.0406, GLCA_AA.0513, GLCA_AA.1768, GLCA_AA.1772, GLCA_AA.1777).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Blackburn et al. 1968c, Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Clark et al. 2009, Driscoll et al. 1984, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEGL002909] Juniperus osteosperma / Coleogyne ramosissima Woodland
Translated Name: Utah Juniper / Blackbrush Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Intermountain Singleleaf Pinyon - Juniper Woodland (M026)
Group: Colorado Plateau-Great Basin Juniper Open Woodland (G246)
Alliance: *Juniperus osteosperma* / Shrub Understory Woodland Alliance (A3496)

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Element Concept

Global Summary: This woodland association is known from the Colorado Plateau in Utah and desert ranges in the Mojave Desert in California. The vegetation is characterized by an open tree canopy of scattered *Juniperus osteosperma* with between 5 and 16% cover, and an open shrub (<10% cover) understory dominated by *Coleogyne ramosissima*. Total vegetation cover does not exceed 30%. Herbaceous cover is low and diverse. Biological soil crusts provide up to 22% cover and are generally well-developed.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association is distributed on mesatops, slickrock benches and rims, broad plateaus, and valley sides within the recreation area. Sites are on gentle to moderate slopes (up to 21°) between 1189 and 1758 m elevation. Bedrock and bare soil cover most of the unvegetated surface, with low to moderate exposure of small rocks, litter and biological soil crusts. Soils are rapidly drained to well-drained sands, loams, silt loams, sandy loams, and loamy sands derived from the Carmel Formation, Navajo or Cedar Mesa sandstones.

Global Environment: This woodland association is distributed on mesatops, slickrock benches and rims, broad plateaus, and valley sides. Sites are on gentle to moderate slopes (up to 21°) between 1189 and 1758 m elevation. Bedrock and bare soil cover most of the unvegetated surface, with low to moderate exposure of small rocks, litter and biological soil crusts. Soils are rapidly drained to well-drained sands, loams, silt loams, sandy loams, and loamy sands derived from the Carmel Formation, Navajo, Kayenta Formation, White Rim, or Cedar Mesa sandstones.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This juniper woodland is fairly common within the recreation area. Total vegetation cover does not exceed 20%. Stands are characterized by scattered *Juniperus osteosperma* with between 1 and 5% cover, and a shrub understory dominated by *Coleogyne ramosissima* with between 1 and 15% cover. These communities often contain a high diversity of species all with trace to very low cover. Associated shrubs include *Amelanchier utahensis, Chrysothamnus viscidiflorus, Fraxinus anomala, Ephedra cutleri, Ephedra viridis, Ephedra torreyana, Psorothamnus fremontii,* and *Yucca angustissima*. Herbaceous species providing low cover may include *Achnatherum hymenoides, Pleuraphis jamesii, Sporobolus cryptandrus,* and *Bromus tectorum*. Biological soil crusts are common.

Global Vegetation: The vegetation is characterized by an open tree canopy of scattered *Juniperus osteosperma* with between 5 and 16% cover, and an open shrub (<10% cover) understory dominated by *Coleogyne ramosissima*. Total vegetation cover does not exceed 30%. These communities often contain a high diversity of species, all with trace to very low cover. Associated shrubs include *Amelanchier utahensis, Artemisia bigelovii, Chrysothamnus viscidiflorus, Ephedra cutleri, Ephedra viridis, Ephedra torreyana, Eriogonum microthecum, Fraxinus anomala, Gutierrezia microcephala, Opuntia erinacea, Psorothamnus fremontii, Sclerocactus whipplei*, and *Yucca angustissima*. Graminoid species providing low cover may include *Achnatherum hymenoides, Bouteloua gracilis, Pleuraphis jamesii, Sporobolus cryptandrus, Vulpia octoflora,* and the non-native *Bromus tectorum*. Forb cover includes *Packera multilobata (= Senecio multilobatus), Machaeranthera canescens,*

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Plantago patagonica, Eriogonum alatum, Lepidium montanum, Cryptantha flava, Hymenopappus filifolius, and *Comandra umbellata*. Biological soil crusts are common and are generally well-developed.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Coleogyne ramosissima, Juniperus osteosperma*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GU (28-Oct-2002).

Related Concepts

Global Related Concepts:

- *Juniperus osteosperma / Coleogyne ramosissima* (Evens et al. 2014) =

Classification

Status: Standard
Classification Confidence:
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau and Mojave Desert.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland association is distributed on plateaus and mesatops within the recreation area and was sampled on Brown's Rim, Early Weed Bench, near Egypt, Grand Bench, near Hite, north of High Spur, Rock Canyon, and Wilson Mesa.

Global Range: This woodland association is known from the Colorado Plateau in Utah and the ranges in the Mojave Desert in California.

Nations: US
States/Provinces: CA, CO:S1, UT
TNC Ecoregions: 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331:C
Federal Lands: NPS (Canyonlands, Death Valley, Glen Canyon, Mojave)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plants grow in this area wherever there is enough soil to sustain them.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2012 field data (9 plots): (Plots: GLCA.4120, GLCA.4312, GLCA.5002, GLCA.5092, GLCA.5232, GLCA.5562, GLCA.5563, GLCA.6108, GLCA.9104).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and G. Kittel
References: CNHP 2015, CNHP Ecology Team 2001, Evens et al. 2014, Western Ecology Working Group n.d.*

[CEGL003965] Juniperus osteosperma / Mahonia fremontii Woodland
Translated Name: Utah Juniper / Fremont's Mahonia Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Intermountain Singleleaf Pinyon - Juniper Woodland (M026)
Group: Colorado Plateau-Great Basin Juniper Open Woodland (G246)
Alliance: *Juniperus osteosperma* / Shrub Understory Woodland Alliance (A3496)

Element Concept

Global Summary: This woodland association is known primarily from the Colorado Plateau in Utah. The vegetation is characterized by an open canopy, typically 2 to 5 m tall, of *Juniperus osteosperma* with 6 to 30% cover, and an understory dominated by *Mahonia fremontii* with 3 to 12% cover; total vegetation cover ranges from 23 to 61%. Associated shrubs include *Atriplex canescens, Ephedra viridis, Gutierrezia sarothrae, Rhus trilobata, Symphoricarpos longiflorus*, and *Yucca angustissima*. Herbaceous species provide sparse cover and may include *Achnatherum hymenoides, Pleuraphis jamesii, Aristida purpurea, Sporobolus airoides, Machaeranthera canescens*, and *Lepidium montanum var. jonesii*. Biological soil crusts are well-developed but sparse in some stands and provide up to 43% cover in others. Stands occur on the deep soils of plateaus, stream terraces, benches, and wash banks. Sites are flat to steep slopes between 1362 and 1865 m elevation. Bare soil or litter cover most of the unvegetated surface, depending on density of the vegetation and degree of disturbance. Dead wood and biological soil crusts provide sparse to moderate cover. Soils are rapidly drained sandy loams or loamy sands derived from alluvium or eolian deposits.

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Environmental Description

Glen Canyon National Recreation Area Environment: This woodland occurs on the deep soils of mesas, canyon sides, and stream terraces. Sites are on flat to steep (up to 35°) slopes between 1588 and 1753 m elevation. Bare soil or litter covers most of the unvegetated surface, with lesser cover by large and small rocks, biological soil crusts, and bedrock. Soils are rapidly drained loamy sands derived from alluvium or from Navajo sandstone.

Global Environment: Stands occur on the deep soils of plateaus, stream terraces, benches, and wash banks. Sites are found on flats and steep to gentle slopes between 1362 and 1865 m elevation. Bare soil or litter covers most of the unvegetated surface, depending on density of the vegetation and degree of disturbance. Dead wood and biological soil crusts provide sparse to moderate cover. Soils are rapidly drained sandy loams or loamy sands derived from alluvium or eolian deposits.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Utah juniper woodland is uncommon within the recreation area. Total vegetation cover ranges from 36 to 50%. Stands are characterized by an open canopy, typically 2 to 5 m tall, of *Juniperus osteosperma* with up to 30% cover and an understory dominated by *Mahonia fremontii* with 3 to 12% cover. *Pinus edulis* may be present in the canopy layer with trace cover. Associated shrubs include *Ephedra cutleri, Ephedra viridis, Purshia stansburiana, Quercus havardii, Ericameria nauseosa, Fraxinus anomala,* and *Gutierrezia sarothrae*. Herbaceous species provide sparse cover and may include *Pleuraphis jamesii* and *Hesperostipa comata*.

Global Vegetation: The vegetation is characterized by an open canopy, typically 2 to 5 m tall, of *Juniperus osteosperma* with 6 to 30% cover, and an understory dominated by *Mahonia fremontii* with 3 to 12% cover; total vegetation cover ranges from 23 to 61%. Associated shrubs include *Atriplex confertifolia, Atriplex canescens, Ephedra cutleri, Ephedra viridis, Eriogonum corymbosum, Ericameria nauseosa, Fraxinus anomala, Purshia stansburiana, Quercus havardii, Rhus trilobata, Symphoricarpos longiflorus, Yucca angustissima,* and *Gutierrezia sarothrae*. Herbaceous species provide sparse cover and may include *Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii, Aristida purpurea, Sporobolus airoides, Machaeranthera canescens,* and *Lepidium montanum var. jonesii*. Biological soil crusts are well-developed but sparse in some stands and provide up to 43% cover in others.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*, *Mahonia fremontii*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Hesperostipa comata*, *Pleuraphis jamesii*

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Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Mahonia fremontii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Juniperus osteosperma*, *Mahonia fremontii*

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (10-Jul-2006).

Related Concepts

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is rare within the recreation area and was sampled in Waterhole Flat, the south fork of Happy Canyon and Clyde's Spring Canyon.

Global Range: This woodland association has only been described from Canyonlands National Park and Glen Canyon National Recreation Area in Utah.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Canyonlands, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This community is growing along the flat banks of the wash, perhaps 0.5 m above the wash bottom, and clearly is located here because of the intermittent saturation of the soil from flood events in the channel.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2014, and 2015 field data (1 plot, 2 accuracy assessment points): (Plots: GLCA.0768; AA Points: GLCA_AA.0401, GLCA_AA.0604).

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Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and G. Kittel
References: Western Ecology Working Group n.d.*

[CEPP005696] Juniperus osteosperma / Quercus gambelii Woodland
Translated Name: Utah Juniper / Gambel Oak Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Intermountain Singleleaf Pinyon - Juniper Woodland (M026)
Group: Colorado Plateau-Great Basin Juniper Open Woodland (G246)
Alliance: *Juniperus osteosperma* / Shrub Understory Woodland Alliance (A3496)

Element Concept

Global Summary: This woodland is known from Glen Canyon National Recreation Area but occurs more widely in the Colorado Plateau. It is characterized by an open canopy, typically 2 to 10 m tall, composed of *Juniperus osteosperma* (with 4-20% cover). *Pinus edulis* is absent. The shrub layer is dominated by scattered, dense clones of *Quercus gambelii* with between 3 and 14% cover. Associated shrub diversity is high, with 19 species listed, although individual cover by species is generally low. The herbaceous layer has low to moderate cover and is a diverse mixture of native grasses and forbs that range from dry species such as *Achnatherum hymenoides, Bouteloua gracilis, Heterotheca villosa, Phlox austromontana, Pleuraphis jamesii,* and *Sporobolus cryptandrus,* to more mesic species such as *Eleocharis rostellata, Elymus canadensis, Juncus balticus, Phragmites australis, Solidago* spp., *Sorghastrum nutans,* and *Typha domingensis* that are common along drainages. The exotic grasses *Bromus tectorum* and *Bromus rubens* are present with low cover in some stands. Stands occur on the deep soils of valley sides, canyon bottoms, canyon seeps, hills, steep dunes, terraces, and benches between 1165 and 1535 m elevation, but sites are frequently found on sheltered, steep slopes or along canyon bottom drainages. Sites are gentle to steeply sloping with eastern, southeastern, and occasionally western aspects. Bare soil, sand, and litter cover most of the unvegetated surface, with occasional to moderate cover of large rocks, gravel, bedrock, and biological soil crusts. Soils are rapidly drained sands or loamy sands derived from alluvial or eolian deposits, shales or sandstones.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland occurs on the deep soils of valley sides, canyon bottoms, canyon seeps, hills, steep dunes, terraces, and benches. Sites are gentle to steeply sloping (up to 38°), are mostly oriented to the east, southeast, and occasionally to the west, and lie between 1165 and 1535 m elevation. Bare soil, sand, and litter cover most of the unvegetated surface, with occasional to moderate cover of large rocks, gravel, bedrock, and biological soil crusts. Soils are rapidly drained sands or loamy sands derived from alluvial or eolian deposits, from shales of the Carmel Formation or Salt Wash Member of the Morrison Formation, or from sandstones of the Kayenta or Navajo formations.

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Global Environment: This Colorado Plateau woodland association occurs on the deep soils of valley sides, canyon bottoms, canyon seeps, hills, steep dunes, terraces, and benches but sites are frequently found on sheltered, steep slopes or along canyon bottom drainages. Sites are gentle to steeply sloping (up to 38°), are mostly oriented to the east, southeast, and occasionally to the west, and lie between 1165 and 1535 m elevation. Bare soil, sand, and litter cover most of the unvegetated surface, with occasional to moderate cover of large rocks, gravel, bedrock, and biological soil crusts. Soils are rapidly drained sands or loamy sands derived from alluvial or eolian deposits, from shales of the Carmel Formation or Salt Wash Member of the Morrison Formation, or from sandstones of the Kayenta or Navajo formations.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This woodland is moderately common, especially on sheltered, steep slopes or along canyon bottom drainages within the recreation area. Total vegetation cover ranges from 24 to 61%. Stands are characterized by an open canopy, typically 2 to 10 m tall, of *Juniperus osteosperma* (with 4-20% cover). *Pinus edulis* is absent. The shrub layer is dominated by scattered, dense clones of *Quercus gambelii* with between 3 and 14% cover. Associated shrub diversity is high, though individual cover by species is generally low; *Atriplex canescens, Amelanchier utahensis, Artemisia bigelovii, Coleogyne ramosissima, Ephedra viridis, Ephedra torreyana, Ericameria nauseosa, Fraxinus anomala, Grayia spinosa, Gutierrezia sarothrae, Quercus turbinella, Opuntia* spp., *Purshia stansburiana, Rhus aromatica, Shepherdia rotundifolia, Symphoricarpos longiflorus, Tamarix chinensis, Toxicodendron rydbergii*, and *Yucca* spp. are all present with more than trace cover. The herbaceous layer is likewise diverse and generally provides low to moderate cover. Native grasses include *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Bouteloua gracilis, Elymus canadensis, Muhlenbergia asperifolia, Panicum* sp., *Phragmites australis, Pleuraphis jamesii, Poa fendleriana, Sorghastrum nutans, Sporobolus cryptandrus, Sporobolus contractus*, and the grasslike species *Juncus balticus, Eleocharis rostellata*, and *Typha domingensis*. Forbs occur with less cover than grasses and include *Artemisia ludoviciana, Cirsium arizonicum, Comandra umbellata, Heterotheca villosa, Iva acerosa, Machaeranthera canescens, Phlox austromontana, Solidago canadensis, Solidago velutina*, and *Psoralidium junceum*. The exotic grasses *Bromus tectorum* and *Bromus rubens* are present with low cover in some stands.

Global Vegetation: This woodland association is characterized by an open tree canopy, typically 2 to 10 m tall, composed of *Juniperus osteosperma* (with 4-20% cover). *Pinus edulis* is absent. Total vegetation cover ranges from 24 to 61%. The shrub layer is dominated by scattered, dense clones of *Quercus gambelii* with between 3 and 14% cover. Associated shrub diversity is high, though individual cover by species is generally low; *Atriplex canescens, Amelanchier utahensis, Artemisia bigelovii, Coleogyne ramosissima, Ephedra viridis, Ephedra torreyana, Ericameria nauseosa, Fraxinus anomala, Grayia spinosa, Gutierrezia sarothrae, Quercus turbinella, Opuntia* spp., *Purshia stansburiana, Rhus aromatica, Shepherdia rotundifolia, Symphoricarpos longiflorus, Tamarix chinensis, Toxicodendron rydbergii*, and *Yucca* spp. are all present with more than trace cover. The herbaceous layer has low to moderate cover and is a diverse mixture of native grasses and forbs that range from dry species to more mesic species that are common along drainages. Native grasses include *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Bouteloua gracilis, Elymus*

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canadensis, Muhlenbergia asperifolia, Panicum sp., *Phragmites australis, Pleuraphis jamesii, Poa fendleriana, Sorghastrum nutans, Sporobolus cryptandrus, Sporobolus contractus,* and the grasslike species *Juncus balticus, Eleocharis rostellata,* and *Typha domingensis*. Forbs occur with less cover than grasses and include *Artemisia ludoviciana, Cirsium arizonicum, Comandra umbellata, Heterotheca villosa, Iva acerosa, Machaeranthera canescens, Phlox austromontana, Solidago canadensis, Solidago velutina,* and *Psoralidium junceum*. The exotic grasses *Bromus tectorum* and *Bromus rubens* are present with low cover in some stands.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Quercus gambelii*, *Rhus trilobata*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Quercus gambelii*

Characteristic Species

Glen Canyon National Recreation Area: *Rhus trilobata*
Global: *Juniperus osteosperma, Quercus gambelii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High)

Global: Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (18-Aug-2016).

Classification

Status: Provisional
Classification Confidence: 3 - Weak

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is moderately common within the recreation area but has still fairly localized distribution; it was sampled in Cottonwood Canyon, Twitchell Canyon, Grand Gulch, and the South Fork Ticaboo Canyon.

Global Range: This open juniper woodland is documented from Glen Canyon National Recreation Area but occurs more widely in the Colorado Plateau.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plot lies within a shaded drainage that sits under a protective canyon alcove. Soil is primarily wind-blown sand that has become trapped in the upper canyon and has piled up against the canyon wall.

Glen Canyon National Recreation Area Plots: The description is based on 2012, 2013, and 2015 field data (2 plots, 7 accuracy assessment points): (Plots: GLCA.4249, GLCA.5410; AA Points: GLCA_AA.1928, GLCA_AA.1936, GLCA_AA.1938, GLCA_AA.1969, GLCA_AA.1972, GLCA_AA.1984, GLCA_AA.2083).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEPP005694] Juniperus osteosperma / Quercus havardii - Artemisia filifolia - Ephedra cutleri Sandsheet Scrub
Translated Name: Utah Juniper / Havard Oak - Sand Sagebrush - Cutler's Joint-fir Sandsheet Scrub
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Intermountain Singleleaf Pinyon - Juniper Woodland (M026)
Group: Colorado Plateau-Great Basin Juniper Open Woodland (G246)
Alliance: *Juniperus osteosperma* / Shrub Understory Woodland Alliance (A3496)

Element Concept

Global Summary: This open scrub is known from Glen Canyon National Recreation Area and likely occurs more widely on sandy sites in the Colorado Plateau. It is characterized by a sparse to open tree canopy composed of *Juniperus osteosperma* with 3-15% cover. The shrub layer is dominated by *Quercus havardii* and codominated by *Ephedra cutleri* and *Artemisia filifolia*. Other commonly associated shrubs include *Eriogonum leptocladon* and *Vanclevea stylosa*. The herbaceous layer is typically dominated by graminoids with *Achnatherum hymenoides* always present and usually dominant. Many other native grasses may be present with low to moderate cover such as *Bouteloua gracilis, Sporobolus contractus, Sporobolus cryptandrus, Sporobolus flexuosus, Sporobolus giganteus, Muhlenbergia pungens, Pleuraphis jamesii,* and *Vulpia octoflora (= Festuca octoflora)*. Native forbs have sparse to low cover with moderately low diversity. Exotic annuals *Bromus tectorum*

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Subset: GLCA; Glen Canyon National Recreation Area

and *Salsola tragus* may be present with sparse to low cover. This sandy site scrub occurs on benches, sand dunes/dunefields, sandsheets and mesas between 1491 and 1546 m elevation. Sites are gently to moderately sloping with mostly westerly aspects. Bare soil and sand cover most of the unvegetated surface, with lesser cover by dark cyanobacteria, litter, gravel, and bedrock. Soils are loamy sands derived from eolian deposits or from sandstones.

Environmental Description

Glen Canyon National Recreation Area Environment: This dune-like shrubland association occurs on benches, sand dunes/dunefields, and mesas that are gently to moderately sloping (2-11°), are mostly west-facing, and lie between 1491 and 1546 m elevation. Bare soil and sand cover most of the unvegetated surface, with lesser cover by dark cyanobacteria, litter, gravel, and bedrock. Soils are well-drained to rapidly drained loamy sands derived from eolian deposits or from sandstones of the Navajo Formation.

Global Environment: This open scrub occurs on sandy sites in the Colorado Plateau. Stands occur on benches, sand dunes/dunefields, sandsheets and mesas between 1491 and 1546 m elevation. Sites are gently to moderately sloping with mostly westerly aspects. Bare soil and sand cover most of the unvegetated surface, with lesser cover by dark cyanobacteria, litter, gravel, and bedrock. Soils are well-drained to rapidly drained loamy sands derived from eolian deposits or from sandstones of the Navajo Formation.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Total vegetation cover in this sandsheet shrubland does not exceed 49% and may be as low as 7% in areas with actively blowing sand. The canopy layer consists entirely of scattered *Juniperus osteosperma* trees, with 3-15% cover (though one stand has 21% cover). The shrub canopy is dominated by *Quercus havardii* (with up to 13% cover) and codominated by *Ephedra cutleri* (with up to 8% cover) and *Artemisia filifolia* (absent to 5% cover). Other commonly associated shrubs include *Eriogonum leptocladon* and *Vanclevea stylosa*. Less commonly associated shrubs include *Atriplex canescens, Ephedra viridis, Gutierrezia* spp., *Opuntia polyacantha, Poliomintha incana, Shepherdia rotundifolia,* and *Yucca angustissima*. The understory may appear quite grassy and *Achnatherum hymenoides* is always present, though not always dominant (with trace to 9% cover). Other native grasses with low to moderate cover include *Bouteloua gracilis, Sporobolus contractus, Sporobolus cryptandrus, Sporobolus flexuosus, Sporobolus giganteus, Muhlenbergia pungens, Pleuraphis jamesii*, and *Vulpia octoflora (= Festuca octoflora)*. It may also include sparse to low cover of the exotic annual grass *Bromus tectorum*. Forbs have sparse cover to low cover and include *Ambrosia acanthicarpa, Artemisia campestris, Astragalus mollissimus, Cordylanthus wrightii, Cryptantha flava, Helianthus anomalus, Machaeranthera canescens*, and *Penstemon ambiguus*, and the exotic *Salsola tragus*.

Global Vegetation: This open scrub is characterized by a sparse to open tree canopy composed of *Juniperus osteosperma* with 3-15% cover (occasionally to 21% cover). The open shrub layer is dominated by *Quercus havardii* (with up to 13% cover) and codominated by *Ephedra cutleri* (with up to 8% cover) and *Artemisia filifolia* (absent to 5% cover). Other commonly associated shrubs include *Eriogonum leptocladon* and *Vanclevea stylosa*. Less commonly associated shrubs include *Atriplex*

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canescens, Ephedra viridis, Gutierrezia spp., *Opuntia polyacantha, Poliomintha incana, Shepherdia rotundifolia*, and *Yucca angustissima*. The herbaceous layer is typically dominated by graminoids with *Achnatherum hymenoides* always present and usually dominant (with trace to 9% cover). Other native grasses with low to moderate cover include *Bouteloua gracilis, Sporobolus contractus, Sporobolus cryptandrus, Sporobolus flexuosus, Sporobolus giganteus, Muhlenbergia pungens, Pleuraphis jamesii,* and *Vulpia octoflora (= Festuca octoflora)*. It may also include sparse to low cover of the exotic annual grass *Bromus tectorum*. Forbs have sparse to low cover and include *Ambrosia acanthicarpa, Artemisia campestris, Astragalus mollissimus, Cordylanthus wrightii, Cryptantha flava, Helianthus anomalus, Machaeranthera canescens*, and *Penstemon ambiguus*, and the exotic *Salsola tragus*. Total vegetation cover in this sandsheet shrubland does not exceed 49% and may be as low as 7% in areas with actively blowing sand.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved deciduous shrub	*Artemisia filifolia*, *Quercus havardii*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Muhlenbergia pungens*, *Sporobolus flexuosus*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved deciduous shrub	*Artemisia filifolia*, *Quercus havardii*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*
Herb (field)	Graminoid	*Achnatherum hymenoides*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Achnatherum hymenoides, Artemisia filifolia, Ephedra cutleri, Juniperus osteosperma, Quercus havardii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: GNR (18-Aug-2016).

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Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak

Element Distribution

Glen Canyon National Recreation Area Range: This localized shrubland was found to be fairly common in the northwest corner of the Escalante arm of the NRA and was sampled on Scorpion Flat, near Egypt, near Twentyfive Mile Wash, and above Harris Wash / near The V.

Global Range: This woodland is documented only from Glen Canyon National Recreation Area and likely occurs more widely in the Colorado Plateau on sandy sites.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Wind-blown stabilized sand dunes. *Quercus* and *Ephedra* are growing on sand mounds. Patches of soil in low depressions between the dunes are protected by gravel, moss, and *Juniperus osteosperma* litter layers.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (2 plots, 18 accuracy assessment points): (Plots: GLCA.4311, GLCA.4315; AA Points: GLCA_AA.1221, GLCA_AA.1237, GLCA_AA.1242, GLCA_AA.1243, GLCA_AA.1248, GLCA_AA.1250, GLCA_AA.1251, GLCA_AA.1252, GLCA_AA.1258, GLCA_AA.1263, GLCA_AA.2025, GLCA_AA.3074, GLCA_AA.3080, GLCA_AA.3093, GLCA_AA.3094, GLCA_AA.3097, GLCA_AA.4000, GLCA_AA.4002).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEGL002266] *Juniperus osteosperma* / Mixed Shrubs Talus Woodland
Translated Name: Utah Juniper / Mixed Shrubs Talus Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Intermountain Singleleaf Pinyon - Juniper Woodland (M026)
Group: Colorado Plateau-Great Basin Juniper Open Woodland (G246)
Alliance: *Juniperus osteosperma* / Shrub Understory Woodland Alliance (A3496)

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Element Concept

Global Summary: This association is known from the Colorado Plateau and the western slope of Colorado. This woodland is characterized by an open tree canopy of stunted *Juniperus osteosperma* with from 5 to 40% cover. *Pinus edulis* and *Fraxinus anomala* may occasionally be present. The shrub layer is highly variable in cover and composition among stands. The herbaceous layer is typically sparse to low in terms of cover but high in species diversity. *Pleuraphis jamesii* consistently provides the highest cover of the graminoid species. Common forbs include scattered *Eriogonum inflatum* and *Chamaesyce fendleri*. Stands occur on midslopes, ledges, benches, bottoms and especially talus or rockfall slopes of canyons and midslopes of ridges. Elevations range between 1231 and 1799 m. Sites are moderately steep to very steep (16-84% slopes) and include all aspects. Soils are shallow, poorly developed, rapidly drained sandy clays, clay loams and sandy loams. The unvegetated surface is mostly bedrock and rocks with some bare soil and litter. Parent materials are sandstones, shale, and Precambrian gneiss.

Environmental Description

Glen Canyon National Recreation Area Environment: This talus slope association occurs on canyon walls and sides, colluvial slopes, buttes, hills, valley sides, mesa sides, benches, gullies, slumps, and rockfalls within the recreation area at elevations ranging from 1231 to1799 m. Sites are extremely rocky, often unstable and moderately steep to very steep (5-45° slopes). Aspects are variable and appear to not be as influential as the colluvial substrate in indicating vegetation and physiognomy. Soils are rapidly drained to moderately well-drained clay loams derived from talus/colluvial deposits, from sandstones of the Kayenta and Dakota formations, and from shales of the Moenkopi, Chinle, and Shinarump formations.

Global Environment: This association occur on midslopes, ledges, benches, bottoms, buttes, hills, valley sides, mesa sides, gullies, slumps, and especially talus or rockfall slopes of canyons and midslopes of ridges. Elevations range between 1231 and 1799 m on the Colorado Plateau and extend up to 2121 m on the Western Slope of Colorado. Sites are moderately steep to very steep (16-84% slopes) and include all aspects. Soils are shallow, poorly developed, rapidly drained sandy clays, clay loams and sandy loams. The unvegetated surface has low to moderate cover of litter and bare soil and high cover of bedrock, large and small rocks. Parent materials are sandstones, shale, and Precambrian gneiss. Typical sites at Arches National Park are Morrison or Chinle shales overlain by Wingate or Salt Wash sandstone colluvium. Other parent materials include Moenkopi Formation, Navajo sandstone, and Elephant Canyon Formation at Canyonlands National Park, and Tidwell Member of the Morrison Formation and Kayenta Formation at Black Canyon National Park.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This association is characterized by a sparse to open canopy of *Juniperus osteosperma* trees with 2 to 19% cover. If *Pinus edulis* trees are present (rare but occasionally recorded), it is only with sparse cover, and they are not codominant with *Juniperus osteosperma*. Total cover in these stands ranges from 7 to 38%. As a result of the unstable substrate, the sparse understory consists of a highly variable array of tall and short shrub species, including *Amelanchier utahensis, Artemisia bigelovii, Artemisia tridentata, Atriplex confertifolia,*

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Chrysothamnus greenei, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Fraxinus anomala, Glossopetalon spinescens, Grayia spinosa, Gutierrezia sarothrae, Mahonia fremontii, Purshia stansburiana, Rhus trilobata var. trilobata (= Rhus aromatica var. trilobata), Shepherdia rotundifolia, Xylorhiza tortifolia, and *Yucca angustissima*. As a result of poor rooting substrate, herbaceous cover is generally sparse, though grass cover may be low to moderate; common native grass species include *Achnatherum hymenoides, Aristida purpurea, Leymus salinus, Hesperostipa comata, Pleuraphis jamesii,* and *Achnatherum speciosum (= Stipa speciosa)*. Forbs noted with more than trace cover include *Cordylanthus wrightii, Heterotheca villosa, Tetraneuris acaulis (= Hymenoxys acaulis),* and *Lepidium montanum*.

Global Vegetation: This woodland is characterized by an open tree canopy of stunted *Juniperus osteosperma* that ranges in cover from 5 to 40%, but may be less if juniper cover is still significant relative to total vegetation and the stand appears wooded. *Pinus edulis* and *Fraxinus anomala* may occasionally be present. The shrub layer is highly variable in cover and composition among stands and can include *Amelanchier utahensis, Artemisia bigelovii, Artemisia tridentata ssp. tridentata, Atriplex canescens, Atriplex confertifolia, Brickellia microphylla, Cercocarpus montanus, Chrysothamnus greenei, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Fendlera rupicola, Glossopetalon spinescens, Grayia spinosa, Gutierrezia sarothrae, Mahonia fremontii, Rhus trilobata, Shepherdia rotundifolia, Xylorhiza tortifolia,* and *Yucca angustissima*, as well as a number of succulents. The herbaceous layer is typically sparse to low in terms of cover but high in species diversity. Common graminoids provide sparse to low cover and include *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Aristida purpurea, Bouteloua curtipendula, Bromus tectorum, Elymus elymoides, Vulpia octoflora, Hesperostipa comata, Leymus salinus, Pleuraphis jamesii, Poa fendleriana,* and *Pseudoroegneria spicata*. *Pleuraphis jamesii* consistently provides the highest cover of the graminoid species. Common forbs include scattered *Eriogonum inflatum, Chamaesyce fendleri, Cordylanthus wrightii, Heterotheca villosa, Tetraneuris acaulis (= Hymenoxys acaulis),* and *Lepidium montanum*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*, *Shepherdia rotundifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii*, *Ephedra viridis*, *Ericameria nauseosa*, *Eriogonum corymbosum*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Leymus salinus*, *Pleuraphis jamesii*

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Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Amelanchier utahensis*, *Artemisia bigelovii*, *Artemisia tridentata* ssp. *tridentata*, *Atriplex canescens*, *Brickellia microphylla*, *Cercocarpus montanus*, *Chrysothamnus viscidiflorus*, *Coleogyne ramosissima*, *Ephedra torreyana*, *Ephedra viridis*, *Eriogonum corymbosum*, *Eriogonum microthecum*, *Fendlera rupicola*, *Fraxinus anomala*, *Juniperus osteosperma*, *Rhus trilobata*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4)
Global: Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (10-Jan-2005).

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. This association is closely related to a number of other colluvial slope types with sparse, variable vegetation described for the northern Colorado Plateau network of national parks. These include *Fendlera rupicola* Talus Shrubland (CEGL002765) (ARCH, COLM), *Atriplex canescens - Ephedra viridis* Talus Shrubland (CEGL001287) (CANY, CARE, COLM), and *Chrysothamnus viscidiflorus* Talus Shrubland (CEGL002347) (CANY, CARE, DINO). At some point the plots assigned to the various types should be re-analyzed to see if patterns are apparent and particular names can be assigned to groups of plots, or if a generic name such as this should be retained.

Element Distribution

Glen Canyon National Recreation Area Range: This association is widespread in the recreation area and was sampled below Muley Point, in the West Fork of Big Water Canyon, the South Fork of Happy Canyon, upper Millard Canyon, East Moody Canyon, Middle Moody Canyon, Fence Canyon, Miller's Creek, the north fork of Ticaboo Creek, on Ticaboo Mesa, Circle Cliffs, Fourmile Bench, Navajo Bench, Fiftymile Bench, above North Trail Canyon, above Teapot Canyon, and along the Escalante River.

Global Range: This association occurs on the Colorado Plateau of southern Utah and the western slope of Colorado.

Nations: US
States/Provinces: CO, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Colorado, Curecanti, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plot lies in the talus and boulderfield at the base of Cedar Mesa. Numerous gullies run through the plot. Shade from large boulders provides microhabitat for vegetation. A layer of gravel covers the soil.

Glen Canyon National Recreation Area Plots: The description is based on 2012, 2014, and 2015 field data (2 plots, 25 AA points): (Plots: GLCA.5133, GLCA.6111; AA Points:GLCA_AA.0195, GLCA_AA.0198, GLCA_AA.0216, GLCA_AA.0609, GLCA_AA.0641, GLCA_AA.0647, GLCA_AA.0660, GLCA_AA.1171, GLCA_AA.1185, GLCA_AA.1186, GLCA_AA.1245, GLCA_AA.1370, GLCA_AA.1373, GLCA_AA.1374, GLCA_AA.1505, GLCA_AA.1507, GLCA_AA.1755, GLCA_AA.1830, GLCA_AA.1960, GLCA_AA.1990, GLCA_AA.2006, GLCA_AA.2014, GLCA_AA.2028, GLCA_AA.2031, GLCA_AA.2033).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): M.S. Reid, J. Coles, K.A. Schulz and G. Kittel
References: Coles et al. 2009a, Tendick et al. 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.*

[CEGL000732] *Juniperus osteosperma* / Sparse Understory Woodland
Translated Name: Utah Juniper / Sparse Understory Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Intermountain Singleleaf Pinyon - Juniper Woodland (M026)
Group: Colorado Plateau-Great Basin Juniper Open Woodland (G246)
Alliance: *Juniperus osteosperma* / Shrub Understory Woodland Alliance (A3496)

Element Concept

Global Summary: This widespread woodland association occurs in the Great Basin, Colorado Plateau and western Rocky Mountain regions where it occupies sites in which junipers have become established but that are too dry to support a developed understory of shrubs, forbs and grasses. Total vegetation cover ranges from (3) 10 to 70% and consists almost entirely of the *Juniperus osteosperma* canopy. Shrub cover and herbaceous cover each total less than 5%, and usually total 1% or less. Because of the sparseness of the understory vegetation, there are few species that can be expected

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Subset: GLCA; Glen Canyon National Recreation Area

throughout the range of this association. Common species include *Ephedra viridis, Gutierrezia sarothrae*, and *Elymus elymoides*. Cryptobiotic crust cover may be high where there is little disturbance from cattle grazing. Lack of soil moisture-holding capacity, southern or western aspects, old-growth conditions (lack of disturbance), or high cover by rocks or bedrock may all contribute to the development of these stands. Elevations range between 1400 and 2200 m, and stands occur on a variety of soils, geology, slopes, aspects and landforms.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association occurs on sand dunes, canyon sides, valley bottoms, benches, and plateaus. Sites are on flat to gentle slopes at 1200 to 1690 m elevation. Bare soil, sand, and small rocks cover most of the unvegetated surface, with lesser cover by litter, bedrock, and large rocks. Soils are well-drained to rapidly drained silt loams, clay loams, and sands derived from Cedar Mesa, Navajo, or Kayenta sandstones or from wind deposits.

Global Environment: This widespread woodland association occurs on slopes, ridges, benches and mesas at elevations ranging between 1200 and 2200 m (3940-7220 feet). Slopes range from gentle to moderately steep, with a few examples on very steep slopes. Sites may be oriented to any aspect. In Colorado Plateau and Great Basin stands, substrates and soils tend to have poor water-holding capacity (hydrothermally altered volcanic tuff, clay or coarse sands) and are on warm south or west exposures. In some Colorado Plateau stands, the substrate is so rocky as to afford few places for shrubs or herbaceous species to grow, or the woodland is in an old-growth condition and juniper trees are using all of the available light and moisture. The unvegetated ground surface may have high cover of cryptobiotic crusts on sandy sites; shale sites usually have high cover of bare ground, and other sites may have high cover by rock, bedrock and gravel.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This juniper woodland type tends to have sparse total vegetation cover ranging from 5 to 23%. Stands are characterized by a canopy of *Juniperus osteosperma* with 3 to 15% cover. Neither shrubs nor herbaceous species provide sufficient cover (>5%) to constitute a layer. Shrubs present include *Ephedra viridis, Fraxinus anomala, Shepherdia rotundifolia, Artemisia filifolia, Chrysothamnus greenei, Gutierrezia sarothrae, Gutierrezia microcephala, Opuntia* spp., and *Yucca angustissima*. Herbaceous species present include *Achnatherum hymenoides, Pleuraphis jamesii, Amsonia tomentosa, Cordylanthus wrightii, Dalea* sp., *Rumex hymenosepalus,* and *Heterotheca villosa (= Chrysopsis villosa)*. Most stands have little in the way of biological soil crusts; the lack of soil crust development and the sparse understory cover may be attributable to continual disturbances to the site in the form of cattle grazing.

Global Vegetation: This common woodland association is characterized by a canopy of *Juniperus osteosperma* with between 10 and 70% cover, sometimes less in very open stands. In many stands the total vegetation cover does not exceed 20%. *Pinus edulis* is generally absent from the canopy. Trees may be barely 2 m high on shale sites, or in old-growth stands the trees may approach 5 m in height. Scattered shrubs are usually present, but do not exceed 5% cover, and usually the total is 1% or less. Shrub species present are variable and may include *Ephedra viridis, Chrysothamnus greenei, Cercocarpus montanus, Artemisia filifolia, Artemisia tridentata ssp. wyomingensis, Gutierrezia*

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microcephala, Gutierrezia sarothrae, Fraxinus anomala, Shepherdia rotundifolia, and *Opuntia* spp. Forbs and grasses also total less than 5% (usually 1% or less) and may include *Pleuraphis jamesii, Achnatherum hymenoides, Heterotheca villosa (= Chrysopsis villosa), Petradoria pumila,* or *Elymus elymoides*. Cryptobiotic crusts may cover as much as 25% of the unvegetated area in stands with sandy substrates.

Global Dynamics: This association is generally the result of the development of a juniper woodland on soils with poor water-holding capacity, such as shale or coarse sands. Less often it results from a lack of sites for herbaceous species to establish, such as talus slopes or sites with high exposure of bedrock. It is not meant to include stands where the understory is sparse because of disturbance such as grazing, drought or fire. Some stands are very open, sparse woodlands, while others have a well-developed, relatively dense canopy, but they have in common the fact that the substrate cannot support a developed understory, even in wet years.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia microcephala*, *Gutierrezia sarothrae*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Ephedra viridis, Juniperus osteosperma*

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNRQ (23-Feb-1994).

Related Concepts

Global Similar Types:
- *Pinus edulis* - *Juniperus osteosperma* / Sparse Understory Woodland (CEGL002148)

Global Related Concepts:
- *Juniperus osteosperma*/Barren (Bourgeron and Engelking 1994) =

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- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 1 - Strong
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Milton and Purdy (1983) describe a pinyon-juniper / sparse understory woodland type at two sites in the Great Basin of Nevada and western Utah. The soils at these sites are derived from hydrothermally altered rocks. Juniper (*Juniperus osteosperma*) is the dominant tree; however, the scattered pinyon pine in these sites is *Pinus monophylla*, not *Pinus edulis* as occurs in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland association is infrequent within the recreation area. It was sampled in the Circle Cliffs, Purple Hills, Andy Miller Flats, Wilson Creek, Scorpion, and on Fourmile Bench.

Global Range: This association occurs widely in the Great Basin, Colorado Plateau and western Southern Rocky Mountains, and extends north to the Uinta Mountains.

Nations: US
States/Provinces: AZ, CO, NV, UT
TNC Ecoregions: 6:P, 9:C, 11:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331E:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Dinosaur, Glen Canyon, Grand Canyon, Grand Canyon-Parashant, Hovenweep)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: A layer of gravel and a few large rocks are present. Shrubs are widely spaced and grasses are patchy. Cattle grazing evidence.

Glen Canyon National Recreation Area Plots: The description is based on 2012, 2014 and 2015 field data (2 plots, 6 accuracy assessment points): (Plots: GLCA.4092, GLCA.5046; AA Points: GLCA_AA.0481, GLCA_AA.1257, GLCA_AA.2018, GLCA_AA.3020, GLCA_AA.3050, GLCA_AA.3084).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and G. Kittel
References: Bourgeron and Engelking 1994, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Driscoll et al. 1984, Milton and Purdy 1983, Reid and Hall 2010, Romme et al. 1993, Von Loh et al. 2008, Western Ecology Working Group n.d.*

M027. Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland

G250. Colorado Plateau Pinyon - Juniper Woodland

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Group Summary Description: This woodland group occurs in dry mountains and foothills of the Colorado Plateau region, including the Western Slope of Colorado and the Wasatch Range, south to the Mogollon Rim, and east into the northwestern corner of New Mexico. These woodlands are typically composed of a mix of *Pinus edulis* and *Juniperus osteosperma* in the tree canopy. Either tree may dominate as long as there is significant presence of *Pinus edulis* (not accidental) to characterize the stand as a pinyon-juniper stand and not the typically more xeric lower-elevation *Juniperus osteosperma* woodland and savanna. *Juniperus scopulorum* may replace *Juniperus osteosperma* and codominate at higher-elevation/less xeric sites.

In the southern portion of the Colorado Plateau in northern Arizona and northwestern New Mexico, hybrids of *Juniperus monosperma* and *Juniperus osteosperma* or both juniper species may dominate or codominate the tree canopy. Understory layers are variable and may be dominated by shrubs, graminoids, or be absent. Associated species include *Arctostaphylos patula, Artemisia tridentata, Cercocarpus intricatus, Cercocarpus montanus, Coleogyne ramosissima, Purshia stansburiana, Purshia tridentata, Quercus gambelii, Bouteloua gracilis, Pleuraphis jamesii, Pseudoroegneria spicata, Poa secunda*, or *Poa fendleriana*. This group occurs at higher elevations than Great Basin Pinyon - Juniper Woodland Group (G247) where sympatric on the Colorado Plateau.

Stands are typically found at lower elevations but ranges from 1500-2440 m. These woodlands occur on warm, dry sites on mountain slopes, mesas, plateaus, and ridges. Severe climatic events occurring during the growing season, such as frosts and drought, are thought to limit the distribution of pinyon-juniper woodlands to relatively narrow altitudinal belts on mountainsides. Soils supporting this group vary in texture, ranging from stony, cobbly, gravelly, or sandy loams to clay loam or clay.

A3572 Pinus edulis - Juniperus osteosperma / Herbaceous Understory Open Woodland Alliance

Alliance Summary Description: This woodland alliance is characterized by diagnostic tree species *Pinus edulis* that forms a very open to moderately dense tree layer often with *Juniperus osteosperma* or, less frequently, *Juniperus monosperma* within the range of *Juniperus osteosperma* in northern Arizona. *Juniperus osteosperma* may also dominate stands as long as there is significant presence of *Pinus edulis* (not accidental) to characterize the stand as a pinyon-juniper stand and not the more xeric, typically lower elevation *Juniperus osteosperma* woodland and savanna. At higher elevations and relatively mesic sites, such as along drainages, *Juniperus scopulorum* may be present and sometimes dominant. Other conifers are absent or accidental with very low cover. The understory is characterized by an open to dense herbaceous layer. Scattered shrubs may be present but do not form a layer and do not exceed cover of the herbaceous layer. Perennial grasses typically dominate the herbaceous layer, although diverse forbs species are often present, but with low cover. Characteristic species include *Achnatherum hymenoides, Bouteloua gracilis, Elymus elymoides, Hesperostipa comata, Hesperostipa neomexicana, Leymus salinus, Muhlenbergia pungens, Poa fendleriana, Poa secunda, Pleuraphis jamesii*, and *Pseudoroegneria spicata*. The non-native, invasive annual grass *Bromus tectorum* becomes abundant in disturbed stands and may dominate the understory of highly disturbed stands. Some stands included in this alliance have been seeded with non-native perennial grasses such as *Psathyrostachys juncea* or *Agropyron cristatum* to control soil erosion or increase forage production and now have a semi-natural understory. This alliance occurs on warm, dry sites on mountain slopes,

foothills, and plateaus in the Colorado Plateau extending east into the west slope of the southern Rocky Mountains. The climate of the region is semi-arid with drought not uncommon. Stands typically occur on nearly level to moderately steep, rocky slopes on hillsides and mesatops. Aspect does not seem important except in elevational extremes for a given latitude where low-elevation stands are restricted to the more mesic north slopes; canyons and high-elevation stands occur on south aspects. Sites are typically dry with shallow, rocky, calcareous and alkaline soils. Other sites include eroded "badlands," lava flows, scree slopes, and deep sands.

[CEGL002364] Pinus edulis - Juniperus osteosperma / Achnatherum hymenoides Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Indian Ricegrass Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis* - *Juniperus osteosperma* / Herbaceous Understory Open Woodland Alliance (A3572)

Element Concept

Global Summary: This woodland association currently is documented from Canyonlands, Glen Canyon and Capitol Reef national parks in southeastern Utah. The open woodland canopy consists of *Pinus edulis* and *Juniperus osteosperma* trees with from 5 to 50% canopy coverage and a bunchgrass understory dominated by *Achnatherum hymenoides* with up to 25% cover. The total vegetation cover rarely exceeds 50%. Shrubs do not have high enough cover to constitute a layer (<5% total cover) but are often present. The herbaceous layer is moderate in terms of species diversity and is generally low in cover. This woodland occurs in basin floors, canyon bottoms, and channels, as well as on mesatops and hillslopes, therefore sites range from gentle to moderate (0-19%) slopes. Stands are documented between 1506 and 1940 m (4946-6365 feet) in elevation, and are oriented with southwestern and northwestern aspects. Parent materials include shale and sandstone formations, alluvium, outcrops and/or basalt boulders. Soils are rapidly drained and fine-textured.

Environmental Description

Glen Canyon National Recreation Area Environment: This association occurs on basin floors, canyon bottoms, and mesatops within the recreation area at elevations ranging from 1423 to 1936 m. Sites have moderate slopes (5-19%), and are mostly oriented to the west and northwest. Bare soil and biological soil crusts cover most of the unvegetated surface, with lesser cover by litter. Soils are well-drained silt loams derived from alluvium or Navajo sandstone.

Global Environment: It occurs on basin floors, canyon bottoms, channels, mesatops, and hillslopes. Sites are gentle to moderate (0-19%), occur between 1506 and 1940 m (4946-6365 feet) elevation, and are oriented to southwestern and northwestern aspects. Parent materials include Moenkopi Formation

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(shale), Cedar Mesa sandstone, Navajo sandstone, new alluvium, outcrops and basalt boulders. Soils are rapidly drained and fine-textured.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This association is characterized by a canopy codominated by *Pinus edulis* (with 1-13% cover) and *Juniperus osteosperma* (with 2-11% cover). Shrub cover is sparse with no clear dominants and may include *Ericameria nauseosa, Ephedra cutleri, Gutierrezia sarothrae,* and *Atriplex confertifolia*. The herbaceous layer is dominated by *Achnatherum hymenoides* with up to 7% cover. Other herbaceous species present with low cover include *Bouteloua gracilis, Muhlenbergia pungens, Pleuraphis jamesii,* and *Sporobolus cryptandrus.*

Global Vegetation: Total vegetation cover generally does not exceed 50%. The open canopy consists of Pinus edulis and Juniperus osteosperma trees that range in cover from 5 to 50%, with a bunchgrass understory dominated by Achnatherum hymenoides that ranges in cover up to 25%. Shrubs do not have high enough cover to constitute a layer (<5% total cover) but are often present; common species include scattered individuals of Atriplex confertifolia, Cercocarpus montanus, Ephedra cutleri, Ephedra viridis, Artemisia spp., Ericameria nauseosa, Fraxinus anomala, Gutierrezia sarothrae, Amelanchier utahensis, Rhus aromatica, and Opuntia polyacantha. The herbaceous layer is moderate in terms of species diversity and sparse to low in terms of cover. Achnatherum hymenoides is the most abundant species. Other graminoid species that may be present include Andropogon gerardii, Bouteloua gracilis, Muhlenbergia pungens, Pleuraphis jamesii, and Sporobolus cryptandrus.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Herb (field)	Graminoid	*Achnatherum hymenoides*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Herb (field)	Graminoid	*Achnatherum hymenoides*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Achnatherum hymenoides, Juniperus osteosperma, Pinus edulis*

Other Noteworthy Species

Global: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4)

Conservation Status Rank

Global Rank & Reasons: GNR (22-Mar-2005).

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Related Concepts

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This association is rare within the recreation area and was sampled on Gordon Flats, near Egypt, and in Silver Falls Creek.

Global Range: This Colorado Plateau association has been documented from Moenkopi Formation outcrops in the central part of Capitol Reef National Park, Gordon Flats, near Egypt, and in Silver Falls Creek in Glen Canyon National Recreation Area, and The Fins of Ernies Country, Teapot Rock, and Davis Canyon in Canyonlands National Park in southeastern Utah.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
USFS Ecoregions (2007): 341Bj:C
Federal Lands: NPS (Canyonlands, Capitol Reef, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Steep slope of sandy but stable soils.
Glen Canyon National Recreation Area Plots: The description is based on 2012, 2014, and 2015 field data (1 plot, 2 accuracy assessment points): (Plots: GLCA.4329; AA Points: GLCA_AA.0234, GLCA_AA.1241).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, M.E. Hall and G. Kittel
References: Clark et al. 2009, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEGL002373] Pinus edulis - Juniperus osteosperma / Muhlenbergia pungens Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Sandhill Muhly Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis* - *Juniperus osteosperma* / Herbaceous Understory Open Woodland Alliance (A3572)

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Element Concept

Global Summary: This rare, open woodland association is currently known only from Canyonlands, Glen Canyon and Capitol Reef national parks in southeastern Utah. The woodland has *Pinus edulis* and *Juniperus osteosperma* trees that range in cover from 10-35% and an understory dominated by the ring-forming grass *Muhlenbergia pungens* with up to 25% cover. Shrubs do not form a layer (<5% total cover). Stands occur on the lower and middle slopes of ridges, on benches, terraces and dunes. Sites are gentle (<5% slopes), occur between 1640 and 2134 m (5379-7000 feet) in elevation, and tend to be oriented with easterly aspects. Parent materials include eolian deposits. Soils are rapidly drained sand.

Environmental Description

Glen Canyon National Recreation Area Environment: This association is known from high level mesas on sand dune deposits. Sites are on gentle slopes (<6%), oriented to the east, and occur between 1955 and 1995 m elevation. Parent materials include wind-deposited eolian sands.

Global Environment: This woodland association was observed on ridges, low level areas, low slopes, midslopes, and steps-in-slope on terrace and dune deposits of sand. Sites are gentle (<5%), occur between 1640 and 2134 m elevation, and are oriented to northeastern, eastern and southeastern aspects. Parent materials are variable and include sandstones and shale that have eroded and become wind-transported into eolian deposits. Soils are rapidly drained and texturally are sand.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This woodland association is characterized by a sparse canopy of *Pinus edulis* and *Juniperus osteosperma* which does not exceed 9% total cover and an herbaceous understory where *Muhlenbergia pungens* is generally dominant with 5-8% cover. Shrub cover is patchy and inconsistent, some stands have hardly any shrub cover and some have shrub cover nearly as high as herbaceous cover. Common shrub species may include *Opuntia macrorhiza, Ephedra viridis, Ephedra cutleri, Gutierrezia sarothrae*, and *Chrysothamnus greenei*. Other graminoids present with low cover include *Achnatherum hymenoides* and *Bouteloua gracilis*. Forb cover is sparse or absent.

Global Vegetation: This woodland association is characterized by an open canopy of *Pinus edulis* and *Juniperus osteosperma* trees that range in cover 5 to 75% and an understory of the ring-forming grass *Muhlenbergia pungens* that ranges in cover from biomass estimates from 5 to 100%. The shrub layer is low to moderate in terms of species composition and is composed of short and dwarf-shrubs and succulents that provide sparse to low cover. Common dwarf-shrubs include *Atriplex canescens, Artemisia frigida, Chrysothamnus greenei, Coleogyne ramosissima, Ephedra cutleri, Ephedra viridis, Gutierrezia sarothrae, Opuntia macrorhiza*, and *Opuntia polyacantha*. The remaining herbaceous layer is diverse in terms of species composition and provides sparse to low cover. It is dominated by *Muhlenbergia pungens*. Other grasses present include *Achnatherum hymenoides* and *Bouteloua gracilis*. Forbs are moderately diverse in terms of species composition and include *Abronia elliptica, Arenaria eastwoodiae, Streptanthella longirostris*, and *Townsendia incana*. Some stands have moderate cover of cryptogamic soil crust.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*, *Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Short shrub/sapling	Succulent shrub	*Opuntia macrorhiza*
Herb (field)	Graminoid	*Muhlenbergia pungens*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Herb (field)	Graminoid	*Muhlenbergia pungens*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Juniperus osteosperma*, *Muhlenbergia pungens*, *Pinus edulis*

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (23-Mar-2005).

Related Concepts

Global Similar Types:

- *Muhlenbergia pungens* Grassland (CEGL002363)

Classification

Status: Standard

Classification Confidence: 3 - Weak

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. This association has only been described from Glen Canyon National Recreation Area, and Capitol Reef and Canyonlands national parks and appears inherently rare. Further inventory is needed to develop a more comprehensive description.

Element Distribution

Glen Canyon National Recreation Area Range: This association is rare within the recreation area and was documented near Hans Flat Ranger Station and above East Moody Canyon.

Global Range: This Colorado Plateau association has been documented from scattered sites throughout Capitol Reef and Canyonlands national parks and Glen Canyon National Recreation Area in southeastern Utah.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
USFS Ecoregions (2007): 341Bj:C
Federal Lands: NPS (Canyonlands, Capitol Reef, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Areas of denser pinyon-juniper canopy have much less *Muhlenbergia pungens*, while some open areas have more *Artemisia tridentata ssp. wyomingensis* mixed in with *Muhlenbergia pungens*. This site is definitely pinyon-juniper / *Muhlenbergia pungens*, however.

Glen Canyon National Recreation Area Plots: The description is based on 2014 and 2015 field data (2 AA points): (GLCA_AA.0275, GLCA_AA.1722).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, M.E. Hall and G. Kittel
References: Clark et al. 2009, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEGL002379] Pinus edulis - Juniperus osteosperma / Pleuraphis jamesii Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / James' Galleta Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis - Juniperus osteosperma* / Herbaceous Understory Open Woodland Alliance (A3572)

Element Concept

Global Summary: This woodland association is documented from the Colorado Plateau in western Colorado and Utah. The vegetation is characterized by an open canopy of *Pinus edulis* and *Juniperus osteosperma* trees with between 5 and 15% cover and an understory dominated by *Pleuraphis jamesii* with up to 10% cover. Shrubs do not form a layer (<5% total cover), but scattered individuals of several species may be present. It occurs on ridges, hills, canyon sides and mesatops on gentle to steep slopes (4-23°) on warm aspects, and lies between 1411 and 2020 m (4630-6625 feet) in elevation. Soils are rapidly drained loamy sands.

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Environmental Description

Glen Canyon National Recreation Area Environment: This rare association occurs on canyon sides and mesatops on gentle to steep slopes (4-23°) at warmer (south- and west-facing) aspects, and lies between 1411 and 1741 m elevation. Boulders, small rocks, and bare ground cover most of the unvegetated surface. Litter and biological soil crusts have sparse to low cover. Soils are rapidly drained loamy sands derived from the Chinle or Kayenta formations.

Global Environment: Stands occur on ridges and hills of eroding pediment surfaces, as well as canyon sides and mesatops on gentle to steep slopes (4-23°) at warmer (south- and west-facing) aspects, and lies between 1411 and 2020 m (4630-6625 feet) in elevation. Boulders, small rocks, and bare ground cover most of the unvegetated surface. Litter and biological soil crusts have sparse to low cover. Soils are rapidly drained loamy sands derived from basalt alluvium, colluvium overlying Moenkopi siltstone, Chinle or Kayenta formations that is occasionally exposed.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This pinyon-juniper woodland is characterized by a sparse to open canopy mostly dominated by *Juniperus osteosperma* (with 2-8% cover) with lesser amounts of *Pinus edulis* (with 1-3% cover). Total vegetation cover ranges from 7-27%. The understory may have low shrub cover but is mostly graminoid-dominated. Shrubs may include *Ericameria nauseosa var. juncea (= Chrysothamnus nauseosus var. junceus), Atriplex confertifolia, Ephedra viridis, Gutierrezia sarothrae,* and *Coleogyne ramosissima*. The dominant graminoid is *Pleuraphis jamesii* (with 3-7% cover) with lesser amounts of *Bouteloua eriopoda, Hesperostipa comata,* and *Achnatherum hymenoides*.

Global Vegetation: The vegetation is characterized by an open canopy of *Pinus edulis* and *Juniperus osteosperma* trees with between 5 and 15% cover and an understory dominated by *Pleuraphis jamesii* with up to 10% cover. Total vegetation cover is around 30%. Shrubs do not form a layer (<5% total cover), but scattered individuals of *Ericameria nauseosa var. juncea (= Chrysothamnus nauseosus var. junceus), Coleogyne ramosissima, Gutierrezia sarothrae, Atriplex confertifolia, Shepherdia rotundifolia, Chrysothamnus viscidiflorus, Ephedra torreyana*, and *Ephedra viridis* are commonly present. The dominant graminoid is *Pleuraphis jamesii* with lesser amounts of *Achnatherum hymenoides, Bouteloua eriopoda, Bouteloua gracilis, Hesperostipa comata*, and a variety of forbs with sparse cover.

Global Dynamics: This association has only been described from Capitol Reef National Park. Until further inventory is completed, there is no global information.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*, *Ericameria nauseosa*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Pleuraphis jamesii*

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Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Juniperus osteosperma*, *Pinus edulis*, *Pleuraphis jamesii*

Other Noteworthy Species

Global: Vulnerable Plants: *Ericameria nauseosa* var. *juncea* (G5T3T4)

Conservation Status Rank

Global Rank & Reasons: GNR (23-Mar-2005).

Related Concepts

Global Similar Types:
- *Juniperus osteosperma / Pleuraphis jamesii* Open Woodland (CEGL002362)

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This association is rare within the recreation area and was sampled on the Escalante River, in the South Fork of Happy Canyon, and near the Golden Stairs.

Global Range: This association has been documented from the high plateaus and Colorado Plateau of Utah, and western Colorado.

Nations: US
States/Provinces: CO, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Bryce Canyon, Canyonlands, Capitol Reef, Glen Canyon, Mesa Verde)

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Element Sources

Glen Canyon National Recreation Area Inventory Notes: Rocky shallow soil sideslope, stabilized by grasses, small shrubs and pinyon-juniper. At least 5 m above the floodplain, so receives no flood moisture despite close proximity (50 m) to river.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2014 field data (1 plot, 2 accuracy assessment points): (Plots: GLCA.4317; GLCA_AA.0135, GLCA_AA.0616).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and G. Kittel
References: Clark et al. 2009, Coles et al. 2010, Romme et al. 1993, Tendick et al. 2011b, Thomas et al. 2009b, Western Ecology Working Group n.d.*

[CEGL002340] Pinus edulis - Juniperus spp. / Leymus salinus Woodland
Translated Name: Two-needle Pinyon - Juniper species / Saline Wildrye Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis - Juniperus osteosperma* / Herbaceous Understory Open Woodland Alliance (A3572)

Element Concept

Global Summary: This woodland association is widespread throughout the Colorado Plateau, but limited to small stands on specific substrates. The canopy may be very open with both *Pinus edulis* and *Juniperus osteosperma*. Shrubs are generally present but do not provide enough cover to constitute a stratum. The herbaceous layer is more conspicuous than the shrub layer in this community, consisting of a variety of grasses, among which *Leymus salinus* is clearly dominant. Total herbaceous cover can range from 5% in sparse stands to more than 30% in more sheltered sites. Common associated herbaceous species include *Achnatherum hymenoides* and *Pleuraphis jamesii*. Total vegetation cover ranges from sparse (7%) to moderate (50%) in this variable community, with drier, more exposed sites supporting less overall plant cover. Stands tend to occupy the tops, shoulders, upper and middle slopes of ridges, as well as canyon sides and cliffs. These sites range from gentle to steeply sloping (10-100%). Elevations range between 1483 and 2301 m (4865-7550 feet). Soils are rapidly drained and include sandy clay loams, clay loams and sandy loams.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland occurs on canyon sides, rims, cliffs, and talus/colluvial slopes. Sites are steep (12-45° slopes), oriented to the north or east, and lie between 1649 and 1902 m elevation. Bare soil, large rocks, gravel, and bedrock cover most of the unvegetated surface, with lesser cover by litter, downed wood and biological soil crusts. Soils are

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rapidly drained sandy loams, clay loams, or loamy sands derived from a variety of parent materials, including sandstones, shales, and talus/colluvium.

Global Environment: This woodland association is widespread throughout the Colorado Plateau, but limited to small stands on specific substrates. Stands tend to occupy well-drained, exposed sites on the tops, shoulders, upper and middle slopes of ridges, as well as canyon sides, rims, cliffs, gullies, ledges, and talus/colluvial slopes. These sites range from gentle to steeply sloping (10-100% slopes), although a minority of stands occur on gentle slopes. Elevations range between 1483 and 2301 m (4865-7550 feet), with most stands occurring above 1700 m. Stands at higher elevations and latitudes (e.g., Black Canyon of the Gunnison National Park and Dinosaur National Monument) tend to be oriented to the south or west, but stands at lower elevations occur primarily on north or east aspects. Parent materials are variable but generally include a significant element of Paleozoic or Mesozoic marine shale, sometimes redeposited with other rocks as alluvium or colluvium. Soils are rapidly drained and include sandy clay loams, clay loams and sandy loams.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This pinyon-juniper woodland is moderately common within the recreation area. Total vegetation cover ranges from 11 to 22%. Stands are characterized by an open canopy, typically 2 to 10 m tall, of *Pinus edulis* (with 1-8% cover) and *Juniperus osteosperma* (with 2-8% cover), and an herbaceous layer dominated by *Leymus salinus* with between 1 and 6% cover. Scattered *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. Shrubs contribute sparse to low cover and may include *Shepherdia rotundifolia* (with up to 5% cover), *Fraxinus anomala, Ephedra viridis, Atriplex confertifolia, Gutierrezia* spp., *Artemisia bigelovii, Eriogonum corymbosum, Chrysothamnus viscidiflorus var. stenophyllus, Cercocarpus intricatus,* and *Mahonia fremontii*. The remaining herbaceous layer provides little cover but may include many species; the most commonly noted were *Pleuraphis jamesii, Achnatherum hymenoides,* and *Bromus tectorum*.

Global Vegetation: Total vegetation cover ranges from sparse (7%) to moderate (50%) in this variable community, with drier, more exposed sites supporting less overall plant cover. The canopy may be very open to moderate (5 to 30%) and consists of both *Pinus edulis* and *Juniperus osteosperma*. Either tree species may dominate the canopy, but both should have at least 2% cover, and their seedlings may be present. Shrubs are generally present but do not provide enough cover to constitute a stratum. Common species include scattered *Artemisia bigelovii, Atriplex confertifolia, Cercocarpus intricatus, Chrysothamnus viscidiflorus, Ephedra viridis, Eriogonum corymbosum, Fraxinus anomala, Gutierrezia* spp., *Mahonia fremontii, Opuntia* spp., and *Shepherdia rotundifolia*. The herbaceous layer is more conspicuous than the shrub layer in this community, consisting of a variety of grasses, among which *Leymus salinus* is clearly dominant. Total herbaceous cover can range from 5% in sparse stands to more than 30% in more sheltered sites. Common associated herbaceous species include *Achnatherum hymenoides* and *Pleuraphis jamesii*. Other common graminoids may include *Poa fendleriana, Koeleria macrantha,* and *Vulpia octoflora*; additional forbs include *Arenaria fendleri, Calochortus gunnisonii, Cymopterus bulbosus, Erigeron utahensis, Machaeranthera grindelioides, Phlox hoodii, Sphaeralcea parvifolia, Stanleya pinnata, Stenotus armerioides (= Haplopappus*

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armerioides), Streptanthella longirostris, and *Tetraneuris acaulis (= Hymenoxys acaulis)*. *Bromus tectorum* is common in stands that have experienced disturbance from roads or grazing.

Global Dynamics: This association requires an unusual combination of circumstances: the substrate must be saline enough to favor *Leymus salinus* over other grass species, but well-drained and deep enough to support the growth of *Pinus edulis* without also favoring shrubs. Sites meeting these requirements include shale slopes with an element of colluvial sandstone, slopes and flats derived from shaly sandstones or sandy shales (such as the Kayenta Formation), or alluvial terraces derived from a mix of sandstone and shale. Most stands tend to be mature to old-growth in their structure; it seems unlikely that most of these stands result from trees invading *Leymus salinus* grasslands. Fire is not a factor in the dynamics of this association, as most stands are too sparsely vegetated to carry fire.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Shepherdia rotundifolia*
Short shrub/sapling	Broad-leaved deciduous shrub	*Chrysothamnus viscidiflorus* var. *stenophyllus*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Herb (field)	Graminoid	*Leymus salinus*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Herb (field)	Graminoid	*Leymus salinus*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Juniperus osteosperma, Leymus salinus, Pinus edulis*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High)
Global:

Conservation Status Rank

Global Rank & Reasons: G3G4 (26-Jan-2006). This association is likely to be somewhat more common than *Juniperus osteosperma / Leymus salinus* Open Woodland (CEGL003109), because the combination of *Pinus edulis* and *Juniperus osteosperma* has a greater ecological amplitude than does *Juniperus osteosperma* alone. However, this is an unusual and probably rare type, as *Pinus edulis* usually does not grow in the same habitats or elevations favored by *Leymus salinus*.

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Related Concepts

Global Similar Types:

- *Juniperus osteosperma / Leymus salinus* Open Woodland (CEGL003109)
- *Juniperus osteosperma / Leymus salinus ssp. salmonis* Wooded Grassland (CEGL001488)

Classification

Status: Standard

Classification Confidence: 1 - Strong

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Baker (1982b) cites Shute and West (1978) as reporting a *Pinus edulis - Juniperus osteosperma / Leymus salinus* community in the vicinity of Price, Utah. There is no other information given for this community, other than that it occurs on Mancos shale. All other data used to support this association are derived from vegetation plots gathered by the National Park Vegetation Mapping Program.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is common but only in the Orange Cliffs section of the recreation area and was sampled in Red Cove, near Cleopatra's Chair, in upper Millard Canyon and on the Millard Canyon rim, in North Trail Canyon, and near Sunset Pass.

Global Range: This association has been documented from southeastern Utah and western Colorado. It is likely to be found in small stands in similar environments throughout the Colorado Plateau.

Nations: US
States/Provinces: CO, UT
TNC Ecoregions: 9:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331E:CC, M331G:CC, M341C:CC
USFS Ecoregions (2007): 341Bj:C
Federal Lands: NPS (Black Canyon of the Gunnison, Bryce Canyon, Canyonlands, Capitol Reef, Colorado, Dinosaur, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This is a steep loose slope with some bedrock showing, but mostly consisting of boulders, rocks and a little soil. There's a pretty good community here, probably encouraged by the steep slope and shady aspect. The bunchgrass looks especially good. The slope moves easily and many of the plants have rocks and dirt piled on their uphill sides. The trees look mature, but are short, usually less than 8 feet tall.

Glen Canyon National Recreation Area Plots: The description is based on 2004 field data (9 plots): (Plots: GLCA.0134, GLCA.0309, GLCA.0332, GLCA.0583, GLCA.0707, GLCA.0715, GLCA.0774, GLCA.9100, GLCA.9504).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel

References: Baker 1982b, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2010, Romme et al. 1993, Shute and West 1978, Tendick et al. 2011b, Von Loh et al. 2007, Western Ecology Working Group n.d.*

[CEGL000787] Pinus edulis - Juniperus spp. / Poa fendleriana Woodland

Translated Name: Two-needle Pinyon - Juniper species / Muttongrass Woodland

Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)

Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)

Group: Colorado Plateau Pinyon - Juniper Woodland (G250)

Alliance: *Pinus edulis* - *Juniperus osteosperma* / Herbaceous Understory Open Woodland Alliance (A3572)

Element Concept

Global Summary: This association is widespread and common throughout the Colorado Plateau of Utah, Arizona, New Mexico and Colorado. This woodland association is characterized by an open to moderately closed, mixed canopy of *Pinus edulis* and *Juniperus osteosperma*, about 2-10 m tall. The understory is dominated by the bunchgrass *Poa fendleriana* with up to 25% cover. Scattered shrubs present are varied and fail to form a stratum. Stands occur on the slopes of canyons, ridges, toeslopes, alluvial fans, benches and plateaus at elevations ranging from 1525 to 2560 m (5000-8400 feet). Slopes range from 4-50% and are oriented to any aspect. Soils are sandy, sandy loam, silt loam or clay loam.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland occurs on plateaus, mesas, ridges, drainage channels, and talus/colluvial side slopes. Sites are flat to very steep (2-50° slopes), oriented mostly to the south or east, and lie between 1679 and 2289 m elevation. Bare soil and litter cover most of the unvegetated surface, with low to moderate cover of large rocks, gravel, and bedrock, and with lesser cover by downed wood, litter, and biological soil crusts. Soils are rapidly drained to well-drained sandy loams, silt loams, or loamy sands derived from the Straight Cliffs Formation and/or from talus/colluvium.

Global Environment: This association is widespread and common throughout the Colorado Plateau of Utah, Arizona, New Mexico and Colorado. It occurs on the gentle to moderate slopes of canyons, ridges, toeslopes, benches and plateaus at elevations ranging from 1525 to 2560 m (5000-8400 feet). Stands may occur on slopes ranging from 4 to 50% and oriented to any aspect. Soils are sandy, sandy loam, silt loam or clay loam derived from sedimentary, granitic or metamorphic rocks, Straight Cliffs Formation and/or from talus/colluvium. A third to half the unvegetated ground surface is bare ground, and in some plots large rocks and gravel cover up to a third of the surface. In some cases, cryptogamic crusts and moss or litter cover up to 25% of the soil surface.

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Vegetation Description

Glen Canyon National Recreation Area Vegetation: This pinyon-juniper woodland is highly restricted within the recreation area to the mesatop of Navajo Point. Total vegetation cover ranges from 16 to 64%. Stands are characterized by a 2- to 10-m tall canopy of *Pinus edulis* (with 5-45% cover) and *Juniperus osteosperma* (with 4-22% cover), and an herbaceous layer dominated by *Poa fendleriana* with between 3 and 30% cover. Scattered *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. Shrubs contribute sparse to low cover and may include *Amelanchier utahensis, Artemisia tridentata, Artemisia nova, Ephedra viridis, Gutierrezia sarothrae, Quercus gambelii,* and *Shepherdia rotundifolia*. The exotic species *Bromus tectorum* may have nearly equal cover to *Poa fendleriana* in some stands. The remaining herbaceous layer provides little cover; the most commonly encountered species were *Petradoria pumila, Heterotheca villosa, Lepidium montanum, Achnatherum hymenoides, Hesperostipa comata,* and *Bouteloua gracilis*.

Global Vegetation: This woodland association is widespread and relatively common at moderate elevations throughout the Colorado Plateau. Total vegetation cover ranges from 40% to more than 75%. This woodland association is characterized by an open to moderately closed, mixed canopy of *Pinus edulis* and *Juniperus osteosperma* 2-10 m tall. In the southern part of the range, *Juniperus monosperma* and *Juniperus scopulorum* may be present in the canopy. The understory is dominated by the bunchgrass *Poa fendleriana* with between 1 and 25% cover. Scattered shrubs present include *Amelanchier utahensis, Artemisia nova, Artemisia tridentata, Cercocarpus montanus, Gutierrezia sarothrae, Quercus gambelii, Purshia tridentata, Yucca baccata, Opuntia* spp., *Symphoricarpos oreophilus, Fallugia paradoxa,* and *Fendlera rupicola*. Other common herbaceous species (always with less cover than *Poa fendleriana*) include *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Heterotheca villosa, Koeleria macrantha, Muhlenbergia montana, Blepharoneuron tricholepis, Pascopyrum smithii, Bouteloua gracilis, Balsamorhiza sagittata, Mirabilis multiflora, Penstemon linarioides,* and *Petradoria pumila*.

Global Dynamics: Stands with grassy understories tend to occur in areas with deeper, finer-textured soils that are some distance from the rim of Mesa Verde (Erdman et al. 1969). Most sampled stands appear to be in mature to old-growth condition. This association is vulnerable to fire; most of the stands at Mesa Verde National Park have been converted by fire in the past 30 years to weedy herbaceous communities (Erdman 1969, Floyd et al. 2001).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Amelanchier utahensis*
Herb (field)	Flowering forb	*Petradoria pumila*
Herb (field)	Graminoid	*Bromus tectorum*, *Poa fendleriana*

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Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Herb (field)	Graminoid	*Poa fendleriana*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Achnatherum hymenoides, Juniperus osteosperma, Juniperus scopulorum, Pinus edulis, Poa fendleriana*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)

Global: Vulnerable Plants: *Arabis fernaldiana* var. *fernaldiana* (G4T3T4, rare, endemic (known only from Dinosaur NM)); Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: G5 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis* Woodland (CEGL000778) also supports an open canopy of *Pinus edulis* and *Juniperus osteosperma* and a well-developed graminoid layer that is dominated by *Bouteloua gracilis* rather than *Poa fendleriana*.
- *Pinus edulis - Juniperus osteosperma / Purshia tridentata* Woodland (CEGL000789)
- *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland (CEGL002148)

Global Related Concepts:

- *Pinus edulis - Juniperus osteosperma / Poa fendleriana* Plant Association (Johnston 1987) =
- *Pinus edulis / Poa fendleriana* Plant Association (Larson and Moir 1987) =
- *Pinus edulis/Poa fendleriana* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >

Classification

Status: Standard

Classification Confidence: 1 - Strong

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Even if stands have relatively sparse cover of *Poa fendleriana* (<5%), if no other species are present with more than trace cover, they have been placed in this association rather than *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland (CEGL002148).

Element Distribution

Glen Canyon National Recreation Area Range: This woodland was sampled on Fiftymile Bench/Navajo Point, Choprock Bench, at Corral Ridge and Bull Ridge.

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Subset: GLCA; Glen Canyon National Recreation Area

Global Range: This association occurs at moderate elevations in the Colorado Plateau region of western Colorado, northern Arizona and New Mexico and eastern Utah.

Nations: US
States/Provinces: AZ:S2?, CO:S5, NM:S5, UT
TNC Ecoregions: 9:C, 19:C, 20:C, 21:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 331J:CC, M313A:CC, M313B:CC, M331E:CC, M331F:C?, M331G:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Canyon de Chelly, Curecanti, Dinosaur, Glen Canyon, Grand Canyon, Mesa Verde); USFS (Coconino, Kaibab)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Ridge-lined pinyon-juniper community, very little understory. Seemingly exposed to lightning, but lack of understory probably suppresses spread of fire, allowing for this mature pinyon-juniper.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (3 plots, 6 accuracy assessment points): (Plots: GLCA.6130, GLCA.6131, GLCA.6133; AA Points: GLCA_AA.1400, GLCA_AA.1401, GLCA_AA.1500, GLCA_AA.1502, GLCA_AA.1762, GLCA_AA.2015).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and G. Kittel
References: Baker 1982b, Barnes 1987, Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Coles et al. 2008a, Coles et al. 2010, Driscoll et al. 1984, Erdman 1962, Erdman 1969, Erdman et al. 1969, Floyd 2003, Floyd et al. 2001, Isaacson 1967, Johnston 1987, Larson and Moir 1987, Moir and Carleton 1987, Reid and Hall 2010, Tendick et al. 2010, Thomas et al. 2009b, Thomas et al. 2010, USFS 1985a, Western Ecology Working Group n.d.*

A3573 Pinus edulis - Juniperus osteosperma / Shrub Understory Colorado Plateau Woodland & Scrub Alliance

Alliance Summary Description: This open woodland and scrub alliance is characteristic of exposed rocky mesatops and canyon slopes and rims on the Colorado Plateau, but extends upslope into foothills and on xeric sites. The vegetation is sparse to moderately dense (10-80% total vegetation cover) and is dominated by dwarfed (usually <3 m tall) *Pinus edulis* and/or *Juniperus osteosperma* trees that form extensive tall shrublands or scrublands in the canyon country of the Colorado Plateau region. Both tree species are present with 3-25% cover. The understory is lacking or characterized by an open to moderately dense layer of shrubs (>10% cover) or, if less, then exceeding cover of grasses. Shrubs, if present, often include *Artemisia bigelovii, Atriplex canescens, Cercocarpus intricatus, Cercocarpus montanus, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra torreyana, Ephedra viridis, Fendlera rupicola, Glossopetalon spinescens var. aridum (= Glossopetalon nevadense), Petradoria pumila, Purshia stansburiana, Quercus havardii var. tuckeri*, or *Quercus turbinella*. Herbaceous layers are typically sparse and composed of xeric grasses and forbs. *Opuntia fragilis* or cushion plants such as *Arenaria eastwoodiae* and *Paronychia sessiliflora* may characterize the understory and exceed

shrub cover. Sites are variable but generally xeric. Stands occur on dry canyon rims, ridges, hills, benches, hogbacks, mesas, elevated plains and occasionally in intermittent drainages. Elevations generally range from 1400 to 2165 m (4600-7100 feet), but may extend up to 2480 m (8135 feet). Stands typically occur on gentle to moderately steep slopes on all aspects, but range from flat to steep slopes (0-30%). The soils are variable but generally shallow, poorly developed and skeletal, ranging from well-drained clay loam or sandy clay to rapidly drain loamy sand. The unvegetated ground surface is typically composed of litter, bedrock, and bare soil. Because this is a relatively xeric woodland, bare soil and rocks may cover up to 70% of the unvegetated surface, although biological soil crusts provide up to 40% cover.

[CEGL002334] Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis) Wooded Shrubland

Translated Name: Two-needle Pinyon - Utah Juniper / (Roundleaf Buffaloberry, Utah Serviceberry) Wooded Shrubland

Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis* - *Juniperus osteosperma* / Shrub Understory Colorado Plateau Woodland & Scrub Alliance (A3573)

Element Concept

Global Summary: This wooded shrubland association occurs on the slopes of mesas, buttes and plateaus in southern and eastern Utah. The vegetation is characterized by a sparse to moderately closed canopy (5-30%) of *Pinus edulis*, often accompanied by *Juniperus osteosperma* with a thick shrub layer of mixed *Amelanchier utahensis* and *Shepherdia rotundifolia*. The shrub layer is often has greater canopy coverage than the emergent tree layer. The herbaceous layer is moderate to high in terms of species diversity and typically provides sparse to moderate cover. The typical occurrence is located on the lower and middle sections of a shale slope that is overlain by rockfall from the sandstone or conglomerate that caps the landform. Most sites are moderately steep to steep (up to 85% slope), occur between 1422 and 2348 m (4665-7700 feet) elevation, and are oriented to cooler north to northeastern aspects. Parent materials are typically shales or sandstones modified by colluvial fragments of overlying conglomerate or sandstones. Soils are rapidly drained silt loams, sandy loams and clay loams.

Environmental Description

Glen Canyon National Recreation Area Environment: This wooded shrubland occurs on talus/colluvial slopes, canyon walls/sides, mesa sides, benches, and along drainages. Sites are gently to steeply sloping (up to 40°), lie between 1644 and 1974 m elevation, and are mostly oriented to the north, northwest, and east. Exposed soil, large and small rocks cover most of the unvegetated surface,

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with lesser cover by bedrock and litter. Soils are rapidly drained sandy loams, sandy clays, loams, clay loams, sandy clay loams, or loamy sands derived from Organ Rock shale, Navajo sandstone, Chinle, Straight Cliffs, Moenkopi or Kayenta formations.

Global Environment: This common northern Colorado Plateau wooded shrubland occurs on canyon rims, sides, and bottoms, ridges, benches and the colluvial slopes of mesas, buttes and plateaus in southeastern Utah. The typical occurrence is located on the lower and middle sections of a shale slope that is overlain by rockfall from the sandstone or conglomerate that caps the landform. Sites range from gentle to very steep on all aspects (5-85% slope), but most are moderately steep, occur between 1422 and 2348 m (4665-7700 feet) elevation, and are oriented to cooler northern to northeastern aspects. The unvegetated surface has sparse to low cover of litter and low to high exposure of bare soil, gravel and large rocks. Large rocks cover up to 40% of the ground surface. Biological soil crusts provide sparse to low cover. Parent materials are typically shales of the Organ Rock shale, Navajo sandstone, Chinle, Straight Cliffs, Moenkopi, Kayenta, Cutler or Carmel formations, modified by colluvial fragments of overlying conglomerate or sandstones. Soils are rapidly drained silt loams, sandy loams and clay loams.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This pinyon-juniper wooded shrubland is common within the recreation area. Total vegetation cover ranges from 5 to 27%. Stands are characterized by an open canopy, typically 2 to 5 m tall, of *Pinus edulis* and *Juniperus osteosperma* with between 1 and 13% individual cover. The shrub layer is mixed, but *Amelanchier utahensis* (with trace to 9% cover) and *Shepherdia rotundifolia* (with trace to 5% cover) are always present and generally dominant The remaining shrub layer may be diverse and include low cover of *Fraxinus anomala, Ephedra viridis, Ephedra torreyana, Eriogonum corymbosum, Chrysothamnus viscidiflorus, Symphoricarpos longiflorus, Mahonia fremontii, Artemisia tridentata, Ericameria nauseosa, Rhus aromatica, Purshia stansburiana,* and *Coleogyne ramosissima*. The herbaceous layer may include *Achnatherum hymenoides, Leymus salinus,* and *Achnatherum coronatum (= Stipa coronata),* and *Tetraneuris acaulis (= Hymenoxys acaulis).*

Global Vegetation: This mesic wooded shrubland is consistent and predictable in its unique habitat in the eastern Colorado Plateau. Total cover varies from 15% to nearly 90%. The vegetation is characterized by a sparse to moderately closed canopy (5-30%) of *Pinus edulis,* often accompanied by *Juniperus osteosperma*. In some stands the trees may be very widespread and the community will appear to be a shrubland with very scattered pinyon and juniper. The shrub layer is variable but often has higher total cover than the trees. The shrub layer is mixed, but *Amelanchier utahensis* or *Shepherdia rotundifolia* are usually both present. Other shrubs often present include *Artemisia tridentata, Cercocarpus montanus, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Gutierrezia sarothrae, Mahonia fremontii, Purshia stansburiana, Rhus trilobata,* and *Symphoricarpos longiflorus*. The herbaceous layer is moderate to high in terms of species diversity and typically provides sparse to moderate cover. Common graminoids include *Achnatherum coronatum (= Stipa coronata), Achnatherum hymenoides, Bouteloua gracilis, Bromus tectorum, Hesperostipa comata, Leymus salinus,* and *Pleuraphis jamesii*. Forbs that are occasionally present include *Cryptantha flava,*

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Subset: GLCA; Glen Canyon National Recreation Area

Machaeranthera grindelioides, Penstemon utahensis, Phlox austromontana, Lepidium montanum, Stanleya pinnata, Streptanthella longirostris, Stenotus armerioides (= Haplopappus armerioides), and *Tetraneuris acaulis*. Constant downslope soil movement tends to keep the nonvascular cover low.

Global Dynamics: Downslope soil movement, the saline shale substrate and the mesic microclimates provided by the sandstone boulders are the necessary elements of this association. Depending on exposures, elevation and substrate, stands may be relatively sparse with only scattered trees to a well-developed woodland with a richly diverse shrub understory. Rockier, lower and warmer sites tend to have sparser and less-diverse vegetation.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Chrysothamnus viscidiflorus*, *Shepherdia rotundifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Herb (field)	Graminoid	*Leymus salinus*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Shepherdia rotundifolia*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Amelanchier utahensis, Cercocarpus montanus, Ephedra viridis, Juniperus osteosperma, Pinus edulis, Pleuraphis jamesii, Shepherdia rotundifolia, Stanleya pinnata*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Vulnerable Plants: *Astragalus harrisonii* (G2G3), *Shepherdia rotundifolia* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High), *Lactuca serriola* (Low/Insignificant)

Conservation Status Rank

Global Rank & Reasons: G3G4 (11-Jan-2006). The range of the principal shrub species only overlaps in southeastern Utah, so this association is likely to be common only within a relatively narrow range. Stands may cover many hectares, covering the sides of entire mesas or canyon walls.

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Related Concepts

Global Similar Types:

- *Pinus edulis - Juniperus osteosperma / Amelanchier utahensis* Woodland (CEGL002329)
- *Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia* Woodland (CEGL002335)

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Although this association is now well-documented from several sites, there are two closely related associations: *Pinus edulis - Juniperus osteosperma / Amelanchier utahensis* Woodland (CEGL002329) and *Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia* Woodland (CEGL002335). With better information for all three associations, it may be necessary to lump or split them differently than they are now. This association is one of a series of related Colorado Plateau types that occur on shale slopes covered by sandstone colluvium. It is distinct from others in that it has a developed (albeit sparse) canopy of pinyon and sometimes juniper trees and usually contains *Shepherdia rotundifolia*. Because of the patchy nature of these colluvial slope communities, not every vegetation plot taken in this association will contain all the named species.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is common within the recreation area, but is mainly restricted to the Orange Cliffs section. It was sampled in Water Canyon, Red Cove, northeast of Hans Flat Ranger Station, near Bagpipe Butte, in Big Water Canyon, near Teapot Rock, China Neck, Sunset Pass, The Gap, in upper Millard Canyon, above Happy Canyon, below Muley Point, and on Fourmile Bench.

Global Range: This association is known from the Colorado Plateau of southern and eastern Utah. It may also occur in similar habitats in Arizona and western Colorado; however, *Shepherdia rotundifolia* is somewhat rare east of the LaSal Mountains.

Nations: US
States/Provinces: AZ?, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Glen Canyon, Natural Bridges)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Some stands occur in a Moenkopi slope environment: clay soils with a flaky or platy rock surface that facilitates sheet runoff.

Glen Canyon National Recreation Area Plots: The description is based on 2004 field data (22 plots): (Plots: GLCA.0105, GLCA.0133, GLCA.0305, GLCA.0510, GLCA.0554, GLCA.0555, GLCA.0561, GLCA.0564, GLCA.0565, GLCA.0567, GLCA.0569, GLCA.0570, GLCA.0573, GLCA.0747,

GLCA.0753, GLCA.0757, GLCA.0758, GLCA.0769, GLCA.4070, GLCA.5037, GLCA.9112, GLCA.9511).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Clark et al. 2009, Coles et al. 2008c, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEGL002118] Pinus edulis - Juniperus osteosperma / Artemisia bigelovii Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Bigelow's Sagebrush Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis* - *Juniperus osteosperma* / Shrub Understory Colorado Plateau Woodland & Scrub Alliance (A3573)

Element Concept

Global Summary: This association is found in western Colorado and eastern Utah, usually on mesatops and canyon rims. This woodland association generally has sparse to moderate total vegetation cover. There is an open tree canopy, 2-5 m tall, dominated by *Pinus edulis* and *Juniperus osteosperma*. The shrub layer is also open and dominated by *Artemisia bigelovii*, with 2-10% cover. Other typical shrubs are *Echinocereus triglochidiatus, Ephedra torreyana, Ephedra viridis, Eriogonum corymbosum, Fraxinus anomala,* and *Gutierrezia sarothrae*. The herbaceous layer typically has less than 5% cover and contains graminoid species such as *Achnatherum hymenoides, Elymus elymoides,* and *Pleuraphis jamesii* and forbs such as *Arenaria fendleri, Erodium cicutarium, Heterotheca villosa,* and *Tetraneuris acaulis*. Sites can have gentle to steep slopes and with varying local aspects but have been most commonly observed on sites whose general aspect is north or east. This association has been found at sites between 1476 and 2104 m (4840-6900 feet) elevation and mostly on sandstone. Soils are shallow, well-drained to rapidly drained loamy sands, sandy loams, or silt loams. The unvegetated ground surface is typically composed of litter, bedrock, and bare soil.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association occurs on gentle to moderately steep talus slopes (2-19°) with exposed bedrock slabs and ledges, as well as on mesatops, plateaus and buttes that lie between 1430 and 2210 m elevation. Small rocks, large rocks, bedrock and exposed soil cover most of the unvegetated surface, with lesser cover by litter. The soil is a rapidly drained loam or silty clay loam derived from Cedar Mesa, Navajo, or Entrada sandstones, Straight Cliffs Formation, or Shinarump conglomerate.

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Global Environment: This association is most commonly found on mesatops, canyon rims, talus and midslopes with rocky or ledgy substrates. Slopes can vary in steepness (sampled plots are between 1-35°) with generally north or east aspects. This association has been found at sites between 1476 and 2210 m elevation and mostly on sandstone substrates. Soils are shallow, well-drained to rapidly drained loamy sands, sandy loams, clay loams or silt loams. The unvegetated ground surface is typically composed of litter, bedrock, and bare soil. Large and small rocks can be present but are rarely abundant; fractures in the underlying bedrock control the density and distribution of woody vegetation. Parent materials include Dakota, Cedar Mesa, Kayenta Formation and Wingate Formation sandstones.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This pinyon-juniper woodland is somewhat uncommon within the recreation area. Total vegetation cover ranges from 8 to 25%. Stands are characterized by an open canopy, between 5 and 10 m tall, of *Pinus edulis* (with trace to 10% cover) and *Juniperus osteosperma* (with 3-17% cover). The understory is mixed and often diverse but dominated by *Artemisia bigelovii* with 2 to 5% cover. Associated shrubs include *Amelanchier utahensis, Coleogyne ramosissima, Ephedra viridis, Ericameria nauseosa, Gutierrezia sarothrae, Gutierrezia microcephala, Opuntia polyacantha, Purshia stansburiana,* and *Shepherdia rotundifolia*. The herbaceous layer may include (with low cover) *Pleuraphis jamesii, Artemisia ludoviciana, Bromus rubens, Stenotus armerioides (= Haplopappus armerioides), Lepidium montanum, Cryptantha flava,* and *Hymenopappus filifolius*.

Global Vegetation: This woodland association generally has sparse to moderate total vegetation cover, and stands at higher elevations with northern aspects can have greater vegetation cover. There is an open tree canopy, 2-5 m tall, dominated by *Pinus edulis* and *Juniperus osteosperma*, with 2-20% cover each. The shrub layer has sparse to low cover and is dominated by *Artemisia bigelovii* with 2-10% cover, and a variety of companion shrubs such as *Artemisia tridentata ssp. wyomingensis, Atriplex canescens, Cercocarpus intricatus, Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Fendlera rupicola, Fraxinus anomala, Grayia spinosa, Gutierrezia microcephala, Gutierrezia sarothrae, Opuntia polyacantha, Purshia stansburiana, Rhus trilobata, Tetradymia spinosa*, and *Yucca baccata*. The herbaceous layer is sparse, typically less than 5% cover, and contains graminoid species such as *Achnatherum hymenoides, Elymus elymoides*, and *Pleuraphis jamesii*. Forbs include *Arenaria fendleri, Cryptantha flava, Erodium cicutarium, Heterotheca villosa, Hymenopappus filifolius, Lepidium montanum, Machaeranthera grindelioides, Stenotus armerioides (= Haplopappus armerioides), Streptanthus cordatus*, and *Tetraneuris acaulis*. Stands of this community sampled at higher elevation have northern aspects and more dense vegetation cover.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii*

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Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Gutierrezia microcephala*, *Gutierrezia sarothrae*
Herb (field)	Flowering forb	*Cryptantha flava*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Dwarf-shrub	*Artemisia bigelovii*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Artemisia bigelovii*, *Juniperus osteosperma*, *Pinus edulis*

Other Noteworthy Species

Global: Invasive/Exotic Plants: *Erodium cicutarium* (Medium/Low)

Conservation Status Rank

Global Rank & Reasons: GNR (15-Dec-2004).

Related Concepts

Global Similar Types:

- *Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis* Woodland (CEGL000778)
- *Pinus edulis - Juniperus (monosperma, deppeana) / Cercocarpus montanus* - Mixed Shrubs Woodland (CEGL005649)
- *Pinus edulis - Juniperus osteosperma / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana)* Woodland (CEGL005658) also supports an open canopy of *Pinus edulis* and *Juniperus osteosperma*, but *Artemisia tridentata* rather than *Artemisia bigelovii* is the dominant shrub.
- *Pinus edulis - Juniperus osteosperma / Cercocarpus montanus* - Mixed Shrubs Woodland (CEGL005657)
- *Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland (CEGL000782)

Classification

Status: Standard

Classification Confidence:

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands may be similar to open *Artemisia bigelovii* dwarf-shrublands with scattered pinyon and juniper trees, but they are considered a variation of the woodland type because of the ecological values of the trees.

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Element Distribution

Glen Canyon National Recreation Area Range: This woodland association is somewhat uncommon within the recreation area and was sampled on Muley Point, Grand Bench, Navajo Point, Gordon Flats, Fourmile Bench, Grey Mesa, and near Cleopatra's Chair.

Global Range: This Colorado Plateau woodland association is found in western Colorado, northern Arizona and southeastern Utah.

Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Colorado, Glen Canyon, Grand Canyon, Hovenweep)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Topographically flat high level sandstone soil, not a specific site of water catchment or runoff, generally undisturbed by flooding, etc., allowing for a stable, mature pinyon-juniper community.

Glen Canyon National Recreation Area Plots: The description is based on 2012, 2014, and 2015 field data (2 plots, 6 accuracy assessment points): (Plots: GLCA.4055, GLCA.6134; AA Points: GLCA_AA.0182, GLCA_AA.0309, GLCA_AA.1152, GLCA_AA.1732, GLCA_AA.1834, GLCA_AA.5555).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Drake, J. Coles, K.A. Schulz and G. Kittel
References: Clark et al. 2009, Reid and Hall 2010, Romme et al. 1993, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.*

[CEGL002331] Pinus edulis - Juniperus osteosperma / Artemisia nova Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Black Sagebrush Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis* - *Juniperus osteosperma* / Shrub Understory Colorado Plateau Woodland & Scrub Alliance (A3573)

Element Concept

Global Summary: This association occurs in western Colorado, eastern Utah and northeastern Arizona. This woodland association typically has an open tree canopy (10-60% cover) dominated by

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short evergreen trees 2-10 m tall. *Pinus edulis* and *Juniperus osteosperma* dominate and scattered *Pseudotsuga menziesii* may be present at higher elevations. Shrubs provide low to moderate cover. The dwarf-shrub *Artemisia nova* is the most abundant shrub, usually with less than 20% cover. A number of herbaceous species can be found across the range of this association and includes graminoids such as *Achnatherum hymenoides, Bouteloua gracilis, Carex* spp., *Elymus elymoides, Koeleria macrantha*, and *Poa fendleriana* and forbs *Antennaria parvifolia, Arabis* spp., *Hymenoxys richardsonii, Petradoria pumila, Phlox* spp., and many others. Sites are nearly level to moderately steep and tend toward northern aspects on the higher areas. Stands occur on canyon rims, mesas, hills, ridgetops, and upper slopes. Elevation ranges from 1772 to 2518 m (5800-8260 feet). The soils are shallow and rapidly drained sandy loam to silt clay loam and sandy clay soil textures. Parent materials are often sandstones or limestones but can also be eolian deposits or shale.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association occurs on flat to gently sloping mesatop sites (up to 7° slopes) between 2026 and 2256 m elevation. Bare soil and litter cover most of the unvegetated surface, with lesser cover by small rocks, bedrock, biological soil crusts, and downed wood. Soils are rapidly drained loamy sands or silt loams derived from eolian deposits, the Straight Cliffs or the Kayenta formations.

Global Environment: This Colorado Plateau association occurs on the higher areas of local topographical features such as canyon rims, mesas, hills, ridgetops, and upper slopes. Sites are nearly level to moderately steep and tend toward northern aspects, although stands are found on other aspects. Elevation ranges from 1772 to 2518 m (5800-8260 feet). The soils are variable and include sandy loam, sandy clay loam, silt loam, and silt clay loam soil textures. They tend to be shallow and rapidly drained. Parent materials are often sandstones but can also be eolian deposits, limestone, or shale. The unvegetated surface is composed of litter, bare soil, bedrock, and large and small rocks. Cryptogams often have moderate to high cover.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This pinyon-juniper woodland is somewhat uncommon within the recreation area and was only encountered on high-elevation mesatops, mostly in the Orange Cliffs section. Total vegetation cover ranges 23 to 58%. Stands are characterized by a 2- to 5-m tall tree canopy of *Pinus edulis* (with 8-40% cover) and *Juniperus osteosperma* (with 2-15% cover). *Artemisia nova* is the dominant shrub in an often sparse understory with between 2 and 15% cover. Associated shrubs include *Amelanchier utahensis, Artemisia tridentata, Chrysothamnus viscidiflorus, Chrysothamnus greenei, Ephedra viridis, Purshia stansburiana, Shepherdia rotundifolia, Symphoricarpos longiflorus, Gutierrezia sarothrae*, and *Opuntia* spp. There is not much of an herbaceous layer, though a few forbs and grasses may be present with trace to low cover, notably *Petradoria pumila* and *Poa fendleriana*.

Global Vegetation: This woodland association ranges from a moderately dense to a more typically open tree canopy (10-60% cover) dominated by short evergreen trees 2-10 m tall. *Pinus edulis* and *Juniperus osteosperma* dominate the tree canopy and may form a sparse subcanopy 2-5 m tall where the upper canopy is taller. In most stands, *Pinus edulis* and *Juniperus osteosperma* each have between

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3 and 35% canopy cover, although in some sparsely vegetated stands, they may have less. Shrubs are present but provide low to moderate cover. The dwarf-shrub *Artemisia nova* is the most abundant shrub, usually with less than 20% cover, but stands with up to 50% cover have been observed. Other shrubs that are typically found include *Amelanchier utahensis, Artemisia tridentata, Cercocarpus montanus, Chrysothamnus viscidiflorus, Chrysothamnus greenei, Ephedra viridis, Gutierrezia microcephala, Gutierrezia sarothrae, Purshia stansburiana, Purshia tridentata, Opuntia* spp., *Shepherdia rotundifolia,* and *Symphoricarpos longiflorus*. Herbaceous species can be relatively diverse between stands, but any one stand usually has low to moderate diversity and less than 10% cover in aggregate. Common species include *Achnatherum hymenoides, Bouteloua gracilis, Carex* spp., *Elymus elymoides, Koeleria macrantha*, and *Poa fendleriana*. Forbs can include *Antennaria parvifolia, Arabis* spp., *Hymenoxys richardsonii, Petradoria pumila, Phlox* spp., and many others.

Global Dynamics: Fire is likely to convert stands of this association to forb- or graminoid-dominated associations.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Shepherdia rotundifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia nova*, *Purshia mexicana*
Herb (field)	Flowering forb	*Petradoria pumila*
Herb (field)	Graminoid	*Poa fendleriana*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Dwarf-shrub	*Artemisia nova*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Achnatherum hymenoides*, *Artemisia nova*, *Juniperus osteosperma*, *Petradoria pumila*, *Pinus edulis*, *Poa fendleriana*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4)

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (11-Jan-2005).

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Related Concepts

Global Similar Types:

- *Pinus edulis - Juniperus osteosperma / Purshia tridentata* Woodland (CEGL000789)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland association is somewhat uncommon and is mostly restricted to the Orange Cliffs section of the recreation area. It was sampled near Land's End, near the Flint Trail, on the Big Ridge, and on Fiftymile Bench/Navajo Point.

Global Range: This association is found on the Colorado Plateau and western slope of the southern Rocky Mountains in western and northern Colorado, southern and eastern Utah and northeastern Arizona.

Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 9:C, 10:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, M331E:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Bryce Canyon, Canyon de Chelly, Capitol Reef, Colorado, Dinosaur, Glen Canyon, Mesa Verde)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: There is no evidence of fire in the sampled stand. There was one recent drought-killed *Pinus edulis* tree on the plot and some older *Juniperus osteosperma* skeletons (probably age- or drought-related mortality). *Artemisia nova* grows in thin soils in bedrock cracks, while pinyon and juniper trees have mounds of soil deposited around them.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2014 field data (2 plots, 6 accuracy assessment points): (Plots: GLCA.0503, GLCA.0520; AA Points: GLCA_AA.0129, GLCA_AA.0146, GLCA_AA.0150, GLCA_AA.0152, GLCA_AA.1485, GLCA_AA.1495).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Drake, J. Coles, K.A. Schulz and G. Kittel
References: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2010, Romme et al. 1993, Tendick et al. 2011b, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.*

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[CEGL000779] Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland

Translated Name: Two-needle Pinyon - Utah Juniper / Littleleaf Mountain-mahogany Woodland

Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)

Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)

Group: Colorado Plateau Pinyon - Juniper Woodland (G250)

Alliance: *Pinus edulis* - *Juniperus osteosperma* / Shrub Understory Colorado Plateau Woodland & Scrub Alliance (A3573)

Element Concept

Global Summary: This woodland association occurs on the Colorado Plateau, and in western Colorado, northern Utah, and possibly Wyoming. The vegetation is characterized by a short (2-10 m), open tree canopy (10-25% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*, and by the dominance of *Cercocarpus intricatus* in the relatively sparse short-shrub layer (5-25% cover). Other shrubs may be present such as *Amelanchier utahensis, Arctostaphylos patula, Gutierrezia sarothrae, Mahonia fremontii, Quercus gambelii*, or *Yucca* spp. are often present in many stands. Herbaceous cover is sparse (<5% cover) and is composed of scattered forbs and grasses such as species of *Cryptantha, Penstemon*, and *Opuntia, Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Elymus elymoides, Pleuraphis jamesii*, and *Poa fendleriana*. Stands occur on dry sandstone ridgetops, mesa edges, outcrops, colluvial slopes, slickrock hills, benches and knolls at moderate elevations of 1484 to 2470 m (4870-8100 feet) on south and southwest aspects, on slopes of varying steepness. Exposed bedrock and large rock may cover over 50% of the stand, with vegetation growing in the cracks. These sandstone-derived soils are generally poorly developed, coarse-textured and skeletal.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland is common and widespread in the park and recreation area, occurring primarily in areas of extensive bedrock exposures. It was sampled on canyon rims, ledges, plateaus, mesas, shelves, and colluvial slopes. Sites are on flat to steep slopes (up to 32°), include all aspects, and lie between 1554 and 1890 m elevation. Bedrock, exposed soil or small rocks covers most of the unvegetated surface, with low cover by litter, biological soil crusts, downed wood, and sand. Soils are well-drained to rapidly drained loamy sands, sandy loams, loams, or sands derived from colluvium, Navajo sandstone, Cedar Mesa sandstone, or Kayenta Formation.

Global Environment: This woodland association occurs on dry, sandstone ridgetops, mesa edges, outcrops, colluvial slopes, slickrock hills, benches and knolls at moderate elevations (1484 -2470 m). South and southwest aspects are common, and slopes can vary from gentle to steep. Exposed bedrock and large rock may cover over 50% of the stand, with vegetation growing in soil that has collected in joints and cracks. These sandstone-derived soils are generally poorly developed, coarse-textured and skeletal. Soils are rapidly drained sandy loams, sands, or silt loams derived from colluvium derived

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from a variety of parent materials, including Carmel Formation, Cedar Mesa sandstone, Chinle Formation, Dakota Formation, Kayenta Formation, Morrison Formation, Navajo Formation, or Wingate Formation. Bare soil is common.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse, sometimes dwarfed pinyon-juniper woodland is characterized by an open tree canopy (2-10% cover) of *Pinus edulis* and *Juniperus osteosperma* with between 1 and 7% individual cover. *Cercocarpus intricatus* dominates a patchy understory and ranges in cover from 1 to 4%. Scattered *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. A diversity of associated shrubs is generally present and may include *Fraxinus anomala, Amelanchier utahensis, Ephedra viridis, Artemisia bigelovii, Rhus trilobata, Coleogyne ramosissima, Ceanothus greggii, Gutierrezia sarothrae, Yucca angustissima,* and *Opuntia polyacantha*. The herbaceous layer is very diverse but provides only sparse cover. Graminoids include *Achnatherum hymenoides, Aristida purpurea, Leymus salinus,* and *Pleuraphis jamesii*. Forbs include *Arenaria fendleri, Stenotus armerioides (= Haplopappus armerioides), Tetraneuris acaulis (= Hymenoxys acaulis), Machaeranthera grindelioides, Petradoria pumila,* and *Cryptantha flava*. Biological soil crusts can cover as much as 15% of the soil and are generally well-developed.

Global Vegetation: The association is characterized by an open tree canopy (10-25% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. The tree canopy may be between 2 and 10 m tall; *Pinus edulis* and *Juniperus osteosperma* vary in cover between 1 and 15%, with some stands having up to 25% cover of *Pinus edulis*. Some stands may have an occasional emergent *Pinus ponderosa, Pseudotsuga menziesii*, or *Juniperus scopulorum* tree. Additionally, some sparse (<10% total cover), tree-dominated stands from extremely dry, rocky sites in the Colorado Plateau are included in this woodland association. The shrub layer represents the mesic end of the pinyon-juniper / mixed shrub communities found on slickrock exposures. *Cercocarpus intricatus* is the dominant shrub with 5-25% but is usually with a variety of other shrubs at much lower cover. The companion shrubs are highly variable and include *Artemisia bigelovii, Amelanchier utahensis, Arctostaphylos patula, Brickellia microphylla, Ceanothus greggii, Cercocarpus montanus, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Echinocereus triglochidiatus, Ephedra viridis, Eriogonum corymbosum, Fendlerella utahensis, Fraxinus anomala, Gutierrezia sarothrae, Glossopetalon spinescens var. meionandrum, Holodiscus dumosus, Mahonia fremontii, Philadelphus microphyllus, Quercus gambelii, Quercus turbinella, Purshia stansburiana, Rhus trilobata, Shepherdia rotundifolia*, and *Yucca* spp. Herbaceous cover is sparse (<5% cover) and is composed of scattered grasses such as *Achnatherum hymenoides (= Oryzopsis hymenoides), Aristida purpurea, Bouteloua gracilis, Elymus elymoides, Leymus salinus, Pleuraphis jamesii,* and *Poa fendleriana*. Forbs present include *Arenaria fendleri, Cryptantha flava, Machaeranthera grindelioides, Opuntia* spp., *Petradoria pumila, Penstemon* spp., *Stenotus armerioides (= Haplopappus armerioides),* and *Tetraneuris acaulis (= Hymenoxys acaulis)*. Biological soil crusts can cover as much as 15% of the soil surface and are generally well-developed.

Global Dynamics: Fire is not frequent because open tree and shrub canopies and lack of continuous fine fuel prevent the spread.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Cercocarpus intricatus*, *Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Achnatherum hymenoides*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous tree	*Amelanchier utahensis*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Cercocarpus intricatus*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Elymus elymoides*, *Poa fendleriana*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Cercocarpus intricatus, Pinus edulis*

Other Noteworthy Species

Global: Vulnerable Plants: Glossopetalon spinescens var. meionandrum (G5T3), Hymenoxys lapidicola (G1), Shepherdia rotundifolia (G3G4), Yucca elata var. utahensis (G5T3?, endemic variety)

Conservation Status Rank

Global Rank & Reasons: G3 (30-Dec-2000). The plant association is limited to a small geographic area and is documented from a narrow elevational band on sandstone substrates in extreme northwestern Colorado and possibly adjacent Utah. There are 11 documented stands in Colorado with size ranging from 4-450 acres. Although most occurrences are considered in good to excellent condition, those in excellent condition tend to be small. Grazing and woodcutting are the primary threats where stands are accessible.

Related Concepts

Global Similar Types:

- *Juniperus osteosperma / Cercocarpus intricatus* Woodland (CEGL000733)
- *Pinus edulis - Juniperus osteosperma / Quercus turbinella* Woodland (CEGL004007) supports a woodland canopy of pinyon and juniper and abundant *Quercus turbinella* in the shrub layers, but *Cercocarpus intricatus* rarely occurs.

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Global Related Concepts:

- *Juniperus osteosperma - Pinus edulis / Cercocarpus ledifolius var. intricatus* Plant Association (Baker 1983c) =
- *Juniperus osteosperma - Pinus edulis / Cercocarpus ledifolius var. intricatus* Plant Association (Baker 1984a) =
- *Juniperus osteosperma - Pinus edulis / Cercocarpus ledifolius var. intricatus* Plant Association (Baker and Kennedy 1985) =
- *Pinus edulis/Cercocarpus ledifolius* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Compare this association with *Juniperus osteosperma / Cercocarpus intricatus* Woodland (CEGL000733) which is very similar, but lacks *Pinus edulis*. On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands may be similar to open *Cercocarpus intricatus* shrublands with scattered pinyon and juniper trees but is considered to be a variation of the woodland type because of the ecological values of the trees.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is common within the recreation area. It was sampled near Hans Flat Ranger Station, near Land's End, near Cleopatra's Chair, on Millard Canyon rim, in Calf Canyon, east of Teapot Rock Campsite, on Muley Point, and in Andy Miller Flats.

Global Range: This plant association is found throughout the Colorado Plateau and in extreme northwestern Colorado, adjacent Utah, and Wyoming.

Nations: US
States/Provinces: AZ, CO:SU, UT, WY
TNC Ecoregions: 9:C, 10:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, 341C:CC, M331E:CC, M341C:CC
Federal Lands: NPS (Arches, Canyon de Chelly, Canyonlands, Capitol Reef, Colorado, Dinosaur, Glen Canyon, Grand Canyon, Natural Bridges, Navajo, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plot is located on slickrock ledges with a step-like topography. This is a classic rimrock environment, with very thin sandy soils collected in fractures and low concavities on ledges. Trees and large shrubs grow in fractures; smaller vegetation can survive in the shallow pools of soil.

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Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2012 field data (16 plots): (Plots: GLCA.0302, GLCA.0307, GLCA.0504, GLCA.0505, GLCA.0527, GLCA.0575, GLCA.0581, GLCA.0700, GLCA.0714, GLCA.0764, GLCA.4045, GLCA.4048, GLCA.5034, GLCA.5036, GLCA.5313, GLCA.9301).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): A.E. Black, K.A. Schulz, J. Drake, J. Coles, G. Kittel
References: Baker 1983b, Baker 1983c, Baker 1984a, Baker and Kennedy 1985, Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2009a, Driscoll et al. 1984, Reid and Hall 2010, Romme et al. 1993, Salas et al. 2010a, Thomas et al. 2010, Von Loh et al. 2007, WNDD unpubl. data, Western Ecology Working Group n.d.*, Zimmerman 1978

[CEGL005657] Pinus edulis - Juniperus osteosperma / Cercocarpus montanus - Mixed Shrubs Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Alderleaf Mountain-mahogany - Mixed Shrubs Woodland

Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis* - *Juniperus osteosperma* / Shrub Understory Colorado Plateau Woodland & Scrub Alliance (A3573)

Element Concept

Global Summary: This woodland association is common on the Colorado Plateau, from northwestern New Mexico west to the Mogollon Rim of Arizona, and north into western Colorado and Utah. This association is characterized by an open to moderately dense tree canopy (10-60% cover) dominated by a combination of *Pinus edulis* and *Juniperus osteosperma* with a shrub layer dominated by *Cercocarpus montanus*. The tree canopy averages 2-5 m tall, but some stands may be as tall as 10 m. *Pinus edulis* and *Juniperus osteosperma* codominate in most stands, but sometimes one may be more prevalent than the other. The total shrub cover may range from sparse to moderate. *Cercocarpus montanus* is the dominant shrub with up to 35% cover. It typically occurs as a short shrub but can be a tall shrub on some sites. Herbaceous cover is variable, ranging from sparse to moderately dense, and generally dominated by graminoids (>5% cover) with scattered forbs. It occurs on sheltered colluvial slopes, sandstone hogbacks, dry foothills and mesas. Elevations range from 1472 to 2480 m (4830-8135 feet). Stands occur on gentle to steep slopes on all aspects. The soils are variable but generally shallow, poorly developed and skeletal, ranging from clayey marl to loamy sands. Sandstone or shale are the most common parent materials.

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Environmental Description

Glen Canyon National Recreation Area Environment: This rare woodland occurs on the high slopes of plateaus, mesas, and canyon rims. Stands are on moderate slopes (up to 11°), are generally oriented to the north, and lie between 1999 and 2028 m elevation. Bedrock, large rocks, gravel, and bare soil cover most of the unvegetated surface, with lesser cover by litter and biological soil crusts. Soils are rapidly drained sandy loams derived from talus/colluvium or from Navajo sandstone.

Global Environment: This broadly defined woodland association is common on the Colorado Plateau, occurring on sheltered colluvial slopes, sandstone hogbacks, dry foothills and mesas. It can be found on any slope position (upper, middle, or lower), though lower slopes are the least common. Elevations range from 1472 to 2480 m (4830-8135 feet). Stands occur on gentle to steep (3-36°) slopes on all aspects. The soils are variable but generally shallow, poorly developed and skeletal, ranging from clayey marl to loamy sands. The unvegetated surface is characterized by bedrock, large and small rocks, and/or bare soil. Litter has low cover. Parent materials are often sandstone or shale, but others are possible.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This pinyon-juniper / mixed shrubs woodland is rare within the recreation area. Total vegetation cover ranges from 19 to 49%. Stands are characterized by an open canopy, typically 2 to 5 m tall, of *Pinus edulis* and *Juniperus osteosperma* with 4 to 15% cover each. The tall shrub *Cercocarpus montanus* dominates a mixed shrub understory and provides between 5 and 11% cover. Scattered *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. The remainder of the shrub stratum may include *Fraxinus anomala, Amelanchier utahensis, Purshia stansburiana, Ephedra viridis, Symphoricarpos longiflorus, Shepherdia rotundifolia, Gutierrezia sarothrae,* and *Mahonia fremontii*. The often diverse herbaceous layer provides sparse cover. *Petradoria pumila* was the only herbaceous species recorded with more than trace cover. Biological soil crusts are patchy but may contribute up to 16% cover and are generally well-developed.

Global Vegetation: This association is characterized by an open to moderately dense tree canopy (10-60% cover) dominated by a combination of *Pinus edulis* and *Juniperus osteosperma*. The canopy averages 2-5 m tall, but some stands may be as tall as 10 m. *Pinus edulis* and *Juniperus osteosperma* codominate in most stands, but sometimes one may be more prevalent than the other. *Pinus edulis* and *Juniperus* spp. are also present as smaller individuals in the shrub and field strata. The species of *Juniperus* varies with geography and elevation. *Juniperus deppeana* and *Juniperus monosperma* may be present in northern Arizona. *Juniperus osteosperma* is common from northwestern New Mexico west into Arizona and north into western Colorado and Utah. *Juniperus scopulorum* is more common in higher elevation stands. The total shrub cover may range from sparse to moderate. *Cercocarpus montanus* is the dominant shrub with 1-35% cover. It typically occurs as a short shrub <2 m tall but can be a tall shrub (2-5 m) on some sites. Other shrubs may be present, including *Amelanchier* spp., *Artemisia bigelovii, Artemisia tridentata, Ephedra viridis, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Fendlera rupicola, Fraxinus anomala, Garrya ovata, Mahonia* spp., *Purshia stansburiana, Quercus gambelii* (<5% cover), *Rhus trilobata, Symphoricarpos oreophilus, Symphoricarpos*

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longiflorus, Shepherdia rotundifolia, Gutierrezia sarothrae, or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, and generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Andropogon gerardii, Aristida purpurea, Bouteloua curtipendula, Bouteloua gracilis, Bouteloua hirsuta, Carex rossii, Hesperostipa comata, Koeleria macrantha, Leymus salinus (= Elymus salinus), Muhlenbergia pauciflora, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana, Pseudoroegneria spicata*, and *Schizachyrium scoparium*. Common forbs include species of *Chamaesyce, Cryptantha, Eriogonum, Machaeranthera, Packera, Penstemon, Petradoria pumila, Phlox*, and *Tetraneuris*. Extremely open stands of this association occurring on exposed and fractured slickrock may have as little as 5% total vegetation cover and an upper canopy only 2 m tall. Biological soil crusts are patchy but may contribute up to 27% cover and are generally well-developed.

Global Dynamics: Fires in this association are thought to be infrequent because *Pinus edulis, Juniperus osteosperma*, and *Juniperus monosperma* are killed or severely damaged by burns and do not resprout (Wright et al. 1979). *Cercocarpus montanus,* however, resprouts after burning and will re-establish relatively quickly (Pase and Lindenmuth 1971, Bradley et al. 1992). Conifers will re-establish more slowly. Stands occur in dry and often rocky habitats where fire frequency is low because of fuel discontinuity. When fire occurs, it will likely be severe because of greater fuel loads from decadent shrubs (Bradley et al. 1992).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Cercocarpus montanus*, *Mahonia fremontii*
Short shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos longiflorus*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus monosperma*, *Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Cercocarpus montanus*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Amelanchier utahensis, Cercocarpus montanus, Juniperus monosperma, Juniperus osteosperma, Pinus edulis*

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Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4); Other Plants: *Ephedra viridis* (G5)

Conservation Status Rank

Global Rank & Reasons: G5 (13-Jan-2016).

Related Concepts

Global Similar Types:

- *Pinus edulis - Juniperus (monosperma, deppeana) / Cercocarpus montanus* - Mixed Shrubs Woodland (CEGL005649)
- *Pinus edulis - Juniperus osteosperma / Artemisia bigelovii* Woodland (CEGL002118)
- *Pseudotsuga menziesii / Cercocarpus montanus* Woodland (CEGL000898)

Global Related Concepts:

- *Juniperus osteosperma - Pinus edulis / Amelanchier utahensis - Cercocarpus montanus* Marlstone Barrens Plant Association (Baker 1983b) =
- *Juniperus osteosperma - Pinus edulis / Cercocarpus montanus - Peraphyllum ramosissimum* Plant Association (Baker 1984a) =
- *Pinus edulis - Juniperus osteosperma / Cercocarpus montanus* Plant Association (Vories 1974) =
- *Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* - Mixed Shrubs Woodland (Bradley et al. 1992) =
- *Pinus edulis / Cercocarpus montanus* Plant Association (Stuever and Hayden 1997a) =
- *Pinus edulis / Cercocarpus montanus* Plant Association (Larson and Moir 1987) =
- *Pinus edulis/Cercocarpus montanus* (Bourgeron and Engelking 1994) =
- Coronado Province Pinyon - Juniper Woodlands (Isaacson 1967) >
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >
- La Sal Province Pinyon - Juniper Woodlands (Isaacson 1967) >

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. This is a widely distributed and variable association, found throughout much of the Colorado Plateau, western edges of the Colorado Rockies and south into northwestern New Mexico. On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands may be similar to open *Cercocarpus montanus* shrublands with scattered pinyon and juniper trees but is considered to be a variation of the woodland type because of the ecological values of the trees.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is rare within the recreation area and was sampled only on Flint Flat and near Flint Seep in the Orange Cliffs section.

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Global Range: This woodland association is common in foothills and plateaus throughout the Colorado Plateau region from northwestern New Mexico along the Mogollon Rim to the Grand Canyon in northern Arizona, and north across much of Utah and western Colorado.

Nations: US
States/Provinces: AZ:S3, CO:S5, NM:S5, UT
TNC Ecoregions: 9:C, 10:C, 18:C, 19:C, 20:C, 21:?
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313E:CC, 341B:CC, M313A:C?, M331E:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Arches, Black Canyon of the Gunnison, Bryce Canyon, Canyon de Chelly, Canyonlands, Capitol Reef, Cedar Breaks, Chaco Culture, Colorado, Curecanti, Dinosaur, Glen Canyon, Grand Canyon, Hovenweep, Natural Bridges, Walnut Canyon, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: There is no evidence of fire in this stand. The community is controlled by access to bedrock cracks for rooting, a north/northeast exposure that experiences snow accumulation, and contribution of moisture via minor drainages.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2014 field data (2 plots, 2 accuracy assessment points): (Plots: GLCA.0511, GLCA.0531; AA Points: GLCA_AA.0141, GLCA_AA.0151).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Drake, J. Coles and G. Kittel
References: Baker 1983b, Baker 1984a, Baker and Kennedy 1985, Bourgeron and Engelking 1994, Bradley et al. 1992, CNHP 2003, CNHP 2015, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2009a, Coles et al. 2010, Driscoll et al. 1984, Erdman 1962, Erdman 1969, Hansen et al. 2004a, Isaacson 1967, Larson and Moir 1987, Marr et al. 1979, Medina 1986, Moir 1963, Moir and Carleton 1987, Moir and Ludwig 1979, Pase and Lindenmuth 1971, Reid and Hall 2010, Romme et al. 1993, Salas et al. 2010b, Salas et al. 2011, Stuever and Hayden 1997a, Tendick et al. 2010, Tendick et al. 2011a, Tendick et al. 2011b, Thomas et al. 2010, Von Loh et al. 2007, Von Loh et al. 2008, Vories 1974, Western Ecology Working Group n.d.*, Wright et al. 1979

[CEGL000781] Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Blackbrush Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis - Juniperus osteosperma* / Shrub Understory Colorado Plateau Woodland & Scrub Alliance (A3573)

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Element Concept

Global Summary: This woodland association occurs extensively across the Colorado Plateau from southwestern Colorado through southern Utah into Arizona. This woodland has variable cover, ranging from very open and sparsely vegetated (<10% total cover) to relatively dense (80% cover). Sparsely vegetated stands also tend to have dwarfed trees not exceeding 2 m in height. Typically, stands have an open (5-25% cover) tree canopy 3-6 m tall with both *Pinus edulis* and *Juniperus osteosperma*. The shrub layer has 5 to 55% cover and is dominated by *Coleogyne ramosissima*. Other common shrub species may include *Agave utahensis, Cercocarpus montanus, Ephedra viridis, Glossopetalon spinescens, Gutierrezia sarothrae, Purshia stansburiana, Quercus turbinella*, and *Yucca* spp. The herbaceous layer is sparse and composed of graminoids such as *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Elymus elymoides, Poa fendleriana, Bouteloua curtipendula,* and *Aristida* species. Forbs are typically variable and scattered, contributing little cover. Sites occur in valley bottoms, terraces, benches, slopes, mesa rims, elevated plains and rolling terrain sometimes interrupted by bedrock. Sites occur on flat to moderate slopes (0-20%) between 1070 and 1890 m (3500-6200 feet) elevation on all aspects. Cryptogam cover can be as high as 45%. Soils are typically shallow, rocky sandy loams derived from sandstone, eolian sands, alluvium or limestone.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland type is widespread throughout the recreation area and occurs on a variety of substrates, though most commonly in areas with extensive bedrock exposure. It is documented on canyon rims, plateaus, benches, sand dunes, canyon bottoms, and valley floors. Sites are on flat to moderate slopes (up to 8°), oriented to all aspects, and lie between 1518 and 1820 m elevation. Most of the unvegetated surface consists of exposed soil, bedrock, and small rocks. Litter, downed wood, sand, and biological soil crusts are present with low cover in most stands. Soils are well-drained to rapidly drained sandy loams, sandy clay loams, loamy sands, or sands derived from the Kayenta Formation, Chinle Formation, White Rim sandstone, Cedar Mesa sandstone, or eolian deposits.

Global Environment: This woodland association has been described from valley bottoms, terraces, benches, sand dunes, slopes, mesa rims, elevated plains and rolling terrain sometimes interrupted by bedrock. It likely occurs extensively across the Colorado Plateau from southwestern Colorado through southern Utah into Nevada. Sites are on flat to moderate slopes (0-20%) between 1070 and 1890 m (3500-6200 feet) elevation on all aspects. Bare soil covers most of the unvegetated surface, although cryptogam cover can be as high as 45%. Soils are typically shallow, rocky sandy loams derived from sandstone, eolian sands, alluvium or limestone. A few stands occur on deep or clay-textured soils derived from shale. Parent materials are variable and include eolian deposits derived from Chinle Formation, White Rim sandstone, Cedar Mesa, Dakota or Navajo sandstones and the Morrison Formation (Salt Wash Member), Kayenta Formation, and Moenkopi Formation.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This pinyon-juniper woodland is common within the recreation area. Total vegetation cover ranges from 7 to 29%. Stands are characterized by an

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open canopy, typically 2 to 5 m tall, of *Pinus edulis* (with 1-10% cover) and *Juniperus osteosperma* (with trace to 16% cover). *Coleogyne ramosissima* dominates the shrub understory with between 1 and 14% cover. Scattered *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. Associated shrubs include *Amelanchier utahensis, Cercocarpus intricatus, Rhus trilobata var. trilobata (= Rhus aromatica var. trilobata), Ephedra viridis, Shepherdia rotundifolia, Symphoricarpos longiflorus, Artemisia bigelovii, Gutierrezia sarothrae, Yucca angustissima*, and *Opuntia* spp. Herbaceous species provide sparse cover and may include *Achnatherum hymenoides, Aristida purpurea, Pleuraphis jamesii, Poa fendleriana, Hesperostipa comata, Cryptantha flava, Lepidium montanum*, and *Packera multilobata (= Senecio multilobatus)*. Biological soil crusts are variable in cover and stage of development, with some stands having none and others having cover as high as 50%.

Global Vegetation: Stands of this association can vary greatly in appearance, ranging from sparsely vegetated (<10% total cover) to relatively dense (80% cover). Sparsely vegetated stands also tend to have dwarfed trees not exceeding 2 m in height. Typically, stands have an open (5-25% cover) tree canopy 3-6 m tall that contains both *Pinus edulis* and *Juniperus osteosperma*, although one or the other tree may dominate. The shrub layer has 5 to 55% cover and is dominated by *Coleogyne ramosissima*. In some parts of the range, *Mortonia sempervirens* may be codominant. Other shrub species present may include *Agave utahensis, Amelanchier utahensis, Artemisia bigelovii, Cercocarpus intricatus, Cercocarpus montanus, Ephedra viridis, Glossopetalon spinescens var. aridum (= Glossopetalon nevadense), Glossopetalon spinescens, Gutierrezia sarothrae, Opuntia polyacantha, Purshia stansburiana, Quercus turbinella, Rhus trilobata var. trilobata, Shepherdia rotundifolia, Symphoricarpos longiflorus, Yucca angustissima, Yucca baccata, Yucca harrimaniae*, and *Yucca elata var. utahensis (= Yucca utahensis)*. Scattered cacti are often present, including *Opuntia erinacea, Opuntia phaeacantha, Opuntia polyacantha, Echinocereus triglochidiatus*, and *Echinocereus engelmannii*. The sparse herbaceous layer is composed of graminoids such as *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Aristida purpurea, Bouteloua curtipendula, Elymus elymoides, Hesperostipa comata, Poa fendleriana, Pleuraphis jamesii*, and native *Aristida* species. Forbs are typically variable and include *Packera multilobata, Psilostrophe sparsiflora*, and *Streptanthella longirostris*. On disturbed sites non-native introduced species such as *Bromus rubens, Bromus tectorum*, and *Vulpia octoflora* may be present to abundant.

Global Dynamics: Sites occupy bedrock with sand-filled fissures and pockets, deep soils of eolian dunes, and shallow soils over bedrock ledges. Soil depth controls plant distribution. Fire could eliminate overstory short shrubs and canopy trees but may not carry well in these sparsely vegetated stands. Disturbance could result in invasion by cheatgrass.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*

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Stratum	Lifeform	Species
Short shrub/sapling	Succulent shrub	*Opuntia* spp.

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Mortonia sempervirens*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Coleogyne ramosissima, Ephedra viridis, Juniperus osteosperma, Mortonia sempervirens, Pinus edulis, Pleuraphis jamesii*

Other Noteworthy Species

Global: Vulnerable Plants: *Quercus havardii* var. *tuckeri* (G4T3?Q); Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: G3 (19-Sep-2000). This late-seral woodland association occurs extensively across the Colorado Plateau in southwestern Colorado and southern Utah into Arizona and probably also Nevada. Introduced annual grasses such as *Bromus rubens* may threaten this woodland because the dry annual grasses provide fine fuels that allow fire to spread. *Coleogyne ramosissima* is very sensitive to fire. A hot fire will completely remove this shrub from a site for decades. More survey work is needed to assess the entire range of this type.

Related Concepts

Global Similar Types:

- *Coleogyne ramosissima* Shrubland (CEGL001332)
- *Pinus edulis - Juniperus osteosperma / Purshia tridentata* Woodland (CEGL000789)

Global Related Concepts:

- *Coleogyne ramosissima - Pinus edulis - Juniperus osteosperma - Ephedra viridis* Association (122.4147) (Warren et al. 1982) =
- *Pinus edulis / Coleogyne ramosissima* Plant Association (Stuever and Hayden 1997a) =
- *Pinus edulis / Coleogyne ramosissima* Plant Association (Larson and Moir 1987) =
- *Pinus edulis/Coleogyne ramosissima* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >

Classification

Status: Standard

Classification Confidence: 1 - Strong

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Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland association is widespread within the recreation area and was sampled in Calf Canyon, Cove Canyon, Range Canyon, upper Millard Canyon, near Bagpipe Butte, Freddie's Cistern, around Sunset Pass, on Millard Canyon rim, the west rim of Big Water Canyon, Fiftymile Bench, and Brown's Rim.

Global Range: This woodland association occurs extensively across the Colorado Plateau from southwestern Colorado through southern Utah into Arizona. It is likely to occur in California and Nevada. More survey work is needed to assess the range.

Nations: US
States/Provinces: AZ:S3, CO:SU, NV?, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This is on a rim of a deep slot canyon within a broader canyon. Cracks in the exposed slickrock support trees and deep soil development facilitates *Coleogyne ramosissima*. Biocrusts are well-developed.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, and 2013 field data (13 plots): (Plots: GLCA.0126, GLCA.0308, GLCA.0335, GLCA.0528, GLCA.0563, GLCA.0578, GLCA.0772, GLCA.4105, GLCA.4211, GLCA.5292, GLCA.5299, GLCA.5312, GLCA.9101).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Coles and G. Kittel
References: Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Clark et al. 2009, Coles et al. 2009a, Driscoll et al. 1984, FEIS 1996, Larson and Moir 1987, Reid and Hall 2010, Romme et al. 1993, Stuever and Hayden 1997a, Warren et al. 1982, Western Ecology Working Group n.d.*

[CEGL002370] Pinus edulis - Juniperus osteosperma / Ephedra viridis - Gutierrezia sarothrae Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Mormon-tea - Broom Snakeweed Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)

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Alliance: *Pinus edulis - Juniperus osteosperma* / Shrub Understory Colorado Plateau Woodland & Scrub Alliance (A3573)

Element Concept

Global Summary: This woodland association occurs in northern Arizona, southeastern Utah and northwestern Colorado. The tree canopy is characterized by the codominance of *Juniperus osteosperma* and *Pinus edulis* trees that are 2-5 m tall with up to 40% cover. The shrub layer is generally sparse and is dominated by *Ephedra viridis*, which contributes approximately 3-15% cover. Few other shrubs are present, and because of the low diagnostic value of *Ephedra viridis*, the associated shrubs have very low cover. *Amelanchier utahensis, Artemisia tridentata, Cercocarpus intricatus, Glossopetalon spinescens var. meionandrum, Shepherdia rotundifolia, Artemisia bigelovii,* and *Mahonia fremontii* may be present. Associated graminoids provide low cover and include *Poa secunda, Bouteloua gracilis, Pleuraphis jamesii, Hesperostipa comata, Achnatherum hymenoides, Pseudoroegneria spicata,* and *Pleuraphis jamesii*. Forbs are diverse but inconsistent among stands and contribute little cover. Stands occur on dry middle and upper slopes of ridges and canyons, as well as on colluvial slopes and benches. Sites are flat to very steep occurring on any aspect between 1170 and 2204 m elevation. Substrates are variable, ranging from rapidly drained sands or loamy sands derived from eolian deposits or from sandstones to finer-textured soils such as loams, sandy loams, or silty clays derived from shales and rocky colluvial slopes.

Environmental Description

Glen Canyon National Recreation Area Environment: This sparse woodland association occurs on a variety of landscape settings, including plateaus, mesas, benches, ridges, hills, sideslopes, dunes, valley floors, canyon floors, basins, terraces, and channels. Sites are gently to moderately sloping (up to 8°), though one site is very steep (45°), oriented to all aspects, and lie between 1171 and 1959 m elevation. The unvegetated surface is composed mainly of bare soil, sand, and/or gravel, with lesser cover of litter and biological soil crusts, and low cover of bedrock and large rocks. Soils are rapidly drained sands or loamy sands derived from eolian deposits or from sandstones of the Navajo, Cedar Mesa, Entrada, or White Rim formations, or loams, sandy loams, or silty clays derived from shales of the Chinle, Moenkopi, or Shinarump conglomerate formations.

Global Environment: This association is known from dry, rocky colluvial slopes and canyons in southern Utah and northwestern Colorado. It occupies steep colluvial and other xeric slopes in canyons or hogbacks and occasionally drainages. Other landforms include plateaus, mesas, benches, ridges, hills, sideslopes, dunes, valley floors, canyon floors, basins, terraces, and channels. Slopes are flat to very steep (0-45°) and oriented to all aspects. Elevation ranges from 1170 and 2204 m (3840-7230 feet). Substrates are variable, ranging from rapidly drained sands or loamy sands derived from eolian deposits or from sandstones to finer-textured soils such as loams, sandy loams, or silty clays derived from shales and rocky colluvial slopes.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse, xeric woodland is characterized by a canopy dominated by *Juniperus osteosperma*, with 1 to 23% cover, and sometimes codominated

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by *Pinus edulis* (which is often absent from the canopy layer), with up to 7% cover. Total cover ranges from 5-51%, but is most commonly at or below 25%. The understory is dominated or codominated by *Ephedra viridis*, with 1-16% cover, and *Gutierrezia sarothrae* (or *Gutierrezia microcephala*), with up to 13% cover. *Opuntia* spp. dwarf-shrubs are also commonly nearly codominant, or at least present in the shrub canopy layer. Other associated shrubs with sparse to low cover may include *Artemisia bigelovii, Atriplex canescens, Atriplex confertifolia, Coleogyne ramosissima, Chrysothamnus viscidiflorus, Chrysothamnus greenei, Ericameria nauseosa, Ephedra torreyana, Mahonia fremontii, Purshia stansburiana, Rhus trilobata var. trilobata (= Rhus aromatica var. trilobata), Shepherdia rotundifolia, Symphoricarpos longiflorus, Yucca angustissima,* and in dunier examples of this type *Poliomintha incana, Vanclevea stylosa*, and *Quercus havardii*. The herbaceous layer is usually well-developed and contributes low to moderate cover. Common graminoids include *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Hesperostipa comata, Leymus salinus, Muhlenbergia pungens, Pleuraphis jamesii, Sporobolus contractus*, and *Sporobolus flexuosus*.

Global Vegetation: This xeric woodland is characterized by a canopy of mixed *Pinus edulis* and *Juniperus osteosperma* with between 5 and 40% cover. Some stands on extremely steep slopes may have less than 10% tree cover but are so sparsely vegetated that they can still be considered a wooded vegetation type. The understory is dominated by *Ephedra viridis* (3-15% cover), or in some stands *Gutierrezia sarothrae* (or *Gutierrezia microcephala*); if other shrubs such as *Fraxinus anomala, Atriplex* spp., *Glossopetalon spinescens var. meionandrum, Purshia stansburiana,* or *Cercocarpus intricatus* are present, they have 1% or less cover. The herbaceous layer is generally sparse and poorly developed because of the moving substrate, but a few stable stands have as much as 10% cover by grasses. Species present vary from stand to stand but may include *Hesperostipa comata, Pleuraphis jamesii, Phlox hoodii, Tetraneuris acaulis, Koeleria macrantha, Achnatherum hymenoides, Phlox austromontana, Artemisia dracunculus, Pseudoroegneria spicata*, and *Poa secunda*.

Global Dynamics: This type appears to prefer rocky, steep, hot slopes, often with active downslope soil movement. *Ephedra viridis* appears to be the only shrub that thrives under these conditions.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia* spp., *Opuntia* spp.
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Hesperostipa comata*, *Muhlenbergia pungens*, *Pleuraphis jamesii*

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Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Gutierrezia sarothrae*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Herb (field)	Graminoid	*Poa secunda*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Ephedra viridis, Juniperus osteosperma, Pinus edulis, Pleuraphis jamesii, Poa secunda*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Vanclevea stylosa* (G3)
Global:

Conservation Status Rank

Global Rank & Reasons: G3 (5-Jun-2006). Although this association appears to be rare, it is likely to be somewhat common but overlooked, because of its lack of attention-grabbing diagnostic species.

Related Concepts

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Data from Glen Canyon National Recreation Area broadened the environmental concept from rocky substrates to include sandy and loamy sites and many new landforms. The floristic concept is also broadened from an understory clearly dominated by *Ephedra viridis* (3-15% cover) with low cover of other shrubs (1% or less cover) to an understory that is dominated or codominated by *Ephedra viridis* with 1-16% cover.

Element Distribution

Glen Canyon National Recreation Area Range: This widespread association was sampled on Grand Bench, Cedar Mesa, North Point, Waterhole Flat, Sunset Pass, China Neck, Fourmile Bench, Allen Dump, Egypt, Scorpion Flat, Fiftymile Bench, Andy Miller Flats, the Purple Hills, the Waterpocket Fold, in Moody Canyon and East Moody Canyon, Elaterite Basin, Waterhole Canyon, the south fork of Happy Canyon, above Clearwater Canyon, and near Cleopatra's Chair.

Global Range: This woodland association occurs in northern Arizona, southeastern Utah and northwestern Colorado. It is likely to occur in xeric, rocky sites throughout the pinyon-juniper zone of the Colorado Plateau.

Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 9:C, 19:C
USFS Ecoregions (1994/95): 341B:CC, M331E:CC
USFS Ecoregions (2007): 341Bj:C
Federal Lands: NPS (Black Canyon of the Gunnison, Canyon de Chelly, Canyonlands, Capitol Reef, Dinosaur, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Soil surface covered in thin layer of tightly distributed gravel forming a loose desert pavement effect with soil crust resulting in very few forbs or grass among the sparse shrubs. Active sand dunes clearly separate this community from the pinyon-juniper/sparse understory vegetation that prevails elsewhere, especially to the east towards Panorama Point.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, 2013, 2014, and 2015 field data (6 plots, 25 accuracy assessment points): (Plots: GLCA.0717, GLCA.0771, GLCA.5060, GLCA.5061, GLCA.5069, GLCA.5311; AA Points: GLCA_AA.0041, GLCA_AA.0069, GLCA_AA.0071, GLCA_AA.0088, GLCA_AA.0102, GLCA_AA.0208, GLCA_AA.0296, GLCA_AA.0310, GLCA_AA.0618, GLCA_AA.0655, GLCA_AA.1158, GLCA_AA.1161, GLCA_AA.1231, GLCA_AA.1239, GLCA_AA.1264, GLCA_AA.1281, GLCA_AA.1369, GLCA_AA.1627, GLCA_AA.1721, GLCA_AA.1728, GLCA_AA.1729, GLCA_AA.1730, GLCA_AA.1735, GLCA_AA.3021, GLCA_AA.3036).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, M.E. Hall and K.A. Schulz
References: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2010, Romme et al. 1993, Thomas et al. 2010, Western Ecology Working Group n.d.*

[CEGL000782] Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Stansbury's Cliffrose Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis - Juniperus osteosperma* / Shrub Understory Colorado Plateau Woodland & Scrub Alliance (A3573)

Element Concept

Global Summary: This woodland association is known from the Colorado Plateau of southern Utah and Colorado south to central Arizona. The vegetation is characterized by an open to moderately dense

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tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. *Purshia stansburiana* dominates or codominates the sparse to moderately dense short-shrub layer, often with *Artemisia tridentata* in the northern part of its range. Other shrubs may be present, including *Amelanchier utahensis, Arctostaphylos patula, Chamaebatiaria millefolium, Ephedra viridis, Gutierrezia sarothrae, Quercus gambelii* (<5% cover), or species of *Yucca* and *Opuntia*. *Cercocarpus montanus* and *Purshia tridentata* are scarce or absent. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (<5% cover) with scattered perennial forbs. It occurs on dry sites on canyon rims, ridges and slopes. Elevations range from 1400 to 2165 m. Stands typically occur on gentle to moderately steep slopes on all aspects. The soils are generally shallow and rocky, ranging from sand to clay loam in texture. Rock outcrop and bare soil are common. Parent materials include sandstone and shale.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland occurs on canyon rims, benches, mesas, plateaus, drainage channels, canyon sides, and valley bottoms. Stands are on flat to gentle slopes (0-12°), include all aspects, and lies between 1381 and 2206 m elevation. Bare soil or sand, bedrock, small rocks, and biological soil crusts cover most of the unvegetated surface, with lesser cover by litter, large rocks, and downed wood. Soils are well-drained to rapidly drained sandy loams, sandy clay loams, loamy sands, sands, loams, silts, or clays derived from alluvium or from a variety of geologic types including Navajo or Cedar Mesa sandstones, Shinarump conglomerate, Kayenta, Chinle, Moenkopi, or Straight Cliffs formations.

Global Environment: This woodland occurs on dry canyon rims, ridges, plateaus, canyon sides, hills, benches, mesas and occasionally in intermittent drainages. Elevations range from 1400 to 2210 m (4600-7250 feet). Stands typically occur on gentle to moderately steep slopes on all aspects, but range from flat to steep slopes (0-30%). Soils are generally shallow and rocky, ranging in texture from sand in most stands to clay loam or sandy clay. Exposed sandstone or limestone bedrock and bare soil have high cover, and woody plants are generally rooted in cracks and joints in bedrock. A minority of stands may also occur on shale slopes covered by sandstone colluvium. Parent materials are variable and include sandstones and shale of the Moab Tongue of the Curtis Formation, Kayenta Formation, Navajo sandstone, Moenkopi Formation, Morrison Formation, Shinarump conglomerate, Cedar Mesa sandstone and eolian silt deposits.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This pinyon-juniper woodland type is relatively common within the recreation area. Total vegetation cover ranges from 5 to 39%. Stands are characterized by an open canopy, typically 2 to 5 m tall, of *Pinus edulis* (with trace to 21% cover) and *Juniperus osteosperma* (with 1-30% cover). The mixed shrub understory may be relatively sparse but is dominated by *Purshia stansburiana* with between trace and 5% cover. Associated shrubs may include *Fraxinus anomala, Amelanchier utahensis, Ephedra viridis, Symphoricarpos longiflorus, Artemisia nova, Rhus trilobata var. trilobata (= Rhus aromatica ssp. trilobata), Shepherdia rotundifolia, Brickellia microphylla, Ericameria nauseosa, Fraxinus anomala, Gutierrezia sarothrae, Gutierrezia microcephala, Yucca angustissima, Artemisia tridentata,* and *Mahonia fremontii*. The

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Subset: GLCA; Glen Canyon National Recreation Area

herbaceous layer is generally sparse but may include a diversity of species, including *Achnatherum hymenoides, Pleuraphis jamesii, Poa fendleriana*, and a variety of forbs with trace cover, including *Amsonia tomentosa, Artemisia ludoviciana, Tetraneuris acaulis (= Hymenoxys acaulis)* and *Cordylanthus wrightii*. Biological soils crusts or dark cyanobacteria may have high cover in some stands, acting to stabilize the soil pockets within the sandstone mosaic.

Global Vegetation: This woodland association is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. *Purshia stansburiana* dominates or codominates the sparse to moderately dense short-shrub layer, often with *Artemisia tridentata* in the northern part of its range. Other shrubs may be present, including *Amelanchier utahensis, Arctostaphylos patula, Artemisia bigelovii, Artemisia nova, Artemisia tridentata, Brickellia microphylla, Chamaebatiaria millefolium, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Fraxinus anomala, Gutierrezia microcephala, Gutierrezia sarothrae, Mahonia fremontii, Quercus gambelii* (<5% cover), *Rhus trilobata, Shepherdia rotundifolia, Symphoricarpos longiflorus, Yucca angustissima,* or other species of *Yucca* and *Opuntia* spp. *Cercocarpus montanus* and *Purshia tridentata* are generally absent or with scarce cover. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Aristida purpurea, Bouteloua curtipendula, Bouteloua gracilis, Bouteloua hirsuta, Elymus elymoides, Hesperostipa comata, Hesperostipa neomexicana, Koeleria macrantha, Poa fendleriana, Pleuraphis jamesii*, and *Schizachyrium scoparium*. Forbs may include *Artemisia ludoviciana, Artemisia frigida, Calliandra humilis, Cordylanthus wrightii, Descurainia pinnata, Eriogonum ovalifolium, Lappula occidentalis, Oenothera pallida, Penstemon linarioides*, and *Tetraneuris acaulis (= Hymenoxys acaulis)*. Total vegetation cover can vary from 12% to more than 65%, with tree canopy sometimes falling below 10% cover in very open stands. Biological soils crusts or dark cyanobacteria may have high cover in some stands, acting to stabilize the soil pockets within the sandstone mosaic.

Global Dynamics: Stuever and Hayden (1997) described two phases of this plant community, an *Artemisia tridentata* phase and a *Purshia stansburiana* phase. Both are restricted geographically, with the *Artemisia tridentata* phase common in northern Arizona, southern Utah, northern New Mexico, and southwestern Colorado, where winter precipitation is higher than summer. The *Purshia stansburiana* phase, which lacks *Artemisia tridentata*, occurs in central Arizona, where summer monsoon precipitation is higher than winter (Stuever and Hayden 1997). Fires in this association are thought to be infrequent because *Pinus edulis, Juniperus osteosperma,* and *Juniperus monosperma* are killed or severely damaged by burns and do not resprout (Wright et al. 1979). *Purshia stansburiana* is also generally killed by fire; however, it is known to resprout after cool burns (Wright et al. 1979, Britton and Wright 1983). This association is little affected by regional drought due to the fact that the woody vegetation roots in bedrock cracks where moisture collects.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*, *Fraxinus anomala*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Purshia stansburiana*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia nova*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia microcephala*, *Gutierrezia sarothrae*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous tree	*Amelanchier utahensis*
Tall shrub/sapling	Broad-leaved evergreen tree	*Purshia stansburiana*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Achnatherum hymenoides*, *Artemisia tridentata* ssp. *wyomingensis*, *Ephedra viridis*, *Juniperus osteosperma*, *Pinus edulis*, *Purshia stansburiana*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)

Global: Vulnerable Plants: *Glossopetalon spinescens* var. *meionandrum* (G5T3), *Shepherdia rotundifolia* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low)

Conservation Status Rank

Global Rank & Reasons: G4? (1-Feb-1996).

Related Concepts

Global Similar Types:

- *Pinus edulis - Juniperus osteosperma / Artemisia bigelovii* Woodland (CEGL002118) occurs in somewhat similar rimrock environments and occasionally supports *Purshia stansburiana* in the tall-shrub stratum, but *Artemisia bigelovii* is the dominant shrub species.
- *Pinus edulis - Juniperus osteosperma / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana)* Woodland (CEGL005658)
- *Pinus monophylla - Juniperus osteosperma / Purshia stansburiana* Woodland (CEGL005397)
- *Purshia stansburiana* Shrubland (CEGL002957)

Global Related Concepts:

- *Juniperus osteosperma - Pinus edulis / Cowania mexicana* Plant Association (Baker 1984a) =
- *Pinus edulis / Cowania mexicana* Plant Association (Larson and Moir 1987) =

- *Pinus edulis / Purshia stansburiana* Plant Association (Stuever and Hayden 1997a) =
- *Pinus edulis/Cowania mexicana* (Bourgeron and Engelking 1994) =
- Coronado Province Pinyon - Juniper Woodlands (Isaacson 1967) >
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >
- Juniper-Pinyon Stand-Type (Northcutt 1978) >
- La Sal Province Pinyon - Juniper Woodlands (Isaacson 1967) >

Classification

Status: Standard
Classification Confidence: 1 - Strong
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. The global name of this association was changed on 2001-09-04 because of a taxonomic change of the nominal species. *Purshia mexicana var. stansburiana* (Torr.) Welsh is now recognized as *Purshia stansburiana* (Torr.) Henrickson (Kartesz 1999). *Purshia mexicana* (D. Don) Henrickson, a closely related species, occurs in Chihuahua, Durango and Zacatecas, Mexico, and possibly extreme southern Arizona, and is not known to be present in this association (Cronquist et al. 1997).

This association appears to be part of a continuum of Colorado Plateau woodland communities growing on fractured sandstone. Stands where *Purshia stansburiana* is the dominant understory shrub are less common than those in which it is a component of a mixed shrub understory that includes *Cercocarpus montanus, Amelanchier utahensis*, and *Cercocarpus intricatus* in mesic stands, or *Coleogyne ramosissima* and *Yucca* spp. in xeric stands. An analysis of the woodland data from four parks (Colorado, Arches, Natural Bridges, Canyonlands) confirmed that *Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland (CEGL000782) is a valid association but not always easy to distinguish from more mixed-shrub woodlands in the field.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is widespread within the recreation area and was sampled near the Hans Flat Ranger Station, in Flint Cove, on North Point, on Panorama Point, near Cleopatra's Chair, in Horse Canyon, in Range Canyon, south of Land's End, near East End Spring, on Andy Miller Flats, in Moody Canyon, Middle Moody Canyon, and in the Purple Hills.

Global Range: This woodland association occurs in the Colorado Plateau region of central Arizona, western New Mexico, southwestern Colorado, and southern Utah.

Nations: US
States/Provinces: AZ:S3, CO:S3?, NM:S4?, UT:S3?
TNC Ecoregions: 18:C, 19:C, 21:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313D:CC, 341B:CC, M313A:CC, M313B:CC, M341C:CC
Federal Lands: NPS (Arches, Bryce Canyon, Canyon de Chelly, Canyonlands, Capitol Reef, Glen Canyon, Grand Canyon, Hovenweep, Natural Bridges, Walnut Canyon, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Area is largely composed of slickrock. Pockets of soil found interspersed on slickrock are stabilized by litter from trees and by thick crust, some pockets have a thinner layer of soil with many small rocks (sandstone clasts). Vegetation is concentrated within soil pockets in the slickrock.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2012 field data (19 plots): (Plots: GLCA.0334, GLCA.0500, GLCA.0514, GLCA.0521, GLCA.0522, GLCA.0524, GLCA.0704, GLCA.0713, GLCA.0716, GLCA.0745, GLCA.4063, GLCA.4067, GLCA.4216, GLCA.5050, GLCA.5052, GLCA.5062, GLCA.5070 GLCA.5323, GLCA.5326).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Coles and G. Kittel
References: BIA 1979, Baker 1980a, Baker 1984a, Bourgeron and Engelking 1994, Britton and Wright 1983, CNHP 2003, CNHP 2015, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008c, Coles et al. 2009a, Cronquist et al. 1997, Driscoll et al. 1984, Hansen et al. 2004a, Isaacson 1967, Kartesz 1999, Larson and Moir 1987, Moir and Carleton 1987, Northcutt 1978, Reid and Hall 2010, Romme et al. 1993, Stuever and Hayden 1997a, Tendick et al. 2011b, Thomas et al. 2010, USFS 1982, USFS 1985c, Von Loh et al. 2008, Western Ecology Working Group n.d.*

[CEGL002497] Pinus edulis - Juniperus osteosperma / Quercus havardii var. tuckeri Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Tucker Sand Shinnery Oak Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis* - *Juniperus osteosperma* / Shrub Understory Colorado Plateau Woodland & Scrub Alliance (A3573)

Element Concept

Global Summary: This woodland appears to be restricted to southeastern Utah. The open tree canopy of *Pinus edulis* and *Juniperus osteosperma* is typically 2-5 m tall and ranges in cover from 10 to 50%. The understory is dominated by clumps of *Quercus havardii var. tuckeri* that range in cover from 5 to 65%. Associated shrubs vary depending on the aspect and the amount of soil moisture available. The herbaceous layer is more consistent in species composition yet provides only sparse cover. Common graminoids include *Achnatherum hymenoides, Bouteloua gracilis, Muhlenbergia pungens,* and *Pleuraphis jamesii*. Forbs often present include species typical of sandy sites such as *Cryptantha flava, Tetraneuris acaulis (= Hymenoxys acaulis), Lepidium montanum,* and *Streptanthella longirostris.* Total vegetation cover ranges from 21% to more than 100%. Sites occur between 1445 and 1905 m (4740-6250 feet) in elevation. It appears to be limited to sites with deep accumulations of eolian and alluvial sands on canyon and valley floors, in intermittent washes, and on dunes and sandsheets on

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Subset: GLCA; Glen Canyon National Recreation Area

plateaus and benches, on any aspect. Bare soil and sand cover most of the unvegetated surface, and biological soil crusts can provide up to 30% cover. Geologic substrates include various sandstones, which for the most part have eroded and been redeposited as eolian sands. Soils are rapidly drained, deep loamy sands, sandy loams, and sands.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association occurs on sand dunes, badlands, mesatops, plateaus, and drainage channels. Sites are on flat to gentle slopes (up to 6°) between 1550 and 1902 m elevation. Sand and bare soil cover most of the unvegetated surface, with lesser cover by small rocks and litter. Soils are moderately well-drained to rapidly drained sands, loamy sands, or loams derived from eolian deposits, Carmel Formation, and Cedar Mesa, Navajo, or Entrada sandstones.

Global Environment: This woodland association is limited to sites with deep, loose sands. It occurs on canyon and valley floors, in intermittent washes, on dunes, sandsheets, badlands, mesatops, plateaus and benches. It is located on level to gently sloping (0-11%) sites between 1445 and 1905 m (4740-6250 feet) elevation. Aspect apparently does not influence the distribution of this association. Bare soil and sand cover most of the unvegetated surface, although there is sometimes low cover of bedrock or gravel, and biological soil crusts can provide up to 30% cover. Soils are deep and loose, rapidly drained, loamy sands, sandy loams, and sands. Geologic substrates include Carmel Formation, Cedar Mesa, Navajo, Moab Tongue, Cedar Mesa or Entrada sandstones, which for the most part have eroded and been redeposited as eolian sands as well as shale of the Tidwell Member.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This pinyon-juniper woodland association is somewhat uncommon within the recreation area. It is restricted to areas with deep, sandy soils. Total vegetation cover ranges from 9 to 28%. Stands are characterized by an open tree canopy, typically 2 to 5 m tall, of *Pinus edulis* (with 1-8% cover) and *Juniperus osteosperma* (with 1-7% cover). *Quercus havardii var. tuckeri* clones occupy sand mounds between tree canopies and provide between 2 and 13% cover. Associated shrubs include *Amelanchier utahensis, Atriplex canescens, Coleogyne ramosissima, Ephedra viridis, Ephedra cutleri, Eriogonum leptocladon, Gutierrezia microcephala,* and succulent *Opuntia* spp. Herbaceous species are diverse and their cover is variable, ranging from sparse to moderate total cover; *Achnatherum hymenoides* (with up to 9% cover), *Hesperostipa comata, Muhlenbergia pungens, Achnatherum speciosum (= Stipa speciosa)* (with up to 7% cover), *Cryptantha flava, Hymenopappus filifolius, Stenotus armerioides (= Haplopappus armerioides),* and *Cordylanthus wrightii* were reported from sampled stands.

Global Vegetation: Total vegetation cover ranges from 21% to more than 100%. The open tree canopy of *Pinus edulis* and *Juniperus osteosperma* is typically 2-5 m tall and ranges in cover from 10 to 50%. *Fraxinus anomala* may occasionally occur as a canopy tree with sparse cover. The understory is dominated by large clumps of *Quercus havardii var. tuckeri* that range in cover from 2 to 65% in sand mounds between tree canopies. Associated shrubs vary depending on the aspect and the amount of soil moisture available; cooler, more mesic stands include *Amelanchier utahensis, Cercocarpus intricatus, Cercocarpus montanus, Mahonia fremontii,* and *Shepherdia rotundifolia*. In more exposed,

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drier stands these shrubs are mostly replaced by *Atriplex canescens, Coleogyne ramosissima, Artemisia bigelovii, Ephedra cutleri, Ephedra viridis, Eriogonum microthecum, Gutierrezia microcephala, Gutierrezia sarothrae, Opuntia polyacantha,* and *Yucca harrimaniae*. The herbaceous layer is more consistent in species composition yet provides only sparse cover. Common graminoids include *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Bouteloua gracilis, Hesperostipa comata, Muhlenbergia pungens,* and *Pleuraphis jamesii*. Forbs often present include species typical of sandy sites such as *Cordylanthus wrightii, Cryptantha crassisepala, Cryptantha flava, Hymenopappus filifolius, Lappula occidentalis, Lepidium montanum, Streptanthella longirostris, Stenotus armerioides (= Haplopappus armerioides),* and *Tetraneuris acaulis (= Hymenoxys acaulis).*

Global Dynamics: Deep eolian sand deposits are necessary to support this community. Fire could eliminate the pinyon and juniper trees in favor of *Quercus havardii var. tuckeri.*

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Quercus havardii* var. *tuckeri*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia microcephala*
Herb (field)	Flowering forb	*Stenotus armerioides*
Herb (field)	Graminoid	*Achnatherum hymenoides*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Fraxinus anomala*
Short shrub/sapling	Broad-leaved deciduous shrub	*Quercus havardii* var. *tuckeri*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Achnatherum hymenoides, Amelanchier utahensis, Juniperus osteosperma, Muhlenbergia pungens, Opuntia polyacantha, Pinus edulis, Pleuraphis jamesii, Quercus havardii* var. *tuckeri, Shepherdia rotundifolia, Streptanthella longirostris*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Quercus havardii* var. *tuckeri* (G4T3?Q)

Global: Vulnerable Plants: *Quercus havardii* var. *tuckeri* (G4T3?Q), *Shepherdia rotundifolia* (G3G4), *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: G3? (10-Jan-2006). Because *Quercus havardii var. tuckeri* is restricted to southeastern Utah, this association is likely to have equally limited distribution in the Colorado Plateau. It may occur in some parts of southern Colorado. Between Arches, Canyonlands, Glen Canyon, and Capitol Reef, the four national parks in which this association has been documented, there are less than a dozen small occurrences. Total number of occurrences on the Colorado Plateau is unlikely to exceed 100, and most occurrences will not exceed 5 hectares in size.

Related Concepts

Global Similar Types:

- *Quercus havardii var. tuckeri* Shrubland (CEGL002486)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland association is somewhat uncommon within the recreation area and was sampled on High Spur, east of The Spur, Muley Point, Clyde's Mesa, near Egypt, and on Sugarloaf Butte.

Global Range: This association is apparently restricted to southeastern Utah. It may also occur in some parts of southern Colorado.

Nations: US
States/Provinces: CO?, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This area is a series of stabilized humps of sand interspersed with blowouts. The ephedra and oak colonies seem especially good at maintaining their sand mounds. The blowouts contain small perennial forbs and many annuals. The trees are old and large, and the skeletons of their ancestors decorate the landscape.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, and 2014 field data (6 plots, 3 accuracy assessment points): (Plots: GLCA.0108, GLCA.0312, GLCA.4044, GLCA.4046, GLCA.4052, GLCA.9305; AA Points: GLCA_AA.0621, GLCA_AA.1228, GLCA_AA.2022).

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Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEGL004007] Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Sonoran Scrub Oak Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis - Juniperus osteosperma* / Shrub Understory Colorado Plateau Woodland & Scrub Alliance (A3573)

Element Concept

Global Summary: This woodland association is known from Canyon de Chelly and Pipe Springs national monuments in northern Arizona in the southern Colorado Plateau. It occurs on canyon slopes, rims and mesatops from 1536 to 2104 m (5040-6900 feet) elevation. Stands occur on gentle to steep slopes (2-35%) on warmer southern and western aspects. The substrates are generally shallow, rocky sandy loam to silt loam soils. The surface typically has moderate to high cover of boulders or rock outcrops. Cover by lichens is moderate to high in some stands. The vegetation is characterized by an open to moderately dense tree canopy (10-50% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. Very open stands may have tree cover between 5-10% cover. *Quercus turbinella* dominates or codominates the open to moderately dense shrub layer. Other shrubs may be present, including *Artemisia bigelovii, Chrysothamnus greenei, Ephedra viridis, Fendlera rupicola, Opuntia phaeacantha, Opuntia polyacantha var. polyacantha*, and *Opuntia whipplei*. Herbaceous cover is variable, ranging from sparse to moderately dense, but is often dominated the perennial graminoid *Bouteloua gracilis* with scattered perennial forbs. Exotic annual grass *Bromus tectorum* is present in some stands.

Environmental Description

Global Environment: This woodland association is known from Canyon de Chelly and Pipe Springs national monuments in the southern Colorado Plateau of northern Arizona. It occurs on canyon slopes, rims, and mesatops from 1536 to 2104 m (5040-6900 feet) elevation. Stands occur on gentle to steep slopes (2-35%) on warmer southern and western aspects. The substrates are generally shallow, rocky sandy loam to silt loam soils. The surface typically has moderate to high cover of boulders or rock outcrops. Cover by lichens is moderate to high in some stands.

Vegetation Description

Global Vegetation: This woodland is characterized by an open to moderately dense tree canopy (10-50% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. Very open stands may have

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tree cover between 5 and 10%. *Quercus turbinella* dominates or codominates the open to moderately dense shrub layer. Other shrubs may be present, including *Amelanchier utahensis, Artemisia bigelovii, Chrysothamnus greenei, Ephedra viridis, Fendlera rupicola, Opuntia phaeacantha, Opuntia polyacantha var. polyacantha, Opuntia whipplei,* and *Purshia stansburiana*. Additional shrubs contribute low cover and include *Ericameria nauseosa, Gutierrezia sarothrae, Opuntia erinacea, Rhus trilobata var. trilobata (= Rhus aromatica var. trilobata), Shepherdia rotundifolia, Sclerocactus whipplei,* and *Yucca angustissima var. kanabensis (= Yucca kanabensis)*. Herbaceous cover is variable, ranging from sparse to moderate, but is often dominated the perennial graminoid *Bouteloua gracilis* with scattered perennial forbs. Other common species include grasses *Achnatherum hymenoides, Aristida purpurea, Bouteloua barbata, Bouteloua curtipendula, Hesperostipa comata, Pleuraphis jamesii, Poa fendleriana*, and forbs such as *Brickellia microphylla var. scabra, Gutierrezia microcephala, Heterotheca villosa, Lesquerella fendleri*, and *Stephanomeria minor var. minor*. Exotic annual grass *Bromus tectorum* is present in some stands.

Most Abundant Species

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Quercus turbinella*

Characteristic Species

Global: Juniperus osteosperma, Pinus edulis, Quercus turbinella

Other Noteworthy Species

Global: Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (19-Jul-2006).

Related Concepts

Global Similar Types:

- *Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus* Woodland (CEGL000779)
- *Pinus monophylla - Juniperus osteosperma / Quercus turbinella* Woodland (CEGL002941)

Global Related Concepts:

- *Pinus edulis-Juniperus osteosperma / Quercus turbinella* (Evens et al. 2014) =

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

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Element Distribution

Global Range: This woodland is known from Canyon de Chelly and Pipe Springs national monuments in the southern Colorado Plateau of northern Arizona.

Nations: US
States/Provinces: AZ, CA, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC
Federal Lands: NPS (Canyon de Chelly, Glen Canyon, Grand Canyon, Grand Canyon-Parashant, Mojave, Pipe Spring)

Element Sources

Global Description Author(s): K.A. Schulz and G. Kittel
References: Coles et al. 2008b, Evens et al. 2014, Reid and Hall 2010, Thomas et al. 2010, Western Ecology Working Group n.d.*

[CEGL002335] Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Roundleaf Buffaloberry Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis - Juniperus osteosperma* / Shrub Understory Colorado Plateau Woodland & Scrub Alliance (A3573)

Element Concept

Global Summary: This woodland association occurs in two distinct situations: At Natural Bridges National Monument and Capitol Reef National Park, stands of this type occupy rolling uplands on eolian, alluvial or residual red sandy silt soils, often in a mosaic with *Pinus edulis - Juniperus osteosperma / Artemisia tridentata* (ssp. *wyomingensis*, ssp. *vaseyana*) Woodland (CEGL005658) and *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland (CEGL002148). In addition, at Capitol Reef and Canyonlands national parks, stands occur on warm, dry, moderately steep lower slopes where sandstone colluvium overlies slopes of Chinle or Organ Rock shales. Elevations range from 1445 to 2273 m (4740-7460 feet). Soils vary depending on substrate, including sandy loams, sandy clays, and silt loams. This woodland association is locally common in the Colorado Plateau of southern Utah. Total vegetation cover ranges between 15 and 80%. *Juniperus osteosperma* and *Pinus edulis* form a canopy 2-5 m tall and with 10-60% cover. The understory is characterized by a shrub layer dominated by *Shepherdia rotundifolia*. Other shrubs present may include *Artemisia tridentata ssp. wyomingensis, Mahonia fremontii, Artemisia nova*, and *Gutierrezia sarothrae*. Herbaceous species generally have low total cover and vary from site to site. Cryptobiotic soils may have significant cover in sites derived from loess.

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Environmental Description

Glen Canyon National Recreation Area Environment: This woodland occurs on shallow soils of canyon bottoms, canyon sides, rims, toeslopes, benches, mesas, and talus/colluvial slopes. Sites are on gentle to steep slopes (up to 40°), oriented to all aspects, and lie between 1445 and 2108 m elevation. Bare soil and large and small rocks cover most of the unvegetated surface, with sometimes moderate cover by bedrock, and low cover by litter, dead wood and biological soil crusts. Soils are variable and include varieties of loams and sands derived from a range of shale, conglomerate and sandstone parent materials.

Global Environment: This association occurs in two distinct situations: (1) At Natural Bridges National Monument and Capitol Reef National Park, stands of this type occupy rolling uplands on eolian, alluvial or residual red sandy silt soils, often in a mosaic with *Pinus edulis - Juniperus* spp. / *Artemisia tridentata* (ssp. *wyomingensis*, ssp. *vaseyana*) Woodland (CEGL000776) and *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland (CEGL002148). (2) In addition, at Capitol Reef and Canyonlands national parks, stands occur on warm, dry, moderately steep lower slopes where sandstone colluvium overlies slopes of Chinle or Organ Rock shales. Elevations range from 1445 to 2273 m (4740-7460 feet). Because this is a relatively xeric woodland, bare soil and rocks may cover up to 70% of the unvegetated surface. Soils vary depending on substrate, including sandy loams, sandy clays, and silt loams.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This pinyon-juniper woodland is common within the Orange Cliffs section of the recreation area. Total vegetation cover ranges from 6 to 27%. Stands are characterized by an open canopy, typically 2 to 5 m tall, of *Pinus edulis* and *Juniperus osteosperma* with between 1 and 15% individual cover. *Shepherdia rotundifolia* dominates the understory with between 1 and 8% cover. *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. Associated shrubs include scattered individuals of *Fraxinus anomala, Ephedra viridis, Ephedra torreyana, Ericameria nauseosa, Chrysothamnus viscidiflorus, Mahonia fremontii*, and *Gutierrezia sarothrae*. Herbaceous species are diverse and provide sparse to low cover. Graminoids include *Leymus salinus, Pleuraphis jamesii*, and *Achnatherum hymenoides*. Forbs include *Machaeranthera grindelioides, Chamaesyce fendleri, Cryptantha flava*, and *Stanleya pinnata*.

Global Vegetation: This woodland association is locally common in the Colorado Plateau of southern Utah. Total vegetation cover ranges between 15 and 80%. *Juniperus osteosperma* and *Pinus edulis* form a canopy 2-5 m tall and with 10-60% cover. The understory is characterized by a shrub layer dominated by *Shepherdia rotundifolia*. Other shrubs present may include *Artemisia tridentata ssp. wyomingensis, Mahonia fremontii, Artemisia nova*, and *Gutierrezia sarothrae*. Herbaceous species generally have low total cover and vary from site to site. Cryptobiotic soils may have significant cover in sites derived from loess.

Global Dynamics: This association occupies ecological sites that, outside of the range of *Shepherdia rotundifolia*, are occupied by pinyon-juniper / serviceberry and pinyon-juniper / Wyoming sagebrush woodland types. The shrubs occupy microsites with elevated soil moisture, either because of gullying of the soil or because of colluvial sandstone blocks concentrating precipitation.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Chrysothamnus viscidiflorus*, *Ericameria nauseosa*, *Shepherdia rotundifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Leymus salinus*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Shepherdia rotundifolia*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Juniperus osteosperma, Pinus edulis, Shepherdia rotundifolia*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High)

Global: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4)

Conservation Status Rank

Global Rank & Reasons: GNR (12-Jan-2005).

Related Concepts

Global Similar Types:

- *Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis)* Wooded Shrubland (CEGL002334)

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is common within the recreation area, especially within the Orange Cliffs section, and was sampled in Millard and Water canyons, above Horseshoe Canyon, adjacent to the Flint Trail, in Flint Cove, near Teapot Rock, at the head of Happy Canyon, south of Land's End, near Sunset Pass, Elaterite Basin, and on Fourmile Bench.

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Global Range: This association has been documented from southern Utah. It may also occur in northern New Mexico within the range of *Shepherdia rotundifolia*.

Nations: US
States/Provinces: AZ, NM?, UT
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M341C:CC
Federal Lands: NPS (Bryce Canyon, Canyonlands, Capitol Reef, Glen Canyon, Natural Bridges, Navajo)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This plot characterizes a large area of colluvium that appears to be primarily Wingate in origin. Soils are sandy, with lots of rock mixed in, and there are many large boulders distributed across the slopes. Coupled with the north exposure, this must be a moister environment, with much better rain absorption than the neighboring Chinle soils.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2012 field data (17 plots): (Plots: GLCA.0102, GLCA.0104, GLCA.0111, GLCA.0506, GLCA.0515, GLCA.0516, GLCA.0519, GLCA.0523, GLCA.0553, GLCA.0585, GLCA.0586, GLCA.0588, GLCA.0589, GLCA.0752, GLCA.0754, GLCA.0756, GLCA.4072).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles
References: Clark et al. 2009, Coles et al. 2008c, Romme et al. 1993, Salas et al. 2010a, Tendick et al. 2011b, Western Ecology Working Group n.d.*

[CEPP009635] Pinus edulis - Juniperus osteosperma / Symphoricarpos longiflorus Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Desert Snowberry Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis* - *Juniperus osteosperma* / Shrub Understory Colorado Plateau Woodland & Scrub Alliance (A3573)

Element Concept

Global Summary: This rare pinyon-juniper woodland has been sampled in Glen Canyon National Recreation Area in the Colorado Plateau. It is characterized by a moderately dense tree canopy, with total cover between 31 and 34%. *Juniperus osteosperma* cover ranges from 7 to 8% and *Pinus edulis* cover from 9 to 13%. The mixed shrub understory is only slightly dominated by *Symphoricarpos longiflorus*, with 4% cover. Other shrubs present include *Amelanchier utahensis, Cercocarpus*

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intricatus, Mahonia fremontii, Ephedra viridis, Shepherdia rotundifolia, Coleogyne ramosissima, Gutierrezia sarothrae, and *Opuntia* spp. Common herbaceous species include *Comandra umbellata, Tetraneuris acaulis (= Hymenoxys acaulis)*, and *Lepidium montanum*. Stands occur on gently sloping canyon rims or canyon bottoms between 1631 and 1640 m elevation. Bare soil, litter, and biological soil crusts cover most of the unvegetated surface, with sparse cover of bedrock, sand, and wood. Soils are rapidly drained loamy sands derived from Cedar Mesa sandstone.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association occurs on gently sloping canyon rims or canyon bottoms between 1631 and 1640 m elevation. Bare soil, litter, and biological soil crusts cover most of the unvegetated surface, with sparse cover of bedrock, sand, and wood. Soils are rapidly drained loamy sands derived from Cedar Mesa sandstone.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This rare pinyon-juniper woodland is characterized by a moderately dense tree canopy, with total cover between 31 and 34%. *Juniperus osteosperma* cover ranges from 7 to 8% and *Pinus edulis* cover from 9 to 13%. The mixed shrub understory is only slightly dominated by *Symphoricarpos longiflorus*, with 4% cover. Other shrubs present include *Amelanchier utahensis, Cercocarpus intricatus, Mahonia fremontii, Ephedra viridis, Shepherdia rotundifolia, Coleogyne ramosissima, Gutierrezia sarothrae*, and *Opuntia* spp. Herbaceous species present include *Comandra umbellata, Tetraneuris acaulis (= Hymenoxys acaulis)*, and *Lepidium montanum*.

Most Abundant Species

Characteristic Species

Glen Canyon National Recreation Area:
Global:

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (22-Mar-2011).

Related Concepts

Classification

Status: Provisional
Classification Confidence:
Global Classification Comments: This community is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is very rare within the recreation area and was only sampled near Teapot Rock and on Dry Mesa.

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Global Range: This rare pinyon-juniper woodland has been sampled in Glen Canyon National Recreation Area in the Colorado Plateau in southern Utah.

Nations: US
States/Provinces: UT
TNC Ecoregions:
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2014 field data (1 plot, 1 accuracy assessment point): (Plots: GLCA.0765; AA Points: GLCA_AA.0495).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEGL002328] *Pinus edulis - Juniperus osteosperma* / Mixed Shrubs Talus Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Mixed Shrubs Talus Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis - Juniperus osteosperma* / Shrub Understory Colorado Plateau Woodland & Scrub Alliance (A3573)

Element Concept

Global Summary: This Colorado Plateau open woodland association is found in western Colorado and eastern Utah. The sparse to open tree canopy is 2-10 m tall. *Pinus edulis* and *Juniperus osteosperma* are the dominant canopy trees. The composition of the shrub stratum can be diverse with low to sparse canopy coverage. Common species are *Amelanchier utahensis, Artemisia bigelovii, Artemisia tridentata ssp. vaseyana, Cercocarpus montanus, Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Ephedra viridis, Eriogonum corymbosum, Fendlera rupicola, Gutierrezia sarothrae, Opuntia* spp., and *Rhus trilobata*. The herbaceous layer also provides sparse to low cover. Cryptogams are rare or absent on these active slopes. This woodland association can have sparse to moderate total vegetation cover (4-61%) but is most often relatively sparse (<15% cover). Sites occur between 1330 and 2290 m (4365-7500 feet) in elevation, on gentle to steep slopes on any aspect and generally occur on lower slopes where rocks accumulate. The unvegetated ground surface is mostly bedrock and large and small rocks. Soils are rapidly drained. The parent material is talus rockfall.

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Environmental Description

Glen Canyon National Recreation Area Environment: This mixed community type occurs on colluvial slopes and talus-covered ledges, canyon sides, and hills. Sites are moderate to steep (9-35° slopes), on all aspects, and lie between 1581 and 1939 m elevation. Boulders, small rocks, bedrock and bare ground cover most of the unvegetated surface. Litter and biological soil crusts have sparse cover. Soils are rapidly drained sandy clays, clay loams, sandy loams, loams, and loamy sands; parent materials include Chinle, Kayenta, Moenkopi formations and Organ Rock shale.

Global Environment: This association is found on midslopes of ridges on dry colluvial slopes and in ravines and canyons on talus and rockfalls in the Colorado Plateau. Sites are found between 1330 and 2290 m elevation. Slopes can be gentle to steep (up to 78%) and of any aspect. The unvegetated ground surface is mostly bedrock and large and small rocks. Bare soil and litter are also found. Soils are variable and are generally rapidly drained clay loam, loam, sandy loam, loamy sand and, less commonly, silty clay soils. The parent material is talus rockfall and older landslide deposits from the Tidwell Member of the Morrison Formation, Chinle Formation, Kayenta and Wingate sandstones, Moenkopi Formation, Organ Rock shale and Cutler Group (including Cedar Mesa sandstone).

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This open woodland grows on colluvial slopes and canyon walls throughout the recreation area. Total vegetation cover is low and ranges from 3 to 21%. The vegetation is characterized by an open canopy of *Pinus edulis* and *Juniperus osteosperma* with between 1 and 5% individual cover. The shrub layer often has as much or more cover than the tree canopy. Shrubs present vary greatly from site to site; the most common species are *Artemisia bigelovii, Rhus trilobata var. simplicifolia (= Rhus aromatica var. simplicifolia), Ephedra torreyana, Ephedra viridis, Gutierrezia* spp., *Ericameria nauseosa, Purshia stansburiana, Shepherdia rotundifolia,* and *Chrysothamnus viscidiflorus*. The herbaceous layer is typically sparse in cover. Common graminoids include *Leymus salinus, Aristida purpurea, Pleuraphis jamesii,* and *Achnatherum hymenoides.* Forbs vary among sites.

Global Vegetation: The tree canopy is 2-10 m tall with sparse to open canopy coverage. *Pinus edulis* and *Juniperus osteosperma* are the dominant canopy trees. Either species can have extremely low cover. *Juniperus osteosperma* has been observed with up to 45% cover, and *Pinus edulis* with up to 15% cover, but typically they have a combined coverage of 10-15%. *Fraxinus anomala* may be a tree canopy component in some stands. The composition of the shrub stratum is diverse and always mixed with sparse to low cover. Common species are *Amelanchier utahensis, Artemisia bigelovii, Artemisia tridentata ssp. vaseyana, Brickellia microphylla, Cercocarpus montanus, Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Ephedra viridis, Ephedra torreyana, Ericameria nauseosa, Eriogonum corymbosum, Fendlera rupicola, Gutierrezia sarothrae, Opuntia* spp., *Purshia stansburiana, Rhus trilobata,* and *Shepherdia rotundifolia*. The herbaceous layer also provides sparse to low cover, usually less than 5%. Common graminoid species are *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Elymus elymoides, Leymus salinus, Pleuraphis jamesii,* and *Poa fendleriana*. Common forbs are *Chamaesyce fendleri, Descurainia pinnata, Heterotheca villosa, Lepidium montanum,* and *Streptanthus cordatus*. Cryptogams are rare or absent on these active slopes.

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This woodland association can have very sparse to moderate total vegetation cover (4-61%) but is most often relatively sparse (<15%).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*, *Rhus trilobata*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii*, *Ephedra torreyana*, *Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii*, *Ephedra viridis*
Short shrub/sapling	Succulent shrub	*Opuntia fragilis*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Elymus elymoides*, *Poa fendleriana*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Artemisia bigelovii*, *Juniperus osteosperma*, *Pinus edulis*

Other Noteworthy Species

Global: Invasive/Exotic Plants: *Bromus tectorum* (High); Other Plants: *Cercocarpus montanus* (G5)

Conservation Status Rank

Global Rank & Reasons: GNR (11-Jan-2005).

Related Concepts

Global Similar Types:

- *Artemisia bigelovii - Ephedra (viridis, torreyana)* Talus Shrubland (CEGL003755)

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

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Element Distribution

Glen Canyon National Recreation Area Range: This sparsely vegetated association is common, especially within the Orange Cliffs section of the recreation area. It was sampled near the Golden Stairs, Red Cove, Burro Seep, in Cove, Clearwater, North Trail and Water canyons, near Teapot Rock, on Choprock Bench, and near North Point.

Global Range: This association is found on the Colorado Plateau in northern Arizona, southern and eastern Utah, and the western slope of the Southern Rocky Mountains in western Colorado.

Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331G:CC
Federal Lands: NPS (Arches, Black Canyon of the Gunnison, Canyonlands, Colorado, Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Steep, bouldery colluvial slopes with small microenvironments on the downslope sides of the large boulders.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, and 2013 field data (10 plots): (Plots: GLCA.0131, GLCA.0304, GLCA.0556, GLCA.0572, GLCA.0594, GLCA.0705, GLCA.0708, GLCA.0748, GLCA.4090, GLCA.5303).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Drake, K.A. Schulz and G. Kittel
References: Coles et al. 2009a, Coles et al. 2010, Reid and Hall 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.*

[CEGL002148] *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Sparse Understory Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)

Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis - Juniperus osteosperma* / Shrub Understory Colorado Plateau Woodland & Scrub Alliance (A3573)

Element Concept

Global Summary: This variable woodland association is widespread in parts of western Colorado and eastern Utah. This widespread association has total vegetation cover ranging from 10-75%. Sparsely vegetated stands (<10% total vegetation cover) composed of only trees are included in this woodland

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association in extremely dry, rocky portions of the Colorado Plateau. The tree canopy is dominated by *Pinus edulis* and *Juniperus osteosperma*. Both typically range from 1-35% cover with some stands having canopy cover by one species up to 50%. The tree canopy is short, usually 2-10 m tall, and open to moderately closed. Several shrub species are commonly found in this association, but they occur as widely scattered individuals, and do not form a shrub stratum. The lack of an understory may be due to high rock cover, low soil moisture, or a closed evergreen canopy of pinyon and juniper. Shrubs include *Amelanchier utahensis, Artemisia tridentata, Cercocarpus montanus, Ephedra viridis, Eriogonum microthecum, Shepherdia rotundifolia*, and/or *Opuntia* spp. The herbaceous layer is low in cover (<5%) and usually low in diversity. It is found most commonly on mid to upper slopes, though other topographic positions are possible. It occurs at elevations between 1354 and 2389 m and on all aspects. Sites range from flat to moderately steep. The ground has variable amounts of litter and often has moderate to high amounts of gravel, rocks, and exposed bedrock. Cryptogamic cover is usually low to moderate, but some sites have up to 55-65% cover. Soils are always rapidly drained to moderately well-drained. Parent materials are also highly variable and can be sandstones, shales, or limestones.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland occurs on sandstone soils on valley floors, plateaus, colluvial slopes, hills, canyon rims, canyon sides, mesas, plains, ridge, benches, and along drainage channels. Stands occupy flat to steep slopes (up to 26°), are oriented to any aspect, and occur between 1589 and 2210 m elevation. Depending on the site, most of the unvegetated surface consists of exposed bare soil, small rocks, or biological soils crusts. Litter, bedrock, sand, and large rocks may occur with low cover. Soils include well-drained to rapidly drained sandy loams, sandy clays, silt loams, sandy clay loams, loamy sands, loams, or sands derived from Navajo, Entrada, or Cedar Mesa sandstones, or from eolian, alluvial, or colluvial deposits.

Global Environment: This woodland association is found most commonly on mid to upper slopes, on valley floors, plateaus, colluvial slopes, hills, canyon rims, canyon sides, mesas, plains, and benches. It has been sampled at elevations between 1354 and 2389 m and on all aspects. Sites range from flat to moderately steep (0-25°). The ground has variable amounts of litter and often has moderate to high amounts of gravel, rocks, and exposed bedrock. Cryptogamic cover is usually low to moderate, but some sites have up to 55-65% cover. Soils vary in texture and can be loamy sand, silts, loams or silty clay but are always rapidly drained to moderately well-drained. Parent materials are also highly variable and can be sandstones, shales, limestones, among others.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: The understory of a pinyon-juniper stand may be sparse for any of a number of reasons, including (1) xeric shale or sand substrates with poor water-holding capacity, (2) a surface covered primarily by bedrock or gravel limiting germination sites, or (3) because the stand is old-growth with well-developed biological soils crusts dominating the understory and the dense mature canopy excludes most understory species. Total vegetation cover in Glen Canyon National Recreation Area stands is variable, ranging from 7 to 36%. The woodland canopy may be 2 to 10 m tall and consists of *Pinus edulis* (with trace to 27% cover) and *Juniperus osteosperma* (with 3-20% cover). Total understory cover does not exceed 4% and is usually much less.

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Common shrubs with trace to 1% cover include *Ephedra* spp., *Shepherdia rotundifolia, Purshia tridentata, Artemisia tridentata, Mahonia fremontii, Amelanchier utahensis, Ericameria nauseosa, Artemisia nova, Coleogyne ramosissima, Symphoricarpos longiflorus, Gutierrezia* spp., *Yucca angustissima*, and *Opuntia* spp. Herbaceous species are likewise diverse but sparse, including *Achnatherum hymenoides, Pleuraphis jamesii, Aristida purpurea, Leymus salinus, Cryptantha flava, Cordylanthus wrightii, Petradoria pumila*, and *Lepidium montanum*. The sparsest sites have only trace vascular understory cover, but often high cover of biological soil crusts.

Global Vegetation: This widespread pinyon-juniper woodland association occurs as relatively sparse to moderately vegetated stands with total vegetation cover ranging from 10-75%. Sparsely vegetated stands (<10% total vegetation cover) composed of only trees are included as a best fit in this woodland association in extremely dry, rocky portions of the Colorado Plateau. The tree canopy is dominated by *Pinus edulis* and *Juniperus osteosperma*. Both typically range from 1-35% cover with some stands having canopy cover by one species up to 50%. The tree canopy is short, usually 2-10 m tall, and open to moderately closed. *Fraxinus anomala* has been observed in the canopy of some stands at Colorado National Monument but always at no more than 5% cover. Several shrub species are commonly found in this association, but they occur as widely scattered individuals or an open shrub stratum. Scattered small *Pinus edulis* and *Juniperus osteosperma* are found along with shrubs such as *Amelanchier utahensis, Artemisia bigelovii, Artemisia nova, Artemisia tridentata, Cercocarpus montanus, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra viridis, Ericameria nauseosa, Eriogonum microthecum, Gutierrezia sarothrae, Mahonia fremontii, Opuntia fragilis, Opuntia polyacantha, Purshia tridentata, Shepherdia rotundifolia*, and *Symphoricarpos longiflorus*. The herbaceous layer is low in cover (<5%) and usually low in diversity. *Achnatherum hymenoides, Bouteloua gracilis, Bromus tectorum, Poa fendleriana,* and *Pleuraphis jamesii* are common graminoids. Forbs are not abundant, but typical species include *Descurainia pinnata, Cryptantha flava, Cordylanthus wrightii, Lepidium montanum, Petradoria pumila*, and *Tetraneuris acaulis*. The sparsest sites have only trace vascular understory cover, but often high cover of biological soil crusts.

Global Dynamics: The variability of this association is due to the range of circumstances in which it can occur. Some stands have a sparse understory because the substrate has poor water-holding capacity (e.g., shale-derived), or because the surface is nearly completely covered by rock or bedrock. Other stands may have low understory cover because the canopy is nearly closed and herbaceous and shrub species cannot exist in the conditions of low light and available moisture that characterize these stands.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*

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Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Achnatherum hymenoides*, *Ephedra viridis*, *Juniperus osteosperma*, *Opuntia fragilis*, *Pinus edulis*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Chenopodium album*

Global: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: G5 (15-Dec-2004).

Related Concepts

Global Similar Types:

- *Juniperus osteosperma* / Sparse Understory Woodland (CEGL000732)
- *Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis* Woodland (CEGL000778)
- *Pinus edulis - Juniperus* spp. / *Poa fendleriana* Woodland (CEGL000787)

Classification

Status: Standard
Classification Confidence: 1 - Strong
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Environmental and physiognomic variability within this association is high. There are few consistent understory species across all parks, but that is part of the concept of this type. The general sparseness of the understory is one of the main diagnostic features. Because of the wide range of circumstances that result in a sparse understory, a lot of variability in the floristic components of the understory is allowed. It is possible that this type will be split into several associations based on environmental factors, since floristic factors are not diagnostic. On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%, and they are considered a variation of the woodland type because of the ecological values of the trees.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is common and widely distributed within the recreation area. It is represented by plots sampled near Hans Flat Ranger Station, Land's End, north of Happy Canyon Campground, on Waterhole Flat, in Cove Canyon, in Flint Cove, near

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Subset: GLCA; Glen Canyon National Recreation Area

Flint Seep, east of Gordon Flats, near Bagpipe Butte, at North Point, Muley Point, Observation Rock, Corral Ridge, on Clyde's Mesa, Andy Miller Flats, and in the Purple Hills.

Global Range: This association is known from the Colorado Plateau and Southern Rocky Mountains in northern Arizona, southern Utah, and western Colorado.

Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 9:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, M331E:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Bryce Canyon, Canyon de Chelly, Canyonlands, Capitol Reef, Colorado, Curecanti, Dinosaur, Glen Canyon, Grand Canyon, Hovenweep, Hubbell Trading Post, Mesa Verde, Natural Bridges)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: The trees are very old, indicating a reasonably stable substrate/habitat for several hundred years. This area is a low slope of a mesa side where small sandstone flakes completely cover the soil surface and may inhibit plant establishment.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012 and 2013 field data (22 plots): (Plots: GLCA.0100, GLCA.0110, GLCA.0301, GLCA.0507, GLCA.0512, GLCA.0513, GLCA.0517, GLCA.0532, GLCA.0533, GLCA.0534, GLCA.0560, GLCA.0592, GLCA.0701, GLCA.0718, GLCA.4051, GLCA.5033, GLCA.5067, GLCA.5068, GLCA.5300, GLCA.5308, GLCA.6132, GLCA.9303).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Drake, J. Coles, K.A. Schulz and G. Kittel
References: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2010, Reid and Hall 2010, Romme et al. 1993, Salas and Bolen 2010b, Tendick et al. 2010, Tendick et al. 2011b, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.*

A3571 Pinus edulis - Juniperus osteosperma / Shrub Understory Foothill & Lower Montane Dry-Mesic Woodland Alliance

Alliance Summary Description: This woodland alliance is characterized by diagnostic tree species *Pinus edulis* that forms an open to dense tree layer often with *Juniperus osteosperma* or, less frequently, *Juniperus monosperma* within the range of *Juniperus osteosperma* in northern Arizona. *Juniperus osteosperma* may also dominate stands as long as there is significant presence of *Pinus edulis* (not accidental) to characterize the stand as a pinyon-juniper stand and not the more xeric, typically lower elevation *Juniperus osteosperma* woodland. At higher elevations and relatively mesic sites, such as along drainages, *Juniperus scopulorum* may be present and sometimes dominant. Other conifers are absent or accidental with very low cover. The understory is characterized by relatively mesic shrubs that typically form an open to moderately dense layer. Diagnostic shrubs include *Amelanchier utahensis, Arctostaphylos patula, Arctostaphylos pungens, Artemisia tridentata ssp.*

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tridentata, Artemisia tridentata ssp. vaseyana, Artemisia tridentata ssp. wyomingensis, Cercocarpus ledifolius, Quercus gambelii, and *Symphoricarpos oreophilus*. The herbaceous layer is sparse to moderate and composed of grasses often with diverse, but low cover of forbs. Common species may include *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Hesperostipa neomexicana, Poa fendleriana, Poa secunda, Pleuraphis jamesii*, and *Pseudoroegneria spicata*. The non-native, invasive annual grass *Bromus tectorum* may become abundant in disturbed stands and dominate the herbaceous layer of highly disturbed stands. These woodlands occur on warm, dry-mesic sites on mountain slopes and foothills and in the higher plateaus and mountains in the Colorado Plateau and the west slope of the southern Rocky Mountains. Stands occur on flat to moderate slopes along drainages, on mesatops, and on moderate to steep, sometimes rocky slopes of foothills, mountains and canyons, especially in draws where soil moisture is concentrated, or on northern aspects or where shaded by upper canyon walls. Aspects are variable and elevations range from 1500-2770 m (4920-9090 feet). The soils are variable but tend to be shallow, gravelly and rapidly drained, ranging from sandy loams to silt clay loams. Litter from shrubs may be extensive (over 50% cover). Parent materials include alluvial, colluvial or eolian deposits derived from sandstone, shale, limestone, granite quartzite and rhyolite.

[CEGL002329] Pinus edulis - Juniperus osteosperma / Amelanchier utahensis Woodland

Translated Name: Two-needle Pinyon - Utah Juniper / Utah Serviceberry Woodland

Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)

Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)

Group: Colorado Plateau Pinyon - Juniper Woodland (G250)

Alliance: *Pinus edulis - Juniperus osteosperma* / Shrub Understory Foothill & Lower Montane Dry-Mesic Woodland Alliance (A3571)

Element Concept

Global Summary: This association occurs on rocky slopes throughout the Colorado Plateau, the southern Rocky Mountains of western Colorado and northeastern Arizona. This is an open woodland association with *Juniperus osteosperma* and *Pinus edulis* in the tree canopy. There is a tall-shrub stratum dominated by *Amelanchier utahensis*. Other tall and dwarf-shrubs may be present with low cover. The herbaceous layer has sparse to low cover. Stands occur at 1406-2510 m in elevation, with southern-most and lower elevations on cooler aspects and more northerly and higher stands on warmer aspects. They occur on gentle to steep slopes, and the soils are very rocky, well-drained, and vary from clay to sandy loams derived from marine shale, sandstones or granite.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association was sampled on mesa sides, ridges, and on talus/colluvial slopes within the recreation area. Sites are on moderate to steep slopes (11-37°), oriented to the north, northwest, and east, and lie between 1626 and 2289 m

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elevation. Rocks (large and small) and bedrock cover most of the unvegetated surface, with lesser cover by bare soil and litter. Soils are rapidly drained silt loams, sandy clay loams, sandy loams, or loamy sands derived from the Moenkopi Formation, Straight Cliffs Formation, or Organ Rock shale.

Global Environment: This association is characteristic of rocky slopes in the Colorado Plateau and extends into the southern Rocky Mountains in western Colorado and northeastern Arizona. Elevations and aspects are variable. Stands occurring at lower elevations (1406-2006 m) on the Colorado Plateau and northwestern Colorado tend to occur on northerly aspects, whereas stands occurring in west-central and southwestern Colorado occur at higher elevations (2481-2510 m) and have southerly aspects. Stands throughout the range may be on gentle to steep slopes (7-160%). Soils are rapidly drained, but texture and parent materials vary from clay to sandy loam and from marine shale to sandstone and granite. The unvegetated ground is composed primarily of exposed bedrock, rocks, gravel and bare ground.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Stands of this pinyon-juniper woodland are characterized by an open canopy of *Juniperus osteosperma* (with 1-6% cover) and *Pinus edulis* (with 1-4% cover). The understory is likewise sparse and tends to be a mixed shrub community dominated by *Amelanchier utahensis* (with 1-5% cover). Total vegetation cover ranges from 6 to 19%. Associated shrub cover is diverse and includes scattered individuals of *Fraxinus anomala, Shepherdia rotundifolia, Purshia stansburiana, Chrysothamnus viscidiflorus, Ephedra torreyana, Ephedra viridis, Artemisia tridentata, Artemisia bigelovii*, and *Symphoricarpos longiflorus*. The herbaceous layer provides sparse to low cover; forbs noted include *Heterotheca villosa* and *Comandra umbellata* and graminoids include *Leymus salinus, Poa fendleriana*, and *Bromus tectorum*.

Global Vegetation: This woodland association has an open to relatively closed tree canopy and sparse to dense total vegetation cover. The dominant tree species, *Juniperus osteosperma* and *Pinus edulis*, are typically between 2 and 10 m tall and individually do not exceed 25% cover. There is a tall-shrub stratum with up to 25% cover dominated by *Amelanchier utahensis*. Other tall shrubs that may be present with low cover (<5% cover) include *Artemisia bigelovii, Artemisia tridentata, Coleogyne ramosissima, Cercocarpus montanus, Eriogonum microthecum, Fraxinus anomala, Ephedra viridis, Fendlera rupicola, Quercus gambelii, Purshia mexicana, Purshia stansburiana, Rhus trilobata, Symphoricarpos longiflorus, Shepherdia rotundifolia*, and *Symphoricarpos oreophilus*. Dwarf-shrubs may also be present and include *Chrysothamnus viscidiflorus, Ephedra torreyana, Ephedra viridis, Gutierrezia sarothrae*, and *Yucca harrimaniae*. The herbaceous layer has sparse to low cover and contains graminoids, such as *Aristida purpurea, Achnatherum hymenoides, Carex geyeri, Leymus salinus, Pleuraphis jamesii*, and *Poa fendleriana*, and forbs, such as *Antennaria parvifolia, Artemisia ludoviciana, Astragalus moencoppensis, Collinsia parviflora, Comandra umbellata, Cryptantha flava, Erigeron peregrinus, Erigeron utahensis, Eriogonum ovalifolium, Heterotheca villosa, Hymenopappus filifolius, Lathyrus lanszwertii, Lepidium montanum, Phlox austromontana*, and *Streptanthella longirostris*. Disturbed stands may contain *Bromus tectorum*.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Chrysothamnus viscidiflorus*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Amelanchier utahensis, Juniperus osteosperma, Pinus edulis, Poa fendleriana*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)

Global: Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (11-Jan-2005).

Related Concepts

Global Similar Types:

- *Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis)* Wooded Shrubland (CEGL002334)

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. *Amelanchier utahensis* is a common constituent of plant communities on rocky slopes in the Colorado Plateau. There is some overlap with *Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis)* Wooded Shrubland (CEGL002334), and as more information becomes available, woodlands with *Amelanchier utahensis* as a significant component should be re-analyzed.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland association was sampled in Red Cove, near The Gap, on Navajo Point, and in Range Canyon.

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Global Range: This association is found in the Colorado Plateau in northeastern Arizona and southeastern Utah and extends east into the southern Rocky Mountains of western Colorado.

Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 9:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, M331E:CC, M331G:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Canyon de Chelly, Canyonlands, Capitol Reef, Colorado, Dinosaur, Glen Canyon, Grand Canyon, Mesa Verde, Navajo)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Mesic slope due to its northerly-facing aspect. This slope is fairly steep and has small interfluves where bedrock juts out, creating flatter areas for shrubs to grow on. Between the interfluves are steeper surficial drainage channels where rainwater pours off from the cliffs above. Many large Organ Rock boulders, half car-sized, are just downslope from plot. Soils are covered with many small, platy rocks. Slope seems fairly stable, although some soil/rock build-up observed on backsides of shrubs.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2012 field data (5 plots): (Plots: GLCA.0132, GLCA.0750, GLCA.4202, GLCA.6135, GLCA.9312).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Drake, J. Coles, K.A. Schulz and G. Kittel
References: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2010, Romme et al. 1993, Salas et al. 2010a, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.*

[CEGL005658] Pinus edulis - Juniperus osteosperma / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland

Translated Name: Two-needle Pinyon - Utah Juniper / (Wyoming Big Sagebrush, Mountain Big Sagebrush) Woodland

Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis* - *Juniperus osteosperma* / Shrub Understory Foothill & Lower Montane Dry-Mesic Woodland Alliance (A3571)

Element Concept

Global Summary: This woodland association is common on the Colorado Plateau, the dry foothills and mesas of northwestern New Mexico and southwestern Colorado, and continues west into the

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eastern portions of the Mojave Desert, as well as northwestern Colorado and northern Utah. The vegetation is characterized by an open tree canopy (<50% cover) that is dominated by *Pinus edulis* and *Juniperus osteosperma*. *Juniperus monosperma* may be present in northern Arizona, and *Juniperus scopulorum* is more common in higher elevation stands. *Artemisia tridentata ssp. vaseyana* or *Artemisia tridentata ssp. wyomingensis* strongly dominates the short-shrub layer (10-35% cover). Other shrubs are often present but are not consistent nor have as much cover. The herbaceous cover is variable but generally sparse and dominated by graminoids (<5% cover) with scattered forbs. Elevations range from 1465 to 2500 m (4800-8200 feet). Stands occur most often on flat to gentle slopes on all aspects. The soils are generally poorly developed, moderately deep to deep, well-drained to rapidly drained loams and sands. Ground cover is variable; bare soil is common, but bedrock, litter, and large or small rocks can also be abundant on some sites. Parent material includes sandstone and shale.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland occurs on deep soils of mesatops, ridges, plains, plateaus, and canyon bottoms. Sites are flat to gently sloping (less than 6°), oriented to the west and northwest, and lie between 1709 and 2260 m elevation. Exposed soil, litter, and biological soil crust covers most of the unvegetated surface, with lesser cover by dead wood and small rocks. Soils are rapidly drained sandy loams, loamy sands, loams, and silts derived from alluvial and eolian deposits or from the Straight Cliffs Formation.

Global Environment: This woodland association occurs on dry foothills and mesas across much of the Colorado Plateau and adjacent areas. Elevations range from 1459 to 2502 m. Stands occur most often on flat to gentle slopes but can be found on moderate to moderately steep slopes on all aspects. The soils are often deep, generally poorly developed, moderately well-drained to rapidly drained loams and sands, and skeletal. Ground cover is variable; bare soil is common, but bedrock, litter, and large or small rocks, and biological soil crust can also be abundant on some sites. Parent material includes sandstone and shale.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This pinyon-juniper woodland type is somewhat uncommon within the mapping area. Total vegetation cover ranges from 12 to 55% and is characterized by an open canopy of *Pinus edulis* (with 1-16% cover) and *Juniperus osteosperma* (with up to 35% cover) that are less than 10 m tall. *Artemisia tridentata ssp. wyomingensis* dominates the shrub understory with between 2 and 23% cover. Scattered *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. Associated shrubs include *Chrysothamnus viscidiflorus, Ephedra cutleri, Ephedra viridis, Gutierrezia* spp., *Opuntia polyacantha,* and *Mahonia fremontii*. The often diverse herbaceous layer provides sparse to low cover and may include *Achnatherum hymenoides, Pleuraphis jamesii, Bouteloua gracilis, Hesperostipa comata, Packera multilobata (= Senecio multilobatus), Heterotheca villosa,* and *Descurainia pinnata*. *Bromus tectorum* may be present in disturbed stands with up to 20% cover.

Global Vegetation: This woodland is characterized by a typically open tree canopy (usually 10-30% cover but ranges up to 50% cover) that ranges from 2 to 10 m tall in most stands. The tree canopy is

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usually codominated by *Pinus edulis* and *Juniperus osteosperma*. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* may be present northern Arizona. *Juniperus osteosperma* is common in stands reported from northwestern New Mexico, western Colorado, Arizona and Utah. *Juniperus scopulorum* is more common in higher elevation stands. *Artemisia tridentata* strongly dominates the relatively sparse to moderately dense short-shrub layer (10-35% cover); either *ssp. vaseyana* or *ssp. wyomingensis* may be present, with *ssp. vaseyana* being more characteristic of higher elevations or more mesic conditions. *Purshia stansburiana* is typically absent or scarce. Other shrubs present may include *Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus, Chrysothamnus viscidiflorus, Ephedra cutleri, Ephedra viridis, Gutierrezia sarothrae, Mahonia fremontii, Quercus gambelii* (typically <5% cover), *Yucca* spp., *Opuntia polyacantha*, and other *Opuntia* species. Herbaceous cover is variable but is generally sparse and dominated by graminoids (<5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Carex filifolia, Hesperostipa comata, Koeleria macrantha, Muhlenbergia torreyi, Pascopyrum smithii, Pleuraphis jamesii*, and *Poa fendleriana*. Forbs include *Cryptantha* spp., *Eriogonum* spp., *Packera multilobata (= Senecio multilobatus), Heterotheca villosa, Penstemon* spp., and *Descurainia pinnata*. Cryptogram cover tends to be low, but some stands may have moderate cover.

Global Dynamics: Stuever and Hayden (1997) described two phases of this plant community, a *Juniperus osteosperma* and a *Juniperus monosperma* phase. Both are restricted by its geographic range, and where the *Juniperus* spp. are sympatric, *Juniperus osteosperma* generally occurs at high elevations. Fires in this association are thought to be infrequent because *Pinus edulis, Juniperus osteosperma, Juniperus monosperma*, and *Artemisia tridentata* are killed by burns and do not resprout (Wright et al. 1979). *Artemisia tridentata* will re-establish relatively quickly (about 10-20 years) if a seed source is nearby (Bunting 1987). However, *Pinus edulis, Juniperus osteosperma*, and *Juniperus monosperma* are relatively slow to recover following fire, and sagebrush may dominate the sites for decades (Jameson et al. 1962, Erdman 1970). If fire-return intervals are more frequent than 10 years, then *Artemisia tridentata* has difficulty recovering (Bunting 1987, Everett 1987).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *wyomingensis*, *Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*

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Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus monosperma*, *Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *vaseyana*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Artemisia tridentata* ssp. *vaseyana*, *Artemisia tridentata* ssp. *wyomingensis*, *Pinus edulis*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)

Global: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4)

Conservation Status Rank

Global Rank & Reasons: G5 (13-Jan-2016).

Related Concepts

Global Similar Types:

- *Juniperus osteosperma / Artemisia tridentata* Woodland (CEGL000730)
- *Pinus edulis - Juniperus monosperma / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana)* Woodland (CEGL005650)
- *Pinus edulis - Juniperus osteosperma / Artemisia bigelovii* Woodland (CEGL002118) also supports an open canopy of *Pinus edulis* and *Juniperus osteosperma* and a shrub layer dominated by *Artemisia bigelovii* rather than *Artemisia tridentata*.
- *Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland (CEGL000782)

Global Related Concepts:

- 122.4143 *Juniperus osteosperma - Pinus edulis - Artemisia tridentata* Vegetation Type (Warren et al. 1982) <
- 122.4144 *Juniperus osteosperma - Artemisia tridentata - Pinus edulis* Vegetation Type (Warren et al. 1982) <
- *Pinus edulis - Juniperus osteosperma / Artemisia tridentata* Plant Association (Johnston 1987) =
- *Pinus edulis / Artemisia tridentata* Plant Association (Larson and Moir 1987) =
- *Pinus edulis / Artemisia tridentata* Plant Association (Stuever and Hayden 1997a) =
- *Pinus edulis/Artemisia tridentata* (Bourgeron and Engelking 1994) =
- Coronado Province Pinyon - Juniper Woodlands (Isaacson 1967) >
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >
- High-elevation Pinyon-Juniper/Shallow Sand Loams (Tiedemann 1978) =
- La Sal Province Pinyon - Juniper Woodlands (Isaacson 1967) >
- Tree type (Jameson et al. 1962) <
- Upland sand (pinyon - juniper) site (Mason et al. 1967) ><

Classification

Status: Standard

Classification Confidence: 1 - Strong

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands may be similar to open *Artemisia tridentata* shrublands with scattered pinyon and juniper trees but is considered to be a variation of the woodland type because of the ecological values of the trees.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is somewhat uncommon within the recreation area, occurring only on higher elevation mesatops. It was sampled near Hans Flat Ranger Station, in Big Water Canyon, on Muley Point, and on Fiftymile Bench/Navajo Point.

Global Range: This woodland association is common on the Colorado Plateau and western slope of the Southern Rocky Mountains to the eastern Mojave Desert. Stands occur from northwestern New Mexico across northern Arizona to southeastern Nevada, and north into western Colorado and southwestern Wyoming and Utah.

Nations: US
States/Provinces: AZ:S4, CO:S5, NM:S5, NV, UT, WY
TNC Ecoregions: 9:C, 10:C, 11:C, 17:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 322A:??, 341B:CC, 341F:C?, M331E:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Aztec Ruins, Black Canyon of the Gunnison, Bryce Canyon, Canyon de Chelly, Capitol Reef, Colorado, Curecanti, Dinosaur, Glen Canyon, Grand Canyon, Hovenweep, Mesa Verde, Natural Bridges, Navajo, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Gently rolling mesatop with seemingly deep soils. Crusts are not well-developed, they appear young here, perhaps the area was fairly recently grazed? There is decent recruitment of young pinyon and juniper trees in the area.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2012 field data (8 plots): (Plots: GLCA.0101, GLCA.0502, GLCA.0568, GLCA.0724, GLCA.4053, GLCA.4201, GLCA.4218, GLCA.5035).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Drake, J. Coles and G. Kittel
References: Bourgeron and Engelking 1994, Bunting 1987, CNHP 2003, CNHP 2015, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2010, Dick-Peddie 1993, Driscoll et al. 1984, Erdman 1970, Everett 1987, Heinze et al. 1962, Isaacson 1967, Jameson et al. 1962, Johnston 1987, Larson and Moir 1987, Mason et al. 1967, Moir and Carleton 1987, Reid and Hall 2010, Romme et al. 1993, Salas et al. 2009, Salas et al. 2010a, Stuever and Hayden 1997a, Tendick et al. 2010, Tendick et al. 2011b, Thomas et al. 2009b, Thomas et al. 2010, Tiedemann 1978,

USFS 1983a, USFS 1985a, USFS 1985e, Von Loh et al. 2007, Von Loh et al. 2008, WNDD unpubl. data, Warren et al. 1982, Western Ecology Working Group n.d.*, Wright et al. 1979

[CEGL005659] Pinus edulis - Juniperus osteosperma / Quercus gambelii Woodland
Translated Name: Two-needle Pinyon - Utah Juniper / Gambel Oak Woodland
Common Name:

USNVC Classification

Division: Western North American Pinyon - Juniper Woodland & Scrub (1.B.2.Nc)
Macrogroup: Southern Rocky Mountain-Colorado Plateau Two-needle Pinyon - Juniper Woodland (M027)
Group: Colorado Plateau Pinyon - Juniper Woodland (G250)
Alliance: *Pinus edulis - Juniperus osteosperma* / Shrub Understory Foothill & Lower Montane Dry-Mesic Woodland Alliance (A3571)

Element Concept

Global Summary: This widespread woodland association is known from the Colorado Plateau and western slope of the southern Rocky Mountains, occurring in northern New Mexico, the Mogollon Rim of Arizona, in the Grand Canyon, and north into Utah and western Colorado. The vegetation is characterized by an open tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. The species of *Juniperus* can vary with geography and elevation. *Juniperus monosperma* or *Juniperus deppeana* are sometimes present in northern Arizona and *Juniperus scopulorum* is more common in higher elevation stands. *Quercus gambelii* dominates the often patchy, moderately dense tall-shrub layer with at least 5% cover, but often over 25% cover. *Amelanchier utahensis, Cercocarpus montanus, Symphoricarpos oreophilus*, or species of *Yucca* and *Opuntia* are common shrub associates. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Carex geyeri, Carex rossii, Elymus elymoides, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Poa fendleriana*, and *Schizachyrium scoparium*. Elevations range from 1509-2665 m. Sites are variable but generally are relatively mesic. Stands occur on flat to moderate slopes along drainages and on mesatops, and on moderate to steep, rocky slopes of foothills, mountains and canyons, especially in draws where soil moisture is concentrated, or on northern aspects or where shaded by upper canyon walls. The soils are variable and range from deep to shallow, silty clay to sandy loam, and often gravelly. Litter from *Quercus gambelii* and other shrubs is often extensive (over 50% cover).

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland occurs on the deep soils of canyon sides, sideslopes, canyon bottoms, and along drainages. Sites are gentle to steeply sloping (up to 27°), are mostly oriented to the north and east, and lie between 1570 and 2221 m elevation. Litter, rocks, and exposed soil cover most of the unvegetated surface. Soils are rapidly drained to well-drained silt loams, loams, sands, or loamy sands derived from alluvial, colluvial or eolian deposits.

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Global Environment: This widespread woodland association is known from the Colorado Plateau and western slope of the southern Rocky Mountains, occurring from western Colorado to southwestern New Mexico, west along the Mogollon Rim of Arizona, and north into Utah. Elevations normally range from 1509-2665 m but may be higher in stands in southern New Mexico. Sites are variable but generally are relatively mesic. Stands occur on flat to moderate slopes along drainages and on mesatops, and on moderate to steep, sometimes rocky slopes of foothills, mountains and canyons, especially in draws where soil moisture is concentrated, or on northern aspects or where shaded by upper canyon walls. Stands are less common on hot south-facing slopes, unless they are located in a moisture-concentrating gully. Soils are variable and range from deep to shallow, silty clay to sandy loam, and are often gravelly or rocky. Litter from *Quercus gambelii* and other shrubs is often extensive (over 50% cover). Parent materials include alluvial, colluvial or eolian deposits derived from sandstone, shale, limestone and rhyolite.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This woodland is moderately common, especially on sheltered, steep slopes at higher elevations within the recreation area. Total vegetation cover ranges from 16 to 71%. Stands are characterized by an open canopy, typically 2 to 10 m tall, of *Pinus edulis* (with 4-9% cover) and *Juniperus osteosperma* (with trace to 12% cover). The shrub layer is dominated by scattered, dense clones of *Quercus gambelii* with between 3 and 40% cover. Scattered *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. Associated shrubs may include *Amelanchier utahensis, Ericameria nauseosa, Shepherdia rotundifolia, Mahonia fremontii, Quercus turbinella, Artemisia tridentata, Fraxinus anomala, Rhus aromatica,* and *Symphoricarpos longiflorus.* The herbaceous layer generally provides sparse cover; common species include *Artemisia ludoviciana, Pseudoroegneria spicata (= Elymus spicatus), Muhlenbergia asperifolia* (with 30% cover in one stand), and *Poa fendleriana* (with 20% cover in one stand).

Global Vegetation: This widespread association is characterized by an open to moderately dense tree canopy (10-70% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. The species of *Juniperus* can vary with geography and elevation. *Juniperus osteosperma* is common in northwestern New Mexico, northern Arizona, western Colorado and Utah. *Juniperus scopulorum* is more common in higher elevation stands. An occasional *Pinus ponderosa* tree may be present is some stands. *Quercus gambelii* dominates the often patchy, moderately dense tall-shrub layer with at least 5% cover, but often with more than 25% cover. *Amelanchier utahensis, Artemisia tridentata, Cercocarpus montanus, Symphoricarpos oreophilus,* or species of *Yucca* and *Opuntia* are common shrub associates. Other shrubs may be present, depending on geography, and may include *Artemisia tridentata, Artemisia nova, Arctostaphylos patula, Cercocarpus ledifolius, Ephedra viridis, Fendlera rupicola, Fraxinus anomala, Gutierrezia sarothrae, Garrya* spp., *Mahonia fremontii, Ptelea trifoliata, Prunus* spp., *Quercus turbinella, Robinia neomexicana, Rhus aromatica, Rosa* spp., *Shepherdia rotundifolia,* and *Symphoricarpos longiflorus*. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Carex geyeri, Carex rossii, Elymus elymoides, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Poa fendleriana, Pseudoroegneria spicata (= Elymus spicatus),* and *Schizachyrium scoparium*. Common

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forbs may include *Artemisia ludoviciana, Artemisia frigida, Balsamorhiza sagittata, Geranium caespitosum, Lepidium montanum, Machaeranthera grindelioides, Packera neomexicana, Thalictrum fendleri, Tetraneuris acaulis,* and/or *Vicia americana*.

Global Dynamics: *Quercus gambelii* is adapted to fire and will resprout profusely after a burn, forming a dense thicket (Wright 1972). *Pinus edulis, Juniperus monosperma, Juniperus osteosperma,* and *Juniperus scopulorum* are killed or severely damaged by fire and do not resprout after burning (Wright et al. 1979). When burned, these woodlands will convert to oak shrublands. However, because *Juniperus deppeana* resprouts after burning, it will not be eliminated from the site (Wright 1972, Bassett 1987). Frequent burning will reduce cover of both *Quercus gambelii* and *Juniperus deppeana* (Kallender 1959, Erdman 1970).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Pinus edulis*
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Quercus gambelii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*
Herb (field)	Graminoid	*Poa fendleriana*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*, *Juniperus scopulorum*, *Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous tree	*Amelanchier utahensis*, *Quercus gambelii*
Tall shrub/sapling	Broad-leaved evergreen tree	*Cercocarpus montanus*
Short shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos oreophilus*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Juniperus osteosperma, Juniperus scopulorum, Pinus edulis, Quercus gambelii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Chenopodium album*
Global: Vulnerable Plants: *Galium wrightii* (G3G4), *Lupinus ammophilus* (G3G4), *Shepherdia rotundifolia* (G3G4)

Conservation Status Rank

Global Rank & Reasons: G5 (13-Jan-2016).

Related Concepts

Global Similar Types:

- *Pinus discolor / Quercus gambelii* Woodland (CEGL000770)
- *Pinus edulis - Juniperus (monosperma, deppeana) / Quercus gambelii* Woodland (CEGL005651)
- *Pinus ponderosa / Quercus gambelii* Woodland (CEGL000870)

Global Related Concepts:

- 122.4148 *Pinus edulis - Amelanchier utahensis - Quercus gambelii - Juniperus osteosperma* Plant Association (Warren et al. 1982) =
- *Pinus edulis - Juniperus osteosperma / Quercus gambelii* Plant Association (Vories 1974) =
- *Pinus edulis / Quercus gambelii / Carex geyeri* Habitat Type (Hess and Wasser 1982) =
- *Pinus edulis / Quercus gambelii* Plant Association (Johnston 1987) =
- *Pinus edulis / Quercus gambelii* Plant Association (Larson and Moir 1987) =
- *Pinus edulis / Quercus gambelii* Plant Association (Stuever and Hayden 1997a) =
- *Pinus edulis/Quercus gambelii* (Bourgeron and Engelking 1994) =
- Coronado Province Pinyon - Juniper Woodlands (Isaacson 1967) >
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >
- La Sal Province Pinyon - Juniper Woodlands (Isaacson 1967) >

Classification

Status: Standard
Classification Confidence: 1 - Strong
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is moderately common within the recreation area and was sampled near Burro Seep, on Navajo Point (Corral Ridge), in Moody Canyon, and in the Purple Hills.

Global Range: This woodland association occurs throughout the Colorado Plateau, in foothills and mesas from southern Colorado, south-central New Mexico, the Mogollon Rim of Arizona, and northern Utah and western Colorado.

Nations: US
States/Provinces: AZ, CO:S5, NM:S5, UT
TNC Ecoregions: 18:C, 19:C, 20:C, 21:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313E:CC, 341B:CC, M313A:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Bryce Canyon, Canyon de Chelly, Canyonlands, Capitol Reef, Curecanti, Glen Canyon, Grand Canyon, Hovenweep, Mesa Verde, Natural Bridges, Zion); USFS (White River NF)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: The soil is deep here and, surprisingly, there is no talus or rubble on the slope. It's possible some moisture is seeping in from the sandstone

cliff, because patches of *Phragmites* are popping up across the slope. The trees are large and tall, and the pinyons have been chewed on. The oak comes in two layers: a canopy and low shrubbery.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2012 field data (8 plots): (Plots: GLCA.0303, GLCA.4207, GLCA.4215, GLCA.5063, GLCA.5064, GLCA.5066, GLCA.6126, GLCA.6128).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Coles and G. Kittel
References: Bassett 1987, Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008c, Coles et al. 2010, Driscoll et al. 1984, Harmon 1980, Hess and Wasser 1982, Holm 1927, Isaacson 1967, Johnston 1987, Kallender 1959, Larson and Moir 1987, Marr et al. 1973b, Reid and Hall 2010, Romme et al. 1993, Steinhoff 1978, Stuever and Hayden 1997a, Tendick et al. 2010, Tendick et al. 2011b, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2008, Vories 1974, Warren et al. 1982, Western Ecology Working Group n.d.*, Wright 1972, Wright et al. 1979

1.B.3. Temperate Flooded & Swamp Forest

1.B.3.Nc. Rocky Mountain-Great Basin Montane Flooded & Swamp Forest

M034. Rocky Mountain-Great Basin Montane Riparian & Swamp Forest

G506. Rocky Mountain-Great Basin Montane Riparian & Swamp Forest

Group Summary Description: This group contains woodlands dominated by cottonwood, conifer and aspen that line montane streams. Dominant tree species usually include *Abies lasiocarpa, Picea engelmannii, Pinus ponderosa, Juniperus scopulorum*, and/or *Populus angustifolia*; other important species include *Pseudotsuga menziesii, Picea pungens, Picea engelmannii x glauca*, and *Populus tremuloides*. Other trees possibly present but not usually dominant include *Alnus incana, Abies concolor, Abies grandis, Pinus contorta*, and *Juniperus osteosperma*. Shrub cover tends to be limited but may include *Alnus incana, Betula occidentalis, Cornus sericea, Crataegus rivularis, Forestiera pubescens var. pubescens, Ribes* spp., *Rosa woodsii, Salix* spp., and others. The herbaceous undergrowth can be lush to depauperate. Herbaceous species include *Calamagrostis canadensis, Carex aquatilis var. aquatilis, Carex obnupta, Carex pellita, Equisetum arvense, Heracleum maximum, Ranunculus alismifolius, Senecio bigelovii var. bigelovii, Streptopus amplexifolius,* and *Veratrum californicum*. This riparian group includes seasonally flooded forests found at montane to subalpine elevations of the Rocky Mountain cordillera, from southern New Mexico north into Montana, and west into the Intermountain West region and the Colorado Plateau. It occurs throughout the interior of British Columbia and the eastern slopes of the Cascade Range. These are communities tolerant of periodic flooding and high water tables. Snowmelt moisture may create shallow water tables or seeps for a portion of the growing season. Stands typically occur at elevations between 1500 and 3300 m (4920-10,830 feet); farther north, elevation ranges between 900 and 2000 m. This is confined to specific riparian environments occurring on floodplains or terraces of rivers and streams, in V-shaped, narrow valleys and canyons (where there is cold-air drainage). Less frequently, occurrences are found in moderately wide valley bottoms on large floodplains along broad, meandering rivers, and on pond or lake margins.

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A4154 Acer negundo - Alnus incana ssp. tenuifolia - Cornus sericea Riparian Woodland Alliance
Alliance Summary Description:

[CEGL002797] *Acer negundo / Quercus gambelii* Riparian Woodland
Translated Name: Box-elder / Gambel Oak Riparian Woodland
Common Name:

USNVC Classification

Division: Rocky Mountain-Great Basin Montane Flooded & Swamp Forest (1.B.3.Nc)
Macrogroup: Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (M034)
Group: Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (G506)
Alliance: *Acer negundo - Alnus incana ssp. tenuifolia - Cornus sericea* Riparian Woodland Alliance (A4154)

Element Concept

Global Summary: This is a riparian woodland found in scattered locations on the Colorado Plateau. The vegetation is characterized by an open to moderately dense tree canopy of *Acer negundo* and *Quercus gambelii*. Occasional emergent *Pseudotsuga menziesii* trees or subcanopy *Juniperus scopulorum* may be present. The understory is typically sparse and variable in species composition. Tall, short, and dwarf-shrubs contribute low cover and include *Celtis laevigata var. reticulata (= Celtis reticulata), Cornus sericea, Fendlerella utahensis, Holodiscus dumosus, Mahonia repens, Rhus trilobata, Ribes cereum, Ribes inerme*, and *Prunus virginiana*. The herbaceous layer is sparse and low in species diversity. Species include *Maianthemum stellatum, Piptatherum micranthum, Arabis* sp., *Brickellia grandiflora, Solidago canadensis*, and *Artemisia michauxiana*. This woodland association is known from the Gunnison River in Curecanti National Recreation Area, and on seeps and streams in Glen Canyon National Recreation Area. Stands occur in riparian sites and springs and seeps with natural or human disturbance, including constructed roadway fill slopes and rockfall or talus from adjacent cliffs. Sites are steep (75% slopes), occur between 2032 and 2073 m elevation, and are oriented to northeastern and southern aspects. The unvegetated surface has high cover of bedrock, large and small rocks, and low to moderate cover of litter. Soil is not present in the rockfill and rockfall substrate in the sampled stands.

Environmental Description

Vegetation Description

Most Abundant Species

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer negundo*, *Quercus gambelii*

Characteristic Species

Global: Acer negundo, Quercus gambelii

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Subset: GLCA; Glen Canyon National Recreation Area

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (21-Jun-2005).

Related Concepts

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association has only been sampled from a few locations in western Colorado, and a few locations on the Colorado Plateau of southern Utah and northern Arizona. More survey and classification work are needed to understand the full distribution of this association.

Element Distribution

Global Range: This association has been sampled from a few isolated locations in in western Colorado, northern Arizona and in southern Utah.

Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, M331G:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Capitol Reef, Curecanti, Glen Canyon, Grand Canyon)

Element Sources

Global Description Author(s): K.A. Schulz and G. Kittel
References: Clark et al. 2009, Coles et al. 2010, Reid and Hall 2010, Romme et al. 1993, Spence 2008, Tendick et al. 2010, Western Ecology Working Group n.d.*

[CEGL003971] *Ostrya knowltonii* Riparian Woodland
Translated Name: Knowlton's Hophornbeam Riparian Woodland
Common Name:

USNVC Classification

Division: Rocky Mountain-Great Basin Montane Flooded & Swamp Forest (1.B.3.Nc)
Macrogroup: Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (M034)
Group: Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (G506)
Alliance: *Acer negundo - Alnus incana ssp. tenuifolia - Cornus sericea* Riparian Woodland Alliance (A4154)

Element Concept

Global Summary: This riparian woodland is characterized by a dense canopy of the small tree *Ostrya knowltonii* with up to 40% cover. Scattered trees may be present but do not constitute a tree layer. Associated shrubs include *Amelanchier utahensis, Brickellia longifolia, Fraxinus anomala, Mahonia*

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repens, Quercus gambelii, Rhus trilobata, Rubus neomexicanus, Symphoricarpos longiflorus, and *Yucca angustissima,* among others. The herbaceous layer is diverse and provides significant cover. Common grasses include *Sporobolus airoides* and *Poa fendleriana,* with *Carex curatorum* up to 30% cover in some stands, and forbs include *Adiantum capillus-veneris, Aquilegia micrantha, Castilleja linariifolia, Cirsium calcareum, Cirsium rydbergii, Galium aparine, Heterotheca villosa, Mimulus eastwoodiae, Platanthera zothecina, Solidago canadensis,* and *Thelypodium integrifolium*. This riparian woodland occurs on sideslopes, intermittently flooded alcoves, and wash bottoms. Soils are rapidly drained sands, loamy sands or loams derived from alluvium or colluvium. This Colorado Plateau association is known from Glen Canyon Recreational Area in southeastern Utah and Grand Canyon National Park in northern Arizona.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association occurs on sideslopes and wash bottoms. Sites are on moderate slopes (10-14°) and between 1211 to 1603 m elevation. Bare soil and litter cover most of the unvegetated surface with lesser cover by bedrock, large and small rocks, and dead wood. Soils are rapidly drained sands or loamy sands derived from alluvium or colluvium.

Global Environment: This riparian woodland occurs on sideslopes, intermittently flooded and permanently wet alcoves, and wash bottoms. Sites are on moderate slopes (10-14°) and between 1211 to 1750 m elevation. Bare soil and litter cover most of the unvegetated surface, with lesser cover by bedrock, large and small rocks, and dead wood. Soils are rapidly drained sands, loamy sands or sandy loams derived from alluvium or colluvium. When unobscured, the underlying bedrock is typically limestone or sandstone.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Knowlton's hophornbeam woodland type has high total vegetation cover ranging from 54 to 92%. Stands are characterized by a moderately dense canopy of *Ostrya knowltonii* with 18 to 40% cover. Several other tree species may be present with low to moderate cover, including *Populus fremontii, Pinus edulis, Juniperus osteosperma,* and *Cercis orbiculata (= Cercis occidentalis var. orbiculata)*. Shrubs are present with low to moderate cover and may include *Quercus gambelii, Frangula betulifolia, Rhus aromatica, Fraxinus anomala, Amelanchier utahensis, Symphoricarpos longiflorus,* and *Yucca angustissima*. The herbaceous layer may include *Clematis ligusticifolia, Heterotheca villosa, Solidago canadensis, Cirsium* spp., *Sporobolus airoides,* and the exotic species *Bromus tectorum*.

Global Vegetation: Total vegetation cover is 92%. Stand are characterized by a moderate to dense canopy of the tall shrub *Ostrya knowltonii* with 15-40% cover. Scattered *Populus fremontii, Pinus edulis, Juniperus osteosperma,* and *Cercis orbiculata (= Cercis occidentalis var. orbiculata)* emerge from the shrub canopy but do not constitute a tree layer. Associated shrubs include *Amelanchier utahensis, Brickellia longifolia, Fendlera rupicola, Frangula betulifolia, Fraxinus anomala, Fraxinus cuspidata, Glossopetalon spinescens, Quercus gambelii, Ptelea trifoliata, Rhus trilobata, Symphoricarpos longiflorus,* and *Yucca angustissima*. The riparian vine *Clematis ligusticifolia* provides sparse cover. The herbaceous layer is diverse and provides significant cover (up to 52%).

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Common grasses include *Sporobolus airoides* and *Poa fendleriana*, with *Carex curatorum* up to 30% cover in some stands, and forbs include *Adiantum capillus-veneris, Aquilegia micrantha, Castilleja linariifolia, Cirsium calcareum, Heterotheca villosa, Solidago canadensis,* and *Thelypodium integrifolium*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Ostrya knowltonii, Populus fremontii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii, Rhus aromatica*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Ostrya knowltonii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Ostrya knowltonii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Ostrya knowltonii* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Vulnerable Plants: *Carex curatorum* (G3), *Cirsium rydbergii* (G3), *Ostrya knowltonii* (G3G4), *Platanthera zothecina* (G2G3)

Conservation Status Rank

Global Rank & Reasons: GNR (12-Jul-2006).

Related Concepts

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau, and classification and data from John Spence, Ph.D., Chief Scientist and Terrestrial Natural Resources Branch Chief, Science & Resource Management, Glen Canyon National Recreation Area (Spence 2008).

Element Distribution

Glen Canyon National Recreation Area Range: This extremely rare woodland association was sampled in Waterhole Canyon and in the South Fork of Ticaboo Creek.

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Global Range: This is a rare association occurring in the Colorado Plateau and is described from Glen Canyon National Recreation Area in southern Utah and Grand Canyon National Park in northwestern Arizona.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Almost overhanging alcove above, water seeping down, bedrock ledges in drainage, high litter depth on slopes. Steep slopes, shaded under trees, north-facing.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2013 (2 plots): (Plots: GLCA.0776, GLCA.5411).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): M.E. Hall, G. Kittel and K.A. Schulz
References: Reid and Hall 2010, Spence 2008, Western Ecology Working Group n.d.*

A3761 Picea pungens Riparian Forest Alliance

Alliance Summary Description: This alliance is characterized by the dominance of *Picea pungens* in the tree canopy. Other conifers are usually present in these stands, depending upon geographic location, site moisture, and stand history. Common associates include *Abies concolor, Abies lasiocarpa, Picea engelmannii, Pinus contorta, Pinus ponderosa*, and *Pseudotsuga menziesii* (which may replace *Picea pungens*). *Populus angustifolia* is the most commonly present deciduous tree species, although *Populus tremuloides* may persist as a seral species on well-drained sites of this alliance. A shrub layer is often present but many stands lack a shrub layer. Common shrub species include *Alnus incana, Betula occidentalis, Cornus sericea, Rosa woodsii*, and several species of *Salix*. Other shrubs that may be present include *Dasiphora fruticosa ssp. floribunda (= Pentaphylloides floribunda), Lonicera involucrata*, and *Acer glabrum*. Because of favorable soil moisture, the herbaceous layer is usually a luxuriant mixture of forbs and graminoids, including *Calamagrostis canadensis, Carex siccata (= Carex foenea), Conioselinum scopulorum, Equisetum arvense, Fragaria virginiana, Heracleum sphondylium, Maianthemum stellatum, Mertensia ciliata*, and *Rudbeckia laciniata*. The herbaceous layer can have very high cover in some stands, but also may be very sparse. This riparian woodland alliance is found at middle elevations (from 1900-2900 m) of the central and southern Rocky Mountains and the Colorado Plateau region. Stands typically occur in narrow, or V-shaped, valleys and canyons subject to cold-air drainage and limited sunlight. They occupy streambanks, terraces, narrow floodplains or benches, and subirrigated toeslopes; stream gradients are often steep. These sites can be subject to spring flooding, and usually water tables are within 1 m of the soil surface even late in the growing season. The soils are somewhat variable, often with signs of mottling.

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[CEGL000899] Pseudotsuga menziesii / Cornus sericea Riparian Woodland

Translated Name: Douglas-fir / Red-osier Dogwood Riparian Woodland

Common Name:

USNVC Classification

Division: Rocky Mountain-Great Basin Montane Flooded & Swamp Forest (1.B.3.Nc)
Macrogroup: Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (M034)
Group: Rocky Mountain-Great Basin Montane Riparian & Swamp Forest (G506)
Alliance: *Picea pungens* Riparian Forest Alliance (A3761)

Element Concept

Global Summary: This Rocky Mountain montane riparian woodland association is known from Montana, Idaho, Colorado and Utah. The vegetation is characterized by the overstory tree canopy dominated by *Pseudotsuga menziesii* with *Cornus sericea* prominent in the shrub understory. Other tree species present include *Abies concolor, Abies lasiocarpa, Acer negundo, Juniperus scopulorum, Picea engelmannii, Picea pungens, Populus angustifolia, Populus balsamifera ssp. trichocarpa* or *Populus tremuloides*. The lush shrub layer is dominated or codominated by *Cornus sericea* with 10-75% cover. Other common shrubs include *Acer glabrum, Amelanchier alnifolia, Alnus incana, Frangula betulifolia, Mahonia repens, Prunus virginiana, Quercus gambelii, Rosa woodsii, Salix exigua, Spiraea betulifolia, Shepherdia rotundifolia*, and *Symphoricarpos* spp. The herbaceous layer is sometimes sparse due to the dense shrub canopy, but when the shrub canopy is disturbed graminoids such as *Poa pratensis, Calamagrostis rubescens*, or *Elymus glaucus* dominate. Forb diversity is typically high with common forbs including *Actaea rubra, Fragaria virginiana, Geranium* spp., *Heracleum maximum, Maianthemum* spp., *Osmorhiza* spp., and *Thalictrum occidentale*. Elevations range from 1100 to 2590 m (3600-8500 feet). Stands occur on floodplains and benches along drainages and adjacent lower hill slopes in narrow valleys. Stream channels are typically narrow and steep, but also include major streams and rivers. Substrates are usually well-drained soils with clay loam to sandy loam textures derived from various alluvial or colluvial parent materials. Ground surface has high cover of litter.

Environmental Description

Global Environment: This montane riparian woodland association is known from throughout the Rocky Mountains. Elevations range from 1100 to 2600 m (3600-8500 feet). Stands occur on floodplains and benches along drainages and adjacent lower hill slopes in narrow valley. Stream channels are typically narrow and steep, but also include major streams and rivers. Substrates are usually well-drained soils with clay loam to sandy loam textures derived from various alluvial or colluvial parent materials. Ground surface has high cover of litter.

Vegetation Description

Global Vegetation: This woodland association is characterized by an overstory tree canopy dominated by *Pseudotsuga menziesii* with *Cornus sericea* prominent in the shrub understory. Other tree species present include *Abies concolor, Abies lasiocarpa, Acer negundo, Juniperus scopulorum, Picea engelmannii, Picea pungens, Populus angustifolia, Populus balsamifera ssp. trichocarpa,* or *Populus tremuloides*. The lush tall-shrub layer is dominated or codominated by *Cornus sericea* with

10-75% cover. Other common tall, short and dwarf-shrubs include *Acer glabrum, Amelanchier alnifolia, Alnus incana, Frangula betulifolia, Mahonia repens, Prunus virginiana, Quercus gambelii, Rosa woodsii, Salix exigua, Shepherdia rotundifolia, Spiraea betulifolia*, *Symphoricarpos oreophilus*, or *Symphoricarpos albus*. Herbaceous layer is sparse except when shrub canopy is disturbed, and graminoids such as *Poa pratensis, Calamagrostis rubescens, Carex rossii, Sorghastrum nutans*, or *Elymus glaucus* dominate. Forb diversity is typically high with common forbs including *Actaea rubra, Aquilegia micrantha, Apocynum cannabinum, Fragaria virginiana, Galium boreale, Geranium* spp., *Heracleum maximum, Maianthemum racemosum, Maianthemum stellatum, Osmorhiza* spp., and *Thalictrum occidentale*.

Most Abundant Species

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pseudotsuga menziesii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Cornus sericea*
Herb (field)	Flowering forb	*Maianthemum stellatum*
Herb (field)	Graminoid	*Calamagrostis rubescens*

Characteristic Species

Global: Cornus sericea, Pseudotsuga menziesii

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: G4 (1-Feb-1996).

Related Concepts

Global Similar Types:

- *Picea engelmannii / Cornus sericea* Swamp Woodland (CEGL002677)
- *Picea pungens / Cornus sericea* Riparian Woodland (CEGL000388)
- *Pinus contorta / Cornus sericea* Swamp Woodland (CEGL005929)
- *Populus angustifolia / Cornus sericea* Riparian Woodland (CEGL002664)
- *Populus balsamifera ssp. trichocarpa - Populus tremuloides* - Conifer / *Cornus sericea* Riparian Forest (CEGL005905)
- *Populus balsamifera ssp. trichocarpa / Cornus sericea* Riparian Forest (CEGL000672)
- *Populus tremuloides / Cornus sericea* Riparian Forest (CEGL000582)
- *Pseudotsuga menziesii / Acer negundo* Riparian Woodland (CEGL002754)

Global Related Concepts:

- *Pseudotsuga menziesii / Cornus sericea* Woodland (Carsey et al. 2003a) =
- *Pseudotsuga menziesii / Cornus stolonifera* Habitat Type (Hansen et al. 1995) =
- *Pseudotsuga menziesii / Cornus stolonifera* Habitat Type (Hall and Hansen 1997) =
- *Pseudotsuga menziesii/Cornus sericea* (Bourgeron and Engelking 1994) =

- *Pseudotsuga menziesii/Cornus sericea* (Kittel et al. 1999b) =
- DRISCOLL FORMATION CODE:II.A.2.b. (Driscoll et al. 1984) >
- Douglas fir /red-osier dogwood (*Pseudotsuga menziesii / Cornus sericea*) Plant Association (Kittel et al. 1999a) =

Classification

Status: Standard
Classification Confidence: 1 - Strong
Global Classification Comments: More research to determine the full range extent of this association as it relates to Bailey's sections is needed.

Element Distribution

Global Range: This Rocky Mountain montane riparian woodland association is known from Montana, Idaho, and Colorado, and also occurs on the Colorado Plateau in southern Utah.

Nations: US
States/Provinces: CO:S2, ID:S4, MT:S3, UT
TNC Ecoregions: 7:C, 8:C, 10:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 341B:CC, M331G:CC, M331H:CC, M332C:CC, M332D:CP, M333C:CC, M341B:CC
Federal Lands: BIA (Blackfeet); NPS (Glacier, Glen Canyon); USFS (San Juan)

Element Sources

Global Description Author(s): K.A. Schulz and G. Kittel
References: Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Carsey et al. 2003a, Driscoll et al. 1984, Hall and Hansen 1997, Hansen et al. 1990, Hansen et al. 1991, Hansen et al. 1995, Hop et al. 2007, IDCDC 2005, Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1995, Kittel et al. 1999a, Kittel et al. 1999b, MTNHP 2002b, Reid et al. 2004, Richard et al. 1996, Spence 2008, Western Ecology Working Group n.d.*

1.B.3.Nd. Western North American Interior Flooded Forest

M036. Interior Warm & Cool Desert Riparian Forest

G797. Western Interior Riparian Forest & Woodland

Group Summary Description: This group consists of riparian woody vegetation. Dominant trees may include Acer negundo, Celtis laevigata var. reticulata, Cephalanthus occidentalis, Fraxinus velutina, Juglans major, Platanus wrightii, Populus deltoides ssp. wislizeni, Populus deltoides ssp. monilifera, Populus fremontii, Platanus racemosa, Quercus lobata, Salix gooddingii, Salix laevigata, Sapindus saponaria, and Washingtonia filifera. Dominant shrubs include Alnus oblongifolia, Baccharis salicifolia, Prunus spp., Salix exigua, Salix lasiolepis, Shepherdia argentea, and Vitis californica. Other dominants on serpentine substrates include Aquilegia eximia, Carex serratodens, Cirsium fontinale, Cupressus sargentii, Frangula californica ssp. tomentella (= Rhamnus tomentella), Mimulus glaucescens, Mimulus guttatus, Packera clevelandii (= Senecio clevelandii), Salix breweri, Solidago spp., Stachys albens, and Umbellularia californica. The variety of plant associations within this group reflects elevation, stream gradient, floodplain width, and flooding events. It also includes

springs, seeps, and perennial and intermittent streams and riparian areas found on serpentine substrates. These are disturbance-driven systems that require flooding, scour and deposition for germination and maintenance. Periodic flooding and associated sediment scour are necessary to maintain growth and reproduction of vegetation. Flooding regimes have been significantly altered in all but a few tributaries that support this group. This group occurs throughout lowlands of the interior west, including southwest warm and cool deserts and Mediterranean California, generally below about 1800 m (6000 feet) elevation. Known occurrences include the following rivers and their tributaries: Colorado, Gila, Pecos, Rio Grande, Sacramento, San Joaquin, Santa Cruz, Salt, San Pedro, Truckee rivers, and others.

A3796 Acer negundo - Fraxinus anomala - Celtis laevigata var. reticulata Riparian Woodland Alliance

Alliance Summary Description: This alliance consists of riparian woodlands dominated by Acer negundo, Fraxinus anomala, and/or Celtis laevigata var. reticulata. Common associates include Alnus incana, Betula occidentalis, Brickellia grandiflora, Brickellia longifolia, Cornus sericea, Quercus gambelii, Rhus trilobata, and others. Cottonwoods and willows are usually not present and, if present, are in very low abundance. It is found adjacent to streams and rivers, seeps and springs, near the base of colluvial slopes, and on alluvial terraces or in slickrock canyons, and occurs on the Colorado Plateau and south into Arizona and New Mexico.

[CEGL002752] *Fraxinus anomala* Riparian Woodland

Translated Name: Singleleaf Ash Riparian Woodland

Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
MacroGroup: Interior Warm & Cool Desert Riparian Forest (M036)
Group: Western Interior Riparian Forest & Woodland (G797)
Alliance: *Acer negundo - Fraxinus anomala - Celtis laevigata var. reticulata* Riparian Woodland Alliance (A3796)

Element Concept

Global Summary: This riparian woodland is found in deep canyons and mountains on the Colorado Plateau in Utah and western Colorado. The vegetation is characterized by a moderately dense (30-50%) cold-deciduous tall-shrub (2-5 m) canopy that is dominated by *Fraxinus anomala*. Other tall shrubs that may be present include *Amelanchier alnifolia* and *Quercus gambelii*. Short shrubs present include *Ephedra viridis, Ericameria nauseosa, Holodiscus dumosus, Rhus trilobata, Symphoricarpos rotundifolius*, and the vine *Vitis arizonica*. Herbaceous species are variable and contribute minimal cover. Stands occur between 1430 and 2043 m (4700-6700 feet) elevation, and are restricted to mesic sites, such as near seeps, springs and ephemeral stream channels, or on lower colluvial slopes where additional soil moisture is available. In rare cases, it occurs on upland sites where fractured bedrock concentrates runoff to create small areas of mesic conditions. Substrates are nearly always derived from colluvium but are often redistributed into alluvial deposits. Soils have large amounts of gravel and cobble. Parent material is typically sandstone.

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Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association occurs along intermittently flooded drainages and associated terraces on mesatops or in canyon bottoms. Sampled sites are flat to moderately sloping (up to 18°), oriented to the west and north, and lie between 1123 and 1540 m elevation. Sand covers most of the unvegetated surface, with lesser cover by biological soil crusts, large rocks, or bedrock, and low to moderate cover of gravel, bare soil, and litter. The soil is a moderately well-drained to rapidly drained sand derived from alluvial deposits.

Global Environment: This woodland association is found in deep canyons and mountains on the Colorado Plateau in southwestern Utah and western Colorado. Elevation ranges from 1430 to 2043 m (4700-6700 feet). Climate is semi-arid; however, this vegetation is restricted to mesic sites, such as near seeps, springs and ephemeral stream channels, on fractured bedrock or on lower colluvial slopes where additional soil moisture is available. Sites are flat to gently sloping and may have any aspect. Substrates are nearly always derived from colluvium but often have been transported or redistributed by water to form alluvial deposits. Soils have large amounts of gravel and cobble and are well-drained to rapidly drained. Parent material is typically sandstone but can be shale, colluvium or other materials.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This unusual woodland type is rare within the recreation area. Total vegetation cover is low and ranges from 5 to 28%. The canopy consists of widely scattered individuals of *Fraxinus anomala* (with up to 7% cover and between 1 and 5 m tall), growing with scattered individuals of *Amelanchier utahensis, Symphoricarpos* spp., *Purshia stansburiana, Rhus trilobata, Ericameria nauseosa, Ephedra torreyana, Ephedra viridis, Coleogyne ramosissima, Gutierrezia sarothrae*, *Yucca angustissima*, and *Brickellia longifolia*. The trees *Juniperus osteosperma* or *Cercis orbiculata (= Cercis occidentalis var. orbiculata)* may be present with trace to low cover. Herbaceous species are moderately diverse but contribute only sparse to low cover. Common bunchgrasses include *Achnatherum hymenoides, Hesperostipa comata, Leymus salinus*, and *Pleuraphis jamesii*. Forbs include *Dalea* sp., *Machaeranthera canescens, Lepidium fremontii, Amsonia tomentosa*, and *Artemisia ludoviciana*. Scattered *Juniperus osteosperma* trees may be present with low cover.

Global Vegetation: This association is characterized by a moderately dense (30-50%) cold-deciduous tall-shrub canopy typically 2-5 m tall and dominated by *Fraxinus anomala*. Associated tall shrubs include *Amelanchier alnifolia* and *Quercus gambelii*. Taller trees are sometimes present and include *Juniperus osteosperma, Pinus edulis*, or *Pseudotsuga menziesii*. Short shrubs contribute low cover and include *Brickellia longifolia, Coleogyne ramosissima, Ephedra viridis, Ephedra torreyana, Ericameria nauseosa, Gutierrezia sarothrae, Holodiscus dumosus, Rhus trilobata, Symphoricarpos rotundifolius, Vitis arizonica*, and *Yucca angustissima*. Herbaceous species are variable and contribute minimal cover. Common species include *Achnatherum hymenoides, Amsonia tomentosa, Artemisia ludoviciana, Elymus elymoides, Eriogonum* spp., *Hesperostipa comata, Leymus salinus, Lepidium fremontii, Machaeranthera canescens, Pleuraphis jamesii*, and *Poa fendleriana*. Disturbed sites may contain the non-native *Bromus tectorum*.

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Global Dynamics: *Fraxinus anomola* is a shade-intolerant species requiring full exposure to sunlight and, like other ash species, may reproduce vegetatively from root crowns following fire or logging.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Fraxinus anomala*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*, *Rhus trilobata*
Herb (field)	Graminoid	*Achnatherum hymenoides*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous tree	*Amelanchier alnifolia*, *Fraxinus anomala*, *Quercus gambelii*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*, *Rhus trilobata*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Fraxinus anomala*

Other Noteworthy Species

Global: Vulnerable Plants: *Asclepias labriformis* (G3), *Shepherdia rotundifolia* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GUQ (26-Jun-2001).

Related Concepts

Global Related Concepts:

- *Fraxinus anomala* Woodland (Kittel et al. 1999a) =

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. This association is known from several locations in the Colorado Plateau region: the Roan Plateau and Colorado National Monument in western Colorado, Canyonlands National Park, Capitol Reef National Park, Zion National Park, and Glen Canyon National Recreation Area. More survey and classification work are needed to fully describe this association rangewide. *Fraxinus anomala* is present in many montane shrubland and woodland communities on the Colorado Plateau but is only a dominant species in this association.

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Element Distribution

Glen Canyon National Recreation Area Range: This woodland association is rare within the recreation area and was sampled in Little Valley Canyon, Fourmile Canyon, Gypsum Canyon, below Choprock Bench, south of Horsethief, and near the Dirty Devil River.

Global Range: This woodland association is known from inventory done by the National Park Service and the Bureau of Land Management in the Colorado Plateau in southern Utah and western Colorado. It may occur in similar habitats in Arizona and New Mexico.

Nations: US
States/Provinces: AZ?, CO:SU, NM?, UT
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC
Federal Lands: BLM (Escalante Canyon, Roan Plateau); NPS (Canyonlands, Capitol Reef, Colorado, Glen Canyon, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Occasional flooding in the canyon bottom and rockfall control plant distribution.

Glen Canyon National Recreation Area Plots: The description is based on 2011, 2013, 2014, and 2015 field data (2 plots, 4 accuracy assessment points): (Plot: GLCA.1016, GLCA.5511; AA Points: GLCA_AA.0435, GLCA_AA.0544, GLCA_AA.0550, GLCA_AA.1194).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): G. Kittel, J. Drake and J. Coles
References: CNHP 2015, CNHP Ecology Team 2001, Clark et al. 2009, Cogan et al. 2004, Girard et al. 1987, Kittel et al. 1999a, Romme et al. 1993, Von Loh et al. 2007, Welsh et al. 1987, Western Ecology Working Group n.d.*

A3803 Populus fremontii - Fraxinus velutina - Salix gooddingii Riparian Forest & Woodland Alliance
Alliance Summary Description: This alliance consists of riparian woodlands dominated by *Populus fremontii* or *Salix gooddingii* often with *Fraxinus velutina*, although there are many associations and stands without ash. It occurs along streams and rivers of the southwestern U.S. in Arizona, southern Utah and southwestern New Mexico and northern Mexico, and is limited to the warm Sonoran and Chihuahuan deserts and southern edge of the Colorado Plateau.

[CEGL002684] Populus fremontii - Salix gooddingii / Salix exigua Riparian Forest
Translated Name: Fremont Cottonwood - Goodding's Willow / Narrowleaf Willow Riparian Forest
Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
MacroGroup: Interior Warm & Cool Desert Riparian Forest (M036)
Group: Western Interior Riparian Forest & Woodland (G797)

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Alliance: *Populus fremontii - Fraxinus velutina - Salix gooddingii* Riparian Forest & Woodland Alliance (A3803)

Element Concept

Global Summary: This community occurs primarily in the Colorado Plateau, along the lowland river valleys of the Gila River Basin of New Mexico, and on Colorado River tributaries in Arizona and Utah. This type is characterized by tall trees of *Populus fremontii* and *Salix gooddingii*, with a shrubby understory dominated by *Salix exigua*. Other trees present include *Alnus oblongifolia, Platanus wrightii*, or *Fraxinus velutina*. Other shrubs that may be present include *Baccharis salicifolia, Ericameria nauseosa*, and *Rhus aromatica*. The non-native *Tamarix ramosissima* can be abundant. The herbaceous layer is usually well-developed with a diversity of native obligate wetland graminoids and pioneering forbs. Stands occur at elevations ranging between 1117 and 1525 m (3600-5000 feet). Stream gradients are low to moderate (0.3% on average), and channel substrates tend to be sands and gravels. Typically, it occurs on low- to mid-level sand and gravel bars within active stream channels that are at bankfull discharge stage or just above it and hence flooded from every one to five years. Soils are moist, well-drained Entisols that are either sandy throughout or sandy underlain by a gravelly matrix. They tend to be dry on the surface most of the year but are usually moist within the rooting zone of most species, particularly during spring runoff.

Environmental Description

Glen Canyon National Recreation Area Environment: This riparian forest association occurs on intermittently flooded to permanently flooded low-lying areas, including canyon bottom washes, streambanks, and springs, often near perennial water. Sites are flat or slope gently and lie between 1117 and 1529 m elevation. Litter, bare soil, and downed wood cover most of the unvegetated surface, with sparse cover by sand and gravel. Soils range from rapidly drained to poorly drained sandy loams, loamy sands, and silt loams derived from alluvium.

Global Environment: This community occurs in lowland river valleys at elevations ranging between 1117 and 1525 m (3600-5000 feet). The stream gradients are low to moderate (0.3% on average), and channel substrates tend to be sands and gravels. Typically, it occurs on low- to mid-level sand and gravel bars and streambanks of active channels that are at bankfull discharge or just above and hence flooded from every one to five years. Soils are moist, well-drained Entisols that are either sandy throughout or sandy underlain by a gravelly matrix. They tend to be dry on the surface most of the year but are usually moist within the rooting zone of most species, particularly during spring runoff.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Fremont cottonwood type grows in low-lying areas within the park. Total vegetation cover ranges from 26 to nearly 100%. Stands are characterized by a canopy between 5 and 25 m tall codominated by *Populus fremontii* and *Salix gooddingii* with up to 35% individual cover. The understory is dominated by low to dense cover of *Salix exigua*, with 4 to 40% cover. *Acer negundo* may be present in the tree canopy, but with only trace to very low cover. Associated shrubs with low to moderate cover include *Ericameria nauseosa, Rhus aromatica*, and *Baccharis salicina*. The herbaceous layer is variable in cover and composition and

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Subset: GLCA; Glen Canyon National Recreation Area

includes a diversity of both graminoids and forbs; *Achnatherum hymenoides, Elymus trachycaulus, Juncus* spp., *Equisetum* spp., *Distichlis spicata, Euthamia occidentalis (= Solidago occidentalis),* and *Senecio spartioides* are common species. The vine *Clematis ligusticifolia* is a common species. Introduced species such as *Elaeagnus angustifolia, Bromus rubens,* and *Bromus tectorum* are often present in disturbed stands.

Global Vegetation: This type is characterized by young to middle-aged stands of *Populus fremontii* and *Salix gooddingii*, with a shrubby understory dominated by *Salix exigua*. Stands are moderately open to closed (40-85% cover). Saplings of *Alnus oblongifolia, Platanus wrightii*, or *Fraxinus velutina* may be common in the understory. Other shrub species that may be common but not dominant include *Baccharis salicifolia, Ericameria nauseosa,* and *Rhus aromatica*. In some stands, *Tamarix ramosissima* has invaded and is well-represented. The vine *Clematis ligusticifolia* can be a common species. The herbaceous layer is usually well-developed with a diversity of native obligate wetland graminoids and pioneering forbs. Of the 37 grasses and forbs recorded for the type, 14 are wetland indicators. The most common natives are *Juncus torreyi, Paspalum distichum, Muhlenbergia asperifolia, Cicuta douglasii,* and *Equisetum laevigatum*. Common non-native species present include *Elaeagnus angustifolia, Tamarix* spp., *Bromus rubens, Bromus tectorum, Agrostis stolonifera, Echinochloa crus-galli,* and *Polypogon monspeliensis*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*, *Salix gooddingii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Baccharis salicina*, *Salix exigua*
Herb (field)	Liana	*Clematis ligusticifolia*
Herb (field)	Graminoid	*Muhlenbergia asperifolia*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*, *Salix gooddingii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Salix exigua*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Populus fremontii*, *Salix exigua*, *Salix gooddingii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Elaeagnus angustifolia* (High), *Tamarix ramosissima* (High)

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Global: Invasive/Exotic Plants: *Agrostis stolonifera* (Medium/Low), *Bromus rubens*, *Bromus tectorum* (High), *Echinochloa crus-galli* (Medium/Insignificant), *Elaeagnus angustifolia* (High), *Polypogon monspeliensis* (High/Low), *Tamarix* spp.

Conservation Status Rank

Global Rank & Reasons: G2 (4-Apr-2001).

Related Concepts

Global Similar Types:

- *Populus angustifolia / Salix exigua* Riparian Woodland (CEGL000654)
- *Populus fremontii - Salix gooddingii / Baccharis salicifolia* Riparian Forest (CEGL002683)
- *Populus fremontii - Salix gooddingii* Riparian Woodland (CEGL000944)
- *Populus fremontii / Baccharis salicifolia* Riparian Woodland (CEGL000941)
- *Populus fremontii / Frangula betulifolia - Quercus gambelii* Spring & Riparian Woodland (CEPP005699)
- *Populus fremontii / Salix exigua* Riparian Forest (CEGL000666)
- *Salix gooddingii / Salix exigua* Riparian Woodland (CEGL003778)

Global Related Concepts:

- *Populus fremontii / Salix gooddingii* Community Type (Campbell and Dick-Peddie 1964) >
- *Populus fremontii / Salix gooddingii* Community Type (Szaro 1989) >
- *Populus fremontii / Salix gooddingii* Vegetation Type (Dick-Peddie 1993) >
- *Populus fremontii / Salix gooddingii* community type (Reichenbacher 1984) >
- Fremont Cottonwood-Goodding Willow/Coyote Willow CT (Muldavin et al. 2000a) =

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: The northern extent of this association is largely known from National Park Service inventory efforts in the Colorado Plateau. This is a mid-successional community that forms between the early herbaceous/shrub types on low bars following floods and the late-mature forest types of upper terraces, and is maintained by frequent flooding, especially in confined canyons. This type is closely related to both *Populus fremontii / Baccharis salicifolia* Riparian Woodland (CEGL000941) and *Populus fremontii - Salix gooddingii / Baccharis salicifolia* Riparian Forest (CEGL002683) (Muldavin et al. 2000a). All three types, in turn, are probably refinements of the Fremont cottonwood - willow type of Laurenzi et al. (1983) and Brown et al. (1979), and *Populus fremontii / Salix gooddingii* community type of Reichenbacher (1984) and Szaro (1989) documented for Arizona, and by Campbell and Dick-Peddie (1964) and Dick-Peddie (1993) in New Mexico.

This type is closely related to both the *Populus fremontii / Baccharis salicifolia* CT and *Populus fremontii - Salix gooddingii / Baccharis salicifolia* CT. These types, in turn, are probably further refinements of the Fremont cottonwood-willow type of Laurenzi et al. (1983) and Brown et al. (1979b), and the *Populus fremontii / Salix gooddingii* community type of Reichenbacher (1984) and Szaro (1989) documented for Arizona, and by Campbell and Dick-Peddie (1964) and Dick-Peddie (1993) in New Mexico.

Element Distribution

Glen Canyon National Recreation Area Range: This riparian forest is distributed in low-lying areas along drainages and canyon bottoms within the recreation area and was sampled in Big Water Spring, Coyote Gulch, Dry Fork, Escalante River, Willow Gulch, Farley Canyon, Hansen Creek, Harris Wash, and Hurricane Wash.

Global Range: This community occurs primarily in the Colorado Plateau along the lowland river valleys of the Gila River Basin of New Mexico, and on Colorado River tributaries in Arizona and Utah.

Nations: US
States/Provinces: AZ?, NM:S1, UT
TNC Ecoregions: 19:C, 21:P, 24:P
USFS Ecoregions (1994/95): 313A:CC, 321A:CC, M313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: The willows and cottonwoods grow here because of high groundwater levels. Well-shaded by cottonwood overstory, well-moistened by nearby river and any flood events, ground surface well-covered by dense leaf litter.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2012 field data (10 plots): (Plots: GLCA.4102, GLCA.4138, GLCA.4297, GLCA.4307, GLCA.4319, GLCA.4326, GLCA.5221, GLCA.5235, GLCA.5263, GLCA.9110).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): E. Muldavin et al. (2000a) and G. Kittel
References: Campbell and Dick-Peddie 1964, Dick-Peddie 1993, Muldavin et al. 2000a, Muldavin et al. 2000a*, NHNM unpubl. data, Reichenbacher 1984, Szaro 1989, Western Ecology Working Group n.d.

[CEGL000944] Populus fremontii - Salix gooddingii Riparian Woodland
Translated Name: Fremont Cottonwood - Goodding's Willow Riparian Woodland
Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
MacroGroup: Interior Warm & Cool Desert Riparian Forest (M036)
Group: Western Interior Riparian Forest & Woodland (G797)
Alliance: *Populus fremontii - Fraxinus velutina - Salix gooddingii* Riparian Forest & Woodland Alliance (A3803)

Element Concept

Global Summary: This riparian woodland community occurs from the Trans-Pecos region of western Texas to the Mojave Desert in southeastern California, north into the Colorado Plateau in western Colorado and southern Utah. *Populus fremontii* and *Salix gooddingii* may be nearly equal in

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Subset: GLCA; Glen Canyon National Recreation Area

abundance, or either may dominate. The understories of most examples have been considerably altered by grazing and other factors, thus the shrub layer is generally lacking. A large variety of shrub and tree saplings may be present; however, these do not form a true shrub layer. An herbaceous layer is often present and dominated by a mix of annuals and short-lived perennials. This association is dependent upon a subsurface water supply which varies considerably throughout the growing season. Major flood events and consequent flood scour, overbank deposition of water and sediments, and stream meandering are important factors that shape this community. Soils are typically stratified sands, loams, and gravels. This deciduous woodland typically towers above the surrounding vegetation.

Environmental Description

Glen Canyon National Recreation Area Environment: This riparian woodland association occurs on intermittently flooded to permanently flooded low-lying areas, including washes, terraces, seeps, and springs, often near perennial water. Sites are flat or slope gently and lie between 1074 and 1260 m elevation. Litter, bare soil, and sand cover most of the unvegetated surface, with lesser cover by water, live vegetation litter, wood, and gravel. Soils range from moderately well-drained to somewhat poorly drained loamy sands and silt loams derived from alluvium.

Global Environment: This deciduous woodland is best developed along alluvial floodplains of large, low-gradient, perennial streams that flow through wide, unconstrained valleys. It has also been recorded surrounding perennially wet potholes within intermittent canyon drainages, as well as in the floodplains of intermittent streams. The vegetation is dependent upon a subsurface water supply and varies considerably with the height of the water table. Major flood events and consequent flood scour, overbank deposition of water and sediments, and stream meandering are important factors that shape this community. Soils are typically stratified sands, loams, and gravels classified as Torrifluvents or Ustifluvents, with Haplustolls on more stable sites. These coarse-textured, alluvial sediments have a low water-holding capacity and low nutrient availability.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This rare Fremont cottonwood type grows in low-lying areas within the park. Total vegetation cover ranges from 16 to 89%. Stands are characterized by a canopy between 5 and 20 m tall codominated by *Populus fremontii* (with up to 65% cover) and *Salix gooddingii* (with 2-16% cover). *Acer negundo* may be present in the tree canopy with low cover. The understory has low to moderate shrub cover, with characteristic shrub species, including *Ericameria nauseosa, Atriplex canescens, Rhus aromatica, Gutierrezia sarothrae*, and *Baccharis salicina*. The herbaceous layer is variable in cover and composition and includes a diversity of both graminoids and forbs; *Juncus* spp., *Equisetum* spp., *Euthamia occidentalis (= Solidago occidentalis), Lepidium montanum, Carex* spp., *Elymus canadensis, Muhlenbergia asperifolia, Poa fendleriana*, and *Artemisia ludoviciana* are common species. The vine *Clematis ligusticifolia* is also a common species. Introduced species such as *Elaeagnus angustifolia, Tamarix* spp., and *Bromus tectorum* are often present with low to moderate cover in disturbed stands.

Global Vegetation: This community occurs as small isolated stands or as narrow bands that parallel the stream channel or border potholes. This deciduous woodland typically towers above the surrounding vegetation, with *Populus fremontii* and *Salix gooddingii* as the dominant species. These

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species may be nearly equal in abundance, or either may dominate. Individuals of *Populus fremontii* are scattered or occur in groves and may reach 30 m in height and 2 m in diameter. Other species that may occur in the canopy/subcanopy include *Populus deltoides ssp. wislizeni, Acer negundo, Salix lasiolepis, Salix amygdaloides, Fraxinus berlandieriana, Celtis laevigata var. reticulata, Fraxinus velutina, Juglans microcarpa, Prosopis pubescens, Prosopis glandulosa*, and *Prosopis velutina*. The understory of most examples has been considerably altered by grazing and other factors, thus the composition and cover of the native understory is difficult to ascertain. The understory is highly variable with an open coverage of shrubs and small trees 1-5 m tall, that do not form a true shrub or subcanopy layer, and include such species as *Prosopis* spp., *Baccharis salicifolia, Ericameria nauseosa, Atriplex canescens, Rhus aromatica, Gutierrezia sarothrae, Salix exigua, Sambucus nigra ssp. caerulea (= Sambucus mexicana), Rhamnus* spp., *Morus microphylla*, and *Amorpha fruticosa*. The woody exotics *Elaeagnus angustifolia* and various species of *Tamarix* can be abundant. The herbaceous stratum varies in composition and coverage but is characterized by mixed annuals and short-lived perennials. While most examples now have a herbaceous flora dominated by exotic species, in particular *Cynodon dactylon*, native species reported from this community include *Amaranthus palmeri, Amsinckia* spp., *Anemopsis californica, Boerhavia coccinea, Bowlesia incana, Carex* spp., *Chloracantha spinosa, Conyza canadensis var. canadensis, Cucurbita* spp., *Datura wrightii, Distichlis spicata, Euthamia occidentalis, Gutierrezia sarothrae, Juncus balticus, Lemna* spp., *Oenothera* spp., *Sorghum halepense, Sporobolus wrightii*, and *Trifolium longipes ssp. shastense*. Exotic plant species found in this community include *Tamarix chinensis, Elaeagnus angustifolia, Cynodon dactylon, Bromus rubens, Hordeum murinum ssp. leporinum, Pennisetum setaceum, Schismus* spp., *Sisymbrium irio*, and *Erodium* spp.

Global Dynamics: This association is dependent on periodic flooding and a water table that remains high throughout the growing season. As riparian terraces become isolated from the water table, the understory of this community will shift toward upland species such as *Ericameria nauseosa, Prosopis* spp., *Artemisia tridentata*, and *Artemisia ludoviciana*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*, *Salix gooddingii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Baccharis salicina*, *Tamarix chinensis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Herb (field)	Graminoid	*Juncus* spp.
Herb (field)	Fern (Spore-bearing forb)	*Equisetum* spp.

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Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*, *Salix gooddingii*
Tree subcanopy	Broad-leaved deciduous tree	*Fraxinus velutina*, *Prosopis* spp.
Tall shrub/sapling	Broad-leaved deciduous shrub	*Baccharis* spp.

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Populus fremontii, Salix gooddingii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Elaeagnus angustifolia* (High), *Tamarix chinensis*, *Tamarix ramosissima* (High)

Global: Vulnerable Plants: *Trifolium longipes* ssp. *shastense* (G5T2T3); Invasive/Exotic Plants: *Bromus rubens*, *Cynodon dactylon* (Medium/Low), *Elaeagnus angustifolia* (High), *Erodium* spp., *Hordeum murinum* ssp. *leporinum*, *Pennisetum setaceum* (High/Medium), *Schismus* spp., *Sisymbrium irio* (Medium/Insignificant), *Sorghum halepense* (High/Medium), *Tamarix chinensis*, *Xanthium strumarium*

Conservation Status Rank

Global Rank & Reasons: G2 (23-Feb-1994). Few intact examples of this association remain in the southwestern United States. The association continues to be in decline, primarily as a function of major hydrological alterations (dams and diversions), grazing, off-road vehicles and agricultural conversion. The remaining functional stands are restricted to wild rivers such as the Gila and San Francisco rivers, and possibly along the Mimbres River in New Mexico, or the San Pedro River in Arizona. A few remnant stands are also known from the middle Rio Grande and a few locations in western Texas. This is a very significant association with respect to biodiversity and was once one of the major riparian communities of the Southwest. Stands that have not been invaded by exotic trees, shrubs and herbs are also very rare. Even protected examples are threatened by continued declines in upland watershed conditions and hydrological modification.

Related Concepts

Global Similar Types:

- *Populus deltoides (ssp. wislizeni, ssp. monilifera) - Salix gooddingii* Flooded Forest (CEGL005964)
- *Populus fremontii - Fraxinus velutina* Riparian Woodland (CEGL000942)
- *Populus fremontii - Salix gooddingii / Baccharis salicifolia* Riparian Forest (CEGL002683)
- *Populus fremontii - Salix gooddingii / Salix exigua* Riparian Forest (CEGL002684)
- *Populus fremontii / Baccharis (emoryi, salicina)* Riparian Woodland (CEGL002946) occurs in similar riparian habitats; *Populus fremontii* is also present in the canopy, but *Salix gooddingii* is absent.
- *Salix gooddingii - Fraxinus velutina* Riparian Woodland (CEGL003729)

Global Related Concepts:

- *Populus fremontii / Salix gooddingii* Community Type (Szaro 1989) =
- *Populus fremontii-Salix gooddingii* (Bourgeron and Engelking 1994) =
- *Populus fremontii-Salix goodingii* (Evens et al. 2014) =
- Broadleaf Cottonwood / Willow Woodland (Boles and Dick-Peddie 1983) =
- Cottonwood-Willow Series (Diamond 1993) **?**
- DRISCOLL FORMATION CODE:II.B.3.a. (Driscoll et al. 1984) >
- IIA7d. Western Cottonwood - Willow Riverfront Forest (Allard 1990) **?**

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. In Trans-Pecos Texas this woodland is dependent on a subsurface water supply and varies considerably with the water table levels. Major flood events and consequent flood scour, overbank deposition of water and sediments, and stream meandering are important factors that shape this community. These woodlands once occupied the floodplains and riverbanks of most perennial waterways within its range, but have mostly been replaced by disturbance types dominated by exotic species.

Element Distribution

Glen Canyon National Recreation Area Range: This rare riparian forest is distributed in low-lying areas along drainages and canyon bottoms within the recreation area and was sampled in Moqui Canyon, Coyote Gulch, along the Escalante River, and in Bown's Canyon.

Global Range: This riparian community occurs widely across the southwestern U.S., from the Trans-Pecos region of western Texas to the Mojave Desert in southeastern California, north into the Colorado Plateau in western Colorado and southern Utah and likely the southern Great Basin and northern Sonoran Desert. It also likely extends south into northern Mexico but more research is needed.

Nations: MX?, US
States/Provinces: AZ:S2, CA, CO:S1, MXCH?, MXSO?, NM:S2, NV?, TX:S3, UT
TNC Ecoregions: 11:?, 17:C, 19:C, 21:C, 22:C, 23:?, 24:C
USFS Ecoregions (1994/95): 313A:CC, 321A:CC, 322A:CC, 322B:C?, 341B:CC, 341F:C?, M313A:CC
Federal Lands: NPS (Capitol Reef, Death Valley, Glen Canyon, Grand Canyon, Mojave, Tuzigoot); USFWS (Buenos Aires)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plot represents a band of *Populus fremontii*-dominated riparian vegetation with *Salix gooddingii* and *Acer negundo* in the subcanopy. Between this community and the canyon wall, there are some swales where the canopy is less dense and the understory is *Equisetum*. Between the swales are patches of *Equisetum laevigatum* and *Toxicodendron rydbergii* or *Baccharis emoryi*.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (4 plots, 2 accuracy assessment points): (Plots: GLCA.4289, GLCA.4299, GLCA.4304, GLCA.5213; AA Points: GLCA_AA.1260, GLCA_AA.1999).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): E. Milford, E. Muldavin, J. Coles, G. Kittel, K.A. Schulz
References: Allard 1990, Boles and Dick-Peddie 1983, Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Campbell and Dick-Peddie 1964, Clark et al. 2009, Diamond 1993, Diamond et al. 1992, Driscoll et al. 1984, Evens et al. 2014, Grossman et al. 1994, Metcalfe 1902, NHNM unpubl. data, Reid and Hall 2010, Romme et al. 1993, Schulz 2004, Stromberg 1993a, Szaro 1989, TNC 1992b, TNC 1995e, Western Ecology Working Group n.d.*

[CEGL000662] Populus fremontii / Acer negundo Riparian Forest
Translated Name: Fremont Cottonwood / Box-elder Riparian Forest
Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup: Interior Warm & Cool Desert Riparian Forest (M036)
Group: Western Interior Riparian Forest & Woodland (G797)
Alliance: *Populus fremontii - Fraxinus velutina - Salix gooddingii* Riparian Forest & Woodland Alliance (A3803)

Element Concept

Global Summary: This forested riparian association is known from canyon bottoms in southwestern New Mexico, southern Utah and northern Arizona, but it is likely to also occur in Nevada and California. *Populus fremontii* and *Acer negundo* form the dominant overstory canopy, often with *Juglans major* as a codominant in the southern part of the range. Associated woody understory species form a very open canopy and do not form a true shrub layer, and may include *Artemisia tridentata, Baccharis salicina, Brickellia longifolia, Brickellia californica, Ericameria nauseosa, Quercus gambelii, Rhus aromatica, Rhus trilobata, Salix exigua,* and *Toxicodendron rydbergii*. The herbaceous component of the community is variable depending on the site, the depth to water table and the flood frequency. Stands occur on gently sloping, lower riparian terraces associated with perennial streams. These are sites that flood periodically but not necessarily annually.

Environmental Description

Glen Canyon National Recreation Area Environment: This riparian forest association occurs on intermittently flooded low-lying areas such as canyon bottoms and wash terraces. Sites are flat to gently sloping and lie between 1183 and 1668 m elevation. Litter, sand, and bare soil cover most of the unvegetated surface, with low cover by downed wood, rocks, and live vegetation litter. Soils are moderately well-drained to well-drained loamy sands derived from alluvium.

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Global Environment: Stands occur on gently sloping, lower riparian terraces, canyon bottoms, and washes associated with perennial streams. These are sites that flood periodically but not annually. Soils are coarse, sandy and generally are poorly developed.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This rare Fremont cottonwood - box-elder type grows in low-lying areas within the park. Total vegetation cover ranges from 51 to 92%. Stands are characterized by a dense canopy between 5 and 15 m tall codominated by *Populus fremontii* (with 6 to 30% cover) and *Acer negundo* (with 9 to 20% cover). *Salix gooddingii* is absent. The often dense understory contains a variety of shrubs, including *Ericameria nauseosa, Artemisia tridentata, Rhus aromatica, Salix exigua, Baccharis salicina, Brickellia californica, Toxicodendron rydbergii*, and *Quercus gambelii*. The herbaceous layer is variable and includes a diversity of both graminoids and forbs; *Clematis ligusticifolia, Artemisia ludoviciana, Conyza canadensis, Lepidium montanum, Euthamia occidentalis (= Solidago occidentalis), Machaeranthera canescens, Medicago sativa, Elymus trachycaulus, Elymus canadensis, Juncus tenuis, Sporobolus contractus,* and *Equisetum* spp. are common species. Introduced species such as *Elaeagnus angustifolia, Tamarix chinensis, Salsola tragus*, and *Bromus tectorum* are often present in disturbed stands.

Global Vegetation: In this association, *Populus fremontii* and *Acer negundo* form moderate to dense canopies, sometimes accompanied by *Juglans major* as a codominant in the southern part of the range. *Salix gooddingii* is absent. Associated woody understory species in the Colorado Plateau include *Ericameria nauseosa, Artemisia tridentata, Rhus aromatica, Rhus trilobata, Salix exigua, Brickellia longifolia, Baccharis salicina, Brickellia californica, Toxicodendron rydbergii*, and *Quercus gambelii*. Associated woody species in southern New Mexico include *Ptelea trifoliata var. angustifolia (= Ptelea angustifolia)* and *Amorpha fruticosa*. The herbaceous component of the community is variable depending on the site, the depth to water table and the flood frequency. The herbaceous layer includes a diversity of both graminoids and forbs; *Clematis ligusticifolia, Artemisia ludoviciana, Conyza canadensis, Lepidium montanum, Euthamia occidentalis (= Solidago occidentalis), Machaeranthera canescens, Medicago sativa, Elymus trachycaulus, Elymus canadensis, Juncus tenuis, Sporobolus contractus,* and *Equisetum* spp. are common species.

Global Dynamics: This association occurs on lower terraces and sometimes on the banks of perennial streams. The principal species depend on the water table being within 1 meter of the surface throughout the growing season in order to become established. Once established, both *Populus fremontii* and *Acer negundo* are capable of persisting (although not reproducing) as terraces become isolated from the water table.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer negundo*, *Populus fremontii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Baccharis salicina*, *Tamarix chinensis*

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Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Herb (field)	Graminoid	*Bromus tectorum*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer negundo*, *Populus fremontii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Acer negundo*, *Populus fremontii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: Bromus tectorum (High), Elaeagnus angustifolia (High), Elymus trachycaulus, Salsola tragus, Tamarix chinensis

Global: Invasive/Exotic Plants: Bromus tectorum (High)

Conservation Status Rank

Global Rank & Reasons: G2Q (1-Dec-2000). This lowland riparian association is limited to southwestern New Mexico and southern Utah where plants, particularly trees and shrubs, have access to an active groundwater table. As with many riparian zone communities in the Southwest, impacts over the past 150 years from livestock use, agricultural conversion, urbanization, recreational use, and the alteration of hydrological regimes have led to extensive fragmentation and loss of this community. Viable occurrences are mostly found along unregulated rivers where periodic flooding and sustained maintenance flows lead to successful reproduction and establishment of native riparian species. In the Southwest, such unregulated rivers are few, hence the community has become globally rare, still is threatened, and declines continue today. This association is ranked G2Q to reflect its rarity and the fact that it is reported only from a single research study. More vegetation inventory and classification work are needed to resolve this questionable status.

Related Concepts

Global Similar Types:

- *Populus deltoides ssp. wislizeni / Acer negundo* Flooded Woodland (CEGL002336)

Global Related Concepts:

- *Populus fremontii - Acer negundo* Association (Vaghti 2003) =
- *Populus fremontii / Acer negundo* (Sawyer et al. 2009) =
- *Populus fremontii/Acer negundo* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:I.B.3.d. (Driscoll et al. 1984) >

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Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This northern extent of this association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Reported only by Henry (1981) but has also been documented in Capitol Reef National Park in Utah. Further east, in a zone of hybridization between *Populus fremontii* and *Populus deltoides ssp. wislizeni*, the very similar association *Populus deltoides ssp. wislizeni / Acer negundo* Flooded Woodland (CEGL002336) occurs in Natural Bridges National Monument.

Element Distribution

Glen Canyon National Recreation Area Range: This rare riparian forest is distributed in low-lying areas along drainages and canyon bottoms within the recreation area and was sampled in Harris Wash and Coyote Gulch.

Global Range: This association is known to occur in southwestern New Mexico, northern Arizona and southern Utah. It may occur in Nevada and California.

Nations: US
States/Provinces: AZ, CA?, NM:S2, NV?, UT
TNC Ecoregions: 11:C, 17:C, 19:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, 321A:CC, 322A:CC, 341B:CC
Federal Lands: NPS (Capitol Reef, Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: On a terrace 10 m above stream level. Terrace has two levels with *Acer negundo* dominant on lower and *Quercus gambelii* present on second higher level (closer to canyon wall). Soil is loose and easily disturbed but almost completely covered by *Populus fremontii* litter.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (2 plots, 2 accuracy assessment points): (Plots: GLCA.5244, GLCA.5245; AA Points: GLCA_AA.1293, GLCA_AA.3078).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): E. Muldavin, J. Coles and G. Kittel
References: Bourgeron and Engelking 1994, Clark et al. 2009, Driscoll et al. 1984, Henry 1981, Reid and Hall 2010, Romme et al. 1993, Sawyer et al. 2009, Vaghti 2003, Western Ecology Working Group n.d.*

[CEGL002946] Populus fremontii / Baccharis (emoryi, salicina) Riparian Woodland
Translated Name: Fremont Cottonwood / (Emory's Baccharis, Willow Baccharis) Riparian Woodland

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Subset: GLCA; Glen Canyon National Recreation Area

Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup: Interior Warm & Cool Desert Riparian Forest (M036)
Group: Western Interior Riparian Forest & Woodland (G797)
Alliance: *Populus fremontii - Fraxinus velutina - Salix gooddingii* Riparian Forest & Woodland Alliance (A3803)

Element Concept

Global Summary: This Fremont cottonwood woodland association occurs in riparian areas in the Colorado Plateau. This association is characterized by an open to moderately dense tree canopy solely dominated by *Populus fremontii* (15-35%). The understory is a distinct shrub layer consisting mostly of *Baccharis emoryi* and/or *Baccharis salicina* often with *Salix exigua*. Other small trees or shrubs may be present with low cover such as *Cercis orbiculata, Fallugia paradoxa, Purshia stansburiana*, and *Salix gooddingii*. *Brickellia longifolia, Chrysothamnus linifolius, Pluchea sericea*, and exotic *Tamarix* spp. may also be present. If present, herbaceous cover is generally low (<10% cover) and is composed of wetland graminoid species such as *Phragmites australis, Cladium californicum, Imperata brevifolia,* and *Muhlenbergia asperifolia*. Forb cover averages about 2% and includes species such as *Typha* spp., *Oenothera elata,* and *Artemisia ludoviciana*; *Equisetum hyemale* may occur as well. Stands occur on flat canyon bottoms, benches, floodplains, and along intermittent streams, between 725 to 1200 m (2325-5175 feet) elevation on gently sloping drainage channels on low levels and interfluves. Soils are poorly drained to rapidly drained sands and sandy loams derived from various parent materials that are commonly obscured by the soil. Ground cover is mostly litter, surface rocks and bare soil. This is a riparian vegetation type and is restricted to areas with perennial creeks and/or reliable springs and seeps.

Environmental Description

Glen Canyon National Recreation Area Environment: This rare woodland association occurs on flat canyon bottoms, benches, floodplains, and along intermittent streams, between 961 and 1105 m elevation. Bare soil, sand, and litter cover most of the unvegetated surface, with lesser cover by dead wood. Soils are well-drained to rapidly drained sands derived from alluvium.

Global Environment: This Fremont cottonwood woodland association occurs on flat canyon bottoms, benches, floodplains, and along intermittent streams, between 725 to 1200 m (2325-5175 feet) elevation on gently sloping drainage channels on low levels and interfluves (Reid and Hall 2010). Soils are poorly drained to rapidly drained sands and sandy loams derived from various parent materials that are commonly obscured by the soil. Ground cover is mostly by litter, surface rocks and bare soil. This is a riparian vegetation type and is restricted to areas with perennial creeks and/or reliable springs and seeps.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Fremont's cottonwood woodland with a willow baccharis understory has moderate total vegetation cover of 42-44%. Stands are characterized

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by a moderately dense canopy of *Populus fremontii* trees 2-10 m tall, with 27 to 34% cover, and a sparse shrub understory dominated by *Baccharis salicina*, with 4 to 8% cover. Other shrubs present with low cover may include *Pluchea sericea, Salix exigua, Tamarix chinensis*, and *Chrysothamnus linifolius*. The only herbaceous species noted with more than trace cover was the exotic *Salsola tragus*.

Global Vegetation: This association is somewhat variable depending on site conditions, but always has a tree canopy comprised almost exclusively of *Populus fremontii* (15-35%) (Reid and Hall 2010). Beneath the tree canopy is a well-defined tall-shrub layer consisting mostly of *Baccharis emoryi* and/or *Baccharis salicina* often with *Salix exigua*. Other tall shrubs may be present with low cover, such as *Cercis orbiculata, Fallugia paradoxa, Purshia stansburiana*, and *Salix gooddingii*. *Brickellia longifolia, Chrysothamnus linifolius, Pluchea sericea*, and exotic *Tamarix* spp. may also be present. If present, herbaceous cover is generally low (<10% cover) and is composed of wetland graminoid species such as *Phragmites australis, Cladium californicum, Imperata brevifolia*, and *Muhlenbergia asperifolia*. Forb cover averages about 2% and includes species such as *Typha* spp., *Oenothera elata*, and *Artemisia ludoviciana*; *Equisetum hyemale* occurs in some stands as well. The undulating terrain in drainages and interfluves is capable of supporting xeric understory species as well, including *Aristida purpurea, Achnatherum speciosum*, and *Datura wrightii*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Baccharis salicina*, *Pluchea sericea*, *Salix exigua*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Baccharis salicina*, *Salix exigua*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Baccharis emoryi*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Baccharis emoryi, Baccharis salicina, Populus fremontii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Salsola tragus, Tamarix chinensis*
Global: Vulnerable Plants: *Imperata brevifolia* (G3); Invasive/Exotic Plants: *Tamarix chinensis, Tamarix ramosissima* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (14-Aug-2001).

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Related Concepts

Global Similar Types:

- *Populus fremontii - Salix gooddingii* Riparian Woodland (CEGL000944)

Classification

Status: Standard
Classification Confidence:
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This extremely rare woodland association was sampled near Lee's Ferry and in Trachyte Canyon.

Global Range: This Colorado Plateau association has been described from Grand Canyon and Zion national parks and Glen Canyon National Recreation Area in southern Utah and northern Arizona.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon, Grand Canyon, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Riparian corridor with (almost) perennial waterflows. Community occurs along the stream channel and on very slightly elevated adjacent benches.

Glen Canyon National Recreation Area Plots: The description is based on 2011 and 2013 field data (2 plots): (Plots: GLCA.2040 GLCA.5503).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Cogan et al. 2004, Reid and Hall 2010, Western Ecology Working Group n.d.*

[CEPP005699] Populus fremontii / Frangula betulifolia - Quercus gambelii Spring & Riparian Woodland
Translated Name: Fremont Cottonwood / Beechleaf Frangula - Gambel Oak Spring & Riparian Woodland

Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup: Interior Warm & Cool Desert Riparian Forest (M036)
Group: Western Interior Riparian Forest & Woodland (G797)

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Alliance: *Populus fremontii - Fraxinus velutina - Salix gooddingii* Riparian Forest & Woodland Alliance (A3803)

Element Concept

Global Summary: This riparian cottonwood community occurs on slope-springs and riparian areas where deep alluvial soils can accommodate cottonwood phreatophytic roots. It is characterized by an overstory canopy of tall cottonwood, willows and/or box-elders which are structurally striking, but can be very low in cover, sometimes <10%, but may be up to 75%. The shrub layer is characteristically fairly dense with a moderate to high cover of *Quercus gambelii, Frangula betulifolia,* and/or *Rhus trilobata*. Herbaceous cover can be minimal or lush. Other tree species present may include *Juniperus osteosperma, Salix gooddingii, Salix amygdaloides,* and *Acer negundo*. This association is located in desert of the southwestern U.S., canyons of southern Utah, and on the central Colorado Plateau and is likely to be found in northern Arizona.

Environmental Description

Global Environment: These wetland and riparian stands occur around hillslope springs and perennial streams and their upper terraces. Springs have seasonal (often dry by mid-June) to permanent (but variable) flow, and are generally within 100 m of a riparian zone, but occur specifically because there is a spring on the slope above. They are structurally simple with just the sloped area around the spring. These springs and associated community occur from 60 m to 1.5 km apart from each other, and occur along the Navajo-Kayenta and Kayenta-Chinle formations interface, as well as within the Chinle Formation.

Vegetation Description

Global Vegetation: These are woody wetlands dominated by the presence of an overstory canopy that may be low cover (<10%) or high (>75%), with *Populus fremontii ssp. fremontii* and/or *Acer negundo, Salix gooddingii*, *Salix amygdaloides*, and *Juniperus osteosperma*. While the tree canopy cover may be low (< 30%), the influence is notable. Shrub understory ranges from 5-50% cover and consists of one or more of wetland facultative species, and is usually dominated by *Quercus gambelii*, with some amount of *Frangula betulifolia* and/or *Rhus trilobata* present to abundant, but not all stands have all three shrubs and some stands lack *Frangula betulifolia*. Other mesic woody species present include *Baccharis salicina, Betula occidentalis, Cercis orbiculata (= Cercis occidentalis var. orbiculata), Celtis laevigata var. reticulata (= Celtis reticulata), Clematis ligusticifolia, Ericameria nauseosa, Fraxinus anomala, Mahonia fremontii, Shepherdia rotundifolia, Amelanchier utahensis, Mahonia repens, Rosa woodsii, Toxicodendron rydbergii, Yucca angustissima var. toftiae (= Yucca toftiae),* and *Salix exigua*. Herbaceous cover is low, ranging from <1% to about 10% and includes *Adiantum capillus-veneris, Andropogon glomeratus, Apocynum cannabinum, Asclepias speciosa, Calamagrostis scopulorum, Carex aquatilis, Carex aurea, Carex curatorum (= Carex haysii), Carex hystericina, Carex pellita, Cirsium calcareum, Epipactis gigantea, Equisetum arvense, Equisetum hyemale, Eurybia glauca, Euthamia occidentalis, Fimbristylis thermalis (= Fimbristylis spadicea), Glyceria striata, Juncus balticus, Juncus torreyi, Lobelia cardinalis, Maianthemum stellatum, Muhlenbergia asperifolia, Oenothera elata, Dichanthelium acuminatum (= Panicum acuminatum), Panicum virgatum, Phragmites australis, Solidago canadensis, Solidago velutina,* and *Typha domingensis*.

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Most Abundant Species

Characteristic Species

Global:

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (22-Aug-2016).

Related Concepts

Global Similar Types:

- *Frangula betulifolia* Wet Shrubland (CEPP009630)
- *Populus fremontii - Salix gooddingii / Salix exigua* Riparian Forest (CEGL002684) is a wetter type with presence of overstory *Salix gooddingii*, and a higher cover of *Populus fremontii* and an understory of *Salix exigua*.
- *Populus fremontii / Ericameria nauseosa* Riparian Woodland (CEGL002465) is very similar but with constant presence of *Ericameria nauseosa*, and a higher cover of *Populus fremontii*.
- *Populus fremontii / Salix exigua* Riparian Forest (CEGL000666) is a wetter type with understory dominated by the wetland obligate *Salix exigua*, and a higher cover of *Populus fremontii*.

Classification

Status: Provisional

Classification Confidence: 3 - Weak

Glen Canyon National Recreation Area Classification Comments: This association was called a variety of names during the field data collection. Plots and AA points from the following preliminary names have now been combined into this new association: *Quercus gambelii - Frangula betulifolia* Shrubland, *Frangula betulifolia - Parthenocissus vitacea* Shrubland, *Frangula betulifolia / Phragmites australis* Shrub Herbaceous Vegetation, and *Quercus gambelii / Phragmites australis* Shrubland. Other plots and AA points with the above names were placed into *Frangula betulifolia* Wet Shrubland (CEPP009630).

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau and classification and data from John Spence, Ph.D., Chief Scientist and Terrestrial Natural Resources Branch Chief, Science & Resource Management, Glen Canyon National Recreation Area, who feels that only true spring communities should be included and riparian stands without springs not included. However, the AA point data collection from Glen Canyon National Recreation Area does not always mention if a spring is nearby (source of water) for some perennial stream points, and many plots are clearly "just" riparian and not spring-associated. The woody overstory appears to be the same variety of shrubs and trees whether spring or not, but the herbaceous understory can have spring indicators; still, not all spring-associated plots/AA points have those herbaceous indicators. So for simplicity, NatureServe has included all of the GLCA plots and AA points that we believe fit this "*Populus fremontii / Frangula betulifolia - Quercus gambelii*" association type, even though it originally was conceived by Spence from spring

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data. This association includes "*Populus fremontii / Quercus gambelii - Rhus trilobata* Woodland" from 3 plots and 15 AA points.

Element Distribution

Global Range: These riparian woodlands occur in the central Colorado Plateau of southeastern Utah and may occur in Arizona.

Nations: US
States/Provinces: AZ?, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:C?
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Plots: The description is based on 12 plots and 26 AA points, along with several plots from J. Spence.

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): G. Kittel
References: Spence 2008*, Western Ecology Working Group n.d.

[CEGL005978] *Populus fremontii* / Scour Riparian Forest
Translated Name: Fremont Cottonwood / Scour Riparian Forest
Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup: Interior Warm & Cool Desert Riparian Forest (M036)
Group: Western Interior Riparian Forest & Woodland (G797)
Alliance: *Populus fremontii - Fraxinus velutina - Salix gooddingii* Riparian Forest & Woodland Alliance (A3803)

Element Concept

Global Summary: This association is known from the Gila River, San Francisco River and Colorado River watersheds, and is likely to occur elsewhere in southwestern U.S. This type is characterized by open to dense, young regeneration stands of *Populus fremontii*. A variety of other trees and shrubs may be present, but with low cover. As the name implies, these are recently established young stands on newly exposed sands and gravels, meaning that the vegetation has not had time to develop or the herbaceous layer has been buried under recent deposition. The vegetation structure is overstory tree canopy with very little shrub or herb cover with mostly bare ground. Scattered shrubs and herbs can often be found; however, their species composition is not characteristic of this association. *Ericameria nauseosa, Rhus aromatica, Purshia stansburiana, Salix exigua,* and *Baccharis salicifolia* are common shrubs but not abundant. Forbs and grasses are scattered and variously represented by a suite of wetland indicators that may include *Cyperus esculentus, Echinochloa crus-galli, Juncus balticus,*

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Polypogon monspeliensis, Polypogon viridis, Schoenoplectus pungens, Schoenoplectus tabernaemontani, Equisetum arvense, Polygonum lapathifolium, Rorippa sphaerocarpa, and *Veronica americana*. This early- to mid-successional forest association is found within the floodplain of large lowland valleys at elevations ranging from 1111 to 1640 m (3600-5370 feet). Stands occur on low bars or riverwash within the active channel. Sites are seasonally flooded, scouring away much of the undergrowth. Soils are either sandy, moist, weakly developed Entisols (Sandy Aquic Ustipsamments) or riverwash composed of non-cohesive and unconsolidated deposits of sands, gravels, or cobbles.

Environmental Description

Glen Canyon National Recreation Area Environment: This riparian forest association occurs on intermittently flooded to semipermanently flooded low-lying areas such as narrow canyon bottoms and along drainage and/or overflow channels. Sites are flat to gently sloping and lie between 1111 and 1562 m elevation. Sand and bare soil cover most of the unvegetated surface, with lesser cover by large and small rocks, and with sparse cover by downed wood and litter. Soils are moderately well-drained to rapidly drained sands, loamy sands, and sandy loams derived from alluvium.

Global Environment: This riparian forest association occurs on intermittently flooded to annually flooded low-lying areas such as canyon bottoms, and drainage channels and overflow channels of larger river bottoms. Stands are found within the floodplain of large lowland valleys at elevations ranging from 1111 to 1640 m (3600-5370 feet), and occur on low bars or riverwash within the active channel. Sites are seasonally flooded, scouring away much of the undergrowth. Soils are either sandy, moist, weakly developed Entisols (Sandy Aquic Ustipsamments) or riverwash composed of non-cohesive and unconsolidated deposits of sands, gravels, or cobbles.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Fremont cottonwood woodland grows in low-lying areas within the recreation area. Total vegetation cover ranges from 5 to 22%. Stands are characterized by an open canopy (2-13% cover) of *Populus fremontii* trees between 2 and 10 m tall. *Acer negundo* and *Ostrya knowltonii* trees may be present with sparse to low cover but are not codominant in the canopy layer. The understory is generally sparse (scoured out) but may contain a variety of short and tall shrubs with trace to low cover, generally growing on the margins of this community and neighboring terrace communities. Shrubs recorded include *Amelanchier utahensis, Baccharis emoryi, Brickellia longifolia, Ephedra viridis, Ericameria nauseosa, Rhus aromatica, Purshia stansburiana*, and *Salix exigua*. The herbaceous layer is variable and may include *Achnatherum hymenoides, Artemisia ludoviciana, Iva acerosa (= Oxytenia acerosa), Psoralidium lanceolatum, Sporobolus airoides*, and *Stephanomeria pauciflora*. Introduced species such as *Tamarix* spp. and *Bromus tectorum* are often present in disturbed stands.

Global Vegetation: This type is characterized by open to dense, young regeneration stands of *Populus fremontii*. A variety of other trees and shrubs may be present, but with low cover. As the name implies, these are recently established young stands on newly exposed sands and gravels. *Acer negundo* and *Ostrya knowltonii* trees may be present with sparse to low covered. Shrub species that may be present include *Ericameria nauseosa, Rhus aromatica, Purshia stansburiana, Salix exigua*, and *Baccharis salicifolia* which are common but not abundant. Forbs and grasses are scattered and variously

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represented by a suite of wetland indicators that may include *Cyperus esculentus, Echinochloa crus-galli, Juncus balticus, Polypogon monspeliensis, Polypogon viridis, Schoenoplectus pungens, Schoenoplectus tabernaemontani, Equisetum arvense, Polygonum lapathifolium, Rorippa sphaerocarpa, Veronica americana, Iva acerosa (= Oxytenia acerosa), Sporobolus airoides,* and *Artemisia ludoviciana*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Populus fremontii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Tamarix ramosissima* (High)

Global: Invasive/Exotic Plants: *Echinochloa crus-galli* (Medium/Insignificant)

Conservation Status Rank

Global Rank & Reasons: G3 (28-Sep-2004). This association requires low-gradient floodplain habitats in which natural hydrological processes are operational to ensure reproduction and maintenance of *Populus fremontii* and other key wetland species. These habitats have been significantly altered over the past 100+ years in the lower reaches of the Gila and San Francisco rivers (along with other rivers of the Southwest) because of agricultural conversion and water diversions. This, in combination with intensive livestock and off-road vehicle use, has likely led to significant declines of the association, particularly at lower elevations. The best conditions are found in the undammed middle reaches of the basins where somewhat natural hydrological conditions still prevail, but these sites are under threat from further agricultural conversion and proposed water impoundments. These conditions and the limited quantitative data preclude ranking higher than G3.

Related Concepts

Global Similar Types:

- *Populus deltoides (ssp. wislizeni, ssp. monilifera)* / Scour Flooded Woodland (CEGL005974) known from northwestern New Mexico.
- *Populus fremontii / Equisetum* spp. Riparian Woodland (CEGL003775)

- *Populus fremontii* / Sparse Riparian Forest (CEGL005979) of high terraces at the edge of floodplains that are rarely flooded and also lacks a significant understory, but it is characterized by mature trees and relatively dry conditions and shading that limit shrub and herbaceous growth.

Global Related Concepts:
- Fremont Cottonwood/Scour CT (Muldavin et al. 2000a) =

Classification

Status: Standard
Classification Confidence:
Global Classification Comments: The northern extent of this association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. This type may represent a younger stage of the *Populus fremontii - Salix gooddingii / Baccharis salicifolia* CT (New Mexico state type). It should not be confused with the *Populus fremontii* / Sparse Riparian Forest (CEGL005979) of high terraces at the edge of floodplains that are rarely flooded.

Element Distribution

Glen Canyon National Recreation Area Range: This riparian forest is distributed in low-lying areas along drainages and canyon bottoms within the recreation area and was sampled in Cornerstone Canyon, Clearwater Canyon, Grand Gulch, Fiftymile Canyon, North Wash, and Wilson Mesa.

Global Range: This association is found along the Gila and San Francisco rivers (Catron and Grant counties, New Mexico) and the Colorado River basin in southern Utah, and likely probably elsewhere in the southwestern U.S.

Nations: US
States/Provinces: AZ?, NM:S3, UT
TNC Ecoregions: 19:C, 21:C, 22:?
USFS Ecoregions (1994/95): 313A:CC, 321:C, M313:C
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This relatively narrow canyon is subject to flooding and the scouring of plants that ensues. This area appears to be frequently disturbed by floods so no upland shrubs and few riparian plants have been able to take hold.

Glen Canyon National Recreation Area Plots: The description is based on 2012, 2013, 2014, and 2015 field data (4 plots, 3 accuracy assessment points): (Plots: GLCA.4232, GLCA.4334, GLCA.5287, GLCA.5574; AA Points: GLCA_AA.0648. GLCA_AA.0650, GLCA_AA.1147).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): E. Muldavin and G. Kittel
References: Muldavin et al. 2000a, Muldavin et al. 2000a*, NHNM unpubl. data, Western Ecology Working Group n.d.

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Subset: GLCA; Glen Canyon National Recreation Area

[CEGL005979] *Populus fremontii* / Sparse Riparian Forest

Translated Name: Fremont Cottonwood / Sparse Riparian Forest

Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)

Macrogroup: Interior Warm & Cool Desert Riparian Forest (M036)

Group: Western Interior Riparian Forest & Woodland (G797)

Alliance: *Populus fremontii - Fraxinus velutina - Salix gooddingii* Riparian Forest & Woodland Alliance (A3803)

Element Concept

Global Summary: This mature riparian forest association is known from the San Francisco River watershed in New Mexico and from southeastern Utah. Large, tall and mature *Populus fremontii* form dense canopies (>60% cover) with only scattered representatives of other floodplain tree species. The understory is highly variable and any shrubs present do not form a proper shrub layer. Some of the more consistent species include *Baccharis salicifolia, Salix exigua*, and *Ericameria nauseosa*. The herbaceous cover is also very sparse with a wide variety of species, often introduced, disturbance-tolerant species such as *Melilotus officinalis*, known to exceed 1% cover. As a keystone species, the reproduction of *Populus fremontii* is reliant on flooding and once established a sufficient groundwater table is critical to the long-term presence of this community. Stands are found within the floodplain of large, lowland valleys at elevations around 1525 m (5000 feet). Sites are typically 1- to 3-m high alluvial terraces that are rarely flooded. Soils are deep, sandy and relatively dry.

Environmental Description

Glen Canyon National Recreation Area Environment: This riparian forest association occurs on infrequently flooded canyon bottom floodplain areas adjacent to the main wash channel. Sites are flat and lie between 1285 and 1448 m elevation. Bare soil and litter cover most of the unvegetated surface, with sparse cover by sand, water, and downed wood. Soils are moderately well-drained to well-drained sandy loams and loams derived from alluvium.

Global Environment: Stands are found within the floodplain of large, lowland valleys at elevations around 1285 to 1525 m (4200-5000 feet). Sites are typically alluvial terraces that are rarely flooded (25- to 100-year recurrence interval and discharge ratios of 3.6 to 11.2). In keeping with the high landscape position, soils are deep but sandy and relatively dry (sandy and sandy-skeletal Oxyaquic Ustifluvents).

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Fremont cottonwood type grows in low-lying areas within the park. Total vegetation cover ranges from 45 to 98%. Stands are characterized by a dense canopy (40-85% cover) of *Populus fremontii* between 10 and 15 m tall. *Salix gooddingii* and/or *Acer negundo* may occur in the canopy layer with low cover. The understory is sparse with few notable species; *Salix exigua* and *Ericameria nauseosa* may be present with low cover.

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Introduced species such as *Elaeagnus angustifolia, Tamarix* spp., *Salsola tragus*, and *Bromus tectorum* are often present in disturbed stands.

Global Vegetation: Large, tall and mature *Populus fremontii* form dense canopies (>60% cover) with only scattered representatives of other floodplain tree species, such as *Salix gooddingii* and/or *Acer negundo*. The understory is highly variable and any shrubs present do not form a proper shrub layer. Some of the more consistent species include *Baccharis salicifolia, Salix exigua*, and *Ericameria nauseosa*. The herbaceous cover is also very sparse with a wide variety of species. Introduced species such as *Elaeagnus angustifolia, Tamarix* spp., *Salsola tragus, Melilotus officinalis*, and *Bromus tectorum* are often present in disturbed stands, but with very low cover.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Populus fremontii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Elaeagnus angustifolia* (High), *Salsola tragus*, *Tamarix ramosissima* (High)

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Elaeagnus angustifolia* (High), *Melilotus officinalis* (Medium/Low), *Salsola tragus, Tamarix* spp.

Conservation Status Rank

Global Rank & Reasons: G2G3 (28-Sep-2004). This association requires low-gradient floodplain habitats in which natural hydrological processes are operational to ensure reproduction and maintenance of *Populus fremontii* and other key wetland species. These habitats have been significantly altered over the past 100+ years in the lower reaches of the Gila and San Francisco rivers (along with other rivers of the Southwest) because of agricultural conversion and water diversions. This, in combination with intensive livestock and off-road vehicle use, has likely led to significant declines of the association, particularly at lower elevations. The best conditions are found in the undammed middle reaches of the basins where somewhat natural hydrological conditions still prevail, but these sites are under threat from further agricultural conversion and proposed water impoundments.

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Given these conditions, the limited quantitative data in New Mexico, and the expectation of further Element Occurrences in Arizona, the rank of G2G3 seems prudent.

Related Concepts

Global Similar Types:

- *Populus deltoides (ssp. wislizeni, ssp. monilifera)* / Sparse Flooded Forest (CEGL005976) more eastern association of southern New Mexico within the Rio Grande basin.
- *Populus fremontii* / Scour Riparian Forest (CEGL005978) has a sparse undergrowth, but with the sparseness due to repeated flooding and cobbly substrate.

Global Related Concepts:

- Fremont Cottonwood/Sparse CT (Muldavin et al. 2000a) =

Classification

Status: Standard

Classification Confidence:

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. While plot-level documentation is limited, additional surveys are expected to further confirm this association.

Element Distribution

Glen Canyon National Recreation Area Range: This riparian forest is distributed in low-lying areas along drainages and canyon bottoms within the recreation area and was sampled in Coyote Gulch, Harris Wash, and on the Escalante River.

Global Range: This association is found in the San Francisco River watershed (Catron County) and in southeastern Utah, and probably elsewhere in southwestern New Mexico and southeastern Arizona.

Nations: US
States/Provinces: AZ?, NM:S1S2, UT
TNC Ecoregions: 19:C, 21:C, 22:?
USFS Ecoregions (1994/95): 313A:?C, 321:C, M313:C
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Area is a floodplain at times of extreme flooding as evidenced by mounds and gullies that run parallel to each other. Soil is loose and sandy, but stabilized by high cover of *Populus fremontii* litter.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (2 plots, 1 accuracy assessment point): (Plots: GLCA.4294, GLCA.5248; AA Points: GLCA_AA.3072).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): E. Muldavin and G. Kittel

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References: Muldavin et al. 2000a, Muldavin et al. 2000a*, NHNM unpubl. data, Western Ecology Working Group n.d.

A0644 Populus fremontii Great Basin Riparian Forest Alliance

Alliance Summary Description: This alliance contains riparian woodlands dominated by *Populus fremontii*. Individuals of *Populus fremontii* are scattered or occur in groves and may reach 30 m in height and 2 m in diameter. Other species that may occur in the canopy/subcanopy include *Baccharis salicifolia, Celtis laevigata var. reticulata, Fraxinus berlandieriana, Fraxinus velutina, Juglans microcarpa, Populus deltoides ssp. wislizeni, Prosopis glandulosa, Prosopis pubescens, Prosopis velutina, Salix amygdaloides, Salix exigua, Salix gooddingii*, and *Salix lasiolepis*. The understory of most examples has been considerably altered by grazing and other factors, thus the composition and cover of the native understory are difficult to ascertain, but frequently consists of shrubs and small trees (1-5 m tall). The herbaceous stratum varies in composition and coverage but is characterized by mixed annuals and short-lived perennials. Some areas have high amounts of *Tamarix* spp. and other exotic invasive trees. This woodland alliance occurs as small isolated stands or as linear bands that parallel stream channels on alluvial fans, in lower canyons in desert mountains, and valleys with dependable subsurface groundwater that varies considerably during the year. In the southwestern U.S., it occurs in western New Mexico, throughout Arizona, lower elevations of Utah, southern and central Nevada and just into the eastern desert of California.

[CEGL002465] Populus fremontii / Ericameria nauseosa Riparian Woodland

Translated Name: Fremont Cottonwood / Rubber Rabbitbrush Riparian Woodland

Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup: Interior Warm & Cool Desert Riparian Forest (M036)
Group: Western Interior Riparian Forest & Woodland (G797)
Alliance: *Populus fremontii* Great Basin Riparian Forest Alliance (A0644)

Element Concept

Global Summary: This common woodland association occurs on the upper terraces of perennial streams, on the banks of intermittent washes, and in spring-fed alcoves throughout the Colorado Plateau on sites that flood infrequently. It is one of the drier riparian forests, often well away from the stream channel, but still on the floodplain. Total vegetation cover ranges from 34 to 170%. The 10- to 15-m tall canopy is dominated by mature *Populus fremontii* trees that range in cover from 5 to 50%. Other trees, both riparian and upland, may be present with low cover in the canopy and subcanopy, including *Populus angustifolia* and *Juniperus osteosperma*. Young *Populus* and *Salix* are rare, because these stands are often at least 2 m above the water table. The shrub layer has low cover. *Ericameria nauseosa* dominates or codominates the shrub stratum, often with *Artemisia tridentata ssp. tridentata*. The herbaceous layer is diverse. Common graminoids include *Achnatherum hymenoides, Bromus japonicus, Elymus canadensis, Sporobolus* spp., and *Juncus balticus*. Forbs commonly present include *Ambrosia acanthicarpa, Artemisia campestris, Castilleja linariifolia, Equisetum hyemale, Lepidium*

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montanum, Sphaeralcea spp., and *Heterotheca villosa*. The non-native *Agrostis stolonifera* and *Bromus tectorum* can be abundant on disturbed sites. Sites are level to gently sloping and are located between 1110 and 2165 m (3610-7100 feet) elevation. Substrates are often coarse-textured soils such as sands and loamy sands, but may include finer-textured soils such as silt loams and silty clay loams derived from alluvium.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association occurs on intermittently flooded and seasonally flooded low-lying areas including stream benches, drainage channels, and canyon bottoms. Sites are flat or slope gently and occur between 1110 and 1603 m elevation. The unvegetated surface is mostly litter, sand, or bare soil, with low cover by gravel, large rocks, and woody debris. Soils are rapidly drained, well-drained, or moderately well-drained sands, loamy sands, silt loams, or silty clay loams derived from alluvium.

Global Environment: This common riparian woodland association occurs on the upper terraces of perennial streams, on the banks of intermittent washes, and spring-fed alcoves throughout the Colorado Plateau. These habitats are rarely subject to flooding. Sites are level to gently sloping and are located between 1110 and 2165 m (3640-7100 feet) elevation. Aspect is not important in determining the distribution of this association. Bare soil and litter cover most of the unvegetated surface. Substrates are often poorly developed, rapid to well-drained, coarse-textured soils such as sands and loamy sands, but may include finer-textured soils such as silt loams and silty clay loams derived from alluvium.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Fremont cottonwood woodland type grows in many drainages and low-lying areas within the recreation area. Total vegetation cover ranges from 16 to 88% depending on the length of time stands have been isolated from active flooding. Stands are characterized by a canopy between 5 and 20 m tall of *Populus fremontii* trees with between 8 and 50% cover. *Populus fremontii* seedlings are rare and provide sparse cover. *Juniperus osteosperma* is often present in the subcanopy with low cover (5%). The understory is dominated by *Ericameria nauseosa* with up to 25% cover. Other shrubs present include scattered individuals of *Atriplex canescens, Artemisia tridentata ssp. tridentata, Baccharis salicina, Brickellia longifolia, Fraxinus anomala, Lycium andersonii, Quercus gambelii, Rhus trilobata, Salix exigua, Gutierrezia* spp., as well as the non-native shrubs *Tamarix chinensis* and *Caragana arborescens*. The herbaceous layer is diverse and provides sparse to low cover. Common herbs include *Bromus tectorum, Sporobolus contractus, Distichlis spicata, Echinochloa crus-galli, Elymus elymoides, Muhlenbergia asperifolia, Phragmites australis, Artemisia dracunculus, Artemisia ludoviciana, Chenopodium fremontii, Grindelia squarrosa, Salsola tragus, Solidago velutina, Iva acerosa, Xanthium strumarium*, and *Juncus tenuis*.

Global Vegetation: This riparian woodland association is common throughout the Colorado Plateau, where it occupies terraces along intermittent and perennial stream courses. Total vegetation cover ranges from 27 to 100%. The 10- to 15-m tall canopy is dominated by mature phreatophytic *Populus fremontii* trees that range in cover from 5 to 50%, which may come from a single large tree. Other trees,

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Subset: GLCA; Glen Canyon National Recreation Area

both riparian and upland species, may be present with low cover in the canopy or subcanopy, including *Populus angustifolia*, *Quercus gambelii*, and *Juniperus osteosperma*. Very young *Populus* are generally not seen on these upper terraces, except for sucker shoots, because these stands are often from 0.2 to >2 m above the water table. The shrub layer has open to moderate cover and is fairly simple in diversity. *Ericameria nauseosa* dominates or codominates the shrub stratum, often with other shrubs, including *Artemisia tridentata ssp. tridentata. Atriplex canescens, Atriplex confertifolia, Coleogyne ramosissima, Forestiera pubescens, Fraxinus anomala, Gutierrezia microcephala, Opuntia* spp., *Rhus trilobata*, and/or *Sarcobatus vermiculatus*, and in the southern extent *Parryella filifolia* and *Isocoma drummondii*. The exotics *Tamarix chinensis* and *Caragana arborescens* may also be present. The herbaceous layer is diverse in terms of species composition, although many species are exotic, and most reflect upland conditions. Common graminoids include *Achnatherum hymenoides, Bromus japonicus, Elymus canadensis, Distichlis spicata, Juncus balticus, Juncus tenuis, Muhlenbergia asperifolia, Phragmites australis, Sporobolus airoides, Sporobolus cryptandrus, Sporobolus contractus*, and *Typha domingensis*. Forbs commonly present include *Ambrosia acanthicarpa, Artemisia campestris, Artemisia dracunculus, Artemisia ludoviciana, Castilleja linariifolia, Epipactis gigantea, Equisetum hyemale, Heterotheca villosa, Iva acerosa, Lepidium montanum, Solidago velutina*, and *Sphaeralcea* spp. Non-native herbaceous species on disturbed sites include *Agrostis stolonifera, Bromus tectorum, Echinochloa crus-galli*, and *Salsola tragus*.

Global Dynamics: This association is a wetland obligate community, with the early-seral *Populus fremontii* that is dependent on flooding for germination, but lives for up to 150 years by tapping into the water table. More shallow-rooted and short-lived riparian species are gradually replaced by upland species if the water table drops permanently below their rooting zone.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Herb (field)	Flowering forb	*Artemisia dracunculus*, *Artemisia ludoviciana*, *Salsola tragus*
Herb (field)	Graminoid	*Bromus tectorum*, *Muhlenbergia asperifolia*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *tridentata*, *Atriplex canescens*
Herb (field)	Flowering forb	*Artemisia campestris*
Herb (field)	Graminoid	*Achnatherum hymenoides*

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Characteristic Species

Glen Canyon National Recreation Area:
Global: *Achnatherum hymenoides, Artemisia campestris, Artemisia tridentata* ssp. *tridentata, Atriplex canescens, Ericameria nauseosa, Populus fremontii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Caragana arborescens* (High/Low), *Salsola tragus, Tamarix chinensis*

Global: Invasive/Exotic Plants: *Agrostis gigantea* (Medium/Low), *Agrostis stolonifera* (Medium/Low), *Bromus japonicus, Bromus tectorum* (High), *Caragana arborescens* (High/Low), *Salsola tragus, Tamarix chinensis*; Other Plants: *Heterotheca villosa* (G5), *Hymenopappus filifolius* (G5), *Juncus balticus* (G5), *Populus angustifolia* (G5), *Salix gooddingii* (G5), *Sporobolus* spp. (N/A, includes *Sporobolus flexuosus, Sporobolus cryptandrus,* and *Sporobolus airoides*)

Conservation Status Rank

Global Rank & Reasons: GNR (24-Mar-2005).

Related Concepts

Global Similar Types:

- *Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Ruderal Shrubland (CEGL002699)
- *Ericameria nauseosa / Bromus tectorum* Ruderal Shrubland (CEGL002937)
- *Populus deltoides (ssp. wislizeni, ssp. monilifera) / Artemisia tridentata* Flooded Woodland (CEGL005966)
- *Populus fremontii / Frangula betulifolia - Quercus gambelii* Spring & Riparian Woodland (CEPP005699)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This shrubland is distributed on intermittently flooded low-lying sites within the recreation area and was sampled in Last Chance Creek, Carcass Wash, Hall's Creek, Hall Mesa, Harris Wash, Fourmile Canyon, Waterhole Canyon, and Cottonwood Canyon.

Global Range: This association has been described from southeastern Utah and northern Arizona. It is likely to be widespread throughout the Colorado Plateau.

Nations: US
States/Provinces: AZ, CO?, NM?, UT

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TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon, Petrified Forest)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This community occurs on a flat bench just upslope (1-2 feet.) of the actual drainage channel. Stream channel shows evidence of intermittent flooding and subsurface water seems to be present for much of the year (as evidenced by the phreatophytic cottonwoods).

Glen Canyon National Recreation Area Plots: The description is based on 2011, 2012, and 2013 field data (8 plots): (Plots: GLCA.2012, GLCA.5181, GLCA.5211, GLCA.5241, GLCA.5249, GLCA.5508, GLCA.6232, GLCA.9707).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, G. Kittel and K.A. Schulz
References: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Thomas et al. 2009a, Western Ecology Working Group n.d.*

[CEGL000666] Populus fremontii / Salix exigua Riparian Forest
Translated Name: Fremont Cottonwood / Narrowleaf Willow Riparian Forest
Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup: Interior Warm & Cool Desert Riparian Forest (M036)
Group: Western Interior Riparian Forest & Woodland (G797)
Alliance: *Populus fremontii* Great Basin Riparian Forest Alliance (A0644)

Element Concept

Global Summary: This association is documented from along large rivers in Utah, southwestern New Mexico, and Arizona. Characteristic of this deciduous forest is the dominance of *Populus fremontii* in the moderately dense to dense tree canopy and *Salix exigua* in the tall-shrub layer; in some stands *Forestiera pubescens* is common. This is one of the wettest riparian forests. *Salix gooddingii* or *Baccharis salicifolia* are not abundant or are absent. Other associated species include *Castilleja linariifolia, Distichlis spicata, Leymus cinereus, Muhlenbergia asperifolia, Iva acerosa (= Oxytenia acerosa), Phragmites australis,* and species of *Equisetum, Juncus,* and *Carex*. Introduced species such as *Elaeagnus angustifolia, Tamarix* spp., *Poa pratensis, Melilotus* spp., and other exotic forage species are often present in disturbed stands. Stands occur on streambanks, stable bars and low elevations of the active floodplain. Substrates are typically relatively recently deposited alluvium. Periodic flooding is required for the growth, maintenance and reproduction of this forest.

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Environmental Description

Glen Canyon National Recreation Area Environment: This riparian forest association occurs on intermittently flooded to seasonally flooded low-lying areas, including perennial streambanks, riverbanks, washes, valleys, and canyon bottoms, drainage channels, terraces, and floodplains. Sites are flat or slope gently (up to 11°) and lie between 1051 and 1610 m elevation. Litter, bare soil, and sand cover most of the unvegetated surface, with sparse to low cover by downed wood, large rocks, bedrock, and water. Soils are rapidly drained to moderately well-drained to somewhat poorly drained loamy sands, loams, and silt loams derived from alluvium.

Global Environment: This riparian forest association is documented from along large rivers in southwestern Utah, southwestern New Mexico, and Arizona. Sites include perennial streambanks, riverbanks, wash, valley, and canyon bottoms, drainage channels, terraces, and floodplains. Elevation ranges from 1050-1950 m (3445-6400 feet). Stands are found on stable bars in floodplains and along streambanks in canyons, where the water table is still high and flooding occurs less than annually. Substrates are typically relatively recently deposited alluvium. Stream gradient is typically gentle, and soils are rapidly to somewhat poorly drained, and range from loamy sand to silty clays derived from alluvium (Szaro 1989, Muldavin et al. 2000a).

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Fremont cottonwood type grows in low-lying areas within the park. Total vegetation cover ranges from 23 to 100%. Stands are characterized by a canopy between 5 and 20 m tall of *Populus fremontii* with 5 to 50% cover. The understory is dominated by low to dense cover of *Salix exigua,* with 3 to 60% cover. *Acer negundo* may be present in the tree canopy, but with only trace to very low cover, and *Salix gooddingii* is absent. Associated shrubs include *Baccharis salicina, Ericameria nauseosa, Chrysothamnus linifolius, Forestiera pubescens, Pluchea sericea, Sarcobatus vermiculatus, Rhus aromatica,* and *Gutierrezia sarothrae*. The herbaceous layer is variable and includes a diversity of both graminoids and forbs; *Distichlis spicata, Elymus canadensis, Elymus trachycaulus, Muhlenbergia asperifolia, Phragmites australis, Juncus* sp., *Equisetum hyemale, Typha domingensis, Artemisia ludoviciana, Artemisia campestris, Melilotus officinalis, Medicago sativa,* and *Iva acerosa (= Oxytenia acerosa)* are common species. The introduced species *Tamarix ramosissima* and *Elaeagnus angustifolia* are often present in disturbed stands.

Global Vegetation: This association is characterized by an open to dense, deciduous tree canopy (10 to 75% cover) that is dominated by *Populus fremontii* with *Salix exigua* dominating the tall-shrub layer. *Acer negundo* may be present in the tree canopy, but *Salix gooddingii* is typically not present. *Baccharis salicifolia* is also typically not abundant in the shrub layer, but a variety of other riparian and upland shrub species may be present, including *Betula occidentalis, Amelanchier* spp., *Ericameria nauseosa, Chrysothamnus linifolius, Rhus aromatica, Gutierrezia sarothrae, Artemisia tridentata, Forestiera pubescens, Pluchea sericea, Sarcobatus vermiculatus* or *Quercus gambelii*. The herbaceous layer is generally sparse, depending on the density of the shrub and tree layers. *Castilleja linariifolia, Distichlis spicata, Elymus canadensis, Elymus trachycaulus, Leymus cinereus, Muhlenbergia asperifolia, Iva acerosa (= Oxytenia acerosa), Artemisia ludoviciana, Artemisia campestris,*

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Subset: GLCA; Glen Canyon National Recreation Area

Phragmites australis, and species of *Equisetum, Juncus*, and *Carex* are commonly present (Szaro 1989, Muldavin et al. 2000a). Introduced species such as *Elaeagnus angustifolia, Tamarix* spp., *Alhagi maurorum, Medicago sativa, Melilotus officinalis, Bromus* spp., and *Poa pratensis* are often present in disturbed stands.

Global Dynamics: Periodic flooding and a high water table are required for the growth, maintenance and reproduction of this forest.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Salix exigua*
Herb (field)	Graminoid	*Muhlenbergia asperifolia*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*
Tall shrub/sapling	Broad-leaved deciduous tree	*Betula* spp., *Salix exigua*
Herb (field)	Graminoid	*Phragmites australis*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Populus fremontii*, *Salix exigua*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Tamarix ramosissima* (High)
Global: Invasive/Exotic Plants: *Alhagi maurorum* (Medium/Low), *Bromus tectorum* (High), *Elaeagnus angustifolia* (High), *Melilotus officinalis* (Medium/Low), *Melilotus* spp., *Poa pratensis* (Medium), *Tamarix* spp.

Conservation Status Rank

Global Rank & Reasons: GNR (20-Sep-2001). Few intact examples of this association remain in the southwestern U.S. It is documented from the Gila, middle Rio Grande and, possibly the lower Pecos rivers of southern New Mexico, as well as a number of tributary drainages in southern Utah. It may also occur in southern Arizona. This association is found on stable bars at mid-elevations of the floodplain; it develops on recently deposited alluvium. Flood flows are required for the growth, maintenance and reproduction of this community type. The association continues to be in decline, primarily as a function of major hydrological alterations (dams and diversions), grazing, off-road vehicles and agricultural conversion. The remaining functional stands are restricted to wild rivers such as the Gila and San Francisco rivers, and possibly along the Mimbres River in New Mexico, or the San

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Pedro River in Arizona. A significant association with respect to biodiversity, particularly birds in the Southwest. Stands are rare that have not been invaded by exotic trees, shrubs and herbs. Even protected examples are threatened by continued declines in upland watershed conditions.

Related Concepts

Global Similar Types:

- *Populus fremontii - Salix gooddingii / Salix exigua* Riparian Forest (CEGL002684)
- *Populus fremontii / Baccharis salicifolia* Riparian Woodland (CEGL000941)
- *Populus fremontii / Frangula betulifolia - Quercus gambelii* Spring & Riparian Woodland (CEPP005699)

Global Related Concepts:

- *Populus fremontii / Salix exigua* (Sawyer et al. 2009) **?**
- *Populus fremontii/Salix exigua* (Bourgeron and Engelking 1994) =
- *Populus fremontii* Community Type (Szaro 1989) >
- DRISCOLL FORMATION CODE:I.B.3.d. (Driscoll et al. 1984) >

Classification

Status: Standard

Classification Confidence: 3 - Weak

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. *Salix gooddingii* is not present and that distinguishes it from the similar *Populus fremontii - Salix gooddingii / Salix exigua* Riparian Forest (CEGL002684). This association was not reported in the Handbook of Wetland Vegetation Communities of New Mexico (Muldavin et al. 2000a) and needs further review to distinguish it from similar associations such as *Populus fremontii - Salix gooddingii / Salix exigua* Riparian Forest (CEGL002684). Part of the confusion is related to a taxonomic change in Rio Grande cottonwood from *Populus fremontii var. wislizeni* S. Wats. to *Populus deltoides ssp. wislizeni* (S. Wats.) Eckenwalder. This change resulted in part of this association (central NM along the Rio Grande) being moved into *Populus deltoides (ssp. wislizeni, ssp. monilifera) / Salix exigua* Riparian Woodland (CEGL002685). More work is needed to determine the range and possible areas of overlap between these two cottonwood species, and vegetation types in which they are important. There may be a mix up with this type occurring at Aztec Ruins National Monument and Chaco Culture National Historical Park as *Populus fremontii* does not occur in San Juan County according to USDA PLANTS (USDA NRCS n.d.); nor is this type reported for New Mexico by Muldavin et al. (2000a). This is likely due to the old name of Rio Grande cottonwood (*Populus fremontii* S. Watson var. *wislizeni*). Global description currently does not specify northwestern New Mexico.

Element Distribution

Glen Canyon National Recreation Area Range: This riparian forest is distributed in low-lying areas along drainages and canyon bottoms within the recreation area and was sampled in Harris Wash and on the Escalante River.

Global Range: This riparian forest is known from southwestern New Mexico (Gila River), and in the Colorado Plateau of northwestern New Mexico, southern Utah and northern Arizona (Colorado River

and tributaries such as the Fremont and Virgin rivers). It likely occurs elsewhere in the southwestern U.S.

Nations: US
States/Provinces: AZ, NM, UT
TNC Ecoregions: 18:C, 19:C, 21:C, 22:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 341B:CC, M313B:??, M331F:??, M341C:CC
Federal Lands: NPS (Arches, Aztec Ruins, Canyonlands, Capitol Reef, Chaco Culture, Glen Canyon, Wupatki, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Streamflow controls plant distribution.
Glen Canyon National Recreation Area Plots: The description is based on 2012 field data (4 plots, 11 accuracy assessment points): (Plots: GLCA.0552, GLCA.4325, GLCA.4327, GLCA.5234; AA Points: GLCA_AA.0020, GLCA_AA.0023, GLCA_AA.0493, GLCA_AA.1070, GLCA_AA.1198, GLCA_AA.1206, GLCA_AA.1233, GLCA_AA.1244, GLCA_AA.3082, GLCA_AA.3085, GLCA_AA.4024).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): E. Milford, E. Muldavin, K.A. Schulz, J. Coles, G. Kittel
References: Bourgeron and Engelking 1994, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2003, Coles et al. 2009a, Driscoll et al. 1984, Hansen et al. 2004b, Muldavin et al. 1993b, Muldavin et al. 2000a, NHNM unpubl. data, Romme et al. 1993, Salas et al. 2009, Salas et al. 2011, Sawyer et al. 2009, Szaro 1989, USDA NRCS n.d., Western Ecology Working Group n.d.*

[CEGL002470] *Populus fremontii* / Mesic Forbs Riparian Woodland
Translated Name: Fremont Cottonwood / Mesic Forbs Riparian Woodland
Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup: Interior Warm & Cool Desert Riparian Forest (M036)
Group: Western Interior Riparian Forest & Woodland (G797)
Alliance: *Populus fremontii* Great Basin Riparian Forest Alliance (A0644)

Element Concept

Global Summary: This riparian woodland association occurs in southeastern Utah. Total vegetation cover ranges from 50% to nearly 100% in these moist woodlands. The vegetation is characterized by an open to moderately closed canopy of *Populus fremontii* with between 26 and 50% cover. There is no developed shrub layer, although scattered shrubs such as *Rosa woodsii* and *Forestiera pubescens* may be present. The herbaceous layer is diverse and provides up to 50% cover, and usually consists several species of forbs. The forb understory varies greatly from site to site and from year to year, depending on the timing of flooding and the height of the water table. Species with significant cover include *Iva acerosa*, *Maianthemum stellatum*, *Equisetum arvense*, and *Equisetum laevigatum*. Graminoids are low

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Subset: GLCA; Glen Canyon National Recreation Area

in cover and include *Juncus balticus, Phragmites australis*, and *Schoenoplectus americanus*. This riparian woodland occurs along low-gradient perennial and intermittent streams, in mesic valley bottoms and below springs. Although these stands may not flood regularly, the water table is generally within a few feet of the surface through most of the growing season. Sites slope gently (less than 5%) and are located between 1116 and 1890 m (3670-6200 feet) elevation. Soils are typically somewhat poorly drained fine sands in these temporarily flooded sites and are derived from alluvium and colluvium.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association was sampled along intermittently to seasonally flooded to perennial streams in canyon bottom drainages. Sites are flat and lie between 1116 m and 1243 m elevation. Litter, bare soil, or sand covers most of the unvegetated surface with sparse exposure of small rocks and water. The soil is a somewhat poorly-drained silt loam derived from alluvium.

Global Environment: This woodland association is documented along low-gradient perennial and intermittent streams, in mesic valley bottoms and below springs in southeastern Utah. Sites slope gently (less than 5%) and are located between 1116 and 1890 m (3670-6200 feet) elevation. Soils are typically somewhat poorly drained fine sands in these temporarily flooded sites and are derived from alluvium and colluvium.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Fremont cottonwood woodland type is rare within the recreation area. Total vegetation cover ranges from 47 to 67% and is characterized by a canopy between 5 and 20 m tall of *Populus fremontii* trees with up to 23% cover. The understory is dominated by a carpet of *Iva acerosa*, or by a variety of forbs with low to moderate cover, including *Equisetum* spp., *Artemisia dracunculus, Artemisia ludoviciana, Comandra umbellata, Solidago canadensis*, and *Heterotheca villosa*. Shrubs are present with sparse to low cover; common species include *Ericameria nauseosa, Salix* sp., *Tamarix chinensis, Baccharis salicina*, and *Toxicodendron rydbergii*. Associated graminoid species, which in combination may have nearly as much cover as the forb layer, include *Phragmites australis, Poa fendleriana, Bromus tectorum, Elymus canadensis, Muhlenbergia asperifolia, Panicum* spp., *Typha* spp., *Scirpus* and/or *Schoenoplectus* spp., and *Juncus* spp.

Global Vegetation: Total vegetation cover ranges from 50% to nearly 100% in these moist woodlands. The vegetation is characterized by an open to moderately closed canopy of *Populus fremontii* with between 26 and 50% cover. There is no developed shrub layer, although scattered shrubs such as *Rosa woodsii* and *Forestiera pubescens* may be present. The exotic tall shrub *Tamarix chinensis* may be present. The herbaceous layer is diverse and provides up to 50% cover. The forb understory varies greatly from site to site and from year to year, depending on the timing of flooding and the water table. The layer is usually a combination of several species rather than any single species having particularly high cover; species include *Artemisia dracunculus, Artemisia ludoviciana, Comandra umbellata, Equisetum arvense, Equisetum laevigatum, Heterotheca villosa, Iva acerosa, Maianthemum stellatum*, and *Solidago canadensis*. Graminoids are low in cover and include *Elymus*

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canadensis, Juncus balticus, Muhlenbergia asperifolia, Panicum spp., *Phragmites australis, Poa fendleriana, Typha* spp., *Scirpus* spp., and *Schoenoplectus americanus.*

Global Dynamics: Although these stands may not occur on sites that flood regularly, the water table is generally within a few feet of the surface through most of the growing season.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*
Herb (field)	Flowering forb	*Artemisia dracunculus*, *Artemisia ludoviciana*, *Iva acerosa*, *Solidago canadensis*
Herb (field)	Graminoid	*Juncus* spp.
Herb (field)	Fern (Spore-bearing forb)	*Equisetum* spp.

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Iva acerosa, Maianthemum stellatum, Populus fremontii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Tamarix chinensis*

Global: Invasive/Exotic Plants: *Tamarix chinensis*

Conservation Status Rank

Global Rank & Reasons: GNR (24-Mar-2005).

Related Concepts

Global Similar Types:
- *Populus fremontii* / Mesic Graminoids Riparian Woodland (CEGL002473)

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. This association is intended to describe *Populus fremontii* woodlands occupying the active floodplain (water table is still high) that lack a

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developed shrub layer and in which most of the understory cover is composed of non-graminoid herbaceous species, where there is no consistent dominant or diagnostic element.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is rare within the park and was sampled approximately in Coyote Gulch, Moqui Canyon, and Miller's Creek.

Global Range: This association has been described from a few locations in southeastern Utah. It is likely more widespread, although probably not common, throughout the Colorado Plateau.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Floodplain along east edge of streambed, narrow (25 m), flat band of young *Populus fremontii* with forbs not previously sampled, bound on east side by sandstone wall, appears to be flooded during larger seasonal events.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (1 plot, 2 accuracy assessment points): (Plot: GLCA.5225; AA Points: GLCA_AA.1126, GLCA_AA.1966).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and G. Kittel
References: Clark et al. 2009, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEGL002473] *Populus fremontii* / Mesic Graminoids Riparian Woodland
Translated Name: Fremont Cottonwood / Mesic Graminoids Riparian Woodland
Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup: Interior Warm & Cool Desert Riparian Forest (M036)
Group: Western Interior Riparian Forest & Woodland (G797)
Alliance: *Populus fremontii* Great Basin Riparian Forest Alliance (A0644)

Element Concept

Global Summary: This woodland association occurs in southeastern Utah. Total vegetation cover generally exceeds 50%. The vegetation is characterized by an open canopy of *Populus fremontii* trees that range in cover from 5 to 40%, although cover in some stands may be as high as 80%. There is no developed shrub layer, although scattered individuals of shrubs such as *Salix exigua, Salix lutea, Ericameria nauseosa,* and *Artemisia tridentata ssp. tridentata* may be present. The herbaceous layer is

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usually a combination of several graminoid species that combine to form the lush herbaceous cover. Species include *Carex aquatilis, Distichlis spicata, Elymus trachycaulus, Equisetum* spp., *Juncus balticus, Juncus ensifolius, Juncus tenuis, Muhlenbergia asperifolia, Panicum* sp., *Phragmites australis,* and *Polypogon viridis.* Forbs are present but are inconsistent and provide low cover. Stands occur on the banks of intermittent and perennial streams, in seepy areas on valley bottoms and in active floodplains. Flooding occurs irregularly, but the water table remains within a few feet of the surface throughout the growing season. Stands are located on gently sloping (less than 5%) sites between 1152 and 1768 m (3780-5800 feet) elevation. Soils are typically somewhat poorly drained fine sands derived from alluvium.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association occurs in intermittently to seasonally to permanently flooded low-lying areas of canyon bottoms, drainages, floodplains, and perennial streams. Sites are flat to gently sloping and lie between 1152 and 1444 m elevation. Litter, live vegetation litter, and sand cover most of the unvegetated surface, with moderate exposure of bare soil and sparse cover of downed wood, rocks, bedrock, and gravel. Soils are rapidly drained to moderately well-drained to poorly drained sands, loams, or sandy loams derived from alluvium.

Global Environment: This woodland association occurs on the banks of intermittent and perennial streams, in seepy areas on valley bottoms and in active floodplains. Flooding occurs irregularly, but the water table remains within a few feet of the surface throughout the growing season. Stands are located on flat to gently sloping (less than 5%) sites between 1150 and 1768 m (3770-5800 feet) elevation. Soils are typically somewhat poorly drained fine sands derived from alluvium.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Fremont cottonwood woodland type is uncommon within the park. Total vegetation cover ranges from fairly sparse to 100%. The canopy, typically 10 to 20 m tall, is of *Populus fremontii* trees with 3 to 40% cover, and an understory of mesic perennial graminoids with a total cover of up to 45%. Characteristic species include *Phragmites australis, Muhlenbergia asperifolia, Elymus trachycaulus, Schizachyrium scoparium, Juncus balticus, Juncus tenuis, Panicum* sp., *Carex aquatilis,* and *Distichlis spicata*. Scattered *Juniperus osteosperma* or *Salix gooddingii* trees may occasionally contribute low cover to a subcanopy layer. Shrubs contribute low to moderate cover and may include scattered *Salix exigua, Tamarix chinensis, Rhus trilobata, Atriplex canescens, Ericameria nauseosa, Fraxinus anomala,* and *Fallugia paradoxa*. Associated herbaceous species contributing low cover include *Bromus tectorum, Solidago* sp., *Artemisia dracunculus, Artemisia ludoviciana, Salsola tragus, Melilotus officinalis,* and *Bromus rubens. Clematis ligusticifolia* provides sparse cover.

Global Vegetation: Total vegetation cover generally exceeds 50%. This woodland association is characterized by an open canopy of *Populus fremontii* trees that range in cover from 5 to 40%, although cover in some stands may be as high as 80%. There is no developed shrub layer, although scattered individuals of shrubs such as *Artemisia tridentata ssp. tridentata, Atriplex canescens, Ericameria nauseosa, Fallugia paradoxa, Fraxinus anomala, Rhus trilobata, Salix exigua,* and *Salix*

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lutea may be present. The exotic shrub *Tamarix chinensis* is often present. The herbaceous layer is constant only in that it is dominated by graminoids; otherwise it varies greatly in composition and cover from site to site and from year to year, depending on the flooding regime and the height of the water table. No single species is characteristic of this type, but a combination of graminoid species together form a lush herbaceous layer. Species include *Carex aquatilis, Distichlis spicata, Elymus trachycaulus, Equisetum* spp., *Juncus balticus, Juncus ensifolius, Juncus tenuis, Muhlenbergia asperifolia, Panicum* sp., *Phragmites australis,* and *Polypogon viridis.* Forbs are present but are inconsistent and provide low cover.

Global Dynamics: This association requires riparian conditions that support mesic graminoids while discouraging the growth of shrubs. A change in flood regime can easily convert this type to the less stable *Populus fremontii* / Mesic Forbs Riparian Woodland (CEGL002470).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Rhus aromatica*, *Salix exigua*, *Tamarix chinensis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Herb (field)	Graminoid	*Elymus trachycaulus*, *Juncus balticus*, *Juncus tenuis*, *Muhlenbergia asperifolia*, *Phragmites australis*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*
Herb (field)	Graminoid	*Juncus balticus*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Juncus balticus, Populus fremontii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High), *Elaeagnus angustifolia* (High), *Phragmites australis* (High), *Tamarix chinensis*

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Dactylis glomerata* (Medium/Insignificant), *Melilotus officinalis* (Medium/Low), *Tamarix chinensis, Trifolium repens* (Medium/Low)

Conservation Status Rank

Global Rank & Reasons: GNR (24-Mar-2005).

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Related Concepts

Global Similar Types:

- *Populus fremontii* / Mesic Forbs Riparian Woodland (CEGL002470)

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. This association is intended to describe *Populus fremontii* woodlands occupying the active floodplain (water table is still high) that lack a developed shrub layer and in which most of the understory cover is composed of sedges, rushes or grasses.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland association is uncommon within the park and was sampled in Moody Canyon, Cottonwood Canyon, Rock Canyon, Horsethief Canyon, along the Escalante River, and in a tributary of Sevenmile Creek.

Global Range: This association has been described from a few locations in southeastern Utah. It is likely more widespread, although not common, throughout the Colorado Plateau.

Nations: US
States/Provinces: AZ?, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Upper end of segment boxed out on three sides by canyon walls, all drainage forced into this channel segment, allowing for this dense native woodland. Well-shaded, dense grass understory.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2013 field data (4 plots, 3 accuracy assessment points): (Plots: GLCA.4087, GLCA.4321, GLCA.5180, GLCA.5435; AA Points: GLCA_AA.0488, GLCA_AA.1196, GLCA_AA.4023).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and G. Kittel
References: Clark et al. 2009, Romme et al. 1993, Western Ecology Working Group n.d.*

A3752 Salix gooddingii - Salix laevigata Riparian Forest Alliance

Alliance Summary Description: This alliance consists of riparian woodlands and forests dominated by *Salix gooddingii* and/or *Salix laevigata*, either as single-species stands or as mixed stands. Stands may or may not include *Populus fremontii*, and if they do, it is a minor component relative to dominant overstory canopy species. Other tree species present include *Acer macrophyllum, Alnus rhombifolia,*

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Subset: GLCA; Glen Canyon National Recreation Area

Alnus rubra, Celtis laevigata var. reticulata, Fraxinus velutina, Juglans microcarpa, Platanus racemosa, Populus balsamifera, Prosopis glandulosa, Quercus pungens, Salix hookeriana, Salix sitchensis, Sapindus saponaria var. drummondii, and/or *Ungnadia speciosa*. These stands occur throughout California riparian areas with deep alluvial soils generally restricted to less than 2000 m in elevation.

[CEGL003778] *Salix gooddingii / Salix exigua* Riparian Woodland
Translated Name: Goodding's Willow / Narrowleaf Willow Riparian Woodland
Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup: Interior Warm & Cool Desert Riparian Forest (M036)
Group: Western Interior Riparian Forest & Woodland (G797)
Alliance: *Salix gooddingii - Salix laevigata* Riparian Forest Alliance (A3752)

Element Concept

Global Summary: This riparian woodland is known primarily from the Colorado Plateau and is characterized by tall *Salix gooddingii* trees with a tall-shrub understory dominated by *Salix exigua*. Other woody species present may include *Forestiera pubescens, Celtis laevigata var. reticulata,* and non-native *Tamarix* spp. The herbaceous undergrowth includes graminoid species such as *Eleocharis rostellata, Equisetum laevigatum, Juncus arcticus,* and *Schoenoplectus pungens,* and native forbs such as *Ambrosia acanthicarpa, Salsola tragus,* and *Xanthium strumarium*. Sites are gently sloping alluvial terraces, sandy wash bottoms, canyon bottom drainage channels or streams, and narrow slickrock canyons where the water table generally remains within the rooting zone of the trees throughout the growing season, and are known to occur from 1098 to 1835 m in elevation.

Environmental Description

Glen Canyon National Recreation Area Environment: This rare woodland association occurs on flat to gently sloping, intermittently to perennially flooded canyon bottom drainage channels or streams within or in close proximity to the floodplain (high lake level) of the Colorado River/Lake Powell between 1098 and 1129 m elevation. Litter, live vegetation litter, or bare soil covers most of the unvegetated surface, with sparse to low cover by wood, sand, water, bedrock, small rocks, and large rocks. The soil is a moderately well-drained to well-drained loamy sand derived from alluvium.

Global Environment: This riparian woodland occurs on sandy wash bottoms, alluvial terraces, and in narrow slickrock canyons of the Colorado River, Lake Powell, and their tributaries. Water tables remain within the rooting zone of the trees throughout the growing season. Sites are gently sloping and occur at 1099-1835 m elevation. The ground surface has high litter cover with some sand, bare soil, or large rocks. Soils are intermittently moist to saturated loamy sands to poorly drained sandy clay derived from alluvium.

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Vegetation Description

Glen Canyon National Recreation Area Vegetation: This rare riparian woodland has a total vegetation cover ranging from 37 to 72%. The 2- to 15-m tall canopy is dominated by *Salix gooddingii* trees with 3 to 45% cover. Shrubs dominate the understory; *Salix exigua* is generally dominant (with 6-23% cover), but *Tamarix chinensis* can contribute significant cover, and *Ericameria nauseosa, Atriplex canescens,* and *Ephedra viridis* may contribute low cover. Herbaceous species recorded with sparse to low cover include *Artemisia ludoviciana, Eurybia glauca (= Aster glaucodes), Bromus tectorum,* and the vine *Parthenocissus vitacea*.

Global Vegetation: This riparian woodland is characterized by an open to moderately dense tree canopy (up to 85% cover) that is dominated by 10- to 35-m tall *Salix gooddingii* trees. Scattered *Celtis laevigata var. reticulata (= Celtis reticulata)* and emergent *Populus fremontii* or *Populus angustifolia* trees may be present in or above the tree canopy. The tall-shrub understory is dominated by *Salix exigua,* usually with 35 to 45% cover. Other shrubs present include *Ericameria nauseosa, Atriplex canescens, Ephedra viridis,* and *Forestiera pubescens*, the vine *Parthenocissus vitacea*, and non-native *Tamarix chinensis*. Native graminoid species may include obligate and facultative wetland species such as *Eleocharis rostellata, Equisetum laevigatum, Juncus arcticus, Schoenoplectus pungens,* and *Typha* sp. The herbaceous layer often consists largely of forbs such as *Ambrosia acanthicarpa, Artemisia ludoviciana, Eurybia glauca (= Aster glaucodes), Salsola tragus,* and *Xanthium strumarium,* or the introduced pasture grass *Lolium arundinaceum (= Festuca arundinacea)* and the invasive annual *Bromus tectorum*. Seedling *Populus fremontii* may also be present in the ground layer.

Global Dynamics: *Salix exigua* is often associated with sand bars and scoured banks that are characteristic of streams with active flooding.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Salix gooddingii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Salix exigua*, *Tamarix chinensis*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Salix gooddingii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Salix exigua*

Characteristic Species

Glen Canyon National Recreation Area: *Salix exigua*
Global: *Salix exigua, Salix gooddingii*

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Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Tamarix chinensis*

Global: Invasive/Exotic Plants: *Ambrosia acanthicarpa*, *Lolium arundinaceum* (High/Medium), *Salsola tragus*, *Tamarix chinensis*, *Xanthium strumarium*

Conservation Status Rank

Global Rank & Reasons: GNR (20-Mar-2006).

Related Concepts

Global Similar Types:

- *Populus fremontii - Salix gooddingii / Salix exigua* Riparian Forest (CEGL002684) is similar but has *Populus fremontii* codominant in tree canopy.

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland is very rare within the recreation area and was sampled in Rock Creek Bay and in The Rincon.

Global Range: This association is known primarily from the Colorado Plateau, documented from Arches and Canyonlands national parks and Glen Canyon National Recreation Area, as well as from isolated locations in eastern New Mexico.

Nations: US
States/Provinces: NM, UT
TNC Ecoregions: 19:C, 21:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M313B:CC
Federal Lands: NPS (Arches, Canyonlands, Glen Canyon, Salinas Pueblo Missions)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Narrow drainage channel bounded by tall, steep sandstone walls. Lined in soft, sandy sedimentary soils with a deep litter layer and well-shaded by overstory and canyon walls, choking out almost any understory.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (2 plots, 1 accuracy assessment point): (Plots: GLCA.4229, GLCA.4258; AA Points: GLCA_AA.4014).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, K.S. King and G. Kittel

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Subset: GLCA; Glen Canyon National Recreation Area

References: Coles et al. 2009a, Muldavin et al. 2012a, Western Ecology Working Group n.d.*

M298. Interior West Ruderal Flooded & Swamp Forest & Woodland

G510. Interior West Ruderal Riparian Forest & Scrub

Group Summary Description: This group consists of low-elevation riparian areas, seeps and springs throughout the southwestern U.S. and into Mexico that are dominated by non-native invasive woody species. Present to abundant species include *Elaeagnus angustifolia, Myoporum laetum, Phoenix canariensis, Prunus mahaleb, Robinia pseudoacacia, Schinus molle, Schinus terebinthifolius, Tamarix* spp., *Ulmus pumila,* or *Washingtonia robusta*. Salt-cedar habitats tend to support fewer species and individuals than native habitats. If present, native species contribute less than 10% relative cover. Elevation ranges from sea level to above 2135 m (7000 feet). Sites are typically streambanks and benches, floodplains and canyons with permanent, intermittent or temporary waterflow.

A4155 Acer negundo - Populus spp. - Picea spp. Ruderal Riparian Forest Alliance

Alliance Summary Description:

[CEGL002693] *Acer negundo* / Disturbed Understory Riparian Woodland

Translated Name: Box-elder / Disturbed Understory Riparian Woodland

Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup: Interior West Ruderal Flooded & Swamp Forest & Woodland (M298)
Group: Interior West Ruderal Riparian Forest & Scrub (G510)
Alliance: *Acer negundo* - *Populus* spp. - *Picea* spp. Ruderal Riparian Forest Alliance (A4155)

Element Concept

Global Summary: This riparian association is found in the Colorado Plateau and other areas of the southwestern U.S. The tree canopy of this association is open and 5-15 m tall. The dominant tree species is *Acer negundo* alone or with other scattered trees such as *Acer glabrum, Juniperus osteosperma,* or *Juniperus scopulorum*. There is a sparse shrub layer up to 2 m tall with *Artemisia tridentata, Ericameria nauseosa, Fraxinus anomala, Rhus trilobata, Ribes cereum, Tamarix ramosissima,* and (in the south) *Quercus gambelii*. Herbaceous cover and species composition are variable. The herbaceous stratum may be sparse or dominated by native and introduced species typically found in disturbed areas. *Bromus tectorum* is common. Other typical species are *Heterotheca villosa, Poa pratensis, Sisymbrium altissimum, Lepidium latifolium, Taraxacum officinale,* and *Verbascum thapsus*. Stands occur on upper alluvial terraces below 2015 m (6600 feet) elevation. Sites are on gentle slopes or flat areas near permanent or temporary streams but are rarely flooded because of their location on high, abandoned stream terraces. Soils are usually sandy.

Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association occurs on intermittently flooded river terraces and canyon sides. Sites are flat to gently sloping (up to 6° slopes), oriented to all aspects, and lie between 1444 and 1452 m elevation. The unvegetated surface has high

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cover of litter and bare soil, and moderate cover of downed wood and moss. Parent materials are sandstones and shale that have eroded and redeposited as alluvium. The soil is a well-drained to moderately well-drained loamy sand or sandy loam.

Global Environment: This association is found on flat to gently sloping riparian sites near permanent or temporary streams below 2015 m (6600 feet) elevation. Sites are usually found on terraces several meters above the active floodplain and below the steeper upland slopes on any aspect. They rarely flood. Soils are usually sandy alluvium and can range from well-drained to poorly drained. The ground surface is largely covered by large rocks, litter, downed wood, or bare soil.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This riparian woodland is very rare within the recreation area. Total vegetation cover ranges from 61 to nearly 100% and is characterized by an open canopy of 2- to 10-m tall *Acer negundo* trees with between 15 and 20% cover. The shrub layer may be moderately dense and includes *Artemisia tridentata* and *Ericameria nauseosa*. The herbaceous layer is moderately dense to very dense and includes forbs such as *Artemisia* spp., *Machaeranthera canescens, Conyza canadensis,* and *Boerhavia* sp., and grasses such as *Sporobolus* spp., *Elymus trachycaulus, Poa fendleriana,* and the non-native annual grass *Bromus tectorum*.

Global Vegetation: This woodland association has an open to moderately closed (10-80%) tree canopy and moderate to dense total vegetation cover. The tree canopy is between 5 and 15 m tall and dominated by *Acer negundo*. *Acer negundo* is also present as seedlings and saplings. Other trees that can be present are *Acer glabrum, Juniperus osteosperma,* and *Juniperus scopulorum*. Shrub cover is sparse, though it can be more prominent when the tree canopy is open. The shrub stratum is usually less than 2 m tall and contains species such as *Artemisia tridentata ssp. tridentata, Ericameria nauseosa, Fraxinus anomala, Rhus trilobata, Ribes cereum, Tamarix ramosissima,* and (in the south) *Quercus gambelii*. Herbaceous cover and species composition are variable. The herbaceous stratum is dominated by native and introduced species typically found in disturbed areas. *Bromus tectorum* (exotic) is common. Other typical components of the herbaceous stratum are *Boerhavia* sp., *Conyza canadensis, Heterotheca villosa, Machaeranthera canescens, Poa pratensis, Lepidium latifolium, Sisymbrium altissimum, Taraxacum officinale,* and *Verbascum thapsus*.

Global Dynamics: The shade provided by the tree canopy and proximity to water make stands of this association attractive to domestic livestock and wildlife. The subsequent grazing, trampling, browsing, and importation of weed seeds can be significant disturbances in this association and are likely instruments in shaping its composition.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer negundo*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Bromus tectorum*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer negundo*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Acer negundo*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Lepidium latifolium* (High), *Poa pratensis* (Medium), *Sisymbrium altissimum, Tamarix ramosissima* (High), *Taraxacum officinale, Verbascum thapsus* (Medium)

Conservation Status Rank

Global Rank & Reasons: GNA (ruderal) (18-Feb-2015).

Related Concepts

Global Similar Types:
- *Acer negundo - Celtis laevigata var. reticulata* Riparian Woodland (CEGL002599)
- *Populus deltoides ssp. wislizeni* / Disturbed Understory Ruderal Flooded Woodland (CEGL003810)

Classification

Status: Standard
Classification Confidence:
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This community is very rare within the recreation area and was only sampled in Harris Wash.

Global Range: This association has been sampled in the Colorado Plateau from northwestern Colorado to southwestern Utah and northeastern Arizona; it is likely widespread elsewhere in the southwestern U.S.

Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 9:C, 10:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, M331E:CC, M331G:CC

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Federal Lands: NPS (Black Canyon of the Gunnison, Canyon de Chelly, Canyonlands, Colorado, Curecanti, Dinosaur, Glen Canyon, Navajo, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Segment is located on a high bank/terrace 7 m above stream level. Soil is loose and easily disturbed but is almost entirely covered by forbs and grasses; sideslopes are easily eroded. Area is basin-like and most likely accumulates water pools during rain.

Glen Canyon National Recreation Area Plots: The description is based on 2012 field data (2 plots): (Plot: GLCA.5238, GLCA.5240).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Drake, J. Coles, K.A. Schulz and G. Kittel
References: Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2010, Salas et al. 2010a, Tendick et al. 2010, Thomas et al. 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.*

[CEGL005485] *Populus fremontii / Tamarix* sp. Ruderal Riparian Woodland
Translated Name: Fremont Cottonwood / Tamarisk species Ruderal Riparian Woodland
Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup: Interior West Ruderal Flooded & Swamp Forest & Woodland (M298)
Group: Interior West Ruderal Riparian Forest & Scrub (G510)
Alliance: *Acer negundo* - *Populus* spp. - *Picea* spp. Ruderal Riparian Forest Alliance (A4155)

Element Concept

Global Summary: This ruderal riparian community is likely to be widespread throughout the range of *Populus fremontii* within the southwestern United States. This deciduous woodland is characterized by a sparse to open canopy of *Populus fremontii* with an open to very dense tall-shrub layer of *Tamarix chinensis*. Few other shrubs attain substantial cover due to the competitive nature of *Tamarix chinensis*, but they may include *Forestiera pubescens, Salix exigua*, and *Ericameria nauseosa (= Chrysothamnus nauseosus)*. Herbaceous cover is very sparse and may include *Artemisia dracunculus, Acroptilon repens (= Centaurea repens), Distichlis spicata, Distichlis spicata, Iva acerosa (= Oxytenia acerosa)*, and *Sporobolus airoides*. Stands occur in linear patches on streambanks and terraces, channel beds and river islands at elevations ranging from 1169-1536 m. Slopes are flat to gentle (not exceeding 3% grade), and substrates are composed of new alluvium.

Environmental Description

Glen Canyon National Recreation Area Environment: This uncommon woodland association occurs on flat to gently sloping drainage channels, terraces, and floodplains, between 1158 and 1394 m elevation. Bare soil, sand, and litter cover most of the unvegetated surface, with lesser cover by dead wood and bedrock. Soils are sandy and derived from alluvium.

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Global Environment: Stands of this ruderal riparian *Populus fremontii* woodland are reported from the southwestern U.S. from Green River in the Colorado Plateau, south to middle and lower Colorado rivers (Hunter et al. 1985, Szaro 1989, Von Loh et al. 2002, Lynn et al. 2003). It likely occurs elsewhere in scattered locations along disturbed reaches of rivers and streams within the distribution ranges of *Populus fremontii* and *Tamarix* spp. Sites are restricted to streambanks, river islands, terraces and floodplains.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This ruderal riparian woodland is characterized by dense stands of vegetation (57-100% total cover) with an open to dense canopy layer dominated by *Populus fremontii* trees 10-15 m tall, with 10-70% cover, and a patchy tall-shrub layer dominated by the exotic *Tamarix chinensis*, with 5-11% cover. *Salix gooddingii* and the exotic tree *Elaeagnus angustifolia* may join cottonwood in the canopy layer, but with only sparse to low cover. The shrub understory layer is often diverse and has low to moderate cover; it may include *Quercus gambelii, Salix exigua, Salix eriocephala, Ericameria nauseosa, Atriplex canescens, Artemisia filifolia*, and *Sarcobatus vermiculatus*. The herbaceous layer has low to moderate cover and may include the graminoids *Achnatherum hymenoides, Bromus tectorum, Elymus canadensis, Elymus trachycaulus*, and *Sporobolus flexuosus*, and the forbs *Ambrosia acanthicarpa, Conyza canadensis, Machaeranthera canescens, Medicago sativa, Melilotus* spp., and *Salsola tragus*.

Global Vegetation: This deciduous woodland is characterized by a sparse to open canopy of *Populus fremontii* with an open to very dense tall-shrub layer of *Tamarix chinensis*. Few other shrubs attain substantial cover due to the competitive nature of *Tamarix* spp., but they may include *Forestiera pubescens, Salix exigua, Baccharis salicifolia*, and *Ericameria nauseosa (= Chrysothamnus nauseosus)*. Herbaceous cover is very sparse and may include *Artemisia dracunculus, Acroptilon repens (= Centaurea repens), Distichlis spicata, Distichlis spicata, Iva acerosa (= Oxytenia acerosa)*, and *Sporobolus airoides*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*, *Tamarix chinensis*
Herb (field)	Flowering forb	*Ambrosia acanthicarpa*, *Medicago sativa*, *Melilotus officinalis*, *Salsola tragus*
Herb (field)	Graminoid	*Bromus tectorum*, *Elymus canadensis*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Tamarix chinensis*

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Characteristic Species

Glen Canyon National Recreation Area:
Global: *Populus fremontii*, *Tamarix chinensis*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Medicago sativa* (Insignificant), *Melilotus officinalis* (Medium/Low), *Salsola tragus*, *Tamarix chinensis*

Global: Invasive/Exotic Plants: *Tamarix chinensis*

Conservation Status Rank

Global Rank & Reasons: GNA (ruderal) (19-Feb-2011).

Related Concepts

Global Related Concepts:

- *Populus fremontii* Alliance (Von Loh et al. 2002) >
- *Populus fremontii* Community Type (Szaro 1989) >

Classification

Status: Provisional
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Due to low conservation priority and stand density, this community is under-sampled rangewide, but is likely to be widespread within the range of *Populus fremontii*.

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon ruderal woodland association was sampled in Moqui Canyon and along the Escalante River.

Global Range: Stands of this ruderal riparian *Populus fremontii* woodland are reported from the southwestern U.S. from Green River in the Colorado Plateau, south along the middle and lower Colorado River and tributaries. In the Colorado Plateaus it has been documented from Canyonlands National Park, Glen Canyon National Recreation Area, and Ouray National Wildlife Refuge.

Nations: US
States/Provinces: AZ?, CA?, CO?, NM?, NV?, TX?, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 341B:CC
USFS Ecoregions (2007): 341Bj:C
Federal Lands: NPS (Canyonlands, Glen Canyon); USFWS (Ouray)

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Element Sources

Glen Canyon National Recreation Area Plots: The description is based on 2015 field data (4 accuracy assessment points): (AA Points: GLCA_AA.1122, GLCA_AA.1195, GLCA_AA.1234, GLCA_AA.1778).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): M.E. Hall and K.A. Schulz
References: Hunter et al. 1985, Lynn et al. 2003, Szaro 1989, Von Loh et al. 2002, Western Ecology Working Group n.d.*

A3566 Elaeagnus angustifolia Ruderal Riparian Scrub Alliance

Alliance Summary Description: This wooded alliance is dominated by the introduced tree species *Elaeagnus angustifolia* with a variety of native and introduced species in the shrub and herbaceous layers. Additional associated species have not been documented. The alliance is widespread and found throughout much of the southwestern United States. It is a naturalized species that has been widely planted in hedgerows for windbreaks. It has since spread (by birds distributing their seeds) to a variety of native habitats, particularly more mesic ones, such as near streams and rivers. Stands tend to be small and linear.

[CEGL005269] *Elaeagnus angustifolia* Ruderal Riparian Woodland

Translated Name: Russian-olive Ruderal Riparian Woodland
Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup: Interior West Ruderal Flooded & Swamp Forest & Woodland (M298)
Group: Interior West Ruderal Riparian Forest & Scrub (G510)
Alliance: *Elaeagnus angustifolia* Ruderal Riparian Scrub Alliance (A3566)

Element Concept

Global Summary: This widespread Russian-olive woodland type is found in the northern Great Plains, Colorado Plateau, and probably throughout much of the western United States and adjacent Canada. It is a naturalized species that has been widely planted in hedgerows for windbreaks. It has since spread to a variety of native habitats, particularly more mesic ones, such as near streams and rivers, although small upland stands are also known. The vegetation is dominated by *Elaeagnus angustifolia*, sometimes accompanied by *Tamarix* spp. Remnant *Populus fremontii* trees may remain as canopy emergents. Stands may be small and linear. The vegetation is dominated by the tree *Elaeagnus angustifolia* with a variety of native and introduced species in the shrub and herbaceous layers. Associated species have not been characterized. Canopy closure is between 40 and 50%. Shrub cover may be present with species such as *Salix exigua* or *Amorpha fruticosa*, but the species present are highly variable. *Pascopyrum smithii, Sporobolus airoides, Distichlis spicata*, and *Hordeum jubatum* comprise the herbaceous layer in some stands; in others the understory is dominated by introduced species, such as *Lepidium latifolium, Descurainia sophia,* and *Bassia scoparia (= Kochia scoparia)*.

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Environmental Description

Glen Canyon National Recreation Area Environment: This woodland association occurs on flat to gently sloping canyon bottoms at 1407 to 1462 m elevation. Litter covers most of the unvegetated surface, with lesser cover by bare soil, sand, and downed wood. Soils are moderately well-drained loamy sands or sandy loams derived from alluvium.

Global Environment: This woodland type is naturalized throughout the interior West and Great Plains, probably spreading as a result of *Elaeagnus angustifolia* being widely planted in hedgerows for windbreaks, and its fruit and seeds being spread by birds. It has spread to a variety of native habitats, particularly more mesic ones, such as riverbanks, stream terraces and shorelines. Stands also occur in upland basins and drainages. Stands may be small and linear, but many extend for great distances along streams. Adjacent vegetation includes other riparian shrublands and wetlands dominated by *Salix exigua* or *Scirpus* and/or *Schoenoplectus* spp. Upland vegetation is variable.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This rare ruderal woodland type tends to have very high total vegetation cover ranging from 54 to 100%. Stands are characterized by a mixed canopy of the exotic species *Elaeagnus angustifolia* (with 19-25% cover) and the native species *Populus fremontii* (with 13-46%). The shrub layer has moderate to high cover and is often diverse, including such species as *Ericameria nauseosa, Salix exigua, Rhus aromatica, Quercus gambelii*, and *Atriplex canescens*. The herbaceous layer is likewise diverse and includes low to moderate cover of *Muhlenbergia asperifolia, Poa fendleriana, Sporobolus cryptandrus, Phragmites australis, Equisetum* spp., the vine *Clematis ligusticifolia*, and the forbs *Euthamia occidentalis (= Solidago occidentalis)* and *Machaeranthera canescens*. These disturbed stands generally have moderate to high cover of several exotic species, most commonly *Tamarix chinensis, Salsola tragus, Bromus tectorum,* and *Elymus trachycaulus.*

Global Vegetation: The vegetation is dominated by the tree *Elaeagnus angustifolia* with a variety of native and introduced species in the shrub and herbaceous layers. Canopy closure is open to moderately dense (25-50% cover). In the Colorado Plateau, *Tamarix ramosissima* may be present in the tree canopy with less cover than *Elaeagnus angustifolia*, or relict *Populus deltoides* or *Populus fremontii* trees may remain as canopy emergents; however, the dominant tree is clearly *Elaeagnus*. Shrubs in the understory include *Salix exigua, Rhus trilobata, Artemisia tridentata ssp. tridentata, Chrysothamnus linifolius*, and *Amorpha fruticosa*. The herbaceous understory is variable in composition and abundance depending on location. Some species known to occur include *Atriplex patula, Distichlis spicata, Eleocharis palustris, Euthamia occidentalis, Glycyrrhiza lepidota, Grindelia* sp., *Hordeum jubatum, Muhlenbergia asperifolia, Pascopyrum smithii, Spartina pectinata*, and *Sporobolus airoides*. Exotic herbaceous species may be common to abundant, including *Bassia scoparia, Bromus tectorum, Descurainia sophia, Lepidium latifolium,* and *Xanthium strumarium*.

Global Dynamics: *Elaeagnus angustifolia* has been planted widely across the western U.S. in windbreaks and as an ornamental. This tree species has bird-dispersed seeds and has invaded riparian woodlands extensively, replacing the native tree species, especially where flood control efforts limit regeneration of native trees such as *Populus deltoides* and *Populus fremontii*. *Elaeagnus angustifolia* is

shade tolerant, so it is able to become established in the understory of *Populus* gallery forests and becomes the dominant when the mature cottonwood trees fall.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Elaeagnus angustifolia*, *Populus fremontii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Salix exigua*, *Tamarix chinensis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Herb (field)	Graminoid	*Bromus tectorum*, *Elymus trachycaulus*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Elaeagnus angustifolia*
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Amorpha fruticosa*
Tall shrub/sapling	Broad-leaved deciduous tree	*Salix exigua*, *Tamarix ramosissima*
Herb (field)	Graminoid	*Distichlis spicata*, *Pascopyrum smithii*, *Sporobolus airoides*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Elaeagnus angustifolia*, *Pascopyrum smithii*, *Salix exigua*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Elaeagnus angustifolia* (High), *Tamarix chinensis*

Global: Invasive/Exotic Plants: *Bassia scoparia* (Low), *Bromus tectorum* (High), *Descurainia sophia* (Medium/Low), *Elaeagnus angustifolia* (High), *Lepidium latifolium* (High), *Tamarix ramosissima* (High), *Xanthium strumarium*

Conservation Status Rank

Global Rank & Reasons: GNA (invasive) (5-Nov-1999).

Related Concepts

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. *Populus deltoides*- and *Populus*

fremontii-dominated associations may have significant cover of *Elaeagnus angustifolia* in the tree canopy but are generally considered native woodlands until *Elaeagnus angustifolia* comprises more than 80-90% of the tree cover. Some stands have a nearly closed tree canopy (80% cover) or may have significant gaps in the tree canopy.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland association is very rare within the recreation area. It was sampled only in Harris Wash, a side canyon of Harris Wash, and at the confluence of Harris Wash and the Escalante River.

Global Range: This widespread Russian-olive woodland type is reported from the northern Great Plains, Colorado Plateau, and probably occurs throughout much of the western United States and adjacent Canada along rivers and streams, where it replaces native *Populus* spp.- and *Acer negundo*-dominated forests and woodlands.

Nations: US
States/Provinces: AZ, CO, ID, ND, SD, UT
TNC Ecoregions: 9:C, 10:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, 341C:CC, M331E:CC
Federal Lands: NPS (Arches, Badlands, Canyon de Chelly, Dinosaur, Glen Canyon); USFWS (Minidoka, Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plot is on a terrace above Harris Wash (about 6 m high) and below an upland hill that is 4 m above this point. The area is high enough above the streambed that it only floods during extremely high water. Soil is loose on top but fairly compacted and mostly covered by leaf litter.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (2 plots, 1 accuracy assessment point): (Plots: GLCA.5237, GLCA.5246; AA Point: GLCA_AA.3073).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): D. Faber-Langendoen, J. Coles, K.A. Schulz and G. Kittel
References: Coles et al. 2008a, Coles et al. 2009a, Great Plains Flora Association 1986, Midwestern Ecology Working Group n.d.*, NDNHI unpubl. data, Thomas et al. 2010, Von Loh et al. 1999, Von Loh et al. 2002

A0842 Tamarix spp. Ruderal Riparian Scrub Alliance

Alliance Summary Description: This alliance is composed of shrublands dominated by introduced species of *Tamarix,* including *Tamarix chinensis, Tamarix gallica, Tamarix parviflora,* and *Tamarix ramosissima*. It forms moderately dense to dense thickets on banks of larger streams, rivers and playas across the southwestern U.S. and northern Mexico. Introduced from the Mediterranean, *Tamarix* spp. have become naturalized in various sites, including salt flats, springs, and especially along streams and

regulated rivers, often replacing *Salix* or *Prosopis* spp. shrublands or other native vegetation. A remnant herbaceous layer may be present, depending on the age and density of the shrub layer. These species have become a critical nuisance along most large rivers in the semi-arid western U.S.

[CEPP005697] *Tamarix chinensis* Ruderal Lakeshore Scrub
Translated Name: Chinese Tamarisk Ruderal Lakeshore Scrub
Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup: Interior West Ruderal Flooded & Swamp Forest & Woodland (M298)
Group: Interior West Ruderal Riparian Forest & Scrub (G510)
Alliance: *Tamarix* spp. Ruderal Riparian Scrub Alliance (A0842)

Element Concept

Global Summary: This ruderal scrub herbaceous association is known from Glen Canyon National Recreation Area but occurs more widely in the interior western U.S. It is characterized by sparse cover of *Tamarix chinensis* with generally less than 3% cover. Associated shrubs with sparse to very low cover may include *Atriplex confertifolia, Baccharis salicina,* and *Gutierrezia sarothrae*. The herbaceous layer has low to moderate cover and is dominated by one or more of the following exotic annual species: *Bromus rubens* (with up to 6% cover), *Bromus tectorum, Schismus barbatus,* and *Salsola tragus,* and/or the weedy native, perennial species such as *Mentzelia multiflora, Kochia americana, Rumex maritimus,* and *Stephanomeria pauciflora*. Stands occur on plateaus, bajadas, canyon sides, canyon or valley floors, drainage channels, beaches that occur along the shores of reservoirs and is a result flood disturbance regime of continually fluctuating lake levels. Elevations are between1090 and 1187 m. Sites range from flat to steeply sloping and occur on all aspects. Bare soil, sand, and bedrock cover most of the unvegetated surface, with lesser cover of gravel, large rocks, and litter. Soils are variable and include silty clay loams, silt loams, loamy sands, and sands derived from alluvial or talus/colluvial deposits, shales or sandstones

Environmental Description

Glen Canyon National Recreation Area Environment: This ruderal mixed shrub herbaceous association occurs on plateaus, bajadas, canyon sides, canyon or valley floors, drainage channels, beaches, and lakeshores. Sites range from flat to steeply sloping (up to 20°), are oriented to all aspects, and lie between 1090 and 1187 m elevation. Bare soil, sand, and bedrock cover most of the unvegetated surface, with lesser cover of gravel, large rocks, and litter, and low cover of biological soil crusts and driftwood. Soils are somewhat poorly drained to rapidly drained silty clay loams, silt loams, loamy sands, and sands derived from alluvial, eolian or talus/colluvial deposits, shales of the Chinle or Carmel formations, or from sandstones of the Cedar Mesa Formation.

Global Environment: This ruderal scrub herbaceous association is known from Glen Canyon National Recreation Area but occurs more widely in the interior western U.S. Stands occur on plateaus, bajadas, canyon sides, canyon or valley floors, drainage channels, beaches that occur along the shores of reservoirs and is a result flood disturbance regime of continually fluctuating lake levels. Elevations

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are between 1090 and 1187 m. Sites range from flat to steeply sloping (up to 20°) and occur on all aspects. Bare soil, sand, and bedrock cover most of the unvegetated surface, with lesser cover of gravel, large rocks, and litter, and low cover of biological soil crusts and driftwood. Soils are somewhat poorly drained to rapidly drained silty clay loams, silt loams, loamy sands, and sands derived from alluvial or talus/colluvial deposits, shales of the Chinle or Carmel formations, or from sandstones of the Cedar Mesa Formation.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This ruderal shrub herbaceous association occurs along the shores of Lake Powell and is a result of the flood disturbance regime of continually fluctuating lake levels. Total cover varies as a result of underlying substrate exposed at the lakeshore and other environmental factors such as soil depth, slope, and aspect; it can be as low as 2% or as high as 35%. The shrub canopy is typically <2 m tall and is dominated by *Tamarix chinensis* with generally less than 3% cover (though one example has 7% cover). Associated shrubs with sparse to very low cover may include *Atriplex confertifolia, Isocoma rusbyi, Baccharis salicina, Pluchea sericea*, and *Gutierrezia sarothrae*. The understory has low to moderate cover and is dominated by one or more of the following exotic annual species: *Bromus rubens* (with up to 6% cover), *Bromus tectorum* (with up to 15% cover), *Schismus barbatus* (with up to 3% cover), and *Salsola tragus* (with up to 10% cover), and/or the following native, perennial (but sometimes considered weedy) species: *Mentzelia multiflora* (with up to 8% cover), *Kochia americana* (with up to 8% cover), *Rumex maritimus* (with up to 25% cover), *Machaeranthera canescens* (with up to 4% cover), *Oenothera pallida* (with up to 5% cover), and *Stephanomeria pauciflora* (with up to 4% cover). Other species occasionally present with more than trace cover include *Eriogonum racemosum, Eriogonum inflatum, Eriogonum deflexum, Bassia hyssopifolia, Reverchonia arenaria, Vulpia octoflora (= Festuca octoflora), Heliotropium curassavicum*, and *Stanleya pinnata*.

Global Vegetation: This ruderal scrub herbaceous association is characterized by sparse cover of *Tamarix chinensis* with generally less than 3% cover (though one example has 7% cover). Associated shrubs with sparse to very low cover may include *Atriplex confertifolia, Baccharis salicina*, and *Gutierrezia sarothrae*. The herbaceous layer has low to moderate cover and is dominated by one or more of the following exotic annual species: *Bromus rubens* (with up to 6% cover), *Bromus tectorum* (with up to 15% cover), *Schismus barbatus* (with up to 3% cover), and *Salsola tragus* (with up to 10% cover), and/or the weedy native, perennial species such as *Mentzelia multiflora* (with up to 8% cover), *Kochia americana* (with up to 8% cover), *Rumex maritimus* (with up to 25% cover), and *Stephanomeria pauciflora* (with up to 4% cover). Other species occasionally present with more than trace cover include *Eriogonum racemosum, Eriogonum inflatum, Eriogonum deflexum, Bassia hyssopifolia, Vulpia octoflora (= Festuca octoflora), Heliotropium curassavicum*, and *Stanleya pinnata*. Total cover varies as a result of underlying substrate exposed along shoreline and other environmental factors such as soil depth, slope, aspect, and substrate ranging from 2-35%.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Tamarix chinensis*
Herb (field)	Flowering forb	*Kochia americana*, *Rumex maritimus*, *Salsola tragus*, *Stephanomeria pauciflora*
Herb (field)	Graminoid	*Bromus rubens*, *Bromus tectorum*, *Schismus barbatus*

Global

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Tamarix chinensis*
Herb (field)	Flowering forb	*Kochia americana*, *Mentzelia multiflora*, *Rumex maritimus*, *Salsola tragus*, *Stephanomeria pauciflora*
Herb (field)	Graminoid	*Bromus rubens*, *Bromus tectorum*, *Schismus barbatus*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Tamarix chinensis*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Salsola tragus*, *Schismus barbatus* (High/Medium), *Tamarix chinensis*

Global: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Salsola tragus*, *Schismus barbatus* (High/Medium), *Tamarix chinensis*

Conservation Status Rank

Global Rank & Reasons: GNA (ruderal) (18-Aug-2016).

Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak

Element Distribution

Glen Canyon National Recreation Area Range: This ruderal shrub herbaceous association occurs along the lakeshore throughout the recreation area and was sampled in Rock Creek Bay, Bullfrog Bay, Hall's Creek Bay, across from Good Hope Bay, at the mouth of Farley Canyon, Narrow Canyon, Lake Canyon, West Canyon, Ticaboo Canyon, Gunsight Canyon, near Hall's Crossing, The Rincon, Wahweap, and on Antelope Island.

Global Range: This ruderal scrub herbaceous association is known from Glen Canyon National Recreation Area but occurs more widely in the interior western U.S. It occurs along the shores of reservoirs and is a result of flood disturbance.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Glen Canyon Dam is the reason for this community being present here; fluctuating lake levels and close proximity to the lakeshore drive this community. This site was formerly submerged under higher lake levels and is now just above the water's edge, providing the necessary water for the <2-m tall *Tamarix chinensis* shrubs. Otherwise, this is a sparse slickrock community with very shallow sand and annuals. There is a boulder field nearby and lots of driftwood in the area.

Glen Canyon National Recreation Area Plots: The description is based on 2011, 2012, 2013, 2014, and 2015 field data (18 plots, 6 accuracy assessment points): (Plots: GLCA.1039, GLCA.1051, GLCA.1071, GLCA.2052, GLCA.2094, GLCA.4037, GLCA.4230, GLCA.4261, GLCA.4275, GLCA.4277, GLCA.4279, GLCA.4283, GLCA.4287, GLCA.5094, GLCA.5099, GLCA.5105, GLCA.5196, GLCA.5430; AA Points: GLCA_AA.0506, GLCA_AA.0507, GLCA_AA.1014, GLCA_AA.1098, GLCA_AA.1099, GLCA_AA.1100).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEGL003114] *Tamarix* spp. Ruderal Riparian Shrubland
Translated Name: Tamarisk species Ruderal Riparian Shrubland
Common Name:

USNVC Classification

Division: Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup: Interior West Ruderal Flooded & Swamp Forest & Woodland (M298)
Group: Interior West Ruderal Riparian Forest & Scrub (G510)
Alliance: *Tamarix* spp. Ruderal Riparian Scrub Alliance (A0842)

Element Concept

Global Summary: This shrubland association is composed of thickets on banks of streams across the western U.S. and northern Mexico. Stands are dominated by introduced species of *Tamarix*, including *Tamarix ramosissima, Tamarix chinensis, Tamarix gallica,* and *Tamarix parviflora*. Introduced from the Mediterranean, this genus has become naturalized in various sites, including salt flats and other

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Subset: GLCA; Glen Canyon National Recreation Area

saline habitats, springs, and especially along streams and regulated rivers, where it replaces the native vegetation, such as shrublands dominated by species of *Salix* or *Prosopis* or woodlands of *Populus* spp. An herbaceous layer may be present, depending on the age and density of the shrub layer, which may consist of aggressive exotic species such as *Lepidium latifolium*.

Environmental Description

Glen Canyon National Recreation Area Environment: This invasive riparian shrubland occurs in intermittently or seasonally flooded low-lying areas including alluvial fans, arroyos, bajadas, lakeshore beaches, terraces, valley and canyon bottoms, along drainage channels/washes, intermittent streams, near pools, and on toeslopes, piedmont slopes, sideslopes, hills, and canyon sides. Sites are mostly flat, though some are moderately sloping (up to 15°), oriented to all aspects, and are located between 953 m and 1686 m elevation. Litter and bare soil cover most of the unvegetated surface, with low to moderate cover of gravel and sand, and sparse to low cover of downed wood, large rocks, and standing water. Soils are somewhat poorly drained to moderately well-drained to rapidly drained sands, loamy sands, sandy loams, silt loams, silty clay loams, loams, clays, or silts derived from alluvium or less commonly eolian deposits.

Global Environment: These widespread shrublands are common along streams, rivers, and around playas in the western U.S. and Mexico. Elevation ranges from 75 m below sea level to 1860 m above sea level. *Tamarix* spp. have become naturalized in various sites including riverbanks, floodplains, basins, sandbars, side channels, springs, salt flats, and other saline habitats. Stands grow especially well along regulated rivers where agricultural runoff has increased water salinity and the dam decreases any flushing flows. *Tamarix* is highly competitive and excludes native riparian species such as *Salix* and *Populus*. Along regulated rivers, the absence of regular scouring floods allows *Tamarix* seedlings to become established. Substrates range from sands to loams, and are nearly always associated with alluvial deposits of sand, gravel or cobbles.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Salt-cedar shrublands have become established on the floodplains and banks of rivers, streams, and lakes throughout the recreation area. Total vegetation cover in these stands is highly variable and ranges from 4 to 100%; stands are dominated by a canopy, typically 2 to 10 m tall, of *Tamarix chinensis* with 3-85% of the total vegetation cover. Other shrubs may be present with low cover, including *Baccharis salicina, Atriplex canescens, Artemisia filifolia, Ericameria nauseosa, Salix exigua*, and *Gutierrezia* spp. The herbaceous layer tends to be limited, as it is inhibited by the dense canopy and litter cover, or in more open stands it may be dense and dominated by weedy, annual species. It consists largely of weedy or exotic salt-tolerant species, including *Bromus tectorum* (with up to 85% cover), *Bromus rubens* (with up to 30% cover), *Erodium cicutarium, Vulpia octoflora (= Festuca octoflora), Plantago patagonica, Lepidium montanum, Sisymbrium irio, Schedonnardus paniculatus, Schismus barbatus, Alhagi maurorum*, and *Salsola tragus* (with up to 50% cover). Native grasses may be present with very low cover, including *Aristida purpurea, Achnatherum hymenoides, Sporobolus contractus*, and *Sporobolus flexuosus*, as well as the native forbs *Artemisia ludoviciana, Eurybia glauca (= Aster glaucodes), Chloracantha spinosa, Datura wrightii, Descurainia incana, Machaeranthera canescens*, and *Polygonum lapathifolium*.

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Global Vegetation: This introduced shrubland forms a moderate to dense tall-shrub layer that is solely or strongly dominated by species of *Tamarix*, including *Tamarix ramosissima, Tamarix chinensis, Tamarix gallica*, and *Tamarix parviflora*. Other native shrubs may include species of *Salix* (especially *Salix exigua*) and *Prosopis*, as well as *Rhus trilobata* and *Sarcobatus vermiculatus* but with low cover (if shrub species are codominant, then the stand is classified as a natural shrubland). Scattered native trees such as *Acer negundo, Salix amygdaloides, Populus* spp., or another introduced tree, *Elaeagnus angustifolia*, may also be present. Depending on stand age and density of the shrub layer, an herbaceous layer may be present. Associated native species include *Distichlis spicata* and *Sporobolus airoides*, and introduced species include *Agrostis gigantea, Agrostis stolonifera*, and *Poa pratensis*. Introduced herbaceous species such as *Polypogon monspeliensis, Conyza canadensis, Lepidium latifolium*, and many others have been reported from shrublands in this association.

Global Dynamics: *Tamarix* species are highly competitive and have invaded many riparian and wetland environments in the western U.S. Hansen et al. (1995) report that these shrubs are extremely drought- and salt-tolerant, produce prolific wind-dispersed seeds, can resprout after burning or cutting, and if kept moist, buried or broken branches will develop adventitious roots and grow. Stands seem to favor disturbed and flow-regulated rivers, because the lack of annual overbank flooding and subsequent scouring allows seedlings to become established. However, *Tamarix* spp. will establish well in pristine areas, too, especially under drought conditions such as experienced by the Colorado Plateau in 2002-2003. Under optimum conditions riparian areas can be converted to a dense thicket in less than 10 years (Hansen et al. 1995). Once established, stands are extremely difficult to eradicate, requiring cutting along with herbicide application on stumps to prevent resprouting (Smith and Douglas 1989), as well as restoration of the original flooding and scouring regime. Many of the national parks in the western states have active programs of tamarisk removal and riparian restoration that have been moderately successful. A biocontrol agent, the northern tamarisk beetle (*Diorhabda carinulata*), has been used to defoliate tamarisk throughout the southwestern U.S. since 2001 and defoliation has been highly effective (Bateman et al. 2012).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Tamarix chinensis*
Herb (field)	Flowering forb	*Salsola tragus*
Herb (field)	Graminoid	*Bromus rubens*, *Bromus tectorum*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous tree	*Tamarix chinensis*, *Tamarix gallica*, *Tamarix parviflora*, *Tamarix ramosissima*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Tamarix chinensis, Tamarix gallica, Tamarix parviflora, Tamarix ramosissima*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Alhagi maurorum* (Medium/Low), *Bromus rubens, Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low), *Plantago patagonica, Salsola tragus, Schismus barbatus* (High/Medium), *Sisymbrium irio* (Medium/Insignificant), *Tamarix chinensis*

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Lepidium latifolium* (High), *Poa pratensis* (Medium), *Tamarix chinensis, Tamarix gallica, Tamarix parviflora, Tamarix ramosissima* (High)

Conservation Status Rank

Global Rank & Reasons: GNA (invasive) (24-Jul-2001).

Related Concepts

Global Similar Types:
- *Tamarix* spp. - (*Baccharis halimifolia*) Ruderal Wet Shrubland (CEGL004918)

Global Related Concepts:
- *Tamarix chinensis* Community Type (Hansen et al. 1995) <
- *Tamarix pentandra* Community Type (Szaro 1989) **?**
- *Tamarix ramosissima* (Salt cedar) Association (Nachlinger and Reese 1996) **?**
- *Tamarix ramosissima* Shrubland (Carsey et al. 2003a) =
- *Tamarix* spp. (Tamarisk thickets) Semi-natural Stands (Sawyer et al. 2009) =
- *Tamarix* spp. Semi-Natural Shrubland Stands (Evens et al. 2012) =
- *Tamarix* spp. Temporarily Flooded Semi-natural (Evens et al. 2014) =
- Palustrine (Cowardin et al. 1979) >
- Salt cedar series (Paysen et al. 1980) **?**
- Saltcedar Alliance (Muldavin et al. 2000a) =
- Tamarisk Scrub (#63810) (Holland 1986b) =
- Tamarisk series (Sawyer and Keeler-Wolf 1995) =

Classification

Status: Standard
Classification Confidence: 1 - Strong
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau and Mojave Desert. This is a broadly defined plant association that is composed of many diverse *Tamarix* spp.-dominated vegetation communities from a wide variety of environments. Muldavin et al. (2000a) described 8 community types that will be reviewed as possible USNVC associations.

Element Distribution

Glen Canyon National Recreation Area Range: This very common invasive riparian shrubland occurs on floodplains and banks of rivers, streams, and washes within the recreation area. It was

sampled near Bullfrog Bay, Lee's Ferry, Warm Creek Bay, Hall's Creek Bay, Wahweap, the Rincon, The Sand Hills, the Purple Hills, Crossing of the Fathers, Friendship Cove, Dangling Rope, Clay Hill's Crossing, the Burr Trail, Cookie Jar Butte, and Balanced Rock, in Blue Notch Canyon, Calf Canyon, Cornerstone Canyon, Cottonwood Canyon, Crosby Canyon, Coyote Gulch, Iceberg Canyon, Last Chance Creek, Hansen Creek, Little Valley Canyon, Navajo Canyon, Neanderthal Cove, North Wash, Red Canyon, Farley Canyon, Rock Creek Canyon and Bay, the south fork of Ticaboo Creek, Wagon Box Canyon, Warm Springs Canyon, the Cane Spring Desert, and West Canyon, across from Good Hope Mesa, on Billie Flat Top, Hall Mesa, Antelope Island, Bull Points, Romana Mesa, and along the San Juan and Dirty Devil rivers.

Global Range: This semi-natural shrubland is found along drainages in the semi-arid western Great Plains, interior and southwestern U.S. and northern Mexico, from central and eastern Montana, south to Colorado, western Oklahoma and Texas, west to California.

Nations: MX, US
States/Provinces: AZ, CA, CO, MT, MXCH, MXCO, MXSO, NM, NV, OK, TX, UT, WY
TNC Ecoregions: 5:C, 9:C, 10:C, 11:C, 12:C, 13:C, 15:C, 16:C, 17:C, 19:C, 21:C, 22:C, 23:C, 24:C, 26:C, 27:C, 28:C

USFS Ecoregions (1994/95): 261A:CC, 261B:CC, 262A:CC, 313A:CC, 313B:CC, 313C:CC, 313D:CC, 313E:CC, 315B:CC, 321A:CC, 322A:CC, 331I:CC, 341B:CC, 341C:CC, 341F:CC, M261A:CC, M261E:CC, M261F:CC, M262A:CC, M262B:CC, M331E:CC
Federal Lands: NPS (Arches, Big Bend, Canyonlands, Capitol Reef, Death Valley, Dinosaur, Glen Canyon, Grand Canyon, Grand Canyon-Parashant, Joshua Tree, Lake Mead, Lake Meredith, Mojave, Petrified Forest, Wupatki, Zion); USFS (Humboldt-Toiyabe, Spring Mountains); USFWS (Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Very flat topographical step, previously under the lake, now highly disturbed, *Tamarix chinensis* monoculture.

Glen Canyon National Recreation Area Plots: The description is based on 2011, 2012, and 2013 field data (92 plots): (Plots: GLCA.1010, GLCA.1026, GLCA.1057, GLCA.1072, GLCA.1078, GLCA.1084, GLCA.1088, GLCA.2015, GLCA.2045, GLCA.2051, GLCA.2057, GLCA.2062, GLCA.2066, GLCA.2077, GLCA.2079, GLCA.2080, GLCA.2082, GLCA.2084, GLCA.2086, GLCA.4032, GLCA.4097, GLCA.4098, GLCA.4103, GLCA.4116, GLCA.4128, GLCA.4130, GLCA.4132, GLCA.4134, GLCA.4135, GLCA.4137, GLCA.4221, GLCA.4227, GLCA.4233, GLCA.4237, GLCA.4238, GLCA.4240, GLCA.4242, GLCA.4243, GLCA.4257, GLCA.4259, GLCA.4260, GLCA.4262, GLCA.4265, GLCA.4273, GLCA.4274, GLCA.4276, GLCA.4280, GLCA.4282, GLCA.5018, GLCA.5054, GLCA.5071, GLCA.5072, GLCA.5095, GLCA.5098, GLCA.5102, GLCA.5106, GLCA.5108, GLCA.5110, GLCA.5114, GLCA.5115, GLCA.5120, GLCA.5126, GLCA.5127, GLCA.5129, GLCA.5145, GLCA.5147, GLCA.5158, GLCA.5163, GLCA.5165, GLCA.5167, GLCA.5168, GLCA.5170, GLCA.5171, GLCA.5172, GLCA.5173, GLCA.5183, GLCA.5190, GLCA.5198, GLCA.5201, GLCA.5205, GLCA.5206, GLCA.5207,

GLCA.5208, GLCA.5214, GLCA.5288, GLCA.5403, GLCA.5404, GLCA.5406, GLCA.5428, GLCA.5429, GLCA.6220, GLCA.9508).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Coles and G. Kittel
References: Baalman 1965, Bateman et al. 2013, Carsey et al. 2003a, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2003, Coles et al. 2008a, Coles et al. 2009a, Cowardin et al. 1979, Evens et al. 2012, Evens et al. 2014, Hansen et al. 1995, Hansen et al. 2004b, Hoagland 2000, Holland 1986b, MTNHP 2002b, Muldavin et al. 2000a, Nachlinger and Reese 1996, Ortenberger and Bird 1933, Paysen et al. 1980, Reid and Hall 2010, Romme et al. 1993, Sawyer and Keeler-Wolf 1995, Sawyer et al. 2009, Sawyer et al. 2009*, Smith and Douglas 1989, Stevens and Shannon 1917, Szaro 1989, TNHS unpubl. data, Thomas et al. 2009a, Ungar 1968, Von Loh et al. 2002, WNDD unpubl. data, Ware and Penfound 1949, Western Ecology Working Group: n.d.

2. Shrub & Herb Vegetation

2.B.2. Temperate Grassland & Shrubland

2.B.2.NA. WESTERN NORTH AMERICAN GRASSLAND & SHRUBLAND

M168. Rocky Mountain-Vancouverian Subalpine-High Montane Mesic Meadow

G268. Southern Rocky Mountain Montane-Subalpine Grassland

Group Summary Description: This southern Rocky Mountains group extends west to high plateaus and mountains in the Colorado Plateau. Vegetation is characterized by an open to dense perennial graminoid layer. Larger occurrences usually consist of a mosaic of two or three plant associations with one of the following dominant grasses: *Blepharoneuron tricholepis, Danthonia parryi, Festuca arizonica, Muhlenbergia montana, Pascopyrum smithii*, or *Pseudoroegneria spicata* at lower elevation / warmer aspects, or *Danthonia intermedia, Festuca idahoensis, Festuca thurberi*, or *Muhlenbergia filiculmis* at subalpine elevation / cooler aspects. The common subdominants include *Bouteloua gracilis, Hesperostipa comata*, or *Poa secunda*. *Bouteloua gracilis* often dominates sites with warm aspects and heavy grazing history. Forb species such as *Potentilla hippiana* may be present to codominant. These large-patch grasslands are intermixed with matrix stands of spruce-fir, lodgepole pine, ponderosa pine, and aspen forests. In limited circumstances (e.g., South Park in Colorado), they form the "matrix" of high-elevation plateaus and inter-montane valleys. Stands typically occur between 2200 and 3000 m elevation on flat to rolling plains and parks or on lower sideslopes that are dry, but may extend up to 3350 m on warm aspects. Soils resemble prairie soils in that the A-horizon is dark brown, relatively high in organic matter, slightly acidic, and usually well-drained. Small-patch representations of this group do occur at high elevations of the Trans-Pecos where they present as occurrences of *Festuca arizonica - Blepharoneuron tricholepis* Grassland (CEGL004508). These occurrences often occupy sites adjacent to Eastern Madrean Chaparral Group (G280).

A3953 Festuca arizonica - Muhlenbergia montana - Poa fendleriana Southern Rocky Mountain Montane Grassland Alliance

Alliance Summary Description: Vegetation of this grassland alliance is characterized by an open to dense perennial graminoid layer composed of bunchgrasses *Festuca arizonica* and *Muhlenbergia*

montana, which are widespread dominants, with *Achnatherum lettermanii, Blepharoneuron tricholepis, Carex duriuscula, Carex rossii, Carex siccata, Elymus lanceolatus, Hesperostipa comata, Muhlenbergia filiculmis, Poa fendleriana, Pseudoroegneria spicata,* or *Schizachyrium scoparium* often present to codominant. Forb species such as *Potentilla hippiana* may be present to codominant. This alliance occurs largely in the southern Rocky Mountains extending west to the mountains and high plateaus of Arizona, Utah and Nevada and northeast to the Black Hills. It primarily occurs in the montane zone (2440-3050 m [8000-10,000 feet]), but may extend down into the foothills. Stands are typically found in xeric forest openings or parks in the ponderosa pine zone with southern aspects on moderately steep slopes and ridgetops. Occasionally the stands occupy rolling parklands. The xeric nature of sites appears to be an important environmental factor. Soils are moderately deep Mollisols, with high coarse-fragment content, sandy loam textures, and a distinct clay horizon. Parent materials are primarily colluvium derived from granite and gneiss. Bare soil, exposed gravels, and small rocks account for as much as 50% of the ground surface area. These large-patch grasslands are intermixed with matrix stands of ponderosa pine, Douglas-fir and aspen forests. In limited circumstances (e.g., South Park in Colorado), they form the "matrix" of high-elevation plateaus and inter-montane valleys.

[CEGL001925] *Poa fendleriana* Grassland

Translated Name: Muttongrass Grassland

Common Name:

USNVC Classification

Division: Western North American Grassland & Shrubland (2.B.2.Na)

Macrogroup: Rocky Mountain-Vancouverian Subalpine-High Montane Mesic Meadow (M168)

Group: Southern Rocky Mountain Montane-Subalpine Grassland (G268)

Alliance: *Festuca arizonica - Muhlenbergia montana - Poa fendleriana* Southern Rocky Mountain Montane Grassland Alliance (A3953)

Element Concept

Global Summary: This herbaceous association occurs widely in the Colorado Plateau and southern Rocky Mountains. This sparsely to moderately vegetated grassland is characterized by the bunchgrass *Poa fendleriana* that provides up to 25% cover. The herbaceous layer is often diverse and may include low cover of graminoids such as *Achnatherum pinetorum, Agropyron cristatum, Bouteloua gracilis, Bromus tectorum,* and *Elymus elymoides*. Forbs commonly present include *Antennaria dimorpha, Eriogonum umbellatum, Lepidium montanum, Phlox hoodii, Senecio spartioides var. multicapitatus (= Senecio multicapitatus),* and *Sphaeralcea parvifolia*. Scattered tall, short and dwarf-shrubs may be present, such as *Artemisia frigida, Chrysothamnus depressus, Fraxinus anomala, Gutierrezia sarothrae, Krascheninnikovia lanata, Mahonia fremontii,* and *Purshia tridentata*. Cryptogam cover is sparse for all sampled stands. Stands are found on lower slopes of hills and midslopes of ridges and mesas. Sites are flat, moderately steep to steep (11-55% slopes), occur between 2339 to 2700 m elevation, and include all aspects. The unvegetated surface has sparse to low cover of litter and low to high cover by large and small rocks and exposures of bare soil. Parent materials are Tertiary volcanic rocks that have eroded to colluvium or talus on slopes. Soils are rapidly drained and texturally range from loamy sand to sandy clay loam and sandy loam.

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Environmental Description

Glen Canyon National Recreation Area Environment: This uncommon grassland association occurs on gently to steeply sloping (up to 32°) canyon sides and ridges, between 1522 and 2289 m elevation. Bare soil, large rocks, and gravel cover most of the unvegetated surface, with low cover by litter. Soils are well-drained to rapidly drained clay loams and sandy loams derived from the Moenkopi or Straight Cliffs formations.

Global Environment: This herbaceous association occurs on lower slopes of hills and midslopes of ridges and mesas. Sites include gentle to steep (11-55%) slopes between 1522 and 2700 m elevation on all aspects. The unvegetated surface has sparse to low cover of litter and low to high cover by large and small rocks and exposures of bare soil. Parent materials are sedimentary and volcanic rocks that have eroded to colluvium or talus on slopes or sandstones that have been eroded to alluvium. Soils are well- to rapidly drained and texturally range from loamy sand to sandy clay loam and sandy loam. The cryptogamic soil community provides low cover.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This herbaceous association is characterized by a moderately dense herbaceous layer (17-33% total cover) that is typically dominated by the bunchgrass *Poa fendleriana* that provides 6-10% cover. Shrubs present with low cover may include *Artemisia bigelovii, Ephedra viridis, Rhus trilobata var. trilobata (= Rhus aromatica var. trilobata), Fraxinus anomala*, and *Gutierrezia sarothrae*. Other herbaceous species present with low cover include the grasses *Achnatherum hymenoides, Bromus tectorum, Elymus elymoides, Sporobolus cryptandrus*, and *Achnatherum speciosum (= Stipa speciosa),* and the forbs *Artemisia ludoviciana, Petradoria pumila, Wyethia scabra*, and *Xylorhiza tortifolia*.

Global Vegetation: This herbaceous association is characterized by a sparse to moderately dense herbaceous layer (5-40% total cover) that is typically dominated by the bunchgrass *Poa fendleriana* that provides from up to 25% cover. The herbaceous layer is often diverse and may include graminoids that provide low cover of *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Achnatherum pinetorum, Agropyron cristatum, Bouteloua gracilis, Bromus tectorum, Elymus elymoides*, and *Sporobolus cryptandrus*. Forbs commonly present include *Antennaria dimorpha, Eriogonum umbellatum, Lepidium montanum, Phlox hoodii, Senecio spartioides var. multicapitatus (= Senecio multicapitatus),* and *Sphaeralcea parvifolia*. Scattered tall, short and dwarf-shrubs may be present, such as *Artemisia bigelovii, Artemisia frigida, Artemisia ludoviciana, Chrysothamnus depressus, Ephedra viridis, Fraxinus anomala, Gutierrezia sarothrae, Krascheninnikovia lanata, Mahonia fremontii, Petradoria pumila, Purshia tridentata, Wyethia scabra*, and *Xylorhiza tortifolia*. The cryptogamic soil community provides low cover and includes dark cyanobacteria, moss, *Collema* sp., and *Fulgensia* sp.

Global Dynamics: In drier areas, this association occurs on sites with cooler aspects such as north-facing aspects and landscape positions where additional moisture accumulates by runoff from higher areas or deposition of snow.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Poa fendleriana*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Poa fendleriana*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Poa fendleriana*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Vulnerable Plants: *Potentilla crinita* (G3G4); Invasive/Exotic Plants: *Agropyron cristatum* (Medium/Low), *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GU (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Ceanothus fendleri / Poa fendleriana* Shrub-Steppe (CEGL005501) also occurs in burned openings within a larger matrix of live *Pinus ponderosa* vegetation but has more *Ceanothus fendleri* present.

Global Related Concepts:

- *Poa fendleriana* (Bourgeron and Engelking 1994) =
- *Potentilla diversifolia - Poa fendleriana* Alpine Meadow Unit (Olgeirson 1972) =
- *Potentilla diversifolia - Poa fendleriana* Alpine Meadow Unit (Olgeirson 1974) =
- DRISCOLL FORMATION CODE:V.C.6.b. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Data from Loder (1964) and Olgeirson (1972, 1974) indicate that this association may also occur in the subalpine/alpine zones. However, the data contained in these references do not give enough information to confirm that the high-elevation stands are part of this association or whether they belong to a different association. More field inventories are needed to resolve this classification issue.

Element Distribution

Glen Canyon National Recreation Area Range: This very rare herbaceous association was only sampled in Moody Canyon and on Bull Ridge.

Global Range: This herbaceous association occurs widely in the Colorado Plateau and southern Rocky Mountains on lower slopes of hills and midslopes of ridges and mesas in western Colorado, eastern Utah, northern Arizona and is likely more widespread.

Nations: US
States/Provinces: AZ, CO:SU, UT
TNC Ecoregions: 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Bryce Canyon, Canyonlands, Cedar Breaks, Curecanti, Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: All of the trees in the segment are burned snags. Herbaceous ground cover and scattered short shrubs along with a few patches of *Quercus gambelii* make up the primary vegetation.

Glen Canyon National Recreation Area Plots: The description is based on 2012 field data (2 plots): (Plots: GLCA.4088, GLCA.4208).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and G. Kittel
References: Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Coles et al. 2010, Driscoll et al. 1984, Loder 1964, Olgeirson 1972, Olgeirson 1974, Reid and Hall 2010, Tendick et al. 2010, Tendick et al. 2011a, Tendick et al. 2011b, Western Ecology Working Group n.d.*

M049. Southern Rocky Mountain Montane Shrubland

G277. Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland

Group Summary Description: This group occurs in the mountains, plateaus and foothills of the southern Rocky Mountains and Colorado Plateau, including the Uinta and Wasatch ranges and the Mogollon Rim. The vegetation is typically dominated by *Quercus gambelii* alone or codominant with *Amelanchier alnifolia, Amelanchier utahensis, Artemisia tridentata, Cercocarpus montanus, Fendlera rupicola, Fraxinus anomala, Holodiscus dumosus, Jamesia americana, Prunus virginiana, Purshia stansburiana, Purshia tridentata, Robinia neomexicana, Symphoricarpos oreophilus,* or *Symphoricarpos rotundifolius*. There may be inclusions of other mesic montane shrublands with *Quercus gambelii* absent or as a relatively minor component. These shrublands are most commonly found along dry foothills, lower mountain slopes, and at the edge of the western Great Plains from approximately 2000 to 2900 m in elevation, and are often situated above pinyon-juniper woodlands. Substrates are variable and include soil types ranging from calcareous, heavy, fine-grained loams to sandy loams, gravelly loams, clay loams, deep alluvial sand, or coarse gravel. This group intergrades with Southern Rocky Mountain Mountain-mahogany - Mixed Foothill Shrubland Group (G276) and

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shares many of the same site characteristics. However, this group includes more mesic communities. Density and cover of *Quercus gambelii* and *Amelanchier* spp. often increase after fire.

A3736 Fraxinus anomala - Rhus trilobata - Fendlera rupicola Talus & Rock Outcrop Shrubland Alliance
Alliance Summary Description: This shrubland alliance occurs in Colorado Plateau, southern Rocky Mountains, and Great Basin. Vegetation in this mixed, short (<2 m tall) shrubland alliance is variable. The shrub canopy has sparse to moderate cover, often with irregularly distributed dense shrub patches located below cliffs, on benches, in dry channels, on toeslopes and lower slopes, and near seeps where soil moisture is more available. Stands are often characterized by a sparse to low cover (<15% total cover) mix of xeric shrubs; *Brickellia californica, Fraxinus anomala, Fendlera rupicola*, and *Rhus trilobata* are conspicuous and usually at least codominant. At higher elevations and in microsites, mesic- and cool-site shrubs such as *Jamesia americana, Prunus virginiana, Ribes cereum, Rubus deliciosus, Holodiscus dumosus, Dasiphora fruticosa ssp. floribunda*, and *Acer glabrum* are characteristic. Many other shrub species may be present. The herbaceous layer is also variable depending on site characteristics and may include many species but none provides more than a few percent cover. Biological soil crust formation is rare on active slopes. Lichens provide large amounts of foliar cover, at times from 30-60% on more stable rock. This shrubland alliance occurs in canyons, plateaus, foothill and mountain slopes or rocky colluvial slopes and rock outcrop/large cliff faces. Elevations range from 1268 to 2715 m (4160-8900 feet). Slopes are moderate to very steep and are often oriented to the cooler north or east aspects. Soils tend to be sandy and skeletal.

[CEGL003963] *Fraxinus anomala - Rhus trilobata* Dry Talus and Slickrock Shrubland
Translated Name: Singleleaf Ash - Skunkbush Sumac Dry Talus and Slickrock Shrubland
Common Name:

USNVC Classification

Division: Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup: Southern Rocky Mountain Montane Shrubland (M049)
Group: Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277)
Alliance: *Fraxinus anomala - Rhus trilobata - Fendlera rupicola* Talus & Rock Outcrop Shrubland Alliance (A3736)

Element Concept

Global Summary: This open shrubland occurs on rocky sites in the Colorado Plateau and is characterized by sparse to low cover (<15% total cover) of a mix of xeric shrubs, among which *Fraxinus anomala* and *Rhus trilobata* are conspicuous and usually at least codominant. Many other shrub species are usually present, including *Artemisia bigelovii, Atriplex confertifolia, Ephedra torreyana, Chrysothamnus viscidiflorus var. stenophyllus*, and *Gutierrezia sarothrae*. The herbaceous layer may include many species but never provides more than a few percent cover; *Pleuraphis jamesii, Achnatherum hymenoides, Stanleya pinnata, Chamaesyce fendleri*, and *Xylorhiza* spp. are the most consistent species. This association occurs on a range of physical sites, from steep, rocky colluvial slopes to flat areas with thin soils near the edges of canyon and mesa rims. Slopes range from gentle to steep (1-34°) and elevation ranges from 1113 to 1536 m, with a strong orientation toward northerly

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aspects. Soils are most often sandy but include very rocky soils to fine silt loams or clay loams derived from sandstone and shale.

Environmental Description

Glen Canyon National Recreation Area Environment: This mixed shrubland association occurs on steep, rocky colluvial slopes on mesa or canyon sides, as well as on thin soils near the edges of canyon rims, ledges, plateaus, terraces, and on benches. Sites are gently to steeply sloping (3-35°) slopes, oriented mostly to the north and northwest, and occur between 1113 and 1492 m elevation. The unvegetated surface is mostly covered by large rocks, gravel, and bare soil, with lesser cover by bedrock, sand, and biological soil crusts (mostly moss and dark cyanobacteria), and trace litter or dead wood evident. Soils are moderately well-drained to rapidly drained sands, loamy sands, sandy loams, silt loams, silty clay loams, or sandy clay loams derived from Moenkopi or Organ Rock shales, Kayenta or White Rims sandstones, or from alluvial or talus/colluvial deposits.

Global Environment: This shrubland association occurs on a variety of sites, from steep, rocky colluvial slopes to thin soils near the edges of canyon and mesa rims. Landforms also include ledges, plateaus, terraces, and benches. Slopes range from gentle to steep (1-34°) and elevation ranges from 1113 to 1536 m, with a strong orientation toward cooler northerly aspects. The unvegetated surface is mostly covered by rocks, gravel, boulders, bedrock and bare soil, with little litter or dead wood evident. Soils are most often sandy, but a few stands have fine silt loams, silty clay loams or sandy clay loams derived from sandstone, shale, or from talus/colluvial deposits.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This mixed shrubland occurs on steep colluvial slopes. Total vegetation cover ranges from 3 to 21%. Characteristic of this association is a mix of xeric shrubs, among which *Fraxinus anomala* and *Rhus trilobata* are conspicuous and usually at least codominant, with trace to 5% individual cover. Many other shrub species are usually present, including *Artemisia bigelovii, Atriplex canescens, Atriplex confertifolia, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Chrysothamnus viscidiflorus var. stenophyllus, Coleogyne ramosissima, Picrothamnus desertorum (= Artemisia spinescens), Glossopetalon spinescens, Eriogonum corymbosum, Brickellia microphylla, Symphoricarpos longiflorus*, and *Gutierrezia* spp. The herbaceous layer may include many species but never provides more than a few percent cover; *Pleuraphis jamesii, Achnatherum hymenoides, Poa fendleriana, Bromus tectorum, Sporobolus flexuosus* are common grasses, and the forbs *Amsonia tomentosa, Heterotheca villosa (= Chrysopsis villosa)*, and *Xylorhiza tortifolia* may be present in some stands. Biological soil crust formation is rare on these active slopes and is generally in early stages of development, but may have up to 45% cover in some stands.

Global Vegetation: This open shrubland is characterized by sparse to low cover (<15% total cover) from a mix of xeric shrubs, among which *Fraxinus anomala* and *Rhus trilobata* are conspicuous and usually at least codominant. Other shrub species are usually present, including *Artemisia bigelovii, Atriplex canescens, Atriplex confertifolia, Brickellia microphylla, Chrysothamnus viscidiflorus var. stenophyllus, Coleogyne ramosissima, Ephedra torreyana, Ephedra viridis, Eriogonum corymbosum, Glossopetalon spinescens, Gutierrezia sarothrae, Picrothamnus desertorum (= Artemisia spinescens),*

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or *Symphoricarpos longiflorus*. The herbaceous layer may include many species but never provides more than a few percent cover. Grasses such as *Achnatherum hymenoides, Pleuraphis jamesii, Poa fendleriana, Sporobolus flexuosus,* and forbs *Amsonia tomentosa, Chamaesyce fendleri, Heterotheca villosa (= Chrysopsis villosa), Stanleya pinnata,* and *Xylorhiza tortifolia* are the most consistent species. Biological soil crust formation is rare on these active slopes Exotic annual grass *Bromus tectorum* can be present.

Global Dynamics: Although the species composition and cover are highly variable on these sparsely vegetated rocky, colluvial slopes, *Fraxinus anomala* and *Rhus trilobata* are typically found on more mesic sites and within this extremely xeric environment, it appears they survive by occurring more often on north-facing slopes.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Fraxinus anomala*, *Rhus trilobata*
Short shrub/sapling	Broad-leaved deciduous shrub	*Chrysothamnus viscidiflorus*, *Ericameria nauseosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii*, *Ephedra torreyana*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia microcephala*, *Gutierrezia sarothrae*
Herb (field)	Flowering forb	*Xylorhiza tortifolia*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Fraxinus anomala*, *Rhus trilobata*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Fraxinus anomala, Rhus trilobata*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (10-Jul-2006).

Related Concepts

Classification

Status: Standard
Classification Confidence: 3 - Weak

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Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This mixed shrubland association is widespread in the Orange Cliffs section of the recreation area. Sites sampled include near Ekker Butte, in Millard Canyon, Blue Notch Canyon, Knowles Canyon, Ticaboo Creek, the lower Dirty Devil, near Hite, on Andy Miller Flats, Horsethief Canyon rim, Anderson Bottom rim, and in a tributary of Sevenmile Creek.

Global Range: This association occurs in Arizona and Utah and is described from Canyonlands National Park, Grand Canyon National Park and Glen Canyon National Recreation Area and likely occurs elsewhere in canyons of the Colorado Plateau.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Canyonlands, Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plant distribution controlled by erosion and talus rockfall from the cliffs above. Soil is protected by a layer of small rocks and dark cyanobacteria. North-facing slope.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, and 2013 field data (12 plots): (Plots: GLCA.0119, GLCA.0317, GLCA.0326, GLCA.0329, GLCA.0729, GLCA.4095, GLCA.5081, GLCA.5085, GLCA.5324, GLCA.5416, GLCA.5434, GLCA.5514).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and G. Kittel
References: Reid and Hall 2010, Western Ecology Working Group n.d.*

A3735 Quercus gambelii - Symphoricarpos oreophilus Shrubland Alliance

Alliance Summary Description: This shrubland alliance occurs in the Colorado Plateau and southern Rocky Mountains and is characterized by dominance or codominance of *Quercus gambelii* in a moderately dense to dense tall- or short-shrub layer, typically 2-5 m tall, but can also occur as 1-m tall clumps to small trees over 5 m tall. The variable structure includes patches of oak shrubs with grass growing in between, dense oak thickets with little understory, and relatively mesic, tall shrublands with a rich understory of short shrubs, grasses and forbs. Scattered trees are occasionally present in stands and typically include species of *Pinus* or *Juniperus*. Characteristic shrubs that may codominate or form a separate short-shrub layer include *Amelanchier alnifolia, Amelanchier utahensis, Artemisia tridentata, Cercocarpus montanus, Fendlera rupicola, Prunus virginiana, Rhus trilobata, Symphoricarpos oreophilus*, and *Symphoricarpos rotundifolius*. The herbaceous layer is sparse to

moderately dense, ranging from 1-40% cover and is dominated by perennial graminoids, particularly *Bouteloua curtipendula, Bouteloua gracilis, Carex geyeri, Carex inops, Elymus arizonicus, Festuca thurberi, Koeleria macrantha, Muhlenbergia montana, Hesperostipa comata,* and *Poa fendleriana*. Many forb and fern species can occur, but none has much cover. Stands occur in the foothills and lower montane slopes, mesas and canyons. Elevations range from 1550-2950 m. Sites range from nearly level mesatops to steep (to 80%), rocky slopes on upper slopes and ridgetops. Other stands occur in canyon bottoms and along drainages. Soils are generally deep, coarse-textured, and well-drained.

[CEGL001110] Quercus gambelii / Amelanchier utahensis Shrubland
Translated Name: Gambel Oak / Utah Serviceberry Shrubland
Common Name:

USNVC Classification

Division: Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup: Southern Rocky Mountain Montane Shrubland (M049)
Group: Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277)
Alliance: *Quercus gambelii - Symphoricarpos oreophilus* Shrubland Alliance (A3735)

Element Concept

Global Summary: The vegetation of this association is characterized by a sparse to dense (10-100% canopy coverage) tall-shrub layer (2-5 m tall) codominated by *Quercus gambelii* and *Amelanchier utahensis*. Common shrub associates include *Artemisia tridentata* and *Symphoricarpos oreophilus*. *Cercocarpus montanus* is absent or poorly represented (<5% cover). Other shrubs and dwarf-shrubs present with low cover may include *Chrysothamnus viscidiflorus, Ephedra viridis, Gutierrezia sarothrae, Mahonia repens, Opuntia* spp., *Purshia tridentata*, and *Prunus virginiana*. Graminoids, such as *Pascopyrum smithii, Achnatherum hymenoides, Carex geyeri, Hesperostipa comata,* or *Poa fendleriana*, dominate the sparse herbaceous layer (<10% total cover). Common forbs include *Achillea millefolium, Artemisia ludoviciana, Allium acuminatum, Comandra umbellata, Erigeron speciosus, Lathyrus lanszwertii, Balsamorhiza sagittata, Packera multilobata, Phlox austromontana, Thalictrum fendleri*, and *Vicia americana*. Occasionally, scattered individual trees are present in the overstory, including *Pinus edulis, Pseudotsuga menziesii*, or *Juniperus osteosperma*. Stands occur in canyons, or on mesas, benches, plateaus, ridges, foothills scarps and mountains in in southern Utah and western Colorado. Elevation ranges from 1173 to 2700 m (3850-8860 feet). Slopes are gentle to steep (1-100%) and may be oriented to any aspect. Soil are generally deep, well-developed and are derived from a variety of sources, including sandstones, shales and metamorphic rocks.

Environmental Description

Glen Canyon National Recreation Area Environment: This tall shrubland or woodland community occurs on steep to very steep sites (6-55° slopes), oriented to the north, northeast, or northwest, and lies between 1173 and 2268 m elevation. Sampled sites include benches, sideslopes, canyon sides, and hillsides. Oak leaf litter covers most of the unvegetated surface in dense stands, whereas more open stands have moderate to high cover of bare soil, sand, large, and small rocks, with lesser cover by dead

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wood and bedrock. The soils are rapidly drained to well-drained loams derived from talus/colluvium or from the Chinle Formation.

Global Environment: This mountain shrubland occurs in southern Utah and western Colorado. Elevation ranges from 1173 to 2700 m (3850-8860 feet). Stands occur in canyons or on mesas, benches, plateaus, ridges, foothills scarps and mountains. Slopes are gentle to steep (1-100%) and may be oriented to any aspect. Soil are generally deep, well-developed and are derived from a variety of sources, including sandstones, shales and metamorphic rocks.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This oak - serviceberry tall shrubland forms dense stands with total cover ranging from 37-94%. There is a dense canopy of single-stemmed *Quercus gambelii* tall shrubs or short trees, 2-10 m tall, with 9 to 60% cover. *Amelanchier utahensis* is generally codominant and contributes 4 to 20% cover to the canopy. The remaining shrub layer is often diverse and may include sparse to low cover by *Artemisia tridentata, Symphoricarpos longiflorus, Ericameria nauseosa, Eriogonum microthecum, Eriogonum corymbosum, Ephedra torreyana, Ephedra viridis, Shepherdia rotundifolia, Chrysothamnus viscidiflorus, Rhus aromatica, Atriplex canescens*, and *Gutierrezia sarothrae*. Scattered *Pinus edulis* and *Juniperus osteosperma* trees may be present with low cover. The herbaceous layer is variable and may be poorly developed because of the dense shade and thick leaf litter, or in more open stands may contribute moderately high cover. Associated herbaceous species include *Leymus salinus, Hesperostipa comata, Artemisia ludoviciana, Wyethia scabra, Poa fendleriana, Phragmites australis, Sporobolus cryptandrus, Amsonia tomentosa, Tetraneuris acaulis (= Hymenoxys acaulis), Xylorhiza tortifolia, Stephanomeria pauciflora*, and *Bromus tectorum* (up to 40% cover).

Global Vegetation: This association is characterized by a sparse to dense (10-100% cover) tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii* and codominated by *Amelanchier utahensis*. Sparse stands tend to occur in areas that have burned recently. Common associates include *Artemisia tridentata* and *Symphoricarpos oreophilus*. *Cercocarpus montanus* is absent or poorly represented (<5% cover). Other shrubs and dwarf-shrubs present with low cover may include *Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Gutierrezia sarothrae, Mahonia repens, Opuntia* spp., *Prunus virginiana, Purshia tridentata, Rhus aromatica, Shepherdia rotundifolia*, and *Symphoricarpos longiflorus*. Graminoids, such as *Achnatherum hymenoides, Carex geyeri, Hesperostipa comata, Leymus salinus, Pascopyrum smithii, Phragmites australis, Poa fendleriana*, or *Sporobolus cryptandrus*, dominate the sparse herbaceous layer (<10% total cover). The introduced annual grass *Bromus tectorum* can also be present. Common forbs include *Achillea millefolium, Amsonia tomentosa, Artemisia ludoviciana, Allium acuminatum, Comandra umbellata, Erigeron speciosus, Lathyrus lanszwertii, Balsamorhiza sagittata, Packera multilobata, Phlox austromontana, Stephanomeria pauciflora, Tetraneuris acaulis (= Hymenoxys acaulis),Thalictrum fendleri, Vicia americana, Wyethia scabra*, or *Xylorhiza tortifolia*. Occasionally, tree species are present in the overstory, including *Pinus edulis, Pseudotsuga menziesii*, or *Juniperus osteosperma*.

Global Dynamics: Fire is important in maintaining montane shrublands, as burning eliminates coniferous trees but not the fire-adapted shrub species. *Quercus gambelii* is a fire-adapted species with a well-developed root system it uses to draw moisture from a large volume of soil allowing for rapid resprouting after fire (Clary 1992). Muldavin et al. (1998b) reported that in the Organ Mountains in southwestern New Mexico after a severe fire, *Quercus gambelii* resprouted into a dense thicket that excluded both herbaceous understory and conifer species. *Amelanchier utahensis* also sprouts from the root crown after above-ground parts of the plant are killed by fire (Carmichael et al. 1978). It may be slightly harmed by fire, depending on moisture conditions, but is considered to be fire-tolerant and will persist or increase after burning (Carmichael et al. 1978, Crane 1982).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*, *Quercus gambelii*
Short shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos longiflorus*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*
Herb (field)	Graminoid	*Bromus tectorum*, *Leymus salinus*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*, *Quercus gambelii*

Characteristic Species

Glen Canyon National Recreation Area: *Quercus gambelii*
Global: *Amelanchier utahensis, Quercus gambelii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Vulnerable Plants: *Lupinus ammophilus* (G3G4), *Ostrya knowltonii* (G3G4); Other Plants: *Symphoricarpos oreophilus* (G5)

Conservation Status Rank

Global Rank & Reasons: G3G5 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Amelanchier utahensis* Shrubland (CEGL001067)
- *Quercus gambelii - Arctostaphylos pungens* Shrubland [Park Special] (CEPS009528) is also dominated by *Quercus gambelii* and supports significant cover of *Amelanchier utahensis,* along with *Arctostaphylos pungens.*
- *Quercus gambelii - Holodiscus dumosus* Shrubland (CEGL002341)
- *Quercus gambelii / Amelanchier alnifolia* Shrubland (CEGL001109)

- *Quercus gambelii / Artemisia tridentata* Shrubland (CEGL001111)
- *Quercus gambelii / Prunus virginiana* Shrubland (CEGL005994)
- *Quercus gambelii / Symphoricarpos oreophilus* Shrubland (CEGL001117)

Global Related Concepts:
- *Quercus gambelii/Amelanchier utahensis* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.B.3.a. (Driscoll et al. 1984) >
- Mountain Brush Community (Cedar Creek Associates, Inc. 1987) **?**

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. This plant association is similar to other montane Gambel oak shrublands except for the codominance of *Amelanchier utahensis* with only minor amounts (<10% or 5% cover, respectively) of *Artemisia tridentata* or *Cercocarpus montanus*.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland or tall shrubland community was sampled in Fourmile Canyon, Middle Moody Canyon, Knowles Canyon, the north fork of Ticaboo Creek, on Fiftymile Bench/Navajo Point, Corral Ridge, and Straight Cliff.

Global Range: This montane shrubland occurs in Colorado Plateau, Utah High Plateaus and southern Rocky Mountains in northern Arizona, southern Utah and western Colorado.

Nations: US
States/Provinces: AZ, CO:S2, UT:S3S5
TNC Ecoregions: 9:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331D:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Capitol Reef, Curecanti, Glen Canyon, Grand Canyon, Mesa Verde, Natural Bridges, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Gentle north-facing slope. Ground is covered in oak leaf litter with 1.3 cm of duff underneath. Oaks are thick and all approximately 2 m tall resulting in very little understory.

Glen Canyon National Recreation Area Plots: The description is based on 2012, 2013, and 2015 field data (2 plots, 8 accuracy assessment points): (Plots: GLCA.4203, GLCA.5512; AA Points: GLCA_AA.1372, GLCA_AA.1658, GLCA_AA.1717, GLCA_AA.1718, GLCA_AA.1815, GLCA_AA.1881, GLCA_AA.1884, GLCA_AA.2056).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Coles and G. Kittel
References: Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Carmichael et al. 1978, Cedar Creek Associates, Inc. 1987, Clark et al. 2009, Clary 1992, Cogan et al. 2004, Coles et al. 2008c, Coles

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et al. 2010, Crane 1982, Driscoll et al. 1984, Muldavin et al. 1998b, Reid and Hall 2010, Romme et al. 1993, Tendick et al. 2010, Thomas et al. 2009b, Western Ecology Working Group n.d.*

[CEGL001111] Quercus gambelii / Artemisia tridentata Shrubland
Translated Name: Gambel Oak / Big Sagebrush Shrubland
Common Name:

USNVC Classification

Division: Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup: Southern Rocky Mountain Montane Shrubland (M049)
Group: Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277)
Alliance: *Quercus gambelii - Symphoricarpos oreophilus* Shrubland Alliance (A3735)

Element Concept

Global Summary: This montane shrubland association has been described from mountains and plateaus of Utah and western Colorado. Sites are variable and occur on nearly level mesas to steep hillslopes (to 75%) coves, terraces, and washes. Elevation ranges from 1512-2506 m (4950-8215 feet). Soils are rapidly drained sandy loam, loamy sand, and gravelly loams. There is typically high cover of litter and low to moderate cover by bedrock, large and small rocks, and bare ground. The vegetation is characterized by a moderately dense to dense (10-65% cover) tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii*, with a sparse to moderately dense short-shrub layer dominated by *Artemisia tridentata,* often forming a mosaic of oak and sagebrush. If present, *Amelanchier* spp. and *Cercocarpus montanus* occur in minor amounts (<10% cover). Other shrubs that may be present include *Chrysothamnus viscidiflorus, Purshia tridentata, Opuntia* spp., *Rosa* spp., *Symphoricarpos* spp., and *Tetradymia canescens*. The relatively sparse herbaceous layer is a mixture of grasses and forbs. In stands with a relatively sparse mixed shrub layer (<25% total shrub cover), *Artemisia tridentata* needs to strongly dominate (have twice the cover of other short shrubs such as *Amelanchier* spp. and *Cercocarpus montanus*) to separate from similar associations.

Environmental Description

Global Environment: This shrubland association has been described from mountains and plateaus of Utah and western Colorado. Elevation ranges from 1512-2506 m (4950-8215 feet). Sites are on nearly level mesas to steep hillslopes (to 75%), coves, terraces, and washes. Soils are rapidly drained sandy loam, loamy sand, and gravelly loams. There is typically high cover of litter and low to moderate cover by bedrock, large and small rocks, and bare ground.

Vegetation Description

Global Vegetation: This association is characterized by a moderately dense to dense (10-65% cover) tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii*, with a sparse to moderately dense short-shrub layer dominated by *Artemisia tridentata,* often forming a mosaic of oak and sagebrush. Scattered *Juniperus scopulorum* or *Juniperus osteosperma* trees may be present with low cover. If present, *Amelanchier* spp. and *Cercocarpus montanus* occur in minor amounts (<10% cover). Other shrubs that may be present include *Chrysothamnus viscidiflorus, Fraxinus anomala, Purshia tridentata, Opuntia* spp., *Rosa* spp., *Symphoricarpos* spp., and *Tetradymia canescens*. In stands with a

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relatively sparse mixed shrub layer (<25% total shrub cover), *Artemisia tridentata* needs to strongly dominate (have twice the cover of other short shrubs such as *Amelanchier* spp. and *Cercocarpus montanus*) to separate from similar associations. The relatively sparse herbaceous layer is a mixture of grasses and forbs. Graminoids commonly present are *Achnatherum hymenoides, Achnatherum pinetorum, Carex geyeri, Carex rossii, Elymus elymoides, Poa fendleriana, Pseudoroegneria spicata,* and *Sporobolus cryptandrus*. Common forbs include *Achillea millefolium, Artemisia ludoviciana, Astragalus drummondii, Penstemon teucrioides, Thalictrum fendleri,* or *Vicia americana*.

Global Dynamics: Fire is important in maintaining the montane shrublands, as burning eliminates *Juniperus osteosperma* and *Pinus edulis* trees, but not the more fire-adapted shrub species. *Quercus gambelii* is a fire-adapted species with a well-developed root system used to draw moisture from a large volume of soil allowing for rapid resprouting after fire (Clary 1992). However, *Artemisia tridentata* shrubs are killed by burns and do not resprout (Wright et al. 1979). *Artemisia tridentata* will re-establish relatively quickly (about 10-20 years) if a seed source is nearby (Bunting 1987). If fire-return intervals are more frequent than 10 years, then *Artemisia tridentata* has difficulty recovering (Bunting 1987, Everett 1987). *Artemisia tridentata* may be able to persist in this community where an open shrub canopy and a sparse herbaceous layer limit fire movement and make it unlikely that it would burn except under extreme conditions.

Most Abundant Species

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous tree	*Quercus gambelii*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*

Characteristic Species

Global: Artemisia tridentata, Quercus gambelii

Other Noteworthy Species

Global: Vulnerable Plants: *Penstemon teucrioides* (G2G3Q)

Conservation Status Rank

Global Rank & Reasons: G4G5 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Quercus gambelii / Amelanchier utahensis* Shrubland (CEGL001110)

Global Related Concepts:

- *Quercus gambelii/Artemisia tridentata* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.B.3.a. (Driscoll et al. 1984) >
- Mountain Brush Community (Christensen 1955) >
- Mountain Shrub Complex (Boucek 1986) ><

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Classification

Status: Standard
Classification Confidence: 2 - Moderate
Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Global Classification Comments: This plant association is similar to other montane Gambel oak shrublands, except for the codominance of *Artemisia tridentata* with only minor amounts (<10% cover) of *Amelanchier utahensis* or *Cercocarpus montanus*. In stands with a relatively sparse mixed shrub layer (<25% total shrub cover), *Artemisia tridentata* needs to strongly dominate (have twice the cover of other short shrubs such as *Amelanchier* spp. and *Cercocarpus montanus*) to separate from similar associations.

Element Distribution

Global Range: This montane shrubland association occurs in mountains and plateaus of Utah and western Colorado.

Nations: US
States/Provinces: CO, UT:S4S5
TNC Ecoregions: 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331G:CC, M341C:CC
USFS Ecoregions (2007): 341Bj:C
Federal Lands: NPS (Black Canyon of the Gunnison, Canyonlands, Curecanti, Glen Canyon, Zion)

Element Sources

Global Description Author(s): K.A. Schulz
References: Blackhawk Coal Company 1981, Boucek 1986, Bourgeron and Engelking 1994, Bunting 1987, Christensen 1955, Clary 1992, Cogan et al. 2004, Coles et al. 2010, Driscoll et al. 1984, Everett 1987, Tendick et al. 2010, Western Ecology Working Group n.d.*, Wright et al. 1979

[CEGL002949] Quercus gambelii / Poa fendleriana Shrubland
Translated Name: Gambel Oak / Muttongrass Shrubland
Common Name:

USNVC Classification

Division: Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup: Southern Rocky Mountain Montane Shrubland (M049)
Group: Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277)
Alliance: *Quercus gambelii - Symphoricarpos oreophilus* Shrubland Alliance (A3735)

Element Concept

Global Summary: This montane shrubland association has been described from the Colorado Plateau and the western slope of the southern Rocky Mountains. Elevation ranges from 1770-2337 m (5800-7660 feet). Sites are on nearly level mesas to steep hillslopes (to 59%). Soils are rapidly drained loamy sand and sandy loam derived from sandstones. There is typically high cover of litter and

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moderate cover of large rocks and bare ground. The vegetation is characterized by an open to moderately dense (10-65% cover) tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii*. Other shrubs may be present with low cover and do not form a separate short-shrub layer (generally <10% total). Species include *Amelanchier utahensis, Artemisia tridentata ssp. wyomingensis, Purshia tridentata, Mahonia repens,* and *Symphoricarpos* spp. The herbaceous layer may be diverse and provides low to high cover depending on overstory canopy density. The bunchgrass *Poa fendleriana* is usually dominant (to 30% cover) and occurs consistently. Additional graminoids provide sparse to low cover, such as *Achnatherum hymenoides, Bouteloua gracilis, Carex geyeri,* and *Hesperostipa comata*. Forbs typically have low cover but may be diverse. Common forbs include *Arenaria* spp., *Artemisia ludoviciana, Eriogonum* spp., *Petradoria pumila,* and *Phlox austromontana*.

Environmental Description

Global Environment: This montane shrubland association has been described from the Colorado Plateau and the western slope of the southern Rocky Mountains. Elevation ranges from 1770-2337 m (5800-7660 feet). Sites are on nearly level mesas to steep hillslopes (to 59%). Soils are rapidly drained loamy sand and sandy loam derived from sandstones. There is typically high cover of litter and moderate cover of large rocks and bare ground.

Vegetation Description

Global Vegetation: The vegetation is characterized by an open to moderately dense (10-65% cover) tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii*. Other shrubs may be present with low cover and do not form a separate short-shrub layer (generally <10% total). Species include *Amelanchier utahensis, Artemisia tridentata ssp. wyomingensis, Purshia tridentata, Mahonia repens,* and *Symphoricarpos* spp. The herbaceous layer may be diverse and provides low to high cover depending on overstory canopy density. The bunchgrass *Poa fendleriana* is usually dominant (to 30% cover) and occurs consistently. Additional graminoids provide sparse to low cover, such as *Achnatherum hymenoides, Bouteloua gracilis, Carex geyeri,* and *Hesperostipa comata*. Forbs typically have low cover but may be diverse. Common forbs include *Arenaria fendleri, Arenaria macradenia, Artemisia ludoviciana, Eriogonum racemosum, Eriogonum umbellatum, Petradoria pumila,* and *Phlox austromontana*.

Most Abundant Species

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*
Short shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos rotundifolius*
Herb (field)	Graminoid	*Poa fendleriana*

Characteristic Species

Global: Carex geyeri, Poa fendleriana, Quercus gambelii

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Subset: GLCA; Glen Canyon National Recreation Area

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (14-Aug-2001).

Related Concepts

Global Similar Types:

- *Quercus gambelii / Carex geyeri* Shrubland (CEGL005995)
- *Quercus gambelii* / Sparse Understory Shrubland (CEGL002337)

Classification

Status: Standard
Classification Confidence:
Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Element Distribution

Global Range: This montane shrubland association has been described from the Colorado Plateau and the western slope of the southern Rocky Mountains in southwestern Utah and west-central Colorado.

Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Curecanti, Glen Canyon, Grand Canyon-Parashant, Grand Canyon?, Zion)

Element Sources

Global Description Author(s): K.A. Schulz
References: Cogan et al. 2004, Coles et al. 2010, Reid and Hall 2010, Tendick et al. 2010, Western Ecology Working Group n.d.*

[CEGL002338] Quercus gambelii / Rhus trilobata Shrubland
Translated Name: Gambel Oak / Skunkbush Sumac Woodland
Common Name:

USNVC Classification

Division: Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup: Southern Rocky Mountain Montane Shrubland (M049)
Group: Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277)
Alliance: *Quercus gambelii - Symphoricarpos oreophilus* Shrubland Alliance (A3735)

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Element Concept

Global Summary: This oak shrubland has an open to dense canopy of single-stemmed *Quercus gambelii* shrubs. *Rhus trilobata* shrubs between 1 and 2 m tall are always present, with cover ranging from 2 to 20%. A diverse array of other mesic shrubs are generally present as well, including *Amelanchier utahensis, Prunus virginiana*, *Fendlera rupicola*, *Acer glabrum*, or *Cercocarpus montanus*. The herbaceous layer ranges from sparse to moderately dense in cover and is usually diverse. Common species include *Poa fendleriana*, *Maianthemum stellatum, Senecio amplectens*, and the vine *Clematis ligusticifolia*. Total vegetation cover may range from 67% to well over 100%. This tall-shrub (or occasionally woodland) association occurs on colluvial slopes in canyons of the Colorado Plateau, as well as at the base of sandstone outcrops and in canyon bottoms. Sites range from moderately steep to steep (6-38% slopes), occur between 1132 and 2337 m elevation, and are oriented to north and east aspects.

Environmental Description

Glen Canyon National Recreation Area Environment: This mesic tall shrubland occurs on flat to very steep sites (up to 45°), oriented mostly to the north, and occurs between 1132 and 1455 m elevation. Sampled sites include canyon bottoms, terraces, hillslopes/sideslopes, seeps, and mesatops. Oak leaf litter and live vegetation wood (from oak trunks) cover most of the unvegetated surface in dense stands, whereas more open stands have moderate to high cover of bare soil, sand, and small rocks, with lesser cover by dead wood, bedrock, and moss. The soils are rapidly drained to somewhat poorly drained sands or loams derived from talus/colluvium, Kayenta Formation, or from alluvium.

Global Environment: This tall-shrub association occurs on colluvial slopes in canyons of the Colorado Plateau, as well as at the base of sandstone outcrops and on slopes and benches in canyon bottoms near streams and reservoirs. Sites range from moderately steep to steep (6-38% slopes), occur between 1132 and 2337 m elevation, and are generally oriented to north and east aspects, but may include southwest at higher elevations. The unvegetated ground surface typically has high cover of oak leaf litter (greater than 90%), although stands are variable, and there may be significant cover of bare ground. Substrates are rocky with bedrock and some underlying talus or rocky, steep badlands. Parent materials are sandstone colluvium or eolian/alluvial sands, and soils are moderately well-drained sandy loams and loams.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This rare oak shrubland has a dense canopy of single-stemmed *Quercus gambelii* tall shrubs, 2-10 m tall, with 4 to 85% cover. *Rhus trilobata* is generally codominant and contributes 2 to 40% cover. Associated shrubs providing sparse to low cover include scattered individuals of *Frangula betulifolia (= Rhamnus betulifolia), Grayia spinosa, Ericameria nauseosa, Baccharis salicina, Salix amygdaloides, Mahonia fremontii, Eriogonum corymbosum, Artemisia bigelovii*, and *Gutierrezia sarothrae*. Scattered *Populus fremontii* trees were present in one stand with low cover. The herbaceous layer is variable and may be poorly developed because of the dense shade and thick leaf litter, or in more open stands may contribute moderately high cover, up to 50%. Associated herbaceous species include *Pleuraphis jamesii, Achnatherum hymenoides, Artemisia ludoviciana, Typha domingensis, Bromus tectorum* (up to 50% cover),

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Muhlenbergia asperifolia (up to 20% cover), *Spartina gracilis* (up to 40% cover), *Phragmites australis*, and *Juncus tenuis*.

Global Vegetation: This association may take the form of a woodland or a shrubland, depending on the height and structure of the *Quercus gambelii*, which often forms clones between 5 and 10 m tall providing 35 to 95% cover. *Rhus trilobata* shrubs between 1 and 2 m tall are always present, with cover ranging from 2 to 20%. A diverse array of other mesic shrubs with lesser cover are generally present as well and may include *Acer glabrum, Amelanchier utahensis, Artemisia tridentata ssp. vaseyana, Cercocarpus montanus, Ericameria nauseosa, Fendlera rupicola, Frangula betulifolia (= Rhamnus betulifolia), Mahonia repens*, *Prunus virginiana*, *Rosa woodsii*, or *Symphoricarpos occidentalis*. The herbaceous layer ranges from sparse to moderately dense in cover and is usually diverse. Common graminoids include *Poa fendleriana* and *Piptatherum micranthum*; common forbs include *Lepidium montanum, Maianthemum stellatum*, and *Senecio amplectens*, and the vine *Clematis ligusticifolia* often present. Other herbaceous associates include *Achnatherum hymenoides, Artemisia dracunculus, Comandra umbellata, Descurainia pinnata, Elymus elymoides, Elymus trachycaulus, Heterotheca villosa, Heuchera parvifolia, Lepidium densiflorum, Maianthemum stellatum, Silene antirrhina, Sisymbrium altissimum, Streptanthella longirostris*, and *Vicia americana*. Exotic species *Agropyron cristatum, Bromus tectorum*, and *Chenopodium album* are present in some stands.

Global Dynamics: This association requires mesic, rocky slopes in narrow canyons, or other situations where runoff is concentrated, such as the base of sandstone cliffs and outcrops. It is similar in composition to riparian stands of *Quercus gambelii*, but most examples are located on steep slopes well above the canyon floor.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Quercus gambelii*
Short shrub/sapling	Broad-leaved deciduous shrub	*Rhus trilobata*
Herb (field)	Graminoid	*Bromus tectorum*, *Spartina gracilis*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Amelanchier utahensis, Clematis ligusticifolia, Maianthemum stellatum, Poa fendleriana, Prunus virginiana, Quercus gambelii, Rhus trilobata*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)

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Subset: GLCA; Glen Canyon National Recreation Area

Global: Invasive/Exotic Plants: *Agropyron cristatum* (Medium/Low), *Bromus tectorum* (High), *Chenopodium album*

Conservation Status Rank

Global Rank & Reasons: GNR (13-Jan-2005).

Related Concepts

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This rare woodland or tall shrubland community was sampled in Ribbon Canyon, Forgotten Canyon, Rainbow Bridge, the south fork of Ticaboo Creek, along the Escalante River, near The Rincon, and near Beehive Rock.

Global Range: This association is known from the Colorado Plateau and southern Rocky Mountains in northeastern New Mexico, western Colorado and eastern Utah. It is likely a rare and restricted type because of its preferred habitat and combination of species.

Nations: US
States/Provinces: CO, NM, UT
TNC Ecoregions: 19:C, 20:C, 27:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331G:CC
Federal Lands: NPS (Canyonlands, Capulin Volcano, Colorado, Curecanti, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Soil depth and water availability are probably major factors, but there are no obvious factors affecting distribution.

Glen Canyon National Recreation Area Plots: The description is based on 2012, 2013, and 2015 field data (4 plots, 4 accuracy assessment points): (Plots: GLCA.4324, GLCA.5400, GLCA.5517, RABR.5579; AA Points: GLCA_AA.2053, GLCA_AA.2061, GLCA_AA.2075, GLCA_AA.2078).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Coles et al. 2010, Muldavin et al. 2011d, Tendick et al. 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.*

[CEGL001117] Quercus gambelii / Symphoricarpos oreophilus Shrubland
Translated Name: Gambel Oak / Mountain Snowberry Shrubland
Common Name:

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USNVC Classification

Division: Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup: Southern Rocky Mountain Montane Shrubland (M049)
Group: Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277)
Alliance: *Quercus gambelii - Symphoricarpos oreophilus* Shrubland Alliance (A3735)

Element Concept

Global Summary: This shrubland association is found in foothills, plateaus and mountains from western Texas to southern and western Colorado and throughout southern Utah north into the Wasatch Range, and likely occurs in northern Arizona. It is a mesic upland and non-obligate riparian community. Some stands appear to be transitional between riparian areas and drier upland communities such as *Artemisia* spp. It occurs on cool, moist sites, such as along drainages in canyons and steep draws in more xeric areas, and as a mesic upland shrubland forming extensive stands on cooler northern slopes. Substrates are typically deep, well-drained sandy loam to clay loam derived from alluvium or colluvium. The vegetation is characterized by an open to closed, typically tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii*. The understory is composed of a short-shrub layer that is dominated by *Symphoricarpos oreophilus* or a closely related local *Symphoricarpos* species such as *Symphoricarpos rotundifolius* or *Symphoricarpos palmeri*. Other mesic shrubs may be present, including *Amelanchier* spp., *Prunus virginiana, Robinia neomexicana,* and *Brickellia* sp. In some stands, the *Quercus gambelii* develop into small trees that form a tree canopy. These "woodlands" are included in this association because their floristic composition is identical to the tall shrublands. In other stands the oak is mostly under 2 m tall, forming a short-shrub layer. The herbaceous layer is sparse to moderately dense, depending on density of woody canopy, and is often dominated by graminoids, such as species of *Achnatherum, Bromus, Elymus, Poa,* and *Koeleria*. Common forbs include *Vicia americana, Thalictrum fendleri,* and *Achillea millefolium*. Occasionally, tree species are present in the overstory.

Environmental Description

Global Environment: This shrubland is found in foothills, plateaus and mountains from western Texas to southern and western Colorado, throughout southern Utah north into the Wasatch Range, and likely occurs in northern Arizona. Elevation ranges from 1750-2745 m (6000-8600 feet). It is a mesic upland and non-obligate riparian community. Some stands appear to be transitional between riparian areas and drier upland communities such as *Artemisia* shrublands. It occurs on hills, high slopes, ridges, mesas, canyon rims, knolls and valley floors typically on cooler, moist sites at lower elevations, such as along drainages in canyons and steep draws in more xeric areas, and as a mesic upland shrubland forming extensive stands on cooler northern slopes. Higher-elevation stands occur on all aspects. Substrates are typically deep, well-drained sandy loam to silty clay loam derived from alluvium or colluvium. Parent materials include sandstone, shale, and granite conglomerate.

Vegetation Description

Global Vegetation: The vegetation is characterized by an open to closed, tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii*. The understory is composed of a short-shrub layer that is dominated by *Symphoricarpos oreophilus* or a closely related local *Symphoricarpos* species such as

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Subset: GLCA; Glen Canyon National Recreation Area

Symphoricarpos rotundifolius or *Symphoricarpos palmeri*. Other shrubs may be present, including *Amelanchier* spp., *Artemisia nova, Artemisia tridentata, Chrysothamnus viscidiflorus, Ericameria nauseosa, Mahonia repens, Peraphyllum ramosissimum, Prunus virginiana, Purshia tridentata, Robinia neomexicana, Rosa woodsii,* and *Tetradymia canescens*. Occasionally, emergent trees such as *Pseudotsuga menziesii* or under canopy trees such as *Juniperus scopulorum* may be present. In some stands, *Quercus gambelii* develop into small trees that form a tree canopy. These "woodlands" are included in this association because their floristic composition is identical to the tall shrublands. In other stands, the oak is mostly under 2 m tall, forming a short-shrub layer. The herbaceous layer is sparse to moderately dense, depending on density of woody canopy, and is often dominated by graminoids, such as species of *Achnatherum, Bromus, Elymus, Poa, Pseudoroegneria spicata*, and *Koeleria macrantha*. Common forbs include *Achillea millefolium, Balsamorhiza sagittata, Chenopodium leptophyllum, Clematis ligusticifolia, Ligusticum porteri, Lupinus argenteus, Thalictrum fendleri*, and *Vicia americana*. Occasionally, tree species are present in the overstory, including *Pinus ponderosa, Juniperus scopulorum,* and *Pseudotsuga menziesii*. Introduced graminoids such as *Bromus inermis* and *Poa pratensis* are often common in stands that have been disturbed by heavy livestock grazing.

Global Dynamics: Fire is important in maintaining montane shrublands, as burning eliminates *Juniperus osteosperma, Juniperus scopulorum,* and *Pinus edulis* trees, but not the more fire-adapted shrub species. *Quercus gambelii* is a fire-adapted species with a well-developed root system that draws moisture from a large volume of soil allowing for rapid resprouting after fire (Clary 1992). Muldavin et al. (1998b) reported that, in the Organ Mountains in southwestern New Mexico after a severe fire, *Quercus gambelii* resprouted into a dense thicket that excluded both herbaceous understory and conifer species. *Symphoricarpos oreophilus* is tolerant of fire, is usually undamaged by low-severity fire, and will resprout if the above-ground parts are burned. It is considered a weak sprouter and may take longer to recover from a burn than *Quercus gambelii* (up to 15 years after a severe fire) (Wright et al. 1979, Crane 1982). At Mesa Verde National Park, most of which has burned in the past 30 years, stands of *Pinus edulis - Juniperus* spp. / *Quercus gambelii* Woodland (CEGL000791) persist only in the unburned parts of the park and have the appearance of oak shrublands that have been invaded by pinyon and juniper.

Most Abundant Species

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous tree	*Quercus gambelii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos oreophilus*

Characteristic Species

Global: Quercus gambelii, Symphoricarpos oreophilus

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Other Noteworthy Species

Global: Vulnerable Plants: *Lupinus ammophilus* (G3G4); Invasive/Exotic Plants: *Bromus inermis* (High/Medium), *Poa pratensis* (Medium)

Conservation Status Rank

Global Rank & Reasons: G5 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Quercus gambelii / Amelanchier utahensis* Shrubland (CEGL001110)
- *Quercus gambelii / Prunus virginiana* Shrubland (CEGL005994)
- *Quercus gambelii / Robinia neomexicana / Symphoricarpos rotundifolius* Shrubland (CEGL001116)
- *Quercus gambelii* / Sparse Understory Shrubland (CEGL002337)

Global Related Concepts:

- *Quercus gambelii - Amelanchier alnifolia / Symphoricarpos oreophilus* (Erdman 1962) =
- *Quercus gambelii - Amelanchier utahensis - (Artemisia tridentata - Cercocarpus montanus - Symphoricarpos oreophilus) / Carex geyeri* (Baker 1982b) ><
- *Quercus gambelii - Amelanchier utahensis - (Prunus virginiana - Rosa woodsii - Symphoricarpos oreophilus / Carex geyeri* (Baker 1982b) =
- *Quercus gambelii / Symphoricarpos oreophilus / Carex geyeri* Habitat Type (Hess and Wasser 1982) =
- *Quercus gambelii / Symphoricarpos oreophilus* Habitat Type (Hoffman and Alexander 1980) =
- *Quercus gambelii / Symphoricarpos oreophilus* Habitat Type (Hoffman and Alexander 1983) =
- *Quercus gambelii / Symphoricarpos oreophilus* Habitat Type (Komarkova et al. 1988a) =
- *Quercus gambelii / Symphoricarpos oreophilus* Plant Association (Muldavin et al. 1994a) =
- *Quercus gambelii / Symphoricarpos oreophilus* Plant Association (Johnston 1987) >
- *Quercus gambelii/Symphoricarpos oreophilus* (Bourgeron and Engelking 1994) =
- *Quercus gambelii* / *Symphoricarpos rotundifolius* Shrubland (Kittel et al. 1994) =
- *Quercus gambelii*/*Symphoricarpos* spp. (Kittel et al. 1999b) =
- DRISCOLL FORMATION CODE:III.B.3.a. (Driscoll et al. 1984) >
- Gambel oak/snowberry (*Quercus gambelii/ Symphoricarpos oreophilus*) Plant Association (Kittel et al. 1999a) =
- Gambel's Oak/Palmer's Snowberry PA (Muldavin et al. 2000b)**?**

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Global Classification Comments: This plant association is similar to other montane Gambel oak shrublands except for the codominance of *Symphoricarpos oreophilus* with only minor amounts (<10% cover) of *Amelanchier utahensis, Artemisia tridentata,* or *Cercocarpus montanus.*

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Subset: GLCA; Glen Canyon National Recreation Area

Element Distribution

Global Range: This shrubland is reported from foothills, plateaus and mountains of western Texas to southern and western Colorado, southern Utah north into the Wasatch Range, and likely occurs in Arizona.

Nations: US
States/Provinces: AZ, CO:S5, NM:S5, TX, UT
TNC Ecoregions: 9:C, 10:C, 18:C, 19:C, 20:C, 21:C, 24:C, 27:C
USFS Ecoregions (1994/95): 313A:CC, 313E:CC, 321A:CC, 331I:CC, 331J:CC, 341B:CC, M313A:CC, M313B:CC, M331D:CC, M331F:CC, M331G:CC, M331H:CC, M331I:CC, M341B:CC, M341C:CC
Federal Lands: DOD (White Sands Missile Range?); NPS (Black Canyon of the Gunnison, Bryce Canyon, Curecanti, Glen Canyon, Mesa Verde, Natural Bridges, Navajo, Timpanogos Cave, Zion)

Element Sources

Global Description Author(s): K.A. Schulz and J. Coles
References: Baker 1982b, Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Clary 1992, Cogan et al. 2004, Coles et al. 2008c, Coles et al. 2009b, Coles et al. 2010, Crane 1982, Driscoll et al. 1984, Erdman 1962, Hess and Wasser 1982, Hoffman and Alexander 1980, Hoffman and Alexander 1983, Johnston 1987, Kittel et al. 1994, Kittel et al. 1999a, Kittel et al. 1999b, Komarkova et al. 1988a, Muldavin 1994, Muldavin and Mehlhop 1992, Muldavin et al. 1994a, Muldavin et al. 1998b, Muldavin et al. 2000b, Salas et al. 2010a, Soil Conservation Service 1978, Tendick et al. 2010, Tendick et al. 2011b, Thomas et al. 2009b, Western Ecology Working Group n.d.*, Wright et al. 1979

[CEGL002477] *Quercus gambelii* Shrubland
Translated Name: Gambel Oak Shrubland
Common Name:

USNVC Classification

Division: Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup: Southern Rocky Mountain Montane Shrubland (M049)
Group: Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland (G277)
Alliance: *Quercus gambelii - Symphoricarpos oreophilus* Shrubland Alliance (A3735)

Element Concept

Global Summary: This tall shrubland is known from the Four Corners area north into the Wasatch Range of Utah. The vegetation is characterized by an open to dense (25-75% cover), tall-shrub (>10 m) canopy dominated by *Quercus gambelii*. Scattered *Pinus edulis* and *Juniperus osteosperma* trees may be present. Other shrubs (all with <1% cover) that may be present are *Ericameria nauseosa*, *Gutierrezia sarothrae*, *Mahonia repens*, *Opuntia phaeacantha*, and *Purshia tridentata*. The herbaceous stratum is variable. *Artemisia ludoviciana* and *Elymus elymoides* are important species as is the exotic annual grass and forb species *Bromus tectorum* and *Erodium cicutarium*, respectively. The herbaceous stratum has a diversity of other species with low cover (<1%). Stands occur on southeastern to western aspects at 1076 to 2379 m (3530-7805 feet) in elevation on gentle to

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moderately steep slopes (0-30%). Landforms include canyons, mesas, stream terraces, seeps and springs on slopes, dunes, drainage channels and a toeslope at the base of a cliff. Soils are frequently sandy with low cover of rock and moderate to high cover of littler on the ground surface. There is frequently evidence of past fires.

Environmental Description

Glen Canyon National Recreation Area Environment: This tall shrubland or woodland community occurs on steep to very steep sites (up to 50° slopes), oriented mostly to the north, northwest, or west, and lies between 1076 and 1839 m elevation. Sampled sites include canyon sides or bottoms, hillsides, seeps and springs on slopes, dunes, and drainage channels. Oak leaf litter covers most of the unvegetated surface in dense stands, whereas more open stands have moderate to high cover of bare soil or sand, and low to moderate cover of large and small rocks and biological soil crusts. The soils are well-drained loams or sandy loams derived from talus/colluvium or alluvium.

Global Environment: This tall shrubland is known from northeastern Arizona, southwestern Colorado and southern Utah in the Colorado Plateau and extends north into the Wasatch Range, and south into the high plateaus of southern Utah. Stands occur on southeastern to western aspects at 1076 to 2379 m (3530-7805 feet) in elevation on gentle to moderately steep slopes (0-30%). Sites include canyons, ravines, mesas, stream terraces, seeps and springs on slopes, dunes, drainage channels and toeslopes at the base of cliffs. The soils are often sandy loams but may include silty clay loams with low cover of rock and moderate to high cover of litter on the ground surface. There is frequently evidence of past fires.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Gambel oak tall shrubland forms dense stands with total cover ranging from 30-100%. There is a dense canopy of single-stemmed *Quercus gambelii* tall shrubs or short trees, 2-10 m tall, with 8 to 100% cover. The remaining shrub layer is often diverse and may include low to moderate cover by *Ericameria nauseosa, Ephedra viridis, Amelanchier utahensis, Rhus aromatica, Isocoma rusbyi, Frangula betulifolia (= Rhamnus betulifolia), Artemisia filifolia, Atriplex canescens, Baccharis salicina, Artemisia bigelovii, Psorothamnus fremontii, Krascheninnikovia lanata, Brickellia longifolia,* and *Gutierrezia sarothrae*. Scattered *Populus fremontii, Pinus edulis,* and *Juniperus osteosperma* trees may be present with low cover. The herbaceous layer is variable and may be poorly developed because of the dense shade and thick leaf litter, or in more open stands may contribute moderately high cover. The most common and dominant understory species is *Bromus tectorum*, with up to 60% cover. Other associated graminoid species with low cover include *Panicum* sp., *Achnatherum hymenoides, Hesperostipa comata, Phragmites australis, Sporobolus contractus, Distichlis spicata, Typha* sp., *Equisetum* sp., and *Juncus balticus*. Forbs include *Artemisia ludoviciana, Eurybia glauca (= Aster glaucodes), Machaeranthera canescens, Sphaeralcea grossulariifolia, Iva acerosa (= Oxytenia acerosa), Solidago* sp., *Oenothera pallida, Artemisia dracunculus, Lepidium montanum, Salsola tragus,* and *Mirabilis multiflora*.

Global Vegetation: This tall shrubland is characterized by an open to dense (25-75% cover) tall-shrub (>10 m) dominated by *Quercus gambelii*. Scattered *Pinus edulis* and *Juniperus osteosperma* trees may be present. Other shrubs (all with <1% cover) that may be present are *Amelanchier utahensis,*

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Artemisia bigelovii, Artemisia filifolia, Atriplex canescens, Brickellia longifolia, Baccharis salicina, Ephedra viridis, Ericameria nauseosa, Frangula betulifolia (= Rhamnus betulifolia), Gutierrezia sarothrae, Isocoma rusbyi, Krascheninnikovia lanata, Mahonia repens, Opuntia phaeacantha, Rhus trilobata, and *Purshia tridentata*. Scattered *Populus fremontii*, *Pinus edulis*, and *Juniperus osteosperma* trees may be present with low cover. The herbaceous stratum is variable and often has a high diversity of species with low cover (<1%), such as forbs *Achillea millefolium var. occidentalis, Artemisia ludoviciana, Balsamorhiza sagittata, Eriogonum racemosum, Elymus elymoides, Elymus trachycaulus ssp. trachycaulus, Galium aparine*, *Maianthemum stellatum, Solidago velutina*, and *Vicia americana*, and graminoids *Achnatherum hymenoides, Distichlis spicata, Equisetum* sp., *Juncus balticus, Phragmites australis, Poa fendleriana, Pseudoroegneria spicata*, *Sporobolus contractus*, and *Typha* sp. Exotic species *Bromus tectorum* and *Erodium cicutarium* are frequently present to abundant.

Global Dynamics: Recent fire appears to have a role in this Gambel oak shrubland where other shrubs, such as *Amelanchier utahensis, Artemisia tridentata, Cercocarpus montanus*, or *Symphoricarpos oreophilus*, or a distinctive herbaceous species are slow to reestablish. More survey and research are needed to clarify this type.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Short shrub/sapling	Dwarf-shrub	*Artemisia ludoviciana*
Herb (field)	Graminoid	*Bromus tectorum*

Global

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Quercus gambelii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Quercus gambelii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low); Other Plants: *Artemisia ludoviciana* (G5), *Poa fendleriana* ssp. *longiligula* (G5TNR)

Conservation Status Rank

Global Rank & Reasons: GNR (29-Mar-2005).

Related Concepts

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is intended for shrublands of oak with no other shrubs associated with mixed mountain shrublands (e.g., *Amelanchier* spp., *Symphoricarpos oreophilus, Prunus virginiana, Cercocarpus montanus,* etc.) or a distinctive herbaceous layer. Many stands are in unusual settings, such as recent burns (e.g., Mesa Verde National Park). It is likely to be a transitional phase that will eventually return to a more mixed shrub canopy understory or in some cases become dominated by exotic herbaceous species.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland or tall shrubland community was sampled in Knowles Canyon, Moqui Canyon, Forgotten Canyon, Cottonwood Canyon, Ribbon Canyon, Llewellyn Gulch, Slickrock Canyon, on Bull Ridge, and near Circle Cliffs.

Global Range: This association has been reported from southwestern Colorado, on the Colorado Plateau in northern Arizona and southern Utah, the Wasatch Range of northern Utah, and the high plateaus of central and southern Utah.

Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 9:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, M331D:CC, M341C:CC
Federal Lands: NPS (Bryce Canyon, Canyon de Chelly, Glen Canyon, Grand Canyon, Mesa Verde, Timpanogos Cave)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Steep drainage coming down from alcove, narrow steep sides. North-facing slope.

Glen Canyon National Recreation Area Plots: The description is based on 2012, 2013, 2014, and 2015 field data (3 plots, 12 accuracy assessment points): (Plots: GLCA.5178, GLCA.5189, GLCA.5516; AA Points: GLCA_AA.0238, GLCA_AA.1127, GLCA_AA.1699, GLCA_AA.1702, GLCA_AA.1719, GLCA_AA.1889, GLCA_AA.2060, GLCA_AA.2073, GLCA_AA.2076, GLCA_AA.3061, GLCA_AA.3063, GLCA_AA.3067).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and G. Kittel
References: Coles et al. 2009b, Reid and Hall 2010, Tendick et al. 2011b, Thomas et al. 2009b, Thomas et al. 2010, Western Ecology Working Group n.d.*

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G276. Southern Rocky Mountain Mountain-mahogany - Mixed Foothill Shrubland

Group Summary Description: This Rocky Mountain foothill shrubland group ranges from southern New Mexico north into Wyoming, and west into the Intermountain West region. *Cercocarpus montanus* dominates pure stands in parts of Wyoming and Colorado. The vegetation is typically dominated by a variety of shrubs, including *Amelanchier utahensis, Cercocarpus montanus, Quercus x pauciloba, Purshia tridentata, Rhus trilobata, Ribes cereum, Symphoricarpos oreophilus,* or *Yucca glauca*. Grasses and sedges are dominant in the understory and may include *Achnatherum scribneri, Bouteloua curtipendula, Carex geyeri, Elymus lanceolatus, Hesperostipa comata, Hesperostipa neomexicana, Leymus ambiguus, Muhlenbergia montana*, and *Pseudoroegneria spicata*. Scattered trees or inclusions of grassland patches or steppe may be present. Stands are found in the foothills, canyon slopes and lower mountains of the Rocky Mountains and on outcrops and canyon slopes in the western Great Plains. These shrublands occur between 1500 and 2900 m elevation and are usually associated with exposed sites, rocky substrates, and dry conditions, which limit tree growth. It is common where *Quercus gambelii* is absent, such as the northern Colorado Front Range and in drier foothills and prairie hills. This group is generally drier than Southern Rocky Mountain Gambel Oak - Mixed Montane Shrubland Group (G277), but may include mesic montane shrublands where *Quercus gambelii* does not occur. Fires play an important role in this group as the dominant shrubs usually have a severe die-back, although some plants will stump sprout. *Cercocarpus montanus* requires a disturbance such as fire to reproduce, either by seed sprout or root-crown sprouting. Fire suppression may have allowed an invasion of trees into some of these shrublands, but in many cases, sites are too xeric for tree growth.

A3732 Amelanchier utahensis - Cercocarpus montanus - Cercocarpus intricatus Shrubland Alliance

Alliance Summary Description: This alliance is known from the southern Rocky Mountains, Wyoming Basins, Colorado Plateau and extending west to the Great Basin. Stands are characterized by mixed tall-shrub canopies dominated by *Amelanchier utahensis, Cercocarpus montanus,* or *Cercocarpus intricatus*. Species that may codominate in some stands include *Artemisia tridentata, Fendlera rupicola, Glossopetalon spinescens*, and *Rhus trilobata*. Total canopy cover ranges from sparse to moderately dense. Occasional trees, such as *Juniperus* spp., *Quercus* spp., *Pinus edulis*, *Pinus ponderosa*, or *Pseudotsuga menziesii*, may be scattered in some stands. The herbaceous layer is variable and may have sparse to moderate cover. The most typical dominants are graminoids and may include *Carex geyeri, Elymus lanceolatus ssp. lanceolatus, Hesperostipa comata,* and *Pseudoroegneria spicata*. Elevations range from 1800-2700 m. Sites are variable but are generally xeric and rocky with moderate to very steep slopes or on ridges. Stands are found on various aspects, but typically the higher elevation and northern sites are on warmer, southern exposures, and lower elevation and southern stands are restricted to more mesic north slopes.

[CEGL001067] *Amelanchier utahensis* Shrubland

Translated Name: Utah Serviceberry Shrubland

Common Name:

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USNVC Classification

Division: Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup: Southern Rocky Mountain Montane Shrubland (M049)
Group: Southern Rocky Mountain Mountain-mahogany - Mixed Foothill Shrubland (G276)
Alliance: *Amelanchier utahensis - Cercocarpus montanus - Cercocarpus intricatus* Shrubland Alliance (A3732)

Element Concept

Global Summary: This mountain shrubland association occurs at middle elevations in the foothills, mountains and mesas in north-central Utah, the Colorado Plateau and Great Basin of the western U.S. The sparse to moderately dense tall-shrub layer (10-60% cover) is dominated by the cold-deciduous shrub *Amelanchier utahensis*. *Symphoricarpos oreophilus* often dominates in the short-shrub layer. Other shrub associates may include low cover of *Acer grandidentatum, Artemisia tridentata, Chrysothamnus viscidiflorus, Ephedra viridis, Mahonia repens, Purshia tridentata, Rhus trilobata,* and *Rosa woodsii*. *Quercus gambelii* may also be present, but it is always poorly represented (<5%). Tree species are sometimes present with the tall shrubs or as a very sparse emergent layer. The sparse to moderately dense herbaceous layer is a mixture of perennial graminoids and forbs. Introduced species such as *Agropyron cristatum* and *Bromus tectorum* are common in disturbed stands. Stands occur on moderate to steep slopes characterized by talus or rockfall from further upslope. It is found on relatively warm southern aspects in the Wasatch Mountains but also occurs on northern aspects or in cold-air drainages at lower elevations and more southern latitudes. Substrates are moderately deep, rocky loams and clays.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland association occurs on steep canyon slopes, talus/colluvial slopes, benches, gully sides, and mesa sides. Sites are moderately to steeply sloping (8-38° slopes), oriented mostly to the northeast and northwest, and are located between 1521 and 1900 m elevation. The unvegetated surface is a mix of bare soil, large rocks, small rocks, bedrock, sand, and litter, each with low to moderate cover. The soils are rapidly drained sandy loams derived from talus/colluvium deposits from the Chinle Formation, Organ Rock shale of the Cutler **Group:**, or the Moenkopi Formation.

Global Environment: This shrubland association occurs on foothills, canyons, ridges, mountains and mesas at elevations from 1326-2440 m (4345-8000 feet). Stands occur on moderate to steep slopes (9-46°) with a high proportion of talus or rockfall. It is found on relatively warm southern aspects in the Wasatch Mountains (Yake and Brotherson 1979) but also occurs on northern aspects or in cold-air drainages at lower elevations and more southern latitudes. Substrates are rapidly drained, moderately deep, rocky or sandy soils that range from sand to silt loams and clays. Parent materials include volcanic cinder, and alluvial or colluvial deposits of sandstone and shale. Canyons slopes are often shaly with sandstone cobble veneer.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Utah serviceberry shrubland is locally common within the recreation area. Total vegetation cover ranges from 6 to 44% and is characterized

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by an open shrub canopy, typically 1 to 5 m tall, of *Amelanchier utahensis* that ranges in cover from 1 to 35%. Scattered individuals of the 2- to 5-m tall canopy trees *Pinus edulis* and *Juniperus osteosperma* occur in some stands, and scattered tree seedlings provide sparse cover in some stands. The remaining shrub layer is diverse and provides sparse to low cover. Common associated shrubs include *Fraxinus anomala, Chrysothamnus greenei, Ephedra viridis, Ericameria nauseosa, Mahonia fremontii, Artemisia tridentata, Atriplex confertifolia, Artemisia bigelovii, Acer glabrum,* and *Gutierrezia sarothrae*. In one stand, *Shepherdia rotundifolia* is codominant with *Amelanchier utahensis*. The herbaceous layer may have low to moderate cover and includes *Leymus salinus, Pleuraphis jamesii, Poa fendleriana, Piptatherum micranthum (= Oryzopsis micrantha),* and *Bromus tectorum*. Forbs include *Artemisia ludoviciana* and *Lepidium montanum*.

Global Vegetation: The vegetation is characterized by a sparse to moderately dense (10-60% cover) tall-shrub layer dominated by the cold-deciduous shrub *Amelanchier utahensis*. *Symphoricarpos oreophilus* often forms a short-shrub layer. Other shrub associates may include low cover of *Acer glabrum, Acer grandidentatum, Artemisia bigelovii, Artemisia tridentata, Atriplex confertifolia, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Fraxinus anomala, Mahonia repens, Purshia tridentata, Rhus trilobata,* and *Rosa woodsii*. *Quercus gambelii* may also be present, but it is always poorly represented (<5% cover). Short trees of *Pinus edulis, Juniperus osteosperma,* or *Juniperus scopulorum* may be mixed in with the tall shrubs or emerge above as a very sparse tree layer. The sparse to moderate herbaceous layer is a mixture of perennial graminoids and forbs. Graminoid species include *Achnatherum nelsonii ssp. dorei (= Stipa columbiana), Bromus carinatus, Koeleria macrantha, Leymus salinus, Pleuraphis jamesii,* and *Poa fendleriana*. Forb species include *Astragalus* spp., *Balsamorhiza sagittata, Chenopodium fremontii, Eriogonum* spp., *Machaeranthera canescens, Mertensia* spp., *Penstemon* spp., and *Piptatherum micranthum (= Oryzopsis micrantha)*. Introduced graminoid species such as *Agropyron cristatum* and *Bromus tectorum* are common in disturbed stands.

Global Dynamics: Fire is important in maintaining the montane shrublands, as burning eliminates *Juniperus osteosperma* and *Pinus edulis* trees and other less fire-tolerant species. *Amelanchier utahensis* will sprout from the root crown after aboveground parts of the plant are killed by fire (Carmichael et al. 1978). The shrub may be slightly harmed by fire, depending on moisture conditions, but is considered to be fire-tolerant and will persist or increase after burning (Carmichael et al. 1978, Crane 1982). Steeper sites are often on active slopes with erosion moving rocks and soils further downslope and also bringing materials to these sites from further upslope.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*

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Stratum	Lifeform	Species
Herb (field)	Graminoid	*Leymus salinus*, *Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous tree	*Amelanchier utahensis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos oreophilus*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Amelanchier utahensis*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Vulnerable Plants: *Arabis fernaldiana* var. *fernaldiana* (G4T3T4), *Astragalus scopulorum* (G3G4), *Shepherdia rotundifolia* (G3G4); Invasive/Exotic Plants: *Agropyron cristatum* (Medium/Low), *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: G4 (19-Sep-2000).

Related Concepts

Global Similar Types:
- *Fendlera rupicola* Talus Shrubland (CEGL002765)
- *Quercus gambelii / Amelanchier utahensis* Shrubland (CEGL001110)

Global Related Concepts:
- *Amelanchier utahensis* (Bourgeron and Engelking 1994) =
- *Amelanchier utahensis* Potential Native Plant Community (Eddleman and Jaindl 1994) >
- DRISCOLL FORMATION CODE:III.B.3.a. (Driscoll et al. 1984) >
- Serviceberry Habitat Type (Yake and Brotherson 1979) =

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This rocky slope mixed shrubland was sampled in Flint Cove, southwest of Teapot Campground, in Circle Cliffs, on Fiftymile Bench, Choprock Bench, and in Silver Falls Creek.

Global Range: This shrubland association occurs in the foothills and mountain areas in the Colorado Plateau, Great Basin, Southern Rockies, and Wyoming Basins in northern Arizona, southern and north-central Utah, east-central Nevada, western Colorado, southwestern Wyoming, and likely elsewhere in the western U.S.

Nations: US
States/Provinces: AZ, CO, NV:S4?, UT:S3S4, WY
TNC Ecoregions: 9:C, 10:C, 11:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, 342E:CC, M331E:CC, M341A:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Canyon de Chelly, Canyonlands, Capitol Reef, Colorado, Dinosaur, Fossil Butte, Glen Canyon, Grand Canyon, Great Basin, Hovenweep, Mesa Verde, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Very steep colluvial slope with HUGE (some truck-sized!) slabby boulders from the Wingate layer making up the colluvium on this slope in the Chinle layer. Plot probably receives a good deal of moisture/runoff from Wingate Cliffs above. Slope itself is pretty stable, with large rocks held in place with all the shrubbery. *Amelanchier utahensis* has a lot of dead wood underneath, but the stand is big and healthy, with almost tree-sized individuals of *Amelanchier utahensis*. A few very tall *Pinus edulis* are scattered throughout the area; no *Juniperus osteosperma* here, though.

Glen Canyon National Recreation Area Plots: The description is based on 2004 field data (2 plots, 5 accuracy assessment points): (Plots: GLCA.0112, GLCA.0571; AA Points: GLCA_AA.1189, GLCA_AA.1933, GLCA_AA.1934, GLCA_AA.2045, GLCA_AA.2064).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Drake and G. Kittel
References: Bourgeron and Engelking 1994, Carmichael et al. 1978, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2010, Crane 1982, Driscoll et al. 1984, Eddleman and Jaindl 1994, Friesen et al. 2010, Reid and Hall 2010, Romme et al. 1993, Schulz and Hall 2011, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.*, Yake and Brotherson 1979

2.B.2.ND. WESTERN NORTH AMERICAN INTERIOR CHAPARRAL

M091. Warm Interior Chaparral

G281. Western Madrean Chaparral

Group Summary Description: This interior chaparral group is found across the southwestern U.S. from central New Mexico and southern Utah west to California. The moderate to dense evergreen shrub layer is dominated by sclerophyllous shrubs, especially *Ceanothus greggii* and *Quercus turbinella*. Other common shrubs from the eastern portion of its range (Arizona and New Mexico) include *Arctostaphylos pringlei* (higher elevations), *Arctostaphylos pungens*, *Cercocarpus montanus*,

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Garrya wrightii, Purshia stansburiana, Quercus toumeyi, and *Rhus trilobata*. In desert chaparral stands in the western extent *Arctostaphylos patula* (not dominant), *Arctostaphylos glauca, Cercocarpus montanus var. glaber (= Cercocarpus betuloides), Garrya flavescens, Juniperus californica, Nolina parryi, Quercus john-tuckeri, Quercus cornelius-mulleri, Quercus berberidifolia*, and *Rhus ovata* characterize this shrubland. Scattered remnant pinyon and juniper trees may be present; however, in the western Mojave, *Juniperus californica* sometimes forms an open, shrubby tree layer with the evergreen oaks and other shrubs. Stands occur prominently across central Arizona (Mogollon Rim) and western New Mexico, south into mountains in the northwestern Chihuahuan region and Madrean Occidentale in northern Mexico, and north into extreme southwestern Utah and southern Nevada. It also occurs in mountains in the Sonora and western Mojave deserts, and extends from northeast Kern County, California, and south into Baja Norte, Mexico. Stands are found on foothills, xeric mountain slopes and canyons in hotter and drier habitats and often dominate along the mid-elevation transition zone between desert scrub and montane woodlands (1000-2200 m). Sites are often steep and rocky. Parent materials are varied and include basalt, diabases, gneiss, schist, shales, slates, sandstones and, more commonly, limestone and coarse-textured granitic substrates. Occasional desert scrub species may be present in drier, rockier, more open transition sites. Most chaparral species are fire-adapted, sprouting vigorously after burning or producing abundant fire-resistant seeds. Stands occurring within montane woodlands are seral and a result of recent fires.

The similar Eastern Madrean Chaparral Group (G280) has floristics mostly derived from the Sierra Madre Oriental, whereas floristics of this group are derived from the Sierra Madre Occidentale. However, this group is not mattoral (thornscrub) as it is typically dominated by shrubby evergreen oaks and chaparral species, not thornscrub species. More survey is needed to determine if *Quercus turbinella*, common in this group, also codominates in Eastern Madrean Chaparral Group (G280).

A0793 Quercus turbinella Chaparral Alliance

Alliance Summary Description: This alliance includes evergreen shrublands dominated or codominated by *Quercus turbinella* that typically forms thickets with other shrubs. Important shrub associates can include *Arctostaphylos* spp., *Ceanothus greggii, Cercocarpus montanus, Coleogyne ramosissima, Ephedra viridis, Fraxinus greggii, Garrya wrightii, Juniperus osteosperma, Rhus virens, Rhus trilobata, Rhus microphylla*, and a shrub form of *Quercus grisea*. Ground cover is typically sparse with scattered grasses, forbs and ferns. Some typical herbaceous components include *Aristida* spp., *Astrolepis sinuata (= Notholaena sinuata), Bouteloua curtipendula, Bouteloua eriopoda*, and *Notholaena standleyi*. Shrublands in this alliance are small in extent and occur in a matrix of succulent desert scrub and semi-desert grassland. *Quercus turbinella* shrublands are typically found on steep, rocky slopes, often sheltered slopes in limestone canyons, in the mountains of Nevada, Arizona, New Mexico, and western Texas.

[CEGL005168] Quercus turbinella - (Rhus trilobata, Artemisia tridentata) Shrubland

Translated Name: Sonoran Scrub Oak - (Skunkbush Sumac, Big Sagebrush) Shrubland

Common Name:

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USNVC Classification

Division: Western North American Interior Chaparral (2.B.2.Nd)
Macrogroup: Warm Interior Chaparral (M091)
Group: Western Madrean Chaparral (G281)
Alliance: *Quercus turbinella* Chaparral Alliance (A0793)

Element Concept

Global Summary: This scrub oak shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona, and the description is based on occurrences there. More survey and classification work are needed to fully characterize this type. It occurs on sideslopes, plateaus, and in drainages, often in areas with large amounts of exposed bedrock. This association typically occurs from 1050 to 1475 m (3500-4825 feet) elevation, but can occur as high as 1850 m (6050 feet). It is typically found on gentle to moderate gradients (up to 20°), but can sometimes occur on steeper slopes (23-35°), across all aspects, besides those with northern exposures. Soils are well- to rapidly-drained silty or sandy loams. The underlying geology is typically limestone or sandstone. Vegetation is strongly dominated by the short shrub *Quercus turbinella*, which can be very dense (up to 60% cover). Trees are essentially absent; however, *Pinus edulis* and *Juniperus osteosperma* very rarely occur. Tall shrubs are also essentially absent. The short-shrub layer commonly includes *Rhus trilobata* and *Yucca baccata*. Other chaparral shrub species, including *Purshia stansburiana, Ceanothus greggii*, and *Bernardia myricifolia*, occur less commonly. *Gutierrezia sarothrae* and *Agave utahensis* are fairly common in the dwarf-shrub layer. *Achnatherum speciosum, Poa fendleriana, Aristida purpurea*, and *Bromus rubens* are the most frequent graminoids, although graminoid composition varies among stands. A variety of species sporadically occur in a very sparse and inconsistent forb layer.

Environmental Description

Vegetation Description

Most Abundant Species

Characteristic Species

Global:

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (24-Jun-2010).

Related Concepts

Global Similar Types:

- *Quercus turbinella - Coleogyne ramosissima* Shrubland (CEGL000982) supports a significant layer of *Coleogyne ramosissima* in the short-shrub stratum.
- *Quercus turbinella - Juniperus osteosperma* Shrubland (CEGL000981) has a sparse canopy layer *Juniperus osteosperma*.

- *Quercus turbinella - Ptelea trifoliata - Fraxinus anomala* Mesic Shrubland (CEGL005160) supports the mesic tall shrubs *Ptelea trifoliata* and *Fraxinus anomala* and often occurs in shaded canyon environments.

Classification

Status: Standard
Classification Confidence:
Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Element Distribution

Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:??
Federal Lands: NPS (Glen Canyon, Grand Canyon, Grand Canyon-Parashant)

Element Sources

Global Description Author(s): R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.*

2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland

2.C.4.NB. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland

M888. Arid West Interior Freshwater Marsh

G531. Arid West Interior Freshwater Marsh

Group Summary Description: These arid west freshwater marshes are found at all elevations below timberline throughout the western interior basins and mountains of western North America. Vegetation is characterized by a lush, dense herbaceous layer with low diversity, sometimes occurring as a monoculture. Structure varies from emergent forbs which barely reach the water surface to tall graminoids that reach as tall as 4 m high. Dominant species include *Carex pellita (= Carex lanuginosa), Carex praegracilis, Eleocharis palustris, Juncus balticus, Paspalum distichum, Schoenoplectus americanus, Schoenoplectus pungens, Typha domingensis, Typha latifolia*, and species of *Bidens, Cicuta, Cyperus, Mimulus*, and *Phalaris*. This group includes shallow freshwater to brackish waterbodies found in bottomlands along drainages, in river floodplain depressions, cienegas, oxbow lakes, below seeps, frequently flooded gravel bars, low-lying sidebars, in-fill side channels, small ponds, stockponds, ditches and slow-moving streams, perennial streams in valleys and mountain foothills, as well as in small depressions gouged into basalt by Pleistocene floods, channeled scablands of the Columbia Plateau and within dune fields in the intermountain western U.S. These wetlands are mostly small-patch, confined to limited areas in suitable floodplain or basin topography. They are

mostly semipermanently flooded, but some marshes have seasonal hydrologic flooding. Water is on or above the surface for most of the growing season. A consistent source of freshwater is essential to the function of these communities. Soils are muck or mineral or muck over a mineral soil, and water is high-nutrient. It is often found along the borders of ponds, lakes or reservoirs that have more open water. Some occurrences are interdunal wetlands in wind deflation areas, where sands are scoured down to the water table. The water table may be perched over an impermeable layer of caliche or clay or, in the case of the Great Sand Dunes of Colorado, a geologic dike that creates a closed basin that traps water.

A4164 Cladium californicum Alkaline Seep Alliance

Alliance Summary Description: This alliance forms an intermittent to continuous herbaceous layer. The shrub layer is open and the tree layer, when present, is sparse. The dominant herb is *Cladium californicum*, and other herbs include *Anemopsis californica, Cirsium neomexicanum, Distichlis spicata, Eleocharis rostellata, Juncus arcticus, Samolus valerandi ssp. parviflorus, Schoenoplectus americanus*, and *Solidago spectabilis*. Associated emergent shrubs at sparse to open cover and include *Pluchea sericea, Allenrolfea occidentalis*, and *Vitis arizonica*. This alliance is found in southern California and Nevada. Stands occur in alkali springs along slopes and alkali washes with carbonate rock water discharges at low elevation. Elevation ranges from approximately 220 to 440 m. Soils are alluvium or derived from sandstone.

[CEGL009683] Cladium californicum Seep

Translated Name: California Sawgrass Seep

Common Name:

USNVC Classification

Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (2.C.4.Nb)

Macrogroup: Arid West Interior Freshwater Marsh (M888)

Group: Arid West Interior Freshwater Marsh (G531)

Alliance: *Cladium californicum* Alkaline Seep Alliance (A4164)

Element Concept

Global Summary: This graminoid wetland is dominated by *Cladium californicum*. Other forbs and grasses may be present to codominant, including *Adiantum capillus-veneris, Distichlis spicata, Eleocharis rostellata, Phragmites australis*, and *Schoenoplectus americanus*. Woody species may be present with very low cover, such as *Pluchea sericea, Baccharis* spp., *Allenrolfea occidentalis, Vitis arizonica*, and/or *Yucca angustissima var. toftiae (= Yucca toftiae)*. It occurs on alkali seeps and washes in Death Valley and freshwater hanging gardens found in spring-fed alcoves and cliff faces of the Colorado Plateau.

Environmental Description

Global Environment: The association occurs from 220 to 1160 m in elevation, on alkali and freshwater springs in hanging gardens, on slopes and in alkali washes, which have water discharges from carbonate rock aquifers. Soils are alluvium or derived from sandstone.

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Vegetation Description

Global Vegetation: The association forms a continuous herbaceous layer and the overall herbaceous cover ranges from 35 to 97% cover. Woody plants, when present, are sparse, as are nonvascular plants. The dominant herb is *Cladium californicum*; other herbs present may include *Adiantum capillus-veneris, Anemopsis californica, Cirsium neomexicanum, Distichlis spicata, Eleocharis rostellata, Juncus arcticus, Phragmites australis, Samolus valerandi ssp. parviflorus, Schoenoplectus americanus*, and *Solidago spectabilis*. The shrub layer is emergent and sparse and may include *Pluchea sericea, Baccharis* spp., *Allenrolfea occidentalis, Vitis arizonica*, and/or *Yucca angustissima var. toftiae (= Yucca toftiae).*

Global Dynamics: *Cladium californicum* is tolerant of alkalinity, occurring along both alkali springs and washes with calcareous water discharges as small stands in fine-scale mosaics with other herbs, shrubs and trees. However, it also is found in freshwater seeps, along with *Schoenoplectus americanus*.

Most Abundant Species

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Cladium californicum*

Characteristic Species

Global: Cladium californicum

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (11-Sep-2012).

Related Concepts

Global Related Concepts:

- *Cladium californicum* Seep (provisional) (Evens et al. 2014) =

Classification

Status: Provisional
Classification Confidence:

Element Distribution

Global Range: This association has been documented on springs and seeps throughout the Mojave and lower Colorado River basin of the southwestern U.S.

Nations: US
States/Provinces: AZ, CA, UT
TNC Ecoregions: 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC

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Federal Lands: NPS (Death Valley, Glen Canyon, Grand Canyon, Lake Mead)

Element Sources

Global Description Author(s): M.S. Reid
References: Evens et al. 2014, Kearsley et al. 2015, Western Ecology Working Group n.d.*

A3896 Typha domingensis - Typha latifolia - Typha angustifolia Western Marsh Alliance
Alliance Summary Description: This alliance contains stands dominated by *Typha angustifolia, Typha domingensis,* or *Typha latifolia* either alone or in combination with other tall emergent freshwater marsh species. Associated species vary widely; they include many sedges such as *Carex aquatilis, Carex pellita (= Carex lanuginosa), Carex rostrata,* bulrushes such as *Schoenoplectus acutus (= Scirpus acutus), Schoenoplectus americanus (= Scirpus americanus),* and *Schoenoplectus heterochaetus (= Scirpus heterochaetus),* and broad-leaved herbs such as *Asclepias incarnata, Impatiens capensis, Sagittaria latifolia, Scutellaria lateriflora, Sparganium eurycarpum,* and *Verbena hastata*. It is found most commonly along lake margins and in shallow basins, and occasionally in river backwaters of the central midwestern and western U.S. and Canada.

[CEGL001845] *Typha domingensis* Western Marsh
Translated Name: Southern Cattail Western Marsh
Common Name:

USNVC Classification

Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (2.C.4.Nb)
Macrogroup: Arid West Interior Freshwater Marsh (M888)
Group: Arid West Interior Freshwater Marsh (G531)
Alliance: *Typha domingensis - Typha latifolia - Typha angustifolia* Western Marsh Alliance (A3896)

Element Concept

Global Summary: This wetland association is widespread across the southwestern United States and Great Basin. The vegetation is characterized by a dense, 2- to 4-m tall herbaceous layer of *Typha domingensis* that dominates the site as a monoculture or codominates with *Schoenoplectus acutus (= Scirpus acutus)* or species of *Carex*. Additional associated graminoid species include *Carex nebrascensis, Eleocharis palustris, Eleocharis macrostachya, Juncus balticus, Schoenoplectus maritimus (= Scirpus maritimus), Schoenoplectus pungens,* and under drier conditions *Hordeum jubatum* and *Distichlis spicata* may be present. During extended inundation, aquatic plant such as *Stuckenia pectinata (= Potamogeton pectinatus)* may flourish. Other forbs such as *Euthamia occidentalis (= Solidago occidentalis), Polygonum lapathifolium (= Persicaria lapathifolium), Chenopodium* spp., and *Sagittaria* spp. may also be present. These marshes occur in bottomlands along drainages, in river floodplain depressions, oxbow lakes, and below seeps. Substrates are variable but are generally fine-textured, alkaline, alluvial soil. Flood regimes range from seasonal inundation with the soils drying out and cracking in late summer to permanently flooded marshes.

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Environmental Description

Glen Canyon National Recreation Area Environment: This herbaceous wetland association occurs along canyon bottoms and drainage channels where groundwater intercepts the surface. The sampled sites are flat and occur between 1090 and 1111 m elevation. The unvegetated surface has moderate to high cover of litter and standing water, and low to moderate cover of bare soil. The soils are somewhat poorly drained to poorly drained sands or silt loams derived from alluvium.

Global Environment: This wetland association is widespread across the southwestern United States and Great Basin. This community occurs in areas of standing water or subirrigation. Running water is uncommon, except during periods of extensive irrigation runoff or because of high precipitation (Haase 1972). Elevations range from 300-1450 m. These marshes occur in bottomlands along drainages, in river floodplain depressions, oxbow lakes, and below seeps. Substrates are variable but are generally fine-textured, alkaline, alluvial soil. Flood regimes range from seasonal inundation with the soils drying out and cracking in late summer to permanently flooded marshes. *Typha domingensis* is more alkaline-tolerant than *Typha latifolia*.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This wetland type is very rare within the park; it was sampled only twice on seasonally wet sites. Total vegetation cover is 29 to 54% and is characterized by variable cover by *Typha domingensis* with 6 to 37% cover. Additional herbaceous species present include *Echinochloa crus-galli, Juncus tenuis, Polygonum lapathifolium, Saccharum ravennae, Bromus tectorum, Phragmites australis, Juncus balticus, Muhlenbergia asperifolia, Machaeranthera canescens, Equisetum* sp., and *Artemisia campestris*. Scattered shrubs of *Salix exigua, Baccharis salicina, Ericameria nauseosa*, and *Chrysothamnus viscidiflorus* provide sparse cover along the margins of the community and form dense stands on adjacent sites.

Global Vegetation: The vegetation is characterized by a dense, 2- to 4-m tall herbaceous layer of *Typha domingensis* that dominates the site as a monoculture or codominates with *Schoenoplectus acutus (= Scirpus acutus)* or species of *Carex*. Associated graminoids include *Carex nebrascensis, Eleocharis palustris, Eleocharis macrostachya, Juncus balticus, Schoenoplectus maritimus (= Scirpus maritimus), Schoenoplectus pungens*, and under drier conditions *Hordeum jubatum* and *Polypogon monspeliensis*. During extended inundation aquatic plants like *Stuckenia pectinata (= Potamogeton pectinatus)* may flourish. Other forbs such as *Euthamia occidentalis (= Solidago occidentalis), Polygonum lapathifolium (= Persicaria lapathifolium), Chenopodium* spp., and *Sagittaria* spp. may be present. Introduced species such as *Bassia scoparia (= Kochia scoparia), Lepidium latifolium*, and *Polypogon monspeliensis* may be abundant on disturbed sites.

In Colorado, *Typha domingensis* dominated the sampled stands (60-75% cover), with *Carex nebrascensis* and *Schoenoplectus acutus* associated (5-20% cover). Other species present included *Cicuta douglasii, Eleocharis palustris, Hordeum jubatum*, and *Triglochin maritima*. The *Typha domingensis*-dominated community described in southern Arizona (Haase 1972) included other *Typha* spp., *Schoenoplectus americanus (= Scirpus olneyi)*, and *Phragmites australis (= Phragmites communis)*. In Glen Canyon National Recreational Area, Utah, additional herbaceous species include *Echinochloa crus-galli, Juncus tenuis, Polygonum lapathifolium, Saccharum ravennae, Bromus*

tectorum, Phragmites australis, Juncus balticus, Muhlenbergia asperifolia, Machaeranthera canescens, Equisetum sp., and *Artemisia campestris*.

Global Dynamics: Baker (1982b) reports that this type is not apparently grazed by domestic animals. Drainage and diversion of water could limit the stability of this community.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Juncus* spp., *Phragmites australis*, *Typha domingensis*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Schoenoplectus acutus*, *Typha domingensis*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Schoenoplectus acutus, Typha domingensis*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Saccharum ravennae* (Medium/Low)

Global:

Conservation Status Rank

Global Rank & Reasons: G5? (20-Sep-2000).

Related Concepts

Global Similar Types:

- *Typha (angustifolia, domingensis, latifolia)* - *Schoenoplectus americanus* Marsh (CEGL002032) is only reported from the southeastern U.S.
- *Typha domingensis* - *Pontederia cordata* Marsh (CEGL003988) is only reported from the southeastern U.S.
- *Typha domingensis* - *Setaria magna* Marsh (CEGL004138) is only reported from the southeastern U.S.
- *Typha domingensis* Gulf Coastal Plain Marsh (CEGL004137) is only reported from the southeastern U.S.
- *Typha domingensis* Semipermanently Flooded Tropical Herbaceous Vegetation (CEGL003987) is only reported from the southeastern U.S.
- *Typha domingensis* Tidal Marsh (CEGL008456) is only reported from the southeastern U.S.

Global Related Concepts:

- *Typha domingensis* - *Scirpus acutus* Association (Bundy et al. 1996) <
- *Typha domingensis* Association (Sproul et al. 2011) =

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Subset: GLCA; Glen Canyon National Recreation Area

- *Typha domingensis* (Evens et al. 2014) =
- *Typha domingensis* (Bourgeron and Engelking 1994) =
- *Typha domingensis* Association (Buck-Diaz et al. 2012) =
- *Typha domingensis* Association (Bundy et al. 1996) <
- *Typha domingensis* Riparian Wetland (Baker 1983b) =
- *Typha* community (Haase 1972) =
- DRISCOLL FORMATION CODE:V.C.6.a. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: There are 6 *Typha domingensis* associations described from the southeastern U.S., and only one from the western U.S. It is likely that there are associations yet to be classified in the West. The concept of this association is broad and currently includes both *Typha domingensis* monoculture and mixed stands with seasonally or permanently flooded hydrological regimes. More classification work needs to be done to fully characterize this wetland in the West.

Element Distribution

Glen Canyon National Recreation Area Range: This herbaceous association is very rare within the recreation area and was represented by one plot located in Slickrock Canyon and one plot in Hall's Creek Bay.

Global Range: This wetland association is widespread across the southwestern United States and known from the Sonoran and Mojave deserts to the Great Basin, Colorado Plateau, Southern Rockies and Wyoming Basins.

Nations: US
States/Provinces: AZ, CA, CO:S1, NV:S5?, UT, WY?
TNC Ecoregions: 10:C, 11:C, 18:C, 19:C, 20:C, 22:C, 23:C
USFS Ecoregions (1994/95): 313A:CC, 321A:CC, 322B:CC, 341A:CC, 341C:CC, 341D:CC, 341E:CC, 341F:CC, 341G:CC, M331F:CC, M341B:CC
Federal Lands: NPS (Canyonlands, Death Valley, Glen Canyon, Grand Canyon, Great Sand Dunes); USFWS (Buenos Aires, Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plot placed here to capture otherwise unsampled marsh-like (currently dry) drainage bottom densely filled with *Typha* and tall grasses, surrounded by *Tamarix chinensis* interfluves. Probably has seasonal standing water.

Glen Canyon National Recreation Area Plots: The description is based on 2012 field data (2 plots): (Plots: GLCA.4269, GLCA.4286).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): M.S. Reid, K.A. Schulz and G. Kittel

References: Baker 1982b, Baker 1983b, Bourgeron and Engelking 1994, Buck-Diaz et al. 2012, Bundy et al. 1996, CNHP 2003, CNHP 2015, Driscoll et al. 1984, Evens et al. 2014, Haase 1972, Reid and Hall 2010, Salas et al. 2010b, Schulz 2004, Sproul et al. 2011, Von Loh et al. 2002, Western Ecology Working Group n.d.*

M075. Western North American Montane-Subalpine-Boreal Marsh, Wet Meadow & Shrubland

G526. Rocky Mountain-Great Basin Lowland-Foothill Riparian Shrubland

Group Summary Description: These short to tall shrublands (0.5-5 m in height) occur along streams at and below lower treeline, that is, not up in the mountains, but in between mountain valleys and lowlands of the Interior West. Dominant shrubs include *Acer glabrum, Artemisia cana, Artemisia cana ssp. bolanderi, Artemisia cana ssp. viscidula, Artemisia tridentata ssp. tridentata, Cornus sericea, Crataegus douglasii, Crataegus rivularis, Dasiphora fruticosa ssp. floribunda, Forestiera pubescens, Oplopanax horridus, Philadelphus lewisii, Prunus virginiana, Rhus trilobata, Rosa nutkana, Rosa woodsii, Salix exigua, Salix irrorata, Salix melanopsis, Shepherdia argentea,* and *Symphoricarpos* spp. Herbaceous layers are often dominated by *Athyrium filix-femina, Carex flava (= Carex nevadensis), Carex* spp., *Elymus trachycaulus, Equisetum arvense, Deschampsia caespitosa, Festuca idahoensis, Galium triflorum, Glyceria striata, Gymnocarpium dryopteris, Heracleum maximum, Iris missouriensis, Juncus balticus, Juncus* spp., *Leymus cinereus, Maianthemum stellatum, Muhlenbergia filiformis, Muhlenbergia richardsonis, Pascopyrum smithii, Poa cusickii*, and *Poa secunda (= Poa nevadensis)*. Introduced forage species such as *Agrostis stolonifera, Poa pratensis, Phleum pratense*, and the invasive annual *Bromus tectorum* are often present in disturbed stands. Streams are permanent, intermittent and ephemeral. Stands occur in steep-sided canyons or in broad flat valleys. They can be large, wide occurrences on mid-channel islands in larger rivers or narrow bands on small, rocky canyon tributaries and well-drained benches. They also are typically found in backwater channels and other perennially wet but less scoured sites, such as floodplain swales and irrigation ditches, and they can occur in depressional wetlands and non-alkaline playas. Stands may also occur on upper benches away from active channel movement. Willow-dominated shrublands require flooding and bare gravels for reestablishment. Stands are maintained by annual flooding and hydric soils throughout the growing season. Sites are subject to temporary flooding during spring runoff. The water table is often just below the ground surface. Occurrences are found within the flood zone of rivers, on islands, sand or cobble bars, and immediate streambanks and upper benches, and occasionally on hillslope springs. This group occurs throughout the Rocky Mountain and Colorado Plateau regions from approximately 780 to 1850 m (2560-6000 feet) in elevation, around the edges and between the mountain ranges of the Great Basin and along the lower eastern slope of the Sierra Nevada at about 1220 m (4000 feet) in elevation, at lowland and montane elevations in the Columbia Plateau, on the periphery of the mountains surrounding the Columbia River Basin, and along major tributaries and the main stem of the Columbia at relatively low elevations. It also occurs in the foothills of the northern Rocky Mountains and the east slopes of the Cascades in the lower montane and foothill zones. Climate is generally semi-arid.

A3799 Rhus trilobata - Crataegus rivularis - Forestiera pubescens Shrubland Alliance

Alliance Summary Description: This semi-riparian shrubland alliance is dominated by Corylus cornuta, Crataegus rivularis, Elaeagnus commutata, Forestiera pubescens, Rhamnus alnifolia, Shepherdia argentea, and/or Rhus trilobata, generally in monotypic stands, but they can be mixed as

well. Other shrub associates may include Prunus virginiana. It is an eclectic mix of mesic shrubs that form small, narrow stands at the base of steep hills and cliffs and along washes and upper benches and terraces of riparian areas. These are "fringe" riparian shrublands that occur on upper benches and terraces, dry washes and areas near but not necessarily in the wettest part of riparian areas, but which receive more moisture than surrounding upland slopes. Often these are single-species shrublands, but all occupy similar environments. The alliance has a broad north to south range in the Rocky Mountains.

[CEGL001121] *Rhus trilobata* Moist Wet Shrubland

Translated Name: Skunkbush Sumac Moist Wet Shrubland

Common Name:

USNVC Classification

Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (2.C.4.Nb)

Macrogroup: Western North American Montane-Subalpine-Boreal Marsh, Wet Meadow & Shrubland (M075)

Group: Rocky Mountain-Great Basin Lowland-Foothill Riparian Shrubland (G526)

Alliance: *Rhus trilobata - Crataegus rivularis - Forestiera pubescens* Shrubland Alliance (A3799)

Element Concept

Global Summary: This mesic to wet shrubland association is known from western Colorado, Utah and southern Idaho. *Rhus trilobata* often forms tall, dense, and nearly impenetrable thickets with 30-98% cover. Associated shrubs can sometimes be codominant, but no single species has consistently high cover or constancy across the range of the association. Associated shrubs include *Celtis laevigata var. reticulata, Clematis ligusticifolia, Cornus sericea, Ericameria nauseosa, Ribes aureum, Rosa woodsii, Salix exigua, Salix lasiolepis, Salix lutea, Shepherdia argentea*, and *Toxicodendron rydbergii*. Saplings of *Populus fremontii, Populus angustifolia*, or *Salix amygdaloides* may be present. Total understory herbaceous cover and diversity are low, and herbaceous species are often confined to shrub canopy gaps. *Bromus tectorum* and *Galium aparine* are the most frequently occurring species, but native species such as *Elymus canadensis, Equisetum* spp., *Hordeum jubatum, Muhlenbergia asperifolia, Leymus cinereus, Pascopyrum smithii*, and *Phragmites australis* are sometimes also present. Forb associates include *Apocynum cannabinum* and *Artemisia ludoviciana*. Non-native species are common in disturbed stands. Stands occur in both mesic to wet riparian and non-riparian situations. Throughout its range, the association occurs at low to mid elevations (701-1676 in Idaho and 1555-2000 m in Colorado), most often along mid-order to large rivers, but also in narrow canyons of small creeks and intermittent drainages. This association often forms linear bands above the high-water line on steep shorelines, along rocky toeslopes at cliff bases, on benches, and in intermittent arroyos, usually where there is minimal floodplain development. Stands also occur on rocky hillsides in association with springs and seeps emanating from canyon walls. In broad river bottoms, stands occur in the floodplain on second terraces between older *Populus* spp. forests on upper terraces and *Salix exigua* shrublands next to the river. In these large floodplains, habitats are in flux with stream meanders, channel downcutting, and sediment deposition; sites where this shrubland persists are

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generally too dry for the establishment of *Populus* and *Salix* spp. Substrates are well-drained, fine silty clay to sandy loam soils overlying coarse alluvium, bedrock or talus.

Environmental Description

Glen Canyon National Recreation Area Environment: This uncommon mesic shrubland association occurs along drainage channels and abandoned meanders. Sites are gently to moderately sloping (4-11°) and lie between 1186 and 1351 m elevation. Bare soil, large rocks, and gravel cover most of the unvegetated surface, with low cover by litter, bedrock, and dead wood. Soils are derived from the Moenkopi or Organ Rock Shale formations.

Global Environment: This minor association occurs in mesic, often riparian sites in western Colorado, eastern Utah and southwestern Idaho. Elevation ranges from 700 to 2000 m (2295-6560 feet). These small shrublands are reported from stream and river bottoms and terraces, and upland in mesic swales and on hillslopes below seeps and springs. Along the Yampa, San Miguel, and Dolores rivers, stands often form linear bands on rocky, well-drained benches and toeslopes where it is often confined between the high-water mark of a river and adjacent cliff faces and has access to the high water table. Along the Green River, stands occur in the floodplain on second terraces between older *Populus fremontii* forests on upper terraces and *Salix exigua* shrublands next to the river. In large floodplains, habitats are in flux with stream meanders, channel downcutting, and sediment deposition; sites where this shrubland persists are generally too dry for the establishment of *Populus* and *Salix* spp. Substrates are variable and range from shallow loamy sand to silt loam over coarse alluvium, boulders or bedrock, to fine silty clay with the depth to groundwater between 2-4 m. Adjacent riparian vegetation includes communities dominated by *Schoenoplectus* spp., *Typha* spp., *Phragmites australis, Salix exigua, Alnus incana, Betula occidentalis, Populus angustifolia*, and *Populus fremontii*.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This plant association is characterized by a sparse to moderately dense short-shrub layer dominated by 5-35% cover of *Rhus trilobata* in stands where total vegetation cover ranges from 8 to 50%. Associated shrubs include *Ericameria nauseosa, Forestiera pubescens, Artemisia filifolia, Atriplex canescens*, and *Brickellia longifolia*. The herbaceous layer is relatively sparse and includes *Artemisia dracunculus, Artemisia ludoviciana, Pleuraphis jamesii*, and *Sporobolus airoides*. Exotic species are common in disturbed stands and may include *Tamarix chinensis* and *Salsola tragus*.

Global Vegetation: This plant association is characterized by a dense short-shrub layer dominated by 30-90% cover of *Rhus trilobata* sometimes forming near monocultures. However, the tall shrub *Salix exigua* is often present to codominant on mesic sites. Drier sites further from watercourses can have significant amounts of *Artemisia tridentata ssp. tridentata, Amelanchier utahensis*, or *Chrysothamnus linifolius*. Other associated shrubs include *Artemisia filifolia, Atriplex canescens, Brickellia longifolia, Ericameria nauseosa, Forestiera pubescens, Ribes aureum, Salix lutea, Shepherdia argentea, Toxicodendron radicans*, and occasional sapling trees of *Populus fremontii, Populus angustifolia*, or *Salix amygdaloides*. In cooler, mesic sites *Cornus sericea, Salix ligulifolia (= Salix eriocephala var. ligulifolia), Berberis fendleri, Rosa woodsii*, and *Clematis ligusticifolia* may be present to abundant.

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The herbaceous layer is relatively sparse (<20% cover) and is composed primarily of graminoids such as *Elymus canadensis, Leymus cinereus (= Elymus cinereus), Equisetum* spp., *Hordeum jubatum, Muhlenbergia asperifolia, Pascopyrum smithii, Phragmites australis,* or *Sporobolus airoides*. Forb associates include *Apocynum cannabinum, Artemisia dracunculus, Artemisia ludoviciana, Equisetum hyemale*, and *Solidago canadensis*. Exotic and invasive species are common in disturbed stands and may include *Elaeagnus angustifolia, Tamarix ramosissima, Lepidium latifolium, Cirsium arvense, Thinopyrum intermedium, Poa pratensis, Agropyron cristatum, Melilotus officinalis,* and *Helianthus annuus*.

Global Dynamics: *Rhus trilobata* is a vigorously sprouting shrub that colonizes well after fires or mechanical disturbance (Padgett et al. 1989). The influence of fire on the *Rhus trilobata* association in riparian settings is not known. Although the exact response to disturbance is not known, the association is probably resistant to disturbances and minor changes in structure or composition (Hansen and Hall 2002). Exotic species are commonly observed, but they may not always obtain high cover when in competition with *Rhus trilobata*. The association is probably most sensitive to large-scale environmental changes, such as drying of seeps or springs due to water diversion or clearing for development. Hansen and Hall (2002) suggest that the *Rhus trilobata* association may represent the potential natural vegetation along narrow floodplains or be a seral state of *Juniperus scopulorum / Cornus sericea* Riparian Woodland (CEGL000746) or *Populus angustifolia / Rhus trilobata* Riparian Woodland (CEGL000652) (Padgett et al. 1989). Fire may help maintain dominance by *Rhus trilobata*. This shrubland association is considered late-seral by both Kittel et al. (1999a) and Hall and Hansen (1997). *Rhus trilobata* was observed to rapidly recolonize sandy terraces along the Yampa River once tamarisk was removed.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Rhus trilobata*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous tree	*Salix exigua*
Short shrub/sapling	Broad-leaved deciduous shrub	*Rhus trilobata*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Rhus trilobata, Salix exigua*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Salsola tragus, Tamarix ramosissima* (High)

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Global: Invasive/Exotic Plants: *Agropyron cristatum* (Medium/Low), *Cirsium arvense* (High/Medium), *Elaeagnus angustifolia* (High), *Lepidium latifolium* (High), *Melilotus officinalis* (Medium/Low), *Poa pratensis* (Medium), *Tamarix ramosissima* (High), *Thinopyrum intermedium* (Medium/Insignificant); Other Plants: *Helianthus annuus* (G5, weedy native)

Conservation Status Rank

Global Rank & Reasons: G3 (22-Oct-2002). Throughout its relatively broad range (i.e., western Colorado through Utah to southern Idaho), this association is restricted to hot and dry, low- to mid-elevation creeks and rivers. At least 35 plots have been sampled and 21 other stand observations documented, however, less than 20% of these occurrences are in good to excellent ecological condition. Further inventories throughout the range of the plant association will likely find more occurrences and possibly support classification of additional, distinct *Rhus trilobata* associations. This association often forms large, dense patches that are resistant to minor or occasional disturbance (e.g., fire, livestock damage). However, exotic species, especially *Bromus tectorum*, frequently occur in the understory. In southern Idaho, most stands are protected from land development. Based on the moderate number of occurrences, broad range, and relative resilience of the *Rhus trilobata* association, it is best ranked as G3 rather than G2. Nevertheless, the association is definitely globally rare, being discontinuously distributed through an ecologically degraded landscape with on-going and growing threats, such as agricultural and housing development, livestock grazing, fires and conversion to exotic species, and hydrologic alteration (e.g., irrigation diversions, hydroelectric development, and groundwater pumping).

Related Concepts

Global Similar Types:

- *Rhus trilobata - Prunus serotina* Wet Shrubland (CEGL001119) is described from riparian habitats in southwestern New Mexico.
- *Rhus trilobata* Rocky Mountain Shrubland (CEGL002910)

Global Related Concepts:

- *Celtis laevigata var. reticulata*/*Rhus trilobata*/*Bromus tectorum* (Cole 1996) **?**
- *Rhus aromatica-Salix exigua* (Bourgeron and Engelking 1994) **=**
- *Rhus aromatica* Community Type (Hall and Hansen 1997) **?**
- *Rhus trilobata* (Basket bush thickets) Provisional Alliance (Sawyer et al. 2009) **>**
- *Rhus trilobata* (Kittel et al. 1999b) **=**
- *Rhus trilobata-Rosa woodsii*/*Bromus tectorum* (Cole 1996) **?**
- *Rhus trilobata-Toxicodendron rydbergii* (Cole 1996) **?**
- *Salix exigua-Rhus trilobata*/*Bromus tectorum* (Cole 1996) **?**
- DRISCOLL FORMATION CODE:III.B.3.a. (Driscoll et al. 1984) **>**
- Skunkbrush Plant Association (Kittel and Lederer 1993) **=**

Classification

Status: Standard

Classification Confidence: 3 - Weak

Global Classification Comments: This association has been quantitatively described from numerous locations: 28 plots and 12 stand observations from southern Idaho (Cole 1995, 1996, Jankovsky-Jones

et al. 2001, Hansen and Hall 2002) and a number of plots from western Colorado (e.g., Kittel et al. 1999a). Several riparian communities dominated by, or with high cover of, *Rhus trilobata* have been documented along the Snake River by Cole (1995, 1996). Due to their degraded stand conditions (indicated by abundant *Bromus tectorum*) and to inconsistency in the cover and constancy of associated or codominant shrubs, these 4 communities are considered synonymous variants of this more broadly defined *Rhus trilobata* association. In addition, no diagnostic herbaceous species useful for differentiating between possible *Rhus trilobata* associations is apparent (Jankovsky-Jones et al. 2001, Hansen and Hall 2002). *Rhus trilobata - Salix exigua* has been proposed as a different association, but *Salix exigua* has only moderate constancy in otherwise similar stands sampled from Idaho and Colorado. Although this *Rhus trilobata* plant association occurs in two distinct wetland settings (riverine and canyon-slope seeps or springs), no other distinct *Rhus trilobata* associations have been observed in these different settings. *Rhus trilobata* also occurs as a dominant species in xeric upland stands, especially east of the Continental Divide (Kittel et al. 1999a). These stands are separated by their clearly non-riparian settings and species.

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon shrubland association was sampled only in Anderson Bottom and upper Millard Canyon.

Global Range: This association is known from western Colorado, Utah and southern Idaho. This minor shrubland association is known from the Yampa, San Miguel and Dolores river basins of the western slope of Colorado, along the Green River in northeastern Utah and Idaho, and the Colorado River in western Colorado and eastern Utah.

Nations: US
States/Provinces: CO:S2, ID:S2, UT
TNC Ecoregions: 8:C, 9:C, 10:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 341B:CC, 341C:CC, M331E:CC
Federal Lands: NPS (Arches, Capitol Reef, Colorado, Dinosaur, Glen Canyon); USFWS (Minidoka, Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Glen Canyon National Recreation Area Inventory Notes: Plot is about halfway up this 150 m long (by 4 m wide) drainage way. More *Forestiera pubescens* at base of cliff and more *Rhus trilobata* in drainage way farther down from cliff. Most of the drainage is full of White Rim boulders/rockfall (1x1 m).

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2014 field data (1 plot, 2 accuracy assessment points): (Plots: GLCA.9047; AA Points: GLCA_AA.0036, GLCA_AA.0364).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, C. Murphy, J. Drake and J. Coles

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References: Bourgeron and Engelking 1994, CNHP 2015, CNHP Ecology Team 2001, Clark et al. 2009, Cole 1995, Cole 1996, Coles et al. 2008a, Coles et al. 2009a, Driscoll et al. 1984, Goodrich and Neese 1986, Hall and Hansen 1997, Hansen and Hall 2002, IDCDC 2002, IDCDC 2005, Jankovsky-Jones et al. 2001, Kittel and Lederer 1993, Kittel et al. 1999b, Padgett et al. 1989, Romme et al. 1993, Sawyer et al. 2009, Von Loh et al. 2002, Von Loh et al. 2007, Welsh et al. 1987, Western Ecology Working Group n.d.*

A3800 Salix exigua - Salix irrorata Shrubland Alliance

Alliance Summary Description: Dominant species are *Salix exigua, Salix irrorata,* and/or *Salix melanopsis*. The herbaceous stratum has sparse to moderate cover, including a variety of pioneer species. Other codominants include *Populus fremontii, Populus deltoides,* and *Acer negundo*. The low-shrub component of associations in this alliance consist of *Cornus sericea, Rosa* spp., *Rubus idaeus ssp. strigosus (= Rubus strigosus),* and shrub-sized *Acer negundo*. Common herbaceous species include *Fragaria virginiana ssp. glauca (= Fragaria ovalis), Thalictrum fendleri*, and *Geranium* spp. Elevations range from 780 to 2860 m (2560-9383 feet). Communities within this alliance occur along streams in New Mexico and Arizona. These shrublands are found on open sandbars without tree canopy shading, on larger, well-developed drainages and along larger sandy rivers, or on coarser-textured substrates. They are associated with annual flooding and inundation and will grow well into the channel, where it is flooded, even in drier years. Even though flooding is frequent, surface water is not present for much of the growing season, and the water table is well below the surface. Some stands form large, wide stands on mid-channel islands on larger rivers, or narrow stringer bands on small, rocky tributaries. Stream reaches range widely from moderately sinuous and moderate-gradient reaches to broad, meandering rivers with wide floodplains or broad, braided channels. Many stands also occur within highly entrenched or eroding gullies.

[CEGL005656] *Salix exigua* / Gravel Bar Wet Shrubland

Translated Name: Narrowleaf Willow / Gravel Bar Wet Shrubland

Common Name:

USNVC Classification

Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (2.C.4.Nb)

Macrogroup: Western North American Montane-Subalpine-Boreal Marsh, Wet Meadow & Shrubland (M075)

Group: Rocky Mountain-Great Basin Lowland-Foothill Riparian Shrubland (G526)

Alliance: *Salix exigua* - *Salix irrorata* Shrubland Alliance (A3800)

Element Concept

Global Summary: This riparian shrubland is common in the Rocky Mountains, upper Colorado Plateau and throughout the Great Basin. It is composed of nearly pure stands of *Salix exigua*, with few other species. Exposed gravel, cobbles or sand characterize the ground cover, with an undergrowth of a few, scattered forbs and grasses usually present. This association occurs within the annual flood zone of rivers on point bars, islands, sand or cobble bars, and streambanks.

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Environmental Description

Glen Canyon National Recreation Area Environment: This rare mesic shrubland is distributed along the floodplains of rivers and streams within the recreation area, on intermittently flooded low-lying areas, including canyon bottoms, riverbanks, and perennial streams. Sites slope gently (0-11°) and occur between 1098 and 1147 m elevation. Bare soil and litter cover most of the unvegetated surface; with low to moderate cover of live vegetation litter. Soils are moderately well-drained to well-drained loamy sands derived from new alluvium.

Global Environment: This riparian shrubland is common in the Rocky Mountains, upper Colorado Plateau and throughout the Great Basin. Elevation ranges from 1100-2600 m. This association occurs within the annual flood zone of rivers on point bars, islands, sand or cobble bars, and on streambanks occurring along a wide variety of stream reaches, from moderately sinuous and moderate-gradient reaches. It can form large, wide stands on mid-channel islands in larger rivers or narrow stringer bands on small, rocky tributaries. Substrates are typically coarse alluvial deposits of sand, silt and cobbles that are highly stratified vertically from flooding scour and deposition, often consisting of alternating layers of finer textured soil with organic material over coarser alluvium. Occasionally, this association occurs on deep pockets of sand. The lack of soil development and high ground cover of coarse alluvial material are key indicators for this association.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This willow shrubland occurs as narrow bands of vegetation within the active floodplain of rivers and streams and less often in seeps and springs. Total vegetation cover ranges from 32 to 100%. The shrub canopy is typically 1 to 5 m tall and is dominated by *Salix exigua*, with 16-80% cover. *Tamarix chinensis* may also be present to nearly codominant in some stands. Other shrubs present with low cover may include *Pluchea sericea, Baccharis salicina*, and *Ericameria nauseosa*. Flooding is too frequent to permit the development of a dense herbaceous layer, but species present with low cover include *Bromus tectorum, Elymus canadensis*, and *Artemisia ludoviciana*.

Global Vegetation: This riparian association is characterized by a sparse to dense, tall-shrub (1.5-3 m) canopy composed of *Salix exigua*, with ground cover of exposed gravel, cobbles or sand. *Salix exigua* may be the only shrub in the community, or other shrubs and trees may be present with relatively low cover, including *Alnus incana, Baccharis salicina, Ericameria nauseosa, Pluchea sericea, Rhus trilobata, Salix monticola, Salix ligulifolia (= Salix eriocephala var. ligulifolia), Salix irrorata*, and *Salix lucida*. Tree species may be present as emergent or canopy leaning over from adjacent stands and include *Abies lasiocarpa, Acer negundo, Populus angustifolia*, and *Populus deltoides*. A sparse herbaceous layer may be present among the bare soil, gravel, cobbles, or boulders, consisting of a wide variety of forbs and graminoids. *Mentha arvensis* and species of *Carex, Eleocharis, Juncus, Schoenoplectus*, and *Equisetum* are often present. Introduced species, such as *Elaeagnus angustifolia, Tamarix* spp., *Bromus tectorum, Bromus inermis, Elymus repens (= Elytrigia repens), Poa pratensis, Agrostis stolonifera* (and other exotic forage species), *Taraxacum officinale, Conyza canadensis*, and *Lepidium latifolium*, have been reported from some stands.

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Global Dynamics: This association is an early-seral type that colonizes newly created point bars and other recent alluvial deposits formed in rivers and streams (Kittel et al. 1999). Competition with *Tamarix* spp. in the southwestern U.S. likely limits the abundance of this association where these introduced species dominate.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Salix exigua*, *Tamarix chinensis*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous tree	*Salix exigua*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Salix exigua*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Tamarix chinensis*

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Elaeagnus angustifolia* (High), *Elymus repens* (High/Medium), *Lepidium latifolium* (High), *Melilotus officinalis* (Medium/Low), *Tamarix chinensis*, *Taraxacum officinale*, *Xanthium strumarium*

Conservation Status Rank

Global Rank & Reasons: G5 (14-Jan-2016).

Related Concepts

Global Similar Types:

- *Salix exigua* / Barren Warm Desert Wet Shrubland (CEGL005655)
- *Salix exigua / Equisetum x ferrissii* Shrubland [Park Special] (CEPS009538)
- *Salix exigua* / Mesic Forbs Wet Shrubland (CEGL001202)
- *Salix exigua* / Mesic Graminoids Western Wet Shrubland (CEGL001203)

Global Related Concepts:

- *Salix exigua* - *Salix* spp. / *Poa* spp. Plant Association (Johnston 1987) >
- *Salix exigua* / Barren Ground Plant Association (Kittel et al. 1994) =
- *Salix exigua* / Barren Ground Plant Association (Kittel et al. 1995) =
- *Salix exigua* / Barren Ground Plant Association (Culver et al. 1996) =
- *Salix exigua ssp. exigua* Communities (Tuhy and Jensen 1982) >
- *Salix exigua* / Barren Community Type (Padgett et al. 1989) =
- *Salix exigua* / Barren Ground Shrubland (Carsey et al. 2003a) =

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- *Salix exigua* / Bench Community Type (Manning and Padgett 1995) =
- *Salix exigua* Community Type (Hansen et al. 1995) =
- *Salix exigua* Community Type (Hall and Hansen 1997) =
- *Salix exigua* Plant Association (Richard et al. 1996) =
- *Salix exigua*/Barren (Bourgeron and Engelking 1994) =
- Coyote willow association (Kovalchik 1987) **?**
- Coyote willow/bare ground (*Salix exigua*/bare ground) Plant Association (Kittel et al. 1999a) =
- DRISCOLL FORMATION CODE:III.B.3.c. (Driscoll et al. 1984) >
- Palustrine (Cowardin et al. 1979) >
- unclassified stands of *Salix exigua* (Jones and Walford 1995) =

Classification

Status: Standard

Classification Confidence: 1 - Strong

Global Classification Comments: Former *Salix exigua* / Barren Shrubland (CEGL001200) was split into 2 associations; this one (CEGL005656) for more montane/Rocky Mountain occurrences; the other (CEGL005655) for low-elevation, warm desert occurrences. This association is entirely dominated by *Salix exigua*, the western species. In the western Great Plains this association used to include stands composed of intermediates between *Salix interior (= Salix exigua ssp. interior)* and *Salix exigua (= Salix exigua ssp. exigua)* (Dorn 1997, G. Kittel pers. comm. 2001). Until recently these taxa were combined at the species level (Kartesz 1999). More information on the distribution of introgression between *Salix interior (= Salix exigua ssp. interior)* and *Salix exigua (= Salix exigua ssp. exigua)* is needed to fully understand the ranges of these two species.

Element Distribution

Glen Canyon National Recreation Area Range: This riparian shrubland is rare within the recreation area and was sampled in and along the San Juan River, in Hansen Creek, and Hall's Creek Bay.

Global Range: This riparian shrubland association is common along waterways of all sizes at lower to middle elevations in the Great Basin, Colorado Plateau and Rocky Mountains, extending to the eastern foothills of Wyoming and Colorado, but not out to the plains of those states, where it may overlap with *Salix interior*.

Nations: US
States/Provinces: AZ?, CO:S5, ID, MT:S5, NM?, NV, OR:SU, UT:S3?, WA:S2, WY
TNC Ecoregions: 6:C, 8:C, 9:C, 10:C, 18:C, 19:C, 20:C, 27:P
USFS Ecoregions (1994/95): 313A:CC, 313B:CP, 313D:CC, 331C:CC, 331H:CC, 331I:CC, 341B:CC, 341C:CC, 342B:CC, 342D:CC, 342E:CC, 342G:CC, M331D:CC, M331E:CC, M331G:CC, M331H:CC, M331I:CC, M332A:CC, M332E:CC, M341B:CC, M341C:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Dinosaur, Glen Canyon, John Day Fossil Beds, Lake Roosevelt, Petrified Forest, Wupatki, Zion); USFS (Comanche, Deschutes, Fremont, Malheur NF, Ochoco, San Juan, Winema); USFWS (Ouray)

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Element Sources

Glen Canyon National Recreation Area Inventory Notes: Low-lying floodplain segment, likely submerged during flood season, but not disastrously. So a deep layer of leaf litter persists.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (3 plots, 2 accuracy assessment points): (Plots: GLCA.5119, GLCA.5121, GLCA.5122; AA Points: GLCA_AA.1027, GLCA_AA.1788).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Coles and G. Kittel
References: Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Carsey et al. 2003a, Christy 1973, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2003, Coles et al. 2008a, Coles et al. 2009a, Cowardin et al. 1979, Culver et al. 1996, Dorn 1997, Driscoll et al. 1984, Durkin et al. 1995b, Erixson et al. 2011b, Hall and Hansen 1997, Hansen et al. 1995, Hansen et al. 2004b, IDCDC 2005, Johnston 1987, Jones and Walford 1995, Kagan et al. 2004a, Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1995, Kittel et al. 1996, Kittel et al. 1999a, Kovalchik 1987, MTNHP 2002b, Manning and Padgett 1995, NHNM unpubl. data, Padgett 1981, Padgett et al. 1988b, Padgett et al. 1989, Peterson 2008, Reid and Hall 2010, Richard et al. 1996, Romme et al. 1993, Thomas et al. 2009a, Tuhy and Jensen 1982, Von Loh et al. 2002, WNDD unpubl. data, Western Ecology Working Group n.d.*

[CEGL001203] *Salix exigua* / Mesic Graminoids Western Wet Shrubland
Translated Name: Narrowleaf Willow / Mesic Graminoids Western Wet Shrubland
Common Name:

USNVC Classification

Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (2.C.4.Nb)
MacroGroup: Western North American Montane-Subalpine-Boreal Marsh, Wet Meadow & Shrubland (M075)
Group: Rocky Mountain-Great Basin Lowland-Foothill Riparian Shrubland (G526)
Alliance: *Salix exigua - Salix irrorata* Shrubland Alliance (A3800)

Element Concept

Global Summary: This riparian association is found primarily in the Rocky Mountains and Intermountain West semi-desert regions, and extending into California. The vegetation is characterized by the dominance of *Salix exigua* in a moderately dense tall-shrub canopy with a dense herbaceous layer dominated by graminoids. It typically occurs as a monoculture of *Salix exigua*, but can have other woody species, including saplings of *Populus deltoides* or *Salix amygdaloides*, and shrubs such as *Salix eriocephala, Salix lutea*, and *Amorpha fruticosa*. Tall perennial grasses can appear to codominate the stand when *Spartina pectinata, Panicum virgatum* or other tall grasses are present. Other mesic graminoids, such as *Carex* spp., *Eleocharis* spp., *Juncus* spp., *Pascopyrum smithii, Schoenoplectus pungens (= Scirpus pungens),* and *Sphenopholis obtusata*, may be present. Common forb species include *Bidens* spp., *Lobelia siphilitica, Lycopus americanus, Lythrum alatum, Polygonum* spp., and *Xanthium strumarium*. Diagnostic features of this association include the nearly pure stands of *Salix*

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exigua shrubs, with a dense herbaceous layer of at least 30% cover of mesic graminoids. It generally occurs along backwater channels and other perennially wet but less scoured sites, such as floodplain swales and irrigation ditches.

Environmental Description

Glen Canyon National Recreation Area Environment: This mesic shrubland occurs as narrow bands along intermittently flooded riverbanks and canyon bottom wash channels, generally where surface water is present nearby. Sites are flat to moderately sloping (up to 20°) and occur between 1092 and 1356 m elevation. Litter covers most of the unvegetated surface, with lesser cover by sand, bare soil, live vegetation litter, and wood. Soils are somewhat poorly drained to rapidly drained silt loams or loamy sands derived from alluvium.

Global Environment: This riparian association is found along alluvial terraces of backwater channels and other perennially wet but less scoured sites such as floodplain swales and irrigation ditches. It is found at elevations from 937 to 2700 m (3075-9100 feet). This community is found on temporarily to seasonally flooded sandbars, islands, and shorelines of stream channels and braided rivers. Stands usually occur within 1 m vertical distance of the stream channel on point bars, low floodplains, terraces and along overflow channels. It can also occur away from the stream channel in mesic swales or along the margins of beaver ponds and seeps. Sites are usually relatively flat, though rarely they can have moderate or moderately steep slopes. Soils are derived from alluvium and are quite variable in development, ranging from thin (<1 m) and skeletal with depth (10-50% cobbles) to well-developed Mollisols (Kittel et al. 1999a). Textures are typically loamy sands interspersed with layers of silty clays and alternating with coarse sands. Upper layers (10-30 cm) often have 25-30% organic matter (Kittel et al. 1999a), and organic litter covers most of the unvegetated ground surface.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This rare riparian shrubland has 28 to 100% total vegetation cover, characterized by 2- to 5-m tall clumps of *Salix exigua*, with 10-74% cover, and a mix of mesic graminoid species, contributing 5-30% to the understory cover. Scattered individuals of *Populus fremontii, Salix gooddingii*, and *Elaeagnus angustifolia* may contribute low cover to an emergent canopy layer. Other tall shrubs present along with *Salix exigua* include *Tamarix chinensis* (which may be codominant in some stands), *Baccharis salicina, Pluchea sericea,* and *Ericameria nauseosa*. Mesic graminoids dominating the understory include native species *Juncus tenuis, Elymus canadensis, Muhlenbergia asperifolia, Phragmites australis, Poa* spp., and *Carex* spp., and the non-native grasses *Bromus rubens* and *Bromus tectorum* which provide sparse cover. Forbs include the non-native *Melilotus officinalis (= Melilotus albus), Medicago sativa,* and *Salsola tragus*, as well as the natives *Ambrosia acanthicarpa, Euthamia occidentalis (= Solidago occidentalis),* and the fern ally *Equisetum laevigatum.*

Global Vegetation: This association is characterized by the dominance of *Salix exigua* in the moderately dense tall-shrub canopy with a dense herbaceous layer dominated by graminoids. Others common woody species may include saplings of *Populus deltoides* and *Salix amygdaloides,* and shrubs such as *Salix bebbiana, Salix eriocephala, Salix geyeriana, Salix lucida ssp. lasiandra (= Salix lasiandra), Salix lutea, Salix monticola, Salix planifolia, Amorpha fruticosa,* or *Rosa woodsii*.

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Scattered individuals of *Populus fremontii, Salix gooddingii,* and *Elaeagnus angustifolia* may contribute low cover to an emergent canopy layer. Tall perennial graminoids can be dominant in the undergrowth and include *Carex pellita (= Carex lanuginosa), Carex nebrascensis, Carex rostrata, Deschampsia caespitosa, Eleocharis palustris, Elymus canadensis, Equisetum* spp., *Glyceria* spp., *Juncus balticus, Juncus longistylis, Juncus tenuis, Juncus torreyi, Luzula parviflora, Pascopyrum smithii, Polygonum* spp., *Schoenoplectus americanus, Schoenoplectus pungens (= Scirpus pungens), Sphenopholis obtusata*, and others. The sparse forb cover may include *Lobelia siphilitica, Bidens* spp., *Geum macrophyllum, Lycopus americanus, Lythrum alatum, Mentha arvensis, Typha angustifolia, Veronica americana,* and *Xanthium strumarium*. Introduced forage species such as *Agrostis stolonifera, Bromus inermis, Melilotus officinalis (= Melilotus albus), Medicago sativa, Salsola tragus, Poa pratensis,* or *Phleum pratense* may be present to abundant in disturbed stands of this community.

Global Dynamics: Flooding during spring periods is common, although scouring is rare. This plant association is considered early-seral typical of recent floodplains and highly disturbed, low, wet areas. The presence of *Populus* sp. seedlings within this association indicates succession to a cottonwood stand. Overgrazing by livestock will reduce the vigor of *Salix exigua* and may eventually eliminate it from the site and allow invasion of introduced and non-palatable native species. However, reducing stocking rates will allow *Salix exigua* to re-establish itself, provided it has not been completely eliminated from the site (Hansen et al. 1995). *Tamarix ramosissima* has the potential to invade and even dominate stands of this community.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Salix exigua*, *Tamarix chinensis*
Herb (field)	Graminoid	*Bromus rubens*, *Bromus tectorum*, *Juncus tenuis*
Herb (field)	Fern (Spore-bearing forb)	*Equisetum laevigatum*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous tree	*Salix exigua*
Herb (field)	Graminoid	*Juncus* spp., *Pascopyrum smithii*, *Poa pratensis*, *Schoenoplectus americanus*, *Sorghastrum nutans*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Salix exigua, Schoenoplectus americanus, Sorghastrum nutans, Spartina pectinata*

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Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Medicago sativa* (Insignificant), *Melilotus officinalis* (Medium/Low), *Salsola tragus*, *Tamarix chinensis*

Global: Invasive/Exotic Plants: *Poa pratensis* (Medium)

Conservation Status Rank

Global Rank & Reasons: G5 (7-Apr-1998).

Related Concepts

Global Similar Types:

- Riverine Sand Flats - Bars Sparse Vegetation (CEGL002049)
- *Salix exigua* / Barren Warm Desert Wet Shrubland (CEGL005655)
- *Salix exigua / Equisetum arvense* Wet Shrubland (CEGL001201)
- *Salix exigua* / Gravel Bar Wet Shrubland (CEGL005656)
- *Salix exigua* / Mesic Forbs Wet Shrubland (CEGL001202)
- *Salix exigua* Riparian Wet Shrubland (CEGL001197)
- *Salix interior / Pascopyrum smithii - Equisetum hyemale* Wet Shrubland (CEGL005282)

Global Related Concepts:

- *Salix exigua / Juncus* spp. (Sawyer et al. 2009) =
- *Salix exigua /* Mesic graminoids (Evens et al. 2014) =
- *Salix exigua* / Mesic Graminoids Community Type (Padgett et al. 1989) =
- *Salix exigua* / Mesic Graminoids Community Type (Jones and Walford 1995) =
- *Salix exigua* / Mesic graminoid Community Type (Padgett et al. 1988b) =
- *Salix exigua* / Mesic graminoid Shrubland (Kittel and Lederer 1993) =
- *Salix exigua* / Mesic graminoid Shrubland (Kittel et al. 1996) =
- *Salix exigua/Juncus* spp. Shrubland [Provisional] (Keeler-Wolf et al. 2012) =
- *Salix exigua - Poa pratensis* Association (Cooper and Cottrell 1990) **?**
- *Salix exigua - Poa pratensis* Community (Jones and Walford 1995) **?**
- *Salix exigua - Poa pratensis* Community Type (Walford et al. 2001) =
- *Salix exigua* / Mesic Graminoid Shrubland (Carsey et al. 2003a) =
- *Salix exigua* / Mesic Graminoids Shrubland (Kittel 1994) =
- *Salix exigua* Community Type (Hansen et al. 1995) >
- *Salix exigua*/Mesic graminoid (Bourgeron and Engelking 1994) =
- Coyote willow/Mesic Graminoids (*Salix exigua*/Mesic Graminoids) Plant Association (Kittel et al. 1999a) =
- DRISCOLL FORMATION CODE:III.B.3.c. (Driscoll et al. 1984) >

Classification

Status: Standard

Classification Confidence: 1 - Strong

Global Classification Comments: This broadly defined plant association occupies a rather large range and currently includes *Salix exigua* shrublands with herbaceous layers dominated by the introduced mesic, perennial, sod-grass *Poa pratensis*. Classification review has determined that western stands belong to *Salix exigua* Nutt. *sensu stricto*, and Great Plains stands belong to *Salix*

interior (and their intermediates). *Salix interior* is an entirely Great Plains and eastward species (Kartesz 1999). In Nebraska, this community intergrades and is a successional stage that appears after both Riverine Sand Flats - Bars Sparse Vegetation (CEGL002049) and *Salix exigua* Riparian Wet Shrubland (CEGL001197), which is more frequently disturbed and lacks many of the more mesic herbaceous species.

Element Distribution

Glen Canyon National Recreation Area Range: This riparian shrubland is rare within the recreation area and was sampled in Coyote Gulch, Knowles Canyon, along the Escalante River and San Juan River.

Global Range: This association is found primarily in the Rocky Mountains and Intermountain semi-desert regions, ranging from western Wyoming and Montana west to Idaho, Oregon, Washington, California, and including Nevada, Utah, Arizonica, Colorado and western New Mexico.

Nations: US
States/Provinces: CA, CO:S5, ID, MT:S5, NM, NV, UT:S2S3, WY:S3?
TNC Ecoregions: 6:C, 7:C, 9:C, 10:C, 11:C, 12:C, 18:C, 19:C, 20:C, 26:C, 27:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CP, 331F:CC, 331H:CC, 331I:CC, 332C:CC, 341B:CC, 342D:CC, 342G:CC, M261E:CC, M331D:CC, M331E:CC, M331G:CC, M331H:CC, M331I:CC, M333C:CC, M341A:CC, M341B:CC, M341C:CC
Federal Lands: NPS (Bent's Old Fort, Canyonlands, Capitol Reef, Colorado, Curecanti, Death Valley, Dinosaur, Glen Canyon, Great Basin, Natural Bridges, Yosemite, Zion); USFS (Comanche, San Juan, Shoshone)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: *Salix exigua* is dominant closest to river, then there is a patch of open ground with *Pluchea* and *Ericameria nauseosa*, then there is a stand of large *Tamarix chinensis*.

Glen Canyon National Recreation Area Plots: The description is based on 2012, 2013, and 2015 field data (4 plots, 1 accuracy assessment point): (Plots: GLCA.4302, GLCA.5124, GLCA.5128, GLCA.5518; AA Points: GLCA_AA.4004).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Drake, J. Coles and G. Kittel
References: Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Carsey et al. 2003a, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2010, Cooper and Cottrell 1990, Driscoll et al. 1984, Evens et al. 2014, Hansen et al. 1995, IDCDC 2005, Jones 1992b, Jones and Walford 1995, Keeler-Wolf et al. 2003a, Keeler-Wolf et al. 2012, Kittel 1994, Kittel and Lederer 1993, Kittel et al. 1996, Kittel et al. 1999a, MTNHP 2002b, Muldavin et al. 2000a, NHNM unpubl. data, Padgett et al. 1988b, Padgett et al. 1989, Peterson 2008, Romme et al. 1993, Sawyer et al. 2009, Schulz and Hall 2011, Stevens et al. 2007, Tendick et al. 2010, Von Loh et al. 2007, WNDD unpubl. data, Walford et al. 2001, Western Ecology Working Group n.d.*

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Subset: GLCA; Glen Canyon National Recreation Area

G521. Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh

Group Summary Description: This group contains the wet meadows found in montane and subalpine elevations, occasionally reaching into the lower edges of the alpine elevations (about 1000-3600 m), from California's Transverse and Peninsular ranges north to British Columbia's Coastal Mountains and from throughout the Rocky Mountains of Canada and the U.S. (including the Black Hills of South Dakota) and mountain ranges of the intermountain Interior West. Varying dominant herbaceous species include graminoids *Calamagrostis canadensis, Calamagrostis stricta, Carex bolanderi, Carex exsiccata, Carex illota, Carex microptera, Carex scopulorum, Carex utriculata, Carex vernacula, Deschampsia caespitosa, Eleocharis quinqueflora, Glyceria striata (= Glyceria elata), Juncus drummondii, Juncus nevadensis,* and *Scirpus* and/or *Schoenoplectus* spp. Forb species include *Camassia quamash, Cardamine cordifolia, Dodecatheon jeffreyi, Phippsia algida, Rorippa alpina, Senecio triangularis, Trifolium parryi,* and *Veratrum californicum*. Common but sparse shrubs may include *Betula glandulosa, Salix* spp., *Vaccinium macrocarpon,* and *Vaccinium uliginosum*. Wet meadows occur in open wet depressions, basins and flats with low-velocity surface and subsurface flows. They can be large meadows in montane or subalpine valleys, or occur as narrow strips bordering ponds, lakes and streams, and along toeslope seeps. They are typically found on flat areas or gentle slopes, but may also occur on subirrigated sites with slopes up to 10%. In alpine regions, sites typically are small depressions located below late-melting snow patches. Sites are usually seasonally wet, often drying by late summer, and many occur in a tension zone between perennial wetlands and uplands, where water tables fluctuate in response to long-term climatic cycles. They may have surface water for part of the year, but depths rarely exceed a few centimeters. Wet meadows can be tightly associated with snowmelt and typically are not subjected to high velocity disturbance, but can be flooded by slow-moving waters. Soils are mostly mineral and show typical hydric soil characteristics such as low chroma and redoximorphic features; some areas may have high organic content as inclusions or pockets. Vegetation of this group can manifest as a mosaic of several plant associations, or be a monotypic stand of a single association which is dominated by graminoids or forbs.

A3805 Carex nebrascensis - Carex vesicaria - Carex pellita Wet Meadow Alliance

Alliance Summary Description: These wet meadows are dominated by *Carex nebrascensis, Carex vesicaria,* and/or *Carex pellita*. Stands can be nearly monotypic cover of one of these three *Carex* species. Other graminoids that may be present to codominant include *Calamagrostis stricta, Carex microptera, Carex praegracilis, Carex utriculata, Catabrosa aquatica, Deschampsia caespitosa, Eleocharis palustris, Glyceria* spp., *Juncus balticus, Phalaris arundinacea, Schoenoplectus acutus (= Scirpus acutus), Schoenoplectus pungens (= Scirpus pungens),* and/or *Scirpus microcarpus*. Forb and fern ally cover is generally low and includes such species as *Camassia quamash, Epilobium* spp., *Equisetum arvense, Galium trifidum, Geum macrophyllum, Mentha arvensis, Potentilla gracilis, Prunella vulgaris, Symphyotrichum foliaceum (= Aster foliaceus),* and *Triglochin maritima*. This alliance occurs in the Cascade Range, Sierra Nevada, Intermountain West ranges and Rocky Mountains at mostly lower montane elevations (approximately 1000-2400 m [3000-8000 feet]). Stands occur in gently sloping to flat mountain valleys, lower slopes, foothill draws, stream terraces, on the margins of slow-moving reaches of streams and rivers, and in marshy swales and overflow channels on broad floodplains. Most sites are poorly drained and flooded during spring runoff such that water levels

normally remain in the rooting zone throughout the growing season. Soils are composed of sand, silt, and clay deposits.

[CEGL001813] *Carex nebrascensis* Wet Meadow
Translated Name: Nebraska Sedge Wet Meadow
Common Name: Nebraska Sedge Wet Meadow

USNVC Classification

Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (2.C.4.Nb)
Macrogroup: Western North American Montane-Subalpine-Boreal Marsh, Wet Meadow & Shrubland (M075)
Group: Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh (G521)
Alliance: *Carex nebrascensis - Carex vesicaria - Carex pellita* Wet Meadow Alliance (A3805)

Element Concept

Global Summary: This minor wetlands community occurs on the western Great Plains and throughout much of the western U.S. Elevation ranges from 1000-2800 m (3300-9200 feet). Stands form open meadows that occur along the margins of streambanks, flat floodplains, and lakes often forming a band along the alluvial terrace, or on marshy areas surrounding springs and below seeps on lower hillslopes, as well as small patches within spring-fed alcoves of the southwestern deserts. This association is often found on well-developed soil, but occurs on a wide variety of soil types that tend to be fine-textured alluvium, or clay to organic and are typically gleyed and mottled near the surface because of the high water table most of the growing season. The vegetation is characterized by a moderately dense to dense perennial graminoid layer dominated or codominated by *Carex nebrascensis*. Other graminoid species may be present such as *Carex praegracilis, Calamagrostis stricta, Deschampsia caespitosa, Eleocharis palustris, Glyceria striata, Juncus balticus, Schoenoplectus pungens (= Scirpus pungens)*, or *Triglochin maritima*. Forb cover is generally low, but can be high in moist locations. Scattered short shrubs may be present in some stands.

Environmental Description

Global Environment: This wetland plant association occurs on the western Great Plains and throughout much of the western U.S. Elevation ranges from 1000-2800 m (3300-9200 feet). Stands form open meadows that occur along the margins of streambanks, flat floodplains, and lakes often forming a band along the alluvial terrace. Stands have also been sampled from marshy areas surrounding springs and below seeps on lower hillslopes. This association is often found on well-developed soil, but occurs on a wide variety of soil types ranging from saturated organics to Mollisols to Entisols. Soils tend to be fine-textured alluvium, ranging from sandy, silty loam, clay loam, or clay to organic and are typically gleyed and mottled near the surface because of the high water table most of the growing season.

Vegetation Description

Global Vegetation: These wetlands are characterized by a moderately dense to dense perennial graminoid layer dominated or codominated by *Carex nebrascensis* (25-99% cover), that generally

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forms small- to medium-sized meadows. Stands often are nearly pure *Carex nebrascensis*, but a variety of other graminoid species may be present such as *Carex aurea, Carex praegracilis, Calamagrostis stricta, Calamagrostis canadensis, Deschampsia caespitosa, Eleocharis palustris, Glyceria striata, Juncus balticus, Schoenoplectus pungens (= Scirpus pungens)*, or *Triglochin maritima*. Forb cover is generally low, but can be high in moist locations. Common forbs include *Epilobium ciliatum, Eurybia integrifolia (= Aster integrifolius), Geum macrophyllum, Mentha arvensis, Mimulus glabratus, Heracleum maximum*, and *Ranunculus cymbalaria*. Introduced species *Poa pratensis, Poa palustris, Cirsium arvense*, and *Melilotus officinalis* may also be common. Scattered shrubs *Artemisia cana, Betula occidentalis, Ericameria nauseosa, Dasiphora fruticosa ssp. floribunda (= Pentaphylloides floribunda), Frangula betulifolia*, sapling *Populus tremuloides, Salix monticola, Salix exigua*, and *Salix brachycarpa* may be occasionally present in some stands. In Nebraska, common species include *Agrostis stolonifera, Carex hystericina, Carex pellita (= Carex lanuginosa), Eleocharis erythropoda, Equisetum* spp., *Juncus balticus, Schoenoplectus pungens (= Scirpus pungens)*, and *Triglochin* spp. (Steinauer and Rolfsmeier 2000).

Global Dynamics: In Montana, the *Carex nebrascensis* Community Type is considered a grazing-disclimax. Under season-long grazing, *Carex nebrascensis* increases in abundance, replacing former dominant species (Hansen et al. 1995). However, under extreme grazing conditions and a resulting drop in the water table, *Juncus balticus* or *Poa pratensis* can eventually replace *Carex nebrascensis*. In Nevada, sites dominated by *Carex nebrascensis* are considered the Potential Natural Community (Manning and Padgett 1995), which appears to be the case in undisturbed stands in Colorado.

Most Abundant Species

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Carex nebrascensis*

Characteristic Species

Global: Carex nebrascensis

Other Noteworthy Species

Global: Invasive/Exotic Plants: *Cirsium arvense* (High/Medium), *Melilotus officinalis* (Medium/Low), *Poa palustris*, *Poa pratensis* (Medium)

Conservation Status Rank

Global Rank & Reasons: G4 (1-Feb-1996). This type is widely distributed, but many examples have been heavily grazed by cattle, lowering their floristic quality.

Related Concepts

Global Similar Types:

- *Deschampsia caespitosa - Carex nebrascensis* Wet Meadow (CEGL001601)

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Global Related Concepts:

- *Carex nebrascensis - Catabrosa aquatica - Juncus arcticus* ssp. *ater* Spring Wetland (Baker 1982b) =
- *Carex nebrascensis / Deschampsia cespitosa* Plant Association (Johnston 1987) =
- *Carex nebrascensis* (Durkin et al. 1995a) =
- *Carex nebrascensis* (Bourgeron and Engelking 1994) =
- *Carex nebrascensis* (McCain and Christy 2005) =
- *Carex nebrascensis* (Sawyer et al. 2009) =
- *Carex nebrascensis* (Durkin et al. 1994b) =
- *Carex nebrascensis* (Kovalchik 1987) =
- *Carex nebrascensis* (Kittel et al. 1999b) =
- *Carex nebrascensis* (Crowe and Clausnitzer 1997) =
- *Carex nebrascensis* Association (Crowe et al. 2004) =
- *Carex nebrascensis* Association (Cooper and Cottrell 1990) =
- *Carex nebrascensis* Association (Christy 2004) =
- *Carex nebrascensis* Community Type (Padgett et al. 1989) =
- *Carex nebrascensis* Community Type (Manning and Padgett 1995) =
- *Carex nebrascensis* Community Type (Padgett et al. 1988b) **?**
- *Carex nebrascensis* Community Type (Hall and Hansen 1997) **?**
- *Carex nebrascensis* Community Type (Hansen et al. 1995) **?**
- *Carex nebrascensis* Community Type (Youngblood et al. 1985b) **?**
- *Carex nebrascensis* Community Type (Youngblood et al. 1985a) =
- *Carex nebrascensis* Herbaceous Vegetation (Kittel et al. 1996) **?**
- *Carex nebrascensis* Herbaceous Vegetation (Keeler-Wolf et al. 2012) =
- *Carex nebrascensis* Herbaceous Vegetation (Marriott and Faber-Langendoen 2000) =
- *Carex nebrascensis* Herbaceous Vegetation (Kittel et al. 1994) **?**
- *Carex nebrascensis* Herbaceous Vegetation (Carsey et al. 2003a) =
- DRISCOLL FORMATION CODE:V.C.6.a. (Driscoll et al. 1984) >
- Nebraska Sedge (*Carex nebrascensis*) Community (Jones and Walford 1995) =
- Nebraska sedge (*Carex nebrascensis*) Plant Association (Kittel et al. 1999a) =
- Sedge-Bulrush Wet Meadow (Steinauer and Rolfsmeier 2000) =
- Western Streamside Wet Meadow (Steinauer and Rolfsmeier 2003) =
- Wet Meadow (Hall 1973) >

Classification

Status: Standard

Classification Confidence: 1 - Strong

Global Classification Comments: In the Black Hills, classification of stands was problematic due to identification problems with *Carex nebrascensis* and *Carex aquatilis*. The two are difficult to distinguish based on available keys and written descriptions (Marriott and Faber-Langendoen 2000).

Element Distribution

Global Range: This sedge meadow type is widely distributed from the western Great Plains into the western mountains of the United States, ranging from South Dakota and Montana to possibly as far west as Washington, south to California and east to New Mexico.

Nations: US
States/Provinces: AZ:S2, CA:S3, CO:S4, ID:S3, MT:S4, NE:S2, NM?, NV, OR:S4, SD, UT:S3?, WA?, WY:S3
TNC Ecoregions: 4:C, 5:C, 6:C, 7:C, 8:C, 9:C, 10:C, 11:C, 12:C, 18:C, 19:C, 20:C, 21:C, 25:C, 26:C, 27:C, 33:P
USFS Ecoregions (1994/95): 313A:CC, 331A:CC, 331D:CC, 331E:CC, 331F:CC, 331G:CC, 332C:CP, 341D:CC, 342A:CC, 342B:CC, 342C:CC, 342D:CC, 342E:CC, 342F:CC, 342G:CC, 342H:CC, 342I:CC, M242C:CC, M261A:CC, M261D:CC, M261E:CC, M261G:CC, M313A:CC, M331A:C?, M331B:CC, M331D:CC, M331F:CC, M331H:CC, M332A:CC, M332B:CC, M332C:CC, M332D:CC, M332E:CC, M332F:CC, M332G:CC, M333B:CC, M333C:CC, M333D:CC, M334A:CC, M341A:CC, M341B:CC, M341C:CC
Federal Lands: NPS (Florissant Fossil Beds, Fort Laramie, Fossil Butte, Glen Canyon, Grand Teton, Great Basin, Great Sand Dunes, Yosemite, Zion); USFS (Black Hills, Malheur NF, Ochoco, Umatilla, Wallowa-Whitman, Winema); USFWS (Lacreek, Malheur NWR, Minidoka)

Element Sources

Global Description Author(s): J. Drake, D. Faber-Langendoen and K.A. Schulz
References: BHCI 1999, Baker 1982b, Beguin and Major 1975, Bourgeron and Engelking 1994, Butler et al. 2002, CNHP 2003, CNHP 2015, Caicco et al. 1995, Carsey et al. 2003a, Christy 2004, Christy 2013, Christy and Cornelius 1980, Clary and Webster 1989, Cogan et al. 2004, Cogan et al. 2005, Cooper and Cottrell 1990, Crowe and Clausnitzer 1997, Crowe et al. 2004, Driscoll et al. 1984, Durkin et al. 1994b, Durkin et al. 1995a, Evans 1989b, Friesen et al. 2010, Froiland 1962, Girard 1991, Girard et al. 1997, Griffiths 1902, Hall 1973, Hall and Hansen 1997, Hansen et al. 1988b, Hansen et al. 1991, Hansen et al. 1995, IDCDC 2005, Jankovsky-Jones et al. 1999, Jankovsky-Jones et al. 2001, Johnston 1987, Jones 1992b, Jones and Walford 1995, Kagan et al. 2004a, Keeler-Wolf et al. 2003a, Keeler-Wolf et al. 2012, Kierstead and Pogson 1976, Kittel et al. 1994, Kittel et al. 1996, Kittel et al. 1999a, Kittel et al. 1999b, Kovalchik 1987, MTNHP 2002b, Manning and Padgett 1991, Manning and Padgett 1995, Marriott and Faber-Langendoen 2000, Marriott et al. 1999, McCain and Christy 2005, Mutz and Queiroz 1983, Owns et al. 2004, Padgett et al. 1988b, Padgett et al. 1989, RMS 1998, Ratliff 1982, Reid and Pickford 1946, Rolfsmeier and Steinauer 2010, Salas et al. 2010b, Sawyer et al. 2009, Schulz and Hall 2011, Steinauer and Rolfsmeier 2000, Steinauer and Rolfsmeier 2003, TNC 1998e, Western Ecology Working Group n.d.*, Youngblood et al. 1985a, Youngblood et al. 1985b

G527. Western Montane-Subalpine Riparian & Seep Shrubland

Group Summary Description: These are montane to subalpine riparian shrublands occurring as narrow bands or broad shrublands and are found throughout the Rocky Mountain cordillera from New Mexico north into Montana and northwestern Alberta. They also occur in mountainous areas of the interior Intermountain West and on the Colorado Plateau. This group often occurs as part of a mosaic of multiple communities that are shrub- and herb-dominated and includes above-treeline, willow-dominated, snowmelt-fed basins that feed into streams. Shrubs range from short to tall (0.5-15 m). The shrub species that can be dominant reflect the large elevational gradient of this group and include *Alnus incana, Alnus oblongifolia, Alnus viridis, Betula occidentalis, Betula glandulosa, Betula occidentalis, Cornus sericea, Salix bebbiana, Salix boothii, Salix brachycarpa, Salix drummondiana,*

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Salix eriocephala, Salix geyeriana, Salix monticola, Salix planifolia, and *Salix wolfii*. Generally the upland vegetation surrounding these wet shrublands is either conifer or aspen forest. Stands occur on streambanks, stream benches and alluvial terraces in steep narrow to wide, low-gradient valley bottoms and floodplains with sinuous stream channels, as well as steep moist avalanche chutes. This group is generally found at higher elevations, but can be found anywhere from 1500-3475 m, and may occur at even lower elevations in the Canadian Rockies. Occurrences can also be found around seeps, fens, and isolated springs on hillslopes away from valley bottoms. Many of the plant associations found within this group are associated with beaver activity.

A3772 Betula occidentalis Wet Shrubland Alliance

Alliance Summary Description: In this alliance, *Betula occidentalis* forms a dense, closed canopy with cover up to 95%. The shrub layer may also include *Alnus incana, Artemisia tridentata ssp. vaseyana, Cornus sericea, Crataegus douglasii, Dasiphora fruticosa ssp. floribunda (= Pentaphylloides floribunda), Juniperus horizontalis, Purshia tridentata, Purshia tridentata, Rosa woodsii,* and *Salix* spp. Due to the dense shrub canopy, herbaceous undergrowth is usually limited. Forb species include *Aquilegia formosa, Maianthemum stellatum (= Smilacina stellata),* and *Urtica dioica*. Graminoid cover is usually low and is typically composed of introduced hay grasses. This riparian shrubland alliance occurs in the Rocky Mountains, intermountain ranges of Nevada and Sierra Nevada of California on moderately wide stream benches and floodplains. It may also occur on hillside seeps in the mountains and foothills. Sites are relatively flat (1-5% slope) stream benches and often extend away from the channel edge. The substrate is usually exposed, but surface water can be present for variable periods without detectable seasonal periodicity. Inundation is not predictable to a given season and is dependent upon highly localized rainstorms (e.g., summer thunderstorms in eastern Oregon and Idaho). Soils are derived from alluvium and are fairly shallow, ranging from 30 cm to greater than 60 cm. Substrates are typically alluvial and range from fairly shallow, finer-textured soils to gravel and boulders. Soils usually have signs of saturation (mottles).

[CEPP009680] *Betula occidentalis* Desert Spring Shrubland

Translated Name: Water Birch Desert Spring Shrubland

Common Name:

USNVC Classification

Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (2.C.4.Nb)

Macrogroup: Western North American Montane-Subalpine-Boreal Marsh, Wet Meadow & Shrubland (M075)

Group: Western Montane-Subalpine Riparian & Seep Shrubland (G527)

Alliance: *Betula occidentalis* Wet Shrubland Alliance (A3772)

Element Concept

Global Summary: This spring-fed wet shrubland is dominated by *Betula occidentalis,* in relictual refugia found in desert springs. It is known from the southern Colorado Plateau of southern Utah and northern Arizona. Other shrubs present include *Amelanchier utahensis, Garrya flavescens, Quercus*

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gambelii, Cornus sericea, Rosa woodsii, Frangula betulifolia (= Rhamnus betulifolia), Fraxinus anomala, Salix exigua, and *Rhus trilobata*. Herbaceous cover can be sparse to abundant. Common species include spring indicators such as *Adiantum capillus-veneris, Calamagrostis scopulorum, Epipactis gigantea, Platanthera zothecina (= Habenaria zothecina),* and *Aquilegia micrantha*. Other herbaceous species typical of wetland and riparian areas but not necessarily springs include *Maianthemum stellatum (= Smilacina stellata), Elymus elymoides,* and *Equisetum arvense*. It occurs on springs on slopes and in alcoves on sandstone, or shale substrates. Aspects are north or, if south, then in heavily shaded canyon locations. Elevation ranges from 1130 to 2022 m (3707-6690 feet).

Environmental Description

Vegetation Description

Most Abundant Species

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Betula occidentalis*

Characteristic Species

Global: Betula occidentalis

Other Noteworthy Species

Global: Vulnerable Plants: *Platanthera zothecina* (G2G3)

Conservation Status Rank

Global Rank & Reasons: GNR (11-Sep-2012).

Related Concepts

Global Similar Types:

- *Betula occidentalis / Cornus sericea* Wet Shrubland (CEGL001161)

Classification

Status: Provisional

Classification Confidence:

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. It is documented from 4 plots: 3 from Glen Canyon (GLCA.9300, John Spence's Spring data: spring S80 plot GLCA0397and spring S136 plot ERS01), and one from Grand Canyon (GRCA.01623). This shrubland is similar to *Betula occidentalis / Cornus sericea* Wet Shrubland (CEGL001161), but has less consistent coverage of *Cornus*, and includes warm desert indicators. This shrubland appears to represent the southern extent of the range, and may be found south of these documented locations.

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Subset: GLCA; Glen Canyon National Recreation Area

Element Distribution

Global Range: This spring-fed shrubland is known from the southern Colorado Plateau of southern Utah and northern Arizona and from Grand Canyon. This shrubland appears to represent the southern extent of the range of *Betula occidentalis*, and may be found south of these documented locations.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions:
Federal Lands: NPS (Glen Canyon, Grand Canyon)

Element Sources

Global Description Author(s): G. Kittel
References: Western Ecology Working Group n.d.*

M301. Western North American Ruderal Marsh, Wet Meadow & Shrubland

G524. Western North American Ruderal Marsh, Wet Meadow & Shrubland

Group Summary Description: This group contains disturbed wet meadows found in lowland, montane and subalpine elevations, occasionally reaching into the lower edges of the alpine elevations (sea level to 3600 m) throughout the western U.S. and Canada. Vegetation is dominated by non-native species such as *Agrostis gigantea, Agrostis stolonifera, Alopecurus pratensis, Conyza canadensis, Cirsium arvense, Sonchus* spp., *Lactuca serriola, Phalaris arundinacea, Phragmites australis, Poa palustris*, and *Poa pratensis*. Native species may be present but are so low in abundance that the original native plant association is impossible to determine. These can be wet meadows, wet emergent marshes, coastal backwater dunes, sloughs, open wet depressions, basins and flats with low-velocity surface and subsurface flows. They can be large meadows in montane or subalpine valleys, or occur as narrow strips bordering ponds, lakes, and streams, and along toeslope seeps. They are typically found on flat areas or gentle slopes, but may also occur on subirrigated sites with slopes up to 10%. Sites are usually seasonally wet, often drying by late summer, and many occur in a tension zone between perennial wetlands and uplands, where water tables fluctuate in response to long-term climatic cycles. They may have surface water for part of the year, but depths rarely exceed a few centimeters. Soils are mostly mineral and show typical hydric soil characteristics such as low chroma and redoximorphic features; some areas may have high organic content as inclusions or pockets. Due to disturbance, soils may be compacted.

A3846 Phalaris arundinacea Western Ruderal Marsh Alliance

Alliance Summary Description: This herbaceous alliance covers stands dominated by *Phalaris arundinacea*, which tends to occur in monocultures. Stands are found along riparian areas, pond and lake margins, wet meadows, and intermittent drainages, and is known from throughout the western U.S.

[CEGL001474] *Phalaris arundinacea* Western Marsh

Translated Name: Reed Canarygrass Western Marsh
Common Name: Western Reed Canarygrass Marsh

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USNVC Classification

Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (2.C.4.Nb)
Macrogroup: Western North American Ruderal Marsh, Wet Meadow & Shrubland (M301)
Group: Western North American Ruderal Marsh, Wet Meadow & Shrubland (G524)
Alliance: *Phalaris arundinacea* Western Ruderal Marsh Alliance (A3846)

Element Concept

Global Summary: This herbaceous association is reported from throughout Washington, Colorado, Nebraska, Montana, Idaho, and into northeastern Utah, but is likely more widespread in the western United States. It also occurs in Canada , in the southern two-thirds of British Columbia in areas with warm and relatively dry summers and in Alberta, from the Great Plains north into the Boreal Plains. Its distribution as a natural type is complicated because this native species is widely cultivated as a forage crop and has escaped and established in wetlands and riparian areas, displacing the local flora. Elevations range from near sea level to 2307 m. Stands are found along riparian areas, pond and lake margins, wet meadows, and intermittent drainages. The poorly drained alluvial soils are commonly fine-textured (occasionally coarse-textured) and may be flooded for brief to extended periods. The vegetation is characterized by a dense, tall herbaceous layer (often >80% canopy cover and 1.5-2 m tall) that is dominated by *Phalaris arundinacea,* which tends to occur in monocultures. Associated species may include *Equisetum arvense, Muhlenbergia asperifolia, Mentha arvensis, Schoenoplectus acutus (= Scirpus acutus),* and many other species in trace amounts where disturbed. Introduced species such as *Agrostis gigantea, Bromus inermis, Bromus tectorum, Cirsium arvense, Elymus repens, Euphorbia esula, Hordeum brachyantherum, Lepidium latifolium, Melilotus officinalis, Phleum pratense, Poa pratensis,* and *Sonchus oleraceus* are common in some disturbed stands.

Environmental Description

Global Environment: This association is reported from throughout Washington, Colorado, Nebraska, Montana, Idaho, and northeastern Utah, but is likely more widespread in the western United States. It also occurs in Alberta, Canada. Elevations range from near sea level to 2307 m (7564 feet). Stands are found along riparian areas, pond and lake margins, wet meadows, and intermittent drainages. Sites are flat to rolling. The poorly drained soils are derived from alluvium and are commonly fine-textured but can also be coarser in texture. Subsoil is often mottled and gleyed (Crawford 2001). Sites are generally flooded from brief to extended periods, and soils remain saturated throughout the growing season.

Vegetation Description

Global Vegetation: This association is characterized by a dense, tall herbaceous layer (often >90% canopy cover and 1.5-2 m tall) that is dominated by *Phalaris arundinacea,* which tends to occur in monocultures. Associated species such as *Equisetum arvense, Muhlenbergia asperifolia, Mentha arvensis, Schoenoplectus acutus (= Scirpus acutus), Polygonum amphibium, Solidago canadensis, Urtica dioica,* and many other species may be present in trace amounts especially where disturbed. Occasional *Populus tremuloides, Salix exigua, Rubus idaeus,* or *Symphoricarpos albus* may be present is some stands. Introduced species such as *Agrostis gigantea, Bromus inermis, Bromus tectorum, Cirsium arvense, Elymus repens, Euphorbia esula, Hordeum brachyantherum, Lepidium latifolium,*

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Melilotus officinalis, Phleum pratense, Poa pratensis, and *Sonchus oleraceus* are common in some disturbed stands.

Global Dynamics: *Phalaris arundinacea* produces abundant herbage and is planted for livestock forage. It is tolerant of moderate grazing by livestock, although heavy grazing will reduce density (Hansen et al. 1995). *Phalaris arundinacea* is a threat to riparian and wetland areas because it spreads rapidly from rhizomes, dominating sites, and is extremely difficult to remove once established (Hansen et al. 1995). Fire has been used with limited success to control the spread of *Phalaris arundinacea*, but the high water table where it grows makes it difficult to burn during the growing season (Hansen et al. 1995). Van Loh (2000) found stands growing on selenium-rich sites. It is not known if selenium is translocated into the plant tissue.

Most Abundant Species

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Phalaris arundinacea*

Characteristic Species

Global: Phalaris arundinacea

Other Noteworthy Species

Global: Invasive/Exotic Plants: *Agrostis gigantea* (Medium/Low), *Bromus inermis* (High/Medium), *Bromus tectorum* (High), *Cirsium arvense* (High/Medium), *Elymus repens* (High/Medium), *Euphorbia esula* (High/Medium), *Lepidium latifolium* (High), *Melilotus officinalis* (Medium/Low), *Phleum pratense* (Medium), *Poa pratensis* (Medium), *Sonchus oleraceus*

Conservation Status Rank

Global Rank & Reasons: G5 (3-Mar-1999).

Related Concepts

Global Similar Types:

- *Calamagrostis canadensis* - *Carex* spp. Laurentian & Northeast Wet Meadow (CEGL005448)
- *Calamagrostis canadensis* North-Central Wet Meadow (CEGL005449)
- *Phalaris arundinacea* Eastern Ruderal Marsh (CEGL006044)

Global Related Concepts:

- *Phalaris arundinacea* (Bourgeron and Engelking 1994) =
- *Phalaris arundinacea* Association (Crawford 2001) =
- *Phalaris arundinacea* Habitat Type (Hansen et al. 1995) =
- *Phalaris arundinacea* Habitat Type (Hall and Hansen 1997) =
- *Phalaris arundinacea* Western Herbaceous Provisional Stand Type (Buck-Diaz et al. 2012) =
- *Phalaris arundinacea* Western Herbaceous Vegetation (Carsey et al. 2003a) =
- *Phalaris arundinacea* association (Crawford 2003) =
- DRISCOLL FORMATION CODE:V.A.4.a. (Driscoll et al. 1984) >
- Reed Canarygrass Marsh Site Association (MacKenzie and Moran 2004) **?**

- Reed Canarygrass Monotype CT (Muldavin et al. 2000a) =

Classification

Status: Standard
Classification Confidence: 1 - Strong
Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Global Classification Comments: Other natural associations included in this alliance are found throughout the northeastern United States, but this western association's distribution as a natural type is not clear because of extensive planting as a forage crop (Hansen et al. 1995, Hall and Hansen 1997). The species is native and widespread in Alberta, although some introduced genotypes may be present. Further work is required to resolve the natural versus introduced nature of this type in western North America.

Element Distribution

Global Range: This association is reported from Colorado, Nebraska, Montana, Idaho, Washington and northeastern Utah and is likely more widespread in the western United States. It has been documented to occur in British Columbia and Alberta, Canada, and is likely widespread elsewhere in southern parts of Canadian provinces. Its distribution as a natural type is complicated because this native species is widely cultivated as a forage crop and has escaped and established in many wetlands and riparian areas.

Nations: CA, US
States/Provinces: AB, CA, CO, ID:S4?, MT:S4, ND, NM:S4?, OR:S5, UT, WA, WY
TNC Ecoregions: 6:C, 7:C, 8:C, 10:C, 19:C, 20:C, 21:?, 26:C, 68:C
USFS Ecoregions (1994/95): 313B:C?, 313E:C?, 331D:CC, 331G:CC, 331J:C?, 341C:CC, 342I:CC, M331G:CC, M332D:CC, M333A:CC, M333B:CC, M333C:CC, M333D:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Curecanti, Florissant Fossil Beds, Fort Union Trading Post, Glacier, Glen Canyon, Lake Roosevelt); USFWS (Malheur NWR, Ouray)

Element Sources

Global Description Author(s): K.A. Schulz, L. Allen and G. Kittel
References: ANHIC n.d., Bourgeron and Engelking 1994, Buck-Diaz et al. 2012, Carsey et al. 2003a, Christy 2013, Coles et al. 2010, Cooper et al. 1995, Crawford 2001, Crawford 2003, Driscoll et al. 1984, Erixson et al. 2011b, Hall and Hansen 1997, Hansen et al. 1995, Hop et al. 2007, IDCDC 2005, MTNHP 2002b, MacKenzie and Moran 2004, Muldavin et al. 2000a, Owns et al. 2004, Reid et al. 2004, Salas and Pucherelli 2002a, Tendick et al. 2010, Thompson and Hansen 2002, Von Loh 2000, Von Loh et al. 2002, WNDD unpubl. data, Western Ecology Working Group n.d.*, Willoughby et al. 2004

A3847 Phragmites australis - Arundo donax - Alopecurus pratensis Ruderal Marsh Alliance

Alliance Summary Description: This common reed-dominated marsh alliance is found across the west-temperate regions of the United States and Canada. *Phragmites australis* will often invade into

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existing natural or semi-natural communities present on the site, and once established, this alliance is usually strongly dominated with few or no other vascular plants present. Stands occur in semipermanently flooded marshes, ditches, impoundments, etc. that have often been disturbed by human activity.

[CEGL001475] *Phragmites australis* Western Ruderal Wet Meadow

Translated Name: Common Reed Western Ruderal Wet Meadow

Common Name: Western Ruderal Reed Marsh

USNVC Classification

Division: Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland (2.C.4.Nb)

Macrogroup: Western North American Ruderal Marsh, Wet Meadow & Shrubland (M301)

Group: Western North American Ruderal Marsh, Wet Meadow & Shrubland (G524)

Alliance: *Phragmites australis - Arundo donax - Alopecurus pratensis* Ruderal Marsh Alliance (A3847)

Element Concept

Global Summary: This reed marsh type is found across the west-temperate regions of the United States and Canada. Stands occur in semipermanently flooded marshes, ditches, impoundments, etc. that have often been disturbed by human activity. The vegetation is often variable, as *Phragmites australis* will often invade into existing natural or semi-natural communities present on the site. Once firmly established, this community is usually strongly dominated by *Phragmites australis*, with few or no other vascular plants present. In Colorado, this reed marsh often occurs in small wet patches in seeps and backwater areas of large floodplains, around the fringes of irrigation ponds, ditches, and along railroad embankments that have poor drainage. Stands have a dense, 1- to 1.5-m tall herbaceous layer dominated by the perennial graminoid *Phragmites australis.* Minor cover of associates such as *Agrostis stolonifera, Carex* spp., *Conyza canadensis, Glycyrrhiza lepidota, Iva axillaris, Mentha arvensis, Solidago canadensis, Schoenoplectus acutus (= Scirpus acutus)*, and *Typha latifolia* may be present.

Environmental Description

Global Environment: This association is widespread in the western U.S. and Canada. Elevation ranges from 640-1980 m. Stands occur in temporarily to semipermanently flooded marshes, ditches, impoundments, pond and lake margins, swales, and wet meadows that often have been disturbed by human activity. Sites are usually saturated or flooded during the growing season, but the soil surface may dry out in late summer. Soils are often fine-textured silts and clays. In Colorado and Utah, this reed marsh often occurs in small wet patches in seeps and backwater areas of large floodplains in springs emerging from canyon walls, around the fringes of irrigation ponds, ditches, and along railroad embankments that have poor drainage.

Vegetation Description

Global Vegetation: The vegetation is often variable as *Phragmites australis* will often invade into existing natural or semi-natural communities present on the site. Once firmly established, this

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community is usually strongly dominated by *Phragmites australis* with few or no other vascular plants present. Stands have a dense, 1- to 3-m tall herbaceous layer dominated by the perennial graminoid *Phragmites australis* usually with at least 50% absolute cover. Associated graminoids include *Agrostis stolonifera, Carex* spp., (such as *Carex curatorum*), *Typha latifolia, Juncus balticus, Agrostis gigantea, Elymus canadensis, Equisetum* spp., *Hordeum jubatum, Muhlenbergia asperifolia, Schoenoplectus acutus (= Scirpus acutus),* and *Sporobolus contractus*. Forbs are diverse and provide low cover; those commonly present include *Ambrosia acanthicarpa, Conyza canadensis, Glycyrrhiza lepidota, Eurybia glauca (= Aster glaucodes), Iva acerosa (= Oxytenia acerosa), Iva axillaris, Mentha arvensis, Dichanthelium acuminatum (= Panicum acuminatum), Solidago canadensis, Solidago velutina*, and *Taraxacum officinale*. Introduced species such as *Lepidium latifolium* and *Cirsium arvense* may be present and compete well against *Phragmites australis* in disturbed sites. Some woody species may be present in very low amount; *Clematis ligusticifolia, Parthenocissus vitacea,* and *Rhus trilobata* may be present as well.

Global Dynamics: *Phragmites australis* generally requires seasonal flooding in the spring with water table fluctuating from 0.6 m above to 0.6 m below the surface (Johnston 1987). This rhizomatous species can out compete all but the most aggressive weedy species. With heavy disturbance, however, introduced species such as *Cirsium arvense* or *Lepidium latifolium* may invade this plant association (Hansen et al. 1995, Von Loh 2000).

Most Abundant Species

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Phragmites australis*

Characteristic Species

Global: Phragmites australis

Other Noteworthy Species

Global: Vulnerable Plants: *Carex curatorum* (G3);

Invasive/Exotic Plants: *Agrostis gigantea* (Medium/Low), *Cirsium arvense* (High/Medium), *Lepidium latifolium* (High)

Conservation Status Rank

Global Rank & Reasons: GNA (ruderal) (18-Feb-2015).

Related Concepts

Global Similar Types:

- *Phragmites australis ssp. australis* Eastern Ruderal Marsh (CEGL004141)

Global Related Concepts:

- *Phragmites australis - Scirpus* spp. (Sawyer et al. 2009) **?**
- *Phragmites australis* (Sawyer et al. 2009) =

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- *Phragmites australis* (Bourgeron and Engelking 1994) =
- *Phragmites australis* (Kittel et al. 1999b) =
- *Phragmites australis* Habitat Type (Hall and Hansen 1997) =
- *Phragmites australis* Habitat Type (Hansen et al. 1995) =
- *Phragmites australis* Herbaceous Vegetation (Carsey et al. 2003a) =
- *Phragmites australis* Wetland (Baker 1984a) =
- *Phragmites communis / Carex lacustris* Plant Association (Johnston 1987) =
- Bulrush - Reed Grass Association (Pool 1914) >
- Common Reed Grass Organic Shallow Marsh Type (Lee et al. 1998) **?**
- DRISCOLL FORMATION CODE:V.A.4.a. (Driscoll et al. 1984) >
- Sandhills Freshwater Marsh (Steinauer and Rolfsmeier 2000) >

Classification

Status: Standard
Classification Confidence: 1 - Strong
Global Classification Comments: This vegetation has variable hydrology and is often treated as part of other marshes and meadows. The geographic distribution of the type is arbitrarily limited to Bailey's Dry and Humid Temperate Domain in western North America (Bailey 1997, 1998). Compare with *Phragmites australis ssp. australis* Eastern Ruderal Marsh (CEGL004141). The two types need to be better distinguished, both conceptually and nomenclaturally. Is this intended to accommodate vegetation dominated by native *Phragmites australis ssp. americanus* or introduced *Phragmites australis ssp. australis*, or either?

Element Distribution

Global Range: This reed marsh type is found across the temperate regions of the western United States and Canada, ranging from western North Dakota and Saskatchewan to Oregon, south to California, Utah, Arizona, and Texas. Its distribution is somewhat incomplete as not all states have listed semi-natural types in their state.

Nations: CA, US
States/Provinces: AZ, CA:S3, CO:S5, ID, MB:S3?, MT:S2, ND, NE:S4, NM, NV, OK, ON:S4, OR:S1, SD, SK, TX, UT, WY:S2S3
TNC Ecoregions: 6:C, 7:C, 8:C, 9:C, 10:C, 11:C, 17:C, 19:C, 20:C, 26:C, 27:C, 28:C, 32:P, 33:P, 35:C, 47:P, 48:C
USFS Ecoregions (1994/95): 212Ja:PPP, 251Aa:CCC, 313A:CC, 315B:CC, 322A:CC, 331C:CC, 331D:CC, 331G:CC, 331I:CC, 341A:CC, 341B:CC, 341C:CC, 341E:CC, 342B:CC, 342C:CC, 342D:CC, 342E:CC, 342F:CC, 342G:CC, 342I:C?, M331D:CC, M331E:CC, M331F:CC, M331H:CC, M332A:CC, M332D:CC, M332E:CC, M332F:CC, M333B:CC, M333D:CC, M341A:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Dinosaur, Glen Canyon, Grand Canyon, Great Sand Dunes, Lake Meredith); USFWS (Lacreek, Minidoka, Ouray)

Element Sources

Global Description Author(s): D. Faber-Langendoen, K. Schulz and J. Coles
References: Bailey 1997, Bailey 1998, Baker 1982a, Baker 1984a, Bourgeron and Engelking 1994, Butler et al. 2002, CNHP 2003, CNHP 2015, Carsey et al. 2003a, Clark et al. 2009, Coles et al. 2008a,

Driscoll et al. 1984, Greenall 1996, Hall and Hansen 1997, Hansen et al. 1991, Hansen et al. 1995, Hoagland 1998c, Hoagland 2000, IDCDC 2005, Johnston 1987, Kagan et al. 2004a, Kittel et al. 1995, Kittel et al. 1999b, Lee et al. 1998, MTNHP 2002b, NDNHI unpubl. data, NHNM unpubl. data, Pool 1914, Reid and Hall 2010, Rolfsmeier and Steinauer 2010, Romme et al. 1993, Salas et al. 2010b, Sawyer et al. 2009, Steinauer and Rolfsmeier 2000, TNHS unpubl. data, Von Loh 2000, Von Loh et al. 2002, WNDD unpubl. data, Western Ecology Working Group n.d.*

2.C.4.Nc. Southwestern North American Warm Desert Freshwater Marsh & Bosque

M076. Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland

G545. Colorado Plateau Hanging Garden Seep

Group Summary Description: This group consists of the herbaceous vegetation found in "hanging gardens" in the Colorado Plateau region that are surrounded by an arid environment associated with canyon country. These highly localized environments occur in canyonlands with perennial water sources (seeps) forming pocketed wetlands and draping vegetation across wet cliff faces. Three main garden types exist: alcove, terrace, or windowblind. Each is determined by the nature of the geological formation and the presence or absence of joint systems. They tend to occur at all exposures of the canyon walls, but they are always shaded for much to most of each day. Temperature and humidity are relatively stable compared to the surrounding environment. Most hanging gardens are dominated by herbaceous plants, and a number of these are endemic to this region. Common species include *Adiantum capillus-veneris, Adiantum aleuticum, Cirsium rydbergii, Mimulus eastwoodiae, Mimulus guttatus, Sullivantia hapemanii*, and several species of *Aquilegia*, including *Aquilegia micrantha*. Larger alcoves may have shrubby species as well, such as *Frangula betulifolia (= Rhamnus betulifolia), Quercus gambelii*, and even *Pseudotsuga menziesii* in some north-facing alcoves.

A2506 Aquilegia micrantha Hanging Garden Alliance

Alliance Summary Description: This alliance consists of forb-dominated, spring-fed wetlands dominated by a number of species such as *Mimulus eastwoodiae, Asplenium adiantum-nigrum*, and *Aquilegia micrantha*, which specialize in clinging to near-vertical rock surfaces at the crevice where groundwater emerges. Other species, such as *Calamagrostis scopulorum, Cirsium calcareum*, and *Platanthera zothecina*, are found mostly growing in the saturated sandy debris on the floor of the alcove and on the slope below. Hanging gardens are unique herbaceous wetland communities associated with groundwater springs emerging from sandstone cliffs in the Colorado Plateau. These springs, if they persist over long periods of time, will gradually erode shallow caves into the cliff face that shelter a diverse herbaceous community. Hanging gardens are distinct from riparian and slickrock pothole wetlands in that woody species are generally restricted to the margins of the community.

[CEPP005701] *Adiantum capillus-veneris* - Mixed Forb Hanging Garden

Translated Name: Common Maidenhair - Mixed Forb Hanging Garden

Common Name:

USNVC Classification

Division: Southwestern North American Warm Desert Freshwater Marsh & Bosque (2.C.4.Nc)

Macrogroup: Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland (M076)

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Group: Colorado Plateau Hanging Garden Seep (G545)
Alliance: *Aquilegia micrantha* Hanging Garden Alliance (A2506)

Element Concept

Global Summary: These are herbaceous wet seeps dominated by the fern *Adiantum capillus-veneris*, usually with a few other forbs such as *Mimulus eastwoodiae, Primula specuicola,* and *Aquilegia micrantha*. Graminoids may also be present and include *Carex aurea, Carex curatorum,* and/or *Calamagrostis scopulorum*. This association occurs as an obligate wetland that clings to wet cliffs, spray zones of waterfalls and streambanks found in "hanging garden" alcoves and along "gushettes" of sandstone cliffs in the southwestern U.S. They are spectacular lush wetlands, if small in area, and form a striking contrast in the dry desert environment.

Environmental Description

Global Environment: The vegetation occurs in "hanging gardens," which are spring-fed wetlands of cliff faces. The source of water is above the vegetation, emerging along geologic contacts that seep, drip, or pour onto underlying walls. Elevation ranges between 1130 and 1525 m. They are found primarily within alcoves in cliff faces, but also occur on cliff faces themselves. Within the alcove environment, stands can occur on the wet backwall of the alcove, along the stream channel on the alcove floor, on debris slopes and on small terraces that build up inside the alcove. Spring flow ranges in constancy and amount; some dry up by mid-summer, while others flow all year. This association is found on all aspects. The geomorphology within alcoves can be complex with several different microhabitats which generally support different adjacent vegetative communities (backwall, detritus slope, colluvial slope, stream/riparian, and madicolous (thin film of water over rock surface) as well as waterfall spray zone). The geology of the hanging garden occurs at the interface of the Navajo and Kayenta formations, within the Cedar Mesa sandstone, Navajo sandstone, and Wingate sandstone which all have structural cross-bedding that allows for the formation of deep and high alcoves.

Some of the cliff-face spring locations are not "hanging gardens" but are classified as "gushettes," which are a more discrete source of flow that more-or-less gushes from a cliff wall of a perched, unconfined aquifer. They typically discharge along fractures that support habitats of thin sheets of water flowing over rock faces ("madicolous"). This occurs within the Kayenta Formation. These gardens range from over 1.4 km from a riparian area to directly adjacent. Flow of the spring ranges from very slow, often drying by mid-June, to a permanent and steady flow.

Vegetation Description

Global Vegetation: These are herbaceous patches of vegetation dominated consistently by the fern *Adiantum capillus-veneris,* ranging in canopy cover from 0.5 to 70% with an average of 27%. Additional and often abundant forbs include (in order of diminishing consistency) *Mimulus eastwoodiae, Primula specuicola, Aquilegia micrantha, Cirsium rydbergii, Epipactis gigantea, Lobelia cardinalis,* and *Solidago velutina* whose cover ranges, when present, from 0.1 to 30%, with averages of about 1-7%. Graminoids present include (also in order of diminishing consistency) *Carex aurea, Calamagrostis scopulorum,* and *Carex curatorum,* with cover ranging from 0.1 to 30% with

averages of 1-8%. Occasional shrubs are nearby; *Frangula betulifolia (= Rhamnus betulifolia)* and *Petrophyton caespitosum* were recorded in 30% of the plots.

Global Dynamics: The hydrogeologic processes that form hanging gardens also influence the geomorphologic processes that shape the rock walls or canyons from which they emerge. Alcoves do have dynamics with freeze-thaw events that can cause ceiling rockfall, ice build-up can cause flooding, higher spring flows may cause flooding, extreme cold temperatures can cause freezing and consequently lifting of vegetation off of wet cliff faces.

Most Abundant Species

Characteristic Species

Global:

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (22-Aug-2016).

Related Concepts

Global Similar Types:

- *Cirsium rydbergii - Carex curatorum - Calamagrostis scopulorum* Hanging Garden (CEPP005703)
- *Mimulus eastwoodiae - Primula specuicola* Hanging Garden (CEPP005702) lacks the dominance of *Adiantum capillus-veneris.*

Classification

Status: Provisional
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau, and classification and data from John Spence, Ph.D., Chief Scientist and Terrestrial Natural Resources Branch Chief, Science & Resource Management, Glen Canyon National Recreation Area.

Element Distribution

Global Range: These small-patch wetlands occur in northern Arizona and southern Utah.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:C?
Federal Lands: NPS (Glen Canyon)

Element Sources

Global Description Author(s): G. Kittel
References: Spence 2008*, Western Ecology Working Group n.d.

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Subset: GLCA; Glen Canyon National Recreation Area

[CEGL002592] Aquilegia micrantha - Calamagrostis scopulorum Hanging Garden

Translated Name: Mancos Columbine - Ditch Reedgrass Hanging Garden

Common Name:

USNVC Classification

Division: Southwestern North American Warm Desert Freshwater Marsh & Bosque (2.C.4.Nc)

Macrogroup: Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland (M076)

Group: Colorado Plateau Hanging Garden Seep (G545)

Alliance: *Aquilegia micrantha* Hanging Garden Alliance (A2506)

Element Concept

Global Summary: This association is confined to seeps emerging from sandstone cliffs in the Colorado Plateau and lower elevation canyons in adjacent southern Rocky Mountains where it may occur on metamorphic substrates. Elevations are below 2000 m. Aspect is not important in determining the distribution of this association. Instead, seeps will tend to occur on the side of the canyon where gravity and hydrology combine to force groundwater out. The unvegetated surface often has high cover of bare soil, sometimes coated with a white calcareous crust or bedrock. For the most part, soils are derived from dissolution of sandstone grains and fragments from adjacent slopes and ledges and are saturated year-round from water seeping between sedimentary rock layers. In the case of a stand in the Black Canyon of the Gunnison, a north-facing alcove with a seep and overhanging ledge is cut into Black Canyon schist and gneiss. Total vegetation cover ranges from 20 to 75% and is characterized by clumps of *Calamagrostis scopulorum* and *Aquilegia micrantha*. In drier gardens, *Schizachyrium scoparium* may be dominant. Other herbaceous species occurring frequently in this association include *Zigadenus vaginatus, Epipactis gigantea, Platanthera zothecina, Cirsium ownbeyi, Petrophyton caespitosum, Dodecatheon pulchellum, Clematis ligusticifolia, Solidago nana, Pellaea glabella, Zigadenus elegans*, and *Solidago velutina*. There is no developed shrub or tree layer, but most occurrences include scattered woody plants such as *Pinus edulis, Amelanchier utahensis, Prunus virginiana, Paxistima myrsinites, Cercocarpus intricatus, Glossopetalon spinescens var. meionandrum, Betula occidentalis, Brickellia* sp., *Ericameria* sp., *Symphoricarpos rotundifolius, Holodiscus dumosus*, and *Rhus trilobata*.

Environmental Description

Global Environment: This hanging garden association occurs on ledges and in crevices and alcoves in near-vertical sandstone canyon walls in southeastern Utah and northwestern Colorado and in Black Canyon on the Gunnison metamorphic substrate in west-central Colorado. Elevations are below 2000 m. Sandy soils that accumulate in the cliff crevices or at the bases of canyon alcoves are saturated year-round from water seeping between sedimentary rock layers or in the case of Black Canyon, a north-facing alcove with a seep and overhanging ledge is cut into Black Canyon schist and gneiss. Aspect is not important in determining the distribution of this association. Instead, seeps will tend to occur on the side of the canyon where gravity and hydrology combine to force water out. The unvegetated surface often has high cover of bare soil, sometimes coated with a white calcareous crust or bedrock. For the most part, soils are derived from dissolution of sandstone grains and fragments from adjacent slopes and ledges.

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Vegetation Description

Global Vegetation: This association is confined to seeps emerging from sandstone cliffs in the Colorado Plateau. Total vegetation cover ranges from 20 to 75% and is characterized by clumps of *Calamagrostis scopulorum* and *Aquilegia micrantha*. In drier gardens, *Schizachyrium scoparium* may be dominant. Forbs often present include *Adiantum capillus-veneris, Zigadenus vaginatus (= Anticlea vaginata), Aquilegia micrantha, Castilleja linariifolia, Cirsium ownbeyi, Cirsium rydbergii, Dodecatheon pulchellum, Epipactis gigantea, Equisetum hyemale, Eurybia glauca, Hedeoma drummondii, Lobelia cardinalis, Mimulus eastwoodiae, Oenothera elata, Petrophyton caespitosum, Platanthera zothecina, Primula specuicola, Solidago nana, Solidago velutina, Zigadenus elegans,* and *Zigadenus vaginatus*. Some ferns have been reported from spring-fed locations, such as *Pellaea glabella*. Graminoids are also abundant, including *Andropogon glomeratus, Calamagrostis scopulorum, Carex aurea, Carex curatorum, Juncus ensifolius, Muhlenbergia andina, Muhlenbergia thurberi, Dichanthelium acuminatum (= Panicum acuminatum), Panicum virgatum, Phragmites australis, Schizachyrium scoparium,* and *Sorghastrum nutans*. Woody plants that may be present include *Clematis ligusticifolia, Mahonia repens, Petrophyton caespitosum, Pseudotsuga menziesii, Frangula betulifolia (= Rhamnus betulifolia),* and *Yucca angustissima var. toftiae (= Yucca toftiae).* There is no developed shrub or tree layer, but most occurrences include scattered woody plants such as *Pinus edulis, Amelanchier utahensis, Prunus virginiana, Paxistima myrsinites, Cercocarpus intricatus, Glossopetalon spinescens var. meionandrum, Betula occidentalis, Brickellia* sp., *Ericameria* sp., *Symphoricarpos rotundifolius, Holodiscus dumosus,* and *Rhus trilobata*.

Global Dynamics: The viability of this association is dependent on a steady supply of groundwater seepage throughout the growing season. Few examples observed had flowing water, but most had moist soil, and some had water dripping from the alcove roof.

Most Abundant Species

Global

Stratum	Lifeform	Species
Herb (field)	Flowering forb	*Aquilegia micrantha*
Herb (field)	Graminoid	*Calamagrostis scopulorum*

Characteristic Species

Global: Aquilegia micrantha, Calamagrostis scopulorum, Cirsium ownbeyi, Epipactis gigantea, Platanthera zothecina, Zigadenus vaginatus

Other Noteworthy Species

Global: Vulnerable Plants: *Carex curatorum* (G3, endemic to hanging gardens), *Cirsium ownbeyi* (G3, endemic to hanging gardens), *Cirsium rydbergii* (G3), *Platanthera zothecina* (G2G3), *Sullivantia hapemanii* var. *purpusii* (G3T3), *Zigadenus vaginatus* (G2)

Conservation Status Rank

Global Rank & Reasons: GNR (7-Apr-2005).

Related Concepts

Global Similar Types:

- *Aquilegia micrantha - Mimulus eastwoodiae* Hanging Garden (CEGL002729)
- *Aquilegia micrantha* Hanging Garden (CEGL002762)

Global Related Concepts:

- Foot-Wall (Welsh and Toft 1981) =

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is part of a complex of herbaceous communities collectively known as "hanging gardens." Few systematic studies of these communities have been completed (e.g., Welsh and Toft 1981, Welsh 1989, Fowler 1995), and even fewer quantitative data are available, partly because stands can be difficult or dangerous to access. The National Park Service is undertaking systematic surveys of vegetation, particularly spring and seep communities, throughout the Colorado Plateau (Evenden pers. comm. 2005). As more data become available, the various hanging garden associations should be revisited. John Spence, botanist at Glen Canyon National Recreation Area, is reported to be in the process of publishing a comprehensive study and classification of hanging gardens in the Colorado Plateau (J. Spence pers. comm. 2005).

Element Distribution

Global Range: This association has been documented from the Colorado Plateau and Uinta Basin of western Colorado and eastern Utah. It may also occur at Zion National Park (Malanson 1980, 1982), although it was not documented there during a recent (2003) NPS vegetation mapping effort.

Nations: US
States/Provinces: CO, UT
TNC Ecoregions: 9:C, 19:C, 20:C
USFS Ecoregions (1994/95): 341B:CC, M331E:CC, M331G:CP
Federal Lands: NPS (Black Canyon of the Gunnison, Dinosaur, Glen Canyon, Natural Bridges)

Element Sources

Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2010, Evenden pers. comm., Fowler 1995, Malanson 1980, Malanson 1982, Spence pers. comm., Welsh 1989, Welsh and Toft 1981, Welsh and Toft 1981*, Western Ecology Working Group n.d.

[CEGL002729] Aquilegia micrantha - Mimulus eastwoodiae Hanging Garden
Translated Name: Mancos Columbine - Eastwood's Monkeyflower Hanging Garden
Common Name: Columbine - Eastwood's Monkeyflower Hanging Garden

USNVC Classification

Division: Southwestern North American Warm Desert Freshwater Marsh & Bosque (2.C.4.Nc)
Macrogroup: Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland (M076)

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Group: Colorado Plateau Hanging Garden Seep (G545)
Alliance: *Aquilegia micrantha* Hanging Garden Alliance (A2506)

Element Concept

Global Summary: These wetland communities are scattered throughout the canyons of the Colorado Plateau in Utah, northern Arizona and western Colorado, where groundwater emerges from cracks, crevices, alcoves and ledges in cliffs to create permanently moist seeps. The dominant species within the seep are generally forbs, ferns and graminoids; however, shrubs and trees sometimes form a margin sheltering the gardens. The forb component includes a number of rare and endemic species. Characteristic forbs of this association include *Adiantum capillus-veneris, Aquilegia micrantha,* and *Mimulus eastwoodiae*. Other forbs often present that can also be abundant include *Cirsium rydbergii, Epipactis gigantea, Platanthera zothecina (= Habenaria zothecina), Zigadenus vaginatus, Maianthemum stellatum, Primula specuicola, Solidago velutina (= Solidago sparsiflora),* and *Dodecatheon pulchellum*. Graminoids tend to be more variable from stand to stand; common species include *Juncus ensifolius, Juncus balticus, Calamagrostis scopulorum, Agrostis gigantea, Schizachyrium scoparium, Carex aurea,* and *Carex curatorum*. The woody species that occur on the margins of these wetlands are also variable and may include *Populus* spp., *Pinus edulis, Juniperus scopulorum, Rhus trilobata, Toxicodendron rydbergii, Clematis ligusticifolia, Cercocarpus intricatus, Ericameria nauseosa, Frangula betulifolia,* and *Cercocarpus montanus*. Hanging gardens form exclusively in sedimentary rocks; the best developed examples occur in massive bedded sandstones of eolian origin, such as Navajo, Wingate, Cedar Mesa and Entrada sandstones. Water chemistry is variable, ranging from potable to calcareous to saline. The structure of these communities ranges from a simple crack in a vertical cliff face supporting a narrow line of herbaceous vegetation to deep, shaded alcoves supporting different plant assemblages on the backwall and on the wet colluvial floor of the alcove. Elevations range from 1250 to 1890 m (4100-6200 feet), and aspect is not important in determining stand distribution. Soils are typically poorly developed sandy loams and generally are saturated throughout the growing season.

Environmental Description

Global Environment: These wetland communities are scattered throughout the canyons of the Colorado Plateau in Utah, northern Arizona and western Colorado. Occurrences are defined by cracks, crevices, alcoves and ledges in cliffs where groundwater emerges to create permanently moist seeps. Hanging gardens form exclusively in sedimentary rocks; the best developed examples occur in massive bedded sandstones of eolian origin, such as Navajo, Wingate, Cedar Mesa, Moab Tongue and Entrada sandstones. Water chemistry is variable, ranging from potable to calcareous to saline. The structure of these communities ranges from a simple crack in a vertical cliff face supporting a narrow line of herbaceous vegetation to deep, shaded alcoves supporting different plant assemblages on the back wall and on the wet colluvial floor of the alcove. Elevations range from 1250 to 1890 m (4100-6200 feet), and aspect is not important in determining stand distribution. Soils are typically poorly developed sandy loams and generally are saturated throughout the growing season and may have an alkaline crust.

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Vegetation Description

Global Vegetation: The dominant species within the seep are generally forbs, ferns and graminoids; however, mesophytic shrubs and trees sometimes form a margin sheltering the gardens. Vegetative components of hanging gardens are diverse and include a number of rare and endemic species. *Aquilegia micrantha* and *Mimulus eastwoodiae* are present to codominant. Other characteristic forbs present in many hanging gardens include *Adiantum capillus-veneris, Cirsium rydbergii, Dodecatheon pulchellum, Epipactis gigantea, Euphorbia brachycera, Heterotheca villosa, Platanthera zothecina (= Habenaria zothecina), Zigadenus vaginatus, Maianthemum stellatum, Primula specuicola,* and *Solidago velutina (= Solidago sparsiflora).* Graminoids tend to be more variable from stand to stand; common species include *Juncus ensifolius, Juncus balticus, Calamagrostis scopulorum, Dichanthelium acuminatum (= Panicum acuminatum), Agrostis gigantea, Schizachyrium scoparium, Carex aurea,* and *Carex curatorum*. The woody species that occur on the margins of these wetlands are also variable and may include *Populus* spp., *Pinus edulis, Juniperus scopulorum, Rhus trilobata, Toxicodendron radicans, Toxicodendron rydbergii, Clematis ligusticifolia, Cercocarpus intricatus, Ericameria nauseosa, Frangula betulifolia,* and *Cercocarpus montanus*.

Global Dynamics: The availability of water from a seep and the gradual building of soil caught and held by the moist rock surface are key to this association's survival. This association in general is vulnerable to changes and fluctuations in water availability due to drought.

Most Abundant Species

Global

Stratum	Lifeform	Species
Herb (field)	Flowering forb	*Aquilegia micrantha*, *Mimulus eastwoodiae*
Herb (field)	Fern (Spore-bearing forb)	*Adiantum capillus-veneris*

Characteristic Species

Global: Adiantum capillus-veneris, Aquilegia micrantha, Calamagrostis scopulorum, Epipactis gigantea, Erigeron kachinensis, Mimulus eastwoodiae, Platanthera zothecina, Primula specuicola

Other Noteworthy Species

Global: Vulnerable Plants: *Carex curatorum* (G3), *Cirsium rydbergii* (G3), *Erigeron kachinensis* (G2, endemic to hanging gardens), *Mimulus eastwoodiae* (G3G4), *Platanthera zothecina* (G2G3, endemic to hanging gardens), *Zigadenus vaginatus* (G2); Invasive/Exotic Plants: *Tamarix chinensis*

Conservation Status Rank

Global Rank & Reasons: G2G3 (14-Nov-2005). This association tends to be undersampled because many stands are located on inaccessible vertical cliffs.

Related Concepts

Global Similar Types:

- *Aquilegia micrantha - Calamagrostis scopulorum* Hanging Garden (CEGL002592)
- *Aquilegia micrantha* Hanging Garden (CEGL002762)

- *Calamagrostis scopulorum* Seep Hanging Garden (CEGL002751)

Global Related Concepts:
- *Aquilegia micrantha - (Mimulus eastwoodiae)* Hanging Garden (Carsey et al. 2003a) =

Classification

Status: Standard
Classification Confidence: 1 - Strong
Global Classification Comments: This association is part of a complex of herbaceous communities collectively known as "hanging gardens." Few systematic studies of these communities have been completed (e.g., Welsh and Toft 1981, Welsh 1989, Fowler 1995), and even fewer quantitative data are available, partly because stands can be difficult or dangerous to access. The National Park Service is undertaking systematic surveys of vegetation, particularly spring and seep communities, throughout the Colorado Plateau (A. Evenden pers. comm. 2005). As more data become available, the various hanging garden associations should be revisited. John Spence, botanist at Glen Canyon National Recreation Area, is reported to be in the process of publishing a comprehensive study and classification of hanging gardens in the Colorado Plateau (J. Spence pers. comm. 2005).

Element Distribution

Global Range: This association is restricted to massive sandstone cliffs and slopes in canyons of the Colorado Plateau in western Colorado and southeastern Utah.

Nations: US
States/Provinces: AZ, CO:S2, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon, Navajo)

Element Sources

Global Description Author(s): J. Spence, J. Coles and K.A. Schulz
References: CNHP 2003, CNHP 2015, Carsey et al. 2003a, Clark et al. 2009, Coles et al. 2009a, Evenden pers. comm., Fowler 1995, Malanson 1980, Malanson 1982, Malanson and Kay 1980, Romme et al. 1993, Salas et al. 2010a, Spence pers. comm., Welsh 1989, Welsh and Toft 1981, Western Ecology Working Group n.d.*

[CEPP005703] Cirsium rydbergii - Carex curatorum - Calamagrostis scopulorum Hanging Garden
Translated Name: Rydberg's Thistle - Kaibab Sedge - Ditch Reedgrass Hanging Garden
Common Name:

USNVC Classification

Division: Southwestern North American Warm Desert Freshwater Marsh & Bosque (2.C.4.Nc)
Macrogroup: Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland (M076)
Group: Colorado Plateau Hanging Garden Seep (G545)
Alliance: *Aquilegia micrantha* Hanging Garden Alliance (A2506)

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Element Concept

Global Summary: These are obligate herbaceous wetlands that occur in small patches and are dominated by *Cirsium rydbergii*, with either *Carex curatorum* or *Calamagrostis scopulorum*. They are found in alcoves of hanging gardens of the Colorado Plateau and deserts of the southwestern U.S. Hanging gardens occur where springs form waterfalls on cliff faces either along the backwall of alcoves or on exposed cliff faces. They are spectacular lush wetlands, if small in area, and form a striking contrast in the dry desert environment. These small-patch wetlands occur in northern Arizona and southern Utah.

Environmental Description

Global Environment: The vegetation occurs in "hanging gardens," which are spring-fed wetlands of cliff faces. The source of water is above the vegetation, emerging along geologic contacts that seep, drip, or pour onto underlying walls. Elevation ranges 1130 and 1300 m. Alcoves face primarily south and west with some east-facing. Within the alcove environment, stands can occur on the wet backwall of the alcove, along the stream channel on the alcove floor, on debris slopes and on small terraces that build up inside the alcove. Spring flow ranges in constancy and amount; some dry up by mid-summer, while others flow all year. This association is found on all aspects. The geomorphology within alcoves can be complex with several different microhabitats which generally support different adjacent vegetative communities (backwall, detritus slope, colluvial slope, stream/riparian, and madicolous (thin film of water over rock surface) as well as waterfall spray zone). Spring flow is generally very slow and may dry-up by mid-June. Springs occur at the Navajo-Kayenta interface as well as within the Kayenta Formation. They can be quite isolated from riparian areas (up to 4.25 km away) to immediately adjacent.

Vegetation Description

Global Vegetation: These are obligate herbaceous wetlands that occur in small patches that are dominated by *Cirsium rydbergii*, with either *Carex curatorum* or *Calamagrostis scopulorum* and occasionally both with cover ranging from 0.1 to 70% and averages of 20%. Other herbaceous species often present (>50% constancy) with cover values (0.1-30%, averages 2-12%) include *Solidago velutina, Adiantum capillus-veneris, Epipactis gigantea, Aquilegia micrantha*, and *Carex aurea*. Additional herbaceous species present in <30% of the plots include *Dichanthelium acuminatum (= Panicum acuminatum), Phragmites australis, Lobelia cardinalis, Petrophyton caespitosum, Frangula betulifolia (= Rhamnus betulifolia), Yucca angustissima var. toftiae (= Yucca toftiae), Castilleja linariifolia, Primula specuicola, Clematis ligusticifolia, Apocynum cannabinum, Juncus balticus, Mimulus eastwoodiae, Schizachyrium scoparium*, and/or *Andropogon glomeratus*. Other species that occur in fewer than 23% of the plots but have high cover (average >10%) include *Schizachyrium scoparium, Zigadenus vaginatus (= Anticlea vaginata), Eleocharis palustris, Eurybia glauca*, and *Sorghastrum nutans*.

Global Dynamics: The hydrogeologic processes that form hanging gardens also influence the geomorphologic processes that shape the rock walls or canyons from which they emerge. Alcoves do have dynamics with freeze-thaw events that can cause ceiling rockfall, ice build-up can cause flooding,

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higher spring flows may cause flooding, extreme cold temperatures can cause freezing and consequently lifting of vegetation off of wet cliff faces.

Most Abundant Species

Characteristic Species

Global:

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (22-Aug-2016).

Related Concepts

Global Similar Types:

- *Adiantum capillus-veneris* - Mixed Forb Hanging Garden (CEPP005701) is dominated by the fern, with a few forbs co-mingling.
- *Aquilegia micrantha* Hanging Garden (CEGL002762) has *Aquilegia micrantha* as the dominant forb, and *Cirsium rydbergii*, *Carex curatorum* or *Calamagrostis scopulorum* may be present but are never dominant.
- *Calamagrostis scopulorum* Seep Hanging Garden (CEGL002751) is dominated by *Calamagrostis scopulorum*, has very little forb component and lacks *Carex curatorum*.
- *Mimulus eastwoodiae - Primula specuicola* Hanging Garden (CEPP005702) is dominated by the nominal forbs.

Classification

Status: Provisional
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau, and classification and data from John Spence, Ph.D., Chief Scientist and Terrestrial Natural Resources Branch Chief, Science & Resource Management, Glen Canyon National Recreation Area.

Element Distribution

Global Range: These small-patch wetlands occur in northern Arizona and southern Utah.
Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:C?
Federal Lands: NPS (Glen Canyon)

Element Sources

Global Description Author(s): G. Kittel
References: Spence 2008*, Western Ecology Working Group n.d.

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[CEPP005702] Mimulus eastwoodiae - Primula specuicola Hanging Garden

Translated Name: Eastwood's Monkeyflower - Cave-dwelling Primrose Hanging Garden

Common Name:

USNVC Classification

Division: Southwestern North American Warm Desert Freshwater Marsh & Bosque (2.C.4.Nc)

Macrogroup: Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland (M076)

Group: Colorado Plateau Hanging Garden Seep (G545)

Alliance: *Aquilegia micrantha* Hanging Garden Alliance (A2506)

Element Concept

Global Summary: These small-patch and low-statured herbaceous wetlands are found in "hanging gardens" and hillslope spring locations. The vegetation is dominated by the forbs *Mimulus eastwoodiae* and *Primula specuicola* in equal amounts. Hanging gardens occur in areas where springs form waterfalls on cliff faces either along the backwall of alcoves or on exposed cliff faces. They are spectacular lush wetlands, if small in area, and form a striking contrast in the dry desert environment. This association occurs in northern Arizona and southern Utah.

Environmental Description

Global Environment: The vegetation occurs in "hanging gardens," which are spring-fed wetlands of cliff faces. The source of water is above the vegetation, emerging along geologic contacts that seep, drip, or pour onto underlying walls. Elevation ranges between 1100 and 1800 m. Alcoves face primarily south and west with some east-facing. This association is found primarily within alcoves in cliff faces and on "hillslope springs" where springs emerge from confined or unconfined aquifers on a hillslope of 30-60° slopes. Within the alcove environment, stands can occur on the wet backwall of the alcove, along the stream channel on the alcove floor, on debris slopes and on small terraces that build up inside the alcove. Spring flow ranges in constancy and amount; some dry up by mid-summer, while others flow all year. This association is found on all aspects. The geomorphology within alcoves can be complex with several different microhabitats which generally support different adjacent vegetative communities (backwall, detritus slope, colluvial slope, stream/riparian, and madicolous (thin film of water over rock surface) as well as waterfall spray zone). Hanging gardens occur along the Navajo and Kayenta interface, as well as within both sandstone formations. They range in size from <10 to over 1000 square meters. Spring flow ranges from very slow, drying up by mid-June to permanent, steady flow throughout the growing season.

Vegetation Description

Global Vegetation: These are herbaceous patches of vegetation dominated consistently by the forbs *Mimulus eastwoodiae* and *Primula specuicola* each with >90% constancy and average cover of 8-11%, with ranges from 0.1 to 30%. Usually they are in equal dominance with each other, and often occur with a variety of other less abundant herbs such as (in decreasing constancy from 75-50%) *Cirsium rydbergii, Adiantum capillus-veneris, Carex aurea, Carex curatorum, Aquilegia micrantha, Calamagrostis scopulorum, Solidago velutina,* and/or *Epipactis gigantea*. Other species often present include the low subshrub *Petrophyton caespitosum*.

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Global Dynamics: The hydrogeologic processes that form hanging gardens also influence the geomorphologic processes that shape the rock walls or canyons from which they emerge. Alcoves do have dynamics with freeze-thaw events that can cause ceiling rockfall, ice build-up can cause flooding, higher spring flows may cause flooding, extreme cold temperatures can cause freezing and consequently lifting of vegetation off of wet cliff faces.

Most Abundant Species

Characteristic Species

Global:

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (22-Aug-2016).

Related Concepts

Global Similar Types:

- *Adiantum capillus-veneris* - Mixed Forb Hanging Garden (CEPP005701) is dominated by the fern, and forb cover is secondary.
- *Aquilegia micrantha* Hanging Garden (CEGL002762) is a very similar herbaceous spring-dependent community but lacks significant cover of *Mimulus eastwoodiae* and *Primula specuicola*.
- *Cirsium rydbergii - Carex curatorum - Calamagrostis scopulorum* Hanging Garden (CEPP005703)

Classification

Status: Provisional
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau, and classification and data from John Spence, Ph.D., Chief Scientist and Terrestrial Natural Resources Branch Chief, Science & Resource Management, Glen Canyon National Recreation Area.

Element Distribution

Global Range: These small-patch wetlands occur in northern Arizona and southern Utah.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:C?
Federal Lands: NPS (Glen Canyon)

Element Sources

Global Description Author(s): G. Kittel
References: Spence 2008*, Western Ecology Working Group n.d.

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A2655 Calamagrostis scopulorum - Andropogon glomeratus Hanging Garden Alliance

Alliance Summary Description: This is a lush herbaceous association dominated by Andropogon glomeratus, Calamagrostis scopulorum, Cladium californicum, Muhlenbergia utilis, Schoenus nigricans, Solidago spectabilis var. confinis (= Solidago confinis), and Solidago spectabilis var. spectabilis (= Solidago spectabilis). Other herbaceous species include Comandra umbellata, Solidago missouriensis, and Juncus balticus. Although a shrub layer is usually lacking, scattered Rosa woodsii, Rhus trilobata, Salix exigua, and/or Tamarix ramosissima are known to occur within or just below the alcove containing the seep. These are wetland seeps that usually occur in alcoves and in horizontal fractures in limestone or sandstone canyon walls, or other bedrock springs. They are found in northwestern Colorado, eastern Utah and further south and west in Death Valley National Park in California. Many stands are inaccessible, but one documented site is on the bank of an intermittent wash where groundwater is close to the surface. Known elevation ranges from 1400 to 1675 m (4600-5500 feet). Soil collects on ledges fed by dripping groundwater and becomes the substrate for this small patch of wetland vegetation. The soils are poorly developed, sandy and moist throughout the growing season.

[CEGL002751] *Calamagrostis scopulorum* Seep Hanging Garden

Translated Name: Ditch Reedgrass Seep Hanging Garden

Common Name:

USNVC Classification

Division: outhwestern North American Warm Desert Freshwater Marsh & Bosque (2.C.4.Nc)
Macrogroup: Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland (M076)
Group: Colorado Plateau Hanging Garden Seep (G545)
Alliance: *Calamagrostis scopulorum - Andropogon glomeratus* Hanging Garden Alliance (A2655)

Element Concept

Global Summary: This wetland seep association usually occurs in alcoves and in horizontal fractures in limestone or sandstone canyon walls in northwestern Colorado and eastern Utah. Many stands are inaccessible, but one documented site is on the bank of an intermittent wash where groundwater is close to the surface. Elevation ranges from 1400 to 1675 m (4600-5500 feet). Soil collects on ledges fed by dripping groundwater and becomes the substrate for this small patch of wetland vegetation. The soils are poorly developed, sandy and moist throughout the growing season. This is a lush herbaceous association dominated by *Calamagrostis scopulorum*. Other herbaceous species common to this association include *Comandra umbellata, Solidago missouriensis*, and *Juncus balticus*. Although a shrub layer is lacking, scattered *Tamarix ramosissima, Rosa woodsii, Rhus trilobata,* and *Salix exigua* are known to occur with sparse cover within or just below the alcove containing the seep. Typical hanging garden forb species such as *Mimulus eastwoodiae, Aquilegia micrantha* or *Adiantum capillus-veneris* are absent or have very low cover.

Environmental Description

Global Environment: This wetland seep association usually occurs in alcoves and in horizontal fractures in limestone or sandstone canyon walls in northwestern Colorado and eastern Utah. One site is on the bank of an intermittent wash where groundwater is close to the surface. Elevation ranges from

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1400 to 1675 m (4600-5500 feet). Soil collects on ledges fed by dripping groundwater and becomes the substrate for this small patch of wetland vegetation. The soils are poorly developed, sandy and moist throughout the growing season.

Vegetation Description

Global Vegetation: This is a lush herbaceous association dominated by *Calamagrostis scopulorum*. Other graminoid species common to this association include *Andropogon glomeratus, Carex aurea, Carex curatorum, Juncus balticus, Dichanthelium acuminatum (= Panicum acuminatum), Phragmites australis*, and *Schizachyrium scoparium*. Forbs known to occur from present to abundant include *Cirsium rydbergii, Comandra umbellata, Primula specuicola, Solidago velutina*, and *Solidago missouriensis*. Typical hanging garden forb species such as *Mimulus eastwoodiae, Aquilegia micrantha*, or *Adiantum capillus-veneris* are absent or have very low cover. Although a shrub layer is lacking, scattered natives such as *Mahonia repens, Petrophyton caespitosum, Frangula betulifolia (= Rhamnus betulifolia), Rosa woodsii, Rhus trilobata, Salix exigua*, and *Yucca angustissima var. toftiae (= Yucca toftiae)*, as well as the non-native invasive shrub/tree *Tamarix ramosissima*, are known to occur with sparse cover within or just below the alcove containing the seep.

Global Dynamics: As with all hanging garden types, this association depends on a steady supply of groundwater in order to persist.

Most Abundant Species

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Calamagrostis scopulorum*

Characteristic Species

Global: Calamagrostis scopulorum

Other Noteworthy Species

Global: Vulnerable Plants: *Carex curatorum* (G3), *Cirsium rydbergii* (G3);
Invasive/Exotic Plants: *Tamarix ramosissima* (High);
Other Plants: *Juncus balticus* (G5), *Primula specuicola* (G4Q, endemic to hanging gardens)

Conservation Status Rank

Global Rank & Reasons: GNR (11-Apr-2005).

Related Concepts

Global Similar Types:

- *Aquilegia micrantha - Mimulus eastwoodiae* Hanging Garden (CEGL002729)
- *Cirsium rydbergii - Carex curatorum - Calamagrostis scopulorum* Hanging Garden (CEPP005703)

Classification

Status: Standard
Classification Confidence: 2 - Moderate

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Global Classification Comments: This association is part of a complex of herbaceous communities collectively known as "hanging gardens." Few systematic studies of these communities have been completed (e.g., Welsh and Toft 1981, Welsh 1989, Fowler 1995), and even fewer quantitative data are available, partly because stands can be difficult or dangerous to access. The National Park Service is undertaking systematic surveys of vegetation, particularly spring and seep communities, throughout the Colorado Plateau (Evenden pers. comm. 2005). As more data become available, the various hanging garden associations should be revisited. John Spence, botanist at Glen Canyon National Recreation Area, is reported to be in the process of publishing a comprehensive study and classification of hanging gardens in the Colorado Plateau (J. Spence pers. comm. 2005).

This association is relatively rare among hanging gardens. It can be distinguished from other hanging garden types by the overwhelming dominance of *Calamagrostis scopulorum* and a lack of other typical hanging garden species such as *Aquilegia micrantha, Adiantum capillus-veneris*, or *Mimulus eastwoodiae*.

Element Distribution

Global Range: This association has been documented from canyons in northwestern Colorado and eastern Utah.

Nations: US
States/Provinces: CO, UT
TNC Ecoregions: 9:C, 19:C
USFS Ecoregions (1994/95): 341B:CC, M331E:CC
Federal Lands: NPS (Canyonlands, Dinosaur, Glen Canyon)

Element Sources

Global Description Author(s): J. Coles
References: Coles et al. 2008a, Evenden pers. comm., Fowler 1995, Spence pers. comm., Welsh 1989, Welsh and Toft 1981, Western Ecology Working Group n.d.*

G533. North American Warm Desert Riparian Low Bosque & Shrubland

Group Summary Description: This group consists of riparian scrub found along low-elevation (<1100 m) perennial or intermittent streams and rivers throughout the warm desert regions of the southwestern U.S. and adjacent Mexico. The vegetation is low scrub or shrubland, not tall trees. Dominants include scrub *Prosopis glandulosa* and *Prosopis velutina,* and shrubs *Baccharis salicifolia, Pluchea sericea, Salix geyeriana, Shepherdia argentea*, and/or *Salix exigua*. Woody cover is relatively dense, especially when compared to drier washes. Dominant species, especially the mesquites, tap groundwater below the streambed when surface flows stop. Vegetation is dependent upon annual rise in the water table or annual/periodic flooding and associated sediment scour for growth and reproduction.

A3874 Baccharis emoryi - Baccharis sergiloides Wet Shrubland Alliance

Alliance Summary Description: This alliance includes dry washes, wet valley bottoms and intermittent streambeds where *Baccharis emoryi, Baccharis sarothroides*, or *Baccharis sergiloides*

dominate the upper canopy. Other shrubs present may include *Acacia greggii, Ericameria linearifolia, Eriogonum fasciculatum, Gutierrezia microcephala, Lotus rigidus, Opuntia acanthocarpa, Parkinsonia microphylla, Prunus fasciculata, Rhus trilobata, Salix exigua,* and *Yucca schidigera*. Occasional emergent *Populus fremontii* or *Salix* spp. may occur. This alliance occurs in the Mojave, Sonoran and Chihuahuan deserts, southeastern California, southern Utah, Arizona, and New Mexico.

[CEGL005947] Baccharis (emoryi, salicina) - Salix exigua Wet Shrubland

Translated Name: (Emory's Baccharis, Willow Baccharis) - Narrowleaf Willow Wet Shrubland
Common Name:

USNVC Classification

Division: Southwestern North American Warm Desert Freshwater Marsh & Bosque (2.C.4.Nc)
Macrogroup: Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland (M076)
Group: North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Alliance: *Baccharis emoryi - Baccharis sergiloides* Wet Shrubland Alliance (A3874)

Element Concept

Global Summary: This riparian association is found in the Colorado Plateau and Pecos Basin in southeastern New Mexico and may occur in Trans-Pecos Texas. *Baccharis emoryi* or *Baccharis salicina* forms dense shrub thickets in association with *Salix exigua*. Canopies can exceed 85% cover and reach up to 2.5 m (8 feet) in height. The herbaceous layer is low to moderate in cover. Species may include *Agrostis stolonifera, Eleocharis palustris, Equisetum* spp., *Juncus balticus, Muhlenbergia asperifolia, Iva acerosa (= Oxytenia acerosa), Phragmites australis, Saccharum ravennae, Schoenoplectus pungens (= Scirpus pungens),* and *Typha domingensis*. Stands occur along low-gradient rivers with sandy-bottomed channels of wide lowland valleys at elevations from 450 to 1150 m (1500-3775 feet). Soils are moderately well-drained to well-drained silt loams or sandy loams derived from alluvium. Occasionally, they may have a thin, clayey surface layer that retains greater moisture. Underlying layers have less than 35% cobbles or gravels.

Environmental Description

Glen Canyon National Recreation Area Environment: This riparian shrubland occurs along low-gradient streams, with surface water present, along sandy-bottomed channels of canyon bottoms that lie between 1099 and 1150 m elevation. Litter covers most of the unvegetated surface, with lesser cover of bare soil, and sparse to low cover of sand, gravel, large rocks, water, and dead wood. Soils are moderately well-drained to well-drained silt loams or sandy loams derived from alluvium.

Global Environment: This riparian shrubland occurs along low-gradient rivers with sandy-bottomed channels of wide lowland valleys at elevations from 450 to 1150 m (1500-3775 feet), or in spring-fed alcoves and canyon slopes. Soils are reported as weakly developed Aquic Ustipsamments and Oxyaquic Torrifluvents that are composed of deep sandy sediments that are well-drained. Occasionally, they may have a thin, clayey surface layer that retains greater moisture. Underlying layers have less than 35% cobbles or gravels.

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Vegetation Description

Glen Canyon National Recreation Area Vegetation: Vegetation in these stands has low to high total cover (15-84%) and is codominated by the tall shrubs (which can reach 2 to 5 m in height), *Baccharis salicina*, with 3-18% cover, and *Salix exigua*, with 2-15% cover. Other shrubs are rare, but those noted with more than trace cover include *Ericameria nauseosa* and the exotic *Tamarix chinensis*. The herbaceous layer is dominated by graminoids and has low to moderate cover; it may include *Agrostis stolonifera, Juncus balticus, Equisetum hyemale, Muhlenbergia asperifolia, Phragmites australis, Saccharum ravennae*, and *Typha domingensis*. *Populus fremontii* and *Juniperus osteosperma* trees may be present with low cover on the margins of the community.

Global Vegetation: *Baccharis emoryi* and/or *Baccharis salicina* forms typically dense shrub thickets in association with *Salix exigua*. Canopies can exceed 85% cover and reach up to 2.5 m (8 feet) in height. Other woody species may include *Symphoricarpos longiflorus*. The herbaceous layer is dominated by graminoids and has low to moderate cover; it may include *Agrostis stolonifera, Juncus balticus, Eleocharis palustris, Equisetum hyemale, Equisetum laevigatum, Muhlenbergia asperifolia, Iva acerosa (= Oxytenia acerosa), Phragmites australis, Saccharum ravennae, Schoenoplectus pungens (= Scirpus pungens)*, and *Typha domingensis*. The exotic species *Melilotus officinalis* and *Tamarix* spp. may be present in some stands.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Salix exigua*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Baccharis salicina*
Herb (field)	Graminoid	*Juncus balticus*, *Phragmites australis*, *Typha domingensis*
Herb (field)	Fern (Spore-bearing forb)	*Equisetum hyemale*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Salix exigua*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Baccharis emoryi*, *Baccharis salicina*
Herb (field)	Graminoid	*Schoenoplectus pungens*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Baccharis emoryi, Baccharis salicina, Salix exigua*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Tamarix chinensis*
Global: Invasive/Exotic Plants: *Melilotus officinalis* (Medium/Low), *Tamarix* spp.

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Conservation Status Rank

Global Rank & Reasons: G3 (28-Sep-2004). This riparian shrubland association of the Pecos basin has likely undergone significant declines as a result of impoundments and subsequent river regulation along with agricultural conversion and livestock use. It requires low-gradient floodplain habitats in which natural hydrological processes are operational to ensure reproduction and maintenance of *Baccharis emoryi* and other key wetland species. Conditions such as these are now rare in river basins of the Southwest. In addition, stands can be significantly impacted when minimum in-stream base flows are not maintained, and many occurrences have been invaded by alien species. The rank of G3 was assigned pending further documentation, but the expectation is that this rank will be upheld.

Related Concepts

Global Related Concepts:

- Emory Baccharis-Coyote Willow CT (Muldavin et al. 2000a) =

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. It is distinguished from others in the alliance by the codominance of *Salix exigua* and the relatively low herbaceous cover.

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon association is found along streams in the recreation area and was sampled in Fiftymile Creek, Davis Gulch, Bown's Canyon, and near Rock Creek Bay.

Global Range: This riparian association is found in the Colorado Plateau in northern Arizona and southern Utah, the Pecos Basin in southeastern New Mexico and may occur in Trans-Pecos Texas and westward.

Nations: US
States/Provinces: AZ, NM:S3, TX?, UT
TNC Ecoregions: 19:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, 321:C
Federal Lands: NPS (Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Streambed in tight canyon, at least semipermanently flowing. Well-shaded site, with cliff walls along the southern and western edges. There is a shallow but widespread litter layer on surface.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (3 plots, 1 accuracy assessment point): (Plots: GLCA.4333, GLCA.4339, GLCA.5156; AA Points: GLCA_AA.1997).

Glen Canyon National Recreation Area Description Author(s): A. Tendick

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Global Description Author(s): E. Muldavin et al. (2000a) and K.A. Schulz
References: Muldavin et al. 2000a, Muldavin et al. 2000a*, NHNM unpubl. data, Reid and Hall 2010, Western Ecology Working Group n.d.

A0933 Baccharis salicifolia Wet Shrubland Alliance
Alliance Summary Description: This alliance includes riparian shrublands dominated by *Baccharis salicifolia*. *Salix gooddingii* may be an emergent tree at low cover in some stands. Other associated species can include shrubs such as *Artemisia californica, Baccharis emoryi, Baccharis neglecta, Baccharis pilularis, Malosma laurina, Nicotiana glauca, Pluchea sericea, Prosopis glandulosa var. glandulosa, Rubus* spp., *Salix exigua, Salix lasiolepis,* and *Sambucus canadensis (= Sambucus nigra ssp. canadensis).* Stands are found at lower elevations in mountain ranges of Trans-Pecos Texas and in central and southern California, along sandy watercourses, dry arroyos and wetlands in sand dunes.

[CEGL003549] *Baccharis salicifolia* Riparian Shrubland
Translated Name: Mule-fat Riparian Shrubland
Common Name:

USNVC Classification

Division: Southwestern North American Warm Desert Freshwater Marsh & Bosque (2.C.4.Nc)
Macrogroup: Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland (M076)
Group: North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Alliance: *Baccharis salicifolia* Wet Shrubland Alliance (A0933)

Element Concept

Global Summary: This riparian shrubland is known from central and southern interior coastal mountains of California, the Anza-Borrego Desert, and south into Baja California, Mexico. It is often found along washes, springs and riparian corridors. It is usually a small stringer community. It can occur on steep slopes associated with springs. Soils are course to fine sandy loams, mostly derived from alluvium. Elevation ranges from 216 to over 914 m (708-3000+ feet). The shrub layer is dominated by *Baccharis salicifolia*. Non-native *Tamarix* is often found but usually in relatively low cover. *Baccharis pilularis* may also be present in low cover. The herbaceous layer is dominated by a variety of non-native and native species such as *Ambrosia psilostachya, Bromus hordeaceus, Hirschfeldia incana, Lepidium latifolium, Artemisia douglasiana,* and *Urtica dioica*. *Salix gooddingii* or *Platanus racemosa* may be emergent in some stands.

Environmental Description

Global Environment: This shrubland is often found along washes, springs and riparian corridors. It is usually small, stringer community. It can occur on steep slopes associated with springs. Soils are course to fine sandy loams, mostly derived from alluvium. Elevation ranges from 216 m to over 915 m (708-3000+ feet). In the Anza-Borrego Desert, *Baccharis salicifolia* is found scattered as small stands associated with springs and riparian stringers above 915 m and is most extensive at Sentenac Cienega.

Vegetation Description

Global Vegetation: *Baccharis salicifolia* is usually dominant. Non-native *Tamarix* is often found but usually in relatively low cover. *Baccharis pilularis* may also be present in low cover. *Salix gooddingii*

may be emergent in some stands. The herbaceous layer is dominated by a variety of non-native and native species such as *Ambrosia psilostachya, Bromus hordeaceus, Hirschfeldia incana, Lepidium latifolium, Artemisia douglasiana,* and *Urtica dioica*. Other herbaceous species include forbs *Pseudognaphalium canescens ssp. beneolens (= Gnaphalium canescens ssp. beneolens), Lotus unifoliolatus var. unifoliolatus (= Lotus purshianus var. purshianus), Melilotus indicus*, and *Rumex salicifolius*, and graminoids *Aira caryophyllea, Bromus diandrus,* and *Vulpia myuros*.

Most Abundant Species

Global

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Baccharis salicifolia*

Characteristic Species

Global: Baccharis salicifolia

Other Noteworthy Species

Global: Vulnerable Plants: *Juglans californica* (G3, CA endemic); Invasive/Exotic Plants: *Aira caryophyllea* (Medium/Insignificant), *Bromus diandrus, Bromus hordeaceus, Hirschfeldia incana* (High/Low), *Lepidium latifolium* (High), *Melilotus indicus* (Medium/Insignificant), *Urtica dioica, Vulpia myuros*

Conservation Status Rank

Global Rank & Reasons: G5 (14-Dec-2005).

Related Concepts

Global Related Concepts:

- *Baccharis salicifolia* Association (Sproul et al. 2011) =
- *Baccharis salicifolia* (Sawyer et al. 2009) **?**
- *Baccharis salicifolia* Riparian Shrubland (Evens and San 2006) =
- *Baccharis salicifolia* Riparian Shrubland (Klein and Evens 2006) =
- *Baccharis salicifolia* Riparian Shrubland (Keeler-Wolf et al. 1998a) =
- *Baccharis salicifolia* Riparian Shrubland Association (Keeler-Wolf and Evens 2006) =

Classification

Status: Standard

Classification Confidence: 1 - Strong

Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Global Classification Comments: A similar *Baccharis salicifolia - Sambucus mexicana* association has been described from western Riverside County (Klein and Evens 2006). Very similar stands occur at least as far north as Shasta County in the Sacramento Valley of California (T. Keeler-Wolf pers. obs. 2004). Due to the inherent variability of these riparian scrublands, it remains to be seen if these associations should stay separate.

Element Distribution

Global Range: This association is known from the Santa Monica Mountains region, interior Central Coast Ranges (Pinnacles National Monument), central San Diego County, and the Anza-Borrego Desert. In addition, *Baccharis salicifolia* stands range widely from the northern Sacramento Valley south into Baja California, Mexico.

Nations: MX, US
States/Provinces: AZ, CA:S5, MXBC, NM, UT
TNC Ecoregions: 13:C, 15:C, 16:C, 19:C, 23:C
USFS Ecoregions (1994/95): 261B:CC, 262A:CC, 313A:CC, 322C:CC, 341B:??, M262A:CC, M262B:CC
Federal Lands: NPS (Glen Canyon, Grand Canyon, Pinnacles, Santa Monica Mountains); USFWS (Buenos Aires)

Element Sources

Global Description Author(s): T. Keeler-Wolf, J. Evens, G. Kittel
References: Evens and San 2006, Keeler-Wolf and Evens 2006, Keeler-Wolf and Evens 2006*, Keeler-Wolf et al. 1998a, Keeler-Wolf pers. comm., Kittel et al. 2012a, Klein and Evens 2006, Muldavin et al. 2000a, Reid and Hall 2010, Sawyer et al. 2009, Schulz 2004, Sproul et al. 2011, Western Ecology Working Group n.d.

A1033 Celtis laevigata - Rhus trilobata Wet Shrubland Alliance

Alliance Summary Description: This alliance contains riparian shrublands dominated by a single species such as *Celtis laevigata var. reticulata, Celtis pallida, Prunus serotina,* and *Rhus trilobata*. Other shrubs can include *Berberis fendleri, Juniperus monosperma, Prosopis velutina, Prunus serotina, Quercus grisea, Ribes aureum, Rosa woodsii, Salix exigua,* and *Salix ligulifolia (= Salix eriocephala var. ligulifolia)*. This alliance occurs on alluvial terraces along the drainages that dissect upper bajadas and lower canyons, and occurs as narrow bands between the high-water line and the upland slopes in moderately wide valleys and along narrow reaches of larger rivers.

[CEGL002359] Celtis laevigata var. reticulata - Quercus gambelii - Cercis orbiculata Slickrock Canyon Spring & Riparian Woodland

Translated Name: Netleaf Hackberry - Gambel Oak - California Redbud Slickrock Canyon Spring & Riparian Woodland

Common Name:

USNVC Classification

Division: Southwestern North American Warm Desert Freshwater Marsh & Bosque (2.C.4.Nc)
Macrogroup: Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland (M076)
Group: North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Alliance: *Celtis laevigata - Rhus trilobata* Wet Shrubland Alliance (A1033)

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Element Concept

Global Summary: This shrubland and low bosque association is known from the warm deserts of Mojave and Colorado in southeastern Utah and northern Arizona. This association is characterized by typically 2- to 5-m tall *Celtis laevigata var. reticulata, Cercis orbiculata,* and/or *Quercus gambelii* shrubs or small trees with 3-90% cover, with very little herbaceous understory. The tree layer is moderately diverse and may include *Acer negundo, Juniperus osteosperma, Pinus edulis, Populus fremontii,* and/or *Populus tremuloides.* The shrub layer has moderate to high species diversity, but in some cases may be dominated by a single species, and provides low to moderate cover. Other shrubs commonly to occasionally present include *Amelanchier utahensis, Fraxinus anomala, Mahonia fremontii, Rhus trilobata,* and *Salix exigua*. The herbaceous layer is diverse and provides low to moderate cover. These wet shrublands are found on spring-fed slopes, slickrock canyon bottoms, intermittently flooded washes, at the base of cliffs, in alcoves of canyons, and terraces on flat to 30-60° slopes at elevations ranging from 1125 to 2409 m. Stands may be oriented to all aspects. Soils are rapidly drained sand and sandy loam. They are often above and isolated from a riparian zone, or may merge with riparian vegetation along perennial streams.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland or low bosque association occurs on flat to gently sloping (up to 8° slopes) canyon bottoms, alcove canyons, on intermittently flooded drainage channels, perennial streams, and terraces at elevations ranging from 1125 to 1579 m. Bare soil, sand, and litter cover most of the unvegetated surface, with lesser cover by large and small rocks and bedrock. The soils are somewhat poorly drained to rapidly drained sandy loams or sands derived from alluvium.

Global Environment: This wet shrubland to low bosque association occurs on flat to steep canyon sides and slickrock canyon bottoms, intermittently flooded drainage channels, and terraces on flat to 30-60° slopes at elevations ranging from 1125 to 2409 m. Sites are gentle to steep slopes (1-30°), and are oriented to all aspects. The unvegetated surface has low to high exposure of bedrock, sand, and bare soil. The cover by litter is sparse to low. Parent materials are Navajo sandstone. Soils are rapidly drained and texturally are sand and sandy loam.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This netleaf hackberry-mixed shrub woodland is uncommon within the recreation area. Total vegetation cover ranges from 12 to 99%. The tree canopy layer is dominated or codominated by *Celtis laevigata var. reticulata* (with 3-90% cover) and/or *Cercis orbiculata* (with 8-30% cover), and may also include moderate cover of *Populus fremontii, Juniperus osteosperma, Salix gooddingii,* or *Acer negundo*. The shrub layer is variable and may be clearly dominated by one species, namely *Quercus gambelii* (with up to 82% cover in one stand), or may include low to moderate cover of a variety of species. Associated shrub species with low to moderate cover may include *Salix exigua, Baccharis salicina, Amelanchier utahensis, Purshia stansburiana, Rhus aromatica, Rosa woodsii, Mahonia fremontii, Brickellia longifolia, Symphoricarpos longiflorus, Ericameria nauseosa, Fraxinus anomala, Atriplex canescens, Artemisia filifolia, Ephedra cutleri,* and *Ephedra viridis*. Most stands have a sparse herbaceous layer; however,

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Phragmites australis, when present, may have up to 40% cover, Herbaceous species with low cover may include *Poa fendleriana, Artemisia ludoviciana, Amsonia tomentosa, Ambrosia acanthicarpa, Solidago canadensis, Heterotheca villosa, Stephanomeria pauciflora, Toxicodendron rydbergii,* and *Penstemon ambiguus*. In disturbed stands, several exotic species may be present, including *Tamarix chinensis, Salsola tragus,* and *Bromus tectorum*.

Global Vegetation: This shrub or low bosque community is characterized by typically 2- to 5-m tall *Celtis laevigata var. reticulata, Cercis orbiculata*, and/or *Quercus gambelii* shrubs or small trees with 3-90% cover. The canopy tree layer is moderately diverse, provides sparse to moderate cover, and includes *Acer negundo, Juniperus osteosperma, Pinus edulis, Populus fremontii, Populus tremuloides, Salix gooddingii*, and several other tree species occasionally present. The shrub layer has moderate to high species diversity, but is variable in composition and provides low to moderate cover. Tall shrubs commonly to occasionally present include *Amelanchier utahensis, Fraxinus anomala, Mahonia fremontii*, and *Salix exigua*. Common short and dwarf-shrubs include *Atriplex canescens, Artemisia filifolia, Baccharis salicina, Ephedra cutleri, Ephedra viridis, Ericameria nauseosa, Opuntia polyacantha, Purshia stansburiana, Rhus trilobata, Rosa woodsia, Symphoricarpos longiflorus,* and *Toxicodendron rydbergii*. The herbaceous layer is diverse in terms of species composition and provides low to moderate cover. Graminoids commonly present in the community include *Achnatherum hymenoides, Poa fendleriana,* and *Vulpia octoflora*. Forbs often present include *Ambrosia acanthicarpa, Amsonia tomentosa, Artemisia ludoviciana, Castilleja linariifolia, Heterotheca villosa, Lepidium montanum, Penstemon ambiguus, Solidago canadensis*, and *Stephanomeria pauciflora,*. The vine *Clematis ligusticifolia* is often present and typically provides sparse cover. *Phragmites australis*, when present, may have up to 40% cover, In disturbed stands, several exotic species may be present, including *Tamarix chinensis, Salsola tragus*, and *Bromus tectorum*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Celtis laevigata* var. *reticulata*, *Cercis orbiculata*
Short shrub/sapling	Broad-leaved deciduous shrub	*Rhus aromatica*, *Symphoricarpos longiflorus*
Short shrub/sapling	Broad-leaved evergreen shrub	*Purshia stansburiana*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Tree canopy	Broad-leaved deciduous tree	*Celtis laevigata* var. *reticulata*, *Cercis orbiculata*, *Fraxinus anomala*, *Populus tremuloides*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*, *Fraxinus anomala*, *Quercus gambelii*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Mahonia fremontii*

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Rhus trilobata*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Herb (field)	Liana	*Clematis ligusticifolia*
Herb (field)	Flowering forb	*Artemisia ludoviciana*
Herb (field)	Graminoid	*Achnatherum hymenoides*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Achnatherum hymenoides, Artemisia ludoviciana, Celtis laevigata* var. *reticulata, Cercis orbiculata, Clematis ligusticifolia, Fraxinus anomala, Opuntia polyacantha, Poa fendleriana, Rhus trilobata*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus, Tamarix chinensis*

Global: Vulnerable Plants: *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus, Tamarix chinensis*

Conservation Status Rank

Global Rank & Reasons: GNR (29-Mar-2005).

Related Concepts

Classification

Status: Standard
Classification Confidence:
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. It was previously poorly documented and named *Celtis laevigata var. reticulata* Slickrock Canyon Riparian Woodland. It has now been renamed and former *Cercis orbiculata* Seep Shrubland [Park Special] (CEPS009682) (based on one plot in Capitol Reef NP and another from Grand Canyon NP) has been merged into this association. In addition, several plots from classification and data from John Spence, Ph.D., Chief Scientist and Terrestrial Natural Resources Branch Chief, Science & Resource Management, Glen Canyon National Recreation Area (Spence 2008) are included in this concept.

Element Distribution

Glen Canyon National Recreation Area Range: This woodland association is infrequent within the recreation area and was sampled in Little Valley Canyon, Annie's Canyon, Clearwater Canyon, Sevenmile Creek, Trachyte Canyon, the north fork of Calf Canyon, the south fork of Ticaboo Canyon, near Rainbow Bridge, Coyote Gulch, Grand Gulch, and on the Escalante River.

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Global Range: This Colorado Plateau shrubland association is known from Glen Canyon National Recreation Area, and Capitol Reef and Grand Canyon national parks in southern Utah and northern Arizona.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Capitol Reef, Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plot is in an occasionally active streambed, with enough subsurface water to support hackberry trees. Very sandy. Fairly narrow sandstone canyon drainage drains a good bit of the little Rockies.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, 2012, 2013, 2014, and 2015 field data (6 plots, 5 accuracy assessment points): (Plots: GLCA.1014, GLCA.5194, GLCA.5408, GLCA.5433, GLCA.5501, GLCA.9510; AA Points: GLCA_AA.0649, GLCA_AA.1261, GLCA_AA.1913, GLCA_AA.1982, GLCA_AA.8006).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Von Loh, D. Clark, M.J. Russo and G. Kittel
References: Clark et al. 2009, Reid and Hall 2010, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEPP009630] *Frangula betulifolia* Wet Shrubland
Translated Name: Beechleaf Frangula Wet Shrubland
Common Name:

USNVC Classification

Division: Southwestern North American Warm Desert Freshwater Marsh & Bosque (2.C.4.Nc)
Macrogroup: Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland (M076)
Group: North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Alliance: *Celtis laevigata - Rhus trilobata* Wet Shrubland Alliance (A1033)

Element Concept

Global Summary: This wet shrubland occurs on slope-springs, in hanging gardens and riparian areas and is dominated by *Frangula betulifolia*, with canopy coverage from <1 to 70%. Other woody species that can be abundant include vines *Parthenocissus vitacea* and *Clematis ligusticifolia*, and facultative wetland shrubs such as *Toxicodendron rydbergii, Forestiera pubescens*, and/or *Rhus glabra*. Herbaceous cover is can be minimal or lush. The following species can be present with up to 30% cover or completely absent depending on site conditions: *Adiantum capillus-veneris, Calamagrostis scopulorum, Cirsium rydbergii, Elymus canadensis, Euthamia occidentalis, Juncus ensifolius*, and *Iva*

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acerosa (= Oxytenia acerosa). This association is located in desert of the southwestern U.S., canyons of southern Utah, and on the central Colorado Plateau and is likely to be found in northern Arizona.

Environmental Description

Global Environment: These shrublands occur around springs on slopes, in hanging garden alcoves, as well as on upper terraces, slope bottoms, washes and banks of perennial streams. Springs have seasonal (often dry by mid-June) to permanent (but variable) flow, and are generally within 100 m of a riparian zone. Stands are observed to occur specifically because there is a spring nearby. They are structurally simple with just the sloped area around the spring. These springs and associated community occur from 60 m to 1.5 km apart from each other, and occur along the Navajo-Kayenta and Kayenta-Chinle formations interface, as well as within the Chinle Formation.

Vegetation Description

Global Vegetation: Shrub understory ranges from 5-70% cover and consists of *Frangula betulifolia*, often with other woody species such as vines *Parthenocissus vitacea* or *Clematis ligusticifolia*, and facultative wetland shrubs such as *Toxicodendron rydbergii, Forestiera pubescens*, and/or *Rhus glabra*. Herbaceous cover can be minimal or lush. The following species can be present with up to 30% cover or completely absent depending on site conditions: *Adiantum capillus-veneris, Calamagrostis scopulorum, Cirsium rydbergii, Elymus canadensis, Euthamia occidentalis, Juncus ensifolius,* and *Iva acerosa (= Oxytenia acerosa)*. Several other herbaceous species may be present in low amounts (present to up to 5% cover): *Apocynum cannabinum, Aquilegia micrantha, Carex aurea, Carex curatorum, Carex curatorum (= Carex haysii), Castilleja linariifolia, Epilobium ciliatum, Epipactis gigantea, Equisetum arvense, Equisetum hyemale, Lobelia cardinalis, Maianthemum stellatum, Mimulus eastwoodiae, Muhlenbergia thurberi, Dichanthelium acuminatum (= Panicum acuminatum), Panicum virgatum, Phragmites australis, Platanthera zothecina, Primula specuicola, Solidago canadensis, Solidago velutina*, and *Stephanomeria minor (= Stephanomeria tenuifolia)*.

Most Abundant Species

Characteristic Species

Global:

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (17-Mar-2011).

Related Concepts

Global Similar Types:

- *Populus fremontii / Frangula betulifolia - Quercus gambelii* Spring & Riparian Woodland (CEPP005699) always has a tree overstory component, usually with *Populus fremontii, Acer negundo*, and/or *Salix gooddingii*, with low (1%) to high (75%) cover.

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Classification

Status: Provisional
Classification Confidence:
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau and from classification and data from John Spence, Ph.D., Chief Scientist and Terrestrial Natural Resources Branch Chief, Science & Resource Management, Glen Canyon National Recreation Area.

Element Distribution

Global Range: These wet shrublands occur in the central Colorado Plateau of southeastern Utah and possibly northern Arizona.

Nations: US
States/Provinces: AZ?, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:C?
Federal Lands: NPS (Canyonlands, Capitol Reef, Glen Canyon)

Element Sources

Global Description Author(s): G. Kittel
References: Spence 2008*, Western Ecology Working Group n.d.

[CEPP005700] *Toxicodendron rydbergii* / Mixed Forb Hanging Garden Scrub
Translated Name: Western Poison-ivy / Mixed Forb Hanging Garden Scrub
Common Name:

USNVC Classification

Division: Southwestern North American Warm Desert Freshwater Marsh & Bosque (2.C.4.Nc)
Macrogroup: Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland (M076)
Group: North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Alliance: *Celtis laevigata - Rhus trilobata* Wet Shrubland Alliance (A1033)

Element Concept

Global Summary: These are woody wetlands found in hanging gardens within alcoves of cliffs, or hillslope springs and seeps, dominated by *Toxicodendron rydbergii* with a characteristic hanging garden forb understory of *Adiantum capillus-veneris, Aquilegia micrantha,* and *Mimulus eastwoodiae*. These are found in the Colorado Plateau area of the southwestern U.S. Hanging gardens occur in areas where springs form waterfalls on cliff faces either along the backwall of alcoves or on exposed cliff faces. They are spectacular lush wetlands, if small in area, and form a striking contrast in the dry desert environment.

Environmental Description

Global Environment: The vegetation occurs in "hanging gardens" which are spring-fed wetlands of cliff faces. The source of water is above the vegetation, emerging along geologic contacts that seep, drip, or pour onto underlying walls. Elevation ranges between 1170 and 1190 m. They are found

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primarily within alcoves on wet cliff faces. Vegetation is restricted to the seam. Some of the cliff-face spring locations are not "hanging gardens" but are classified as "hillslope springs," where the spring is not on a cliff but on a 30-60° slope. All locations have a northwest orientation. Spring flow is slow, often drying by mid-June. Springs occur within the Navajo-Kayenta interface and within the Kayenta Formation itself.

Vegetation Description

Global Vegetation: These are woody wetlands found in hanging gardens within alcoves of cliffs, dominated by *Toxicodendron rydbergii*, with 30-70% canopy cover. Herbaceous forb cover is always present in the understory with forbs such as *Adiantum capillus-veneris, Aquilegia micrantha*, and *Mimulus eastwoodiae*. Other woody species present include *Brickellia longifolia, Clematis ligusticifolia, Parthenocissus vitacea, Frangula betulifolia (= Rhamnus betulifolia)*, and *Quercus gambelii*; these are not always present and, if so, generally have no more than 5% cover, although one stand does have 30% *Quercus gambelii* along with 30% *Toxicodendron rydbergii*. One plot has 50% cover of *Apocynum cannabinum*. Graminoids may also occur, including *Juncus balticus, Phragmites australis, Calamagrostis scopulorum*, and *Carex aurea*.

Most Abundant Species

Characteristic Species

Global:

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (22-Aug-2016).

Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau and classification and data from **Glen Canyon National Recreation Area:** Springs research by John Spence, Ph.D., Chief Scientist, based on 6 plots from 2 locations, and from Vegetation Mapping Project, one plot GLCA.9701.

Element Distribution

Global Range: These small-patch wetlands occur in northern Arizona and southern Utah.

Nations: US
States/Provinces: AZ?, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:C?
Federal Lands: NPS (Glen Canyon)

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Element Sources

Global Description Author(s): G. Kittel
References: Spence 2008*, Western Ecology Working Group n.d.

2.C.5. Salt Marsh

2.C.5.ND. NORTH AMERICAN WESTERN INTERIOR BRACKISH MARSH, PLAYA & SHRUBLAND

M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland

G538. North American Desert Alkaline-Saline Marsh & Playa

Group Summary Description: This group is found in the intermountain western U.S. Associations are composed of densely vegetated seasonal wetlands, saltwater emergent marshes to barren and sparsely vegetated playas (generally <10% plant cover). Characteristic species may include *Allenrolfea occidentalis, Atriplex* spp., *Distichlis spicata, Grayia spinosa, Leymus cinereus, Leymus triticoides (= Elymus triticoides), Muhlenbergia* spp., *Poa secunda, Puccinellia lemmonii, Salicornia* spp., *Sarcobatus vermiculatus,* and *Triglochin maritima*. Soils and standing water (if present) are alkaline. Salt crusts are common where there are actively drying ponds, that can have saltgrass beds in depressions and sparse shrubs around the margins. Playa flats are intermittently, seasonally to semipermanently flooded, usually retaining water into the growing season and drying completely only in drought years. Many are associated with hot and cold springs, located in basins with internal drainage. Soils are alkaline to saline clays with hardpans. Seasonal drying exposes mudflats colonized by annual wetland vegetation. Water is prevented from percolating through the soil by an impermeable soil subhorizon and is left to evaporate. Soil salinity varies greatly with soil moisture and greatly affects species composition. During exceptionally wet years, increased precipitation can dilute soil salt concentrations which may allow less salt-tolerant species to become established or more abundant. Some stands occur on floodplains, along the margins of perennial lakes, and in alkaline closed basins, with extremely low-gradient shorelines.

A1332 Distichlis spicata Alkaline Wet Meadow Alliance

Alliance Summary Description: This alkaline or saline wetland herbaceous alliance covers grasslands of playas and ephemeral streams. Cover may be a sparse or dense herbaceous layer dominated by *Distichlis spicata*, sometimes occurring in nearly pure stands, or with any of the following as a codominant: *Carex filifolia, Hordeum jubatum, Juncus balticus, Pascopyrum smithii, Puccinellia nuttalliana*, and/or *Sporobolus airoides*. Forb cover is generally low and may include Asteraceae spp., *Helianthus* spp., *Salicornia rubra, Suaeda calceoliformis (= Suaeda depressa),* and *Triglochin maritima*. Occasionally *Suaeda* may be the dominant species and *Distichlis* may be completely absent. This alliance occurs throughout much of the semi-arid and arid western U.S. on saline or alkaline soils in lowland sites such as playas, swales and terraces along washes that are seasonally, temporarily or intermittently flooded. Soils are deep, saline, alkaline and fine-textured. They generally have an impermeable layer and therefore are poorly drained. When the soil is dry, the surface usually has salt accumulations.

[CEGL001770] *Distichlis spicata* Alkaline Wet Meadow

Translated Name: Saltgrass Alkaline Wet Meadow
Common Name: Saltgrass Saline Prairie

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USNVC Classification

Division: North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup: Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group: North American Desert Alkaline-Saline Marsh & Playa (G538)
Alliance: *Distichlis spicata* Alkaline Wet Meadow Alliance (A1332)

Element Concept

Global Summary: These grasslands occur in semi-arid and arid western North America from southern Saskatchewan, Canada, to Mexico. Vegetation cover is sparse to dense and is dominated by *Distichlis spicata*, occurring in nearly pure stands. Minor cover of associated graminoids may include *Muhlenbergia asperifolia, Hordeum jubatum, Pascopyrum smithii, Sporobolus airoides, Carex filifolia, Eleocharis palustris, Puccinellia nuttalliana*, and *Juncus balticus*. Associated forbs, such as *Iva axillaris, Helianthus* spp., Asteraceae spp. (from lower salinity sites), *Salicornia rubra, Triglochin maritima*, and *Suaeda* spp., may also be present. Shrubs are rare, but scattered *Atriplex canescens* and *Sarcobatus vermiculatus* may be present. Stands are found in lowland habitats such as playas, swales, and terraces along washes that are typically intermittently to seasonally flooded. The flooding is usually the result of highly localized thunderstorms or winter rains which can flood one basin and leave the next dry. However, this association may also occur in other flood regimes (temporarily and semipermanently). Soil texture ranges from clay loam, silty loam, to sandy clay. These soils are often deep, saline and alkaline. They generally have an impermeable layer and therefore are poorly drained. When the soil is dry, the surface usually has salt accumulations. Salinity is likely more important than flooding as an environmental factor.

Environmental Description

Glen Canyon National Recreation Area Environment: This rare and small-patch association is known only from three sites on a mesa, slump, and along a drainage on gentle slopes to moderate slopes (up to 10%) at elevations of 1521 and 1602 m. Soils are rapidly drained sands derived from alluvial deposits on top of Chinle or Moenkopi formation parent material and may be quite alkaline. The unvegetated surface is primarily composed of bare soil or sand and litter.

Global Environment: These grasslands occur in semi-arid and arid western North America on saline and alkaline soils from southern Saskatchewan, Canada, to Mexico. Elevation ranges from 1000-2300 m (3280-7545 feet). Stands are found in lowland habitats such as playas, swales, floodplains, and terraces along washes that are typically intermittently or seasonally flooded. The flooding is usually the result of highly localized thunderstorms or winter rains which can flood one basin and leave the next dry. However, this association may also occur in other flood regimes (temporarily and semipermanently). Soil texture ranges from clay loam, silty loam, to sandy clay (Johnston 1987). These soils are often deep, saline and alkaline. They generally have an impermeable layer and therefore are poorly drained. When the soil is dry, the surface usually has salt accumulations. Salinity is likely more important than flooding as an environmental factor.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Occurrences of this association are characterized by a moderately dense herbaceous layer clearly dominated by *Distichlis spicata* (with

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5-60% cover). Scattered shrubs occur and include *Ericameria nauseosa* (up to 14% cover), *Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus*, and *Gutierrezia sarothrae*. Forbs may be present with trace to low cover and include *Chenopodium* sp., *Lappula occidentalis*, and *Rumex hymenosepalus*. *Bromus tectorum* may be present with low to moderate cover. Scattered *Juniperus osteosperma* and *Tamarix chinensis* trees may be present on the margins of the community.

Global Vegetation: Cover is sparse to dense and is dominated by *Distichlis spicata*, occurring in nearly pure stands. Stands have higher diversity and cover during wet years and near boundaries with other vegetation types. Higher soil salinity favors *Distichlis spicata* over less salt-tolerant species. However, very high salinity will dwarf the *Distichlis spicata* and reduce cover. Generally, vegetation height and cover and species diversity tend to vary inversely with salinity on the plains but may increase on very saline sites (Brotherson 1987). Minor cover of associated graminoids may include *Muhlenbergia asperifolia, Hordeum jubatum, Pascopyrum smithii, Sporobolus airoides, Carex filifolia, Eleocharis palustris, Puccinellia nuttalliana*, and *Juncus balticus*. Associated forbs, such as *Iva axillaris, Helianthus* spp. and Asteraceae spp. (from lower salinity sites), *Chenopodium* sp., *Lappula occidentalis, Rumex hymenosepalus, Salicornia rubra, Triglochin maritima*, and *Suaeda* spp., may also be present. Shrubs are rare, but scattered *Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae*, and *Sarcobatus vermiculatus* may be present. Introduced species are present in some stands and may include *Bromus tectorum, Elymus repens, Lepidium latifolium, Lepidium perfoliatum, Bassia scoparia (= Kochia scoparia)*, and occasionally *Tamarix* spp.

Global Dynamics: The intermittent flooding regime combined with the high evaporation rate in these dry climates causes accumulations of soluble salts in the soil. Total vegetation cover (density and height), species composition, and soil salinity depend on the amount and timing of precipitation and flooding. Growth-inhibiting salt concentrations are diluted when the soil is saturated, allowing the growth of less salt-tolerant species and more robust growth of *Distichlis spicata*. As the saturated soils dry, the salt concentrates until it precipitates on the soil surface (Dodd and Coupland 1966, Ungar 1968). This osmotic stress of growing in alkaline and saline soils is compensated by the accumulation of proline by some halophytic species including *Distichlis spicata*. This aids the plants' water uptake by increasing the osmotic potential of the plant (Shupe et al. 1986). Vegetation forms zones at some saline sites, where species abundance is stratified by salt tolerance (Ungar et al. 1969, Shupe et al. 1986). In playas, the soil salinity at field capacity generally increases from the edge to the center allowing for several different vegetation stands to co-occur (Ungar 1967, 1970, Ungar et al. 1969). Microtopography can also affect vegetation structure. Where soil accumulates to form hummocks, less salt- and alkali-tolerant plants can occur (Ungar 1972, Johnston 1987).

Brotherson (1987) studied species in a saline meadow adjacent to the Great Salt Lake in Utah and found 5 vegetation zones all with *Distichlis spicata* present. The meadow sloped down and away from the shoreline for the first 4 zones, then up for the last. Soil pH and soluble salt levels followed the slope pattern with the lowest zone (4) having lower pH and salt concentrations and the highest cover of *Distichlis spicata* (99%) almost exclusively. The other higher salt zones were codominated by other species such as *Suaeda calceoliformis, Puccinellia nuttalliana, Salicornia rubra, Triglochin maritima,*

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Glaux maritima, or *Eleocharis palustris*. Zone 5 was dominated by *Eleocharis palustris* and had additional moisture from a nearby seep. The salts were concentrated in the higher elevation zones because of evaporation of the salt-laden water that was leached from the lower lying areas.

The warm-season grass *Distichlis spicata* is rhizomatous, tolerant of moderate grazing, and its roots resist trampling. Although relatively unpalatable, it can provide valuable winter forage for livestock, if needed. When grazed, *Distichlis spicata* generally increases because of reduced competition from other less grazing-tolerant species. If grazed heavily, *Distichlis spicata* will decline and may be replaced by less desirable warm-season grasses such as tumblegrass, *Schedonnardus paniculatus*, or *Hordeum jubatum* (Costello 1944b, Jones and Walford 1995). Weeds are generally not a problem because few grow well in saline soils. However, severely disturbed sites are susceptible to invasion by introduced species such as *Bromus tectorum, Lepidium latifolium, Lepidium perfoliatum,* and *Bassia hyssopifolia* (Franklin and Dyrness 1973).
Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Distichlis spicata*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Distichlis spicata*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Distichlis spicata*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Tamarix chinensis*

Global: Vulnerable Plants: *Cleome multicaulis* (G2G3); Invasive/Exotic Plants: *Bassia scoparia* (Low), *Bromus tectorum* (High), *Elymus repens* (High/Medium), *Lepidium latifolium* (High), *Lepidium perfoliatum* (Low/Insignificant)

Conservation Status Rank

Global Rank & Reasons: G5 (1-Feb-1996).

Related Concepts

Global Similar Types:
- *Distichlis spicata - (Hordeum jubatum, Poa arida, Sporobolus airoides)* Wet Meadow (CEGL002042) currently described only from the Great Plains.
- *Distichlis spicata - (Scirpus nevadensis)* Alkaline Wet Meadow (CEGL001773)

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- *Distichlis spicata - Hordeum jubatum - (Poa arida, Iva annua)* Wet Meadow (CEGL002031) currently described only from the Great Plains.
- *Distichlis spicata - Hordeum jubatum - Puccinellia nuttalliana - Plantago maritima* Saline Wet Meadow (CEGL002551) currently described only from the Great Plains.
- *Distichlis spicata - Hordeum jubatum - Puccinellia nuttalliana - Suaeda calceoliformis* Wet Meadow (CEGL002273) currently described only from the Great Plains.
- *Distichlis spicata - Lepidium perfoliatum* Wet Meadow (CEGL001772)
- *Distichlis spicata* - Mixed Herb Wet Meadow (CEGL001771)
- *Distichlis spicata - Schoenoplectus maritimus - Salicornia rubra* Wet Meadow (CEGL002043) currently described only from the Great Plains.
- *Distichlis spicata - Spartina* spp. Wet Meadow (CEGL002275) currently described only from the Great Plains.
- *Eleocharis palustris - Distichlis spicata* Marsh (CEGL001834)
- *Leymus cinereus - Distichlis spicata* Alkaline Wet Meadow (CEGL001481)
- *Pascopyrum smithii - Distichlis spicata* Wet Meadow (CEGL001580)
- *Polygonum* spp. - *Echinochloa* spp. - *Distichlis spicata* Playa Lake Wet Meadow (CEGL002039)
- *Sporobolus airoides - Distichlis spicata* Wet Meadow (CEGL001687)

Global Related Concepts:

- *Distichlis spicata ssp. stricta* Salt Meadow Plant Association (Baker 1984a) >
- *Distichlis spicata var. stricta* (Bourgeron and Engelking 1994) =
- *Distichlis spicata* (Evens et al. 2014) =
- *Distichlis spicata* Association (Buck-Diaz et al. 2012) =
- *Distichlis spicata* Association (Sikes et al. 2016) =
- *Distichlis spicata* Habitat Type (Hansen et al. 1995) =
- *Distichlis spicata* Herbaceous Vegetation (Carsey et al. 2003a) =
- *Distichlis spicata* Vegetation Zone I (Ralston 1969) >
- *Distichlis spicata* var. *spicata* (Kittel et al. 1999b) =
- *Distichlis stricta* Associations on Saline-Alkaline Soils (Franklin and Dyrness 1973) >
- *Distichlis stricta* Habitat Type (Daubenmire 1970) =
- *Distichlis* Meadow (Graham 1937) >
- DRISCOLL FORMATION CODE:V.C.5.a. (Driscoll et al. 1984) >
- Inland Saltgrass (*Distichlis spicata*) Dominance Type (Jones and Walford 1995) =
- Inland Saltgrass Monotype CT (Muldavin et al. 2000a) =
- Inland saltgrass (*Distichlis spicata* var. *spicata*) Plant Association (Kittel et al. 1999a) =
- Saltgrass Series (Sawyer and Keeler-Wolf 1995) >
- Saltgrass Zone (4) (Brotherson 1987) =
- The Salt-grass Association (Vestal 1914) =

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: This association is defined as a PNV vegetation type. This graminoid association is characteristically dominated by *Distichlis spicata*. Closely related communities include *Pascopyrum smithii - Distichlis spicata* Wet Meadow (CEGL001580), *Sporobolus airoides - Distichlis spicata* Wet Meadow (CEGL001687), and several others.

Element Distribution

Glen Canyon National Recreation Area Range: This very rare grassland association was sampled in Moody Canyon and on Fourmile Bench.

Global Range: This grassland association occurs in low areas in semi-arid and arid western North America from southern Saskatchewan, Canada, west to Washington and south to Arizona, Utah, California, New Mexico, and possibly northern Mexico.

Nations: CA, MX?, US
States/Provinces: AZ:S3, CA:S3, CO:S5, ID:S4, MT:S4, NM:S4, NV, OR:S4, SK, UT:S3S5, WA:S1?, WY:S3
TNC Ecoregions: 6:C, 8:C, 9:C, 10:C, 11:C, 15:C, 16:C, 17:C, 18:C, 19:C, 20:C, 23:C, 24:C, 26:C, 27:C, 28:C
USFS Ecoregions (1994/95): 261B:CC, 313D:CC, 315A:CC, 321A:CC, 322A:CC, 322B:CC, 322C:CC, 331A:CC, 331B:CC, 331C:C?, 331D:CC, 331F:CC, 331G:CC, 331H:CC, 331I:CC, 341B:CC, 341C:CC, 341D:CC, 341E:CC, 342A:CC, 342B:CC, 342C:CC, 342F:CC, 342G:CC, 342H:CC, 342I:CC, M262A:CC, M331E:CC, M331F:CC, M332E:CC, M341B:CC
USFS Ecoregions (2007): 341Bj:C
Federal Lands: NPS (Canyonlands, Channel Islands, Death Valley, Dinosaur, Glen Canyon, Great Basin, Great Sand Dunes, Lake Roosevelt, Mojave, Pinnacles); USFWS (Camas, Malheur NWR, Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Stream channel runs north to south when active. The canyon is characterized by steep cliffs and piles of boulders lower down. The banks of the channel are stabilized by *Distichlis spicata* and rocks.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (1 plot, 2 accuracy assessment points): (Plots: GLCA.4069; AA Points: GLCA_AA.1157, GLCA_AA.1759).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Coles, G. Kittel and J. Evens
References: Baker 1984a, Beatley 1976, Bourgeron and Engelking 1994, Brotherson 1987, Buck-Diaz et al. 2012, Bunin 1985, CNHP 2003, CNHP 2015, CNPS 2015b, Carsey et al. 2003a, Christy 2013, Coles et al. 2008a, Costello 1944b, Crouch 1961a, Daniels 1911, Daubenmire 1970, Dodd and Coupland 1966, Driscoll et al. 1984, Erixson et al. 2011b, Evens et al. 2014, Franklin and Dyrness 1973, Graham 1937, HDR 2014, Hansen et al. 1991, Hansen et al. 1995, Hyder et al. 1966, IDCDC 2005, Johnston 1987, Jones and Walford 1995, Kagan et al. 2004a, Keeler-Wolf and Vaghti 2000, Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1999a, Kittel et al. 1999b, Kittel et al. 2012a, Klipple and Costello 1960, MTNHP 2002b, Muldavin et al. 2000a, Osborn 1974, Peterson 2008, Pickart 2006, Ralston 1969, Ramaley 1942, Rogers 1953, Salas et al. 2010b, Sawyer and Keeler-Wolf 1995, Sawyer et al. 2009, Schulz and Hall 2011, Shanks 1977, Shupe et al. 1986, Sikes et al. 2016, Soil Conservation Service 1978, Solomeshch and Barbour 2006, Stearns-Roger, Inc. 1978, Thorne 1976,

Tuhy and Jensen 1982, Ungar 1967, Ungar 1968, Ungar 1970, Ungar et al. 1969, Vestal 1914, Von Loh et al. 2002, WNHP unpubl. data, Weaver and Albertson 1956, Western Ecology Working Group n.d.*, Zedler et al. 1992

A1334 Sporobolus airoides - Muhlenbergia asperifolia - Spartina gracilis Alkaline Wet Meadow Alliance
Alliance Summary Description: Vegetation included in this alliance is characterized by grasslands and meadows dominated by *Muhlenbergia asperifolia, Poa secunda, Puccinellia lemmonii, Puccinellia nuttalliana, Spartina gracilis,* and/or *Sporobolus airoides,* any of which may form monotypic stands. Other species that co-occur include *Carex microptera, Distichlis spicata, Elymus elymoides, Hordeum brachyantherum, Juncus balticus, Juncus ensifolius, Muhlenbergia richardsonis, Pascopyrum smithii,* and/or *Pseudoroegneria*. Forb cover is generally low with *Achillea millefolium, Arnica longifolia, Iris missouriensis, Stellaria longipes,* the annuals *Montia linearis* and *Trifolium cyathiferum,* and may include species of *Atriplex, Polygonum,* and *Rumex*. Shrubs are rare, but because of the patchy distribution of these stands, scattered *Atriplex canescens* and *Sarcobatus vermiculatus* may be present. Sites are found in lowland habitats such as playas, swales, terraces along intermittently flooded washes, and alkali flats. Any flooding that occurs tends to be the result of localized thunderstorms in the summer. Soils are variable, ranging from deep, fine-textured soil to shallow sand deposits. They are alkaline and may be moderately saline and poorly drained due to an impermeable layer. Stands are documented from eastern Oregon, Washington, California, Nevada, Colorado, Utah, and New Mexico.

[CEGL001779] *Muhlenbergia asperifolia* Wet Meadow
Translated Name: Scratchgrass Wet Meadow
Common Name:

USNVC Classification

Division: North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup: Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group: North American Desert Alkaline-Saline Marsh & Playa (G538)
Alliance: *Sporobolus airoides - Muhlenbergia asperifolia - Spartina gracilis* Alkaline Wet Meadow Alliance (A1334)

Element Concept

Global Summary: In Colorado, these alkaline meadows are restricted to poorly drained low lands and alkaline soils. Stands are characterized by sparse cover of *Muhlenbergia asperifolia* and *Spartina gracilis*. Information on stands that occur outside Colorado will be added later.

Environmental Description

Vegetation Description

Most Abundant Species

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Muhlenbergia asperifolia*

Characteristic Species

Global: Muhlenbergia asperifolia

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GU (23-Feb-1994). The community is documented on the western slope and in the eastern Great Plains of Colorado. It is probably not uncommon to find this alkali-tolerant community in and adjacent to arroyos throughout the Great Basin desert of Nevada and Utah, the Four Corners region of New Mexico, Utah, Colorado and Arizona, and in the dry, shortgrass region of the western Great Plains. There is information from Colorado, but more data are needed from other states to assign a global rank other than GU.

Related Concepts

Global Related Concepts:

- *Muhlenbergia asperifolia* (Kittel et al. 1999b) =
- *Muhlenbergia asperifolia* (Bourgeron and Engelking 1994) =
- *Muhlenbergia asperifolia* Herbaceous Vegetation (Carsey et al. 2003a) =
- DRISCOLL FORMATION CODE:V.C.5.a. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 3 - Weak
Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Element Distribution

Nations: US
States/Provinces: AZ, CO:S2, NM, NV, UT
TNC Ecoregions: 10:C, 11:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:C?, 342G:CC, M331F:CC, M331H:CC, M341B:CC
Federal Lands: NPS (Glen Canyon, Grand Canyon, Great Sand Dunes); USFWS (Bosque del Apache)

Element Sources

Global Description Author(s): Western Ecology Group:

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Subset: GLCA; Glen Canyon National Recreation Area

References: Bolen 1964, Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Carsey et al. 2003a, Donnelly et al. 2006, Driscoll et al. 1984, Kittel and Lederer 1993, Kittel et al. 1999b, Reid and Hall 2010, Salas et al. 2010b, USBOR 1976, Western Ecology Working Group n.d.*

[CEGL001685] *Sporobolus airoides* Southern Plains Wet Meadow
Translated Name: Alkali Sacaton Southern Plains Wet Meadow
Common Name: Southern Plains Alkali Sacaton Grassland

USNVC Classification

Division: North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup: Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group: North American Desert Alkaline-Saline Marsh & Playa (G538)
Alliance: *Sporobolus airoides - Muhlenbergia asperifolia - Spartina gracilis* Alkaline Wet Meadow Alliance (A1334)

Element Concept

Global Summary: This alkali sacaton mesic grassland community is found in the southwestern Great Plains, on the Colorado Plateau, in the southwestern United States, and adjacent Mexico. The community is dominated by medium-tall and short grasses. *Sporobolus airoides* is a dominant, often accompanied by *Symphyotrichum subulatum (= Aster subulatus), Pascopyrum smithii, Buchloe dactyloides, Distichlis spicata, Hordeum jubatum,* and *Bouteloua gracilis*. Scattered shrubs, such as *Atriplex* spp. or *Sarcobatus vermiculatus*, may be present. Forb cover is also minor. Stands occur on slightly to moderately saline, nearly level bottomlands and terraces. Additional moisture from washes and sheetflow runoff are important for most stands. Substrates are shallow, moderately well- to poorly drained, silty clay soils formed in alluvium.

Environmental Description

Glen Canyon National Recreation Area Environment: This herbaceous association occurs on intermittently flooded, low level sites including canyon bottoms, stream terraces, and along washes/drainage channels. Sites are flat or slope gently and occur between 1333 and 1629 m elevation. Bare soil or sand and litter cover most of the unvegetated surface depending on the density of grasses, with low to moderate cover by bedrock, large and small rocks. Soils are well-drained to rapidly drained sandy loams or loamy sands derived from alluvium.

Global Environment: This grassland community occurs on alluvial toeslopes and flats, terraces, floodplain depressions, and sandy streambanks and washes in bottomlands throughout the southern Great Plains and Colorado Plateau. Additional moisture from washes and sheetflow runoff are important for most stands. Elevations range from below 1000 m (3050 feet) to over 2000 m (6100 feet). Sites are typically flat to gently sloping but may be as steep as 30% slope. Soils are shallow to moderately deep, moderately well- to poorly drained, alkaline, and often saline with sandy, silty or clay soils (Francis 1986, Johnston 1987, Kittel et al. 1999a, Lauver et al. 1999, Von Loh et al. 2002). Other parent materials include lava flow, cinders, relict Pleistocene river cobbles, and sandstone.

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Vegetation Description

Glen Canyon National Recreation Area Vegetation: This alkali sacaton grassland grows along canyon bottoms and stream terraces within the recreation area. Total vegetation cover ranges from 3 to 29% and is dominated by the bunchgrass *Sporobolus airoides*, with 2-26% cover. Shrubs may be present but do not have enough cover to constitute a stratum (generally <5% total shrub cover). Common species include *Atriplex confertifolia, Ericameria nauseosa, Ephedra torreyana, Coleogyne ramosissima, Purshia stansburiana*, and *Yucca angustissima*. Scattered trees of *Pinus edulis, Juniperus osteosperma*, and *Tamarix chinensis* may occur along wash channels nearby or widely scattered throughout stands of this grassland. Other herbaceous species present may include *Artemisia campestris, Stanleya pinnata, Achnatherum hymenoides*, and *Salsola tragus*.

Global Vegetation: This association is characterized by a sparse to moderately dense (15-75% cover), medium-tall graminoid layer dominated by *Sporobolus airoides*. Associated species include *Achnatherum hymenoides, Artemisia campestris, Symphyotrichum subulatum (= Aster subulatus), Buchloe dactyloides, Distichlis spicata, Hordeum jubatum, Bouteloua gracilis, Panicum obtusum, Pleuraphis jamesii, Salsola tragus, Sphaeralcea* spp., *Sporobolus cryptandrus, Stanleya pinnata*, and *Pascopyrum smithii* (Francis 1986, Johnston 1987, Kittel et al. 1999a, Lauver et al. 1999, Von Loh et al. 2002). Scattered shrubs may be present, such as *Atriplex canescens, Atriplex confertifolia, Coleogyne ramosissima, Ephedra* spp., *Ericameria nauseosa, Gutierrezia sarothrae, Purshia stansburiana, Sarcobatus vermiculatus* and /or *Yucca angustissima*. Total shrub cover is low (<10%), and forb cover is minor.

Global Dynamics: This is an early-seral community that occurs on floodplains and depressions with moderately saline soils (Aldous and Shantz 1924 as cited in Johnston 1987). While the stand sampled may be flooded infrequently, other stands of *Sporobolus airoides* (alkali sacaton) are reported to occur on soils not flooded but with high water tables because of land position. The intermittent flood regime affects soil moisture and salinity which can alter species composition. Sudden increases in salinity will result in a decrease in cover of *Sporobolus airoides*. With no change in salinity, this plant association will form hummocks that accumulate sand. Gradually the sites will decrease in salinity, and moisture and invasion by other grasses will follow (Ungar 1974a as cited in Johnston 1987). Soils are non-saline to moderately saline and usually alkaline. *Sporobolus airoides* will decrease in abundance with increased soil salinity.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Sporobolus airoides*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Sporobolus airoides*

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Characteristic Species

Glen Canyon National Recreation Area:
Global: *Sporobolus airoides*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Salsola tragus*, *Tamarix chinensis*
Global: Vulnerable Plants: *Tiquilia latior* (G3G4)

Conservation Status Rank

Global Rank & Reasons: G3Q (9-Apr-1998). The number of occurrences is unknown. The community is reported from Arizona, Colorado (S3), Kansas, New Mexico (S2), Texas, Utah, and Mexico and may occur in California. The community is found on slightly to moderately saline, nearly level bottomland and terraces with alluvial silty clay soils.

Related Concepts

Global Similar Types:

- *Distichlis spicata - (Hordeum jubatum, Poa arida, Sporobolus airoides)* Wet Meadow (CEGL002042) found in the southeastern Great Plains.
- *Gutierrezia sarothrae / Sporobolus airoides - Pleuraphis jamesii* Shrub Grassland (CEGL001776)
- *Pleuraphis jamesii - Sporobolus airoides* Grassland (CEGL001778)
- *Sporobolus airoides - Bouteloua gracilis* Grassland (CEGL001686) found only in New Mexico.
- *Sporobolus airoides - Distichlis spicata* Wet Meadow (CEGL001687)
- *Sporobolus airoides - Muhlenbergia porteri* Grassland (CEGL001689)
- *Sporobolus airoides - Scleropogon brevifolius* Grassland (CEGL001692)
- *Sporobolus airoides* Monotype Wet Meadow (CEGL001688)
- *Sporobolus airoides* Northern Plains Marsh (CEGL002274) occurs in the northwestern Great Plains.

Global Related Concepts:

- *Sporobolus airoides - Agropyron smithii* Plant Community (Francis 1986) **?**
- *Sporobolus airoides - Elytrigia smithii* Plant Association (Johnston 1987) **?**
- *Sporobolus airoides* (Kittel et al. 1999b) **=**
- *Sporobolus airoides* (Bourgeron and Engelking 1994) **=**
- *Sporobolus airoides* Southern Plains Herbaceous Vegetation (Carsey et al. 2003a) **=**
- DRISCOLL FORMATION CODE:V.B.4.b. (Driscoll et al. 1984) **>**

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: Compare this association with *Sporobolus airoides - Bouteloua gracilis* Grassland (CEGL001686) and *Pleuraphis jamesii - Sporobolus airoides* Grassland (CEGL001778). Stands in Montana are placed with *Sporobolus airoides* Northern Plains Marsh (CEGL002274), which occurs in the northwestern Great Plains, and this type is restricted to the southwestern Great Plains and southwestern United States. In the southeastern Plains see *Distichlis spicata - (Hordeum jubatum, Poa arida, Sporobolus airoides)* Wet Meadow (CEGL002042).

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon herbaceous association is of limited distribution in the recreation area and was only sampled in the Orange Cliffs section, specifically in Millard Canyon and the Millard Canyon benches, Elaterite Basin, Waterhole Flat, and above Deadhorse Canyon.

Global Range: This alkali sacaton mesic grassland community is found in the southwestern Great Plains, Colorado Plateau and elsewhere in the southwestern United States and Mexico, ranging from Kansas and Colorado south to Texas, New Mexico and west to Arizona, Utah, and possibly California.

Nations: MX, US
States/Provinces: AZ, CA?, CO:S2, KS:S2, MT:S2, MXCO, NM:S2, TX, UT
TNC Ecoregions: 10:C, 19:C, 20:C, 24:C, 27:C, 28:C
USFS Ecoregions (1994/95): 262:P, 313B:CC, 313D:CC, 315B:CC, 321A:CC, 322:P, 331I:CC, 341B:CC, 341C:CC, M331G:CC, M331I:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Colorado, Glen Canyon, Lake Meredith, Petrified Forest, Wupatki); USFWS (Bosque del Apache, Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This low level area is one terrace above the channel. The soils are alluvial, though this area rarely floods. Physical crusting has occurred here with some biocrusts. Clumps of *Sporobolus* inhibit erosion, which has created small mounds.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2014 field data (3 plots, 4 accuracy assessment points): (Plots: GLCA.0541, GLCA.0751, GLCA.9512; AA Points: GLCA_AA.0200, GLCA_AA.0297, GLCA_AA.0335, GLCA_AA.0351).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Drake, K.A. Schulz and J. Coles
References: Aldous and Shantz 1924, Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Carsey et al. 2003a, Clark et al. 2009, Coles et al. 2003, Coles et al. 2009a, Donnelly et al. 2006, Driscoll et al. 1984, Francis 1986, Hansen et al. 2004b, Johnston 1987, Kittel and Lederer 1993, Kittel et al. 1999b, Lauver et al. 1999, Lindauer 1970, MTNHP 2002b, Romme et al. 1993, Soil Conservation Service 1978, Steward 1982, Thomas et al. 2009a, Von Loh et al. 2002, Von Loh et al. 2007, Western Ecology Working Group n.d.*

G537. North American Desert Alkaline-Saline Wet Scrub

Group Summary Description: This group occurs throughout much of the western U.S. in intermountain basins. Stands typically occur near drainages on stream terraces and flats or may form rings around more sparsely vegetated playas. Sites typically have saline soils, a shallow water table and flood intermittently, but remain dry for most growing seasons. The water table remains high enough to maintain vegetation, despite salt accumulations. This group consists of open to moderately dense shrublands dominated by *Atriplex lentiformis, Atriplex parryi, Atriplex polycarpa, Atriplex spinifera, Allenrolfea occidentalis, Salicornia rubra, Sarcobatus vermiculatus, Sesuvium verrucosum*, and/or

Suaeda moquinii. Stands may be monotypic or have lesser abundance of other shrubs such as *Atriplex canescens, Atriplex confertifolia, Atriplex gardneri, Artemisia tridentata ssp. wyomingensis, Artemisia tridentata ssp. tridentata, Artemisia cana ssp. cana, Baccharis* spp., *Krascheninnikovia lanata*, and others. The herbaceous layer, if present, is usually dominated by graminoids. There may be inclusions of *Calamovilfa longifolia, Distichlis spicata* (where water remains ponded the longest), *Eleocharis palustris, Pascopyrum smithii, Poa pratensis, Puccinellia nuttalliana*, or *Sporobolus airoides* herbaceous types.

A0798 Pluchea sericea Wet Shrubland Alliance

Alliance Summary Description: Pluchea sericea is dominant or codominant in an open to continuous shrub layer with Allenrolfea occidentalis, Atriplex canescens, Atriplex lentiformis, Atriplex torreyi, Baccharis salicifolia, Baccharis sergiloides, Salix exigua, Suaeda moquinii, and Tamarix spp. Emergent trees may be present at low cover, including Populus fremontii, Populus balsamifera ssp. trichocarpa (= Populus trichocarpa), or Prosopis glandulosa. The herbaceous layer is sparse to continuous and often includes Phragmites australis and sometimes includes Distichlis spicata. The alliance is found in the Great Central Valley and desert areas of California, Nevada, Utah and Arizona. It occurs on playas, basin floors, channel beds, spring-fed slopes, springs, seeps, irrigation ditches, canyon bottoms, stream borders, and seasonally flooded washes. Soils are alluvial- or eolian-derived sands or clay loams from a variety of substrates that are usually alkaline or saline. Textures are variable.

[CEGL003080] *Pluchea sericea* Wet Shrubland

Translated Name: Arrow-weed Wet Shrubland

Common Name:

USNVC Classification

Division: North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup: Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group: North American Desert Alkaline-Saline Wet Scrub (G537)
Alliance: *Pluchea sericea* Wet Shrubland Alliance (A0798)

Element Concept

Global Summary: This evergreen shrubland is found in wetlands from southern California to the Sonoran Desert, and extends north into the Colorado Plateau in southwestern Utah. The vegetation is characterized by a moderately dense to dense short- to tall-shrub layer (1-5 m tall) that is dominated by *Pluchea sericea*, often forming pure stands. Stands generally form small patches within other wetland and riparian vegetation. Other species are present with low cover and vary regionally. Shrub associates may include *Allenrolfea occidentalis*, *Atriplex* spp., *Baccharis* spp., *Prosopis* spp., *Salix exigua, Suaeda moquinii*, and introduced *Tamarix* spp. The typically sparse herbaceous layer, if present, may be composed of *Distichlis spicata, Schoenoplectus americanus (= Scirpus americanus), Sporobolus airoides*, or *Typha angustifolia*. The presence of weedy species is common in disturbed stands. Elevation ranges from sea level to 1220 m (4000 feet). Stands occur in canyon bottoms, irrigation ditches, streamsides, floodplains, and along the margins of springs. Sites are flat to gently sloping and

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are permanently or seasonally flooded with a high water table. Water chemistry may be fresh or saline/alkaline. Substrates are generally alluvial and vary from well-drained to poorly drained and coarse-textured to fine-textured soil.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland occurs along intermittently to perennially flooded drainage channels in canyon bottoms and along perennial streams. Sites are flat to moderately sloping (up to 12°) and occur between 942 and 1156 m elevation. Bare soil or sand and litter cover most of the unvegetated surface, with lesser cover by live vegetation stems and water. Soils are poorly drained to moderately well-drained to rapidly drained sands, silts, or silt loams derived from alluvium.

Global Environment: This evergreen shrubland is found in wetlands in southern California, the Mojave, Colorado and Sonoran deserts, and extends north into the Colorado Plateau in southwestern Utah. Elevation ranges from sea level to 1220 m (4000 feet). Stands occur in canyon bottoms, irrigation ditches, streamsides, floodplains, and along the margins of springs. Sites are flat to gently sloping and are permanently or seasonally flooded with a high water table. Water chemistry may be fresh or saline/alkaline. Substrates are generally alluvial and vary from well-drained to poorly drained and coarse-textured to fine-textured soil.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This riparian shrubland has 21 to 91% total vegetation cover, and is characterized by 2- to 5-m tall *Pluchea sericea* shrubs, with 7-90% cover, often with a mix of other shrubs in the canopy (though none has greater cover than *Pluchea sericea*). Other tall shrubs present include *Salix exigua, Tamarix chinensis, Baccharis salicina, Ericameria nauseosa*, and *Quercus gambelii*; short shrubs include *Isocoma rusbyi, Atriplex canescens, Suaeda moquinii, Gutierrezia sarothrae*, and *Opuntia* sp. Herbaceous species may have moderate cover in the understory and include native species *Phragmites australis, Muhlenbergia asperifolia, Schizachyrium scoparium, Juncus balticus, Artemisia ludoviciana, Heterotheca villosa, Solidago velutina*, and *Euthamia occidentalis (= Solidago occidentalis)*, and the non-native species *Bromus tectorum, Bromus rubens, Schismus barbatus*, and *Saccharum ravennae*. Scattered trees of *Populus fremontii* and *Salix gooddingii* may be present with low cover.

Global Vegetation: This plant association is characterized by a moderately dense to dense short- to tall-shrub layer (1-5 m tall) that is dominated by *Pluchea sericea*, often forming pure stands. Stands generally form small patches within other wetland and riparian vegetation. Other species are present with low cover and vary regionally. Shrub associates may include *Allenrolfea occidentalis, Atriplex canescens, Atriplex torreyi, Baccharis emoryi, Baccharis salicina, Baccharis sergiloides, Ericameria nauseosa, Prosopis glandulosa, Prosopis pubescens, Quercus gambelii, Salix exigua, Suaeda moquinii*, and introduced *Tamarix* spp. Scattered trees of *Populus fremontii* and *Salix gooddingii* may be present with low cover. The typically sparse herbaceous layer, if present, is typically composed of *Artemisia ludoviciana, Distichlis spicata, Euthamia occidentalis (= Solidago occidentalis), Juncus balticus, Heterotheca villosa, Muhlenbergia asperifolia, Phragmites australis, Schoenoplectus americanus (= Scirpus americanus), Schizachyrium scoparium, Sporobolus airoides, Solidago*

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velutina, or *Typha angustifolia*. Non-native weedy species such *Bromus tectorum, Bromus rubens, Erodium cicutarium, Lactuca* spp., *Melilotus officinalis, Schismus barbatus,* and *Saccharum ravennae* are common in disturbed stands.

Global Dynamics: This riparian association grows in seasonally flooded, freshwater and brackish habitats with permanently saturated ground. Exotic tamarisk species have invaded many occurrences of this alliance.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Baccharis salicina*, *Pluchea sericea*
Short shrub/sapling	Dwarf-shrub	*Isocoma rusbyi*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Pluchea sericea*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Pluchea sericea*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Saccharum ravennae* (Medium/Low), *Schismus barbatus* (High/Medium), *Tamarix chinensis*

Global:

Conservation Status Rank

Global Rank & Reasons: G3? (1-Dec-1997).

Related Concepts

Global Related Concepts:

- *Pluchea sericea* (Sawyer et al. 2009) =
- *Pluchea sericea* Seasonally Flooded (Evens et al. 2014) =
- Arrow Weed Series (Sawyer and Keeler-Wolf 1995) >
- Arrowweed Scrub (#63820) (Holland 1986b) >

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau and Mojave Desert.

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Subset: GLCA; Glen Canyon National Recreation Area

Element Distribution

Glen Canyon National Recreation Area Range: This riparian shrubland is found along drainage channels and perennial streams within the recreation area and was sampled in Fiftymile Gulch, Sevenmile Creek, near the Escalante River-Lake Powell confluence, near Lee's Ferry, and along the Paria River.

Global Range: This association occurs in wetlands in southern California, the Mojave, Colorado and Sonoran deserts, and extends north into the Colorado Plateau in southern Utah.

Nations: US
States/Provinces: AZ, CA:S3, NV, UT
TNC Ecoregions: 6:C, 13:C, 15:C, 16:C, 17:C, 19:C, 23:C
USFS Ecoregions (1994/95): 261B:CC, 262A:CC, 313A:CC, 322A:CC, 322B:CC, 322C:CC, 331A:CC, M262A:CC
Federal Lands: NPS (Death Valley, Glen Canyon, Grand Canyon, Lake Mead, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plant distribution controlled by Paria River streamflow.

Glen Canyon National Recreation Area Plots: The description is based on 2011, 2012, 2013, and 2015 field data (4 plots, 2 accuracy assessment points): (Plots: GLCA.2039, GLCA.4332, GLCA.5188, GLCA.5432; AA Points: GLCA_AA.1418, GLCA_AA.1610).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Barbour and Major 1977, Beatley 1976, Cogan et al. 2004, Evens et al. 2014, Holland 1986b, Reid and Hall 2010, Sawyer and Keeler-Wolf 1995, Sawyer et al. 2009, Western Ecology Working Group n.d.*

A1046 Sarcobatus vermiculatus Intermountain Wet Shrubland Alliance

Alliance Summary Description: Shrublands included in this alliance are dominated or codominated by *Sarcobatus vermiculatus*. Other shrubby codominants include *Artemisia cana, Artemisia tridentata, Atriplex confertifolia, Atriplex gardneri, Chrysothamnus* spp., *Collomia linearis, Grayia spinosa,* or *Picrothamnus desertorum (= Artemisia spinescens)*. In more saline environments, *Nitrophila occidentalis* and *Suaeda moquinii* may be present. If present, the sparse to moderate herbaceous layer is dominated by perennial grasses, such as *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Distichlis spicata, Elymus elymoides, Hordeum jubatum, Leymus cinereus, Nassella viridula, Pascopyrum smithii, Poa secunda (= Poa juncifolia),* and *Sporobolus airoides*. Forbs are generally sparse except on disturbed weedy sites. The native perennial forbs include *Achillea millefolium, Artemisia ludoviciana, Astragalus* spp., *Chenopodium fremontii, Glycyrrhiza lepidota,* and *Opuntia polyacantha*. Perennial forbs are typically sparse and often include *Grindelia squarrosa, Iva axillaris,* and *Sphaeralcea coccinea*. Annual grasses, especially the exotic *Bromus* spp., may be present to abundant. Forbs are common on disturbed sites. Weedy annual forbs may include the exotics

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Descurainia spp., *Helianthus annuus, Halogeton glomeratus, Lactuca serriola,* and *Lepidium perfoliatum*. This alliance occurs throughout the arid and semi-arid western United States. Sites are generally flat, poorly drained, seasonally, temporarily or intermittently flooded with a shallow or perched water table often within 1 m depth such as alkali flats around playas and floodplains along stream channels. Substrates are generally shallow, calcareous, fine-textured soils derived from alluvium. Soils are alkaline and typically moderately saline.

[CEGL001360] Sarcobatus vermiculatus / Atriplex gardneri Wet Shrubland
Translated Name: Greasewood / Gardner's Saltbush Wet Shrubland
Common Name:

USNVC Classification

Division: North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup: Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group: North American Desert Alkaline-Saline Wet Scrub (G537)
Alliance: *Sarcobatus vermiculatus* Intermountain Wet Shrubland Alliance (A1046)

Element Concept

Global Summary: This "badlands" association is reported from eastern Utah and western Colorado, across Wyoming to Big Horn Basin and up to northeastern Montana. Stands occur on all aspects of moderately steep to steep eroded slopes or on toeslopes composed of clay or shale sediments. Substrates are fine-textured, alkaline and saline, have low permeability, and are composed of acidic shale, bentonite, or some other highly erodible material. Bare ground and gravel make up the majority (80%) of the ground surface. The vegetation is characterized by a sparse to moderately dense (20-40% cover) woody layer codominated by the short shrub *Sarcobatus vermiculatus* and the dwarf-shrub *Atriplex gardneri*. Other shrubs and dwarf-shrubs include scattered *Artemisia tridentata, Picrothamnus desertorum (= Artemisia spinescens), Atriplex confertifolia, Ericameria nauseosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Suaeda calceoliformis, Suaeda moquinii*, and *Tetradymia canescens*. The graminoid layer, if present, is sparse and may include *Poa secunda, Achnatherum hymenoides, Elymus elymoides,* and the introduced annual *Bromus tectorum*. The forb layer is highly variable in cover and composition because much of it is annual, such as *Endolepis dioica (= Atriplex dioica)* and *Lappula squarrosa*. Common perennial forbs include *Iva axillaris, Machaeranthera canescens*, and *Allium textile*.

Environmental Description

Global Environment: This "badlands" association is reported from lower to middle elevations (1423-2074 m) in eastern Utah, northwestern Colorado, and across much of Wyoming to northeastern Montana. Stands occur on alluvial flats and gentle to steep (to 23°) eroded slopes or toeslopes and evaporational depressions eroded in clay or shale sediments. Substrates are fine-textured, alkaline and saline, have low permeability, and are derived from marine shale, bentonite, or other highly erodible material. Bare ground and gravel make up the majority (80% or more) of the ground surface, which may also have a white crust from the evaporation of saline soil water. The parent materials include

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Subset: GLCA; Glen Canyon National Recreation Area

Manco Shale and Wasatch Formation and other sandstones and shales that have eroded and deposited as alluvium.

Vegetation Description

Global Vegetation: The vegetation in this association is characterized by a sparse to moderately dense (less than 15 to 40% cover) woody layer codominated by the short shrub *Sarcobatus vermiculatus* and the dwarf-shrub *Atriplex gardneri*. Other shrubs and dwarf-shrubs include scattered *Artemisia tridentata, Picrothamnus desertorum (= Artemisia spinescens), Atriplex confertifolia, Ericameria nauseosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Suaeda calceoliformis, Suaeda moquinii,* and *Tetradymia canescens*. The graminoid layer, if present, is sparse and may include *Poa secunda, Achnatherum hymenoides, Elymus elymoides, Pascopyrum smithii*, and the introduced annual *Bromus tectorum*. The forb layer is highly variable in cover and composition because much of it is annual, such as *Endolepis dioica (= Atriplex dioica, = Atriplex suckleyi),* and *Lappula squarrosa*. Common perennial forbs include *Iva axillaris, Machaeranthera canescens*, and *Allium textile*. The exotic species *Halogeton glomeratus* may be abundant in disturbed stands.

Global Dynamics: Both *Sarcobatus vermiculatus* and *Atriplex gardneri*, like many facultative halophytes, are tolerant of highly alkaline and saline soil conditions that allow the species to occur in sites with less interspecific competition (Ungar et al. 1969, Bransen et al. 1976).

Most Abundant Species

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Sarcobatus vermiculatus*
Short shrub/sapling	Dwarf-shrub	*Atriplex gardneri*, *Gutierrezia sarothrae*

Characteristic Species

Global: Atriplex gardneri, Sarcobatus vermiculatus

Other Noteworthy Species

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Halogeton glomeratus* (High/Medium)

Conservation Status Rank

Global Rank & Reasons: G4? (1-Feb-1996).

Related Concepts

Global Similar Types:

- *Atriplex gardneri / Artemisia tridentata* Dwarf-shrubland (CEGL001440)
- *Atriplex gardneri* Dwarf-shrubland (CEGL001438)
- *Sarcobatus vermiculatus / Artemisia tridentata* Wet Shrubland (CEGL001359)
- *Sarcobatus vermiculatus / Pseudoroegneria spicata* Shrubland (CEGL001367)

Global Related Concepts:

- *Sarcobatus vermiculatus / Atriplex gardneri* Shrubland (Von Loh 2000) =

- *Sarcobatus vermiculatus / Atriplex nuttallii* community type (DeVelice et al. 1995) =
- *Sarcobatus vermiculatus / Atriplex nuttallii* community type (DeVelice et al. 1991) =
- *Sarcobatus vermiculatus / Atriplex nuttallii* community type (DeVelice and Lesica 1993) =
- *Sarcobatus vermiculatus/Atriplex gardneri* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.C.2.a. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 1 - Strong
Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Global Classification Comments: This type should be compared to *Sarcobatus vermiculatus / Pseudoroegneria spicata* Shrubland (CEGL001367). The two types may be synonymous since they occupy the same badlands slope habitat.

Element Distribution

Global Range: This shrubland association occurs on semi-arid shaly sites in western U.S. from western Colorado and eastern Utah across western Wyoming to Big Horn Basin in north-central Wyoming and northeastern Montana.

Nations: US
States/Provinces: CO, MT:S3, UT, WY:S4
TNC Ecoregions: 9:?, 10:C, 11:C, 19:C, 26:C
USFS Ecoregions (1994/95): 313A:??, 331D:C?, 331G:C?, 341B:C?, 341C:CC, 342A:CC, 342E:CC, 342F:CC, 342G:CC, M331B:C?, M331E:CC
Federal Lands: NPS (Dinosaur, Fossil Butte, Glen Canyon); USFWS (Ouray)

Element Sources

Global Description Author(s): K.A. Schulz and J. Coles
References: Bourgeron and Engelking 1994, Branson et al. 1976, Coles et al. 2008a, DeVelice and Lesica 1993, DeVelice et al. 1991, DeVelice et al. 1995, Driscoll et al. 1984, Friesen et al. 2010, Hamner 1964, Jones 1992b, MTNHP 2002b, Medicine Bow Mine Application n.d., Sweetwater Uranium Project 1978, Ungar et al. 1969, Von Loh 2000, Von Loh et al. 2002, Western Ecology Working Group n.d.*

[CEGL001368] Sarcobatus vermiculatus / Sporobolus airoides Wet Shrubland
Translated Name: Greasewood / Alkali Sacaton Wet Shrubland
Common Name:

USNVC Classification

Division: North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup: Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group: North American Desert Alkaline-Saline Wet Scrub (G537)
Alliance: *Sarcobatus vermiculatus* Intermountain Wet Shrubland Alliance (A1046)

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Element Concept

Global Summary: This association occurs in the Columbia and Wyoming basins, Colorado Plateau and western Great Plains from eastern Oregon, central and northeastern Wyoming, northwestern and southeastern Colorado, western New Mexico and eastern Utah. *Sarcobatus vermiculatus* typically dominates the open to moderately dense shrub layer with between 10 and 50% cover and includes sparse and open steppe stands with 5-10% shrub cover. Other shrubs present with low cover may include *Atriplex canescens, Ericameria nauseosa, Artemisia tridentata ssp. wyomingensis*, and *Artemisia tridentata ssp. tridentata*. The herbaceous understory is typically dominated by *Sporobolus airoides*, usually with a number of other species present, including *Pascopyrum smithii, Hordeum jubatum, Hesperostipa comata, Bouteloua gracilis, Elymus elymoides, Elymus lanceolatus ssp. lanceolatus*, and *Distichlis spicata*. Forbs generally contribute little cover, although several weedy or exotic forbs may be abundant. Stands of this type usually occur as small, relict patches on level to gently sloping valley floors, on alluvial fans along intermittent washes and streams, and on abandoned stream terraces with fine-textured to sandy, alkaline soils derived from alluvium. The water table rarely reaches the surface, and these sites flood only occasionally. Elevations range from 1180 to 1960 m (3870-6420 feet) in Colorado, New Mexico and Utah.

Environmental Description

Glen Canyon National Recreation Area Environment: Stands of this rare type occur as small, relict patches on level to gently sloping valley floor floodplains and terraces with fine-textured to sandy, alkaline soils derived from alluvium. Elevations range from 1183 to 1405 m. Bare soil and litter cover most of the unvegetated surface, with sparse cover of large rocks and moss.

Global Environment: Stands of this type usually occur as small, relict patches on level to gently sloping valley floors and on abandoned stream terraces with fine-textured to sandy, alkaline soils derived from alluvium. Elevations range from 1180 to 1960 m (3870-6420 feet) in Colorado, New Mexico and Utah. The water table is usually within 1 m of the surface for at least part of the growing season, although it may be a perched water table held by a hard pan just below the ground surface.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Total cover in these stands is moderate to high (25-71%) and *Sarcobatus vermiculatus* dominates the shrub layer with between 4 and 26% cover. Other shrubs present with low cover may include *Atriplex canescens, Atriplex confertifolia, Atriplex obovata, Chrysothamnus linifolius, Forestiera pubescens, Tamarix chinensis*, and *Gutierrezia sarothrae*. The herbaceous understory is dominated by *Sporobolus airoides*, with 10-30% cover. Otherwise the herbaceous layer has low cover and little diversity; other species noted with more than trace cover include *Pleuraphis jamesii, Ambrosia acanthicarpa*, and *Plantago patagonica*. *Populus fremontii* trees may be present with low cover on the margins of the community, generally growing along nearby watercourses.

Global Vegetation: *Sarcobatus vermiculatus* dominates the shrub layer with between 10 and 50% cover. Other shrubs present with low cover may include *Artemisia tridentata ssp. wyomingensis, Artemisia tridentata ssp. tridentata, Atriplex canescens, Atriplex confertifolia, Atriplex obovata, Allenrolfea occidentalis, Chrysothamnus linifolius, Chrysothamnus viscidiflorus, Ericameria*

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nauseosa, Forestiera pubescens, and *Suaeda moquinii (= Suaeda torreyana)*. The herbaceous understory is often dominated by *Sporobolus airoides* and usually a number of other species, including *Pascopyrum smithii, Hordeum jubatum, Bouteloua gracilis, Elymus elymoides, Elymus lanceolatus ssp. lanceolatus, Pleuraphis jamesii,* and *Distichlis spicata*. Forbs generally contribute little cover, although several weedy or exotic forbs may be abundant.

Global Dynamics: This association depends on a high water table and alkaline soils. Disturbed stands are high in weedy forb species and have low cover of *Sporobolus airoides*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Succulent shrub	*Sarcobatus vermiculatus*
Herb (field)	Graminoid	*Sporobolus airoides*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Succulent shrub	*Sarcobatus vermiculatus*
Herb (field)	Graminoid	*Sporobolus airoides*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Sarcobatus vermiculatus, Sporobolus airoides*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Tamarix chinensis*
Global:

Conservation Status Rank

Global Rank & Reasons: G3? (1-Dec-2000). This association has been named from the Thunder Basin National Grassland of northeastern Wyoming, and it apparently also occurs along the North Platte and Sweetwater rivers in central Wyoming. It is ranked G3 because it has been described from a limited geographic range, and many stands seem to contain exotic plants. The lack of detailed descriptions or stand data make the rank questionable. As additional data become available and the full range of the association becomes better understood, this rank should be revisited. It appears that many stands in the Colorado Plateau that historically were this association have been degraded by grazing and water table collapse.

Related Concepts

Global Similar Types:

- *Sarcobatus vermiculatus / Distichlis spicata - (Puccinellia nuttalliana)* Shrub Wet Meadow (CEGL002146)

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- *Sarcobatus vermiculatus / Distichlis spicata* Wet Shrubland (CEGL001363)
- *Sarcobatus vermiculatus / Pascopyrum smithii - (Elymus lanceolatus)* Shrub Wet Meadow (CEGL001508)

Global Related Concepts:

- *Sarcobatus vermiculatus / Sporobolus airoides* Plant Community (Shaw et al. 1989) =
- *Sarcobatus vermiculatus/Sporobolus airoides* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.C.2.a. (Driscoll et al. 1984) >

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: This association was renamed to a shrubland association and moved from a sparsely vegetated to a shrubland alliance based on literature and plot review that indicated that, although some stands are sparse (<10% total vegetation cover), most are not and some have rather dense cover (50% cover of shrubs). This description is based on information from northeastern Wyoming, northwestern and southeastern Colorado and southern Utah. A general vegetation description and habitat description from central Wyoming are also available. The plant species listed for this association also occur in *Sarcobatus vermiculatus / Pascopyrum smithii - (Elymus lanceolatus)* Shrub Wet Meadow (CEGL001508), and this type may also be similar to *Sarcobatus vermiculatus / Distichlis spicata* Wet Shrubland (CEGL001363). These three associations apparently are differentiated on the basis of the relative amounts of the various grass species in the undergrowth. Grass dominance varies with soil salinity and aeration, and this association may represent the more saline but well-aerated conditions. Also compare this association with *Sarcobatus vermiculatus / Distichlis spicata - (Puccinellia nuttalliana)* Shrub Wet Meadow (CEGL002146).

Element Distribution

Glen Canyon National Recreation Area Range: This rare association was only sampled in Saddlehorse Bottom and Moody Creek.

Global Range: This association occurs in the Columbia and Wyoming basins, Colorado Plateau and western Great Plains from eastern Oregon, central and northeastern Wyoming, northwestern and southeastern Colorado, and eastern Utah.

Nations: US
States/Provinces: CO:S1, NM, OR:S4, UT, WY:S3?
TNC Ecoregions: 9:C, 10:C, 19:C, 20:C, 21:C, 26:C, 27:C
USFS Ecoregions (1994/95): 313B:CC, 331G:CC, 341B:CC, 342F:??, M331E:CC, M331F:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Dinosaur, El Malpais, Glen Canyon, Great Sand Dunes); USFS (Thunder Basin)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Disturbed floodplain but not a weedy understory.

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Glen Canyon National Recreation Area Plots: The description is based on 2014 and 2015 field data (2 accuracy assessment points): (AA Points: GLCA_AA.0015, GLCA_AA.1782).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): G.P. Jones, J. Coles and K.A. Schulz
References: Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Driscoll et al. 1984, Jones 1992b, Kagan et al. 2004a, Muldavin et al. 2013c, Romme et al. 1993, Salas et al. 2010b, Shaw et al. 1989, Terwilliger et al. 1979a, Terwilliger et al. 1979b, WNDD unpubl. data, Warren n.d., Western Ecology Working Group n.d.*

[CEGL001370] Sarcobatus vermiculatus / Suaeda moquinii Wet Shrubland
Translated Name: Greasewood / Mojave Seablite Wet Shrubland
Common Name:

USNVC Classification

Division: North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup: Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group: North American Desert Alkaline-Saline Wet Scrub (G537)
Alliance: *Sarcobatus vermiculatus* Intermountain Wet Shrubland Alliance (A1046)

Element Concept

Global Summary: This shrubland association is reported from the Colorado Plateau and Columbia Basin. The vegetation has a generally sparse shrub layer (<20% cover) that is less than 1.5 m tall and is codominated by *Sarcobatus vermiculatus* and *Suaeda moquinii*. The herbaceous layer is sparse. Sites are generally flat to gently sloping saline valley bottoms and toeslopes, river floodplains and playas at elevations ranging from 1179 to 1680 m (3870-5500 feet). Soils are deep, saline, alkaline clay loams.

Environmental Description

Glen Canyon National Recreation Area Environment: Stands of this rare type occur on level to gently sloping canyon bottoms at elevations of 1179-1184 m. Soils are fine-textured and alkaline and are derived from alluvium with shaley parent materials. Bare soil covers most of the unvegetated surface, with lesser cover of litter, and sparse to low cover of moss.

Global Environment: This shrubland association is reported from the Colorado Plateau and Columbia Basin. Sites are generally flat to gently sloping saline valley bottoms and toeslopes, along intermittent washes, floodplains and playas at elevations ranging from 1179 to 1680 m (3870-5500 feet). Soils are deep, saline, alkaline clay loams.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: These moderately to densely vegetated stands (25-75% total cover) are fairly homogenous and dominated by *Sarcobatus vermiculatus*, with 8-50% cover; no other shrubs are present in the shrub layer with more than trace cover. The understory is clearly dominated by *Suaeda moquinii (= Suaeda torreyana)*, with 16-22% cover, otherwise, only *Salsola tragus* was noted with more than trace cover.

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Global Vegetation: The vegetation has a generally sparse shrub layer (<20% cover), but includes some moderate to dense stands (25-70% cover), that is less than 1.5 m tall and codominated by *Sarcobatus vermiculatus* and *Suaeda moquinii (= Suaeda torreyana)*. The herbaceous layer is sparse. Common species include *Distichlis spicata* and *Sporobolus cryptandrus*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Succulent shrub	*Sarcobatus vermiculatus*
Herb (field)	Flowering forb	*Suaeda moquinii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Succulent shrub	*Sarcobatus vermiculatus*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Sporobolus cryptandrus*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Salsola tragus*
Global: Other Plants: *Suaeda moquinii* (G5)

Conservation Status Rank

Global Rank & Reasons: GUQ (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Sarcobatus vermiculatus / Atriplex confertifolia - (Picrothamnus desertorum, Suaeda moquinii)* Wet Shrubland (CEGL001371)
- *Sarcobatus vermiculatus / Distichlis spicata - (Puccinellia nuttalliana)* Shrub Wet Meadow (CEGL002146)
- *Suaeda moquinii* Wet Shrubland (CEGL001991)

Global Related Concepts:

- *Sarcobatus vermiculatus/Suaeda torreyana* (Bourgeron and Engelking 1994) =
- *Sarcobatus vermiculatus* Plant Community (Branson and Owen 1970) =
- DRISCOLL FORMATION CODE:III.C.2.a. (Driscoll et al. 1984) >
- Saltbush - Greasewood (501) (Shiflet 1994) >
- Saltbush-greasewood (Küchler 1964) >

Classification

Status: Standard
Classification Confidence: 3 - Weak

Global Classification Comments: Compare this association with *Sarcobatus vermiculatus / Distichlis spicata - (Puccinellia nuttalliana)* Shrub Wet Meadow (CEGL002146).

Element Distribution

Glen Canyon National Recreation Area Range: This very rare shrubland was only sampled in Anderson Bottom.

Global Range: This saline bottom association is reported from the Colorado Plateau into western Colorado and northern Arizona, and the Columbia Basin in eastern Oregon, and elsewhere in the western U.S.

Nations: US
States/Provinces: AZ, CO:S2, NM, NV, OR:S4, UT
TNC Ecoregions: 20:C, 24:C
USFS Ecoregions (1994/95): 313D:CC, 321A:CC, 341:C, M341:C
Federal Lands: NPS (Glen Canyon, Petrified Forest); USFWS (Bosque del Apache)

Element Sources

Glen Canyon National Recreation Area Plots: The description is based on 2014 field data (2 accuracy assessment points): (AA Points: GLCA_AA.0030, GLCA_AA.0372).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Bourgeron and Engelking 1994, Branson and Owen 1970, CNHP 2003, CNHP 2015, Donnelly et al. 2006, Driscoll et al. 1984, Kagan et al. 2004a, Küchler 1964, Peterson 2008, Shiflet 1994, Thomas et al. 2009a, Western Ecology Working Group n.d.*

[CEGL001357] *Sarcobatus vermiculatus* Disturbed Wet Shrubland
Translated Name: Greasewood Disturbed Wet Shrubland
Common Name:

USNVC Classification

Division: North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup: Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group: North American Desert Alkaline-Saline Wet Scrub (G537)
Alliance: *Sarcobatus vermiculatus* Intermountain Wet Shrubland Alliance (A1046)

Element Concept

Global Summary: This greasewood shrubland occurs on saline soils of terraces, swales, alluvial fans and flats, valley floors, playas, toeslopes and ridges throughout the Colorado Plateau and Great Basin and extends to mountain valleys in the southern Rocky Mountains. It is distinguished from other *Sarcobatus vermiculatus* associations in that disturbance has removed most or all of the native herbaceous understory. *Sarcobatus vermiculatus* dominates the sparse to moderately dense shrub layer, usually with a minor component of *Ericameria nauseosa, Suaeda moquinii (= Suaeda torreyana), Opuntia polyacantha, Atriplex canescens,* or *Atriplex confertifolia*. If *Artemisia tridentata*

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is present, it is with very low cover. The understory ranges from sparse to dense in cover, but native species typically have very low cover. The dominant herbaceous species tend to be weedy and/or exotic; *Vulpia octoflora, Bromus tectorum, Descurainia pinnata, Salsola tragus, Alyssum desertorum*, and *Halogeton glomeratus* are typical understory species. Soil textures in these communities range from sandy loam to silty clay and may have a white salt crust on the soil surface.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland occurs in low-lying areas, including canyon bottoms, benches, and stream terraces. Sampled sites are flat to gently sloping (up to 8°) between 1109 and 1412 m elevation. Most of the unvegetated surface consists of bare soil or sand and litter. Biological soil crusts have up to 40% cover in some stands. Soils are rapidly drained sandy loams derived from alluvium or from Chinle Formation shales.

Global Environment: This widespread but patchy shrubland occurs throughout the Colorado Plateau and Great Basin and extends to mountain valleys in the southern Rocky Mountains. Stands are found on terraces, swales, coppice dunes, playas, alluvial fans and flats, valley floors, toeslopes and ridges. Elevation ranges between 1100 and 2308 m (3600-7570 feet), and slopes tend to be gentle. Soils are typically derived from mixed alluvium (shale, sandstone and gneiss), from shale that erodes into moderate to steep gullies and slopes (badlands), or from eolian deposits. Soil textures range from sand to silty clay and tend to be alkaline and saline, often with a white salt crust on the soil surface. Sabkha substrates (carbonate cemented sand) occur on subirrigated areas near dunes in southern Colorado. Biological soil crusts are typically absent or provide low cover, but occasionally have higher (up to 40%) cover. Bare ground values tend to be high, up to 80%, unless there is an abundant herbaceous cover of non-native species, in which case litter cover values may be high.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This bottomland greasewood shrubland has a total vegetation cover of 6 to 100%. The canopy is overwhelmingly dominated by *Sarcobatus vermiculatus*, with 6-26% cover. Other shrubs present, rarely with more than trace cover, may include *Ericameria nauseosa, Atriplex canescens* (which was codominant in one stand), *Atriplex confertifolia, Gutierrezia sarothrae*, and *Opuntia* spp. Associated grasses include *Sporobolus cryptandrus* and *Bromus tectorum*. Forbs tend to be weedy and generally dominate the understory, especially *Salsola tragus*; other forbs commonly present include *Rumex hymenosepalus, Oenothera pallida,* and *Sphaeralcea ambigua*.

Global Vegetation: This shrubland occurs where conditions support *Sarcobatus vermiculatus,* but disturbance has removed most or all of the native herbaceous understory. *Sarcobatus vermiculatus* dominates the sparse to moderately dense shrub layer with a cover of 10-60%. Other shrubs commonly present may include *Atriplex canescens, Atriplex confertifolia, Atriplex gardneri, Chrysothamnus viscidiflorus, Ericameria nauseosa, Grayia spinosa, Gutierrezia sarothrae, Opuntia polyacantha, Picrothamnus desertorum, Suaeda moquinii (= Suaeda torreyana),* and *Tetradymia canescens*. If *Artemisia tridentata* is present, it is with very low cover. The understory ranges from sparse to dense in cover, but native species typically have very low cover and can include *Rumex hymenosepalus, Oenothera pallida, Sphaeralcea ambigua,* and *Sporobolus cryptandrus*. The dominant herbaceous

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species tend to be weedy and/or exotic; *Vulpia octoflora, Bromus tectorum, Descurainia pinnata, Erodium cicutarium, Salsola tragus, Alyssum desertorum*, and *Halogeton glomeratus* are typical understory dominants.

Global Dynamics: *Sarcobatus vermiculatus* is a very salt-tolerant species, although it will also grow on non-saline and non-alkaline soils (Shantz and Piemeisel 1940). To help it tolerate saline conditions, *Sarcobatus vermiculatus* accumulates salts in its leaves and, once established on a site, creates a salt-enriched microenvironment under its canopy due to leaching of salt from shed leaves (Donovan et al. 1996). This process can discourage less salt-tolerant shrub species such as *Artemisia tridentata* from occupying its habitat; *Sarcobatus vermiculatus* mixed with other shrubs indicates less-saline conditions. *Sarcobatus vermiculatus* stands develop best where subsurface moisture is readily available. It is commonly found on floodplains that are either subject to periodic flooding or have a high water table at least part of the year. It can tolerate up to 40 days of inundation (Ganskopp 1986, Groeneveld and Crowley 1988). Greasewood will increase in density at the expense of grasses such as *Sporobolus airoides* under conditions of heavy grazing, since it is only moderately palatable and is somewhat poisonous to livestock. In central Nevada, the understory of the *Sarcobatus vermiculatus* community is naturally sparse because the community occurs on shifting dune topography on the margins of a former glacial lake (Young et al. 1986). In these stands, the depth to the water table varies from 2.1 m in the spring to 3.2 m in late summer.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Sarcobatus vermiculatus*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Herb (field)	Flowering forb	*Rumex hymenosepalus*, *Salsola tragus*
Herb (field)	Graminoid	*Bromus tectorum*, *Sporobolus cryptandrus*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Sarcobatus vermiculatus*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Sarcobatus vermiculatus*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

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Global: Invasive/Exotic Plants: *Alyssum desertorum*, *Bromus tectorum* (High), *Descurainia pinnata*, *Erodium cicutarium* (Medium/Low), *Halogeton glomeratus* (High/Medium), *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: GNA (ruderal) (14-Nov-2014).

Related Concepts

Global Similar Types:

- *Sarcobatus vermiculatus / Artemisia tridentata* Wet Shrubland (CEGL001359)
- *Sarcobatus vermiculatus / Distichlis spicata* Wet Shrubland (CEGL001363)
- *Sarcobatus vermiculatus / Ericameria nauseosa* Wet Shrubland (CEGL001362)
- *Sarcobatus vermiculatus* Dune Wet Shrubland (CEGL001364)

Global Related Concepts:

- *Sarcobatus vermiculatus* (Bourgeron and Engelking 1994) =
- *Sarcobatus vermiculatus* Phyto-edaphic Community (Francis 1986) =
- *Sarcobatus* Association (Graham 1937) >
- *Sarcobatus* Community (Dastrup 1963) =
- DRISCOLL FORMATION CODE:III.C.2.a. (Driscoll et al. 1984) >

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: Stands included in this association are often affected by livestock grazing, and either lack an understory or possess an understory dominated by weedy or exotic herbaceous species.

Element Distribution

Glen Canyon National Recreation Area Range: This rare shrubland association was sampled in Moody Canyon and Moqui Canyon.

Global Range: This association is widespread on floodplains and valley floors throughout the interior western United States. It is documented from the Colorado Plateau, Great Basin, Uinta Basin, Wyoming Basins, and San Luis Valley from northwestern New Mexico, southern and western Colorado, Utah, Nevada, southwestern Wyoming and eastern California.

Nations: US
States/Provinces: CA:S3?, CO, NM, NV, UT:S5
TNC Ecoregions: 6:C, 9:C, 11:C, 17:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341A:CC, 341B:CC, 341C:CC, 341E:C?, 342B:CC, M331E:CC, M331F:CC, M331G:CC
Federal Lands: NPS (Arches, Aztec Ruins, Black Canyon of the Gunnison, Canyonlands, Capitol Reef, Colorado, Dinosaur, Glen Canyon, Golden Spike, Great Basin, Great Sand Dunes, Hovenweep); USFWS (Bosque del Apache)

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Element Sources

Glen Canyon National Recreation Area Inventory Notes: Controlled by runoff from slopes to the north and deposition of sand; shrubs are on pedestals due to erosion of material from bases.

Glen Canyon National Recreation Area Plots: The description is based on 2004 field data (1 plot, 3 accuracy assessment points): (Plots: GLCA.5058; AA Points: GLCA_AA.1784, GLCA_AA.2081, GLCA_AA.3033).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Bourgeron and Engelking 1994, Brotherson et al. 1986, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Coles et al. 2010, Coles et al. 2011, Dastrup 1963, Donnelly et al. 2006, Donovan et al. 1996, Driscoll et al. 1984, Francis 1986, Ganskopp 1986, Graham 1937, Groeneveld and Crowley 1988, Peterson 2008, Romme et al. 1993, Salas et al. 2009, Salas et al. 2010b, Schulz and Hall 2011, Shantz and Piemeisel 1940, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.*, Young et al. 1986

A3880 Suaeda moquinii - Salicornia rubra Alkaline Wet Scrub Alliance
Alliance Summary Description: This alliance includes stands that are characterized by an open to dense canopy of *Suaeda moquinii* and/or *Salicornia rubra*. Other saline wetland species present may include *Anemopsis californica, Distichlis spicata, Eleocharis palustris, Juncus balticus, Schoenoplectus americanus (= Scirpus americanus), Tiquilia* spp., or *Triglochin maritima*. Stands generally have low cover of vegetation and may be sparse (<10% total vegetation). Sites are moist or seasonally dry flats, and margins of intermittently flooded desert playas and may extend to coast. This highly variable saline wet herbaceous vegetation alliance occurs across the warm deserts of North America, extending into the Central Valley and San Joaquin Valley in California south into Baja California.

[CEGL001991] *Suaeda moquinii* Wet Shrubland
Translated Name: Mojave Seablite Wet Shrubland
Common Name:

USNVC Classification

Division: North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup: Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group: North American Desert Alkaline-Saline Wet Scrub (G537)
Alliance: *Suaeda moquinii - Salicornia rubra* Alkaline Wet Scrub Alliance (A3880)

Element Concept

Global Summary: These shrublands occur in alkaline desert basins or playas in Nevada, Arizona, Utah, and southern and eastern California. The vegetation has a generally sparse shrub layer that is less than 1.5 m tall and strongly dominated by *Suaeda moquinii* with scattered *Atriplex polycarpa, Atriplex canescens, Allenrolfea occidentalis*, or *Sarcobatus vermiculatus* in some stands. The sparse herbaceous layer may include the forbs *Bassia hyssopifolia* and *Salicornia maritima (= Salicornia*

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europaea). Graminoids are not abundant except for *Distichlis spicata* and occasional *Sporobolus airoides* or *Sporobolus cryptandrus*. The adjacent shrublands are dominated by *Sarcobatus vermiculatus* or *Atriplex* spp. Sites are generally flat to gently sloping saline valley bottoms, floodplains and playas, saline seeps, and along intermittent washes at elevations ranging from sea level to 1640 m (5381 feet). Soils are deep, saline, alkaline clay loams.

Environmental Description

Glen Canyon National Recreation Area Environment: This rare association occurs on low-level positions including floodplains, stream terraces, benches, and overflow stream channels at elevations ranging from 1178-1195 m. The unvegetated surface is composed primarily of bare soil or sand, with lesser cover by litter and small rocks. Soils are well-drained to rapidly drained sands or clay loams derived of new alluvium.

Global Environment: Sites are generally flat to gently sloping saline or alkaline valley bottoms, floodplains and playas, saline seeps, and along intermittent washes at elevations ranging from sea level to 1640 m (5381 feet). Soils are deep, saline, alkaline clay loams derived from alluvium.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This association is characterized by a sparse to open dwarf-shrub layer dominated by *Suaeda moquinii* with 9-16% cover. Other characteristic shrubs include *Atriplex corrugata, Atriplex confertifolia, Lycium andersonii,* and *Opuntia erinacea*. Herbaceous cover is sparse to nearly absent although *Eriogonum inflatum, Achnatherum hymenoides*, and *Erodium cicutarium* may be present.

Global Vegetation: This association is characterized by a sparse to open shrub layer less than 1.5 m tall that is strongly dominated by *Suaeda moquinii* sometimes with scattered *Atriplex confertifolia, Atriplex corrugata, Atriplex polycarpa, Atriplex canescens, Allenrolfea occidentalis, Lycium andersonii, Opuntia erinacea*, or *Sarcobatus vermiculatus*. The sparse herbaceous layer may include the forbs *Bassia hyssopifolia, Eriogonum inflatum, Erodium cicutarium*, or *Salicornia maritima (= Salicornia europaea)*. Graminoids are not abundant except for *Achnatherum hymenoides, Distichlis spicata*, and occasional *Sporobolus airoides* or *Sporobolus cryptandrus*.

Global Dynamics: *Suaeda moquinii* is a halophyte, and high soil salinity appears to be an important environmental variable for this community. The stand described by Faden (1977) had soil salinity between 0.11-8.55% (mean 2.00%), which was ten times more than the *Atriplex polycarpa* community (0.20%) and *Atriplex polycarpa - Atriplex confertifolia* community (0.08%), and 100 time more than other communities of the desert playas, such as *Krascheninnikovia lanata* (0.03%), *Ambrosia dumosa* (0.02%), and *Ambrosia dumosa - Larrea tridentata* (0.01%) communities which have low salinity.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Suaeda moquinii*

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Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Suaeda moquinii*
Herb (field)	Graminoid	*Distichlis spicata*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Sarcobatus vermiculatus*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Erodium cicutarium* (Medium/Low)

Global: Other Plants: *Sporobolus cryptandrus* (G5)

Conservation Status Rank

Global Rank & Reasons: G5 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Atriplex obovata / Tidestromia carnosa* Dwarf-shrubland (CEGL004575)
- *Atriplex obovata* Badland Sparse Vegetation (CEGL002928)
- *Sarcobatus vermiculatus / Atriplex confertifolia - (Picrothamnus desertorum, Suaeda moquinii)* Wet Shrubland (CEGL001371)
- *Sarcobatus vermiculatus / Suaeda moquinii* Wet Shrubland (CEGL001370)

Global Related Concepts:

- *Suaeda fruticosa* Community (Faden 1977) =
- *Suaeda moquinii* (Sawyer et al. 2009) =
- *Suaeda moquinii* (Evens et al. 2014) =
- *Suaeda moquinii* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:V.D.2.a. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This very rare association is of very limited extent in the recreation area and was only sampled in Last Chance Creek and Bull Points.

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Global Range: This shrubland association occurs in saline overflow areas in bottomlands in the Colorado Plateau, Great Basin, Mojave, Colorado, and Sonoran deserts, and in the southern part of the Great Central Valley of California. The species occurs throughout the western U.S., so this type may be more widespread.

Nations: US
States/Provinces: AZ, CA:S3?, CO:SU, NM, NV:S5, UT
TNC Ecoregions: 6:C, 11:C, 13:C, 17:C, 19:C, 20:C, 23:C, 24:C
USFS Ecoregions (1994/95): 262A:CC, 313A:CC, 313D:CC, 321A:CC, 322A:CC, 322B:CC, 322C:CC, 341E:CC, 342B:CC, M331F:CC
Federal Lands: NPS (Canyonlands, Death Valley, Glen Canyon, Grand Canyon, Great Sand Dunes, Lake Mead, Mojave, Petrified Forest); USFWS (Bosque del Apache)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This community occurs on flat, sandy benches just upslope from drainage channels or wash bottoms. Presumably the soil/substrate is somewhat alkaline.

Glen Canyon National Recreation Area Plots: The description is based on 2011 and 2015 field data (3 plots, 1 accuracy assessment point): (Plots: GLCA.1009, GLCA.2003, GLCA.2014; AA Point: GLCA_AA.1844).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and G. Kittel
References: Bourgeron and Engelking 1994, CNHP 2015, Donnelly et al. 2006, Driscoll et al. 1984, Evens et al. 2014, Faden 1977, Peterson 2008, Reid and Hall 2010, Salas et al. 2010b, Sawyer et al. 2009, Thomas et al. 2009a, Western Ecology Working Group: n.d.*

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3. Desert & Semi-Desert

3.A.2. Warm Desert & Semi-Desert Scrub & Grassland

3.A.2.Na. North American Warm Desert Scrub & Grassland

M086. Chihuahuan Desert Scrub

G287. Chihuahuan Desert Sand Scrub

Group Summary Description: This group includes the open desert scrub of vegetated coppice dunes and sandy plains found in the Chihuahuan Desert. Stands are usually dominated by *Artemisia filifolia* or *Psorothamnus scoparius* that anchor coppice dunes or occur on open sandsheet flats. They may also be dominated or codominated by *Atriplex canescens, Ephedra torreyana, Ephedra trifurca, Poliomintha incana, Rhus microphylla,* and *Larrea tridentata,* usually with 10-30% total vegetation cover. *Yucca elata, Gutierrezia sarothrae, Bouteloua eriopoda,* and *Sporobolus flexuosus* are commonly present. This group includes degraded sandy desert plains grasslands now dominated by *Artemisia filifolia* and *Prosopis glandulosa*.

A3136 Artemisia filifolia Desert Sand Scrub Alliance

Alliance Summary Description: Stands are moderately open shrubland (25-30% average cover) dominated by *Artemisia filifolia*, with an understory often characterized by scattered, tall bunchgrasses, typically *Sporobolus flexuosus* or *Sporobolus giganteus*. The shrub layer may include over a dozen species, the most common being *Yucca elata, Atriplex canescens*, and *Gutierrezia sarothrae*. Other shrubs associated with sandy soils, and occasionally present, include *Psorothamnus scoparius*. Grass cover may be abundant and diverse with up to 23 mostly sandy-soil-adapted, warm-season species. A common associate is *Achnatherum hymenoides (= Oryzopsis hymenoides)*. A rich forb layer of late summer bloomers is possible within intershrub spaces. The most common are *Dimorphocarpa wislizeni, Baileya multiradiata, Sphaeralcea* spp., and *Helianthus annuus*. This shrubland alliance occurs in southern New Mexico, western and central Texas, and adjacent northern Mexico. Stands occur on smooth to hummocky sandsheets found within the Jornada del Muerto and Tularosa basins of New Mexico at low elevations (1160-1520 m). Occasionally stands are reported from sandy deposits at higher elevations such as leeward footslopes of the southern San Andres Mountains at about 1710 m elevation. Aspect is not important as slopes are mostly gentle. Soils are deep and sandy Torripsamments, and probably of relatively recent origin with little structure development.

[CEGL001547] Artemisia filifolia / Sporobolus flexuosus Shrubland

Translated Name: Sand Sagebrush / Mesa Dropseed Shrubland

Common Name:

USNVC Classification

Division: North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup: Chihuahuan Desert Scrub (M086)
Group: Chihuahuan Desert Sand Scrub (G287)
Alliance: *Artemisia filifolia* Desert Sand Scrub Alliance (A3136)

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Element Concept

Global Summary: From Muldavin et al. (2000b): This shrubland occurs on smooth to hummocky sandsheets found within the Jornada del Muerto and Tularosa basins of New Mexico at low elevations (1160-1520 m [3800-5000 feet]). One stand was reported from sandy deposits located on the leeward footslopes of the southern San Andres Mountains at about 1710 m (5600 feet) elevation. However, because slopes are mostly gentle, aspect is probably not as important a determinant of community distribution as are the sandy soils. Soils are deep and sandy Torripsamments, and probably of relatively recent origin with little structure development. Moderately open, plains shrubland (25-30% average cover) of waist-high *Artemisia filifolia*, with an understory characterized by scattered, tall bunchgrasses, typically *Sporobolus flexuosus*. The shrub layer may include up to 17 species, the most common being *Yucca elata, Atriplex canescens,* and *Gutierrezia sarothrae*. Other shrubs associated with sandy soils, and occasionally present, include *Psorothamnus scoparius*. Grass cover is abundant and diverse with up to 23 mostly sandy-soil-adapted, warm-season species. Of these, *Sporobolus flexuosus* is generally the dominant grass; however, with increased sand depth, *Sporobolus giganteus* (a suggested phase) becomes more prevalent and occasionally may even dominate. An additional common associate is *Achnatherum hymenoides (= Oryzopsis hymenoides)*. A rich forb layer of late summer bloomers is possible within inter-shrub spaces. The most common are *Dimorphocarpa wislizeni, Baileya multiradiata, Sphaeralcea* spp., and *Helianthus annuus*.

Environmental Description

Vegetation Description

Most Abundant Species

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Artemisia filifolia*
Herb (field)	Graminoid	*Sporobolus flexuosus*

Characteristic Species

Global: Artemisia filifolia, Sporobolus flexuosus

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: G5 (17-Jul-2000).

Related Concepts

Global Similar Types:

- *Artemisia filifolia* Colorado Plateau Shrubland (CEGL002697)

Global Related Concepts:

- *Artemisia filifolia / Sporobolus flexuosus* Plant Association (Muldavin et al. 1998d) =

- *Artemisia filifolia/Sporobolus flexuosus* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:V.B.2.g. (Driscoll et al. 1984) >
- Sand Sagebrush/Mesa Dropseed PA (Muldavin et al. 2000b) =

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Global Classification Comments: *Artemisia filifolia / Bouteloua eriopoda* Shrubland (CEGL001077) and Sand Sagebrush/Galleta PA and Hoary Rosemarymint/Mesa Dropseed PA (Muldavin et al. 2000b) are shrubland communities on sandy plains. Mesa Dropseed/Soaptree Yucca grasslands (Muldavin et al. 2000b) are also known from sandy plains, but lack a significant shrub layer. Although sagebrush stands within the northern Jornada Basin may intermix with other habitat types, this type is generally limited to the deepest accumulations of sand. It sometimes occurs on sandy deposits that have accumulated on lower alluvial fan piedmonts below *Larrea tridentata* and *Flourensia cernua* types (commonly located on erosive surfaces rather than sand deposits). Moving sand, rather than lack of water, is the limiting factor for plants on sand (Bowers 1982). *Artemisia filifolia* and *Sporobolus flexuosus* are often seen on sandy substrates, but do not grow rapidly in response to shifting sands. Their abundant presence on these sandsheets indicates these sands are fairly stable.

Element Distribution

Nations: US
States/Provinces: NM:S5, UT
TNC Ecoregions: 19:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, 321A:CC, 341B:CC
Federal Lands: DOD (White Sands Missile Range); NPS (Glen Canyon); USFWS (Sevilleta)

Element Sources

Global Description Author(s): Muldavin et al. (2000b)
References: Bourgeron and Engelking 1994, Bowers 1982, Dick-Peddie 1993, Driscoll et al. 1984, Muldavin and Mehlhop 1992, Muldavin et al. 1998d, Muldavin et al. 2000b, Western Ecology Working Group n.d.*

M092. North American Warm-Desert Xeric-Riparian Scrub

G541. Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope

Group Summary Description: This group is restricted to intermittently flooded washes or arroyos that dissect bajadas, mesas, plains and basin floors throughout the warm deserts of the western U.S. and northwestern Mexico. A woody layer is usually present and is typically scattered clumps to very open and may be dominated by shrubs and small trees such as *Acacia greggii, Brickellia laciniata, Baccharis sarothroides, Chilopsis linearis, Ephedra californica, Ericameria paniculata, Fallugia paradoxa, Forestiera pubescens, Hymenoclea salsola, Hymenoclea monogyra, Hyptis emoryi, Juglans microcarpa, Lepidospartum squamatum, Olneya tesota, Parkinsonia florida, Prosopis* spp.,

Psorothamnus spinosus, Prunus fasciculata, Rhus microphylla, Salazaria mexicana, Sarcobatus vermiculatus, or *Viguiera reticulata*. A few known herbaceous communities dominate intermittent drainages and washes with woody vegetation absent or only with scattered individuals present. Dominant species include *Panicum bulbosum, Alopecurus aequalis,* or *Lycurus phleoides*. Although often dry, the intermittent fluvial processes are characteristic of this group, which are often associated with rapid sheet and gully flow. This group is restricted to drainages in upland areas or ramaderos that are intermittently flooded and occur as linear or sometimes broader braided strips within desert scrub-or desert grassland-dominated landscapes. The vegetation of desert washes is quite variable in species composition and structure, ranging from sparse and patchy to moderately dense, and typically occurs along the banks, but may occur within the channel.

A3258 Baccharis salicina Southern Great Plains Wash Scrub Alliance

Alliance Summary Description: This alliance covers shrublands dominated by *Baccharis salicina* along dry washes and intermittent stream channels of the southern Great Plains. Other shrubs often present include *Salix* spp., *Tamarix* spp., and a few emergent trees of *Populus deltoides*. Soils are sand and can be saline.

[CEGL005007] *Baccharis salicina* Shrubland

Translated Name: Willow Baccharis Shrubland

Common Name:

USNVC Classification

Division: North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup: North American Warm-Desert Xeric-Riparian Scrub (M092)
Group: Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)
Alliance: *Baccharis salicina* Southern Great Plains Wash Scrub Alliance (A3258)

Element Concept

Global Summary: This riparian shrubland occurs from the northern panhandle of Texas, across the southwestern Great Plains, and west into the Colorado Plateau. This shrubland usually has a dense short-shrub canopy strongly dominated by *Baccharis salicina*, but other short and tall shrubs and trees are often present, including *Salix* spp., *Tamarix* spp., and *Populus deltoides*. The herbaceous stratum is typically sparse to moderate due to the heavy shading by shrubs. Common herbaceous species are *Muhlenbergia asperifolia, Panicum virgatum,* and *Phragmites australis*. This association is found near streams and lakes, often on the first terrace and on alluvial soils. The water table is high and seasonal flooding is common.

Environmental Description

Glen Canyon National Recreation Area Environment: This rare mesic shrubland is distributed along intermittently to semipermanently flooded low-lying areas including canyon bottom drainages, terraces/benches, and lakeshores within the recreation area. Sites slope gently (0-7°) and occur between 1093 and 1209 m elevation. Bare soil or sand and litter cover most of the unvegetated surface, with low to moderate cover of live vegetation litter and standing water. Soils are moderately well-drained to rapidly drained loamy sands or silt loams derived from alluvium.

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Global Environment: This riparian plant community occurs in the river floodplain usually on the first stream terrace. The water table is high, generally within 1.6 m of the soil surface, but will fluctuate somewhat due to season. The terrain is nearly level, and the soils are alluvial sandy loams or silt loams with occasional sandier pockets. The area is occasionally to frequently flooded for short periods of time but usually not to a depth of more than 0.3-0.5 m.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This shrubland occurs as generally small pockets of dense vegetation within the active floodplain of rivers and streams. Total vegetation cover ranges from 20 to 80%. The shrub canopy is typically 2 to 5 m tall and is dominated by *Baccharis salicina*, with 6-30% cover. *Ericameria nauseosa* may be nearly codominant in some stands. Other shrubs present with low to moderate cover include *Rhus aromatica, Artemisia filifolia, Atriplex canescens, Salix exigua, Quercus gambelii*, and *Tamarix chinensis.* The herbaceous layer may be sparse to moderately dense and is composed of the grasses *Phragmites australis, Sporobolus giganteus, Sporobolus flexuosus, Achnatherum hymenoides, Muhlenbergia asperifolia, Saccharum ravennae*, and *Bromus tectorum*. Common forbs include *Euthamia occidentalis, Solidago canadensis, Artemisia ludoviciana, Artemisia dracunculus, Machaeranthera canescens, Xanthium strumarium, Dalea candida var. oligophylla (= Dalea oligophylla),* and *Salsola tragus*. *Equisetum* sp., *Juncus tenuis, Juncus balticus*, and the vine *Clematis ligusticifolia* are also common associates in the understory. Scattered trees with low cover are common, especially on the margins of the community, including *Populus fremontii, Salix gooddingii*, and *Acer negundo*.

Global Vegetation: The community is dominated by shrubs with *Baccharis salicina* being the dominant. In general, *Baccharis salicina* is a short shrub but can occasionally reach a height of 2 m. *Ericameria nauseosa* may be nearly codominant in some stands. Other shrubs present with low to moderate cover include *Rhus trilobata, Artemisia filifolia, Atriplex canescens, Salix exigua,* and *Quercus gambelii*. *Tamarix* sp. is frequent in the community with plants varying from 1 to 4 m in height. Occasional *Populus deltoides* trees are scattered throughout the community. Shrubs are usually dense to moderately dense and in places difficult to walk through. There are some grass species present in the community, but shading and competition from shrubs limit both frequency and production. The most common grass species are *Achnatherum hymenoides, Panicum virgatum, Phragmites australis, Saccharum ravennae, Sporobolus giganteus, Sporobolus flexuosus*, and *Muhlenbergia asperifolia*. Forbs are infrequent, but may include *Apocynum cannabinum, Ambrosia psilostachya, Artemisia ludoviciana, Artemisia dracunculus, Dalea candida var. oligophylla (= Dalea oligophylla), Euthamia occidentalis, Machaeranthera canescens, Salsola tragus, Solidago canadensis,* or *Xanthium strumarium*. There is evidence that this community has gone from one of approximately 50:50 shrubs and herbaceous plants to a shrub-dominated community within the last 50 years. This may have been influenced by changes in underground waterflow and the nature of flooding of the river and possibly by frequency of natural fire.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Baccharis salicina*, *Ericameria nauseosa*
Herb (field)	Graminoid	*Muhlenbergia asperifolia*, *Phragmites australis*, *Sporobolus flexuosus*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Tamarix ramosissima*
Short shrub/sapling	Broad-leaved deciduous shrub	*Baccharis salicina*
Herb (field)	Graminoid	*Panicum virgatum*, *Phragmites australis*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Baccharis salicina, Panicum virgatum, Phragmites australis, Tamarix ramosissima*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*, *Tamarix chinensis*

Global: Invasive/Exotic Plants: *Tamarix ramosissima* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (26-Sep-2005).

Related Concepts

Global Similar Types:

- *Baccharis (emoryi, salicina)* - *Salix exigua* Wet Shrubland (CEGL005947)

Global Related Concepts:

- *Baccharis salicina* Shrubland (Kittel et al. 1996) =
- *Baccharis salicina* Shrubland (Bell 2005) =

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. The relationship of this association to other *Baccharis* spp. associations is unclear. The environmental setting is likely similar. The closely allied association *Baccharis (emoryi, salicina)* - *Salix exigua* Wet Shrubland (CEGL005947) has near equal amounts of *Salix exigua* and can be dominated by *Baccharis emoryi*, and is in a more wet (marsh) part of the hierarchy, while this one is in desert washes.

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Element Distribution

Glen Canyon National Recreation Area Range: This riparian shrubland is rare within the recreation area and was sampled in Cottonwood Canyon, Slickrock Canyon, Llewelyn Gulch, and in Bullfrog Bay.

Global Range: This shrubland is known from the southwestern Great Plains in the northern panhandle of Texas, and west into the Colorado Plateau of southeastern Utah and western Colorado.

Nations: US
States/Provinces: CO, TX, UT
TNC Ecoregions: 28:C
USFS Ecoregions (1994/95): 315B:CC
Federal Lands: NPS (Alibates, Glen Canyon, Lake Meredith)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Patch is a single stand of *Baccharis* north of a small slickrock dome near the lake. The stand is in a small depression that appears to fill with water sometimes, but has not in a few years at least.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (2 plots, 4 accuracy assessment points): (Plots: GLCA.4253, GLCA.5109; AA Points: GLCA_AA.1924, GLCA_AA.2062, GLCA_AA.3068, GLCA_AA.3069).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Drake and G. Kittel
References: Bell 2005, Fenton et al. 2007, Kittel et al. 1996, Midwestern Ecology Working Group n.d.*, Spence pers. comm.

A3259 Fallugia paradoxa Desert Wash Scrub Alliance
Alliance Summary Description: This alliance includes *Fallugia paradoxa*-dominated shrublands of washes and upper stream terraces. Two suballiances are defined to recognize the range of associated species, one for the northern Mojave and one for the Sonoran Desert region. This alliance occurs across a wide geographic range of the nominal species, and the two suballiances account for associated species differences from north to south.

[CEGL002357] *Fallugia paradoxa* Colorado Plateau Desert Wash Shrubland
Translated Name: Apache Plume Colorado Plateau Desert Wash Shrubland
Common Name:

USNVC Classification

Division: North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup: North American Warm-Desert Xeric-Riparian Scrub (M092)
Group: Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)
Alliance: *Fallugia paradoxa* Desert Wash Scrub Alliance (A3259)

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Element Concept

Global Summary: This dry wash association has been documented in southern Utah to north-central New Mexico, and may occur further west and north into the Great Basin. The shrub canopy is characterized by *Fallugia paradoxa* with 6 to 50% cover. Associated shrubs include *Amelanchier utahensis, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Fraxinus anomala, Gutierrezia microcephala, Gutierrezia sarothrae, Mahonia fremontii, Purshia stansburiana, Rhus trilobata*, and *Shepherdia rotundifolia*. The herbaceous layer is low in species diversity and provides sparse to low cover; a combination of severe occasional flooding and otherwise dry conditions makes it difficult for herbaceous species to become established. Commonly associated graminoids include *Achnatherum hymenoides*, the exotic annual *Bromus tectorum*, and *Pleuraphis jamesii*. Forbs are typically rare in this community; however, *Stanleya pinnata* frequently occurs. Scattered *Juniperus osteosperma* and *Pinus edulis* may be present but do not form a tree layer. This is a low-elevation shrubland occurring in canyon bottoms, washes, streambanks and point bars of intermittent drainages, and on alluvial terraces. Slopes are low to moderate (3-20%). Elevation ranges between 1111 and 1829 m (3650-6000 feet). Soils include rapidly drained sands and loamy sands.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland occurs as narrow bands along intermittently flooded drainage channels along canyon bottom washes and terraces. Sites are flat to gently sloping (up to 4°) and occur between 1111 and 1525 m elevation. Bare soil or sand and litter cover most of the unvegetated surface, with lesser cover by moss and dark cyanobacteria, and large and small rocks. Soils are somewhat well-drained to rapidly drained sands or sandy loams derived from alluvium.

Global Environment: This community occurs in intermittent drainages, wash bottoms, canyon bottoms, some with low solar exposure, alluvial terraces and bars adjacent to or within drainage channels with low gradients (3-7% slope). Slopes are gentle (1-8°) and are oriented to all aspects, and the elevation ranges between 1111 and 1829 m (3650-6000 feet) elevation. The unvegetated surface has low to moderate cover of litter, gravel, cobble, sand, and bare soil. Parent materials are shale of the Moenkopi Formation and sandstones of the Wingate, Navajo and Morrison formations. Soils are rapidly drained and texturally are sand and loamy sand derived from mixed alluvium of stream terraces, or rocky outcrops.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This riparian shrubland has 13 to 67% total vegetation cover, and is characterized by 1- to 2-m tall *Fallugia paradoxa* shrubs, with 3-60% cover, often with a mix of other shrubs in the canopy (but none with greater cover than *Fallugia paradoxa*). Other tall shrubs present include *Mahonia fremontii, Purshia stansburiana, Grayia spinosa, Rhus aromatica, Ericameria nauseosa, Lycium andersonii, Atriplex canescens*, and the short shrubs *Ephedra torreyana, Ephedra viridis, Ephedra cutleri, Coleogyne ramosissima, Gutierrezia sarothrae*, and *Opuntia polyacantha*. Herbaceous species in the understory include native species *Pleuraphis jamesii, Sporobolus flexuosus, Artemisia ludoviciana, Stanleya pinnata*, and *Stephanomeria pauciflora*, and the non-native and/or invasive species *Plantago patagonica* and *Bromus tectorum*.

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Global Vegetation: Total vegetation cover ranges from 22 to 95%. This tall-shrub community is characterized by *Fallugia paradoxa* shrubs that range in cover from 6 to 50%. The associated shrub layer has moderate to high species composition and provides moderate to dense cover. Commonly associated tall shrubs include *Amelanchier utahensis, Purshia stansburiana, Mahonia fremontii, Rhus trilobata,* and *Fraxinus anomala*. Short and dwarf-shrubs that are typically present include *Atriplex canescens, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra cutleri, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Grayia spinosa, Gutierrezia microcephala, Gutierrezia sarothrae, Lycium andersonii, Opuntia polyacantha*, and/or *Shepherdia rotundifolia*. *Forestiera pubescens* is uncommon or absent. Trees, typically 2-5 m tall, are sometimes present, providing sparse to low cover, and include *Juniperus osteosperma, Juniperus monosperma*, and *Pinus edulis*. The herbaceous layer is low in species diversity and provides sparse to low cover. Common associates include *Achnatherum hymenoides,* the exotic *Bromus tectorum*, and native *Vulpia octoflora* among grasses, and *Ipomopsis longiflora* and *Lappula occidentalis* among forbs.

Global Dynamics: Drainages are subject to ephemeral flood events following large summer thunderstorms that may scour the channels.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Rhus aromatica*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*, *Fallugia paradoxa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Fallugia paradoxa*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Ericameria nauseosa*, *Fallugia paradoxa*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (22-Mar-2005).

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Related Concepts

Global Similar Types:

- *Atriplex canescens* Desert Wash Shrubland (CEGL003470)
- *Ericameria nauseosa* Desert Wash Shrubland (CEGL002261)
- *Fallugia paradoxa - (Atriplex canescens, Ephedra torreyana)* Cinder Shrubland (CEGL005806)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This riparian shrubland is found along intermittently flooded drainage channels within the recreation area and was sampled in Gunsight Canyon, Trachyte Canyon, Rock Canyon, along Ticaboo Creek and the south fork of Ticaboo Creek, and along the Dirty Devil.

Global Range: This association occurs in southern Utah (Capitol Reef National Park and Glen Canyon National Recreation Area) and in north-central New Mexico (Bandelier National Monument). It may occur elsewhere in the Colorado Plateau and Great Basin regions.

Nations: US
States/Provinces: AZ?, NM, UT
TNC Ecoregions: 11:?, 19:C, 20:C
USFS Ecoregions (1994/95): 341B:CC, M331G:CC
Federal Lands: NPS (Bandelier, Capitol Reef, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Dry wash runs down the center of the plot. Wash bottom is devoid of plant life. Vegetation present on sandy bench along edges of wash bottom. Plant distribution controlled by intermittent flash flooding in the canyon.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2013, and 2015 field data (7 plots): (Plots: GLCA.2028, GLCA.4117, GLCA.5412, GLCA.5420, GLCA.5502, GLCA.6101, GLCA.6103).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.S. King and G. Kittel
References: Clark et al. 2009, Muldavin et al. 2011b, Romme et al. 1993, Western Ecology Working Group n.d.*

A4188 Hymenoclea salsola - Bebbia juncea Mojave-Sonoran Desert Wash Scrub Alliance

Alliance Summary Description: The vegetation in this alliance is characterized by a sparse to moderately dense shrub layer of *Hymenoclea salsola, Lycium andersonii, Lycium pallidum,* or

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Salazaria mexicana as dominants or codominants. Other common associate shrubs may include *Acamptopappus sphaerocephalus, Atriplex canescens, Atriplex confertifolia, Bebbia juncea, Brickellia incana, Encelia farinosa, Ephedra californica, Ephedra nevadensis, Ericameria paniculata, Eriogonum fasciculatum, Grayia spinosa, Krascheninnikovia lanata, Larrea tridentata, Opuntia basilaris, Opuntia echinocarpa, Picrothamnus desertorum (= Artemisia spinescens), Psorothamnus schottii, Salvia dorrii, Senna armata (= Cassia armata), Tetradymia axillaris*, and *Viguiera reticulata*. Occasional emergent tall shrubs or small trees may be present, such as *Acacia greggii, Chilopsis linearis, Olneya tesota, Parkinsonia florida, Psorothamnus spinosus*, or *Yucca brevifolia*. The herbaceous layer is usually very sparse and dominated by perennial bunchgrasses, including *Achnatherum hymenoides (= Oryzopsis hymenoides), Achnatherum speciosum*, and *Pleuraphis jamesii (= Hilaria jamesii)*. Frequent perennial forbs include *Astragalus* spp., *Calochortus kennedyi, Castilleja applegatei ssp. martinii (= Castilleja chromosa)*, and *Lomatium mohavense*. Annual grasses and forbs include the introduced *Bromus rubens* and *Bromus madritensis* (Keeler-Wolf and Thomas 2000); other annuals include *Camissonia* spp., *Eriogonum deflexum, Eriogonum inflatum, Mentzelia* spp., and *Oxytheca perfoliata*. This alliance occurs in the Mojave and Sonoran deserts of southern California, southern Nevada, southern Utah, and northern Arizona. The vegetation of this alliance occurs in areas with low topographic relief, such as ephemeral drainages and playa margins. Some sites may experience short-term flooding following precipitation or snowmelt. The affinity of the vegetation in this alliance for basins and drainages has more to do with winter cold-air drainage than soil moisture or other edaphic characteristics. Precipitation ranges from 15-20 cm annually. Temperatures are continental, with large annual and diurnal ranges. Soils are generally medium-textured and often somewhat alkaline. The vegetation in this alliance is intermediate in drought and cold tolerance between relatively cooler, wetter *Artemisia tridentata*-dominated communities and hotter, drier *Larrea tridentata*-dominated communities. Elevation ranges from sea level to 1600 m. Sites include washes and palustrine environments, valley bottoms, and alluvial flats. Wetland substrates are well-drained, coarse-textured soils that are moderately acidic to slightly saline.

[CEGL005392] *Brickellia longifolia* Shrubland

Translated Name: Longleaf Brickellbush Shrubland

Common Name:

USNVC Classification

Division: North American Warm Desert Scrub & Grassland (3.A.2.Na)

Macrogroup: North American Warm-Desert Xeric-Riparian Scrub (M092)

Group: Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)

Alliance: *Hymenoclea salsola - Bebbia juncea* Mojave-Sonoran Desert Wash Scrub Alliance (A4188)

Element Concept

Global Summary: This association is currently known from the Colorado Plateau in Grand Canyon National Park in northern Arizona and Glen Canyon National Recreation Area in southern Utah. This sparse association is characterized and dominated by the short shrub *Brickellia longifolia*. Trees are lacking, but the exotic *Tamarix ramosissima* occurs in the tall-shrub stratum somewhat frequently. The short-shrub layer is almost devoid of associated species, although *Ephedra fasciculata* and *Acacia*

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Subset: GLCA; Glen Canyon National Recreation Area

greggii rarely occur. The dwarf-shrub layer is also essentially lacking, but *Gutierrezia sarothrae* does occur in the majority of stands. Annuals, particularly non-native annuals, constitute the majority of the sparse graminoid layer. *Bromus rubens, Bromus tectorum,* and *Vulpia octoflora* frequently occur. The forb understory is particularly variable in this association; no one species regularly occurs. This association occurs in cobble-filled, rocky drainage bottoms, most commonly in low-level, low-gradient (1-3°) drainages which experience intermittent flooding events. It chiefly occurs at 700 to 1250 m (2350-4100 feet) elevation, and across all aspects except north-facing. Soils are rapidly drained sandy loams and/or sand. Rocks (often cobble-sized), gravel, and sand often dominate the ground cover.

Environmental Description

Glen Canyon National Recreation Area Environment: These sparse shrublands occur most commonly in low-gradient (up to 4°), cobble-filled, rocky canyon bottom drainages which experience intermittent flooding events, and less commonly on rocky toeslopes (up to 15°), oriented to the south. Elevations range from 1158 to 1233 m. Soils are rapidly drained loamy sands derived from alluvial or eolian deposits or from the Paradox Formation. Rocks (often cobble-sized), gravel, and sand strongly dominate the ground cover, with lesser cover by bare soil, moss, litter, and dead wood.

Global Environment: This Colorado Plateau shrubland association occurs in cobble-filled, rocky drainage bottoms. It occurs most commonly in low-level, low-gradient (1-3 degrees) drainages which experience intermittent flooding events. It chiefly occurs at 700 to 1250 m (2350-4100 feet) elevation, and across all aspects except north-facing (Reid and Hall 2010). Soils are rapidly drained sandy loams and/or sand. Rock (cobbles), gravel, and sand often dominate the ground cover.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse association (total cover ranges from 10-21%) is characterized and generally dominated by the short shrub *Brickellia longifolia*, with up to 7% cover. Trees are lacking, but the exotic *Tamarix chinensis* occurs in the tall-shrub stratum frequently. The short-shrub layer may also include sparse to low cover of *Ephedra torreyana, Ephedra viridis, Ericameria nauseosa,* and *Rhus trilobata var. trilobata (= Rhus aromatica var. trilobata).* In the dwarf-shrub layer, *Gutierrezia sarothrae* occurs in the majority of stands. The graminoid layer may have sparse to low cover of such species as *Achnatherum hymenoides, Sporobolus cryptandrus*, and *Sporobolus flexuosus*. The forb understory is sparse and weedy, dominated by *Ambrosia acanthicarpa* and *Salsola tragus*.

Global Vegetation: This association is characterized by a open to sparse shrub layer (7-12% cover) dominated by the *Brickellia longifolia*. Trees are lacking, but the exotic *Tamarix ramosissima* (1-2%) occurs in the tall-shrub stratum somewhat frequently (Reid and Hall 2010). The short-shrub layer has few associate species, although *Acacia greggii, Ephedra fasciculata, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa,* and *Rhus trilobata var. trilobata (= Rhus aromatica var. trilobata)* rarely occur with sparse individual cover. The dwarf-shrub layer is also essentially lacking, but *Gutierrezia sarothrae* is found in the majority of stands. If present, the sparse herbaceous layer is composed mostly of grasses, sometimes with perennial species such as *Achnatherum hymenoides, Sporobolus cryptandrus, Sporobolus flexuosus,* or often annuals such as *Vulpia octoflora* and exotics

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Bromus rubens and *Bromus tectorum*. The forb understory is sparse and weedy, dominated by *Ambrosia acanthicarpa* and *Salsola tragus*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Brickellia longifolia*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Brickellia longifolia*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Brickellia longifolia*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Salsola tragus, Tamarix chinensis*
Global: Vulnerable Plants: *Ephedra fasciculata* (G3?); Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High), *Salsola tragus, Tamarix ramosissima* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (14-Jul-2010).

Related Concepts

Classification

Status: Standard
Classification Confidence:
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This rare association was only sampled in Gypsum Canyon and along the San Juan River.

Global Range: This shrubland association is currently known from the Colorado Plateau in the Grand Canyon National Park in northern Arizona and Glen Canyon National Recreation Area in southern Utah.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC

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Federal Lands: NPS (Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This bouldery wash bottom is *Brickellia longifolia*-dominated with occasional stretches where *Tamarix ramosissima* becomes nearly codominant. *Tamarix ramosissima* comes and goes as you follow the drainage, but *Brickellia longifolia* is the overall dominant species along the canyon bottom.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2014 field data (1 plot, 2 accuracy assessment points): (Plots: GLCA.5118; AA Points: GLCA_AA.0433, GLCA_AA.0434).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K. Christie and K.A. Schulz
References: Reid and Hall 2010, Western Ecology Working Group n.d.*

A4186 Psorothamnus fremontii - Psorothamnus polydenius Desert Wash Scrub Alliance

Alliance Summary Description: The alliance forms an open shrub layer. Dominant and characteristic shrubs include *Psorothamnus fremontii* or *Psorothamnus polydenius*. Other shrubs that are often present include *Ambrosia dumosa* and *Larrea tridentata*. The emergent tree layer is sparse if present, and the herbaceous layer is sparse to open. Herbs that are often present include *Sphaeralcea ambigua*. Commonly associated nonvascular plants include cryptogamic crust. The alliance is found in desert areas of Arizona, California and Nevada. It occurs primarily in alluvial fans, dry washes, lower slopes, and sand dunes, and often occurs in sites that experience disturbance from flooding to shifting substrates. Elevations range from approximately 390 to 1610 m. Soils are derived from a variety of substrates including alluvium, dune sand, and sedimentary rock, and soil textures are sand to sandy loam.

[CEGL005154] *Psorothamnus fremontii* Shrubland

Translated Name: Fremont's Smokebush Shrubland
Common Name:

USNVC Classification

Division: North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup: North American Warm-Desert Xeric-Riparian Scrub (M092)
Group: Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope (G541)
Alliance: *Psorothamnus fremontii - Psorothamnus polydenius* Desert Wash Scrub Alliance (A4186)

Element Concept

Global Summary: This Fremont's smokebush shrubland association is currently described from the Colorado Plateau and northeastern Mojave Desert. Vegetation is moderately dense (39-45% total cover) and dominated by *Psorothamnus fremontii*, with 10-18% cover. *Larrea tridentata* is commonly found in a very sparse tall-shrub layer in lower elevation stands. The short-shrub layer also occasionally includes *Ambrosia dumosa, Atriplex confertifolia, Ericameria nauseosa, Ephedra*

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torreyana, Gutierrezia sarothrae, Hymenoclea salsola, Krameria grayi, and *Opuntia basilaris*. Graminoid cover is quite sparse and generally weedy. Natives *Vulpia octoflora* and *Dasyochloa pulchella* may occur in some stands with exotics *Bromus tectorum* and *Schismus barbatus* common in disturbed stands. *Eriogonum inflatum* regularly occurs in the forb understory, while *Cryptantha* sp., *Antheropeas lanosum, Lepidium montanum, Oenothera* spp., *Plantago ovata, Phacelia crenulata*, and *Tiquilia latior* occur sporadically. This association typically occurs in drainage channels, on sideslopes, and less commonly in valley bottoms or on badlands at 375 to 675 m (1250-2225 feet) elevation, but can be found as high as 1150 m (3750 feet). It is primarily found on gentle slopes (1-12°), but can also occur on steeper gradients (25-30°), and occurs across all aspects. Soils are mostly well-drained sandy or silty loams derived from various parent materials.

Environmental Description

Glen Canyon National Recreation Area Environment: This rare Fremont's smokebush shrubland association occurs on quaternary benches at 1112 m elevation. It is found on gentle, northeast-facing slopes (up to 7°). Bare soil and gravel cover most of the unvegetated surface, with lesser cover by biological soil crusts, and sparse to low cover by large rocks and litter. Soils are sandy and derived from alluvial deposits.

Global Environment: This association typically occurs in drainage channels, on sideslopes, and less commonly in valley bottoms or on badlands at 375 to 675 m (1250-2225 feet) elevation, but can be found as high as 1150 m (3750 feet). It is primarily found on gentle slopes (1-12°), but can also occur on steeper gradients (25-30°), and occurs across all aspects. Soils are mostly well-drained sandy or silty loams derived from various parent materials.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Vegetation is moderately dense (39-45% total cover) and dominated by *Psorothamnus fremontii*, with 13-18% cover, though a variety of other shrubs are commonly associated with smokebush. The short-shrub stratum may also include low cover of *Atriplex confertifolia, Ericameria nauseosa, Ephedra torreyana, Gutierrezia sarothrae*, and *Opuntia* spp. *Ambrosia dumosa* and *Opuntia basilaris* frequently occur in a weak dwarf-shrub layer. Graminoid cover is quite sparse and generally weedy, with *Bromus tectorum* and *Schismus barbatus* occurring in some stands. *Eriogonum inflatum, Lepidium montanum*, and *Oenothera* spp. regularly occur in the forb understory, while *Salsola tragus* and *Tiquilia latior* occur sporadically.

Global Vegetation: Vegetation is moderately dense (39-45% total cover) and dominated by *Psorothamnus fremontii*, with 10-18% cover. *Larrea tridentata* is commonly found in a very sparse tall-shrub layer in lower elevation stands. The short-shrub layer also occasionally includes *Ambrosia dumosa, Atriplex confertifolia, Ericameria nauseosa, Ephedra torreyana, Gutierrezia sarothrae, Hymenoclea salsola, Krameria grayi*, and *Opuntia basilaris*. Graminoid cover is quite sparse and generally weedy. Natives *Vulpia octoflora* and *Dasyochloa pulchella* may occur in some stands with exotics *Bromus tectorum* and *Schismus barbatus* common in disturbed stands. *Eriogonum inflatum* regularly occurs in the forb understory, while *Cryptantha* sp., *Antheropeas lanosum, Lepidium montanum, Oenothera* spp., *Plantago ovata, Phacelia crenulata*, and *Tiquilia latior* occur sporadically.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Psorothamnus fremontii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Psorothamnus fremontii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Psorothamnus fremontii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*, *Schismus barbatus* (High/Medium)

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Schismus barbatus* (High/Medium)

Conservation Status Rank

Global Rank & Reasons: GNR (24-Jun-2010).

Related Concepts

Global Similar Types:

- *Psorothamnus fremontii - Acacia greggii* [Shale] Sparse Vegetation [Park Special] (CEPS009527) is also dominated by *Psorothamnus fremontii*, but *Acacia greggii* regularly occurs as a codominant, and it supports much lower floristic diversity.

Global Related Concepts:

- *Psorothamnus fremontii*-(*Hymenoclea salsola*) (Evens et al. 2014) =

Classification

Status: Standard
Classification Confidence:
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This very rare shrubland was only sampled in Hall's Creek Bay.

Global Range: This Fremont's smokebush shrubland association is currently described from the Colorado Plateau in Grand Canyon National Park in northern Arizona, Glen Canyon National Recreation Area in southern Utah, and Lake Mead National Recreation Area in Nevada.

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Nations: US
States/Provinces: AZ, NM?, NV, UT
TNC Ecoregions: 19:C, 24:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon, Grand Canyon, Grand Canyon-Parashant, Lake Mead)

Element Sources

Glen Canyon National Recreation Area Plots: The description is based on 2015 field data (2 accuracy assessment points): (AA Points: GLCA_AA.1271, GLCA_AA.1272).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): R. Meszaros and K.A. Schulz
References: Evens et al. 2014, Reid and Hall 2010, Western Ecology Working Group n.d.*

3.B.1. Cool Semi-Desert Scrub & Grassland

3.B.1.NE. WESTERN NORTH AMERICAN COOL SEMI-DESERT SCRUB & GRASSLAND

M093. Great Basin Saltbush Scrub

G301. Intermountain Dwarf Saltbush - Sagebrush Scrub

Group Summary Description: This semi-arid dwarf-shrub scrub group occurs in the interior western U.S. and is found on windswept basins and plains, often on marine shales. The vegetation is characterized by an open canopy of dwarf-shrubs composed of relatively pure stands of *Artemisia pedatifida* (important in Wyoming), *Atriplex corrugata* (western Colorado and Utah), or *Atriplex gardneri* (Wyoming and Montana into Canada). Other dominant or codominant dwarf-shrubs may include *Artemisia longifolia, Artemisia pygmaea,* or *Picrothamnus desertorum,* sometimes with a mix of other low shrubs, such as *Krascheninnikovia lanata* or *Tetradymia spinosa*. Occasional individuals or small clumps of *Atriplex confertifolia, Atriplex canescens,* or *Artemisia tridentata ssp. wyomingensis* may be present in some stands within this group but do not codominate. The herbaceous layer is typically sparse. Scattered perennial forbs occur, such as *Xylorhiza glabriuscula* and *Sphaeralcea grossulariifolia*; perennial grasses *Achnatherum hymenoides, Bouteloua gracilis* (not in Wyoming), *Elymus elymoides, Elymus lanceolatus ssp. lanceolatus, Pascopyrum smithii, Poa secunda*, or *Sporobolus airoides* may dominate the herbaceous layer. In less saline areas, there may be inclusions of grasslands dominated by *Hesperostipa comata, Leymus salinus, Pascopyrum smithii*, or *Pseudoroegneria spicata*. Stands occur on gentle slopes and rolling plains. Substrates are shallow, typically saline, alkaline, fine-textured soils developed from shale or alluvium that may be associated with shale badlands. Infiltration rate is typically low. In Wyoming and possibly elsewhere, inclusions of non-saline, gravelly barrens or rock outcrops dominated by cushion plants such as *Arenaria hookeri* and *Phlox hoodii* without dwarf-shrubs may be present (these are not restricted to this group and larger patches would likely be classified in a sparse vegetation group).

A1109 Atriplex corrugata Low Scrub Alliance

Alliance Summary Description: Stands have very sparse to moderate cover (5-30%) of woody vegetation that is dominated by the halophytic, evergreen dwarf-shrub *Atriplex corrugata*. Sparse stands are often completely dominated by this plant. Stands typically have very low species diversity.

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Subset: GLCA; Glen Canyon National Recreation Area

Depending on soil salinity and moisture, other plants may be present, including the shrubs *Krascheninnikovia lanata, Picrothamnus desertorum (= Artemisia spinescens)*, and *Tetradymia spinosa*. The herbaceous layer is very sparse. Scattered perennial forbs, such as *Sphaeralcea grossulariifolia* and *Xylorhiza glabriuscula*, and the perennial grass *Achnatherum hymenoides (= Oryzopsis hymenoides)* have been reported. Annuals are seasonally present and may include *Eriogonum inflatum, Plantago tweedyi*, and the exotics *Bromus tectorum, Malcolmia africana*, and *Salsola kali*. Shrublands in this alliance are found on lower hillslopes and alkaline flats on the Colorado Plateau portions of northwestern New Mexico, western Colorado and Utah. Climate is semi-arid with most of the highly variable precipitation falling in July and August as high-intensity thunderstorms. Mean annual precipitation is approximately 23 cm. Elevation ranges from 1300-1820 m. Sites are nearly flat to moderately steep, and have soils typically derived from Mancos shale. Soils are moderately deep, strongly saline, moderately alkaline, fine-textured (clayey), poorly developed and typically have high erosion rates.

[CEGL001437] *Atriplex corrugata* Dwarf-shrubland
Translated Name: Mat Saltbush Dwarf-shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)
Group: Intermountain Dwarf Saltbush - Sagebrush Scrub (G301)
Alliance: *Atriplex corrugata* Low Scrub Alliance (A1109)

Element Concept

Global Summary: This dwarf-shrubland association occurs on saline sites in the Colorado Plateau from northwestern New Mexico, western Colorado and eastern Utah. The vegetation is characterized by very sparse to moderate cover (5-25%) of woody vegetation that is dominated by the halophytic evergreen dwarf-shrub *Atriplex corrugata*. There is typically very low species diversity, but depending on soil salinity and moisture, other plants may be present, including the shrubs *Atriplex gardneri, Atriplex confertifolia, Tetradymia spinosa, Picrothamnus desertorum (= Artemisia spinescens), Suaeda calceoliformis (= Suaeda depressa)*, and *Krascheninnikovia lanata*. The herbaceous layer is typically very sparse, but may in some stands have as much grass cover as the shrub layer. Only scattered perennial forbs such as *Sphaeralcea grossulariifolia*, *Xylorhiza glabriuscula*, and *Xylorhiza venusta*, and the perennial grasses *Achnatherum hymenoides (= Oryzopsis hymenoides), Elymus elymoides*, and *Pleuraphis jamesii* have been reported. Annuals are seasonally present and may include *Eriogonum inflatum, Phacelia splendens, Plantago tweedyi*, and *Atriplex argentea*. Introduced species such as *Bromus tectorum* and *Salsola kali* are often present. Stands are found on lower hillslopes, clay barrens and alkaline flats. Sites are gently sloping to moderately steep ridges and hills shaped into badlands by water and wind erosion. Soils are typically derived from Mancos shale or other marine shales. They are moderately deep, strongly saline, moderately alkaline, fine-textured (clayey), poorly developed and typically have high erosion rates. The soil surface is mostly barren.

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Environmental Description

Glen Canyon National Recreation Area Environment: This dwarf-shrubland association occurs on badlands, hills, plateaus, valley bottoms, bajadas, and alluvial fans. Sites are on flat to moderately sloping (up to 14°) slopes, include all aspects, and occur between 1188 and 1338 m elevation. The unvegetated surface is mostly bare soil, with trace amounts of litter and small rocks present. Soils are somewhat poorly drained to well-drained clays, silty clays, sandy clays, silty clay loams, and silt loams derived from the Tropic Shale Formation or the Morrison Formation.

Global Environment: This dwarf-shrubland association is found on lower hillslopes, clay barrens and alkaline flats on Colorado Plateau portions of northwestern New Mexico, western Colorado and eastern Utah. Climate is semi-arid with most of the highly variable precipitation falling in July and August as high-intensity thunderstorms. Mean annual precipitation is approximately 23 cm. Elevation ranges from 1300-1975 m (4265-6480 feet). Sites are gently sloping to moderately steep ridges and hills shaped into badlands by water and wind erosion. Soils are typically derived from Mancos shale or, less often, from other Paleozoic or Mesozoic marine shales. They are moderately deep, strongly saline, moderately alkaline, fine-textured (clayey), poorly developed and typically have high erosion rates. The soil surface is mostly barren. In the Badger Wash Basin in Colorado, a relatively lush stand had 25% *Atriplex corrugata*, 60% bare ground, 8% litter and 8% algal crusts (Branson et al. 1976).

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse mat saltbush dwarf-shrubland grows on clayey soils of badland areas within the recreation area. Total vegetation cover ranges from 2 to 17% and is characterized by scattered *Atriplex corrugata* shrubs, with 1-17% cover. No other shrubs are present with more than trace cover. The herbaceous layer is generally extremely sparse; *Eriogonum inflatum, Achnatherum hymenoides, Bromus rubens,* and *Salsola tragus* were the only species recorded with more than trace cover; however, one sampled stand recorded 4% cover of *Pleuraphis jamesii.*

Global Vegetation: These shrublands are found on the slopes of marine shale badlands and alkaline flats on the Colorado Plateau. Stands have very sparse to moderate cover (1-25%) of woody vegetation that is dominated by the halophytic evergreen dwarf-shrub *Atriplex corrugata*. Sparse stands are often solely dominated by this plant. Stands typically have very low species diversity. Depending on soil salinity and moisture, other plants may be present, including the shrubs *Atriplex gardneri, Atriplex confertifolia, Tetradymia spinosa, Gutierrezia sarothrae, Picrothamnus desertorum (= Artemisia spinescens), Suaeda calceoliformis (= Suaeda depressa),* and *Krascheninnikovia lanata*. The herbaceous layer is very sparse. Scattered perennial forbs, such as *Xylorhiza glabriuscula, Xylorhiza venusta,* and *Sphaeralcea grossulariifolia,* and the perennial grasses *Achnatherum hymenoides (= Oryzopsis hymenoides), Aristida purpurea, Elymus elymoides,* and *Pleuraphis jamesii* have been reported. Annuals are seasonally present and may include *Eriogonum inflatum, Phacelia splendens, Plantago tweedyi, Stenogonum salsuginosum,* and *Atriplex argentea*. Introduced species include *Bromus tectorum, Halogeton glomeratus, Malcolmia africana,* and *Salsola kali*. Perennial plants may be pedestalled because of high erosion on these sites.

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Global Dynamics: *Atriplex corrugata*-dominated shrublands are the most saline-tolerant of the Mancos shale plant communities studied by Branson et al. (1976). *Atriplex corrugata* can completely dominate these extremely saline sites (Branson et al. 1976). It is a true evergreen dwarf-shrub retaining leaves for several years, and branches are capable of rooting at the nodes. This plant utilizes winter soil moisture, beginning new growth in March when the soils are relatively warm and moist. It flowers in April, and by mid-July fruits are shattered (Branson et al. 1976). If the soils dry out in midsummer, it can go dormant until the late summer monsoon rains begin. Large areas of *Atriplex corrugata* died during the extreme drought of 2002 in the Four Corners area. By 2004, new seedlings were established and spreading; shrub cover recovered to approximately 50% of what it was before the drought.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Atriplex corrugata*
Herb (field)	Flowering forb	*Eriogonum inflatum*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Atriplex corrugata*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex corrugata*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Salsola tragus*
Global: Vulnerable Plants: *Phacelia splendens* (G3), *Xylorhiza venusta* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High), *Malcolmia africana*

Conservation Status Rank

Global Rank & Reasons: G5 (23-Feb-1994).

Related Concepts

Global Related Concepts:

- *Atripletum corrugatea* (Ibrahim et al. 1972) =
- *Atriplex confertifolia* Plant Community (Branson et al. 1976) =
- *Atriplex corrugata* (Potter et al. 1985) ><
- *Atriplex corrugata* (Bourgeron and Engelking 1994) =
- *Atriplex corrugata* Dwarf-shrubland (Von Loh 2000) =
- *Atriplex corrugata* Habitat Type (West and Ibrahim 1968) =
- *Atriplex corrugata* Shale Barren (Baker 1984a) =
- *Atriplex corrugata* Shrub Association (Baker 1984a) =
- *Atriplex corrugata* cover type (Collins 1984) =

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- *Atriplex corrugata* cover type (Tuhy and MacMahon 1988) =
- DRISCOLL FORMATION CODE:IV.C.1.b. (Driscoll et al. 1984) >
- Desert Shrub Habitat (USBOR 1976) ><
- Mancos Shale (Welsh 1957) ><
- Mat *Atriplex-Hilaria* Community (Dastrup 1963) ><
- Mat *Atriplex* Association (Graham 1937) =
- Mat Saltbush Community, Shrub Phase A3a (Romme et al. 1993) =
- Mat saltbush association (Shantz 1925) =
- Mat saltbush vegetation type (Harper and Jaynes 1986) =

Classification

Status: Standard
Classification Confidence: 1 - Strong
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Vegetation cover in this association may vary greatly depending on soil chemistry and slope. Some stands should be classified as shrublands with 25-30% shrub cover (Branson et al. 1976, Potter et al. 1985). However, most stands are in the 3-20% shrub cover range and should be classified in a sparsely vegetated alliance (West and Ibrahim 1968, Ibrahim et al. 1972, Harper and Jaynes 1986, Von Loh 2000). Further investigation is needed throughout its range to resolve this issue. *Atriplex corrugata* also occurs an as element in mat saltbush shrublands dominated by other species of *Atriplex* (e.g., *Atriplex gardneri* (including *Atriplex cuneata*) and *Atriplex confertifolia*). It is not always clear in the field where to draw the line between these three classes of mat saltbush shrublands, as the mix of the three species may change with small changes in slope, soil texture, topographic position and aspect.

Element Distribution

Glen Canyon National Recreation Area Range: This dwarf-shrubland type occurs on clayey soils throughout the southwest regions of the recreation area. Areas sampled include Sit Down Bench, north of Kane Point, Bull Points, Wiregrass Canyon, Last Chance Creek, Gunsight Canyon, Alstrom Point, Lone Rock Canyon, and Warm Creek.

Global Range: Shrublands in this association are found on lower hillslopes and alkaline flats on Colorado Plateau portions of northwestern New Mexico, western Colorado and eastern Utah.

Nations: US
States/Provinces: CO:S2, NM, UT:S5
TNC Ecoregions: 9:C, 10:C, 18:?, 19:C, 20:C
USFS Ecoregions (1994/95): 341B:CC, 341C:CC, M331E:CC, M331G:CC, M341B:??
Federal Lands: NPS (Arches, Black Canyon of the Gunnison, Capitol Reef, Dinosaur, Glen Canyon); USFWS (Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Clay soils have the biggest influence on plant community, as the *Atriplex corrugata* likes growing in these light-colored clayey soils. The hill is south-facing, favoring drought-resistant, heat-tolerant plants such as *Atriplex corrugata*.

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Glen Canyon National Recreation Area Plots: The description is based on 2011 and 2012 field data (12 plots): (Plots: GLCA.1005, GLCA.1017, GLCA.2001, GLCA.2005, GLCA.2007, GLCA.2017, GLCA.2025, GLCA.4008, GLCA.4010, GLCA.4011, GLCA.4022, GLCA.5005, GLCA.5019).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and J. Coles
References: Baker 1984a, Bourgeron and Engelking 1994, Branson 1966c, Branson et al. 1967, Branson et al. 1976, CNHP 2003, CNHP 2015, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Coles et al. 2010, Collins 1984, Dastrup 1963, Driscoll et al. 1984, Graham 1937, Harper and Jaynes 1986, Ibrahim et al. 1972, Lusby et al. 1963, Potter et al. 1985, Romme et al. 1993, Shantz 1925, Shute and West 1978, Tuhy and MacMahon 1988, USBOR 1976, Von Loh 2000, Von Loh et al. 2002, Welsh 1957, Welsh et al. 2003, West and Ibrahim 1968, Western Ecology Working Group n.d.*

A1110 Atriplex gardneri Low Scrub Alliance
Alliance Summary Description: Stands of this alliance have a very sparse to moderately dense cover of dwarf-shrubs that is dominated by *Atriplex gardneri*. *Artemisia tridentata* and *Picrothamnus desertorum (= Artemisia spinescens)* are codominants in some stands. Many other shrubs and dwarf-shrubs may be present, including *Atriplex* spp., *Krascheninnikovia lanata, Sarcobatus vermiculatus, Suaeda* spp., and *Tetradymia spinosa*. The herbaceous layer, if present, may be dominated by graminoids or forbs. Common species include *Achnatherum hymenoides (= Oryzopsis hymenoides), Eriogonum pauciflorum, Leymus salinus, Monolepis nuttalliana, Pascopyrum smithii, Pleuraphis jamesii (= Hilaria jamesii)*, or *Xylorhiza venusta*. This dwarf-shrubland alliance occurs in western Colorado and eastern Utah, Wyoming and Montana. Stands occur on mesas, plateaus, plains, low hills and eroded "badlands." Sites are nearly flat to moderately steep with moderately deep to deep, usually saline, alkaline soils. Soils are typically fine-textured and often have high erosion rates because of poor infiltration and high runoff. The soil surface is often mostly barren.

[CEGL001441] Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland
Translated Name: Gardner's Saltbush / James' Galleta Dwarf-shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)
Group: Intermountain Dwarf Saltbush - Sagebrush Scrub (G301)
Alliance: *Atriplex gardneri* Low Scrub Alliance (A1110)

Element Concept

Global Summary: This association occurs on barren shale slopes and flats in the northern Colorado Plateau of Colorado and Utah. The vegetation is generally sparse and consists of an open canopy of dwarf-shrubs consisting primarily or entirely of *Atriplex gardneri* and an open to sparse herbaceous stratum in which *Pleuraphis jamesii* is conspicuous. Other grasses, such as *Achnatherum hymenoides* and *Poa secunda*, and a diversity of forbs that are typical of shale badlands are also usually present

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with sparse cover. The substrate is fine-textured soil derived from marine shale, but there is often a layer of gravel or small rocks on the ground surface.

Environmental Description

Glen Canyon National Recreation Area Environment: This rare dwarf-shrubland occurs on talus/colluvial slopes, mesa sides, canyon bottoms, and terraces. Sites range from nearly flat to steeply sloped (up to 30°), oriented to the north, east or west, and lie between 1258 and 1484 m elevation. Large rocks and gravel cover most of the unvegetated surface, with low to moderate cover of bare soil, biological soil crusts, and bedrock. Soils are rapidly drained sandy loams or shaley soils derived from Moenkopi or Chinle formations.

Global Environment: This association occurs on slopes of ridges, hills, eroded pediment slopes and badlands of the Colorado Plateau in eastern Utah and western Colorado. Elevation ranges between 1225 and 1975 m (4020-6480 feet) on slopes from gentle to steep (10-65%). The substrate is a saline, alkaline, well- to rapidly drained sandy loam, sandy clay loam, silt loam, clay loam or silty clay derived from marine shale, including the Brushy Basin Member of the Morrison Formation, Chinle shale, Mancos shale, or Moenkopi Formation. The soil surface often has a coating of gravel or small rocks, although large rocks may be present.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This alkaline dwarf-shrubland is of very limited extent within the recreation area. Total vegetation cover is between 7 and 31% and is dominated by the dwarf-shrub *Atriplex gardneri* (with 1-14%) and the perennial short bunchgrass *Pleuraphis jamesii* (with 1-5%). In many stands of this type, *Ephedra torreyana* has nearly codominant cover with *Atriplex gardneri*. A diversity of other shrubs may be present, including *Atriplex confertifolia, Artemisia bigelovii, Xylorhiza tortifolia, Chrysothamnus viscidiflorus*, and *Gutierrezia sarothrae*. The remaining herbaceous layer tends to be weedy and may include low to moderate cover by *Plantago patagonica, Bromus tectorum, Eriogonum inflatum, Halogeton glomeratus*, and *Mentzelia* sp., but may also include trace cover of *Acnhatherum hymenoides.*

Global Vegetation: This association occurs on alkaline shale badlands, often where the soil surface is modified by a layer of gravel or small rocks. The vegetation is characterized by a typically sparse canopy (1-10% cover) of *Atriplex gardneri* with a sparse to moderate understory of the short bunchgrass *Pleuraphis jamesii*. Total vegetation is generally sparse, rarely exceeding 20%. Occasionally stands have an open to closed canopy of *Atriplex gardneri* dwarf-shrubs that range in cover from 26 to 76% and a herbaceous layer that ranges in cover from 26 to 50%. Total vegetation may exceed 100% in these stands. Other low shrubs and cacti are often present with low cover, including *Atriplex confertifolia, Artemisia bigelovii, Artemisia nova, Atriplex confertifolia, Chrysothamnus viscidiflorus, Ephedra torreyana, Ericameria nauseosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia polyacantha, Picrothamnus desertorum, Sclerocactus whipplei, Shepherdia rotundifolia*, or *Yucca angustissima*. Scattered *Juniperus osteosperma* trees may also be present. The generally sparse herbaceous layer is composed of a mixture of grasses and forbs. *Pleuraphis jamesii, Achnatherum hymenoides*, and *Poa secunda* are the most abundant grasses. A diversity of forbs that are typical of shale badlands is also usually present with sparse cover, including

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Astragalus amphioxys, Astragalus mollissimus, Calochortus nuttallii, Cymopterus purpurascens, Eriogonum inflatum, Lappula occidentalis, Oenothera caespitosa, Plantago patagonica, Platyschkuhria integrifolia, Sphaeralcea coccinea, Sphaeralcea leptophylla, and *Xylorhiza venusta*. Biological soil crusts provide up to 25% cover.

Global Dynamics: This association is very similar to *Atriplex gardneri* Dwarf-shrubland (CEGL001438), but modifications to the soil surface (e.g., a gravel layer or desert pavement) permit the development of an herbaceous layer.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex gardneri*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Flowering forb	*Halogeton glomeratus*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Atriplex gardneri*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex gardneri, Pleuraphis jamesii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Halogeton glomeratus* (High/Medium), *Plantago patagonica*

Global: Vulnerable Plants: *Sclerocactus whipplei* (G2G3), *Shepherdia rotundifolia* (G3G4), *Xylorhiza venusta* (G3G4); Invasive/Exotic Plants: *Ceratocephala testiculata, Malcolmia africana*

Conservation Status Rank

Global Rank & Reasons: G3G5 (23-Feb-1994).

Related Concepts

Global Similar Types:
- *Atriplex gardneri / Achnatherum hymenoides* Dwarf-shrubland (CEGL001444)
- *Atriplex gardneri / Xylorhiza venusta* Dwarf-shrubland (CEGL001446)

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- *Atriplex gardneri* Dwarf-shrubland (CEGL001438) distinguished by the presence of an herbaceous layer that includes *Pleuraphis jamesii*.
- *Pleuraphis jamesii* Grassland (CEGL001777)

Global Related Concepts:
- *Atripletum nuttallae* Association (Ibrahim et al. 1972) =
- *Atriplex gardneri/Hilaria jamesii* (Bourgeron and Engelking 1994) =
- *Atriplex nuttallii var. nuttallii / Hilaria jamesii* Habitat Type (West and Ibrahim 1968) =
- DRISCOLL FORMATION CODE:IV.C.1.b. (Driscoll et al. 1984) >
- Nuttall Saltbush Community (USBOR 1976) =

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. The taxonomic classification of *Atriplex gardneri* was recently revised and several of the former varieties of *Atriplex gardneri* have been raised to species level. Additional review is needed to address classification issues with related taxa *Atriplex bonnevillensis, Atriplex cuneata, Atriplex falcata,* and *Atriplex welshii*, which are currently included in the concept of this association.

Element Distribution

Glen Canyon National Recreation Area Range: This dwarf-shrub association is rare within the recreation area and was only sampled in Millard Canyon and on the Millard Canyon Benches.

Global Range: This association is known from the Colorado Plateau of eastern Utah and western Colorado, including the Grand Valley and the Four Corners areas and extends into southwestern Wyoming.

Nations: US
States/Provinces: CO:S1, UT:S3S5, WY?
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 331:?, 341B:CC, M341C:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Colorado, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Slope is stable and colluvium made up of large boulders (0.5 m to small car-sized) from the Chinle/Mossback member. Shrubs are growing in soil pockets between boulders and look healthy. Soil areas between boulders are either covered with many small rocks or are moss-covered.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2014 field data (1 plot, 9 accuracy assessment points): (Plots: GLCA.0115; AA Points: GLCA_AA.0324, GLCA_AA.0365, GLCA_AA.0369, GLCA_AA.0370, GLCA_AA.0377, GLCA_AA.0380, GLCA_AA.0408, GLCA_AA.0410, GLCA_AA.0624).

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Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and K.A. Schulz
References: Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Clark et al. 2009, Coles et al. 2009a, Driscoll et al. 1984, Ibrahim et al. 1972, Romme et al. 1993, Singh and West 1971, USBOR 1976, Utah Environmental and Agricultural Consultants 1973, Von Loh et al. 2007, West and Ibrahim 1968, Western Ecology Working Group n.d.*

[CEGL001438] *Atriplex gardneri* Dwarf-shrubland
Translated Name: Gardner's Saltbush Dwarf-shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)
Group: Intermountain Dwarf Saltbush - Sagebrush Scrub (G301)
Alliance: *Atriplex gardneri* Low Scrub Alliance (A1110)

Element Concept

Global Summary: This dwarf-shrubland association is reported from Utah, Colorado, Wyoming and Montana and is typically found on alkaline flats. The vegetation is sparse, rarely exceeding 15% total canopy coverage and is composed of a canopy layer dominated by *Atriplex gardneri* with or without other shrubs present and without an herbaceous layer. Associated shrubs may include any of the following species: *Atriplex confertifolia, Atriplex corrugata, Chrysothamnus viscidiflorus, Ephedra torreyana, Eriogonum corymbosum, Gutierrezia sarothrae, Picrothamnus desertorum, Sarcobatus vermiculatus*, and/or *Tetradymia spinosa*. No herbaceous layer is reported, though scattered grasses such as *Achnatherum hymenoides, Pleuraphis jamesii (= Hilaria jamesii)*, and *Elymus elymoides* may be present. Invasive species such as *Bromus tectorum, Halogeton glomeratus*, and *Malcolmia africana* are present in some stands. Biological soil crusts may cover up to 50% of the ground surface. Sites are typically flat but range to steep (58%). Soils are typically highly saline, calcareous, or alkaline, and are usually fine-textured. The dominance of *Atriplex gardneri* and the lack of a significant herbaceous layer are diagnostic of this association.

Environmental Description

Glen Canyon National Recreation Area Environment: This dwarf-shrubland association occurs on saline or alkaline sites of mesa sides, terraces, hills, canyon bottoms, and benches. Sites are on flat to very steep (up to 37°) slopes, include all aspects, and occur between 1253 and 1367 m elevation. Small rocks cover most of the unvegetated surface, with lesser cover by bare soil, biological soil crusts, and large rocks. Soils are rapidly drained loamy sands or sandy clays derived from the Moenkopi Formation.

Global Environment: Elevation ranges from 1196-2101 m and the climate is temperate and semi-arid. Stands most often occur on saline flats, but also occur on alkaline sites. Landforms where found include dry lakebeds, alluvial fans, hillsides, slopes of badland ridges, canyonsides, colluvial slopes, ridges, hills, badlands, mesas, and benches. Slopes are flat to steep (58%). Soils are calcareous,

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alkaline, and most often saline and typically fine-textured loamy sands or sandy clays, often derived from alluvium or shale from Chinle, Moenkopi, Mancos, Morrison, and Wasatch formations. One site has a gravelly/cobbly substrate. The unvegetated surface is composed of soil or rocks, or biological soil crusts may cover up to 40% of the ground surface.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Gardner's saltbush dwarf-shrubland grows on alkaline to saline soils within the recreation area. Total vegetation cover ranges from 2 to 17% and is characterized by scattered *Atriplex gardneri* shrubs, with 1-9% cover. Other shrubs may be present including *Ephedra torreyana* (nearly codominant in some stands) and *Atriplex confertifolia*. The herbaceous layer is sparse; *Eriogonum inflatum, Halogeton glomeratus,* and *Mentzelia* sp. were the only species recorded with more than trace cover. Biological soil crusts may cover up to 40% of the ground surface; those stands that are protected from grazing are advanced in development and include *Collema* sp., *Fulgensia* sp., *Psora* sp., mosses, and dark cyanobacteria.

Global Vegetation: This association is a dwarf-shrubland composed solely of or dominated by *Atriplex gardneri* with or without a variety of companion shrub species and without a herbaceous layer. Total vegetation cover is generally sparse, rarely exceeding 15%, and sometimes as low as 1% or as high as 35%. Associated shrubs may include any of the following with low to up to codominant cover: *Artemisia arbuscula ssp. longiloba, Artemisia tridentata ssp. wyomingensis, Atriplex confertifolia, Atriplex corrugata, Chrysothamnus viscidiflorus, Ephedra torreyana, Eriogonum corymbosum, Gutierrezia sarothrae, Krascheninnikovia lanata, Picrothamnus desertorum, Sarcobatus vermiculatus*, and/or *Tetradymia spinosa*. No herbaceous layer is reported, though scattered clumps of grass (usually <5%) such as *Achnatherum hymenoides, Pleuraphis jamesii (= Hilaria jamesii)*, and *Elymus elymoides* or occasional *Eriogonum inflatum* or *Mentzelia* sp. may be present. Invasive species such as *Agropyron cristatum, Bromus tectorum, Ceratocephala testiculata (= Ranunculus testiculatus), Halogeton glomeratus,* and *Malcolmia africana* are present in some stands. Biological soil crusts may cover up to 50% of the ground surface; those stands that are protected from grazing are advanced in development and include *Collema* sp., *Fulgensia* sp., *Psora* sp., mosses, and dark cyanobacteria. The dominance of *Atriplex gardneri* and the lack of a significant herbaceous layer are diagnostic of this association.

Global Dynamics: Although very slow-growing, *Atriplex gardneri* can completely dominate these extremely saline sites (Branson et al. 1976). This plant utilizes winter soil moisture, beginning new growth in March when the soils are relatively warm and moist. It flowers in April and by mid-July fruits are shattered (Branson et al. 1976). *Atriplex gardneri*-dominated vegetation occurs on the most saline-alkaline soils that Gates et al. (1956) studied. It is not limited to the harsh saline soils but is also found on calcareous loam.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Short shrub/sapling	Dwarf-shrub	*Atriplex gardneri*
Herb (field)	Flowering forb	*Eriogonum inflatum*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Atriplex gardneri*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex gardneri*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Vulnerable Plants: *Eriogonum bicolor* (G3G4); Invasive/Exotic Plants: *Agropyron cristatum* (Medium/Low), *Bromus tectorum* (High), *Ceratocephala testiculata*, *Halogeton glomeratus* (High/Medium), *Malcolmia africana*

Conservation Status Rank

Global Rank & Reasons: G3G5 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Allenrolfea occidentalis / Atriplex gardneri* Wet Shrubland (CEGL000989)
- *Artemisia pedatifida - Atriplex gardneri* Shrubland (CEGL001525)
- *Atriplex gardneri - Picrothamnus desertorum* Dwarf-shrubland (CEGL001439)
- *Atriplex gardneri / Achnatherum hymenoides* Dwarf-shrubland (CEGL001444)
- *Atriplex gardneri / Artemisia tridentata* Dwarf-shrubland (CEGL001440)
- *Atriplex gardneri / Leymus salinus* Dwarf-shrubland (CEGL001442)
- *Atriplex gardneri / Monolepis nuttalliana* Dwarf-shrubland (CEGL001443)
- *Atriplex gardneri / Pascopyrum smithii* Dwarf-shrubland (CEGL001445)
- *Atriplex gardneri / Pleuraphis jamesii* Dwarf-shrubland (CEGL001441)
- *Atriplex gardneri / Xylorhiza venusta* Dwarf-shrubland (CEGL001446)
- *Sarcobatus vermiculatus / Atriplex gardneri* Wet Shrubland (CEGL001360)

Global Related Concepts:

- *Atriplex gardneri* (Bourgeron and Engelking 1994) =
- *Atriplex gardneri* Dwarf-shrubland (Von Loh 2000) =
- *Atriplex nuttallii* community (Mitchell et al. 1966) =
- *Atriplex nuttallii* plant community (Branson et al. 1976) >
- *Atriplex* spp. Series (Johnston 1987) >

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- DRISCOLL FORMATION CODE:IV.C.1.b. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Its range and composition have been better defined based on plot data from eight national parks or wildlife refuges. In the past, this association was poorly defined and is only referred to as a "pure, evidently stable stand of saltsage" in Mitchell et al. (1966). Mitchell et al. (1966) investigated the relatively sharp boundaries between the *Atriplex gardneri* and the *Krascheninnikovia lanata* communities at their study site; no edaphic factor was identified to explain the abrupt change. This association is separated from other *Atriplex gardneri*-dominated associations by the lack of codominant shrubs or significant herbaceous layer. It includes both sparse stands growing on harsh, windswept sites and/or strong saline/alkaline substrates, and occasional moderately dense to dense saltbush stands that lack an herbaceous layer because of disturbance. Some stands may be a seral community in areas with a history of overgrazing by livestock.

The taxonomic classification of *Atriplex gardneri* was recently revised and several of the former varieties of *Atriplex gardneri* have been raised to species level. Additional review is needed to address classification issues with related taxa *Atriplex bonnevillensis, Atriplex cuneata, Atriplex falcata,* and *Atriplex welshii*, which are currently included in the concept of this association.

Element Distribution

Glen Canyon National Recreation Area Range: This rare dwarf-shrubland type occurs on alkaline and saline soils of the Moenkopi Formation in the Orange Cliffs section of the recreation area. Areas sampled include Buttes of the Cross, Anderson Bottom, and Millard Canyon.

Global Range: This dwarf-shrubland association is reported from northern and eastern Utah, western Colorado, Wyoming and Montana, but likely has a wider distribution in the interior West. *Atriplex gardneri* is common on shales that cover large areas of the Colorado Plateau, such as the Moenkopi, Mancos, Wasatch, and Morrison formations.

Nations: US
States/Provinces: CO, MT:S2S3, UT:S3S5, WY
TNC Ecoregions: 6:C, 9:C, 10:C, 11:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, 341C:CC, 342B:??, 342E:?C, M331E:CC, M331G:CC
Federal Lands: NPS (Arches, Black Canyon of the Gunnison, Canyonlands, Capitol Reef, Dinosaur, Fossil Butte, Glen Canyon); USFWS (Ouray)

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Element Sources

Glen Canyon National Recreation Area Inventory Notes: Fine, clay soils with a hard pan about 5 cm below the surface and a covering of small, flakey rocks. The surface is mainly covered with rocks or with an impressive thick biocrust layer. This is another hot, dry place, with no shelter.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2014 field data (3 plots, 4 accuracy assessment points): (Plots: GLCA.0319, GLCA.0550, GLCA.0730; AA Points: GLCA_AA.0348, GLCA_AA.0367, GLCA_AA.0409, GLCA_AA.0662).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Coles and G. Kittel
References: Bourgeron and Engelking 1994, Branson et al. 1976, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Coles et al. 2010, Driscoll et al. 1984, Friesen et al. 2010, Gates et al. 1956, Johnston 1987, MTNHP 2002b, MTNHP unpubl. data, Mitchell et al. 1966, Romme et al. 1993, Von Loh 2000, Von Loh et al. 2002, Western Ecology Working Group n.d.*

G300. Intermountain Shadscale - Saltbush Scrub

Group Summary Description: This extensive group includes open-canopied shrublands of typically saline basins, alluvial slopes and plains across the intermountain western U.S. and western Great Plains. The vegetation is characterized by a typically open to moderately dense shrubland composed of one or more *Atriplex* species, such as *Atriplex canescens, Atriplex confertifolia, Atriplex cuneata, Atriplex hymenelytra, Atriplex obovata*, or *Atriplex polycarpa*. Other shrubs present to codominant may include *Artemisia tridentata ssp. wyomingensis, Chrysothamnus viscidiflorus, Ericameria nauseosa, Ephedra nevadensis, Krascheninnikovia lanata, Grayia spinosa, Lycium* spp., *Picrothamnus desertorum*, or *Tetradymia* spp. Northern occurrences lack *Atriplex* species and are typically dominated by *Grayia spinosa*. In Wyoming, occurrences are typically a mix of *Artemisia tridentata ssp. wyomingensis, Atriplex confertifolia, Grayia spinosa, Krascheninnikovia lanata, Sarcobatus vermiculatus*, and various *Ericameria* or *Chrysothamnus* species. Some places are a mix of *Atriplex confertifolia* and *Artemisia tridentata ssp. wyomingensis*. In the Great Basin, *Sarcobatus vermiculatus* is generally absent but, if present, does not codominate. The herbaceous layer varies from sparse to moderately dense and is dominated by perennial graminoids such as *Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus ssp. lanceolatus, Pascopyrum smithii, Pleuraphis jamesii, Pleuraphis rigida, Poa secunda*, or *Sporobolus airoides*. Various forbs are also present. Substrates are often saline and calcareous, medium- to fine-textured, alkaline soils, but include some coarser-textured soils.

A0869 Atriplex canescens Scrub Alliance

Alliance Summary Description: This alliance occurs primarily in arid and semi-arid areas of the southwestern U.S. from western Texas to southern and eastern California and into Chihuahua, Mexico. It is also found in the western Great Plains to the Great Basin from western Kansas, Colorado, and Wyoming to Utah, Nevada and eastern Oregon. Stands typically have a sparse to moderately dense short-shrub canopy that is dominated by *Atriplex canescens*. Associated shrubs may include *Artemisia bigelovii, Artemisia tridentata, Ephedra viridis, Krascheninnikovia lanata, Purshia stansburiana (= Purshia mexicana var. stansburiana), Psorothamnus polydenius, Parthenium confertum, Sarcobatus*

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vermiculatus, and species of *Chrysothamnus, Ericameria*, and *Lycium*. The herbaceous layer is sparse to moderately dense and dominated by warm-season, medium-tall and short grasses depending on geographic range of the grasses. Species may include *Bouteloua gracilis, Distichlis spicata, Elymus elymoides, Hesperostipa comata, Pleuraphis jamesii (= Hilaria jamesii), Achnatherum hymenoides (= Oryzopsis hymenoides), Muhlenbergia porteri, Scleropogon brevifolius, Pascopyrum smithii*, and *Sporobolus* spp. Overall, shrublands in this alliance occur on lowland and upland sites with elevation ranging from 75 m below sea level to 2400 m. Lowland sites include alluvial flats, drainage terraces, playas, washes and interdune basins. Upland sites include bluffs and gentle to moderately steep, sandy or rocky slopes. Stands occur on all aspects. Soils are variable with depths ranging from shallow to moderately deep, and texture ranging from sand to loam to clay.

[CEGL001282] Atriplex canescens - Artemisia tridentata Shrubland

Translated Name: Fourwing Saltbush - Big Sagebrush Shrubland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)
Group: Intermountain Shadscale - Saltbush Scrub (G300)
Alliance: *Atriplex canescens* Scrub Alliance (A0869)

Element Concept

Global Summary: This shrubland is found on the western slope of the Colorado Rocky Mountains, Colorado Plateau, Great Basin, and Mojave Desert. The vegetation is characterized by a sparse to moderately dense (10-35% cover) short-shrub layer that is codominated by *Atriplex canescens* and *Artemisia tridentata*. On some sites, *Pinus edulis* and/or *Juniperus osteosperma* canopy trees provide sparse cover. *Chrysothamnus viscidiflorus, Ephedra nevadensis, Ericameria nauseosa, Gutierrezia sarothrae, Gutierrezia microcephala, Sarcobatus vermiculatus*, and *Suaeda moquinii* may be present with low cover on more saline sites. The sparse to moderate herbaceous layer (10-20% cover) is dominated by graminoids with scattered forbs. *Achnatherum hymenoides, Bouteloua gracilis, Elymus elymoides, Muhlenbergia asperifolia*, and *Pascopyrum smithii* are common grasses. Forbs have low and varied cover and may include *Cirsium neomexicanum, Eriogonum inflatum*, or *Sphaeralcea coccinea*. Introduced species are common in disturbed stands. Elevation ranges from 1160-2100 m (3800-6900 feet). Stands occur on level plains, valley bottoms, alluvial flats, stream terraces, low and midslopes. Slopes are typically less than 25%, but this shrubland has been documented on steep slopes as well. It occurs on all aspects. Substrates are well-drained, typically fine-textured soils (silty loam and clay) but may include coarser-textured soils (loamy sand).

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland association occurs on flat canyon bottoms and lies between 1402 and 1434 m elevation. Bare soil and litter cover most of the unvegetated surface, with lesser cover by live vegetation litter. Soils are moderately well-drained to somewhat poorly drained silt loams derived from alluvium.

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Global Environment: Elevation ranges from 1160-2100 m (3800-6900 feet). Stands occur on level plains, canyon floors, valley bottoms, alluvial flats, stream terraces, benches, low and midslopes. Slopes are typically less than 25%, but this shrubland has been documented on steep slopes. It occurs on all aspects, but northwest-, east- and southeast-facing slopes are common. Substrates are well-drained, typically fine-textured soils (silty loam and clay) but may include coarser-textured soils (loamy sand). Some stands may be subject to periodic flooding. Evidence of erosion, such as rills and gullies, is common (Warren et al. 1982).

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This bottomland shrubland is extremely rare within the recreation area. Total vegetation cover ranges between 17 and 63%. The shrub canopy is typically 1-2 m tall in which *Atriplex canescens* (with 8-10% cover) and *Artemisia tridentata ssp. tridentata* (with 6-30% cover) are codominant. Associated trees and shrubs include *Salix gooddingii* and *Ericameria nauseosa*. The only consistent understory species is *Muhlenbergia asperifolia,* which had up to 20% cover in one stand.

Global Vegetation: This association is characterized by a sparse to moderately dense (10-35% cover) short-shrub layer (1-2 m tall) that is codominated by *Atriplex canescens* and *Artemisia tridentata*. On some sites, *Pinus edulis* and/or *Juniperus osteosperma* canopy trees provide sparse cover. Associated shrubs include *Chrysothamnus viscidiflorus, Ephedra viridis, Ephedra nevadensis, Eriogonum corymbosum, Ericameria nauseosa, Gutierrezia sarothrae, Gutierrezia microcephala, Krascheninnikovia lanata, Lycium* spp., *Opuntia* spp., and *Salix gooddingii* (Warren et al. 1982, Roberts et al. 1992). *Sarcobatus vermiculatus* and *Suaeda moquinii* may be present with low cover on more saline sites. The sparse to moderately dense (10-20% cover) herbaceous layer is dominated by graminoids with scattered forbs. *Achnatherum hymenoides, Bouteloua gracilis, Elymus elymoides, Leymus salinus, Muhlenbergia asperifolia, Pleuraphis jamesii, Pascopyrum smithii*, and *Sporobolus cryptandrus* are common grasses. Forbs may include *Abronia fragrans, Cirsium neomexicanum, Eriogonum inflatum, Eriogonum racemosum, Heliomeris longifolia (= Viguiera longifolia), Lappula occidentalis, Machaeranthera canescens, Mentzelia multiflora, Oenothera caespitosa, Penstemon* spp., *Rumex hymenosepalus,* or *Sphaeralcea coccinea*. Introduced species such as *Agropyron cristatum, Arctium minus, Bromus rubens, Bromus tectorum, Carduus nutans, Chenopodium album, Cirsium arvense, Convolvulus arvensis, Descurainia sophia, Erodium cicutarium, Lactuca serriola, Lappula occidentalis, Medicago sativa, Salsola tragus,* and *Tragopogon dubius* are common in disturbed stands. Cryptogams are generally sparse but one sampled plot had 25% cover.

Global Dynamics: *Atriplex canescens* is tolerant of fire and generally sprouts vigorously from the rootcrown after burning (Wright 1980). It often recovers fully within 2 or 3 years after a burn (Wright 1980). However, *Artemisia tridentata* shrubs are readily killed by fire and do not resprout (Wright et al. 1979). *Artemisia tridentata* will re-establish relatively quickly (about 10-20 years) if a seed source is nearby (Bunting 1987). If fire-return intervals are more frequent than 10 years, then *Artemisia tridentata* has difficulty recovering (Bunting 1987, Everett 1987). This community is an interesting combination of a species with different tolerances to soil alkalinity and salinity. Although *Artemisia tridentata* occurs on a variety of substrates, it is intolerant of strongly alkaline and saline soils (Howard

1999, 2003), whereas *Atriplex canescens*, which also occurs on a wide variety of substrates, can tolerates saline, alkaline, boron, and gypsum soils (Howard 2003). This frequently results in relatively sharp boundaries between fourwing saltbush and big sagebrush communities, although each species may occur as associates for the other. More research is needed to understand the dynamics of this mixed shrub community.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *tridentata*, *Atriplex canescens*
Herb (field)	Graminoid	*Muhlenbergia asperifolia*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*, *Atriplex canescens*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Artemisia tridentata*, *Atriplex canescens*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Global: Invasive/Exotic Plants: *Agropyron cristatum* (Medium/Low), *Arctium minus* (Medium/Insignificant), *Bromus rubens*, *Bromus tectorum* (High), *Carduus nutans* (High/Low), *Chenopodium album*, *Cirsium arvense* (High/Medium), *Convolvulus arvensis* (Medium/Low), *Descurainia sophia* (Medium/Low), *Erodium cicutarium* (Medium/Low), *Lactuca serriola* (Low/Insignificant), *Lappula occidentalis*, *Medicago sativa* (Insignificant), *Salsola tragus*, *Tragopogon dubius* (Medium/Low)

Conservation Status Rank

Global Rank & Reasons: G4 (20-Sep-2000).

Related Concepts

Global Similar Types:

- *Atriplex canescens* Shrubland (CEGL001281)

Global Related Concepts:

- 152.1721 *Atriplex canescens - Artemisia tridentata - Gutierrezia sarothrae* (Warren et al. 1982) =
- *Artemisia tridentata / Atriplex canescens* Habitat Type (Roberts et al. 1992) =
- *Atriplex canescens-Artemisia tridentata* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >

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Classification

Status: Standard
Classification Confidence: 2 - Moderate

Element Distribution

Glen Canyon National Recreation Area Range: This extremely rare shrubland association was only sampled along the Escalante River.

Global Range: This shrubland is found on the western slope of the Colorado Rocky Mountains, Colorado Plateau, Great Basin, and Mojave Desert.

Nations: US
States/Provinces: AZ:S3, CA?, CO, NV, UT:S4
TNC Ecoregions: 11:C, 17:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC, 341:C, M331G:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Bryce Canyon, Canyonlands, Glen Canyon, Pipe Spring, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plant distribution on the floodplain is controlled by proximity to the river. Sage and saltbush seem to grow separately from one another.

Glen Canyon National Recreation Area Plots: The description is based on 2012 field data (2 plots): (Plots: GLCA.4318, GLCA.4323).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and G. Kittel
References: Bourgeron and Engelking 1994, Bunting 1987, Cogan et al. 2004, Coles et al. 2008b, Coles et al. 2010, Driscoll et al. 1984, Everett 1987, Howard 1999, Howard 2003, Peterson 2008, Roberts et al. 1992, Tendick et al. 2011b, Tirmenstein 1999c, Warren et al. 1982, Western Ecology Working Group n.d.*, Wright 1980, Wright et al. 1979

[CEGL003828] Atriplex canescens - Ephedra viridis Shrubland
Translated Name: Fourwing Saltbush - Mormon-tea Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)
Group: Intermountain Shadscale - Saltbush Scrub (G300)
Alliance: *Atriplex canescens* Scrub Alliance (A0869)

Element Concept

Global Summary: This Colorado Plateau shrubland association is known from Canyonlands and Glen Canyon national parks in southeastern Utah. Shrub cover is about 10% and characterized by *Atriplex*

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canescens and *Ephedra viridis* (or *Ephedra cutleri*), each with up to 5% cover. Other shrubs present with lesser cover may include *Coleogyne ramosissima, Ericameria nauseosa,* and many others. The herbaceous layer is moderately diverse and generally contributes only sparse cover, but some stands can have moderate grass cover. Grasses include *Achnatherum hymenoides, Hesperostipa comata, Muhlenbergia pungens, Aristida purpurea, Sporobolus cryptandrus,* and *Sporobolus contractus*. Forbs include sand-loving and weedy species. Stands occur on sand dunes, sandsheets and stream terraces. Sites are flat to moderately sloping (up to 11°), oriented to the southwest, and are located between 1140 and 1860 m elevation. Soils are rapidly drained sandy loams or loamy sands derived from eolian deposits.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland association occurs on plateaus, terraces, dunes, sideslopes, and hills. Sites are flat to steeply sloping (up to 35°), oriented to all aspects, and lie between 1143 and 1559 m elevation. Bare ground or sand covers most of the unvegetated surface, with low to moderate cover by litter, dark cyanobacteria, small rocks, and mosses. Soils are rapidly drained to well-drained sands, loamy sands, sandy loams, or silt loams derived from eolian or alluvial deposits.

Global Environment: Stands occur on sand dunes, sandsheets, plateaus, sideslopes, hills and stream terraces. Sites are flat to moderately sloping (up to 11°), oriented to the southwest, and are located between 1140 and 1860 m elevation. Bare ground covers most of the unvegetated surface, with some litter. Soils are rapidly drained sandy loams or loamy sands derived from eolian deposits.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This often sparse shrubland is somewhat uncommon within the recreation area. Total vegetation cover ranges from 4 to 42% and is characterized by *Atriplex canescens* and *Ephedra viridis* or *Ephedra cutleri*, each with up to 7% cover. Other shrubs present with lesser cover may include *Coleogyne ramosissima, Ericameria nauseosa, Ephedra torreyana, Krascheninnikovia lanata, Psoralidium junceum, Psorothamnus fremontii, Acamptopappus sphaerocephalus, Gutierrezia sarothrae, Gutierrezia microcephala,* and *Opuntia* spp. The herbaceous layer is moderately diverse but contributes only sparse to low cover. Grasses include *Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii, Sporobolus contractus, Sporobolus cryptandrus, Bromus rubens, Bromus tectorum, Bouteloua barbata,* and *Schismus barbatus*. Forbs recorded include *Plantago patagonica, Salsola tragus, Artemisia dracunculus,* and *Sphaeralcea* spp.

Global Vegetation: Total vegetation cover is only around 10-15% and is characterized by a shrub layer of 10% cover with *Atriplex canescens* and *Ephedra viridis* (or *Ephedra cutleri*), each with up to 5% cover. Other shrubs present with lesser cover may include *Coleogyne ramosissima, Ericameria nauseosa, Ephedra torreyana, Krascheninnikovia lanata, Psoralidium junceum, Psorothamnus fremontii, Acamptopappus sphaerocephalus, Gutierrezia microcephala, Gutierrezia sarothrae,* and *Opuntia polyacantha*. The herbaceous layer is moderately diverse and can be sparse to moderate in cover. Grasses include *Achnatherum hymenoides, Hesperostipa comata, Muhlenbergia pungens, Aristida purpurea, Sporobolus cryptandrus, Bouteloua gracilis, Bouteloua barbata, Pleuraphis*

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Subset: GLCA; Glen Canyon National Recreation Area

jamesii, and *Sporobolus contractus*. Forbs include the sand-loving and weedy species *Rumex hymenosepalus, Sphaeralcea parvifolia, Artemisia campestris, Artemisia dracunculus*, and *Plantago patagonica*. Introduced species include *Chenopodium album, Bromus rubens, Bromus tectorum, Salsola tragus,* and *Schismus barbatus*.

Global Dynamics: Both *Atriplex canescens* and *Ephedra viridis* are tolerant of surface fires and will resprout if top-killed (Anderson 2001b, Howard 2003).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*, *Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia* spp.
Short shrub/sapling	Succulent shrub	*Opuntia* spp.
Herb (field)	Graminoid	*Schismus barbatus*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*, *Ephedra cutleri*, *Ephedra viridis*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex canescens*, *Ephedra cutleri*, *Ephedra viridis*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Psoralidium junceum* (G3); Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Chenopodium album*, *Plantago patagonica*, *Salsola tragus*, *Schismus barbatus* (High/Medium)

Global: Vulnerable Plants: *Psoralidium junceum* (G3); Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Chenopodium album*, *Salsola tragus*; Other Plants: *Opuntia polyacantha* (G5)

Conservation Status Rank

Global Rank & Reasons: GNR (12-Jun-2006).

Related Concepts

Classification

Status: Standard
Classification Confidence:

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This shrubland association was sampled on Alstrom Point, in Iceberg Canyon, Calf Canyon, Coyote Gulch, Llewellyn Gulch, Fence Canyon, Easter Pasture Canyon, the south fork of Ticaboo Canyon, and Wahweap Bay.

Global Range: This Colorado Plateau shrubland association is known from southeastern Utah. It may have once been more widespread.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 341B:CC
Federal Lands: NPS (Canyonlands, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Slight topographical basin relative to surrounding segments, lighter appearance, possibly deeper soils supporting *Psoralidium* and *Achnatherum hymenoides (= Stipa hymenoides)*, whereas *Coleogyne ramosissima*-dominated stands surround.

Glen Canyon National Recreation Area Plots: The description is based on 2012, 2013, 2014, and 2015 field data (4 plots, 7 accuracy assessment points): (Plots: GLCA.4019, GLCA.4267, GLCA.4305, GLCA.5407; AA Points: GLCA_AA.0047, GLCA_AA.0548, GLCA_AA.1472, GLCA_AA.1585, GLCA_AA.1594, GLCA_AA.1926, GLCA_AA.1991).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and G. Kittel
References: Anderson 2001b, Howard 2003, NatureServe n.d.*

[CEGL001289] Atriplex canescens / Achnatherum hymenoides Shrubland
Translated Name: Fourwing Saltbush / Indian Ricegrass Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)
Group: Intermountain Shadscale - Saltbush Scrub (G300)
Alliance: *Atriplex canescens* Scrub Alliance (A0869)

Element Concept

Global Summary: This shrubland is found on the western slope of the Colorado Rocky Mountains, northeastern Utah and the Great Salt Lake Desert. The vegetation is characterized by an open (10-25%

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cover) short-shrub layer that is dominated by *Atriplex canescens*, with an herbaceous layer dominated by the bunchgrass *Achnatherum hymenoides*. Associated shrubby species provide sparse cover and may include *Rhus trilobata* and *Krascheninnikovia lanata*. The herbaceous layer is low in species diversity and provides sparse to low cover, except in disturbed stands, where *Bromus tectorum* can be codominant in the understory. Elevation ranges from approximately 1130-2454 m (4260-8545 feet). Stands occur on level desert plains, toeslopes, alluvial terraces and steep slopes at the base of mesas. Soils are well-drained, somewhat alkaline and include sandy clay loam.

Environmental Description

Glen Canyon National Recreation Area Environment: This association is known from canyon bottoms, canyon sides, and dunes. Sites are at elevations ranging from 1132 to 1404 m and occur on flat to moderately steep slopes (up to 20%). Bare soil covers most of the unvegetated surface, with low to moderate cover of biological soil crusts, small rocks, and sand, and trace to low cover of moss and litter. Soils are well-drained or rapidly drained loamy sands, sands, or silt loams derived from alluvial or eolian deposits.

Global Environment: Elevation ranges from approximately 1130-2454 m (4260-8545 feet). Stands occur on level canyon bottoms, alluvial terraces, sand dunes, desert plains, canyon sides, and steep toeslopes at the base of mesas. Soils are well-drained, somewhat alkaline and include sandy clay loam.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This shrubland association is uncommon in the recreation area and is characterized by an often sparse mixed shrub layer dominated or codominated by *Atriplex canescens* (with 1-10% cover). Total cover in these stands ranges from 4-25%. A variety of other shrubs contribute low to moderate cover, and include *Ericameria nauseosa, Coleogyne ramosissima, Ephedra torreyana, Psorothamnus fremontii, Gutierrezia* spp., and *Opuntia* spp. The most abundant herbaceous species is *Achnatherum hymenoides* with 1-7% cover. Other native herbaceous species present with low cover include *Sporobolus flexuosus* (5% cover in one stand) and *Sporobolus contractus*, and the forbs *Abronia fragrans* and *Penstemon ambiguus* (7% cover in one stand). The otherwise weedy understory is dominated by invasive species, including *Salsola tragus, Bromus tectorum, Erodium cicutarium, Schismus barbatus*, and *Plantago patagonica*. Biological soil crusts are common and may have up to 70% cover in some stands.

Global Vegetation: This semi-desert to desert association is characterized by an open (10-25% cover) short-shrub layer that is dominated by *Atriplex canescens*, with an herbaceous layer dominated by the bunchgrass *Achnatherum hymenoides*. Associated shrubby species provide sparse cover and may include *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra torreyana, Ericameria nauseosa, Grayia spinosa, Krascheninnikovia lanata, Opuntia* spp., *Psorothamnus fremontii*, and *Rhus trilobata*. The herbaceous layer is low in species diversity and provides sparse to low cover. Additional species may include the grasses *Bouteloua gracilis, Elymus elymoides, Sporobolus contractus, Sporobolus cryptandrus*, and *Sporobolus flexuosus*. Forbs include *Eriogonum lonchophyllum, Plantago patagonica, Sphaeralcea coccinea*, and *Stephanomeria minor var. minor (= Stephanomeria tenuifolia var. tenuifolia)*. Weedy introduced species include *Bromus tectorum,*

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Erodium cicutarium, Salsola tragus, and *Schismus barbatus,* which may be abundant in disturbed stands.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Herb (field)	Graminoid	*Achnatherum hymenoides*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Achnatherum hymenoides, Atriplex canescens*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low), *Plantago patagonica, Salsola tragus, Schismus barbatus* (High/Medium)

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low), *Salsola tragus, Schismus barbatus* (High/Medium)

Conservation Status Rank

Global Rank & Reasons: G3G5 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Atriplex canescens / Pleuraphis jamesii* Shrubland (CEGL001288)
- *Atriplex canescens / Sporobolus airoides* Shrubland (CEGL001291)
- *Atriplex canescens* Shrubland (CEGL001281)

Global Related Concepts:

- *Atriplex canescens/Oryzopsis hymenoides* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 2 - Moderate

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Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. More survey and classification work are needed to fully characterize it across its range.

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon association was sampled in Llewellyn Gulch, Coyote Gulch, Fiftymile Gulch, Wahweap Creek, near Lee's Ferry and Rainbow Bridge.

Global Range: This shrubland is found on the San Luis Valley in southern Colorado, the Colorado Plateau in northwestern New Mexico, western Colorado and eastern Utah, and the Great Salt Lake Desert north into the Snake River Plain in southern Idaho. This association may have a wider distribution as both diagnostic species are common in the semi-arid western U.S.

Nations: US
States/Provinces: CO, ID, NM, UT:S3S5
TNC Ecoregions: 6:C, 9:C, 19:C, 20:C
USFS Ecoregions (1994/95): 342B:CC, 342C:CC, M331E:CC, M331F:CC, M331G:CC
Federal Lands: NPS (Aztec Ruins, Curecanti, Dinosaur, Glen Canyon, Great Sand Dunes, Hagerman Fossil Beds)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This segment is a part of the canyon that is never inundated with water and has deep soils.

Glen Canyon National Recreation Area Plots: The description is based on 2011, 2012 and 2013 field data (6 plots): (Plots: GLCA.2038, GLCA.4247, GLCA.4301, GLCA.4330, GLCA.5023, RABR.5578).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Coles and G. Kittel
References: Bourgeron and Engelking 1994, Coles et al. 2008a, Coles et al. 2010, Driscoll et al. 1984, Erixson and Cogan 2009, Salas et al. 2009, Salas et al. 2010b, Tendick et al. 2010, Vest 1962a, Western Ecology Working Group n.d.*

[CEGL001288] Atriplex canescens / Pleuraphis jamesii Shrubland
Translated Name: Fourwing Saltbush / James' Galleta Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)
Group: Intermountain Shadscale - Saltbush Scrub (G300)
Alliance: *Atriplex canescens* Scrub Alliance (A0869)

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Element Concept

Global Summary: This shrubland association occurs on the Colorado Plateau and Uinta Basin and may occur in the Chihuahuan Desert and eastern California. The vegetation is characterized by a sparse to moderately dense shrub layer (10-40% cover) dominated by *Atriplex canescens* with *Pleuraphis jamesii* dominating the herbaceous layer. Associated shrubs include *Ericameria nauseosa, Ephedra torreyana, Chrysothamnus viscidiflorus,* and *Krascheninnikovia lanata*, depending on topographic position and substrate. Other graminoids that may be present include *Achnatherum hymenoides* and *Sporobolus cryptandrus* on sandy sites, and *Bouteloua gracilis* and *Sporobolus airoides* on fine-textured soil. Forbs generally have low cover and may include *Sphaeralcea grossulariifolia* and *Chenopodium* spp. Introduced or weedy species, such as *Bromus tectorum, Descurainia pinnata*, and *Salsola kali,* are common on some sites. This association appears to occur on two distinct types of landforms: alluvial flats and stream terraces with alkaline or saline silty clay loam soils, or on upland flats covered by eolian sand deposits.

Environmental Description

Glen Canyon National Recreation Area Environment: This association is known from canyon bottoms, benches, and mesatops. Sites are at elevations ranging from 1120 to 1680 m, with flat to moderately steep slopes (up to 8%) on north- and east-facing aspects. Bare soil covers most of the unvegetated surface, with low to moderate cover of biological soil crusts, small rocks, litter, and sand. Soils are rapidly drained loamy sands derived from alluvial or eolian deposits.

Global Environment: Elevation ranges from 300-1900 m. It occurs on two distinct types of landforms: lowland sites such as alluvial flats and stream terraces with fine-textured soils or upland sites such as sandsheets with coarse-textured soils Water tends to pond temporarily in both kinds of sites following heavy rainstorms or spring floods; thus salts tend to accumulate in the soils. All sites are generally level to gently sloping or may be in nearly undetectable shallow depressions. The upland soils are somewhat shallow eolian sands or sandy loams. Lowland sites typically have deep, alkaline, saline silty clay loams derived from alluvium. These substrates are generally less saline and occur higher in the floodplain (further from the active channel) than *Atriplex canescens / Sporobolus airoides*- or *Atriplex confertifolia*-dominated shrublands that occur on saline bottomland sites.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This shrubland association is uncommon in the recreation area and is characterized by an often mixed shrub layer dominated or codominated by *Atriplex canescens* (with 2-22% cover). Total cover in these stands ranges from 10-53%. A variety of other shrubs contribute low to moderate cover, and include *Ericameria nauseosa, Coleogyne ramosissima, Krascheninnikovia lanata, Ephedra torreyana, Ephedra viridis, Ephedra cutleri, Psorothamnus fremontii, Lycium andersonii, Gutierrezia sarothrae,* and *Opuntia* spp. The most abundant herbaceous species is *Pleuraphis jamesii* with 2-11% cover. Other native herbaceous species present with low cover include *Sporobolus airoides, Achnatherum hymenoides*, and *Hesperostipa comata*. Forbs include *Machaeranthera canescens, Lepidium montanum, Eriogonum inflatum*, and *Sphaeralcea* spp. Invasive species commonly present include *Salsola tragus, Bromus tectorum,*

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Schismus barbatus, and *Plantago patagonica*. Scattered *Juniperus osteosperma* trees may be present with low cover. Biological soil crusts are common and may have up to 75% cover in some stands.

Global Vegetation: This shrubland association is characterized by a sparse to moderately dense shrub canopy (10-40% cover) dominated by *Atriplex canescens*, with a sparse to moderate graminoid layer that is dominated by *Pleuraphis jamesii*. Associated shrubs may include *Artemisia bigelovii, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra cutleri, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Grayia spinosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Lycium andersonii, Opuntia* spp., and *Psorothamnus fremontii*. Other graminoids present include *Achnatherum hymenoides* and *Sporobolus cryptandrus* on sandy sites, and *Bouteloua gracilis* and *Sporobolus airoides* on fine-textured soils of lowland sites. Forbs generally have low cover and may include *Astragalus nuttallianus, Chenopodium* spp., *Cryptantha crassisepala, Descurainia pinnata, Eriogonum inflatum, Lepidium montanum, Machaeranthera canescens, Mentzelia albicaulis, Phacelia crenulata, Sphaeralcea grossulariifolia*, and other species of *Sphaeralcea*. Introduced species such as *Bromus tectorum, Erodium cicutarium*, and *Salsola kali* are common on some sites. In many sites, the herbaceous layer is sparse because of a history of grazing or other disturbance. Many stands have the appearance of a shrubby grassland and may form a mosaic with *Ericameria nauseosa, Sarcobatus vermiculatus*, or *Atriplex confertifolia* shrublands.

Global Dynamics: Ecological processes vary with landscape type. Because of their location in level, accessible areas, most examples of this association have been heavily grazed and are subject to other disturbances, such as small mammal burrowing and sheet erosion, reducing shrub and native grass cover and encouraging the dominance of weedy annual grasses and forbs such as *Bromus tectorum* and *Descurainia pinnata*. Francis (1986) considers this to be an early-seral community.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Sclerophyllous shrub	*Opuntia* spp.
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Chrysothamnus viscidiflorus*, *Ericameria nauseosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*, *Krascheninnikovia lanata*

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Stratum	Lifeform	Species
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Bouteloua gracilis*, *Pleuraphis jamesii*, *Sporobolus airoides*, *Sporobolus cryptandrus*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Atriplex canescens, Pleuraphis jamesii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Plantago patagonica, Salsola tragus, Schismus barbatus* (High/Medium); Other Plants: *Pleuraphis jamesii* (G5)

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low), *Salsola kali*

Conservation Status Rank

Global Rank & Reasons: G3G4 (1-Feb-1996).

Related Concepts

Global Similar Types:

- *Atriplex canescens / Achnatherum hymenoides* Shrubland (CEGL001289) is similar to sandy site stands of this association.
- *Atriplex canescens / Bouteloua gracilis* Shrubland (CEGL001283) is similar to clayey bottomland and alluvial flats stands of this association.
- *Atriplex canescens / Muhlenbergia porteri* Shrubland (CEGL005385) is also dominated by *Atriplex canescens* and supports both *Yucca baccata* and *Gutierrezia sarothrae*, but *Muhlenbergia porteri* rather than *Pleuraphis jamesii* codominates the graminoid understory.
- *Atriplex canescens / Sporobolus airoides* Shrubland (CEGL001291) is similar to clayey bottomland and alluvial flats stands of this association.
- *Atriplex canescens* Shrubland (CEGL001281)
- *Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia)* Sparse Vegetation (CEGL005801)
- *Pleuraphis jamesii* Grassland (CEGL001777)

Global Related Concepts:

- *Atriplex canescens / Hilaria jamesii* Plant Community (Francis 1986) =
- *Atriplex canescens / Pleuraphis jamesii* Shrubland (Von Loh 2000) =
- *Atriplex canescens/Hilaria jamesii* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >
- Greasewood-saltbush map symbol (BLM 1979a) **?**
- Mapping symbol 313.11 Atca - Bogr - Hija - Spai (Miller et al. 1977) ><
- Mesquite-Saltbush Series (Diamond 1993) >

Classification

Status: Standard

Classification Confidence: 2 - Moderate

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Global Classification Comments: Because the habitat and the diagnostic species are relatively common in this region, the association should be widespread; grazing by sheep and cattle may have eliminated most stands. The Colorado Plateau sites used in this description have also been grazed heavily and show high cover by disturbance-tolerant herbaceous species.

As this association is currently defined, it is characterized only by the codominance of *Atriplex canescens* and *Pleuraphis jamesii*, which are both common in the southwestern U.S. Its relation to several similar associations is also unclear. Most of the information available suggests that the sparse shrub canopy is more typical and that this association should not be classified as a shrubland (Miller et al. 1977, Francis 1986, Von Loh 2000). Because it has a wide distribution (from southern Great Plains to the Mojave Desert), stands occur in diverse habitats (clayey bottomland to sand dunes) and vary from a sparse to moderate shrub canopy. It is likely that, when more information becomes available and the needed classification work is completed, this association will be subdivided with associated species representing distinct ecoregions and environments.

The diagnostic species require warm sites with somewhat alkaline soils, so this association should be relatively widespread throughout the Colorado Plateau and western Great Plains. That it is not may reflect spotty sampling of the region, or it may indicate that this association has been mostly altered by grazing. This association may also represent a form of *Atriplex canescens / Sporobolus airoides* Shrubland (CEGL001291) that has been degraded by domestic livestock grazing. The concept of *Atriplex canescens / Sporobolus airoides* Shrubland includes *Pleuraphis jamesii* in the herbaceous layer. In addition, the species lists for related and equivalent communities cited in the References section include both *Pleuraphis jamesii* and *Sporobolus airoides* in the herbaceous layer. It is possible that these associations (CEGL001288 and CEGL001291) should be combined, as it appears they are distinguished primarily by which of the two grasses is dominant. It is possible that summer-long grazing has reduced or eliminated *Sporobolus airoides* from many stands in the Colorado Plateau, leaving *Pleuraphis jamesii* and *Bouteloua gracilis* as more grazing-resistant species. Distinguishing these two associations because of different intensities of historic grazing may not be ecologically valid in certain environments.

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon association was sampled on Bagpipe Butte, Grand Bench, Alstrom Point, in Calf Canyon, the west fork of Big Water Canyon, and Hall's Creek Bay.

Global Range: This wide-ranging shrubland association has been well-documented from the Colorado Plateau. It also occurs north into southwestern Wyoming, southeast and east into the northern Chihuahuan Desert and western Great Plains, and west into the eastern Mojave Desert and Great Basin.

Nations: US
States/Provinces: AZ:S2, CA?, CO:S1, NM, TX:S4, UT:S3S4, WY
TNC Ecoregions: 10:C, 19:C, 24:C, 27:C, 28:?, 29:?
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313D:CC, 315:C, 321:C, 331I:??, 341B:CC, 341C:CC

USFS Ecoregions (2007): 341Bj:C
Federal Lands: NPS (Canyonlands, Capitol Reef, Glen Canyon, Grand Canyon, Hovenweep, Petrified Forest, Petroglyph); USFWS (Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This is a low-lying, flat canyon bottom terrace. The soil may be alluvial deposits. All of the *Atriplex* shrubs appear drought-stressed, and there is no apparent "green-ness" to the *Hilaria*.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2014, and 2015 field data (1 plot, 5 AA points): (Plots: GLCA.0566; AA Points: GLCA_AA.0051, GLCA_AA.0631, GLCA_AA.1080, GLCA_AA.1521, GLCA_AA.1569).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Coles and G. Kittel
References: BLM 1979a, BLM 1979b, Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Clark et al. 2009, Diamond 1993, Driscoll et al. 1984, Francis 1986, Miller et al. 1977, Muldavin et al. 2012f, Reid and Hall 2010, Romme et al. 1993, Shute and West 1978, Soil Conservation Service 1978, Thomas et al. 2009a, USBOR 1976, Von Loh 2000, Von Loh et al. 2002, Von Loh et al. 2008, WNDD unpubl. data, Western Ecology Working Group n.d.*

[CEGL001281] *Atriplex canescens* Shrubland
Translated Name: Fourwing Saltbush Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)
Group: Intermountain Shadscale - Saltbush Scrub (G300)
Alliance: *Atriplex canescens* Scrub Alliance (A0869)

Element Concept

Global Summary: This shrubland association is known from the Great Basin north into the southern Columbia Basin and east into Wyoming and the Colorado Plateau. The vegetation is characterized by a sparse short-shrub layer (10-35% cover) dominated or codominated by *Atriplex canescens*, typically with a variable and often sparse herbaceous layer. Notable codominants in the shrub layer include *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra nevadensis, Eriogonum nummulare (= Eriogonum kearneyi), Grayia spinosa, Gutierrezia sarothrae, Lycium pallidum*, or several species of *Psorothamnus*. The herbaceous layer includes low cover of species such as *Achnatherum hymenoides, Aristida purpurea, Elymus elymoides, Pleuraphis jamesii,* and *Sporobolus cryptandrus*. Introduced species, especially *Bromus tectorum, Bromus diandrus*, and *Salsola kali*, are common on disturbed sites and can create an herbaceous layer much denser than on undisturbed sites. Winter annual forb cover is variable depending on annual precipitation. It is common at middle elevations on

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alluvial fans and toeslopes in deep, sandy soils but will occur at lower elevations along alluvial benches where soils are often finer-textured and possibly saline/alkaline. Parent materials are variable.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland association occurs on deep, fine-textured alkaline soils of canyon bottoms and terraces. Sites are flat to gently sloping (up to 8°) and lie between 1123 and 1542 m elevation. Bare ground covers most of the unvegetated surface, with lesser cover by litter, moss, and dark cyanobacteria. Soils are well-drained to rapidly drained loams, silt loams, or loamy sands derived from alluvium or eolian deposits.

Global Environment: This widespread shrubland association occurs on bajadas, low stream terraces, valley floors and toeslopes. Sites are flat to gently sloping with any aspect. It is commonly found on deep, sandy soils at elevations of 1235-2256 m (2000-7400 feet) on the Colorado Plateau and at lower elevations (down to 610 m [2000 feet]) in the Great Basin region where it occurs along alluvial benches where soils are often finer-textured and possibly saline/alkaline (Beatley 1976). Soils are well-drained to rapidly drained loams, silt loams, or loamy sands derived from alluvium or eolian deposits. The unvegetated surface is predominantly bare soil and/or sand. Larger rocks and organic material are rare. Parent materials include volcanic tuff, shale and sandstone.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This fourwing saltbush shrubland occurs in a number of valley bottoms and dry washes throughout the park. Total vegetation cover is low, ranging from 5 to 16%, and is dominated by an open canopy of *Atriplex canescens* with 3 to 11% cover. The remaining shrub layer may include *Ephedra cutleri, Isocoma rusbyi,* and *Opuntia polyacantha*. The herbaceous layer is mostly dominated by non-native annuals, including *Bromus tectorum, Salsola tragus, Schismus barbatus,* and *Erodium cicutarium*. The native graminoid *Achnatherum hymenoides* was present with low cover in a few stands.

Global Vegetation: This broadly defined association is characterized by a sparse to moderately dense shrub layer (10-35% cover) dominated or codominated by *Atriplex canescens*, typically with a variable and often sparse herbaceous layer. Total vegetation cover ranges from sparse to moderate (5-56% cover). Notable codominants in the shrub layer include *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra nevadensis, Eriogonum nummulare (= Eriogonum kearneyi), Ericameria nauseosa, Grayia spinosa, Gutierrezia sarothrae, Lycium pallidum, Psorothamnus fremontii*, or *Psorothamnus polydenius*. *Artemisia bigelovii, Artemisia filifolia, Artemisia tridentata, Ephedra viridis, Ephedra cutleri, Isocoma rusbyi, Krascheninnikovia lanata, Purshia stansburiana,* or *Opuntia polyacantha* may be present but are not codominants. The typically sparse herbaceous layer includes low cover of semi-arid grasses such as *Achnatherum hymenoides (= Oryzopsis hymenoides), Aristida purpurea, Elymus elymoides, Pleuraphis jamesii (= Hilaria jamesii),* and *Sporobolus cryptandrus*. Common forb species on sandy sites include *Cymopterus ripleyi, Dalea searlsiae, Lesquerella ludoviciana,* and *Oenothera pallida,* and on disturbed sites *Cryptantha crassisepala, Descurainia pinnata, Erodium cicutarium, Lappula occidentalis, Lepidium montanum, Plantago patagonica,* and *Rumex hymenosepalus* may be present. Winter annual forb cover is variable depending on annual precipitation. Introduced species such as *Bromus tectorum, Bromus diandrus, Erodium cicutarium,*

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Salsola kali, *Salsola tragus*, *Schismus barbatus*, and *Tribulus terrestris* can be common on disturbed sites.

Global Dynamics: Stands of this association may be affected during large flood events.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Short shrub/sapling	Succulent shrub	*Opuntia polyacantha*
Herb (field)	Flowering forb	*Salsola tragus*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Bromus tectorum*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex canescens*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low), *Salsola tragus*, *Schismus barbatus* (High/Medium)

Global: Vulnerable Plants: *Cymopterus ripleyi* (G3); Invasive/Exotic Plants: *Bromus diandrus*, *Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low), *Salsola kali*, *Salsola tragus*, *Schismus barbatus* (High/Medium), *Tribulus terrestris*

Conservation Status Rank

Global Rank & Reasons: G5 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Artemisia tridentata - Atriplex canescens - Sarcobatus vermiculatus / (Achnatherum hymenoides)* Shrubland (CEGL001355)
- *Atriplex canescens - Artemisia tridentata* Shrubland (CEGL001282)
- *Atriplex canescens - Ephedra viridis* Talus Shrubland (CEGL001287)
- *Atriplex canescens - Krascheninnikovia lanata* Shrubland (CEGL001285)
- *Atriplex canescens / Achnatherum hymenoides* Shrubland (CEGL001289)
- *Atriplex canescens / Calycoseris parryi* Shrubland (CEGL001284)
- *Atriplex canescens / Pleuraphis jamesii* Shrubland (CEGL001288)
- *Atriplex canescens / Purshia stansburiana* Shrubland (CEGL001286)
- *Atriplex canescens / Sporobolus airoides* Shrubland (CEGL001291)

- *Gutierrezia sarothrae - Krascheninnikovia lanata - Atriplex canescens / Bouteloua eriopoda* Shrub Grassland (CEGL001733)
- *Prosopis glandulosa / Atriplex canescens* Ruderal Shrubland (CEGL001382)

Global Related Concepts:
- *Atriplex canescens* (Evens et al. 2014) =
- *Atriplex canescens* (Sawyer et al. 2009) =
- *Atriplex canescens* (Bourgeron and Engelking 1994) =
- *Atriplex canescens* Association (Evens et al. 2012) =
- *Atriplex canescens* Association (Beatley 1976) >
- *Atriplex canescens* Sparse Plant Association (Muldavin et al. 1998d) =
- *Atriplex* ssp. Shrubland Alliance (Ostler et al. 2000) >
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >
- Fourwing Saltbush/Sparse Undergrowth PA (Muldavin et al. 2000b) =

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This widespread, broadly defined association is characterized by dominance of *Atriplex canescens* in a sparse to moderately dense shrub layer (10-35% cover) with a variable, often sparse herbaceous layer. Therefore, this association may include degraded stands from a variety of other associations. More classification review is needed to determine if stands have associated species that may represent certain ecoregions.

Element Distribution

Glen Canyon National Recreation Area Range: This shrubland association occurs in scattered locations throughout the recreation area. Areas sampled include Cottonwood Gulch, Wahweap Creek, Dry Fork, Davis Gulch, and the north fork of Calf Canyon.

Global Range: This shrubland occurs from the southern Columbia Basin and Great Basin east into Wyoming and south into the Mojave Desert, Colorado Plateau and northern Chihuahuan Desert. This shrubland association occurs throughout much of the interior western U.S.

Nations: US
States/Provinces: AZ, CA:S3, CO, NM, NV:S5, UT, WY:S3?
TNC Ecoregions: 6:C, 10:C, 11:C, 17:C, 18:C, 19:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 321A:CC, 322A:CC, 341B:CC, 342B:CC, 342G:C?, M341C:C?
Federal Lands: DOD (White Sands Missile Range); NPS (Arches, Canyonlands, Capitol Reef, Chaco Culture, Colorado, Death Valley, Glen Canyon, Grand Canyon, Hubbell Trading Post, Joshua Tree, Mojave, Pipe Spring, Zion); USFWS (Sevilleta)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This type is controlled by very rare overbank flooding and wind action. Most areas have been historically grazed.

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Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, and 2012 field data (5 plots): (Plots: GLCA.0580, GLCA.2044, GLCA.4245, GLCA.4296, GLCA.4337).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Drake, J. Coles and G. Kittel
References: Beatley 1976, Bourgeron and Engelking 1994, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008b, Coles et al. 2009a, Driscoll et al. 1984, Evens et al. 2012, Evens et al. 2014, Howard 2003, Muldavin et al. 1998d, Muldavin et al. 2000b, Ostler et al. 2000, Peterson 2008, Reid and Hall 2010, Romme et al. 1993, Salas and Bolen 2010b, Salas et al. 2011, Sawyer et al. 2009, Von Loh et al. 2007, Western Ecology Working Group n.d.*

A0870 Atriplex confertifolia Scrub Alliance
Alliance Summary Description: This shrubland alliance occurs across the western U.S. from the eastern Mojave Desert and Great Basin east to the western Great Plains and north to Montana. The vegetation included in this alliance is characterized by a sparse to moderately dense shrub layer dominated or codominated by *Atriplex confertifolia* and/or *Picrothamnus desertorum*. Shrub associates may include *Atriplex polycarpa, Ephedra nevadensis, Chrysothamnus* spp., *Krascheninnikovia lanata, Lycium* spp., *Sarcobatus vermiculatus,* and *Tetradymia* spp. The usually sparse herbaceous layer is dominated by graminoids such as *Elymus elymoides, Pleuraphis jamesii (= Hilaria jamesii), Pleuraphis rigida (= Hilaria rigida), Leymus salinus, Achnatherum hymenoides (= Oryzopsis hymenoides), Pseudoroegneria spicata, Hesperostipa* spp., and other perennial bunchgrasses. These shrublands are usually associated with margins of large playas, valley bottoms or alluvial slopes with medium- to fine-textured soils but may occur on coarser soils of erosional slopes with calcareous substrates. In most cases, the soils are alkaline and may have substantial salt accumulation.

[CEPP005685] Atriplex confertifolia - (Acamptopappus sphaerocephalus, Picrothamnus desertorum) / (Pleuraphis jamesii) Scrub
Translated Name: Shadscale Saltbush - (Rayless Goldenhead, Bud Sagebrush) / (James' Galleta) Scrub

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)
Group: Intermountain Shadscale - Saltbush Scrub (G300)
Alliance: *Atriplex confertifolia* Scrub Alliance (A0870)

Element Concept

Global Summary: This sparse warm desert scrub association is known from Glen Canyon National Recreation Area but occurs more widely in the Colorado Plateau. It is characterized by dominance of *Acamptopappus sphaerocephalus* (with 1-8% cover) and codominance of *Atriplex confertifolia* and/or *Picrothamnus desertorum (= Artemisia spinescens)*. Associated shrubs with sparse to low cover may

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include *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra* spp., *Lycium andersonii, Gutierrezia* spp., *Opuntia* spp., and *Suaeda moquinii*. The herbaceous layer has sparse to moderate grass cover that is usually dominated by *Pleuraphis jamesii*, with up to 10% cover. Other grass species with low cover may include *Achnatherum hymenoides, Pleuraphis rigida (= Hilaria rigida),* and the exotic *Bromus rubens*. Forb cover is sparse with only exotic *Erodium cicutarium* with more than trace cover. Stands occur on plains, bajadas, alluvial fans, hills, sideslopes, valley floors, overflow stream channels, and arroyos between 1182 and 1330 m elevation. Sites are flat to moderately sloping and occur on all aspects. Soil surface is mostly bare soil and gravel with low cover of litter. Soils are variable and range from loams to silty clay loams and clays derived from older alluvium or eolian deposits from shale or sandstone.

Environmental Description

Glen Canyon National Recreation Area Environment: This common shrubland association occurs on plains, bajadas, alluvial fans, hills, sideslopes, valley floors, overflow stream channels, and arroyos. Sites are flat to moderately sloping (up to 13°), are oriented to all aspects, and lie between 1182 and 1330 m elevation. Bare soil and gravel cover most of the unvegetated surface, with low cover of litter. Soils are moderately well-drained to rapidly drained loams, sandy loams, sandy clay loams, silty clay loams, clay loams, and clays, derived from older alluvium or eolian deposits, from the Salt Wash member of the Morrison Formation, Tropic Shale Formation, or Dakota sandstone.

Global Environment: This sparse warm desert scrub association occurs in the Colorado Plateau on plains, bajadas, alluvial fans, hills, sideslopes, valley floors, overflow stream channels, and arroyos between 1182 and 1330 m elevation. Sites are flat to moderately sloping (up to 13°) and are oriented to all aspects. Soil surface is mostly bare soil and gravel with low cover of litter. Soils are moderately well-drained to rapidly drained loams, sandy loams, sandy clay loams, silty clay loams, clay loams, and clays derived from older alluvium or eolian deposits, from the Salt Wash Member of the Morrison Formation, Tropic Shale Formation, or Dakota sandstone.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse, warm desert shrubland has total vegetation cover generally less than 10%, but can be as high as 23%. The shrub canopy is dominated by *Acamptopappus sphaerocephalus* (with 1-8% cover) and codominated by either or both of the following species: *Atriplex confertifolia* (with 1-7% cover) and *Picrothamnus desertorum (= Artemisia spinescens)* (with 1-4% cover). Associated shrubs with sparse to low cover may include *Atriplex corrugata, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra* spp., *Lycium andersonii, Grayia spinosa, Gutierrezia* spp., *Opuntia* spp., and *Suaeda moquinii*. The understory may be sparse or have moderate grass cover; in the latter case, the cover is dominated by *Pleuraphis jamesii*, with up to 10% cover. Other grass species with low cover may include *Achnatherum hymenoides, Pleuraphis rigida (= Hilaria rigida),* and the exotic *Bromus rubens*. Forbs have negligible cover, only *Erodium cicutarium* and *Eriogonum inflatum* were noted with more than trace cover.

Global Vegetation: This sparse warm desert scrub association is characterized by dominance of *Acamptopappus sphaerocephalus* (with 1-8% cover) and codominance of *Atriplex confertifolia* (with

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1-7% cover) and/or *Picrothamnus desertorum (= Artemisia spinescens)* (with 1-2% cover). Associated shrubs with sparse to low cover may include *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra* spp., *Lycium andersonii, Gutierrezia* spp., *Opuntia* spp., and *Suaeda moquinii*. The herbaceous layer has sparse to moderate grass cover that is usually dominated by *Pleuraphis jamesii*, with up to 10% cover. Other grass species with low cover may include *Achnatherum hymenoides, Pleuraphis rigida (= Hilaria rigida),* and the exotic annual *Bromus rubens*. Forb cover is sparse with only exotic *Erodium cicutarium* with more than trace cover.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Acamptopappus sphaerocephalus*, *Atriplex confertifolia*, *Picrothamnus desertorum*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Acamptopappus sphaerocephalus*, *Atriplex confertifolia*, *Picrothamnus desertorum*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Acamptopappus sphaerocephalus, Atriplex confertifolia, Picrothamnus desertorum, Pleuraphis jamesii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low), *Salsola tragus*
Global: Invasive/Exotic Plants: *Bromus rubens, Erodium cicutarium* (Medium/Low)

Conservation Status Rank

Global Rank & Reasons: GNR (18-Aug-2016).

Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak

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Element Distribution

Glen Canyon National Recreation Area Range: This common shrubland occurs throughout the southwestern portion of the recreation area and was sampled in Warm Creek, Wiregrass Canyon, Gunsight Canyon, Last Chance Creek, on Sit Down Bench, Bull Points, and north of Kane Point.

Global Range: This sparse warm desert scrub association is known from Glen Canyon National Recreation Area but occurs more widely in the Colorado Plateau.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Alluvial fan sloping gradually down to the southeast. Higher ground areas intercepted by shallow drainages approximately every 50 m. Soils are stabilized by a high concentration of small rocks. Large rocks are more uncommon but are present. Drainages are dry.

Glen Canyon National Recreation Area Plots: The description is based on 2011 and 2012 field data (16 plots): (Plots: GLCA.1003, GLCA.1019, GLCA.2004, GLCA.2016, GLCA.2023, GLCA.2024, GLCA.2026, GLCA.4007, GLCA.4016, GLCA.4023, GLCA.5001, GLCA.5009, GLCA.5011, GLCA.5016, GLCA.5020, GLCA.5022).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEGL001311] Atriplex confertifolia / Achnatherum hymenoides Shrubland
Translated Name: Shadscale Saltbush / Indian Ricegrass Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)
Group: Intermountain Shadscale - Saltbush Scrub (G300)
Alliance: *Atriplex confertifolia* Scrub Alliance (A0870)

Element Concept

Global Summary: This plant association occurs predominantly in the Colorado Plateau, Columbia Plateau, and Great Basin in Colorado, Idaho, Nevada, Oregon and Utah, and is also purported to occur in California and Wyoming. Low-growing *Atriplex confertifolia* is the dominant shrub, usually with up to 15% cover, although other shrubs, including *Artemisia tridentata ssp. wyomingensis, Ephedra torreyana, Grayia spinosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia polyacantha,*

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Picrothamnus desertorum (= Artemisia spinescens), Psorothamnus fremontii, and *Sarcobatus vermiculatus*, may also be present in low amounts. In high-quality, ungrazed stands *Achnatherum hymenoides* may have up to 20% cover and dominates the otherwise sparse herbaceous understory. *Elymus elymoides, Hesperostipa comata, Pleuraphis jamesii, Poa fendleriana, Poa secunda* and *Sporobolus cryptandrus* are often present with low cover. Forbs have low cover and diversity, but vary greatly across the range of this association. Some locally common species include *Eriogonum* spp., *Phacelia crenulata (= Phacelia corrugata), Phlox hoodii, Sphaeralcea grossulariifolia, Thelypodium flexuosum*, and *Townsendia florifera*. Total cover is often less than 25%. Stands degraded by excessive livestock grazing have abundant *Bromus tectorum* or *Salsola tragus* in the understory and higher total herbaceous cover. This plant association is widely scattered on colluvial slopes, benches, mesas, plateaus, and gullies within the *Atriplex confertifolia* zone and is best developed in sites with an alkaline, yet coarse-textured soil. Elevations range from 1250 to 1780 m (4100-5840 feet) in Utah and Colorado. The association is typically found on well-drained, alkaline soils derived from volcanic tuff or shale that often have been modified by alluvial deposits. Bare ground or small rocks cover most of the unvegetated surface. Biological soil crusts may be sparse or well-developed and have up to 34% cover.

Environmental Description

Glen Canyon National Recreation Area Environment: This uncommon shrubland association occurs on benches, mesas, and colluvial slopes. Sites are gently sloping (up to 7° slopes), are oriented to the west and northwest, and lie between 1295 and 1434 m elevation. Bare ground or small rocks cover most of the unvegetated surface. Large rocks and dark cyanobacteria have low to moderate cover, and litter has low cover. The soils are derived from shales (mostly loams and clays) of the Chinle Formation.

Global Environment: This plant association is widely scattered on benches, plateaus, and gullies within the *Atriplex confertifolia* zone of Colorado, Idaho, Nevada, Utah and Oregon, and is also purported to occur in California and Wyoming. Elevations range from 1250 to 1780 m (4100-5840 feet) in Utah and Colorado, and slopes vary from gentle to steep. The association is typically found on well-drained, alkaline soils derived from volcanic tuff or shale, that often have been modified by alluvial deposits. Soil textures include rocky and gravelly sandy loams and may have an argillic horizon. Many sites show evidence of sheet and gully erosion.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This uncommon shrubland has total vegetation cover ranging from 16 to 25%, and is characterized by a sparse shrub layer dominated by *Atriplex confertifolia* (with 4-8% cover). The herbaceous understory is dominated by *Achnatherum hymenoides* (with 4-10% cover). Other shrubs are generally present, but with less cover than *Atriplex confertifolia*, and include *Ephedra torreyana, Coleogyne ramosissima, Krascheninnikovia lanata, Polygala acanthoclada, Gutierrezia sarothrae, Psorothamnus fremontii*, and *Opuntia polyacantha*. The herbaceous layer is often diverse, but few species have more than a trace amount of cover. Common species include *Pleuraphis jamesii, Phacelia crenulata (= Phacelia corrugata), Sporobolus*

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cryptandrus, Lappula occidentalis, Bromus tectorum, Salsola tragus, and *Eriogonum deflexum*. Biological soil crusts may be sparse or may be well developed and have up to 34% cover.

Global Vegetation: Low-growing *Atriplex confertifolia* is the dominant shrub, usually with up to 15% cover, though other shrubs, including *Picrothamnus desertorum (= Artemisia spinescens), Artemisia tridentata ssp. wyomingensis, Gutierrezia sarothrae, Opuntia polyacantha, Grayia spinosa*, and *Sarcobatus vermiculatus*, may also be present in low amounts. In high-quality, ungrazed stands *Achnatherum hymenoides* may have up to 20% cover and dominates the otherwise sparse herbaceous understory. Lesser amounts of other perennial grasses, including *Elymus elymoides, Hesperostipa comata, Pleuraphis jamesii, Poa fendleriana*, and *Poa secunda*, are often present. Forbs vary greatly across the range of this association and never contribute significant cover. Some locally common species include *Eriogonum* spp., *Phlox hoodii, Sphaeralcea grossulariifolia, Thelypodium flexuosum,* and *Townsendia florifera*. Stands degraded by excessive livestock grazing have abundant *Bromus tectorum* in the understory and higher total herbaceous cover.

Global Dynamics: This association requires the unusual combination of coarse-textured, alkaline substrates. In many cases, a thin veneer of alluvium overlying marine shale provides the required habitat. In others, an alkaline volcanic or marlstone substrate has weathered to a coarse soil.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*, *Psorothamnus fremontii*
Herb (field)	Graminoid	*Achnatherum hymenoides*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*
Herb (field)	Graminoid	*Achnatherum hymenoides*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Achnatherum hymenoides, Atriplex confertifolia*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*
Global: Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: G3 (17-Jan-2001). This plant association is widespread but not abundant. Throughout its range, this association is discontinuously distributed, and large stands are uncommon.

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Its long-term security throughout its range is questionable. Stands undisturbed by livestock grazing, off-highway vehicles, or other activities have healthy understories of *Achnatherum hymenoides* and minimal *Bromus tectorum*. However, such high-quality stands are probably uncommon. The historic range of this type is unknown; however, widespread *Bromus tectorum* invasion and subsequent large-scale wildfires have likely decreased the total number of occurrences. Petroleum extraction from oil shale in Colorado may also be a threat to this association.

Related Concepts

Global Similar Types:

- *Atriplex confertifolia / Elymus elymoides* Shrubland (CEGL001302)
- *Atriplex confertifolia / Hesperostipa comata* Shrubland (CEGL001314)
- *Atriplex confertifolia / Leymus salinus ssp. salmonis* Shrubland (CEGL001306)
- *Atriplex confertifolia / Pleuraphis jamesii* Shrubland (CEGL001304)
- *Atriplex confertifolia / Pseudoroegneria spicata* Shrubland (CEGL001312)
- *Atriplex confertifolia* Great Basin Shrubland (CEGL001294)
- *Atriplex confertifolia* Sparse Shrubland (CEGL003830)
- *Atriplex confertifolia* Wyoming Basins Shrubland (CEGL001293)

Global Related Concepts:

- *Atriplex confertifolia / Oryzopsis hymenoides* (Caicco and Wellner 1983g) **=**
- *Atriplex confertifolia / Oryzopsis* Shrubland Community Type (Moseley 1987b) **?**
- *Atriplex confertifolia/Oryzopsis hymenoides* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) **>**
- Stable Spike Fescue Community Type (Moseley 1987a) **?**

Classification

Status: Standard

Classification Confidence: 1 - Strong

Global Classification Comments: This plant association is distinguished from other *Atriplex confertifolia* types by the dominance of *Achnatherum hymenoides* in the herbaceous layer (Young et al. 1986, Rust et al. 2000b). Indicators of other *Atriplex confertifolia* associations (e.g., *Picrothamnus desertorum, Elymus elymoides*) may be present but in amounts less than those of *Atriplex confertifolia* and *Achnatherum hymenoides*.

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon shrubland association was sampled on Mike's Mesa and in a tributary of North Wash.

Global Range: This plant association occurs predominantly in the Colorado Plateau, Columbia Plateau, and Great Basin and ranges from southeastern Oregon, southern Idaho, and Nevada to Utah and western Colorado. It is purported to occur in California and Wyoming. In Idaho, it is known from the South Fork Owyhee River canyon, the Owyhee Mountains lowland front near the Snake River, and the Salmon River canyon near Challis (Moseley 1987a, Rust et al. unpubl. data 2000b). In Nevada, it has been observed in Grass Valley and elsewhere, including the Nevada Test Site (Rickard and Beatley 1965, Young et al. 1986). It has been documented in the oil shale region of Colorado by several researchers (e.g., Ward et al. 1974, Keammerer 1977), as well as in several National Parks. Though

widely distributed, its presence is discontinuous in environments dominated by either *Atriplex confertifolia* or *Artemisia tridentata ssp. wyomingensis*.

Nations: US
States/Provinces: CA?, CO:S2, ID:S1, NV, OR:S2, UT, WY?
TNC Ecoregions: 6:C, 8:C, 9:C, 10:C, 11:C, 19:C
USFS Ecoregions (1994/95): 341B:CC, 342A:C?, 342B:CC, 342C:CC, 342D:CC, 342F:C?, 342G:C?, 342H:C?, M331E:CC, M332E:CC
Federal Lands: NPS (Capitol Reef, Dinosaur, Glen Canyon, Hagerman Fossil Beds, John Day Fossil Beds)

Element Sources

Glen Canyon National Recreation Area Plots: The description is based on 2014 and 2015 field data (4 accuracy assessment points): (AA Points: GLCA_AA.0529, GLCA_AA.0540, GLCA_AA.1641, GLCA_AA.1642).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): C. Murphy and J. Coles
References: Baker 1982b, Blackburn et al. 1968a, Blackburn et al. 1969b, Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Caicco and Wellner 1983g, Clark et al. 2009, Coles et al. 2008a, Driscoll et al. 1984, Erixson and Cogan 2009, Kagan et al. 2004a, Keammerer 1974b, Keammerer 1977, Moseley 1987a, Moseley 1987b, Peterson 2008, Rickard and Beatley 1965, Romme et al. 1993, Rust et al. 2000b, WNDD unpubl. data, Ward et al. 1974, Western Ecology Working Group n.d.*, Young et al. 1986

[CEGL001304] Atriplex confertifolia / Pleuraphis jamesii Shrubland
Translated Name: Shadscale Saltbush / James' Galleta Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)
Group: Intermountain Shadscale - Saltbush Scrub (G300)
Alliance: *Atriplex confertifolia* Scrub Alliance (A0870)

Element Concept

Global Summary: This widespread western shrubland association is reported from the southwestern Great Plains, Colorado Plateau, Great Basin, Columbia Plateau and Mojave Desert mountains. This shrubland association is characterized by a sparse to open canopy (5-25% cover) of short shrubs dominated by *Atriplex confertifolia* with a sparse to moderate graminoid layer dominated by *Pleuraphis jamesii*. It includes sparsely vegetated stands with as little as 1-2% cover of shrubs and 1% cover of *Pleuraphis jamesii*. Total vegetation cover is widely variable (2-70%). Associated shrubs include *Artemisia bigelovii, Artemisia tridentata ssp. wyomingensis, Atriplex canescens, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra torreyana, Ericameria nauseosa,*

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Grayia spinosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia polyacantha, Picrothamnus desertorum, Sarcobatus vermiculatus, Suaeda calceoliformis, Suaeda moquinii (= Suaeda fruticosa), and *Tetradymia canescens* depending on substrate. *Amphipappus fremontii, Ambrosia dumosa,* and *Lycium pallidum* occur in the Mojave Desert. Other graminoids include *Achnatherum hymenoides, Sporobolus cryptandrus,* and *Elymus elymoides* on sandy sites and *Bouteloua gracilis* and *Sporobolus airoides* on fine-textured soil. Forbs generally have low cover and may include *Sphaeralcea grossulariifolia, Eriogonum inflatum,* and species of *Chaenactis, Lappula, Phacelia, Plantago,* and *Chenopodium*. Introduced species such as *Bromus tectorum* and *Salsola kali* are common on some sites. It occurs in a variety of habitats and can be found on two distinct substrates: coarse-textured, non-saline soils derived from sandstone or gravel or deep, fine-textured, alkaline, often saline soils derived from shale. Stands with coarse-textured soils tend to be on slopes, while those with fine-textured soils tend to be on low, relatively flat positions in the landscape (valley bottoms, basins, etc.). The common trait of these different substrates is that they are very dry either because of low precipitation or because of high internal plant moisture stress from soil salinity. The unvegetated surface is composed largely of bare soil, gravel, and large or small rocks.

Environmental Description

Glen Canyon National Recreation Area Environment: This common shrubland association occurs on plateaus, benches, mesas, canyon sides, canyon bottoms, valley bottoms, toeslopes, terraces, and plains. Sites are flat to steeply sloping (up to 20° slopes), include all aspects, and lie between 1066 and 1736 m elevation. Bare ground or small rocks cover most of the unvegetated surface. Large rocks and dark cyanobacteria have low to moderate cover. The soils are moderately well-drained to rapidly drained silts, loams, silt loams, clay loams, sandy loams, sandy clay loams, silty clay loams, clay loams, or silty clays that are derived from the Moenkopi Formation or older alluvium.

Global Environment: Elevation ranges from 1066 to 1951 m in the Colorado Plateau. It is found on two distinct substrates: coarse-textured (rocky or sandy), non-saline soils derived from sandstone or gravel, or deep fine-textured, poorly drained, alkaline, often-saline soils derived from shale or shale-derived alluvium. Sites with coarse-textured soils include gravel and cobble outcrops, ridges, mesa escarpments, talus slopes, alluvial fans, mountain and hillslopes, canyonsides, benches and along toeslopes of river bluffs. Fine-textured soil sites include canyon bottoms, plains, alluvial flats, floodplains and basins. Stands with coarse-textured soils can be on flat to moderately steep slopes, while stands with fine-textured soils are typically on flat to gently sloping sites. The common trait of these different substrates is that they are very dry either because of low precipitation (15-23 cm annually) or because of high internal plant moisture stress from soil salinity. The unvegetated surface is composed largely of bare soil, gravel, and large or small rocks. Cryptogamic crusts and mosses are important in some stands. Parent materials are variable and in the Colorado Plateau include sandstones and shale of the Burro Canyon Formation, Cedar Mountain Formation, Chinle Formation, Elephant Canyon Formation, Entrada Formation, Kayenta Formation sandstone, Mancos shale, Morrison Formation, Moenkopi Formation, and Wingate Formation typically deposited as alluvium or eolian sand.

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Vegetation Description

Glen Canyon National Recreation Area Vegetation: This common shrubland is widespread within the recreation area. Total vegetation cover is generally sparse, ranging from 5 to 17%, and is characterized by a sparse shrub layer dominated by *Atriplex confertifolia* (with 2-8% cover). The herbaceous understory is dominated by *Pleuraphis jamesii* (with 2-9% cover). Stands with less than 1% grass cover and less than 5% total cover are placed in *Atriplex confertifolia* Sparse Shrubland (CEGL003830). Other shrubs may be present, including *Ephedra torreyana, Ephedra viridis, Coleogyne ramosissima, Gutierrezia microcephala, Gutierrezia sarothrae,* and *Psorothamnus fremontii*. The herbaceous layer is often diverse, but few species have more than a trace amount of cover. Common species include *Bromus rubens, Bromus tectorum, Phacelia crenulata,* and *Sporobolus flexuosus*.

Global Vegetation: This shadscale shrubland association is characterized by an open canopy (5-25% cover) of short shrubs dominated by *Atriplex confertifolia* with a sparse to moderate graminoid layer dominated by *Pleuraphis jamesii*. This association includes sparsely vegetated stands with as little as 1-2% cover of shrubs and 1% cover of *Pleuraphis jamesii*. Total vegetation cover is widely variable (2-70% in sampled stands). Associated shrubs include *Artemisia bigelovii, Artemisia tridentata ssp. wyomingensis, Atriplex canescens, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Eriogonum microthecum, Grayia spinosa, Gutierrezia microcephala, Gutierrezia sarothrae, Krascheninnikovia lanata, Lycium pallidum, Picrothamnus desertorum, Psorothamnus fremontii, Sarcobatus vermiculatus, Suaeda calceoliformis, Suaeda moquinii (= Suaeda fruticosa),* and *Tetradymia canescens* depending on substrate. *Amphipappus fremontii, Ambrosia dumosa,* and *Lycium pallidum* occur in the Mojave Desert. Succulents may include *Echinocereus triglochidiatus, Opuntia erinacea, Opuntia polyacantha, Sclerocactus whipplei*, and *Yucca harrimaniae*. Rarely, tree and tall-shrub species are present and may include *Juniperus osteosperma* and *Fraxinus anomala*. If other *Atriplex* species are present, they do not dominate the canopy. The herbaceous layer is often sparse, less than 10% total cover, but ranges up to 30% cover. Other graminoids include *Achnatherum hymenoides, Sporobolus cryptandrus, Sporobolus flexuosus,* and *Elymus elymoides* on sandy sites and *Bouteloua gracilis, Poa fendleriana, Poa secunda,* and *Sporobolus airoides* on finer-textured soil. Forbs generally have low cover and moderate diversity and may include *Astragalus nuttallianus, Calochortus flexuosus, Calochortus nuttallii, Cirsium* sp., *Cryptantha flavoculata, Cymopterus purpurascens, Descurainia pinnata, Eriogonum inflatum, Eriogonum lonchophyllum, Lappula occidentalis, Lepidium montanum, Oenothera pallida, Phacelia crenulata, Plantago patagonica, Platyschkuhria integrifolia, Rumex hymenosepalus, Senecio integerrimus, Sphaeralcea coccinea, Sphaeralcea grossulariifolia,* and species of *Chaenactis, Cryptantha, Phacelia,* and *Chenopodium*. Introduced annual species such as *Bromus rubens, Bromus tectorum, Erodium cicutarium,* and *Salsola kali* are common on some sites. Biological soil crusts are variable, with some stands having very little, but cover can be as high as 80%.

Global Dynamics: Ecological processes vary with landscape type, but droughty conditions are important in shaping and maintaining this association. In wetter year, trees such as *Juniperus osteosperma* may invade.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex confertifolia*, *Pleuraphis jamesii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*
Global: Vulnerable Plants: *Sclerocactus whipplei* (G2G3); Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low), *Salsola kali*

Conservation Status Rank

Global Rank & Reasons: G3G5 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Atriplex confertifolia - Sarcobatus vermiculatus* Shrubland (CEGL001313)
- *Atriplex confertifolia / Achnatherum hymenoides* Shrubland (CEGL001311)
- *Atriplex confertifolia / Hesperostipa comata* Shrubland (CEGL001314)
- *Atriplex confertifolia* Great Basin Shrubland (CEGL001294)
- *Atriplex confertifolia* Sparse Shrubland (CEGL003830)
- *Atriplex confertifolia* Wyoming Basins Shrubland (CEGL001293)
- *Pleuraphis jamesii* Grassland (CEGL001777)

Global Related Concepts:

- *Atripletum confertifolae* association (Ibrahim et al. 1972) ><
- *Atriplex confertifolia / Pleuraphis jamesii* Shrubland (Von Loh 2000) =
- *Atriplex confertifolia/Hilaria jamesii* (Bourgeron and Engelking 1994) =
- *Atriplex confertifolia/Hilaria jamesii* Habitat Type (West and Ibrahim 1968) =
- *Atriplex confertifolia* Association in the Mixed Shrub Zone (Annable 1985) ><
- *Atriplex confertifolia* Plant Community (Branson et al. 1976) =
- *Atriplex confertifolia* cover type (Tuhy and MacMahon 1988) =

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- *Atriplex-Tetradymia* Association (Graham 1937) =
- *Gutierrezia sarothrae - Atriplex confertifolia* (Potter et al. 1985) ><
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >
- Frontier Sandstone (Welsh 1957) ><
- Mat *Atriplex-Hilaria* Community (Dastrup 1963) ><
- Shadscale/grass (Harper and Jaynes 1986) =

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: This widespread shrubland association is only defined by the codominance of *Atriplex confertifolia* and *Pleuraphis jamesii*. Stands are found in different regions (primarily the Great Basin and Colorado Plateau with extensions into the Mojave Desert, southwestern Wyoming and in disjunct stands in the southwestern Great Plains), in different environments (clay bottomlands, dunes, desert mountains) and with different associated species. This association will likely need to be subdivided as more classification information becomes available. Stands of this association with a sparse herbaceous layer are similar to *Atriplex confertifolia* Great Basin Shrubland (CEGL001294). Sparse stands included in the concept of this association are very similar to *Atriplex confertifolia* Sparse Shrubland (CEGL003830). More classification work is needed to clarify differences.

Element Distribution

Glen Canyon National Recreation Area Range: This common shrubland association occurs throughout the recreation area. Sites sampled include on Cedar Mesa, Ekker Butte, Millard Canyon Benches, near Buttes of the Cross, Teapot Rock, Lee's Ferry, in North Wash, Moody Creek, south of Deadhorse Canyon, and below Muley Point.

Global Range: This widespread shrubland association occurs throughout much of the southern intermountain western U.S. and is reported from the Great Basin, Colorado Plateau, and Mojave Desert mountains and east into the disjunct stands in the southwestern Great Plains.

Nations: US
States/Provinces: AZ, CA?, CO:S2, NM, NV, UT:S3S5, WY
TNC Ecoregions: 6:C, 9:C, 10:C, 11:C, 17:C, 18:C, 19:C, 27:?
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 331I:C?, 341B:CC, 341C:CC, 342B:CC, M331E:CC
Federal Lands: NPS (Arches, Black Canyon of the Gunnison, Canyon de Chelly, Canyonlands, Capitol Reef, Chaco Culture, Colorado, Death Valley, Dinosaur, Glen Canyon, Hovenweep); USFWS (Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: The soil seems a little deeper here with no bedrock showing in the plot. The surface has been wind-scoured leaving a layer of small flat pebbles covering the soil. The plants look pretty good with only a couple of dead shrubs on the plot. Erosion has not sculpted this slope as it has on the opposite side (north) of the canyon.

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Subset: GLCA; Glen Canyon National Recreation Area

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, 2012, and 2013 field data (12 plots): (Plots: GLCA.0120, GLCA.0122, GLCA.0321, GLCA.0542, GLCA.0759, GLCA.2029, GLCA.4060, GLCA.4062, GLCA.4084, GLCA.5044, GLCA.5289, GLCA.9108).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Drake, J. Coles and G. Kittel
References: Annable 1985, Bourgeron and Engelking 1994, Branson and Owen 1970, Branson et al. 1976, CNHP 2003, CNHP 2015, Campbell 1977, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Coles et al. 2010, Dastrup 1963, Driscoll et al. 1984, Graham 1937, Harper and Jaynes 1986, Ibrahim et al. 1972, Lusby et al. 1963, Peterson 2008, Potter et al. 1985, Romme et al. 1993, Salas et al. 2011, Singh and West 1971, Soil Conservation Service 1978, Thomas et al. 2010, Tuhy and MacMahon 1988, USBOR 1976, Von Loh 2000, Von Loh et al. 2002, Von Loh et al. 2007, Von Loh et al. 2008, WNDD unpubl. data, Welsh 1957, West and Ibrahim 1968, Western Ecology Working Group n.d.*

[CEGL001294] *Atriplex confertifolia* Great Basin Shrubland
Translated Name: Shadscale Saltbush Great Basin Shrubland
Common Name: Great Basin Shadscale Shrubland

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)
Group: Intermountain Shadscale - Saltbush Scrub (G300)
Alliance: *Atriplex confertifolia* Scrub Alliance (A0870)

Element Concept

Global Summary: This shrub association occurs throughout the Colorado Plateau, Great Basin and into Death Valley in southern California. Total vegetation cover rarely exceeds 20% and is clearly dominated by *Atriplex confertifolia*. Many other shrubs species may also be present, although they contribute little to the total canopy. The herbaceous layer rarely has more than 5% total cover; species vary greatly by location, but common graminoids include *Elymus multisetus, Elymus elymoides, Leymus salinus, Poa secunda, Dasyochloa pulchella (= Erioneuron pulchellum),* and *Pleuraphis jamesii*. Forbs are diverse but only contribute measurable cover in unusually wet years; *Chaenactis douglasii, Phacelia crenulata,* and *Mentzelia albicaulis* are widespread. Disturbed sites have high cover of *Bromus tectorum.* Sites tend to occur on ridges, flats, alluvial fans, talus slopes and badlands often in a matrix of other high desert shrublands. Sites are level to gentle to steep slopes between 1040 and 2194 m (3800-7200 feet) elevation. Soils tend to be alkaline, shallow, well-drained clay loams, sometimes with a high rock or gravel content. Parent materials are variable but generally include a high percentage of calcareous source rocks.

Environmental Description

Glen Canyon National Recreation Area Environment: This association occurs on alluvial fans, valley bottom fill, canyon floors, terraces, mesas, plateaus, badlands, ridges, and hills. Sites are flat to steeply sloping (up to 32°), oriented mostly to the south and west, and lie between 1040 to 1331 m

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elevation. The unvegetated surface is dominated by small rocks, large rocks, and bare soil, with lesser cover by litter, sand, and biological soil crusts. The soils are moderately well-drained to rapidly drained sandy clay loams, silty clay loams, or silty clays derived from Dakota sandstone or from the Chinle, Moenkopi, Carmel, or Shinarump formations.

Global Environment: This shrub association occurs in scattered stands on ridges, flats, alluvial fans, talus slopes and badlands throughout the Colorado Plateau and Great Basin. Sites tend to occur on level to gentle slopes between 1040 and 2194 m (3800-7200 feet) elevation. Soils tend to be alkaline, shallow, well-drained and have sandy clay loams, silty clay loams, or silty clays textures, sometimes with a high rock and/or gravel content. Parent materials are variable but generally include a high percentage of calcareous source rocks.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This shadscale shrubland is distinguished from the similar type, *Atriplex confertifolia* Sparse Vegetation (CEGL003830), by having more than 5% total vegetation cover. *Atriplex confertifolia* is the dominant shrub with 5-15% cover. Other shrub species that were present with no more than 2% cover include *Atriplex corrugata, Atriplex canescens, Atriplex obovata, Acamptopappus sphaerocephalus, Lycium andersonii, Ericameria nauseosa, Gutierrezia sarothrae, Ephedra torreyana, Psorothamnus fremontii, Echinocereus triglochidiatus,* and *Opuntia polyacantha*. The herbaceous layer is often weedy and dominated by the non-native annual species *Bromus rubens* (up to 10% cover in one stand), *Salsola tragus, Schismus barbatus, Erodium cicutarium,* and/or *Halogeton glomeratus*. Other species noted in the understory include *Pleuraphis jamesii, Achnatherum hymenoides, Mentzelia albicaulis, Eriogonum inflatum, Bouteloua barbata, Calochortus flexuosus,* and *Tiquilia latior*.

Global Vegetation: Total vegetation cover rarely exceeds 20% and is clearly dominated by *Atriplex confertifolia*. Many other shrubs species may also be present, although they contribute little to the total canopy, including *Acamptopappus shockleyi, Acamptopappus sphaerocephalus, Atriplex canescens, Atriplex corrugata, Atriplex obovata, Ephedra nevadensis, Ephedra torreyana, Ericameria nauseosa, Gutierrezia sarothrae, Kochia americana, Krascheninnikovia lanata, Lycium andersonii, Opuntia polyacantha, Picrothamnus desertorum, Psorothamnus fremontii,* and *Sarcobatus vermiculatus*. The herbaceous layer rarely has more than 5% total cover; species vary greatly by location, but common graminoids include *Achnatherum hymenoides, Bouteloua barbata, Dasyochloa pulchella (= Erioneuron pulchellum), Elymus elymoides, Elymus multisetus, Leymus salinus, Pleuraphis jamesii,* and *Poa secunda*. Forbs are diverse, but only contribute more than trace cover in unusually wet years, and include *Atriplex powellii, Chaenactis douglasii, Eriogonum inflatum, Mentzelia albicaulis, Phacelia crenulata, Sphaeralcea coccinea,* and *Tiquilia latior*. Exotic annuals can be abundant, including *Bromus rubens, Bromus tectorum, Halogeton glomeratus, Salsola tragus,* and/or *Schismus barbatus*. This association often occurs in a matrix of other high desert shrublands.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*
Herb (field)	Graminoid	*Bromus rubens*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex confertifolia*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Halogeton glomeratus* (High/Medium), *Salsola tragus*, *Schismus barbatus* (High/Medium)

Global: Vulnerable Plants: *Acamptopappus shockleyi* (G3?); Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Halogeton glomeratus* (High/Medium), *Salsola tragus*, *Schismus barbatus* (High/Medium)

Conservation Status Rank

Global Rank & Reasons: G5 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Atriplex confertifolia / Achnatherum hymenoides* Shrubland (CEGL001311)
- *Atriplex confertifolia / Kochia americana* Shrubland (CEGL001305)
- *Atriplex confertifolia / Pleuraphis jamesii* Shrubland (CEGL001304)
- *Atriplex confertifolia* Sparse Shrubland (CEGL003830)
- *Atriplex confertifolia* Wyoming Basins Shrubland (CEGL001293)

Global Related Concepts:

- *Atriplex confertifolia* (Community II) (Bourgeron and Engelking 1994) =
- *Atriplex confertifolia* Association (Peterson 1984a) =
- *Atriplex confertifolia* Association (Leary and Peterson 1984) =
- *Atriplex confertifolia* Association (Beatley 1976) >
- *Atriplex confertifolia* Association (Blackburn et al. 1969c) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 2 - Moderate

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Subset: GLCA; Glen Canyon National Recreation Area

Global Classification Comments: This broadly defined association describes *Atriplex confertifolia* shrublands that have either a sparse understory or lack any diagnostic species in the understory.

Element Distribution

Glen Canyon National Recreation Area Range: This shadscale association was sampled in North Wash, Cathedral Wash, Blue Notch Canyon, Hansen Creek, Trachyte Canyon, on Good Hope Mesa, Hoskinnini Mesa, Five Mile Point, Bull Points, Bullfrog Bay, and north of Kane Point.

Global Range: This association occurs in the Colorado Plateau in northern Arizona, western Colorado, and Utah, west into the Great Basin and northern Mojave Desert in Nevada and southeastern California.

Nations: US
States/Provinces: AZ, CA?, CO, NV:S5, UT
TNC Ecoregions: 6:C, 9:C, 11:C, 17:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC, 341B:CC, 342B:CC, M331E:CC, M341C:CC
USFS Ecoregions (2007): 341Bj:C
Federal Lands: NPS (Bryce Canyon, Canyonlands, Capitol Reef, Death Valley, Dinosaur, Glen Canyon, Grand Canyon, Great Basin)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Rocky desert pavement substrate typical of the surrounding bajada. *Atriplex confertifolia* is dominant here while nearby patches of silty soil support larger numbers of *Atriplex corrugata* to form a mosaic.

Glen Canyon National Recreation Area Plots: The description is based on 2011, 2013, 2014, and 2015 field data (4 plots, 11 AA points): (Plots: GLCA.1020, GLCA.2006, GLCA.5290, GLCA.5507; AA Points: GLCA_AA.0520, GLCA_AA.0543, GLCA_AA.1034, GLCA_AA.1040, GLCA_AA.1042, GLCA_AA.1120, GLCA_AA.1366, GLCA_AA.1611, GLCA_AA.1685, GLCA_AA.1851, GLCA_AA.2034).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and G. Kittel
References: Beatley 1976, Blackburn et al. 1969c, Bourgeron and Engelking 1994, Bradley 1964, Clark et al. 2009, Coles et al. 2008a, Driscoll et al. 1984, Leary and Peterson 1984, Peterson 1984a, Peterson 2008, Reid and Hall 2010, Rickard and Beatley 1965, Romme et al. 1993, Schulz and Hall 2011, Tendick et al. 2011b, Western Ecology Working Group n.d.*

[CEGL003830] *Atriplex confertifolia* Sparse Shrubland
Translated Name: Shadscale Saltbush Sparse Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)

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Group: Intermountain Shadscale - Saltbush Scrub (G300)
Alliance: *Atriplex confertifolia* Scrub Alliance (A0870)

Element Concept

Global Summary: This sparse shadscale shrubland occurs in the canyonlands area of the Colorado Plateau. Total vegetation cover rarely exceeds 5% and consists primarily of scattered dwarfed *Atriplex confertifolia* shrubs. Many other species may be present but in general do not exceed a trace or at most 1% cover. Herbaceous associates include *Aristida purpurea, Eriogonum inflatum, Pleuraphis jamesii, Stanleya pinnata, Suaeda moquinii*, and *Tiquilia latior*. Stands occur on steep colluvial slopes, cliffs, escarpments, terraces, and benches with poor, alkaline soils. Sites are moderately to steeply sloping (to 35°) and may occur on any aspect between 1121 and 1621 m elevation. Soils are rapidly drained sands, sandy loams, sandy clay loams, sandy clays, or loams.

Environmental Description

Glen Canyon National Recreation Area Environment: This sparsely vegetated association occurs on plateaus, benches, bajadas, dunes, hills, canyon sides, canyon or valley bottoms, drainages, and alluvial fans. Sites are gently to steeply sloping (up to 23°), include all aspects, and lie between 1121 and 1621 m elevation. The unvegetated surface has moderate to high cover of bare soil and small rocks, low to moderate cover of large rocks, and sparse to low cover of litter and dark cyanobacteria. Soils are moderately well-drained to rapidly drained loams, sandy loams, sandy clay loams, silt loams, silty clay loams, clay loams, silty clays, or sandy clays derived from the Chinle, Moenkopi, or Carmel formations, Dakota sandstone, Shinarump conglomerate, Tropic shale, talus/colluvium, or alluvial deposits.

Global Environment: This sparse shadscale shrubland occurs in the canyonlands area of the Colorado Plateau on steep colluvial slopes, cliffs, escarpments, terraces, and benches with poor, alkaline soils. Sites are gently to steeply sloping (to 35°) and may occur on any aspect between 1121 and 1621 m elevation. The unvegetated surface has low to moderate exposure of bare soil and low to moderate cover of large rocks. Soils are rapidly drained sands, loams, sandy loams, sandy clay loams, silt loams, silty clay loams, clay loams, silty clays, or sandy clays derived from the Chinle, Moenkopi or Carmel formations, Dakota sandstone, Shinarump conglomerate, Tropic shale, talus/colluvium, or alluvial deposits.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse shadscale shrubland grows on poor shale soils within the recreation area and is characterized by having total vegetation cover less than or equal to 5% and consists primarily of scattered dwarfed *Atriplex confertifolia* shrubs with trace to 3% cover. Many other species may be present but in general do not exceed a trace or at most 1% cover; *Ephedra viridis, Psorothamnus fremontii, Sarcobatus vermiculatus*, and *Gutierrezia microcephala* are common shrub associates. Herbaceous associates include *Pleuraphis jamesii, Bromus tectorum, Salsola tragus, Suaeda moquinii*, and *Eriogonum inflatum*.

Global Vegetation: This sparse shadscale shrubland rarely exceeds 5% total vegetation cover and consists primarily of scattered dwarfed *Atriplex confertifolia* shrubs. Many other species may be

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present but in general do not exceed a trace or at most 1% cover. Associated shrubs include *Brickellia microphylla, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Gutierrezia microcephala, Gutierrezia sarothrae, Opuntia polyacantha, Psorothamnus fremontii, Sarcobatus vermiculatus,* and *Xylorhiza glabriuscula*. Herbaceous associates include *Aristida purpurea, Eriogonum inflatum, Pleuraphis jamesii, Stanleya pinnata, Suaeda moquinii,* and *Tiquilia latior*. Introduced species such as *Bromus tectorum* and *Salsola tragus* can be common on some stands.

Global Dynamics: *Atriplex confertifolia* has a deep and extensive rooting network and broad ecological amplitude which allows it to occupy colluvial slopes with large interstitial spaces.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*
Herb (field)	Flowering forb	*Eriogonum inflatum*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*
Herb (field)	Graminoid	*Bromus tectorum*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex confertifolia*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*; Other Plants: *Pleuraphis jamesii* (G5)

Conservation Status Rank

Global Rank & Reasons: GNR (12-Jun-2006).

Related Concepts

Global Similar Types:
- *Atriplex confertifolia / Achnatherum hymenoides* Shrubland (CEGL001311)
- *Atriplex confertifolia / Hesperostipa comata* Shrubland (CEGL001314)
- *Atriplex confertifolia / Pleuraphis jamesii* Shrubland (CEGL001304)
- *Atriplex confertifolia* Great Basin Shrubland (CEGL001294)
- *Atriplex confertifolia* Wyoming Basins Shrubland (CEGL001293)

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Subset: GLCA; Glen Canyon National Recreation Area

Global Related Concepts:
- *Atriplex confertifolia* Sparse Plant Association (Muldavin et al. 1998d) =

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: Sparse stands included in concept of *Atriplex confertifolia / Pleuraphis jamesii* Shrubland (CEGL001304) are very similar to *Atriplex confertifolia* Sparse Shrubland (CEGL003830) if *Pleuraphis jamesii* is present in understory. More classification work is needed to clarify differences.

Element Distribution

Glen Canyon National Recreation Area Range: This sparsely vegetated association occurs on shale soils within the recreation area and was sampled in Millard Canyon, Last Chance Creek, Crosby Canyon, Blue Notch Canyon, Hall's Creek Bay, Moody Creek, The Rincon, on Sit Down Bench, the Purple Hills, Bull Points, north of Bullfrog, and north of Ribbon Canyon.

Global Range: This sparse shadscale shrubland is found in Colorado Plateau in Canyonlands National Park and Glen Canyon National Recreation Area in of southeastern Utah, but is wider ranging and occurs north and west into the Great Basin and Columbia Plateau and southeast to central New Mexico.

Nations: US
States/Provinces: NM, NV, OR, UT
TNC Ecoregions: 6:C, 19:C, 24:C
USFS Ecoregions (1994/95): 341B:CC
Federal Lands: NPS (Canyonlands, Glen Canyon, John Day Fossil Beds); USFWS (Sevilleta)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Desert pavement (layer of small rocks) holds soil together. Plot is on a nearly level plain. Shrubs are widely spaced.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, and 2012 field data (16 plots): (Plots: GLCA.0725, GLCA.1002, GLCA.1013, GLCA.4009, GLCA.4020, GLCA.4066, GLCA.4085, GLCA.4096, GLCA.4266, GLCA.4285, GLCA.5010, GLCA.5021, GLCA.5051, GLCA.5096, GLCA.5107, GLCA.5186).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and G. Kittel
References: Muldavin et al. 1998d, Peterson 2008, Western Ecology Working Group n.d.*

A3180 Atriplex obovata - Atriplex cuneata Scrub Alliance

Alliance Summary Description: This alliance occurs in the northern Chihuahuan Desert and Colorado Plateau from western Texas, south-central and northwestern New Mexico, and northeastern Arizona. The vegetation is characterized by a sparse to moderately dense dwarf-shrub layer that is dominated or codominated by *Atriplex obovata*. Some occurrences may have a dense understory of

perennial grasses. Shrub associates may include scattered *Atriplex confertifolia, Ericameria nauseosa, Isocoma drummondii, Gutierrezia sarothrae, Prosopis glandulosa var. torreyana, Opuntia* spp., or *Suaeda* spp. The herbaceous layer ranges from moderately dense to absent, and is usually dominated by perennial grasses such as *Sporobolus airoides* and *Pleuraphis jamesii*. Other associated species may include *Achnatherum hymenoides, Bouteloua gracilis, Elymus elymoides,* and *Sporobolus cryptandrus*. Stands are known from mesas, plains, floodplains, valley bottoms, alluvial flats, lower to upper hillslopes, often in a "badlands" landscape. Soils are generally shallow, poorly developed, and alkaline.

[CEGL001789] *Atriplex obovata* Talus Dwarf-shrubland
Translated Name: Mound Saltbush Talus Dwarf-shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)
Group: Intermountain Shadscale - Saltbush Scrub (G300)
Alliance: *Atriplex obovata - Atriplex cuneata* Scrub Alliance (A3180)

Element Concept

Global Summary: This saltbush dwarf-shrubland association is currently described from the Colorado Plateau in Grand Canyon National Park and Glen Canyon National Recreation Area in northern Arizona and southern Utah. Vegetation is characterized by the dominance of *Atriplex obovata* in the open short-shrub stratum. *Ephedra torreyana* also regularly occurs in the short-shrub layer. Tall shrubs are absent, but other dwarf-shrubs such as *Atriplex confertifolia, Brickellia atractyloides, Coleogyne ramosissima, Encelia frutescens, Ericameria nauseosa, Gutierrezia sarothrae, Opuntia basilaris, Opuntia polyacantha*, and *Picrothamnus desertorum (= Artemisia spinescens)* may sporadically occur. The herbaceous layer is typically sparse, with scattered grasses including *Dasyochloa pulchella, Muhlenbergia porteri, Pleuraphis jamesii*, and *Sporobolus* sp. *Cryptantha* sp., *Thymophylla pentachaeta, Machaeranthera pinnatifida, Lepidium* sp., *Phacelia crenulata, Plantago patagonica, Sphaeralcea* sp., and *Stanleya pinnata* are common components of the sparse forb understory. Stands occur on talus slopes, toeslopes, hills, and buttes and are typically found on moderate to very steep (15-40°), southwest- to southeast-facing slopes. Elevation ranges from 975 to 1329 m (3225-4360 feet). The unvegetated surface is composed of nearly equal parts large and small rocks and bare soil, with trace to low cover of litter, sand, and bedrock. Soils are moderately well-drained to rapidly drained sands, sandy or silty loams, or clay loams derived from limestone or sandstone bedrock or from talus/colluvial deposits from the Morrison or Chinle formations.

Environmental Description

Glen Canyon National Recreation Area Environment: This dwarf-shrubland association occurs on talus slopes, toeslopes, hills, and buttes. Sites are on steep to very steep (20-35°), south- and southwest-facing slopes, and occur between 1081 and 1329 m elevation. The unvegetated surface is composed of nearly equal parts large and small rocks and bare soil, with trace to low cover of litter,

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sand, and bedrock. Soils are moderately well-drained to rapidly drained sands, sandy loams, or clay loams derived from the Morrison or Chinle formations, or from talus/colluvial deposits.

Global Environment: This saltbush dwarf-shrubland association occurs on talus slopes, toeslopes, hills, and buttes and is typically found on moderate to very steep (15-40°), southwest- to southeast-facing slopes. Elevation ranges from 975 to 1329 m (3225-4360 feet). The unvegetated surface is composed of nearly equal parts large and small rocks and bare soil, with trace to low cover of litter, sand, and bedrock. Soils are moderately well-drained to rapidly drained sands, sandy or silty loams, or clay loams derived from limestone or sandstone bedrock or from talus/colluvial deposits from the Morrison or Chinle formations.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse mound saltbush dwarf-shrubland grows on steep talus slopes within the recreation area. Total vegetation cover ranges from 1 to 13% and is characterized by scattered *Atriplex obovata* shrubs, with trace to 3% cover. Other shrubs present with low cover include *Ephedra torreyana, Encelia frutescens, Coleogyne ramosissima, Picrothamnus desertorum (= Artemisia spinescens), Atriplex confertifolia, Ericameria nauseosa, Brickellia atractyloides,* and *Opuntia polyacantha*. The herbaceous layer is extremely sparse; *Pleuraphis jamesii, Bromus rubens, Bromus tectorum, Stanleya pinnata, Plantago patagonica,* and *Sphaeralcea* sp. were the only species recorded with more than trace cover.

Global Vegetation: Vegetation is characterized by the dominance of *Atriplex obovata* in the open short-shrub stratum. *Ephedra torreyana* also regularly occurs in the short-shrub layer. Tall shrubs are absent, but other dwarf-shrubs such as *Atriplex confertifolia, Brickellia atractyloides, Coleogyne ramosissima, Encelia frutescens, Ericameria nauseosa, Gutierrezia sarothrae, Opuntia basilaris, Opuntia polyacantha*, and *Picrothamnus desertorum (= Artemisia spinescens)* may sporadically occur. The herbaceous layer is typically sparse, with scattered grasses including *Dasyochloa pulchella, Muhlenbergia porteri, Pleuraphis jamesii*, and *Sporobolus* sp. Occasionally a well-developed graminoid layer forms that is typically dominated by non-native annuals *Bromus rubens* or *Bromus tectorum*. *Cryptantha* sp., *Thymophylla pentachaeta, Machaeranthera pinnatifida, Lepidium* sp., *Phacelia crenulata, Plantago patagonica, Sphaeralcea* sp., and *Stanleya pinnata* are common components of the sparse forb understory.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Atriplex confertifolia*, *Atriplex obovata*, *Ephedra torreyana*
Herb (field)	Graminoid	*Bromus rubens*, *Bromus tectorum*, *Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Atriplex obovata*

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Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex obovata*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High)

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (7-Jan-2003).

Related Concepts

Global Related Concepts:

- *Atriplex obovata* Dwarf-shrubland (Thomas et al. 2003b) =

Classification

Status: Standard
Classification Confidence:
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This dwarf-shrubland type occurs on steep, rocky slopes throughout the recreation area. Areas sampled include Lee's Ferry, Cornerstone Canyon, Dirty Devil, Clay Hill's Crossing, Bullfrog Bay, Scorup Canyon, and Castle Butte.

Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona and Glen Canyon National Recreation Area in southeastern Utah. More survey work is needed to fully document its global range.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC
Federal Lands: NPS (Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Rocky talus, south-facing slope. Vegetation is growing between rocks on unstable soil.

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Glen Canyon National Recreation Area Plots: The description is based on 2011, 2012, and 2015 field data (5 plots, 3 accuracy assessment points): (Plots: GLCA.1025, GLCA.2030, GLCA.2069, GLCA.5087, GLCA.5130; AA Points: GLCA_AA.1066, GLCA_AA.1111, GLCA_AA.1688).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): R. Meszaros
References: Reid and Hall 2010, Thomas et al. 2003b, Western Ecology Working Group n.d.*

A3171 Grayia spinosa Scrub Alliance
Alliance Summary Description: Vegetation in this alliance occurs throughout the lower to middle elevations (600-1600 m) of the Great Basin and the eastern Mojave Desert. The vegetation is more drought-tolerant than *Artemisia tridentata*-dominated communities and typically occurs where local climate or salty soils create high moisture stress. This alliance is characterized by a sparse to moderately dense shrub layer of *Grayia spinosa*. Shrub associates include *Artemisia nova, Artemisia tridentata, Atriplex confertifolia, Atriplex canescens, Chrysothamnus* spp., *Coleogyne ramosissima, Ephedra nevadensis, Ephedra viridis, Larrea tridentata, Menodora spinescens, Picrothamnus desertorum (= Artemisia spinescens)*, and *Prunus andersonii*. The herbaceous layer is typically sparse with *Achnatherum hymenoides (= Oryzopsis hymenoides), Achnatherum speciosum (= Stipa speciosa), Elymus elymoides, Navarretia* spp., *Pleuraphis jamesii (= Hilaria jamesii),* and *Poa secunda* being common associates. Stands usually occur on mountain slopes or alluvial fans bordering intermountain basins. Soils are highly variable, but are generally coarse-textured and well-drained, and often alkaline.

[CEGL002358] *Grayia spinosa* Shrubland
Translated Name: Spiny Hopsage Shrubland
Common Name:

USNVC Classification
Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin Saltbush Scrub (M093)
Group: Intermountain Shadscale - Saltbush Scrub (G300)
Alliance: *Grayia spinosa* Scrub Alliance (A3171)

Element Concept
Global Summary: This association occurs in the Great Basin and the eastern Mojave Desert, and extends east into the Colorado Plateau. Total vegetation cover ranges from 5 to 25%, most of which is concentrated in an open canopy of *Grayia spinosa* shrubs. Associated shrubs include *Atriplex confertifolia, Acamptopappus sphaerocephalus, Coleogyne ramosissima, Ephedra viridis, Ephedra torreyana, Ericameria nauseosa, Gutierrezia sarothrae*, and the succulents *Opuntia polyacantha* and *Yucca harrimaniae*. The herbaceous layer contributes little to the community, being both sparse and depauperate. Herbaceous species include *Pleuraphis jamesii, Chamaesyce fendleri (= Euphorbia fendleri)*, and *Lepidium montanum*. Biological soil crusts provide less than 5% cover. This association commonly occurs in large patches on plains, alluvial fans, and benches, but may occur as smaller patches in alluvial flat shrublands. Soils are variable but frequently occur on rapidly drained clay loam.

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Environmental Description

Glen Canyon National Recreation Area Environment: This rare shrubland association occurs on deep, fine-textured soils of sideslopes and mesas. Sites are flat to gently sloping (less than 7°), are oriented to any aspect, and lie between 1286 and 1480 m elevation. Bare soil or sand and small rocks cover most of the unvegetated surface; litter, large rocks, or bedrock have sparse to moderate cover. Soils are rapidly drained sands derived from the Carmel or Morrison (Salt Wash Member) formations.

Global Environment: This association is found in the Great Basin and the eastern Mojave Desert, and extends east into the Colorado Plateau. It occurs as large patches on plains, alluvial fans, and benches, but may occur as smaller patches in alluvial flat shrublands. Soils are variable but frequently occur on rapidly drained clay loam. Bare soil or sand and small rocks cover most of the unvegetated surface; litter, large rocks, or bedrock have sparse to moderate cover.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This rare shrubland occupies deep, fine soils within the recreation area. Total vegetation cover ranges from 4 to 23%; the shrub canopy is dominated by *Grayia spinosa* with 3 to 11% cover. Associated shrubs, all with sparse to low cover, include *Atriplex confertifolia, Acamptopappus sphaerocephalus, Ephedra torreyana, Ephedra cutleri, Ericameria nauseosa, Gutierrezia sarothrae,* and *Opuntia* spp. The understory is sparse or undeveloped, the only species noted with more than trace cover was the perennial bunchgrass *Pleuraphis jamesii*.

Global Vegetation: Total vegetation cover ranges from 5 to 25%, most of which is concentrated in an open canopy of *Grayia spinosa* shrubs. Associated shrubs include *Atriplex confertifolia, Acamptopappus sphaerocephalus, Coleogyne ramosissima, Ephedra cutleri, Ephedra viridis, Ephedra torreyana, Ericameria nauseosa, Gutierrezia sarothrae,* and the succulents *Opuntia polyacantha* and *Yucca harrimaniae*. The herbaceous layer contributes little to the community, being both sparse and depauperate. Herbaceous species include *Pleuraphis jamesii, Chamaesyce fendleri (= Euphorbia fendleri),* and *Lepidium montanum*. Biological soil crusts provide less than 5% cover.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Grayia spinosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Grayia spinosa*

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Characteristic Species

Glen Canyon National Recreation Area:
Global: *Ephedra viridis, Grayia spinosa*

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (22-Mar-2005).

Related Concepts

Global Related Concepts:

- *Grayia spinosa* (Evens et al. 2014) =

Classification

Status: Standard
Classification Confidence:
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. The description is based on plots from Arches National Park and Glen Canyon National Recreation Area. Information from Mojave Desert and Great Basin stands has not yet been incorporated.

Element Distribution

Glen Canyon National Recreation Area Range: This rare shrubland was sampled on Wilson Mesa, Grand Bench, and in Gunsight Canyon.

Global Range: This association occurs in the Great Basin and the eastern Mojave Desert and east into the Colorado Plateau of southern Utah.

Nations: US
States/Provinces: CA, NV, UT
TNC Ecoregions: 11:C, 17:C, 19:C
USFS Ecoregions (1994/95): 341B:CC
Federal Lands: NPS (Arches, Capitol Reef, Death Valley, Glen Canyon, Mojave)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This plot is influenced by a steeper east-facing slope, a more gravelly/cobbly limestone substrate, and a small gully running off the mesa through it.

Glen Canyon National Recreation Area Plots: The description is based on 2013 and 2015 field data (1 plot, 2 accuracy assessment points): (Plots: GLCA.5553; AA Points: GLCA_AA.1517, GLCA_AA.1559).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): G. Kittel and K.A. Schulz

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Subset: GLCA; Glen Canyon National Recreation Area

References: Clark et al. 2009, Coles et al. 2009a, Evens et al. 2014, Peterson 2008, Romme et al. 1993, Western Ecology Working Group n.d.*

M171. Great Basin-Intermountain Dry Shrubland & Grassland

G312. Colorado Plateau Blackbrush - Mormon-tea Shrubland

Group Summary Description: This semi-arid Colorado Plateau shrubland group is characterized by extensive, typically open shrublands dominated by *Coleogyne ramosissima* or one of three species of *Ephedra*: *Ephedra cutleri, Ephedra torreyana,* or *Ephedra viridis*. *Ephedra cutleri* and *Ephedra viridis* often assume a distinctive matty growth form. Other dominant /diagnostic shrubs that occur either singly or in mixed stands include *Artemisia filifolia* (often on deep-sand sites), *Poliomintha incana, Quercus havardii var. tuckeri,* and *Vanclevea stylosa*. Other more widespread shrubs, such as *Ericameria nauseosa* and *Grayia spinosa,* may be present to dominant locally. The herbaceous layer is sparse and composed of graminoids such as *Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii,* or *Sporobolus cryptandrus*. The general aspect of occurrences is an open low shrubland but may include small blowouts and dunes. Occasionally grasses may be moderately abundant locally and form a distinct layer. Stands occur on windswept mesas, benchlands, colluvial slopes, pediments, alluvial fans, broad basins and plains. Elevation ranges from 560-1800 m. Substrates are shallow, typically calcareous, non-saline and gravelly or sandy soils over sandstone bedrock or limestone bedrock (less common), caliche or limestone alluvium. It also occurs in deeper soils on sandy plains and stabilized sandsheets and may form small hummocks or small coppice dunes. Disturbance may be important in maintaining the woody component. Eolian processes are evident, such as pediceled plants, occasional blowouts or small dunes, but the generally higher vegetative cover and less prominent geomorphic features distinguish this group from active and stabilized dune complexes.

A3181 Artemisia filifolia Colorado Plateau Shrubland Alliance

Alliance Summary Description: The vegetation is characterized by an open shrub canopy dominated by *Artemisia filifolia* that is usually mixed with other shrubs. Total vegetation cover ranges broadly from sparsely vegetated disturbed sites with less than 5% total cover to stable, well-developed communities with more than 50% cover. Other shrub associates may include *Atriplex canescens, Coleogyne ramosissima, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Eriogonum leptocladon, Opuntia* spp., *Sarcobatus vermiculatus*, and *Vanclevea stylosa*. The herbaceous layer is moderate in terms of species composition and provides sparse to moderate cover. Graminoids that may be present include *Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii, Sporobolus cryptandrus,* and *Vulpia octoflora*. The non-native *Bromus tectorum* may be prominent on disturbed sites. Forbs vary among sites but are typical of sandy habitats, including *Abronia fragrans, Lepidium montanum, Oenothera pallida, Salsola tragus,* and *Sphaeralcea parvifolia*. Cryptogams may be absent or may provide up to 40% cover. These shrublands are known from the Colorado Plateau and occur on sandy, often somewhat disturbed sites on valley floors, stream terraces, stabilized dunes and sandsheets, benches, floodplains and alluvial fans. Most sites are level to gently sloping, with a few on moderate slopes (up to 21%), and may be oriented to any aspect, although there is a slight tendency toward warmer southerly aspects. Elevations range from 1122 to 1769 m.

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Subset: GLCA; Glen Canyon National Recreation Area

[CEGL002786] Artemisia filifolia - Ephedra (torreyana, viridis) Shrubland

Translated Name: Sand Sagebrush - (Torrey's Joint-fir, Mormon-tea) Shrubland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)

Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)

Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)

Alliance: *Artemisia filifolia* Colorado Plateau Shrubland Alliance (A3181)

Element Concept

Global Summary: This sandy site shrubland association occurs on the Colorado Plateau in southeastern Utah and northern Arizona. Total vegetation cover ranges from 15-67%. The shrub layer is not dominated by a single species but rather by a group of species that codominate. *Artemisia filifolia* is the only consistent shrub to occur within the association and functions as an indicator species. Other shrubs can occur and can dominate or codominate within this association, but they do not have to be present. These main shrubs consist of *Ephedra torreyana*, *Ephedra viridis, Ericameria nauseosa, Gutierrezia sarothrae*, and *Atriplex canescens*. The herbaceous layer is diverse and provides low to moderate cover. Common graminoids include *Achnatherum hymenoides, Distichlis spicata, Pleuraphis jamesii, Sporobolus contractus*, and *Sporobolus flexuosus*. Forbs tend to be weedy and may have moderate cover as well; they include *Ambrosia acanthicarpa, Amsonia tomentosa, Oenothera pallida, Machaeranthera canescens*, and *Sphaeralcea* spp. The presence of the non-native annual grasses *Bromus rubens* or *Bromus tectorum* and the exotic forb *Salsola tragus* indicate disturbances such as grazing. Biological soil crusts may be absent, though may have up to 42% cover, but are generally poorly developed (early stages of development). This shrub association occurs on deep, well-drained sandy soils along or near drainage channels/washes, on canyon and valley bottoms, benches, and stabilized dunes. Sites tend to be flat or slope gently and occur between 1141 and 1490 m elevation. Bare soil, sand, with a layer of sandstone cobbles or black cinder cover most of the unvegetated surface, with low to moderate cover of gravel and biological soil crusts, and sparse to low cover of litter and bedrock. Soils are generally sandy and derived from eolian or alluvial deposits, from Navajo or Kayenta sandstones, or from the Moenkopi Formation.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrub association occurs on deep, well-drained sandy soils along or near drainage channels/washes, on canyon and valley bottoms, benches, mesas, and stabilized dunes. Sites tend to be flat or slope gently and occur between 1141 and 1552 m elevation. Bare soil or sand cover most of the unvegetated surface, with low cover to moderate cover of gravel and biological soil crusts, and sparse to low cover of litter and bedrock. Soils are generally sandy and derived from eolian or alluvial deposits, from Navajo, Entrada, or Kayenta sandstones, or from the Moenkopi Formation.

Global Environment: This shrub association occurs on deep, well-drained sandy soils along or near drainage channels/washes, on canyon and valley bottoms, benches, and stabilized dunes. Sites tend to be flat or slope gently and occur between 1141 and 1490 m elevation. Bare soil, sand, with a layer of

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Subset: GLCA; Glen Canyon National Recreation Area

sandstone cobbles or black cinder cover most of the unvegetated surface, with low to moderate cover of gravel and biological soil crusts, and sparse to low cover of litter and bedrock. Soils are generally sandy and derived from eolian or alluvial deposits, from Navajo or Kayenta sandstones, or from the Moenkopi Formation.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sandy shrubland is somewhat uncommon within the recreation area and total vegetation cover ranges from 17-67%. The canopy is codominated by *Artemisia filifolia*, with 3-14% cover and *Ephedra torreyana* or more rarely, *Ephedra viridis*, with 2-13% cover. *Atriplex canescens* and/or *Ericameria nauseosa* are commonly present and may be nearly codominant in some stands. Other shrubs may be present with sparse to low cover and include *Encelia frutescens, Atriplex confertifolia, Gutierrezia sarothrae, Opuntia* spp., *Psorothamnus* spp., *Coleogyne ramosissima*, and *Purshia stansburiana*. The herbaceous layer is diverse and provides low to moderate cover. Common graminoids include *Achnatherum hymenoides, Sporobolus contractus, Pleuraphis jamesii, Sporobolus flexuosus, Distichlis spicata*, and *Bromus rubens*. Forbs tend to be weedy and may have moderate cover as well; *Salsola tragus* (with up to 26% cover), *Sphaeralcea* spp., *Ambrosia acanthicarpa, Amsonia tomentosa, Erodium cicutarium, Oenothera pallida*, and *Machaeranthera canescens* have been recorded in park plots. The presence of the non-native annual grass *Bromus tectorum* and the forb *Salsola tragus* indicate disturbances such as grazing. Biological soil crusts may be absent, though may have up to 42% cover, but are generally poorly developed (early stages of development).

Global Vegetation: Total vegetation cover ranges from 15-67%. The shrub layer is not dominated by a single species but rather by a group of species that codominate. *Artemisia filifolia* is the only consistent shrub to occur within the association and functions as an indicator species. Other shrubs can occur and can dominate or codominate within this association, but they do not have to be present. These main shrubs consist of *Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Gutierrezia sarothrae*, and *Atriplex canescens*. Other shrubs may be present with sparse to low cover and include *Atriplex confertifolia, Coleogyne ramosissima, Encelia frutescens, Gutierrezia sarothrae, Opuntia* spp., *Psorothamnus* spp., and *Purshia stansburiana*. The herbaceous layer is diverse and provides low to moderate cover. Common graminoids include *Achnatherum hymenoides, Distichlis spicata, Pleuraphis jamesii, Sporobolus contractus*, and *Sporobolus flexuosus*. Forbs tend to be weedy and may have moderate cover as well; *Salsola tragus* (with up to 26% cover), *Ambrosia acanthicarpa, Amsonia tomentosa, Erodium cicutarium, Oenothera pallida, Machaeranthera canescens*, and *Sphaeralcea* spp. have been recorded in park plots. The presence of the non-native annual grasses *Bromus rubens* or *Bromus tectorum* and the exotic forb *Salsola tragus* indicate disturbances such as grazing. Biological soil crusts may be absent, though may have up to 42% cover, but are generally poorly developed (early stages of development).

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Short shrub/sapling	Broad-leaved deciduous shrub	*Artemisia filifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Flowering forb	*Machaeranthera canescens*, *Salsola tragus*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Artemisia filifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Artemisia filifolia*, *Ephedra torreyana*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low), *Salsola tragus*

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (28-Aug-2002).

Related Concepts

Global Similar Types:

- *Artemisia filifolia* Colorado Plateau Shrubland (CEGL002697)

Classification

Status: Standard

Classification Confidence: 3 - Weak

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. The cinder provides a similar habitat as sand for this community.

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Element Distribution

Glen Canyon National Recreation Area Range: This somewhat uncommon association occurs in low-lying areas, generally near drainage channels and was sampled in Millard Canyon, the Rincon, the west fork of Big Water Canyon, above Moqui Canyon, and on Grand Bench.

Global Range: This shrubland association occurs on the Colorado Plateau at Wupatki National Monument and on the Navaho Indian Reservation in northern Arizona and in Glen Canyon National Recreation Area and San Rafael Swell in southeastern Utah.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313B:CC, 313D:CC, 341B:CC
Federal Lands: BIA (Navaho); NPS (Glen Canyon, Wupatki)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Point is in a small wash. Site impacted by cattle.

Glen Canyon National Recreation Area Plots: The description is based on 2012, 2014 and 2015 field data (1 plot, 8 accuracy assessment points): (Plots: GLCA.6190; AA Points: GLCA_AA.0017, GLCA_AA.0018, GLCA_AA.0019, GLCA_AA.0209, GLCA_AA.1134, GLCA_AA.1390, GLCA_AA.2088, GLCA_AA.3065).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Coles et al. 2003, Hansen et al. 2004b, Western Ecology Working Group n.d.*

[CEPP005686] Artemisia filifolia - Ephedra cutleri Sandsheet Shrubland
Translated Name: Sand Sagebrush - Cutler's Joint-fir Sandsheet Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Artemisia filifolia* Colorado Plateau Shrubland Alliance (A3181)

Element Concept

Global Summary: This sandsheet shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely on sandy sites in the Colorado Plateau. It is characterized by an open shrub canopy codominated by *Artemisia filifolia* and *Ephedra cutleri*. Several associated shrubs may be present with sparse to low cover such as *Atriplex canescens, Coleogyne ramosissima, Ephedra torreyana, Eriogonum leptocladon, Gutierrezia* spp., *Opuntia erinacea, Psoralidium junceum, Psorothamnus fremontii, Quercus havardii var. tuckeri (= Quercus welshii),*

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Vanclevea stylosa, and *Yucca angustissima*. The herbaceous layer is dominated by low to moderate cover of native graminoids such as *Achnatherum hymenoides, Bouteloua eriopoda, Sporobolus contractus, Sporobolus cryptandrus, Sporobolus flexuosus*, and *Vulpia octoflora (= Festuca octoflora)*. It may also include sparse to low cover of the exotic annual grass *Bromus tectorum*. Forbs have sparse cover and are often dominated by the exotic annual *Salsola tragus*. Total vegetation cover does not exceed 34% and may be as low as 3% in areas with actively blowing sand. Stands occur on benches, dunes, plains, plateaus, mesas, piedmont slopes, hills, toeslopes, canyon bottoms, valley floors, and terraces along drainages between 1104 and 1468 m elevation (though one plot was sampled at 1936 m elevation). Sites range from flat to moderately sloping and occur on all aspects. Bare soil and sand cover most of the unvegetated surface, with lesser cover by dark cyanobacteria and litter. Soils are sandy loams, loamy sands, and sands derived from eolian or alluvial deposits or from sandstones.

Environmental Description

Glen Canyon National Recreation Area Environment: This common shrubland association occurs on benches, dunes, plains, plateaus, mesas, piedmont slopes, hills, toeslopes, canyon bottoms, valley floors, and terraces along drainages. Sites range from flat to moderately sloping (up to 18°), are oriented to all aspects, and lie between 1104 and 1468 m elevation (though one plot was sampled at 1936 m elevation). Bare soil and sand cover most of the unvegetated surface, with lesser cover by dark cyanobacteria and litter, and sparse to low cover of gravel, bedrock, and live vegetation litter. Soils are moderately well-drained to rapidly drained sandy loams, loamy sands, and sands derived from eolian or alluvial deposits or from sandstones of the Dakota, Entrada, or Navajo formations.

Global Environment: This sandsheet shrubland association occurs on sandy sites in the Colorado Plateau on benches, dunes, plains, plateaus, mesas, piedmont slopes, hills, toeslopes, canyon bottoms, valley floors, and terraces along drainages between 1104 and 1468 m elevation (though one plot was sampled at 1936 m elevation). Sites range from flat to moderately sloping (up to 18°) and occur on all aspects. Bare soil and sand cover most of the unvegetated surface, with lesser cover by dark cyanobacteria and litter, and sparse to low cover of gravel, bedrock, and live vegetation litter. Soils are moderately well-drained to rapidly drained sandy loams, loamy sands, and sands derived from eolian or alluvial deposits or from sandstones of the Dakota, Entrada, or Navajo formations.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Total vegetation cover in this sandsheet shrubland does not exceed 34% and may be as low as 3% in areas with actively blowing sand. The shrub canopy is codominated by *Artemisia filifolia* (with up to 7% cover) and *Ephedra cutleri* (with up to 12% cover). Associated shrubs with sparse to low cover may include *Atriplex canescens, Coleogyne ramosissima, Ephedra torreyana, Eriogonum leptocladon, Gutierrezia* spp., *Opuntia erinacea, Psoralidium junceum, Psorothamnus fremontii, Quercus havardii var. tuckeri (= Quercus welshii), Vanclevea stylosa*, and *Yucca angustissima*. The understory may appear quite grassy and have low to moderate cover of the following native grass species: *Achnatherum hymenoides, Bouteloua eriopoda, Sporobolus contractus, Sporobolus cryptandrus, Sporobolus flexuosus*, and *Vulpia octoflora (= Festuca octoflora)*. It may also include sparse to low cover of the exotic annual grass *Bromus tectorum*. Forbs have sparse cover and are dominated by exotic annuals, such as *Salsola tragus*; *Chloracantha*

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spinosa (= Aster spinosus), Grindelia fastigiata, Plantago patagonica, Sphaeralcea leptophylla, and *Stephanomeria pauciflora* are present with more than trace cover.

Global Vegetation: This sandsheet shrubland association is characterized by an open shrub canopy codominated by *Artemisia filifolia* (with up to 7% cover) and *Ephedra cutleri* (with up to 12% cover). Associated shrubs include *Atriplex canescens, Coleogyne ramosissima, Ephedra torreyana, Eriogonum leptocladon, Gutierrezia* spp., *Opuntia erinacea, Psoralidium junceum, Psorothamnus fremontii, Quercus havardii var. tuckeri (= Quercus welshii), Vanclevea stylosa*, and *Yucca angustissima* with sparse to low cover. The herbaceous layer is dominated by low to moderate cover of native graminoids such as *Achnatherum hymenoides, Bouteloua eriopoda, Sporobolus contractus, Sporobolus cryptandrus, Sporobolus flexuosus*, and *Vulpia octoflora (= Festuca octoflora)*. It may also include sparse to low cover of the exotic annual grass *Bromus tectorum*. Forbs have sparse cover and are often dominated by the exotic annual *Salsola tragus*. Associated forbs include *Chloracantha spinosa (= Aster spinosus), Grindelia fastigiata, Plantago patagonica, Sphaeralcea leptophylla*, and *Stephanomeria pauciflora*. Total vegetation does not exceed 34% and may be as low as 3% in areas with actively blowing sand.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Artemisia filifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*
Herb (field)	Graminoid	*Achnatherum hymenoides*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Artemisia filifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Artemisia filifolia*, *Ephedra cutleri*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: GNR (18-Aug-2016).

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Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak

Element Distribution

Glen Canyon National Recreation Area Range: This common shrubland occurs throughout the southwestern portion of the recreation area and was sampled in Warm Creek Bay, Rock Creek Bay, Warm Springs Canyon, Crosby Canyon, Stanton Canyon, Coyote Gulch, Davis Gulch, Willow Gulch, Wahweap Bay, on Antelope Island, Romana Mesa, Muley Point, Wilson Mesa, the Sand Hills, near Lee's Ferry, Hall's Crossing, Hole-in-the-Rock, and north of Bullfrog.

Global Range: This sandsheet shrubland association is documented only from Glen Canyon National Recreation Area and likely occurs more widely on sandy sites in the Colorado Plateau.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This community is on an undulating part of the slope, and on the edges it becomes dune-like. This was perhaps dune and is now stabilized with shrubs growing on hummocks; the soil now is covered in cyanobacteria (crust). OR Wind-blown sand controls plant distribution. Shrubs are growing on sandy hummocks. Very little soil crust or gravel holding soil in place.

Glen Canyon National Recreation Area Plots: The description is based on 2011, 2012, and 2013 field data (26 plots): (Plots: GLCA.1007, GLCA.1053, GLCA.1086, GLCA.1087, GLCA.2033, GLCA.2056, GLCA.2058, GLCA.2059, GLCA.2061, GLCA.2089, GLCA.2091, GLCA.2096, GLCA.4124, GLCA.4226, GLCA.4340, GLCA.5031, GLCA.5038, GLCA.5104, GLCA.5146, GLCA.5215, GLCA.5250, GLCA.5268, GLCA.5558, GLCA.5561, GLCA.5568, GLCA.5572).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEGL002697] *Artemisia filifolia* Colorado Plateau Shrubland
Translated Name: Sand Sagebrush Colorado Plateau Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)

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Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Artemisia filifolia* Colorado Plateau Shrubland Alliance (A3181)

Element Concept

Global Summary: This sand sagebrush shrubland association is widespread in the Colorado Plateau of Utah, Arizona and probably New Mexico. Total vegetation cover ranges from sparsely vegetated (<5%) on often disturbed sites to stable, well-developed communities with more than 50% cover. Regardless, the vegetation is characterized by an open shrub canopy dominated by *Artemisia filifolia* that is usually mixed with other shrubs, especially *Atriplex canescens, Coleogyne ramosissima, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Psorothamnus fremontii, Rhus aromatica, Sarcobatus vermiculatus*, and *Vanclevea stylosa*. The herbaceous layer is moderate in terms of species composition and provides sparse to moderate cover. Graminoids include *Achnatherum hymenoides, Elymus repens, Hesperostipa comata, Pleuraphis jamesii, Sporobolus cryptandrus, Sporobolus giganteus*, and *Vulpia octoflora*. Forbs vary among sites but are typical of sandy habitats, including *Abronia fragrans, Lepidium montanum, Oenothera pallida*, and *Sphaeralcea parvifolia*. Cryptogams may be absent or may provide up to 40% cover. This shrubland occurs on sandy soils of valley floors, stream terraces, stabilized dunes and sandsheets, benches, floodplains and alluvial fans. Most sites are level to gently sloping. Elevations range from 1122 to 1769 m (3645-5803 feet). Soils are sandy and derived from sandstones, alluvium, or eolian deposits.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrub association occurs on deep, well-drained sandy soils of intermittently flooded washes and drainage channels, alluvial fans, sand dunes, canyon bottoms, and mesatops. Sites tend to be flat or slope gently and occur between 1111 and 1566 m elevation. Bare soil, sand, and litter cover most of the unvegetated surface, with low cover by biological soil crusts and gravel. Soils are rapidly drained sands or loamy sands derived from alluvium or eolian deposits.

Global Environment: This common association occurs on sandy sites on washes, valley floors, valley sides, stream terraces, stabilized dunes and sandsheets, benches, floodplains, terraces, mesatops and alluvial fans. Most sites are level to gently sloping, with a few on moderate slopes (up to 21%), and may be oriented to any aspect, although there is a slight tendency to occur on warmer southerly aspects. Elevations range from 1111 to 1769 m (3645-5803 feet). Sand or bare soil covers most of the unvegetated ground surface, although cryptobiological soil crusts may have up to 40% cover. Soils are sandy to sometimes gravelly and derived from local sandstones, alluvium, or eolian deposits.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sandy shrubland is somewhat common within the recreation area and total vegetation cover ranges from 7-77%. The canopy is dominated by *Artemisia filifolia* with 2-55% cover. *Atriplex canescens* and/or *Ericameria nauseosa* are commonly present and may be nearly codominant with *Artemisia filifolia* in some stands. Other shrubs may be present with sparse to low cover and include *Ephedra torreyana, Ephedra viridis, Eriogonum leptocladon, Gutierrezia* spp., *Opuntia* spp., *Psorothamnus fremontii, Mahonia fremontii, Coleogyne*

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ramosissima, Rhus aromatica, Vanclevea stylosa, and *Fraxinus anomala*. The herbaceous layer is diverse and provides low to moderate cover. Common graminoids include *Achnatherum hymenoides, Sporobolus giganteus, Pleuraphis jamesii, Elymus repens, Schismus barbatus,* and *Bromus tectorum*. Forbs recorded include *Salsola tragus, Sphaeralcea* spp., *Plantago patagonica, Artemisia dracunculus, Cordylanthus* spp., and *Machaeranthera canescens*. The presence of the non-native annual grass *Bromus tectorum* and the forb *Salsola tragus* indicate disturbances such as grazing.

Global Vegetation: Total vegetation cover ranges broadly, from sparsely vegetated disturbed and alluvial terrace sites with less than 5% total cover to more stable, well-developed communities with greater than 50% cover. Regardless of cover, the vegetation is characterized by an open shrub canopy of *Artemisia filifolia,* usually mixed with other shrubs such as *Atriplex canescens, Coleogyne ramosissima, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Eriogonum leptocladon, Fraxinus anomala*. *Gutierrezia* spp., *Mahonia fremontii, Opuntia* spp., *Psorothamnus fremontii, Rhus aromatica, Sarcobatus vermiculatus,* and *Vanclevea stylosa*. The herbaceous layer is moderate in terms of species composition and provides sparse to moderate cover. Graminoids that are consistently present include *Achnatherum hymenoides, Elymus repens, Hesperostipa comata, Pleuraphis jamesii, Sporobolus cryptandrus, Sporobolus giganteus,* and *Vulpia octoflora*. Forbs vary among sites but are typical of sandy habitats, including *Abronia fragrans, Artemisia dracunculus, Cordylanthus* spp., *Lepidium montanum, Machaeranthera canescens, Oenothera pallida, Sphaeralcea parvifolia,* and other *Sphaeralcea* species. Cryptogams may be absent or may provide up to 40% cover. Exotic species are often present and include *Bromus tectorum, Schismus barbatus,* and *Salsola tragus*.

Global Dynamics: Sites are found on active and stabilized dunes, high stream terraces and a few sandsheets. This community is well-adapted to disturbance and to its sandy substrate. On sites in northern Colorado Plateau, *Artemisia filifolia* appears mid-seral with recently disturbed stands having higher cover of *Eriogonum leptocladon* and *Vanclevea stylosa*, versus *Coleogyne ramosissima* in more stabilized sites. *Coleogyne ramosissima* does not occur in southern portions of the Colorado Plateau.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Artemisia filifolia*, *Ericameria nauseosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia* spp.
Short shrub/sapling	Succulent shrub	*Opuntia* spp.
Herb (field)	Flowering forb	*Machaeranthera canescens*, *Salsola tragus*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Bromus tectorum*

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Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Artemisia filifolia*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Achnatherum hymenoides*, *Artemisia filifolia*, *Atriplex canescens*, *Ericameria nauseosa*, *Sphaeralcea coccinea*, *Sporobolus cryptandrus*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Global: Vulnerable Plants: *Parryella filifolia* (G3G4), *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Halogeton glomeratus* (High/Medium), *Malcolmia africana*, *Salsola tragus*, *Schismus barbatus* (High/Medium); Other Plants: *Opuntia* spp. (N/A, includes *Opuntia polyacantha*, *Opuntia phaeacantha*, *Opuntia fragilis*, and *Opuntia erinacea*)

Conservation Status Rank

Global Rank & Reasons: GNR (14-Aug-2001).

Related Concepts

Global Similar Types:
- *Artemisia filifolia - Ephedra (torreyana, viridis)* Shrubland (CEGL002786)
- *Artemisia filifolia / Bouteloua eriopoda* Shrubland (CEGL001077)
- *Artemisia filifolia / Sporobolus cryptandrus* Shrubland (CEGL002179)
- *Artemisia filifolia / Sporobolus flexuosus* Shrubland (CEGL001547)
- *Artemisia filifolia / Sporobolus giganteus* Shrubland (CEGL001078)
- *Poliomintha incana - Artemisia filifolia - Vanclevea stylosa* Shrubland (CEGL002418)

Classification

Status: Standard
Classification Confidence: 1 - Strong
Global Classification Comments: This association is distinguished from other *Artemisia filifolia* shrubland associations by its restriction to the Colorado Plateau, the somewhat mixed shrub canopy that usually includes *Atriplex canescens*, a poorly-developed herbaceous layer and often a number of species that indicate disturbance or somewhat alkaline conditions. This association also occurs in a broader range of habitats than other *Artemisia filifolia* types. However, *Artemisia filifolia - Ephedra (torreyana, viridis)* Shrubland (CEGL002786) is poorly defined, and many stands of *Artemisia filifolia* Colorado Plateau Shrubland (CEGL002697) contain one or the other species of *Ephedra*; it is possible that these two associations should be combined. This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

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Element Distribution

Glen Canyon National Recreation Area Range: This association occurs throughout the mapping area and was sampled in Calf Canyon, Wagon Box Canyon, Easter Pasture Canyon, Blue Pool Wash, North Wash, Anderson Bottom, Steer Gulch, Grand Gulch, on Scorpion Flat, the Escalante River, and near Bullfrog.

Global Range: This sand sagebrush shrubland association is widespread on the Colorado Plateau of Utah, western Colorado, northern Arizona and northwestern New Mexico.

Nations: US
States/Provinces: AZ, CO, NM, UT
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 341B:CC, M341C:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon, Petrified Forest, Pipe Spring, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This vegetation occurs on a terrace above Calf Canyon drainage. *Artemisia filifolia* occurs throughout this canyon along the drainage, but only as narrow bands. This plot is located in a more extensive *Artemisia filifolia*-dominated area above the drainage.

Glen Canyon National Recreation Area Plots: The description is based on 2004 field data (5 plots, 11 accuracy assessment points): (Plots: GLCA.0577, GLCA.0579, GLCA.5013, GLCA.5282, GLCA.9509; AA Points: GLCA_AA.0029, GLCA_AA.0085, GLCA_AA.0483, GLCA_AA.1354, GLCA_AA.1355, GLCA_AA.1870, GLCA_AA.1974, GLCA_AA.2039, GLCA.2041, GLCA_AA.3076, GLCA_AA.3098).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008b, Coles et al. 2009a, Romme et al. 1993, Thomas et al. 2009a, Western Ecology Working Group n.d.*

A3220 Coleogyne ramosissima Colorado Plateau Shrubland Alliance

Alliance Summary Description: The shrub layer is characterized by an open to relatively closed canopy of *Coleogyne ramosissima*. Total vegetation cover ranges from 5 to 70%. Other codominant and associate shrubs may include *Ambrosia dumosa, Artemisia filifolia, Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Ephedra funerea, Ephedra torreyana, Ephedra nevadensis, Ephedra torreyana, Ericameria linearifolia, Ericameria nauseosa, Ericameria teretifolia, Gutierrezia sarothrae, Krascheninnikovia lanata, Lycium* spp., *Menodora spinescens, Opuntia* spp., *Purshia stansburiana,* and *Quercus havardii var. tuckeri*. Occasional *Juniperus* spp., *Pinus edulis,* or *Pinus monophylla* trees are present in some stands. The herbaceous layer varies from sparse to moderate (1-30% cover) and composition varies by region, but is always dominated by graminoids. Dominant species include *Achnatherum hymenoides, Aristida purpurea, Dasyochloa pulchella (=*

Erioneuron pulchellum), Muhlenbergia pungens, and *Pleuraphis jamesii*. Forbs may have high diversity, but do not have high cover. Associate forbs may include *Amsonia tomentosa, Astragalus* spp., *Calochortus nuttallii, Chaenactis* spp., *Cryptantha* spp., *Eriogonum inflatum, Eriogonum nutans, Heterotheca villosa, Ipomopsis polycladon, Phacelia* spp., *Plantago* spp., *Sphaeralcea leptophylla, Stenotus acaulis (= Haplopappus acaulis),* and *Streptanthella* spp. These shrublands are known from the Colorado Plateau, southern Great Basin, Mojave Desert, and Sierra Nevada foothills. Stands occur on plains, ridges, bajadas, mesatops, canyon rims, escarpments, valley sides, sand dunes, washes, alluvial terraces and benches with flat to steep slopes (up to 45%) with elevations ranging between 1000 and 2200 m.

[CEPP005688] Coleogyne ramosissima - Acamptopappus sphaerocephalus - Ephedra torreyana Shrubland
Translated Name: Blackbrush - Rayless Goldenhead - Torrey's Joint-fir Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Coleogyne ramosissima* Colorado Plateau Shrubland Alliance (A3220)

Element Concept

Global Summary: This warm desert shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely on sandy sites in the Colorado Plateau. It is characterized by 4-33% total cover and is characterized by a sparse to open shrub canopy codominated by *Coleogyne ramosissima, Ephedra torreyana,* and *Acamptopappus sphaerocephalus*. In some stands, *Glossopetalon spinescens* is also codominant. A diverse mixture of other associated shrubs may be present with sparse to low cover. The herbaceous layer has sparse to low cover that is generally a weedy mixture of native grasses and exotic annuals. Common species include *Aristida purpurea, Bromus rubens, Bromus tectorum, Hesperostipa comata, Pleuraphis jamesii, Sporobolus contractus, Sporobolus cryptandrus, Schismus barbatus,* and *Vulpia octoflora (= Festuca octoflora)*. Forb cover and diversity are low. Stands occur on mesas, ridges, backslopes, toeslopes, canyon sides, canyon bottoms, bajadas, alluvial fans, and terraces along drainage channels between 1100 and 1486 m elevation. Sites are typically gently to moderately sloping, occurring on all aspects. Bare soil and gravel cover most of the unvegetated surface, with lesser cover by dark cyanobacteria, large rock, bedrock, and litter, and sparse to low cover of moss. Soils are moderately well-drained to rapidly drained with variable textures ranging from sand to sandy clay loams, and silty clays derived from eolian, alluvial, or talus/colluvial deposits, sandstones, or shales.

Environmental Description

Glen Canyon National Recreation Area Environment: This common shrubland association occurs on mesas, ridges, backslopes, toeslopes, canyon sides, canyon bottoms, bajadas, alluvial fans, and terraces along drainage channels. Sites are gently to moderately sloping (up to 13°), though one site has a 34° slope, are oriented to all aspects, and lie between 1100 and 1486 m elevation. Bare soil and gravel

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cover most of the unvegetated surface, with lesser cover by dark cyanobacteria, large rock, bedrock, and litter, and sparse to low cover of moss. Soils are moderately well-drained to rapidly drained sands, loamy sands, loams, sandy loams, sandy clay loams, and silty clays derived from eolian, alluvial, or talus/colluvial deposits, sandstones derived from the Dakota, Entrada, or Navajo formations, or shales derived from the Carmel Formation or Salt Wash Member of the Morrison Formation.

Global Environment: This warm desert shrubland association occurs on sandy sites in the Colorado Plateau on mesas, ridges, backslopes, toeslopes, canyon sides, canyon bottoms, bajadas, alluvial fans, and terraces along drainage channels between 1100 and 1486 m elevation. Sites are typically gently to moderately sloping occurring on all aspects. Bare soil and gravel cover most of the unvegetated surface, with lesser cover by dark cyanobacteria, large rock, bedrock, and litter, and sparse to low cover of moss. Soils are moderately well-drained to rapidly drained with variable textures ranging from sand to sandy clay loams, and silty clays derived from eolian, alluvial, or talus/colluvial deposits, sandstones, or shales.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This warm desert shrubland has total vegetation cover between 4 and 33%. The shrub canopy is codominated by *Coleogyne ramosissima* (with up to 12% cover), *Ephedra torreyana* (with up to 7% cover), and *Acamptopappus sphaerocephalus* (with up to 8% cover). In some stands, *Glossopetalon spinescens* is also codominant, with 1-5% cover. A diverse mixture of associated shrubs may be present with sparse to low cover, including *Atriplex canescens, Atriplex confertifolia, Atriplex obovata, Chrysothamnus viscidiflorus, Encelia frutescens, Ephedra viridis, Ephedra cutleri, Ericameria nauseosa, Gutierrezia microcephala, Krascheninnikovia lanata, Lycium andersonii, Opuntia polyacantha, Picrothamnus desertorum (= Artemisia spinescens), Psorothamnus fremontii*, and *Xylorhiza tortifolia*. The understory may have sparse to low cover and is generally weedy; common species include *Aristida purpurea, Bromus rubens, Bromus tectorum, Hesperostipa comata, Pleuraphis jamesii, Sporobolus contractus, Sporobolus cryptandrus, Schismus barbatus*, and *Vulpia octoflora (= Festuca octoflora)*. Forbs are fewer and have only trace cover; *Eriogonum inflatum, Plantago patagonica*, and *Stephanomeria pauciflora* were the most commonly noted.

Global Vegetation: This warm desert shrubland association has 4-33% total cover and is characterized by a sparse to open shrub canopy codominated by *Coleogyne ramosissima, Ephedra torreyana*, and *Acamptopappus sphaerocephalus*. In some stands, *Glossopetalon spinescens* is also codominant. A diverse mixture of associated shrubs may be present with sparse to low cover, including *Atriplex canescens, Atriplex confertifolia, Atriplex obovata, Chrysothamnus viscidiflorus, Encelia frutescens, Ephedra viridis, Ephedra cutleri, Ericameria nauseosa, Gutierrezia microcephala, Krascheninnikovia lanata, Lycium andersonii, Opuntia polyacantha, Picrothamnus desertorum (= Artemisia spinescens), Psorothamnus fremontii*, and *Xylorhiza tortifolia*. The herbaceous layer has sparse to low cover that is generally a weedy mixture of native grasses and exotic annuals. Common species include *Aristida purpurea, Bromus rubens, Bromus tectorum, Hesperostipa comata, Pleuraphis jamesii, Sporobolus contractus, Sporobolus cryptandrus, Schismus barbatus*, and *Vulpia*

octoflora (= Festuca octoflora). Forb cover and diversity are low with trace cover of *Eriogonum inflatum, Plantago patagonica*, and *Stephanomeria pauciflora*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Acamptopappus sphaerocephalus*, *Coleogyne ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*, *Ephedra torreyana*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Acamptopappus sphaerocephalus*, *Coleogyne ramosissima*, *Glossopetalon spinescens*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Acamptopappus sphaerocephalus*, *Coleogyne ramosissima*, *Ephedra torreyana*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Salsola tragus*, *Schismus barbatus* (High/Medium)

Global: Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High), *Schismus barbatus* (High/Medium)

Conservation Status Rank

Global Rank & Reasons: GNR (18-Aug-2016).

Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak

Element Distribution

Glen Canyon National Recreation Area Range: This common shrubland was sampled in Rock Creek Bay, Dungeon Canyon, Cornerstone Canyon, Dry Rock Creek, Sooner Gulch, Friendship Cove, Neanderthal Cove, on Sit Down Bench, Billie Flat Top, Ticaboo Point, Teddy's Horse Pasture, and near Dangling Rope.

Global Range: This warm desert shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely in the Colorado Plateau.

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Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Vegetation widely spaced, soil held together with a layer of gravel. Some scattered boulders in the plot provide microhabitat for vegetation.

Glen Canyon National Recreation Area Plots: The description is based on 2011, 2012, and 2013 field data (19 plots): (Plots: GLCA.1066, GLCA.1067, GLCA.1069, GLCA.1075, GLCA.2071, GLCA.2075, GLCA.2083, GLCA.2087, GLCA.5006, GLCA.5008, GLCA.5150, GLCA.5155, GLCA.5159, GLCA.5160, GLCA.5162, GLCA.5164, GLCA.5166, GLCA.5254, GLCA.6113).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEPP005687] Coleogyne ramosissima - Ephedra cutleri Sandsheet Shrubland
Translated Name: Blackbrush - Cutler's Joint-fir Sandsheet Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Coleogyne ramosissima* Colorado Plateau Shrubland Alliance (A3220)

Element Concept

Global Summary: This sandsheet shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely on sandy sites in the Colorado Plateau. It is characterized by a sparse to open shrub canopy codominated by *Coleogyne ramosissima* and *Ephedra cutleri*, and occasionally codominated by *Chrysothamnus greenei*. Associated shrubs are moderately diverse with sparse to low cover. The herbaceous layer is dominated by sparse to low cover of native grass species, including *Achnatherum hymenoides, Dasyochloa pulchella*, *Sporobolus contractus*, *Sporobolus cryptandrus*, *Pleuraphis jamesii*, and *Vulpia octoflora (= Festuca octoflora)*. Sparse to low cover of the exotic annual grasses *Bromus tectorum*, *Bromus rubens*, and *Schismus barbatus* may be present with sparse to low cover. Forbs have sparse cover and may include *Oenothera pallida, Sphaeralcea grossulariifolia*, and exotic *Salsola tragus*. Total vegetation cover in this sandsheet shrubland does not exceed 31% and may be as low as 4% in areas with actively blowing sand. Stands occur on sand dunes, plateaus, mesas, ridges, piedmont slopes, hills, canyon sides, valley bottoms, and terraces between 1068 and 1487 m elevation. Sites are gently to moderately sloping and occur on all aspects. Bare soil and sand cover most of the unvegetated surface. Soils are coarser textured and

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include sands, loamy sands, loams, sandy loams, and silt loams derived from eolian deposits or sandstones.

Environmental Description

Glen Canyon National Recreation Area Environment: This common shrubland association occurs on sand dunes, plateaus, mesas, ridges, piedmont slopes, hills, canyon sides, valley bottoms, and terraces. Sites are gently to moderately sloping (up to 12°), are oriented to all aspects, and lie between 1068 and 1487 m elevation. Bare soil and sand cover most of the unvegetated surface, with lesser cover by gravel, dark cyanobacteria and litter, and sparse to low cover of bedrock, moss, and large rocks. Soils are moderately well-drained to rapidly drained sands, loamy sands, loams, sandy loams, and silt loams derived from eolian deposits or from sandstones of the Carmel, Dakota, Entrada, or Navajo formations.

Global Environment: This sandsheet shrubland association occurs in the Colorado Plateau on sand dunes, plateaus, mesas, ridges, piedmont slopes, hills, canyon sides, valley bottoms, and terraces between 1068 and 1487 m elevation. Sites are gently to moderately sloping (up to 12°) and occur on all aspects. Bare soil and sand cover most of the unvegetated surface, with lesser cover by gravel, dark cyanobacteria and litter, and sparse to low cover of bedrock, moss, and large rocks. Soils are moderately well-drained to rapidly drained sands, loamy sands, loams, sandy loams, and silt loams derived from eolian deposits or from sandstones.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Total vegetation cover in this sandsheet shrubland does not exceed 31% and may be as low as 4% in areas with actively blowing sand. The shrub canopy is codominated by *Coleogyne ramosissima* (with up to 15% cover) and *Ephedra cutleri* (with up to 8% cover), and occasionally codominated by *Chrysothamnus greenei* as well (with 3-6% cover). Associated shrubs with sparse to low cover may include *Acamptopappus sphaerocephalus, Artemisia filifolia, Atriplex canescens, Ephedra viridis, Eriogonum leptocladon, Gutierrezia* spp., *Opuntia* spp., *Psorothamnus fremontii, Quercus havardii var. tuckeri (= Quercus welshii),* and *Yucca angustissima*. The understory may have sparse to low cover of the following native grass species: *Achnatherum hymenoides, Dasyochloa pulchella, Sporobolus contractus, Sporobolus cryptandrus, Pleuraphis jamesii*, and *Vulpia octoflora (= Festuca octoflora)*. It may also include sparse to low cover of the exotic annual grasses *Bromus tectorum, Bromus rubens*, and *Schismus barbatus*. Forbs have sparse cover and include *Oenothera pallida, Salsola tragus,* and *Sphaeralcea grossulariifolia*.

Global Vegetation: This sandsheet shrubland association is characterized by a sparse to open shrub canopy codominated by *Coleogyne ramosissima* (with up to 15% cover) and *Ephedra cutleri* (with up to 8% cover), and occasionally codominated by *Chrysothamnus greenei* as well (with 3-6% cover). Associated shrubs are moderately diverse with sparse to low cover of *Acamptopappus sphaerocephalus, Artemisia filifolia, Atriplex canescens, Ephedra viridis, Eriogonum leptocladon, Gutierrezia* spp., *Opuntia* spp., *Psorothamnus fremontii, Quercus havardii var. tuckeri (= Quercus welshii),* and *Yucca angustissima*. The herbaceous layer is dominated by sparse to low cover of native grass species, including *Achnatherum hymenoides, Dasyochloa pulchella, Sporobolus contractus, Sporobolus cryptandrus, Pleuraphis jamesii,* and *Vulpia octoflora (= Festuca octoflora)*. It may also

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include sparse to low cover of the exotic annual grasses *Bromus tectorum, Bromus rubens,* and *Schismus barbatus*. Forbs have sparse cover and may include *Oenothera pallida, Sphaeralcea grossulariifolia,* and exotic *Salsola tragus*. Total vegetation cover does not exceed 31% and may be as low as 4% in areas with actively blowing sand.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Chrysothamnus greenei*, *Coleogyne ramosissima*, *Gutierrezia sarothrae*, *Psorothamnus fremontii*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Chrysothamnus greenei*, *Coleogyne ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Coleogyne ramosissima, Ephedra cutleri*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High), *Salsola tragus, Schismus barbatus* (High/Medium)

Global: Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High), *Salsola tragus, Schismus barbatus* (High/Medium)

Conservation Status Rank

Global Rank & Reasons: GNR (18-Aug-2016).

Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak

Element Distribution

Glen Canyon National Recreation Area Range: This common shrubland was sampled in Warm Creek Bay, Warm Springs Canyon, Coyote Gulch, Davis Gulch, Willow Gulch, Wahweap Bay, on Antelope Island, Wilson Mesa, Alstrom Point, Cookie Jar Butte, Castle Rock, Lone Rock Road, the Sand Hills, near Hole-in-the-Rock, Dangling Rope, Red Well Trailhead, above Fiftymile Creek, and north of Bullfrog.

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Global Range: This sandsheet shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely on sandy sites in the Colorado Plateau.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: *Ephedra* creating little hummocks making an undulating floor. This is a broad, gently sloping hillside with a fairly even distribution of species. Soil is covered in gravel and there are waterways braided through plot leaving exposed sandstone bedrock. Shrubs have collected soil around their bases over time and are growing on their own tiny mounds of sand.

Glen Canyon National Recreation Area Plots: The description is based on 2011, 2012, 2013, and 2015 field data (21 plots, 2 accuracy assessment points): (Plots: GLCA.1035, GLCA.1036, GLCA.1054, GLCA.1080, GLCA.2050, GLCA.2055, GLCA.2073, GLCA.2093, GLCA.4236, GLCA.4291, GLCA.4345, GLCA.5000, GLCA.5100, GLCA.5227, GLCA.5229, GLCA.5260, GLCA.5271, GLCA.5273, GLCA.5555, GLCA.5560, GLCA.5565; AA Points: GLCA_AA.1563, GLCA_AA.1565).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEGL002348] Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Shrubland
Translated Name: Blackbrush - Stansbury's Cliffrose - Tucker Sand Shinnery Oak Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Coleogyne ramosissima* Colorado Plateau Shrubland Alliance (A3220)

Element Concept

Global Summary: This Colorado Plateau shrubland is characterized by a shrub layer of *Coleogyne ramosissima* accompanied by either or both *Purshia stansburiana* and *Quercus havardii var. tuckeri*. Occasionally *Coleogyne ramosissima* may be absent, but then both *Purshia stansburiana* and *Quercus havardii var. tuckeri* are prominent. Several other associated shrubs may be present. The herbaceous layer is moderately diverse in terms of species composition but provides only sparse cover. Total vegetation cover ranges from 5 to 70%. Stands occur on semi-stabilized sandsheets, dunes and

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sand-filled pockets in sandstone slickrock. They occur on a variety of landforms with flat to gentle slopes (0-12%) between 1172 and 1670 m (3845-5475 feet) elevation. Soils are rapidly drained loamy sands, silt loams, sands, or sandy clay loams derived from eolian sands, alluvium, sandstones or shales.

Environmental Description

Glen Canyon National Recreation Area Environment: This mixed shrubland association occurs on semi-stabilized sandsheets on sideslopes, near drainage channels, and in canyon or valley bottoms, on sand dunes, and on sand-filled pockets of sandstone slickrock ridges. Sites are flat to moderately sloping (to 17°), oriented to all aspects, and lie between 1172 and 1607 m elevation. Sand, bare soil, bedrock, and gravel cover most of the unvegetated surface, with sparse to low cover by large rocks, litter, and biological soil crusts. Soils are rapidly drained loamy sands, silt loams, sands, loams, or sandy loams derived from eolian deposits, alluvium, sandstones of the Navajo or Cedar Mesa formations, or shales of the Morrison Formation.

Global Environment: This Colorado Plateau shrub association is characteristic of semi-stabilized sandsheets, dunes and sand-filled pockets in sandstone slickrock in southeastern Utah. Stands occur on plains, ridges, mesatops, canyon rims, escarpments, valley sides, sand dunes, alluvial terraces and benches with flat to gentle slopes (0-12%) between 1172 and 1670 m (3845-5475 feet) elevation. Bare soil, sand, and gravel cover much of the unvegetated surface. Litter cover is sparse to low. Bedrock and biological soil crust cover is variable and can be absent to sparse or can provide up to 40% cover. Soils are rapidly drained loamy sands, silt loams, sands, sandy clay loams, or sandy loams derived from eolian sands, alluvium, sandstones of the White Rim, Kayenta, Dakota, Navajo, Cedar Mesa or Entrada formations, or shales of the Moenkopi Formation or Salt Wash Member of the Morrison Formation.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This mixed shrubland occurs throughout the recreation area. Total vegetation cover ranges from 4 to 30% and is characterized by an open short-shrub canopy of *Coleogyne ramosissima* (with up to 7% cover) codominated by either *Quercus havardii var. tuckeri* or less commonly by *Purshia mexicana*. A variety of other shrubs are often present, including *Ephedra viridis, Ephedra cutleri, Ephedra torreyana, Ericameria nauseosa, Rhus aromatica, Amelanchier utahensis, Artemisia filifolia, Psorothamnus fremontii, Gutierrezia microcephala, Yucca* spp., *Opuntia polyacantha*, and *Eriogonum microthecum*. The herbaceous layer is diverse but contributes only sparse to low cover. Common graminoids include *Achnatherum hymenoides, Sporobolus cryptandrus, Sporobolus contractus*, and *Bromus tectorum*. Forbs may be diverse but contribute only trace cover.

Global Vegetation: This association is locally common on sandy sites throughout the northern Colorado Plateau. Total vegetation cover ranges from 5 to 70%. The shrub layer is characterized by an open to relatively closed canopy of *Coleogyne ramosissima* accompanied by either or both *Purshia stansburiana* and *Quercus havardii var. tuckeri*. Scattered individuals of *Juniperus osteosperma* are present in many stands but not with more than 5% cover. Occasionally *Coleogyne ramosissima* may be absent, but then both *Purshia stansburiana* and *Quercus havardii var. tuckeri* are prominent. Associated shrubs include *Amelanchier utahensis, Artemisia bigelovii, Artemisia filifolia, Brickellia microphylla, Ephedra cutleri, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Eriogonum*

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leptocladon, Eriogonum microthecum, Fraxinus anomala, Gutierrezia microcephala, Gutierrezia sarothrae, Opuntia polyacantha, Psorothamnus fremontii, Rhus aromatica, Yucca harrimaniae, and other *Yucca* species. Exceptionally cool or moist sites support *Cercocarpus intricatus* and *Amelanchier utahensis* as part of the mix. The herbaceous layer is moderately diverse in terms of species composition but provides only sparse cover. Common species include the grasses *Achnatherum hymenoides, Aristida purpurea, Dasyochloa pulchella (= Erioneuron pulchellum), Pleuraphis jamesii, Muhlenbergia pungens, Sporobolus contractus,* and *Sporobolus cryptandrus*. Forbs present include *Chaenactis stevioides, Chamaesyce fendleri, Cryptantha crassisepala, Gilia inconspicua, Tetraneuris acaulis,* and *Streptanthella longirostris*. The exotic annual grass *Bromus tectorum* is common on some sites. Biological soil crusts are typically sparse in terms of cover, but one sampled stand had 40% cover.

Global Dynamics: Active wind erosion and deposition of sand are evident in many stands, where the shrubs grow on sand mounds or pedestals, or are clearly rooted in sand-filled crevices.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Purshia mexicana*
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*, *Quercus havardii* var. *tuckeri*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*, *Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia microcephala*
Short shrub/sapling	Succulent shrub	*Yucca* spp.
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Sporobolus* spp.

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Purshia stansburiana*
Short shrub/sapling	Broad-leaved deciduous shrub	*Quercus havardii* var. *tuckeri*
Short shrub/sapling	Broad-leaved evergreen shrub	*Cercocarpus intricatus*, *Ephedra viridis*
Short shrub/sapling	Succulent shrub	*Yucca angustissima*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Achnatherum hymenoides, Cercocarpus intricatus, Coleogyne ramosissima, Ephedra viridis, Fraxinus anomala, Gutierrezia sarothrae, Pleuraphis jamesii, Purshia stansburiana, Quercus havardii* var. *tuckeri*

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Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Quercus havardii* var. *tuckeri* (G4T3?Q); Invasive/Exotic Plants: *Bromus tectorum* (High)

Global: Vulnerable Plants: *Quercus havardii* var. *tuckeri* (G4T3?Q), *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: G3G4 (11-Jan-2006). This association is somewhat restricted in its range and habitat, but most sampled examples appear to be in good condition, with few exotic species present. The range is restricted by the range of *Quercus havardii var. tuckeri*, which is limited to southeastern Utah. Most stands of this association are small, less than 5 hectares in size and often less than 1 ha in size.

Related Concepts

Global Similar Types:

- *Coleogyne ramosissima* Shrubland (CEGL001332)
- *Quercus havardii var. tuckeri* Shrubland (CEGL002486)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. *Quercus havardii var. tuckeri* is also referred to in Utah as *Quercus undulata* and *Quercus welshii* (Welsh 1986). The literature for Utah should be reviewed for material relating to this association but using these other names.

Element Distribution

Glen Canyon National Recreation Area Range: This shrubland association was sampled in Andy Miller Flats, Little Valley Canyon, Davis Gulch, Coyote Gulch, Fiftymile Creek, near Lee's Ferry, Hite Bridge, Hole-in-the-Rock, and below Cedar Mesa.

Global Range: This association is common in the Colorado Plateau of southeastern Utah.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Segment is a very rocky drainage channel with much exposed bedrock and shallow gravelly soil. Able to collect much runoff from rocky benches above and floods from upslope to the south. Quite inaccessible to cattle, soil undisturbed with abundant moss/crust.

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Glen Canyon National Recreation Area Plots: The description is based on 2011 and 2012 field data (10 plots): (Plots: GLCA.2019, GLCA.2035, GLCA.4147, GLCA.4348, GLCA.5091, GLCA.5228, GLCA.5258, GLCA.5270, GLCA.5306, GLCA.5319).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Welsh 1986, Western Ecology Working Group n.d.*

[CEGL001334] Coleogyne ramosissima / Pleuraphis jamesii Shrubland
Translated Name: Blackbrush / James' Galleta Shrubland
Common Name:

USNVC Classification

Division: estern North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Coleogyne ramosissima* Colorado Plateau Shrubland Alliance (A3220)

Element Concept

Global Summary: This shrubland association occurs in the Colorado Plateau and Mojave Desert in areas with hot summers and cold winters. The vegetation is characterized by an open (10-30% cover) short-shrub layer that is dominated by the deciduous, microphyllous shrub *Coleogyne ramosissima* with a sparse to moderately dense perennial graminoid layer that is dominated or codominated by *Pleuraphis jamesii*. Shrub associates may be present, including *Atriplex canescens, Atriplex confertifolia, Ephedra nevadensis, Ephedra torreyana, Ericameria nauseosa, Gutierrezia sarothrae*, and *Opuntia* spp. *Achnatherum hymenoides, Calochortus nuttallii*, and several annuals may be present to abundant in the herbaceous layer, especially during wet years. Cover of introduced annual *Bromus* species and *Salsola tragus* may be high in disturbed stands. Occasional *Juniperus osteosperma* or *Pinus edulis* trees are present in some stands. Sites are gently sloping to flat and are found on a variety of landforms from canyon rims and ledges to alluvial fans, valleys and washes with some stands occurring on sandsheets or shale barrens. Elevations range up to 1850 m (6070 feet). Substrates are variable and range from deep, well-drained, sandy soils derived from sandstone to rocky, clayey soils derived from shale.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland association occurs on plateaus, canyon rims, ridges, benches, alluvial fans, canyon bottoms, basins, valley floors, and terraces. Sites are flat to moderately sloped (up to 10°), include all aspects, and lie between 1152 and 1691 m elevation. The unvegetated surface tends to be covered by either bare soil or sand or gravel. There is sparse to low cover by litter, bedrock, and/or biological soil crusts. Soils are somewhat poorly drained to well-drained to rapidly drained loamy sands, sandy loams, sands, loams, silty clay loams, or sandy clay loams derived from Navajo or Dakota sandstones, Moenkopi or Carmel formations, or from eolian deposits. Some stands are on sandsheets or dunes, others on shale barrens.

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Global Environment: This shrubland association occurs in the Colorado Plateau and Mojave Desert in areas with hot summers and cold winters. Elevation ranges from 1152-1850 m (3789-6070 feet). Sites are located on level to gently sloping plateaus, canyon rims, ledges, hills, alluvial fans, toeslopes, basins, valleys, dunes, and washes, generally not exceeding a 20% gradient. The unvegetated surface is covered by either bare soil, sand or gravel. There is sparse cover by litter and typically early-stage biological soil crusts, although there may be significant cover locally. Substrates are extremely variable, with some stands occurring on stabilized sandsheets, others on shale barrens. Soil textures range from eolian or alluvial sand; to deep, rapidly drained, alkaline loamy sands or sandy loams derived from sandstone; to silt loam, silty clay loam or rocky clay soils derived from shale and sandstone, including Navajo Moenkopi Formation (Utah Environmental and Agricultural Consultants 1973).

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This common blackbrush shrubland occurs widely within the recreation area. Total vegetation cover tends to be relatively sparse, ranging from 5 to 23%. The shrub canopy consists overwhelmingly of *Coleogyne ramosissima* (with 2-10% cover); *Ephedra torreyana, Atriplex confertifolia, Ericameria nauseosa, Ephedra viridis, Ephedra cutleri, Gutierrezia sarothrae, Gutierrezia microcephala,* and *Opuntia polyacantha* may be present with less cover. Other shrubs occasionally present include *Acamptopappus sphaerocephalus, Psorothamnus fremontii, Chrysothamnus vaseyi, Krascheninnikovia lanata,* and *Yucca* spp. Unlike *Coleogyne ramosissima* Shrubland (CEGL001332), this type has a developed herbaceous understory dominated by *Pleuraphis jamesii* with up to 5% cover. Additional graminoids, with low to codominant cover, include *Achnatherum hymenoides, Sporobolus flexuosus, Sporobolus contractus*, and *Sporobolus cryptandrus*. Forbs are highly variable in species composition among sites and include *Eriogonum inflatum, Xylorhiza tortifolia*, and *Abronia fragrans.*

Global Vegetation: The vegetation is characterized by an open to moderately dense (10-60% cover) short-shrub layer that is dominated by the deciduous, microphyllous shrub *Coleogyne ramosissima* with a sparse to moderately dense perennial graminoid layer that is typically dominated or codominated by *Pleuraphis jamesii*. Shrub associates may be present, including *Acamptopappus sphaerocephalus, Atriplex canescens, Atriplex confertifolia, Chrysothamnus vaseyi, Ephedra cutleri, Ephedra nevadensis, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Gutierrezia microcephala, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia polyacantha,* and other *Opuntia* species, *Psorothamnus fremontii, Sclerocactus whipplei, Yucca baccata*, and *Yucca angustissima*. Cover of *Pleuraphis jamesii* ranges from 1-5% in stands with sparse herbaceous layers to over 30% where the understory is denser. Additional graminoids include *Achnatherum hymenoides, Aristida purpurea, Sporobolus contractus, Sporobolus cryptandrus, Sporobolus flexuosus*, or introduced annual *Bromus* species, which may be common in disturbed stands. Forb cover is generally low and is highly variable in species composition among sites. Forbs include *Abronia fragrans, Amsonia tomentosa, Astragalus* sp., *Calochortus nuttallii, Eriogonum inflatum, Eriogonum nutans, Heterotheca villosa, Ipomopsis polycladon, Phacelia* spp., *Sphaeralcea leptophylla, Stenotus acaulis (= Haplopappus acaulis), Xylorhiza tortifolia*, and the introduced annual

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forb *Salsola tragus*. Annuals provide abundant cover during wet years. Occasional *Juniperus osteosperma* or *Pinus edulis* trees are present in some stands.

Global Dynamics: *Coleogyne ramosissima* is very sensitive to fire because it does not resprout after burning, and seeds in the seed bank are short-lived and destroyed by fire (Bowns and West 1976, Wright 1980). It is slow to recolonize burns, often requiring over 60 years to re-establish (Wright 1980). Burned-over areas often convert to *Gutierrezia microcephala*- or *Artemisia tridentata*-dominated shrublands (Bowns and West 1976). Invasion of introduced annual *Bromus* spp. creates a fire hazard and increases fire frequency in some parts of the range (Warren et al. 1982).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*, *Coleogyne ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra nevadensis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex confertifolia*, *Coleogyne ramosissima*, *Ephedra nevadensis*, *Ephedra torreyana*, *Gutierrezia sarothrae*, *Pleuraphis jamesii*

Other Noteworthy Species

Global: Vulnerable Plants: *Sclerocactus whipplei* (G2G3); Invasive/Exotic Plants: *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: G5 (23-Feb-1994).

Related Concepts

Global Similar Types:
- *Coleogyne ramosissima* Shrubland (CEGL001332)
- *Coleogyne ramosissima* Sparse Shrubland (CEGL003834)
- *Pleuraphis jamesii* Grassland (CEGL001777)

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Global Related Concepts:

- *Coleogyne ramosissima/Hilaria jamesii* (Bourgeron and Engelking 1994) =
- Blackbrush Community (Utah Environmental and Agricultural Consultants 1973) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >

Classification

Status: Standard

Classification Confidence: 1 - Strong

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. This association is similar to the broadly-defined *Coleogyne ramosissima* Shrubland (CEGL001332), which generally has a sparse to extremely sparse herbaceous layer. This association is separated only by the presence of a developed herbaceous layer in which *Pleuraphis jamesii* has at least 1% cover.

Element Distribution

Glen Canyon National Recreation Area Range: This common shrubland association occurs throughout the recreation area. Areas sampled include Ekker Butte, Red Point, Panorama Point, Lone Rock, Balanced Rock Canyon, Hurricane Wash, Teddy's Horse Pasture, Sit Down Bench, Gunsight Canyon, Brown's Rim, The Cove, Rock Canyon, south of Muley Point, and west of Big Water Canyon.

Global Range: This shrubland association occurs in the Colorado Plateau and northern Mojave Desert from southwestern Colorado across southern Utah and Nevada, and possibly into northern Arizona and southeastern California.

Nations: US
States/Provinces: AZ?, CA?, CO:SU, NV, UT:S5
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC, 341B:CC, M341C:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Glen Canyon, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This community occurs regularly in this area, but is patchy. Other areas of slightly darker maroon Moenkopi occurring throughout the same bench area as plot tend to have denser *Coleogyne ramosissima* and less grass than where plot is located. Soils in plot are less pebbly on top and appear to be sandier. Soils also appear deeper (more developed) where plot is located.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, 2012, and 2013 field data (16 plots): (Plots: GLCA.0548, GLCA.0596, GLCA.0741, GLCA.2008, GLCA.2043, GLCA.2072, GLCA.2076, GLCA.4004, GLCA.4015, GLCA.4108, GLCA.4308, GLCA.5045, GLCA.5294, GLCA.6100, GLCA.6105, GLCA.9111).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Coles and G. Kittel

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References: Bourgeron and Engelking 1994, Bowns and West 1976, CNHP 2003, CNHP 2015, Clark et al. 2009, Cogan et al. 2004, Driscoll et al. 1984, Peterson 2008, Romme et al. 1993, Utah Environmental and Agricultural Consultants 1973, Warren et al. 1982, Western Ecology Working Group n.d.*, Wright 1980

[CEGL001332] *Coleogyne ramosissima* Shrubland

Translated Name: Blackbrush Shrubland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Coleogyne ramosissima* Colorado Plateau Shrubland Alliance (A3220)

Element Concept

Global Summary: This broadly defined, common shrubland association occurs in the Colorado Plateau, southern Great Basin, Mojave Desert, and Sierra Nevada foothills. The vegetation is characterized by an open to moderately dense short-shrub layer that is clearly dominated by the evergreen microphyllous shrub *Coleogyne ramosissima*, sometimes in nearly pure stands with a typically sparse herbaceous layer. Shrub cover is usually around 20%, although it can range as low as 5% or as high as 50%. Because it is a wide-ranging type, a variety of other shrub and dwarf-shrub species may be present with low cover, including *Acamptopappus sphaerocephalus, Ambrosia dumosa, Artemisia bigelovii, Artemisia filifolia, Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Ephedra funerea, Ephedra cutleri, Ephedra nevadensis, Ephedra torreyana, Ephedra viridis, Ericameria linearifolia, Ericameria teretifolia, Eriogonum corymbosum, Gutierrezia sarothrae, Gutierrezia microcephala, Krascheninnikovia lanata, Lycium* spp., *Menodora spinescens, Opuntia* spp., *Psorothamnus fremontii*, and *Yucca baccata*. Occasional *Juniperus* spp., *Pinus edulis*, or *Pinus monophylla* trees are present in some stands. The herbaceous layer generally includes only sparse cover of graminoids and forbs, except during wet years when cover of annuals may be high. Cover of the introduced annual *Bromus* spp. may be high in disturbed stands, but in general, the substrate does not support the growth of more than a trace of grasses. Stands are found on a variety of landforms. Sites are on level to steep slopes, rarely exceeding 45% and include all aspects. In southern Nevada, stands occur on lower foothills and upper bajadas, often with cooler northern and eastern aspects. In the Colorado Plateau, stands occupy alluvial fans, benches, canyon bottoms, hills, mesas, plains, plateaus, ridges, rims, sand dunes, sideslopes, terraces, valley bottom fill and colluvial slopes oriented to any aspect. Elevations range from 1065-2133 m (3500-7000 feet). Climate is temperate, continental, with hot summers and cold winters. The unvegetated surface is dominated by bare ground, except on some sandy sites, where biological soil crusts may provide more than 50% cover. Substrates range from barren shales to alluvium and eolian sands to broken limestone. Soils tend to be shallow, calcareous, sandy-textured on eolian sand sites, and clay-textured on shale sites. There is often a caliche subhorizon. Gravel, boulders and rock outcrops are common.

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Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland association occurs throughout the recreation area on alluvial fans, benches, canyon bottoms, hills, mesas, plains, plateaus, ridges, rims, sand dunes, sideslopes, terraces, and valley bottom fill. Sites are flat to steep (0-28° slopes), include all aspects, and lie between 1087 and 1851 m elevation. Bare soil and gravel cover most of the unvegetated surface, with lesser cover by sand, bedrock, litter, and large rocks. Depending on substrate, biological soil crust communities provide sparse to moderate cover. The soils are moderately well-drained to rapidly drained and fall into two **Group:**s: those derived from sandstones (from the Navajo, Dakota, or Entrada sandstones), colluvium, or coarse alluvial or eolian sands or those derived from shales (from the Carmel, Chinle, Kayenta, Moenkopi, or Morrison formations, or the Halgaito or Organ Rock shales). Texture varies accordingly, with loamy sands, sands, loams, and sandy loams in the former group, and silts, silt loams, silty clay loams, sandy clays, sandy clay loams, and clay loams in the shale group.

Global Environment: This broadly defined shrubland association occurs in the Colorado Plateau, southern Great Basin, Mojave Desert, and Sierra Nevada foothills in areas with hot summers and cold winters. Elevations range from 1065-2133 m (3500-7000 feet). Sites are frequently on level to moderate slopes rarely exceeding 20% but have also been found on steep slopes (>45%). In Nevada, stands occur on lower foothills and upper bajadas, often with cooler northern and eastern aspects. In the Colorado Plateau, stands occupy plateaus, ridges, dunes, alluvial fans, canyon rims, bench ledges valleys, plains, and colluvial slopes with any aspect. The upper elevation ecotones are generally narrow, and *Coleogyne ramosissima* may mix with *Artemisia* spp. or *Pinus edulis* and *Juniperus osteosperma*. The lower elevation ecotones tend to be broader, and *Coleogyne ramosissima* may mix with grasslands or with shrublands dominated by *Larrea tridentata, Ambrosia dumosa, Atriplex* spp., or *Grayia spinosa* (Beatley 1976). Stands described from the Colorado Plateau often occur in a mosaic with pinyon-juniper woodlands (Warren et al. 1982). The unvegetated surface is dominated by bare ground, except on some sandy sites, where biological soil crusts may provide more than 50% cover. Substrates range from barren shales to alluvium and eolian sands to broken limestone. Soils tend to be shallow, calcareous, sandy-textured on eolian sand sites, and clay soils on shale sites. There is often with a caliche subhorizon. Gravel, boulders and rock outcrops are common.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This is one of the most common and widespread associations in the recreation area. Total vegetation cover ranges from 5 to 38% and is characterized by an open short-shrub canopy of *Coleogyne ramosissima* (with 4-35% cover). Other shrubs present with lesser cover than *Coleogyne ramosissima* may include scattered individuals of *Ephedra torreyana, Atriplex confertifolia, Ephedra viridis, Ephedra cutleri, Ericameria nauseosa, Artemisia bigelovii, Psorothamnus fremontii, Acamptopappus sphaerocephalus, Eriogonum corymbosum, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Opuntia polyacantha*, and *Opuntia erinacea*. The herbaceous layer is usually sparse, but common species (usually present with only trace cover) include the grasses *Pleuraphis jamesii, Achnatherum hymenoides, Bouteloua gracilis, Bromus rubens*, and *Bromus tectorum*. Forbs vary from site to site and include *Xylorhiza tortifolia, Erodium cicutarium, Chaenactis stevioides, Sphaeralcea* spp., *Cryptantha crassisepala var. elachantha*, and

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Salsola tragus. Cryptogam cover is variable and may contribute up to 22% cover. Occasional *Juniperus osteosperma* trees are present in some stands.

Global Vegetation: This common association is characterized by an open to moderately dense short-shrub layer that is clearly dominated by the evergreen microphyllous shrub *Coleogyne ramosissima*. Shrub cover is usually around 20%, although it can range as low as 5% or as high as 50%. It can occur in almost pure stands. Other shrub and dwarf-shrub species may be present with low cover, including *Ambrosia dumosa, Artemisia filifolia, Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Ephedra funerea, Ephedra torreyana, Ephedra nevadensis, Ephedra viridis, Ericameria linearifolia, Ericameria teretifolia, Gutierrezia sarothrae, Gutierrezia microcephala, Krascheninnikovia lanata, Lycium* spp., *Menodora spinescens, Opuntia* spp., and *Yucca baccata*. Locally, disturbance may reduce abundance of *Coleogyne ramosissima* and favor *Artemisia filifolia* until it nearly codominates. Occasional *Juniperus* spp., *Pinus edulis*, or *Pinus monophylla* trees are present in some stands. The herbaceous layer generally includes only sparse cover of graminoids and forbs, except during wet years when cover of annuals may be high. Cover of the introduced annual *Bromus* spp. may be high in disturbed stands, but in general, the substrate does not support the growth of more than a trace of grasses. Forbs may include species of *Chaenactis, Cryptantha, Phacelia, Plantago*, and *Streptanthella*. Scattered *Juniperus osteosperma* may also be present.

Global Dynamics: *Coleogyne ramosissima* is very sensitive to fire because it does not resprout after burning, and seeds in the seed bank are short-lived and destroyed by fire (Bowns and West 1976, Wright 1980). Many stands are too sparse to burn, but if burned, *Coleogyne ramosissima* is slow to recolonize, often requiring more than 60 years to re-establish (Wright 1980). Burned-over areas convert to *Gutierrezia microcephala*- or *Artemisia tridentata*-dominated shrublands (Bowns and West 1976). Invasion of the introduced annual *Bromus* spp. creates a fire hazard and increases fire frequency (Warren et al. 1982).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*, *Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Short shrub/sapling	Succulent shrub	*Opuntia polyacantha*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*

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Characteristic Species

Glen Canyon National Recreation Area:

Global: *Atriplex canescens*, *Atriplex confertifolia*, *Coleogyne ramosissima*, *Ephedra nevadensis*, *Ephedra torreyana*, *Ephedra viridis*, *Gutierrezia microcephala*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low), *Salsola tragus*

Global: Vulnerable Plants: *Ephedra funerea* (G2G3), *Quercus havardii* var. *tuckeri* (G4T3?Q); Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High); Other Plants: *Opuntia* spp. (N/A, common associated shrub on sandy sites; includes *Opuntia erinacea*, *Opuntia polyacantha*, and *Opuntia phaeacantha*)

Conservation Status Rank

Global Rank & Reasons: G4G5 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Coleogyne ramosissima - Ephedra* spp. Warm Desert Shrubland (CEGL005297) is also dominated by *Coleogyne ramosissima* and is found on similar landforms, but the associate Ephedra spp. occur more frequently and with more cover.
- *Coleogyne ramosissima - Eriogonum fasciculatum* Shrubland (CEGL001333)
- *Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri* Shrubland (CEGL002348)
- *Coleogyne ramosissima - Purshia stansburiana* Shrubland (CEGL002720)
- *Coleogyne ramosissima - Thamnosma montana* Shrubland (CEGL002718)
- *Coleogyne ramosissima / Pleuraphis jamesii* Shrubland (CEGL001334)
- *Larrea tridentata - Coleogyne ramosissima* Shrubland (CEGL002717)
- *Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima* Woodland (CEGL000781)
- *Quercus turbinella - Coleogyne ramosissima* Shrubland (CEGL000982)

Global Related Concepts:

- 152.1311 *Coleogyne ramosissima - Ephedra viridis - Yucca baccata* (Warren et al. 1982) =
- *Coleogyne ramosissima - Ephedra nevadensis* Association (Peterson 1984a) =
- *Coleogyne ramosissima - Ephedra nevadensis* Shrubland (Ostler et al. 2000) =
- *Coleogyne ramosissima* (Sawyer et al. 2009) =
- *Coleogyne ramosissima* (Evens et al. 2014) =
- *Coleogyne ramosissima* (Bourgeron and Engelking 1994) =
- *Coleogyne ramosissima* Association (Annable 1985) **?**
- *Coleogyne ramosissima* Communities (Beatley 1976) >
- Blackbrush Plant Community (Armstrong 1969) =
- Blackbrush Type (Schultz et al. 1987) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >
- Desert Shrub (BIA 1979) >
- Mohavean Shrub (*Coleogyne*) Formation (Wells 1960) =

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Classification

Status: Standard
Classification Confidence: 1 - Strong
Global Classification Comments: This widespread plant association is defined by the strong dominance of *Coleogyne ramosissima* without diagnostic codominate shrubs or a developed herbaceous layer. It is similar to the broadly defined *Coleogyne ramosissima / Pleuraphis jamesii* Shrubland (CEGL001334) and is separated from it by the lack of a *Pleuraphis jamesii*-dominated herbaceous layer. In cases where the grass element is missing or is greatly reduced because of grazing and not because of edaphic factors, there is potential for misclassification of stands.

Element Distribution

Glen Canyon National Recreation Area Range: This very common shrubland grows in diverse habitats all throughout the recreation area. It was sampled in Andy Miller Flats, Big Spring Canyon, Bullfrog Bay, below Cedar Mesa, Clearwater Canyon, Clyde's Mesa, Deadhorse Canyon, east of The Spur, Ekker Butte, Fiftymile Bench, Grand Bench, Hall's Crossing, Head Spur, High Spur, Hole-in-the-Rock, Last Chance Creek, Lee's Ferry, Little Valley Canyon, Lone Rock Road, Millard Canyon Benches, south of Moqui Canyon, south of Muley Point, North Trail Canyon, Rainbow Bridge, Range Canyon, Rock Creek Bay, Sit Down Bench, Sooner Bench, Sunset Pass, above Tapestry Wall, The Gap, Wahweap, Water Canyon, Waterhole Flat, and Wilson Mesa.

Global Range: This widespread and common blackbrush shrubland association occurs in the Colorado Plateau, southern Great Basin, Mojave Desert, and Sierra Nevada foothills. It ranges from northern Arizona to Utah west to California and Nevada.

Nations: US
States/Provinces: AZ:S4, CA:S4, NV, UT:S4S5
TNC Ecoregions: 11:C, 12:C, 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Death Valley, Glen Canyon, Grand Canyon, Mojave, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: The terrain slopes gently away from the small mesa nearby to join the rolling land of the plateau. The soil is apparently quite deep here, and the blackbrush has taken over as only blackbrush can. There is some mature biocrust here, but it is scattered and spread out, resembling isolated structures rather than a continuous crust. Most of the moss is under the shrubs.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, 2012, and 2013 field data (59 plots): (Plots: GLCA.0310, GLCA.0313, GLCA.0314, GLCA.0336, GLCA.0537, GLCA.0540, GLCA.0551, GLCA.0593, GLCA.0709, GLCA.0720, GLCA.0733, GLCA.0734, GLCA.0736, GLCA.0761, GLCA.0770, GLCA.1006, GLCA.1021, GLCA.1037, GLCA.1038, GLCA.2021, GLCA.2022, GLCA.2036, GLCA.2046, GLCA.2081, GLCA.2097, GLCA.4005, GLCA.4041, GLCA.4141, GLCA.4146, GLCA.4210, GLCA.4212, GLCA.4223, GLCA.4281,

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GLCA.4284, GLCA.4347, GLCA.5003, GLCA.5007, GLCA.5028, GLCA.5030, GLCA.5043, GLCA.5111, GLCA.5153, GLCA.5252, GLCA.5255, GLCA.5264, GLCA.5269, GLCA.5274, GLCA.5320, GLCA.5321, GLCA.5436, GLCA.5559, GLCA.9103, GLCA.9105, GLCA.9107, GLCA.9513, GLCA.9704, GLCA.9705, GLCA.9706, RABR.5577).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and J. Coles
References: Annable 1985, Armstrong 1969, BIA 1979, Beatley 1976, Bourgeron and Engelking 1994, Bowns and West 1976, Bradley 1964, Callison et al. 1985, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2009a, Driscoll et al. 1984, Evens et al. 2014, Ostler et al. 2000, Peterson 1984a, Peterson 2008, Reid and Hall 2010, Romme et al. 1993, Sawyer et al. 2009, Schultz et al. 1987, Shields et al. 1959, Warren et al. 1982, Wells 1960, West 1983d, Western Ecology Working Group n.d.*, Wright 1980

A2644 Ephedra cutleri Shrubland Alliance
Alliance Summary Description: There is no description or data for this alliance. A review of the literature will be necessary when alliance descriptions are completed.

[CEPP005691] *Ephedra cutleri - Opuntia* spp. / Mixed Grass Shrub-Steppe
Translated Name: Cutler's Joint-fir - Prickly-pear species / Mixed Grass Shrub-Steppe
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Ephedra cutleri* Shrubland Alliance (A2644)

Element Concept

Global Summary: This shrub-steppe association is known from Glen Canyon National Recreation Area and likely occurs more widely in the Colorado Plateau. It is characterized by an open shrub canopy dominated or codominated by *Ephedra cutleri* (with up to 20% cover) and often codominated by *Opuntia* spp. (with up to 20% cover). The herbaceous layer is typically abundant with nearly equal cover to the shrub layer and is dominated by one or more of the following (mostly warm-season) native grasses: *Sporobolus* spp. (*Sporobolus cryptandrus, Sporobolus contractus, Sporobolus flexuosus*) (with up to 16% total cover), *Pleuraphis jamesii*, and *Achnatherum hymenoides*. If *Hesperostipa comata* is present, it is only with trace to 2% cover. Commonly associated shrubs include *Atriplex canescens, Coleogyne ramosissima, Ephedra torreyana, Gutierrezia* spp., *Psoralidium junceum, Psorothamnus fremontii*, and *Yucca angustissima*. Forb cover is typically sparse and is composed of weedy annuals, as well as native perennial species of *Amsonia, Eriogonum, Hymenopappus, Machaeranthera, Oenothera*, and *Sphaeralcea*. The exotic annual grasses *Bromus tectorum* and *Schismus barbatus* are present with low cover in some stands. Scattered *Pinus edulis* and *Juniperus osteosperma* trees may be present with sparse to low cover on the margins of the community. Total vegetation cover ranges from 45% down to 3% in areas with current grazing and/or past overgrazing.

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Stands occur on mesas, plains, benches, canyon sides, hills, sand dunes, basins, valley bottoms, and terraces between 1120 and 1923 m elevation. Sites are flat to moderately sloping and can occur on all aspects. Sand and bare soil cover most of the unvegetated surface, with lesser cover by dark cyanobacteria and moss, and sparse to low cover of litter. Soils are variable texture ranging from sand to sandy clay loams derived from eolian or older alluvial deposits, sandstones or shales.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrub herbaceous association occurs on mesas, plains, benches, canyon sides, hills, sand dunes, basins, valley bottoms, and terraces. Sites are flat to moderately sloping (up to 20°), oriented to all aspects, and lie between 1120 and 1923 m elevation. Sand and bare soil cover most of the unvegetated surface, with lesser cover by dark cyanobacteria and moss, and sparse to low cover of litter. Soils are well-drained to rapidly drained sands, loamy sands, loams, silt loams, and sandy clay loams derived from eolian or older alluvial deposits, sandstones of the Entrada, Cedar Mesa, Kayenta, or White Rim formations, or shales of the Carmel Formation.

Global Environment: This Colorado Plateau shrub-steppe occurs on mesas, plains, benches, canyon sides, hills, sand dunes, basins, valley bottoms, and terraces between 1120 and 1923 m elevation. Sites are flat to moderately sloping (up to 20°) and can occur on all aspects. Sand and bare soil cover most of the unvegetated surface, with lesser cover by dark cyanobacteria and moss, and sparse to low cover of litter. Soils are well-drained to rapidly drained sands, loamy sands, loams, silt loams, and sandy clay loams derived from eolian or older alluvial deposits, sandstones or shales.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This shrub herbaceous association has total vegetation cover of up to 45%, but may be as low as 3% in areas with current grazing and/or past overgrazing. The shrub canopy is dominated by *Ephedra cutleri* (with up to 20% cover) and often codominated by *Opuntia* spp. (with up to 20% cover). The grassy understory has nearly equal cover to the shrub layer and is dominated by one or more of the following (mostly warm-season) native grasses: *Sporobolus* spp. (*Sporobolus cryptandrus, Sporobolus contractus, Sporobolus flexuosus*) (with up to 16% total cover), *Pleuraphis jamesii* (with up to 8% cover), and *Achnatherum hymenoides* (with up to 4% cover). If *Hesperostipa comata* is present, it is only with trace to 2% cover. Commonly associated shrubs include *Atriplex canescens, Coleogyne ramosissima, Ephedra torreyana, Gutierrezia* spp., *Psoralidium junceum, Psorothamnus fremontii*, and *Yucca angustissima*. Other shrubs occasionally present include *Artemisia filifolia, Atriplex confertifolia, Chrysothamnus greenei, Krascheninnikovia lanata*, and *Vanclevea stylosa*. Forbs have sparse to low cover and include weedy annuals, such as *Ambrosia acanthicarpa, Lappula occidentalis, Plantago patagonica*, and *Salsola tragus*, as well as native perennials, such as *Amsonia tomentosa, Eriogonum inflatum, Hymenopappus filifolius, Machaeranthera canescens, Oenothera pallida*, and *Sphaeralcea* spp. The exotic annual grasses *Bromus tectorum* and *Schismus barbatus* are present with low cover in some stands. *Pinus edulis* and *Juniperus osteosperma* trees may have sparse to low cover on the margins of the community.

Global Vegetation: This shrub-steppe association is characterized by an open shrub canopy dominated or codominated by *Ephedra cutleri* (with up to 20% cover) and often codominated by

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Opuntia spp. The herbaceous layer is typically abundant with nearly equal cover to the shrub layer and is dominated by one or more of the following (mostly warm-season) native grasses: *Sporobolus* spp. (*Sporobolus cryptandrus, Sporobolus contractus, Sporobolus flexuosus*), *Pleuraphis jamesii*, and *Achnatherum hymenoides*. If present *Hesperostipa comata* has only trace to 2% cover. Commonly associated shrubs include *Atriplex canescens, Coleogyne ramosissima, Ephedra torreyana, Gutierrezia* spp., *Psoralidium junceum, Psorothamnus fremontii*, and *Yucca angustissima*. Other shrubs occasionally present include *Artemisia filifolia, Atriplex confertifolia, Chrysothamnus greenei, Krascheninnikovia lanata*, and *Vanclevea stylosa*. Forb cover is typically sparse and is composed of weedy annuals, such as *Ambrosia acanthicarpa, Lappula occidentalis, Plantago patagonica*, and exotic *Salsola tragus*, as well as native perennials, such as *Amsonia tomentosa, Eriogonum inflatum, Hymenopappus filifolius, Machaeranthera canescens, Oenothera pallida*, and *Sphaeralcea* spp. The exotic annual grasses *Bromus tectorum* and *Schismus barbatus* are present with low cover in some stands. Scattered *Pinus edulis* and *Juniperus osteosperma* trees may be present with sparse to low cover on the margins of the community. Total vegetation cover ranges from 45% down to 3% in areas with current grazing and/or past overgrazing.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*
Short shrub/sapling	Succulent shrub	*Opuntia* spp.
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Pleuraphis jamesii*, *Sporobolus cryptandrus*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*
Short shrub/sapling	Succulent shrub	*Opuntia* spp.
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Pleuraphis jamesii*, *Sporobolus contractus*, *Sporobolus cryptandrus*, *Sporobolus flexuosus*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Ephedra cutleri*, *Opuntia* spp.

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*, *Schismus barbatus* (High/Medium)

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*, *Schismus barbatus* (High/Medium)

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Conservation Status Rank

Global Rank & Reasons: GNR (18-Aug-2016).

Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak

Element Distribution

Glen Canyon National Recreation Area Range: This common shrubland was sampled near in Rock Creek Bay, The Cove, Grand Gulch/Waterpocket Fold, Range Canyon, Cottonwood Canyon, Calf Canyon, Wagon Box Canyon, Twentyfive Mile Wash, on Muley Point, Alstrom Point, Waterhole Flat, Andy Miller Flats, Ticaboo Mesa, Cane Springs Desert, Hoskinnini Mesa, near The Rincon, Lone Rock Road, the Escalante River, above Clearwater Canyon and Horsethief Canyon.

Global Range: This shrub-steppe association is known from Glen Canyon National Recreation Area and likely occurs more widely in the Colorado Plateau.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Developed loam soil, not sand, in shallow basin surrounded by higher elevation segments in all directions. Appears to catch runoff/sediment from the south. This appears to have been heavily grazed in the past, an influence on what survives here now.

Glen Canyon National Recreation Area Plots: The description is based on 2014 and 2015 field data (11 plots, 16 accuracy assessment points): (GLCA.1034, GLCA.2009, GLCA.4228, GLCA.4263, GLCA.4264, GLCA.5039, GLCA.5293, GLCA.5310, GLCA.5314, GLCA.6114, GLCA.9313; AA Points: GLCA_AA.0014, GLCA_AA.0057, GLCA_AA.0058, GLCA_AA.0079, GLCA_AA.0093, GLCA_AA.1024, GLCA_AA.1028, GLCA_AA.1045, GLCA_AA.1056, GLCA_AA.1145, GLCA_AA.1262, GLCA_AA.1359, GLCA_AA.1566, GLCA_AA.1568, GLCA_AA.2074, GLCA_AA.3088).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEPP005689] Ephedra cutleri / Achnatherum hymenoides - Muhlenbergia pungens - Oenothera pallida Sandsheet Shrubland

Translated Name: Cutler's Joint-fir / Indian Ricegrass - Sandhill Muhly - Pale Evening-primrose Sandsheet Shrubland

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Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Ephedra cutleri* Shrubland Alliance (A2644)

Element Concept

Global Summary: This sandsheet shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely in the Colorado Plateau. It is characterized by an open shrub canopy dominated by *Ephedra cutleri* (with 5 to 14% cover) with an abundant herbaceous layer. Associated shrubs present with sparse to low cover may include *Coleogyne ramosissima, Gutierrezia sarothrae, Eriogonum leptocladon, Psoralidium junceum, Psorothamnus fremontii, Vanclevea stylosa*, and *Yucca angustissima*. The herbaceous layer is moderately dense and is dominated by sand-loving plants such as *Achnatherum hymenoides, Muhlenbergia pungens*, and/or *Oenothera pallida*. Other native grass species may be present with sparse to low cover, including *Bouteloua gracilis, Sporobolus contractus*, and *Sporobolus cryptandrus*. Forbs have sparse to low cover and are dominated by weedy annuals, such as *Ambrosia acanthicarpa, Descurainia pinnata, Dicoria canescens, Plantago patagonica*, and *Salsola tragus*; native perennial forbs *Amsonia tomentosa, Dalea candida, Cryptantha* spp., *Helianthus annuus, Hymenopappus filifolius, Machaeranthera canescens*, and *Sphaeralcea ambigua* are present with more than trace cover. This shrubland has total vegetation cover between 17 and 40%. This dune-like shrubland association occurs on dunefields and mesatops generally between 1113 and 1176 m elevation although occasionally extending to 1780 m elevation. Sites are gently to moderately sloping and occur on cooler north and east aspects. Sand and bare soil cover most of the unvegetated surface. Soils are sands derived from eolian deposits or sandstones.

Environmental Description

Glen Canyon National Recreation Area Environment: This dune-like shrubland association occurs on dunefields and mesatops that are gently to moderately sloping (up to 12°), oriented mainly to the north and east, and lie between 1113 and 1303 m elevation (though one plot was sampled at 1780 m elevation). Sand and bare soil cover most of the unvegetated surface, with lesser cover by dark cyanobacteria, gravel, and litter. Soils are sands derived from eolian deposits or sandstones of the Navajo Formation.

Global Environment: This sandsheet shrubland association occurs in the Colorado Plateau on dunefields and mesatops generally between 1113 and 1176 m elevation (rarely extending to 1780 m elevation). Sites are gently to moderately sloping (up to 12°) and occur on cooler north and east aspects. Sand and bare soil cover most of the unvegetated surface, with lesser cover by dark cyanobacteria, gravel, and litter. Soils are sands derived from eolian deposits or sandstones.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sandsheet shrubland has total vegetation cover between 17 and 40%. The shrub canopy is dominated by *Ephedra cutleri* (with 5 to 14% cover).

Associated shrubs with sparse to low cover may include *Coleogyne ramosissima, Gutierrezia sarothrae, Eriogonum leptocladon, Psoralidium junceum, Psorothamnus fremontii, Vanclevea stylosa*, and *Yucca* spp. The moderately herbaceous understory is dominated by one or more of the following: *Achnatherum hymenoides* (absent to 8% cover), *Muhlenbergia pungens* (absent to 3% cover), and/or *Oenothera pallida* (absent to 14% cover). Other native grass species may be present with sparse to low cover, including *Bouteloua gracilis, Pleuraphis jamesii, Sporobolus contractus*, and *Sporobolus cryptandrus*. Forbs have sparse to low cover and are dominated by weedy annuals, such as *Ambrosia acanthicarpa, Descurainia pinnata, Dicoria canescens, Helianthus annuus, Plantago patagonica*, and *Salsola tragus*; native perennial forbs *Amsonia tomentosa, Dalea candida, Cryptantha* spp., *Hymenopappus filifolius, Machaeranthera canescens*, and *Sphaeralcea ambigua* are present with more than trace cover.

Global Vegetation: This sandsheet shrubland association is characterized by an open shrub canopy dominated by *Ephedra cutleri* (with 5 to 14% cover) with an abundant herbaceous layer. Associated shrubs may be present with sparse to low cover may include *Coleogyne ramosissima, Gutierrezia sarothrae, Eriogonum leptocladon, Psoralidium junceum, Psorothamnus fremontii, Vanclevea stylosa*, and *Yucca angustissima*. The herbaceous layer is moderately dense and is dominated by sand-loving plants *Achnatherum hymenoides, Muhlenbergia pungens*, and/or *Oenothera pallida*. Other native grass species may be present with sparse to low cover, including *Bouteloua gracilis, Sporobolus contractus*, and *Sporobolus cryptandrus*. Forbs have sparse to low cover and are dominated by weedy annuals, such as *Ambrosia acanthicarpa, Descurainia pinnata, Dicoria canescens, Helianthus annuus, Plantago patagonica*, and *Salsola tragus*; native perennial forbs *Amsonia tomentosa, Dalea candida, Cryptantha* spp., *Hymenopappus filifolius, Machaeranthera canescens*, and *Sphaeralcea ambigua* are present with more than trace cover. This shrubland has total vegetation cover between 17 and 40%.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*
Herb (field)	Flowering forb	*Oenothera pallida*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Muhlenbergia pungens*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*
Herb (field)	Flowering forb	*Oenothera pallida*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Muhlenbergia pungens*

Characteristic Species

Glen Canyon National Recreation Area:

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Global: *Achnatherum hymenoides*, *Ephedra cutleri*, *Muhlenbergia pungens*, *Oenothera pallida*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Global: Invasive/Exotic Plants: *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: GNR (18-Aug-2016).

Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon shrubland was sampled near Halls Creek Bay, on Hoskinnini Mesa, north of Hans Flat, and east of Ferry Swale.

Global Range: This sandsheet shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely in the Colorado Plateau.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: None available.
Glen Canyon National Recreation Area Plots: The description is based on 2014 and 2015 field data (8 accuracy assessment points): (AA Points: GLCA_AA.0024, GLCA_AA.0319, GLCA_AA.0321, GLCA_AA.1036, GLCA_AA.1049, GLCA_AA.1055, GLCA_AA.1285, GLCA_AA.1596).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEGL005804] *Ephedra cutleri* Shrubland
Translated Name: Cutler's Joint-fir Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)

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Subset: GLCA; Glen Canyon National Recreation Area

Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Ephedra cutleri* Shrubland Alliance (A2644)

Element Concept

Global Summary: This sandsheet association occurs in the Colorado Plateau and was sampled in Glen Canyon National Recreation Area in southern Utah and northern Arizona. This open shrubland is dominated by *Ephedra cutleri*, with 4-25% cover. Stands tend to be homogenous, though occasionally *Coleogyne ramosissima, Gutierrezia sarothrae, Opuntia phaeacantha, Vanclevea stylosa*, and *Yucca angustissima* may be present with sparse to low cover. The understory is typically poorly developed with weedy species such as *Bromus tectorum, Grindelia fastigiata*, and *Salsola tragus*. Stands occur on gently sloping hills, sideslopes, and mesatops at elevations ranging from 1112 to 1599 m. Sand and bare soil cover most of the unvegetated surface, with lesser cover by litter and gravel. Soils are rapidly drained sands and loamy sands derived from Dakota or Navajo sandstones or from eolian deposits.

Environmental Description

Glen Canyon National Recreation Area Environment: These sandsheet shrublands occur on gently sloping (up to 6°) hills, sideslopes, and mesatops at elevations ranging from 1112 to 1599 m. Sand and bare soil cover most of the unvegetated surface, with lesser cover by litter, biological soil crusts, and gravel. Soils are rapidly drained sands and loamy sands derived from Dakota or Navajo sandstones or from eolian deposits.

Global Environment: Stands occur on gently sloping hills, sideslopes, and mesatops at elevations ranging from 1112 to 1599 m. Sand and bare soil cover most of the unvegetated surface, with lesser cover by litter and gravel. Soils are rapidly drained sands and loamy sands derived from Dakota or Navajo sandstones or from eolian deposits.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: These open shrublands (8-50% total cover) are dominated by *Ephedra cutleri*, with 4-25% cover. Stands tend to be homogenous, though occasionally *Coleogyne ramosissima, Gutierrezia sarothrae, Opuntia phaeacantha, Opuntia macrorhiza, Vanclevea stylosa*, and *Yucca angustissima* may be found in the shrub layer with sparse to low cover. The understory is poorly developed and weedy, with signs of cattle grazing evident; *Bromus tectorum, Grindelia fastigiata, Rumex hymenosepalus, Plantago patagonica* (20% cover in one stand), and *Salsola tragus* were the only species noted with more than trace cover.

Global Vegetation: This open shrubland is dominated by *Ephedra cutleri*, with 4-25% cover. Stands tend to be homogenous, though occasionally *Coleogyne ramosissima, Gutierrezia sarothrae, Opuntia phaeacantha, Vanclevea stylosa*, and *Yucca angustissima* may be present with sparse to low cover. The understory is typically poorly developed with weedy species such as *Bromus tectorum, Grindelia fastigiata*, and *Salsola tragus*.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Ephedra cutleri*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Grindelia fastigiata* (G3), *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Global: Vulnerable Plants: *Grindelia fastigiata* (G3), *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: GNR (7-Oct-2004).

Related Concepts

Classification

Status: Provisional
Classification Confidence:
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This sandsheet shrubland was sampled on Andy Miller Flats, Wilson Mesa, near Wahweap Bay, in the Waterpocket Fold area, and east of Ferry Swale.

Global Range: This association occurs in the Colorado Plateau and was sampled in Glen Canyon National Recreation Area in southern Utah and northern Arizona. More survey is needed to determine its full extent.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC
Federal Lands: NPS (Glen Canyon)

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Element Sources

Glen Canyon National Recreation Area Inventory Notes: This is a low, open valley with sandy soil, no canopy, and with a history of grazing. Deep sand, mounds of *Ephedra*.

Glen Canyon National Recreation Area Plots: The description is based on 2013 and 2015 field data (2 plots, 4 accuracy assessment points): (Plots: GLCA.5317, GLCA.5566; AA Points: GLCA_AA.1476, GLCA_AA.1601, GLCA_AA.1602, GLCA_AA.3029).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

A2572 Ephedra torreyana Shrubland Alliance

Alliance Summary Description: The vegetation is characterized by an open canopy of *Ephedra torreyana* shrubs. Stands range from less than <10 to 75% total vegetation cover and range in structure from shrub-herbaceous (steppe) to shrublands. Vegetation composition is dominated or codominated by *Ephedra torreyana* that ranges between 2 and 25% cover. Associated shrubs and cacti include *Atriplex canescens, Atriplex confertifolia, Echinocereus triglochidiatus, Gutierrezia sarothrae, Opuntia polyacantha*, and *Yucca harrimaniae*. *Coleogyne ramosissima* is absent or has low cover. If present, the understory may include a sparse to moderately dense herbaceous layer composed mostly of dry grasses, such as *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii, Sporobolus airoides*, and *Sporobolus flexuosus*, with low cover of forbs. This alliance includes semi-desert shrublands from the Colorado Plateau region of eastern Utah and northern Arizona between 1220 and 2000 m elevation. Stands occur in large patches on broad sandy plains, as well as in smaller patches on knolls, toeslope pediments, and a mesa capped with basalt boulders. Sites are flat to gentle (up to 10% slope) and occur on all aspects, although it often is found on warmer south- or west-facing slopes. The unvegetated surface has up to 90% exposure of sand, bare soil, cinder, large and small rocks or gravel. Litter cover is generally low. Soils are rapidly drained to well-drained loamy sands to sandy clays derived from basalt, cinder, sandstone or shales.

[CEPP005690] Ephedra (torreyana, viridis) - Psorothamnus fremontii Shrubland
Translated Name: (Torrey's Joint-fir, Mormon-tea) - Fremont's Smokebush Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Ephedra torreyana* Shrubland Alliance (A2572)

Element Concept

Global Summary: This shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely in the Colorado Plateau. It is characterized by a sparse to open shrub canopy dominated by one or more of the following *Ephedra* species: *Ephedra cutleri, Ephedra viridis*,

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and/or *Ephedra torreyana*, and codominated by *Psorothamnus fremontii*. A variety of associated shrubs may be present with sparse to low cover. The herbaceous layer is highly variable, ranging from sparse to codominant with the shrub layer. This could be a result of overgrazing and/or related to the underlying substrate and environmental setting. The sparse to moderately dense herbaceous understory is generally dominated by *Achnatherum hymenoides, Sporobolus cryptandrus, Sporobolus contractus,* and *Sporobolus flexuosus*. Weedy, annual grasses may have low to moderate cover as well, including *Bouteloua barbata, Vulpia octoflora (= Festuca octoflora),* and exotic *Bromus rubens, Bromus tectorum,* and *Schismus barbatus*. Forbs have sparse to low cover of native perennials, as well as the weedy annuals. Total vegetation cover is highly variable, ranging from 42% down to 3% in areas that lack herbaceous cover. Stands occur on dunefields, sand dunes, plateaus, mesas, benches, hills, canyon or valley sides, sideslopes, slumps, alluvial fans, and valley bottoms between 1106 and 1433 m elevation. Sites are gently to steeply sloping and occur on all aspects. Sites may be sandy or gravelly with high cover of bare soil. Soils are variable in texture ranging from sand to clay loam and are derived from eolian or alluvial deposits, sandstone, or shale parent material.

Environmental Description

Glen Canyon National Recreation Area Environment: This common shrubland association occurs on dunefields, sand dunes, plateaus, mesas, benches, hills, canyon or valley sides, sideslopes, slumps, alluvial fans, and valley bottoms. Sites are gently to steeply sloping (up to 32°), oriented to all aspects, and lie between 1106 and 1433 m elevation. Sites may be sandy or gravelly. Bare soil covers most of the unvegetated surface, with lesser cover by gravel and sand, and sparse to low cover of litter, large rocks, bedrock, dark cyanobacteria, and moss. Soils are moderately well-drained to rapidly drained sands, loamy sands, loams, sandy loams, silt loams, and clay loams derived from eolian or alluvial deposits, sandstones of the Navajo or Kayenta formations, or shales of the Carmel or Chinle formations.

Global Environment: This Colorado Plateau shrubland association occurs on dunefields, sand dunes, plateaus, mesas, benches, hills, canyon or valley sides, sideslopes, slumps, alluvial fans, and valley bottoms between 1106 and 1433 m elevation. Sites are gently to steeply sloping (up to 32°) and occur on all aspects. Sites may be sandy or gravelly. Bare soil covers most of the unvegetated surface, with lesser cover by gravel and sand, and sparse to low cover of litter, large rocks, bedrock, dark cyanobacteria, and moss. Soils are moderately well-drained to rapidly drained with a variable texture ranging from sand to clay loam. Substrates are derived from eolian or alluvial deposits, sandstones, or shales.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Total vegetation cover in this shrubland association does not exceed 42% and may be as low as 3% in areas with active grazing or past overgrazing; this variation is mostly attributable to the amount of herbaceous cover in the understory. The shrub canopy is dominated by one or more of the following *Ephedra* species: *Ephedra cutleri* (with 2-10% cover), *Ephedra viridis* (with 1-7% cover), and/or *Ephedra torreyana* (with 1-5% cover) and codominated by *Psorothamnus fremontii* (with 1-10% cover). Associated shrubs with sparse to low cover may include *Artemisia filifolia, Atriplex canescens, Coleogyne ramosissima,*

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Chrysothamnus viscidiflorus, Eriogonum leptocladon, Ericameria nauseosa, Glossopetalon spinescens, Gutierrezia spp., *Lycium andersonii, Opuntia polyacantha, Psoralidium junceum, Vanclevea stylosa,* and *Yucca angustissima*. The understory is highly variable, ranging from sparse to nearly codominant cover with the shrub layer. This could be a result of overgrazing and/or related to the underlying substrate and environmental setting. The sparse to moderately herbaceous understory is generally dominated by one or more of the following: *Achnatherum hymenoides, Sporobolus cryptandrus, Sporobolus contractus,* and *Sporobolus flexuosus*; however, *Hesperostipa comata* and *Pleuraphis jamesii* may also be present. Weedy, annual grasses may have low to moderate cover as well, including *Bouteloua barbata, Bromus rubens, Bromus tectorum, Vulpia octoflora (= Festuca octoflora),* and *Schismus barbatus*. Forbs have sparse to low cover and include *Abronia fragrans, Amsonia tomentosa, Dalea* spp., *Eriogonum inflatum, Hymenopappus filifolius, Lepidium montanum, Machaeranthera canescens, Oenothera* spp., *Sphaeralcea* spp., *Streptanthella longirostris*, and *Tiquilia latior*, as well as the weedy annuals *Erodium cicutarium* and *Mentzelia multiflora*.

Global Vegetation: This shrubland association is characterized by a sparse to open shrub canopy dominated by one or more of the following *Ephedra* species: *Ephedra cutleri, Ephedra viridis,* and/or *Ephedra torreyana* and codominated by *Psorothamnus fremontii*. Associated shrubs with sparse to low cover may include *Artemisia filifolia, Atriplex canescens, Coleogyne ramosissima, Chrysothamnus viscidiflorus, Eriogonum leptocladon, Ericameria nauseosa, Glossopetalon spinescens, Gutierrezia* spp., *Lycium andersonii, Opuntia polyacantha, Psoralidium junceum, Vanclevea stylosa,* and *Yucca angustissima*. The herbaceous layer is highly variable, ranging from sparse to codominant cover with the shrub layer. This could be a result of overgrazing and/or related to the underlying substrate and environmental setting. The sparse to moderately herbaceous understory is generally dominated by *Achnatherum hymenoides, Sporobolus cryptandrus, Sporobolus contractus*, and *Sporobolus flexuosus*. *Hesperostipa comata* and *Pleuraphis jamesii* may also be present. Weedy, annual grasses may have low to moderate cover as well, including *Bouteloua barbata, Bromus rubens, Bromus tectorum, Vulpia octoflora (= Festuca octoflora),* and *Schismus barbatus*. Forbs have sparse to low cover and include *Abronia fragrans, Amsonia tomentosa, Dalea* spp., *Eriogonum inflatum, Hymenopappus filifolius, Lepidium montanum, Machaeranthera canescens, Oenothera* spp., *Sphaeralcea* spp., *Streptanthella longirostris*, and *Tiquilia latior*, as well as the weedy annuals *Erodium cicutarium* and *Mentzelia multiflora*. Total vegetation cover does not exceed 42% and may be as low as 3% in areas with active grazing or past overgrazing that reduced the herbaceous cover.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Psorothamnus fremontii*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*, *Ephedra torreyana*, *Ephedra viridis*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Sporobolus* spp.

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Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Psorothamnus fremontii*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*, *Ephedra torreyana*, *Ephedra viridis*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Sporobolus contractus*, *Sporobolus cryptandrus*, *Sporobolus flexuosus*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Ephedra cutleri*, *Ephedra torreyana*, *Ephedra viridis*, *Psorothamnus fremontii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low), *Salsola tragus*, *Schismus barbatus* (High/Medium)

Global: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low), *Schismus barbatus* (High/Medium)

Conservation Status Rank

Global Rank & Reasons: GNR (18-Aug-2016).

Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak

Element Distribution

Glen Canyon National Recreation Area Range: This common shrubland was sampled in Stanton Canyon, Cottonwood Canyon, Fiftymile Canyon, Coyote Gulch, Sooner Gulch, White Canyon, Forgotten Canyon, Trachyte Canyon, Fourmile Canyon, North Wash, Millers Creek, on Brown's Rim, Hoskinnini Mesa, Sooner Bench, Wilson Mesa, Cane Springs Desert, near Bullfrog Bay, Hole-in-the-Rock, Hall's Crossing, northeast of Bullfrog, and across from Good Hope Mesa.

Global Range: This shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely in the Colorado Plateau.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

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Element Sources

Glen Canyon National Recreation Area Inventory Notes: A layer of gravel and some crust covers the ground, keeping the sandy soil in place. Fairly duney, but most of the surface sand is stabilized by plants, small gravel, and a very light crust layer. Fairly dynamic local topography with a series of dunes and shallow drainage channels, which do not majorly effect vegetation.

Glen Canyon National Recreation Area Plots: The description is based on 2012, 2013, and 2015 field data (23 plots, 10 accuracy assessment points): (Plots: GLCA.4109, GLCA.4125, GLCA.4140, GLCA.4244, GLCA.4248, GLCA.4278, GLCA.4335, GLCA.5026, GLCA.5075, GLCA.5200, GLCA.5220, GLCA.5251, GLCA.5256, GLCA.5259, GLCA.5283, GLCA.5401, GLCA.5504, GLCA.5509, GLCA.5551, GLCA.5552, GLCA.6233, GLCA.6234, GLCA.6235; AA Points: GLCA_AA.1023, GLCA_AA.1032, GLCA_AA.1039, GLCA_AA.1051, GLCA_AA.1059, GLCA_AA.1335, GLCA_AA.1662, GLCA_AA.1663, GLCA_AA.1965, GLCA_AA.3099).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEGL005801] Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation
Translated Name: Torrey's Joint-fir - (Fourwing Saltbush, Shadscale Saltbush) Sparse Vegetation
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Ephedra torreyana* Shrubland Alliance (A2572)

Element Concept

Global Summary: This sparsely vegetated association is widely distributed in southern Utah and northern Arizona. This scrub is characterized by low cover of *Ephedra torreyana* with between 1 and 5% cover, usually accompanied by *Atriplex confertifolia* and/or *Atriplex canescens* as codominant species. Other associated shrubs contribute little cover. The herbaceous layer is diverse but contributes only sparse to low cover. Graminoids commonly present include *Pleuraphis jamesii, Achnatherum hymenoides,* and *Bromus tectorum*. Forbs are highly variable in composition and include *Eriogonum inflatum, Tiquilia latior, Sphaeralcea leptophylla, Stanleya pinnata, Amsonia tomentosa, Sphaeralcea parvifolia, Abronia fragrans,* and *Chamaesyce fendleri*. It occurs on a broad range of depositional and erosional landforms, including alluvial fans, benches, dunes, canyon bottoms, stream terraces, ledges, badlands, canyon rims, colluvial slopes, toeslopes, hillsides, ridges, mesas, and plateaus. Slopes range from flat to steep at elevations from 1043 to 1603 m. Substrates vary from rapidly drained clay soils to sand derived from colluvium or alluvium, riverine and basaltic cobbles, and sandstone bluffs.

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Environmental Description

Glen Canyon National Recreation Area Environment: This sparsely vegetated association occurs on a broad range of depositional and erosional landforms, including alluvial fans, arroyos, bajadas, benches, basins, dunes, canyon bottoms and sides, stream terraces, badlands, talus/colluvial slopes, toeslopes, hillsides, ridges, mesas, plains, and valley bottoms. Sites are flat to moderately steep (0-25° slopes) and occur on all aspects between 1043 m and 1620 m elevation. Bare soil or gravel cover most of the unvegetated surface, with lesser cover by sand and large rocks, and absent to moderate cover of biological soil crusts. Soils are moderately well-drained to rapidly drained and variable in texture from loams (clay loam, silty clay loam, silt loam, sandy clay loam, sandy loam) to sands (and loamy sands) with an occasional silt or sandy clay present. Soils are derived from eolian, alluvial, or talus/colluvial deposits, from sandstones of the Cedar Mesa Formation, or from shales of the Carmel, Chinle, Moenkopi, Organ Rock, or Morrison formations.

Global Environment: This sparsely vegetated association occurs on a broad range of depositional and erosional landforms, including alluvial fans, benches, dunes, canyon bottoms, stream terraces, ledges, badlands, canyon rims, colluvial slopes, toeslopes, hillsides, ridges, mesas, and plateaus. Slopes range from flat to steep (0-60% slopes) on all aspects at elevations from 1043 to 1603 m. Substrates vary from rapidly drained clay soils to sand derived from colluvium or alluvium, riverine and basaltic cobbles, and sandstone bluffs. Bare soil or gravel cover most of the unvegetated surface, with lesser cover by litter, large rocks and biological soil crusts. Parent materials include sandstones of the Cedar Mesa Formation, or from shales of the Carmel, Chinle, Moenkopi, Organ Rock, or Morrison formations.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse mixed desert shrubland is common and distributed widely throughout the recreation area. Total vegetation cover ranges from 1 to 9%, with one stand having total cover of 17%. The open shrub canopy is dominated by *Ephedra torreyana* with between trace and 6% cover, usually accompanied by *Atriplex confertifolia* and/or *Atriplex canescens* as codominant species, with trace to 4% cover. Other associated shrubs with trace to very low cover include *Artemisia bigelovii, Picrothamnus desertorum (= Artemisia spinescens), Atriplex gardneri, Ericameria nauseosa var. juncea, Coleogyne ramosissima, Eriogonum corymbosum, Lycium andersonii, Psorothamnus fremontii, Psorothamnus thompsoniae, Xylorhiza tortifolia, Opuntia erinacea, Opuntia polyacantha, Gutierrezia sarothrae, Gutierrezia microcephala,* and *Yucca angustissima*. The herbaceous layer may be diverse but contributes only sparse to low cover. Graminoids commonly present include *Pleuraphis jamesii, Sporobolus* spp., *Achnatherum hymenoides, Aristida purpurea, Vulpia octoflora, Dasyochloa pulchella, Schismus barbatus, Bromus rubens,* and *Bromus tectorum*. Forbs are highly variable in composition and include *Eriogonum inflatum, Mentzelia albicaulis, Lepidium montanum, Cryptantha crassisepala var. elachantha, Astragalus* spp., *Amsonia tomentosa, Oenothera* spp., *Phacelia crenulata, Stephanomeria pauciflora, Sphaeralcea* spp., *Tiquilia latior,* and *Salsola tragus*. Biological soil crust cover is variable, with some stands having none, but cover can be as high as 50%.

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Global Vegetation: Total vegetation cover ranges from less than 1 to 17% and is characterized by sparsely distributed shrubs. The typical dominant species is *Ephedra torreyana* with between 1 and 5% cover, usually accompanied by *Atriplex confertifolia* and/or *Atriplex canescens* which may be absent, codominant or occasionally dominant. Other associated shrubs never contribute more than 5% cover and include *Artemisia filifolia, Ericameria nauseosa, Coleogyne ramosissima, Eriogonum corymbosum, Gutierrezia sarothrae, Xylorhiza tortifolia, Opuntia erinacea, Opuntia polyacantha, Fallugia paradoxa, Gutierrezia microcephala*, and *Sclerocactus whipplei*. Herbaceous species can be few to diverse and contribute only sparse to low cover. Graminoids commonly present include *Pleuraphis jamesii, Achnatherum hymenoides, Muhlenbergia porteri*, and *Bromus tectorum*. Forbs are highly variable in composition and include *Eriogonum inflatum, Tiquilia latior, Sphaeralcea leptophylla, Stanleya pinnata, Amsonia tomentosa, Sphaeralcea parvifolia, Abronia fragrans*, and *Chamaesyce fendleri*. Biological soil crust cover is variable, with some stands having none, but cover can be as high as 59%.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*, *Coleogyne ramosissima*, *Ericameria nauseosa* var. *juncea*, *Psorothamnus fremontii*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*, *Ephedra torreyana*
Herb (field)	Flowering forb	*Eriogonum inflatum*
Herb (field)	Graminoid	*Bromus rubens*, *Bromus tectorum*, *Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*, *Ephedra torreyana*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex canescens, Atriplex confertifolia, Ephedra torreyana*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Ericameria nauseosa* var. *juncea* (G5T3T4), *Psorothamnus thompsoniae* (G3?); Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High), *Salsola paulsenii* (Low), *Salsola tragus, Schismus barbatus* (High/Medium)

Global: Vulnerable Plants: *Ericameria nauseosa* var. *juncea* (G5T3T4), *Psorothamnus thompsoniae* (G3?), *Sclerocactus whipplei* (G2G3), *Tiquilia latior* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High)

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Conservation Status Rank

Global Rank & Reasons: GNR (29-Aug-2002).

Related Concepts

Global Similar Types:

- *Artemisia bigelovii - Ephedra (viridis, torreyana)* Talus Shrubland (CEGL003755)
- *Atriplex canescens / Pleuraphis jamesii* Shrubland (CEGL001288) also supports both *Ephedra torreyana* and *Atriplex canescens*, but *Ephedra torreyana* is not dominant in the short-shrub layer.
- *Ephedra torreyana - Opuntia basilaris* Shrubland (CEGL005107)
- *Ephedra torreyana* Sparse Vegetation (CEGL002353)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This sparsely vegetated association is common and widely distributed within the recreation area. It was sampled in Big Water Canyon, Blue Notch Canyon, Deadhorse Canyon, Coyote Gulch, Farley Canyon, Elaterite Basin, Forgotten Canyon, Fourmile Canyon, Red Canyon, and Stanton Canyon, on Brown's Rim, Ekker Butte, Hall Mesa, Millard Canyon Benches, Muley Point, and Sit Down Bench, near Bullfrog, Buttes of the Cross, Clay Hills Crossing, upper Dirty Devil River, Hall's Crossing, Lee's Ferry, and Warm Creek area.

Global Range: This sparsely vegetated association is widely distributed locally in Canyonlands National Park and Glen Canyon National Recreation Area in southeastern Utah; and Chaco Culture National Historic Park, Grand Canyon National Park, and Wupatki National Monument in northern Arizona.

Nations: US
States/Provinces: AZ, NM, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 341B:CC
Federal Lands: NPS (Canyonlands, Chaco Culture, Glen Canyon, Grand Canyon, Wupatki)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This community grows on clay soils with a flakey rocky surface and a hard pan layer about 10 cm below the surface - classic Moenkopi conditions that are extensive in this area. Rocky surface has stabilized the soil surface and no doubt facilitates sheet erosion. A hot, dry place.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, 2012, and 2013 field data (49 plots): (Plots: GLCA.0114, GLCA.0121, GLCA.0123, GLCA.0124, GLCA.0125, GLCA.0129, GLCA.0320, GLCA.0535, GLCA.0727, GLCA.0731, GLCA.0737, GLCA.1023,

GLCA.1024, GLCA.2032, GLCA.4030, GLCA.4031, GLCA.4061, GLCA.4099, GLCA.4100, GLCA.4101, GLCA.4111, GLCA.4113, GLCA.4119, GLCA.4121, GLCA.4144, GLCA.4145, GLCA.5012, GLCA.5073, GLCA.5078, GLCA.5089, GLCA.5090, GLCA.5093, GLCA.5103, GLCA.5131, GLCA.5132, GLCA.5218, GLCA.5402, GLCA.5422, GLCA.5423, GLCA.5427, GLCA.5513, GLCA.6116, GLCA.6117, GLCA.6119, GLCA.6120, GLCA.6123, GLCA.6124, GLCA.6231, GLCA.9109).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): M.E. Hall and K.A. Schulz
References: Coles et al. 2003, Hansen et al. 2004b, Reid and Hall 2010, Salas et al. 2011, Western Ecology Working Group n.d.*

[CEGL002352] Ephedra torreyana / Achnatherum hymenoides - Pleuraphis jamesii Shrubland
Translated Name: Torrey's Joint-fir / Indian Ricegrass - James' Galleta Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Ephedra torreyana* Shrubland Alliance (A2572)

Element Concept

Global Summary: This shrubland is known from southeastern Utah. Total vegetation cover ranges from 5 to 25% which includes stands that are shrub-herbaceous in structure as well as shrublands and sparse vegetation. Vegetation composition is characterized by an open canopy of *Ephedra torreyana* that ranges between 2 to 25% cover, with an understory codominated by *Achnatherum hymenoides* and *Pleuraphis jamesii* with between 2 and 15% cover. Associated shrubs include *Atriplex canescens, Opuntia polyacantha,* and *Gutierrezia sarothrae*. The remaining herbaceous layer often includes *Astragalus amphioxys, Malacothrix sonchoides, Sporobolus airoides, Sporobolus flexuosus,* and *Sphaeralcea parvifolia*. This shrubland association occurs in large patches on broad sandy plains, as well as in smaller patches on knolls, toeslopes and pediments. Sites are flat to gentle (up to 8° slopes), occur between 1123 and 2000 m elevation, and tend to be oriented to warm south or west aspects. The unvegetated surface has up to 90% exposure of sand or bare soil. Parent materials include Entrada, Navajo, Summerville and Carmel formation materials that have eroded to alluvial or eolian sands and clays. Soils are rapidly drained to well-drained loamy sands where derived from secondary materials or sandy clays where derived from underlying shales.

Environmental Description

Glen Canyon National Recreation Area Environment: This association typically occurs on sandy canyon sideslopes or hills (up to 15°) on variable aspects and at elevations ranging from 1123-1276 m. The unvegetated surface has moderate to high cover of bare soil or sand, and low to moderate cover of bedrock, litter, biological soil crusts, or gravel. Soils are moderately well-drained to rapidly drained sandy loams, silty clay loams, or sands derived from alluvium, eolian, or the Chinle Formation.

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Global Environment: This shrubland association occurs in large patches on broad sandy plains, as well as in smaller patches on knolls, toeslopes and pediments. Sites are flat to gentle (up to 15° [30%] slopes), occur between 1123 and 2000 m elevation, and tend to be oriented to warm south or west aspects. The unvegetated surface has high exposure of sand and bare soil (up to 90%) and sparse to low cover of litter. Parent materials include Entrada, Navajo, Summerville, Chinle and Carmel formation exposures that have eroded to alluvial or eolian sands. Soils are rapidly drained to well-drained loamy sands where derived from secondary materials or sandy clays where derived from underlying shales.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Mormon-tea association is characterized by a shrub layer dominated by *Ephedra torreyana*, with between 2 and 5% cover. Total vegetation cover ranges from 7 to 24%. Associated shrubs may include *Ericameria nauseosa, Ephedra cutleri, Psorothamnus fremontii*, *Opuntia polyacantha*, and *Gutierrezia sarothrae*. The understory is graminoid-dominated, the most abundant species being *Achnatherum hymenoides*, with between 1 and 5% cover. *Pleuraphis jamesii* is generally, but not always, present with up to 4% cover. In a couple examples of this type, *Hesperostipa comata* is codominant with *Achnatherum hymenoides*. Other associated grasses with low cover may include *Sporobolus cryptandrus* and *Bromus tectorum*. *Amsonia tomentosa, Abronia elliptica*, and *Zigadenus paniculatus* are commonly associated forbs. Biological soil crusts and moss may have high cover in some stands, with up to 35% cover.

Global Vegetation: Total vegetation cover ranges from 5 to 25% in this variable community, which includes stands that are shrub-herbaceous in structure as well as shrublands and sparse vegetation. Vegetation composition is characterized by an open canopy of *Ephedra torreyana* that ranges between 2 to 25% cover, with an understory dominated by *Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii*, and *Sporobolus cryptandrus* with between 2 and 15% cover. Associated shrubs include *Atriplex canescens, Ericameria nauseosa, Ephedra cutleri, Gutierrezia sarothrae, Psorothamnus fremontii*, and *Opuntia polyacantha*. *Coleogyne ramosissima* is absent or has 1% or less cover. The remaining herbaceous layer often includes *Amsonia tomentosa, Abronia elliptica, Astragalus amphioxys, Malacothrix sonchoides, Sporobolus airoides, Sporobolus flexuosus, Sphaeralcea parvifolia*, and *Zigadenus paniculatus*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Short shrub/sapling	Succulent shrub	*Opuntia polyacantha*
Herb (field)	Graminoid	*Bromus tectorum*, *Pleuraphis jamesii*

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Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*, *Ephedra torreyana*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Short shrub/sapling	Succulent shrub	*Opuntia polyacantha*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Achnatherum hymenoides, Astragalus amphioxys, Atriplex canescens, Ephedra torreyana, Gutierrezia sarothrae, Opuntia polyacantha, Pleuraphis jamesii, Sphaeralcea parvifolia*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High); Other Plants: *Achnatherum hymenoides* (G5)

Global: Invasive/Exotic Plants: *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: GNR (21-Mar-2005).

Related Concepts

Global Similar Types:
- *Ephedra torreyana / Pleuraphis jamesii* Shrubland (CEGL003772)
- *Ephedra torreyana* Sparse Vegetation (CEGL002353)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This somewhat uncommon association was sampled in Ticaboo Creek, North Wash, on the Dirty Devil and Escalante rivers.

Global Range: This Colorado Plateau association is known from scattered sites in southeastern Utah.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon)

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Element Sources

Glen Canyon National Recreation Area Inventory Notes: The north-facing aspect is the most significant factor here, as the rest of the canyon has more sun exposure. The north-facing microclimate lends to a high density of dark moss.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2013 field data (6 plots): (Plots: GLCA.4115, GLCA.4254, GLCA.5284, GLCA.5285, GLCA.5418, GLCA.5421).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and G. Kittel
References: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEGL003772] Ephedra torreyana / Pleuraphis jamesii Shrubland
Translated Name: Torrey's Joint-fir / James' Galleta Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Ephedra torreyana* Shrubland Alliance (A2572)

Element Concept

Global Summary: This short shrubland occurs in the canyonlands of the Colorado Plateau of southern Utah and possibly Arizona. The vegetation ranges from 5 to 25% total cover and is characterized by an open canopy of *Ephedra torreyana* shrubs with up to 15% cover and the short bunchgrass *Pleuraphis jamesii* that ranges in cover from 1 to 5%. Associated shrubs *Atriplex gardneri* and *Coleogyne ramosissima* may be present to codominant. Other shrubs may include *Atriplex confertifolia, Ericameria nauseosa, Eriogonum microthecum, Opuntia* spp., and *Sclerocactus whipplei* The remaining herbaceous component includes grasses such as *Achnatherum hymenoides, Sporobolus cryptandrus,* and *Vulpia octoflora,* and the forbs *Amsonia tomentosa, Chenopodium album, Lepidium lasiocarpum, Plantago patagonica,* and *Streptanthella longirostris.* Biological soil crusts provide sparse cover in some stands. Stands are found typically on deep alkaline soils of plateaus, mesas, benches, lower slopes and stream terraces that are flat to moderately steep (up to 32% slopes) and occur between 1226 and 1506 m elevation. The unvegetated surface has high cover of bare soil and/or gravel with sparse cover of litter. Soils are rapidly drained loamy sands and clay loams.

Environmental Description

Glen Canyon National Recreation Area Environment: This sparse desert shrubland occurs on often deep, rocky soils of mesas, plateaus, buttes, benches, plains, sideslopes, toeslopes, terraces, badlands, hills, ridges, basins, and valley bottoms. Sites are on gentle to moderate slopes (2-15°), oriented to all aspects, and lie between 1137 and 1731 m elevation. Bare soil and gravel cover most of the unvegetated surface, with low to moderate cover of sand, dark cyanobacteria, or large rocks, and sparse

cover of litter. Soils are somewhat poorly drained to rapidly drained loams, clay loams, silty clay loams, sandy loams, sandy clay loams, clays, silty clays, sandy clays, loamy sands, or sands derived from the Moenkopi, Chinle, or Carmel formations, Organ Rock shale, Shinarump conglomerate, Salt Wash member of the Morrison Formation, eolian, alluvial, or talus/colluvium deposits.

Global Environment: This desert short-shrub association occurs on deep alkaline soils on plateaus, mesas, benches, badlands, lower slopes and stream terraces in canyonlands of the Colorado Plateau. Sites are flat to moderately steep (up to 32% slopes) and occur between 1137 and 1506 m elevation. The unvegetated surface has high cover of bare soil and/or gravel with sparse cover of litter. Soils are rapidly drained loams, clay loams, silty clay loams, sandy loams, sandy clay loams, silty clays, sandy clays, or sands derived from alluvium, Mancos shale, Moenkopi, Carmel or Chinle formations, White Rim sandstone, Organ Rock shale, Shinarump conglomerate, Salt Wash member of the Morrison Formation, eolian or talus/colluvium deposits.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse desert shrubland occurs on deep, alkaline soils within the recreation area. Total vegetation cover ranges from 2 to 20%. The shrub canopy is dominated by scattered *Ephedra torreyana* with 1-10% cover. Associated shrubs include *Coleogyne ramosissima, Atriplex confertifolia, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Krascheninnikovia lanata, Opuntia macrorhiza, Yucca angustissima, Psorothamnus* spp., *Acamptopappus sphaerocephalus, Gutierrezia microcephala*, and *Picrothamnus desertorum (= Artemisia spinescens)*. The dwarf-shrub (or herb) *Xylorhiza tortifolia* is a common associate. The understory is dominated by the perennial grass *Pleuraphis jamesii* with between 1 and 6% cover, with *Achnatherum hymenoides* the only other native grass species commonly present. Other herbaceous species noted are typical of disturbed sites, including *Bromus tectorum, Chenopodium album*, and *Salsola tragus*.

Global Vegetation: The vegetation ranges from 5 to 25% total cover and is characterized by an open canopy of *Ephedra torreyana* shrubs with up to 15% cover and perennial grasses, especially the short bunchgrass *Pleuraphis jamesii*, which ranges in cover from 1 to 6%. Associated shrubs can be quite variable, all with very low cover, and include *Acamptopappus sphaerocephalus, Atriplex canescens, Atriplex confertifolia, Atriplex gardneri, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ericameria nauseosa, Eriogonum microthecum, Gutierrezia microcephala, Krascheninnikovia lanata, Opuntia erinacea, Opuntia macrorhiza, Opuntia phaeacantha, Opuntia polyacantha, Picrothamnus desertorum (= Artemisia spinescens), Psorothamnus* spp., *Sclerocactus whipplei, Xylorhiza tortifolia*, and *Yucca angustissima*. Other herbaceous species include occasional clumps of *Achnatherum hymenoides, Sporobolus cryptandrus, Vulpia octoflora (= Festuca octoflora)*, and the exotic annual *Bromus tectorum*. Forbs commonly present include *Amsonia tomentosa, Chenopodium album, Lepidium lasiocarpum, Plantago patagonica, Sphaeralcea leptophylla, Streptanthella longirostris*, and the exotic annual *Salsola tragus*. Biological soil crust cover is variable, with some stands having none, while others have as much as 33% cover by *Collema* sp., mosses, and dark cyanobacteria.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia microcephala*, *Xylorhiza tortifolia*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex gardneri*, *Ephedra torreyana*, *Pleuraphis jamesii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Global: Vulnerable Plants: *Eriogonum bicolor* (G3G4), *Sclerocactus whipplei* (G2G3); Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: GNR (30-Mar-2006).

Related Concepts

Global Similar Types:

- *Ephedra torreyana / Achnatherum hymenoides - Pleuraphis jamesii* Shrubland (CEGL002352)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Except for the absence of *Achnatherum hymenoides*, this association is very similar to *Ephedra torreyana / Achnatherum hymenoides - Pleuraphis jamesii* Shrubland (CEGL002352). More survey and classification work are needed to clarify differences.

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Element Distribution

Glen Canyon National Recreation Area Range: This shrubland association occurs on deep soils in the recreation area and was sampled west of Deadhorse Canyon, in Horse Canyon, Blue Notch Canyon, Slickrock Canyon, upper Dirty Devil, north of Kane Point, on Fourmile Bench, Muley Point, Andy Miller Flats, Panorama Point, Brown's Rim, in Middle Moody Canyon, Rock Canyon, North Wash, and near Adeiyi Taah Hooti, Ekker Butte, and Allen Dump.

Global Range: This association is widespread throughout the canyonlands of the Colorado Plateau in southeastern Utah and possibly northern Arizona.

Nations: US
States/Provinces: AZ?, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Very steep, rocky basin surrounded by canyon walls to the north, east, and south. Bound by a deep-cut drainage channel along the north. Gravelly soil surface stabilized by healthy moss/crust layer and shrubs/bunchgrasses. This area receives extra runoff from canyon wall to the south.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, 2012, and 2013 field data (24 plots): (Plots: GLCA.0118, GLCA.0328, GLCA.0331, GLCA.0742, GLCA.0743, GLCA.1018, GLCA.2078, GLCA.4074, GLCA.4075, GLCA.4076, GLCA. 4081, GLCA.4094, GLCA.4107, GLCA.4270, GLCA.4313,GLCA.5040, GLCA.5079, GLCA.5080, GLCA.5088, GLCA.5280, GLCA.5286, GLCA.5322, GLCA.6106, GLCA.6110).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and G. Kittel
References: Coles et al. 2009a, Western Ecology Working Group n.d.*

[CEPP005698] *Polygala acanthoclada* - Mixed Scrub
Translated Name: Desert Polygala - Mixed Scrub
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Ephedra torreyana* Shrubland Alliance (A2572)

Element Concept

Global Summary: This rare mixed shrubland association is known from Glen Canyon National Recreation Area and may occur more widely in the Colorado Plateau. It is characterized by a mixed

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shrub canopy dominated by *Polygala acanthoclada* (with 3-7% cover) with either or both of *Coleogyne ramosissima* (with 2-6% cover) and *Ephedra torreyana* (with 1-2% cover) codominant. Other associated shrubs with sparse to very low cover may include *Atriplex confertifolia, Gutierrezia sarothrae, Psorothamnus fremontii,* and *Rhus trilobata*. If present, the herbaceous layer has sparse to low cover and may include *Achnatherum hymenoides, Aristida purpurea,* and *Phacelia crenulata*. Total cover ranges from 7 to 23%. Stands occur on flat to gently sloping canyon benches and canyon bottoms with southwest to northwest aspects. Elevations range from 1167 to 1397 m. Bedrock and bare soil cover most of the unvegetated surface. Soils are derived from shales or sandstones.

Environmental Description

Glen Canyon National Recreation Area Environment: This rare mixed shrubland association occurs on flat to gently sloping (up to 8°) canyon benches and canyon bottoms, oriented to the west, southwest, and northwest. Elevations range from 1167 to 1397 m elevation. Bedrock and bare soil cover most of the unvegetated surface, with lesser cover of biological soil crusts, and low cover of gravel, large rocks, and sand. Soils are derived from Chinle shales or Cedar Mesa sandstones.

Global Environment: This rare mixed shrubland association occurs in the Colorado Plateau on flat to gently sloping (up to 8°) canyon benches and canyon bottoms with southwest to northwest aspects. Elevations range from 1167 to 1397 m. Bedrock and bare soil cover most of the unvegetated surface, with lesser cover of biological soil crusts, and low cover of gravel, large rocks, and sand. Soils are derived from Chinle shales or Cedar Mesa sandstones.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Total cover in this rare mixed shrubland association is between 7% and 23%. The mixed shrub canopy is dominated by *Polygala acanthoclada* (with 3-7% cover) with either or both of *Coleogyne ramosissima* (with 2-6% cover) and *Ephedra torreyana* (with 1-2% cover) codominant. Other associated shrubs with sparse to very low cover may include *Atriplex confertifolia, Gutierrezia sarothrae, Psorothamnus fremontii,* and *Rhus trilobata*. The understory has sparse to low cover and may include *Achnatherum hymenoides, Aristida purpurea,* and *Phacelia crenulata*.

Global Vegetation: This rare mixed shrubland association is characterized by a mixed shrub canopy dominated by *Polygala acanthoclada* (with 3-7% cover) with either or both of *Coleogyne ramosissima* (with 2-6% cover) and *Ephedra torreyana* (with 1-2% cover) codominant. Other associated shrubs with sparse to very low cover may include *Atriplex confertifolia, Gutierrezia sarothrae, Psorothamnus fremontii,* and *Rhus trilobata*. If present, the herbaceous layer has sparse to low cover and may include *Achnatherum hymenoides, Aristida purpurea,* and *Phacelia crenulata*. Total cover ranges from 7 to 23%.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*, *Polygala acanthoclada*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*, *Polygala acanthoclada*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Coleogyne ramosissima, Ephedra torreyana, Polygala acanthoclada*

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (18-Aug-2016).

Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak

Element Distribution

Glen Canyon National Recreation Area Range: This rare mixed shrubland was sampled on Mike's Mesa, Steer Gulch, and Clay Hills.

Global Range: This rare mixed shrubland association is known from Glen Canyon National Recreation Area and may occur more widely in the Colorado Plateau.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Within polygon, dominant shrubs vary between *Polygala acanthoclada, Coleogyne ramosissima*, and Atriplex confertifolia. This polygon is very large. Dominance of common species varies between washes and uplands.

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Glen Canyon National Recreation Area Plots: The description is based on 2015 field data (3 accuracy assessment points): (AA Points: GLCA_AA.1461, GLCA_AA.1860, GLCA_AA.1869).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

A3201 Ephedra viridis Colorado Plateau Shrubland Alliance
Alliance Summary Description: The vegetation is characterized by a sparse to moderately dense shrub layer dominated by xeromorphic evergreen microphyllous shrub *Ephedra viridis*. *Artemisia tridentata* or *Tetradymia canescens* may be present to codominant in some stands of this alliance. A variety of other shrubs may be present with low cover, such as *Acacia greggii, Agave* spp., *Atriplex canescens, Coleogyne ramosissima, Encelia farinosa,* the dwarf-shrub *Gutierrezia sarothrae,* and cacti *Echinocereus engelmannii, Ferocactus cylindraceus, Opuntia erinacea*, *Opuntia polyacantha,* and *Sclerocactus whipplei*. The herbaceous layer is sparse to moderately dense, in some stands being more prominent than the shrubs, and is usually dominated by perennial bunchgrasses such as *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii*, or the exotic annual grass *Bromus tectorum*. Other grasses such as *Aristida purpurea, Muhlenbergia pungens, Sporobolus airoides,* and *Sporobolus cryptandrus* may be present depending on the site. Forb cover is generally sparse but may be surprisingly diverse. Biological crusts are often present and provide up to 25% cover. Stands of this alliance occur in the Colorado Plateau and Great Basin and are found on dry, rocky, gravelly or sandy sites in valleys and washes, and on slopes, alluvial fans, mesas, and foothills from 1380 to 2020 m elevation. Slopes are gentle to moderately steep (1-45%).

[CEPP005684] Acamptopappus sphaerocephalus - Ephedra spp. Shrubland
Translated Name: Rayless Goldenhead - Joint-fir species Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Ephedra viridis* Colorado Plateau Shrubland Alliance (A3201)

Element Concept

Global Summary: This warm desert shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely in the Colorado Plateau. It is characterized by a sparse to open shrub dominated by *Acamptopappus sphaerocephalus* and codominated by one or more species of *Ephedra*, namely *Ephedra cutleri* (with 1-12% cover), *Ephedra torreyana* (with 1-5% cover), or *Ephedra viridis* (with 2-3% cover). Associated shrubs with sparse to low cover may be diverse and include *Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Glossopetalon spinescens, Gutierrezia* spp., *Opuntia* spp., *Psorothamnus fremontii,* and *Yucca angustissima*. The herbaceous layer has low to moderate cover and is dominated by native perennial grasses, including *Achnatherum hymenoides, Achnatherum speciosum (= Stipa*

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speciosa), Aristida purpurea, Pleuraphis jamesii, Sporobolus contractus, Sporobolus cryptandrus, and *Sporobolus flexuosus*. Exotic, annual grasses such as *Bromus rubens, Bromus tectorum*, and *Schismus barbatus* may be present with moderate cover. Forbs have sparse cover and are dominated by annuals, such as *Plantago patagonica, Eriogonum inflatum* and *Stephanomeria pauciflora* and exotic *Salsola tragus*. Total vegetation cover ranges between 5 and 32%. Sites range from flat to steeply sloping and occur on all aspects. Bare soil, gravel, and biological soil crusts cover most of the unvegetated surface. Soils are variable, ranging from silt loams and sandy clays derived from shales to sandy loams, sands, and loamy sands derived from alluvial or eolian deposits, or sandstones.

Environmental Description

Glen Canyon National Recreation Area Environment: This common shrubland association occurs on benches, dunes, plains, bajadas, piedmont slopes, hills, canyon sides, talus slopes, canyon or valley floors, and terraces. Sites range from flat to steeply sloping (up to 32°), are oriented to all aspects, and lie between 1098 and 1265 m elevation. Bare soil, gravel, and biological soil crusts cover most of the unvegetated surface, with lesser cover by moss and litter, and sparse to low cover of sand, large rocks, and bedrock. Soils are moderately well-drained to rapidly drained loams, silt loams, and sandy clays derived from shales of the Salt Wash member of the Morrison or Carmel formations, or sandy loams, sands, and loamy sands derived from alluvial or eolian deposits, or from sandstones of the Navajo or Entrada formations.

Global Environment: This warm desert shrubland association occurs in the Colorado Plateau on benches, dunes, plains, bajadas, piedmont slopes, hills, canyon sides, talus slopes, canyon or valley floors, and terraces between 1098 and 1265 m elevation. Sites range from flat to steeply sloping and occur on all aspects. Bare soil, gravel, and biological soil crusts cover most of the unvegetated surface, with lesser cover by moss and litter, and sparse to low cover of sand, large rocks, and bedrock. Soils are moderately well-drained to rapidly drained loams, silt loams, and sandy clays derived from shales of the Salt Wash Member of the Morrison or Carmel formations, or sandy loams, sands, and loamy sands derived from alluvial or eolian deposits, or from sandstones of the Navajo or Entrada formations.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This warm desert shrubland has total vegetation cover between 5 and 32%. The shrub canopy is typically <1 m tall and is dominated by *Acamptopappus sphaerocephalus* (with 2-11% cover) with one or more of the following species codominant: *Ephedra cutleri* (with 1-12% cover), *Ephedra torreyana* (with 1-5% cover), or *Ephedra viridis* (with 2-3% cover). Associated shrubs with sparse to low cover may include *Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Glossopetalon spinescens, Gutierrezia* spp., *Opuntia* spp., *Psorothamnus fremontii*, and *Yucca angustissima*. The understory may appear quite grassy and have low to moderate cover of the following native grass species: *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Aristida purpurea, Pleuraphis jamesii, Sporobolus contractus, Sporobolus cryptandrus,* and *Sporobolus flexuosus*. It may also include low to moderate cover of the exotic, annual grasses *Bromus rubens* (with up to 25% cover), *Bromus tectorum,* and *Schismus barbatus*. Forbs have sparse cover and are dominated by

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exotic, annuals, such as *Plantago patagonica* and *Salsola tragus*; *Eriogonum inflatum* and *Stephanomeria pauciflora* are present with more than trace cover.

Global Vegetation: This warm desert shrubland association is characterized by a sparse to open shrub dominated by *Acamptopappus sphaerocephalus* and codominated by one or more species of *Ephedra*, namely *Ephedra cutleri* (with 1-12% cover), *Ephedra torreyana* (with 1-5% cover), or *Ephedra viridis* (with 2-3% cover). Associated shrubs with sparse to low cover may be diverse and include *Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Glossopetalon spinescens, Gutierrezia* spp., *Opuntia* spp., *Psorothamnus fremontii*, and *Yucca angustissima*. The herbaceous layer has low to moderate cover and is dominated by native perennial grasses, including *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Aristida purpurea, Pleuraphis jamesii, Sporobolus contractus, Sporobolus cryptandrus,* and *Sporobolus flexuosus*. Exotic, annual grasses such as *Bromus rubens, Bromus tectorum,* and *Schismus barbatus* may be present with moderate cover. Forbs have sparse cover and are dominated by annuals, such as *Plantago patagonica, Eriogonum inflatum* and *Stephanomeria pauciflora* and exotic *Salsola tragus*. Total vegetation cover ranges between 5 and 32%.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Acamptopappus sphaerocephalus*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*, *Ephedra torreyana*, *Ephedra viridis*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Bromus rubens*, *Schismus barbatus*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Acamptopappus sphaerocephalus*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*, *Ephedra torreyana*, *Ephedra viridis*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Acamptopappus sphaerocephalus, Ephedra cutleri, Ephedra torreyana, Ephedra viridis*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High), *Plantago patagonica, Salsola tragus, Schismus barbatus* (High/Medium)

Global: Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High), *Schismus barbatus* (High/Medium)

Conservation Status Rank

Global Rank & Reasons: GNR (18-Aug-2016).

Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak

Element Distribution

Glen Canyon National Recreation Area Range: This common shrubland occurs throughout the southwestern portion of the recreation area and was sampled in Warm Creek Bay, Rock Creek Bay, Gunsight Bay, Crosby Canyon, Padre Canyon, Wagon Box Canyon, Cornerstone Canyon, Teddy's Horse Pasture, on Sit Down Bench, Romana Mesa, Oley Knolls, the Sand Hills, near Dangling Rope, and Balanced Rock.

Global Range: This warm desert shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely in the Colorado Plateau.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plot is on a steep, sandy slope below the canyon wall, dissected by rocky drainages. Site is able to collect and retain at least some surface waterflow, sustaining the dense vegetation layer which stabilizes the soil.

Glen Canyon National Recreation Area Plots: The description is based on 2011, 2012, and 2015 field data (16 plots, 6 accuracy assessment points): (Plots: GLCA.1004, GLCA.1063, GLCA.1068, GLCA.1079, GLCA.1081, GLCA.2065, GLCA.2068, GLCA.2074, GLCA.2085, GLCA.4014, GLCA.4225, GLCA.4231, GLCA.4239, GLCA.4241, GLCA.5161, GLCA.5174; AA Points: GLCA_AA.1405, GLCA_AA.1551, GLCA_AA.1562, GLCA_AA.1567, GLCA_AA.3045, GLCA_AA.8002).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEGL002354] Ephedra viridis / (Achnatherum hymenoides, Hesperostipa comata) Shrubland
Translated Name: Mormon-tea / (Indian Ricegrass, Needle-and-Thread) Shrubland
Common Name:

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USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Ephedra viridis* Colorado Plateau Shrubland Alliance (A3201)

Element Concept

Global Summary: This shrubland is known from southeastern Utah. The vegetation is characterized by an open canopy of clonal *Ephedra viridis* shrubs with between 5 and 20% cover with a well-developed grassy understory dominated by either *Achnatherum hymenoides* or *Hesperostipa comata*. The herbaceous layer totals up to 35% cover. Associated shrubs include scattered *Coleogyne ramosissima, Atriplex canescens, Eriogonum leptocladon,* and the succulent *Opuntia polyacantha*. Other grasses include *Aristida purpurea, Muhlenbergia pungens, Sporobolus cryptandrus,* and *Bouteloua gracilis*. If *Pleuraphis jamesii* is present, it is with much less cover than either *Hesperostipa comata* or *Achnatherum hymenoides*. Forbs include many species typical of sandy communities, including *Abronia fragrans, Chaenactis stevioides, Cymopterus newberryi, Oenothera pallida, Machaeranthera canescens, Plantago patagonica,* and *Sphaeralcea parvifolia*. Cryptogams are often present and provide up to 25% cover. Stands occur on sand dunes and sandsheets deposited on plateaus, benches and valley floors. Sites occupy gentle to moderately steep slopes (1-45%) between 1114 and 2018 m elevation. Soils are rapidly drained loamy sands and sandy loams derived from eolian sands or alluvial deposits.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland occurs on the fine-sandy, deep soils of dunes, bajadas, plains, sideslopes, canyon bottoms, drainage channels, and mesas. Sites are on flat to moderately steep (up to 15°) slopes, include all aspects, and occur between 1114 and 1851 m elevation. The unvegetated surface has moderate to high exposure of bare soil or sand and sparse to moderate cover of litter or gravel. Soils are well-drained to rapidly drained loamy sands, loams, sands or sandy loams derived from alluvium or eolian deposits.

Global Environment: This short-shrub association occurs on sand dunes and sandsheets deposited on plateaus, benches and valley floors in southeastern Utah. Sites occupy gentle to moderately steep slopes (1-45%) between 1114 and 2018 m elevation and oriented to a variety of aspects, with a slight tendency toward northern and eastern aspects. The unvegetated surface has up to 96% sand or bare soil, with the balance covered by litter or dark cyanobacteria. Cover of cryptogamic soil communities is typically sparse (<10%) but ranges from none to 25%. Cover of litter is sparse to low. Soils are rapidly drained loamy sands and sandy loams derived from sandstones and shale that have eroded to eolian sands or alluvial deposits.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This shrubland occurs on deep, sandy soils within the recreation area. Total vegetation cover ranges from 4 to 30%. The shrub canopy is dominated by *Ephedra viridis* (and/or *Ephedra cutleri*) with up to 15% cover and an understory dominated by *Achnatherum hymenoides,* with or without *Hesperostipa comata* codominant, with 1-5%

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individual cover. Other shrubs present include *Atriplex canescens, Atriplex confertifolia, Artemisia filifolia, Acamptopappus sphaerocephalus, Ephedra torreyana, Psorothamnus fremontii, Gutierrezia sarothrae, Gutierrezia microcephala*, and *Yucca angustissima*. Associated graminoids include *Pleuraphis jamesii, Sporobolus cryptandrus, Sporobolus contractus*, and *Schismus barbatus*. Forbs are highly variable in composition; *Plantago patagonica, Sphaeralcea parvifolia, Cryptantha* sp., *Helianthus petiolaris, Hymenopappus filifolius, Psoralidium junceum, Penstemon ambiguus*, and *Salsola tragus* were recorded in the sample plots.

Global Vegetation: Stands of this association usually occur as patches of one to several hectares within a matrix of other sandy communities dominated by *Coleogyne ramosissima* and *Artemisia filifolia*, although occasionally it will be the matrix community. The appearance is that of a grassland containing large, low-growing clonal clumps of *Ephedra viridis*. Total vegetation cover ranges from 5 to 55% but generally is between 15 and 35%. The vegetation is characterized by an open canopy of *Ephedra viridis* shrubs with between 5 and 20% cover with a well-developed grassy understory dominated by either *Achnatherum hymenoides* or *Hesperostipa comata*. The herbaceous layer totals up to 35% cover. Associated shrubs include scattered *Acamptopappus sphaerocephalus, Artemisia filifolia, Atriplex canescens, Atriplex confertifolia, Coleogyne ramosissima, Ephedra torreyana, Eriogonum leptocladon, Gutierrezia microcephala, Gutierrezia sarothrae, Opuntia erinacea, Opuntia polyacantha, Psorothamnus fremontii, Sclerocactus whipplei*, and *Yucca angustissima*. Other grasses include *Aristida purpurea, Bouteloua gracilis, Muhlenbergia pungens, Pleuraphis jamesii, Schismus barbatus, Sporobolus airoides, Sporobolus contractus, Sporobolus cryptandrus*, and *Vulpia octoflora (= Festuca octoflora)*. If *Pleuraphis jamesii* is present, it is with much less cover than either *Hesperostipa comata* or *Achnatherum hymenoides*. Forbs include many species typical of sandy communities, including *Abronia fragrans, Ambrosia acanthicarpa, Artemisia campestris, Chaenactis stevioides, Cryptantha* sp., *Cymopterus newberryi, Descurainia pinnata, Eriogonum deflexum, Helianthus petiolaris, Hymenopappus filifolius, Lappula occidentalis, Machaeranthera canescens, Mentzelia multiflora, Oenothera pallida, Packera multilobata (= Senecio multilobatus), Penstemon ambiguus, Plantago patagonica, Psoralidium junceum*, and *Sphaeralcea parvifolia*. The exotic annual tumbleweed *Salsola tragus* and the exotic annual grass *Bromus tectorum* are common in some stands. Biological soil crusts are often present and provide up to 25% cover.

Global Dynamics: This association occupies deep sand deposits that have formed as dune fields on sandsheets. Although these stands are stabilized, wind erosion can pedestal plants and leave deflation basins between. Historically, these habitats were heavily grazed which, along with drought, likely activated the erosion process. *Ephedra viridis* is known to sprout vigorously from the roots or woody rootcrowns or establish by seed following fire (Anderson 2001b). These fire adaptations may favor it over more fire-sensitive species such as *Coleogyne ramosissima*.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*, *Ephedra viridis*, *Gutierrezia microcephala*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Hesperostipa comata*, *Sporobolus* spp.

Global

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Ephedra viridis*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Hesperostipa comata*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Achnatherum hymenoides, Atriplex canescens, Bouteloua gracilis, Ephedra viridis, Hesperostipa comata, Muhlenbergia pungens, Oenothera pallida, Opuntia polyacantha*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Psoralidium junceum* (G3); Invasive/Exotic Plants: *Salsola tragus*, *Schismus barbatus* (High/Medium)

Global: Vulnerable Plants: *Psoralidium junceum* (G3), *Sclerocactus whipplei* (G2G3); Invasive/Exotic Plants: *Bromus tectorum* (High), *Chenopodium album*, *Salsola tragus*; Other Plants: *Sporobolus* spp. (N/A, includes *Sporobolus cryptandrus, Sporobolus contractus, Sporobolus airoides*)

Conservation Status Rank

Global Rank & Reasons: GNR (21-Mar-2005).

Related Concepts

Global Similar Types:

- *Ephedra viridis / Pleuraphis jamesii* Shrubland (CEGL002356)

Classification

Status: Standard

Classification Confidence: 1 - Strong

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

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Element Distribution

Glen Canyon National Recreation Area Range: This shrubland association occurs on deep, sandy soils in the recreation area and was sampled on Millard Canyon rim, The Sand Hills, in Warm Springs Canyon, Wagon Box Canyon, Bullfrog Bay, Rock Creek Bay, Gunsight Bay, near Hole-in-the-Rock, High Spur, and north of Horsethief Canyon.

Global Range: This association occurs in the Colorado Plateau in southeastern Utah and likely occurs in adjacent states.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plot lies on north-facing stabilized dune, where a small amount of soil crust and gravel are holding the soil in place. Plant distribution is controlled by wind erosion.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, and 2012 field data (11 plots): (Plots: GLCA.0109, GLCA.0529, GLCA.1055, GLCA.1058, GLCA.2060, GLCA.2088, GLCA.5152, GLCA.5169, GLCA.5202, GLCA.5266, GLCA.9306).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Anderson 2001b, Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEGL003934] Ephedra viridis / Bouteloua gracilis Shrubland
Translated Name: Mormon-tea / Blue Grama Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Ephedra viridis* Colorado Plateau Shrubland Alliance (A3201)

Element Concept

Global Summary: This association is currently known only from Glen Canyon National Recreation Area in southeastern Utah. This descriptive information is from there, and it does not seem to be particularly common. Vegetation is characterized by relatively open shrublands dominated by *Ephedra viridis* (or *Ephedra cutleri*) with *Gutierrezia sarothrae* and *Opuntia erinacea* as the only consistently associated shrubs. The understory is dominated by *Bouteloua gracilis*. Other graminoids include

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Achnatherum hymenoides, Sporobolus cryptandrus, Vulpia octoflora (= Festuca octoflora), and exotic *Bromus tectorum*. Forbs commonly present with sparse cover include *Eriogonum cernuum, Lupinus pusillus,* and *Sphaeralcea parvifolia*. Stands are found on plateaus at elevations between 1767 and 1982 m. Soils are rapidly drained loamy sands or sandy loams derived from eolian deposits.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland association occurs only on the high mesatops, plains, and plateaus of the Orange Cliffs. Sites are flat to gently sloping (up to 10°), oriented to all aspects, and lie between 1767 and 1982 m elevation. Bare soil covers most of the unvegetated surface, with low to moderate cover of litter, and sparse cover of biological soils crusts (mostly mosses). Soils are moderately well-drained to rapidly drained loamy sands or sandy loams derived from eolian deposits, or from the Navajo or Kayenta formations.

Global Environment: This shrubland association occurs on the high mesatops, plains, and plateaus. Sites are flat to gently sloping, oriented to all aspects, and lie between 1767 and 1982 m elevation. Bare soil covers most of the unvegetated surface, with low to moderate cover of litter, and sparse cover of biological soils crusts (mostly mosses). Soils are moderately well-drained to rapidly drained loamy sands or sandy loams derived from eolian deposits.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Mormon-tea / blue grama shrubland has total vegetation cover that ranges from 10 to 59%. The shrub canopy is dominated by *Ephedra viridis* (or *Ephedra cutleri*) with 4 to 15% cover; the understory is dominated by *Bouteloua gracilis* with up to 30% cover. Associated shrubs are rare but may include *Gutierrezia sarothrae* and *Opuntia* spp. Associated graminoids with sparse to low cover include *Achnatherum hymenoides* (with up to 12% cover), *Vulpia octoflora (= Festuca octoflora), Hesperostipa comata, Pleuraphis jamesii, Sporobolus airoides, Sporobolus cryptandrus, Muhlenbergia pungens,* and *Bromus tectorum*. Forbs commonly present with sparse cover include *Abronia fragrans, Cryptantha* spp., *Eriogonum cernuum, Helianthus petiolaris, Ipomopsis gunnisonii, Lupinus pusillus, Plantago patagonica, Salsola tragus,* and *Sphaeralcea coccinea*. Scattered *Pinus edulis* and *Juniperus osteosperma* trees may be present with low cover on the margins of this community.

Global Vegetation: Vegetation is characterized by relatively open shrublands dominated by *Ephedra viridis* (and/or *Ephedra cutleri*) with 4 to 15% cover; with *Gutierrezia sarothrae* and *Opuntia erinacea* as the only consistently associated shrubs. The understory is dominated by *Bouteloua gracilis*. Other graminoids include low cover of *Achnatherum hymenoides, Hesperostipa comata, Muhlenbergia pungens, Pleuraphis jamesii, Sporobolus airoides, Sporobolus cryptandrus* and *Vulpia octoflora (= Festuca octoflora)*. Forbs commonly present with sparse cover include *Abronia fragrans, Cryptantha* spp., *Eriogonum cernuum, Helianthus petiolaris, Lupinus pusillus, Sphaeralcea coccinea,* and *Sphaeralcea parvifolia*. Scattered *Pinus edulis* and *Juniperus osteosperma* trees may be present with low cover on the margins of this community. Exotic species may be present especially *Bromus tectorum* and *Salsola tragus*.

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Global Dynamics: *Ephedra viridis* is known to sprout vigorously from roots or woody root crowns or establish by seed following fire (Anderson 2001b). These fire adaptations may favor it over more fire-sensitive species such as *Coleogyne ramosissima*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Short shrub/sapling	Succulent shrub	*Opuntia* spp.
Herb (field)	Flowering forb	*Plantago patagonica*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Bouteloua gracilis*, *Hesperostipa comata*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*, *Ephedra viridis*
Herb (field)	Graminoid	*Bouteloua gracilis*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Bouteloua gracilis*, *Ephedra cutleri*, *Ephedra viridis*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Plantago patagonica*, *Salsola tragus*

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: GNR (12-Jun-2006).

Related Concepts

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

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Subset: GLCA; Glen Canyon National Recreation Area

Element Distribution

Glen Canyon National Recreation Area Range: This shrubland association is somewhat rare within the recreation area and is restricted to the high mesatops of the Orange Cliffs section. It was sampled on North Point, Gordon Flats, Head Spur, High Spur, near Hans Flat Ranger Station, and in East Moody Canyon.

Global Range: This shrubland association is currently known only from Glen Canyon National Recreation Area in southeastern Utah.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 341B:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This is a community on very deep soils, several meters thick when viewed at the road cut. It is a dry site with near constant exposure to wind desiccation. There are signs of past grazing. There is some *Juniperus osteosperma* invasion around the margins of the community.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2014 field data (6 plots, 11 accuracy assessment points): (Plots: GLCA.0106, GLCA.0107, GLCA.0311, GLCA.0525, GLCA.0706, GLCA.0723; AA Points: GLCA.0259, GLCA.0261, GLCA_AA.0316, GLCA.0318, GLCA.0322, GLCA_AA.0352, GLCA_AA.0353, GLCA_AA.0354, GLCA.0384, GLCA.0571, GLCA.1720).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): M.S. Reid, M.E. Hall, G. Kittel, K.A. Schulz
References: Anderson 2001b, Western Ecology Working Group n.d.*

[CEGL002356] Ephedra viridis / Pleuraphis jamesii Shrubland
Translated Name: Mormon-tea / James' Galleta Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Ephedra viridis* Colorado Plateau Shrubland Alliance (A3201)

Element Concept

Global Summary: This shrubland association is found in southeastern Utah on the Colorado Plateau. The vegetation is characterized by an open canopy of *Ephedra viridis* that ranges in cover from 5 to 55% and the short bunchgrass *Pleuraphis jamesii* that ranges in cover from 1 to 15%. If *Achnatherum*

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hymenoides and *Hesperostipa comata* are present, it is with much less cover than *Pleuraphis jamesii*. Associated shrubs include *Atriplex canescens, Gutierrezia sarothrae*, and *Opuntia polyacantha*. The herbaceous layer is diverse in terms of species composition and provides sparse to low cover. Associated graminoids include *Aristida purpurea, Bouteloua gracilis, Sporobolus airoides, Sporobolus cryptandrus*, and the annual exotic grass *Bromus tectorum*. Forbs commonly present include *Cryptantha crassisepala, Helianthus petiolaris, Lappula occidentalis*, and *Sphaeralcea parvifolia*. Total vegetation cover ranges from 6 to 85%. It occurs on partly stabilized dunefields and sandsheets on valley floors, plateau slopes, benches and mesatops. Sites are located on gentle slopes (3-10 %) between 1129 and 1850 m (3700-6070 feet) elevation. The rapidly drained, fine sandy loam, loamy sand, and sandy clay soils are derived from sandstones and shales, eolian deposits and alluvium.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland association occurs on deep, fine-textured soils of sideslopes, benches, terraces, and plateaus. Sites are flat to gently sloping (less than 7°), are oriented to any aspect, and lie between 1129 and 1734 m elevation. Bare soil or sand covers most of the unvegetated surface; litter, small rocks, or biological soil crusts have sparse to moderate cover. Soils are moderately well-drained to rapidly drained sands, sandy loams, loams or loamy sands derived from alluvial or eolian deposits, or from the Salt Wash Member of the Morrison Formation, Chinle Formation, or Cedar Mesa sandstone.

Global Environment: This shrubland association occurs on partly stabilized dunefields and sandsheets on valley floors, plateau slopes, benches and mesatops. Sites are located on flat to gentle slopes (<10%) between 1129 and 1850 m (3700-6070 feet) elevation. Aspect is not important in determining the distribution of this association. The unvegetated surface is variable but generally has high exposure of bare soil and sparse to moderate cover of litter and cryptogamic soil communities; rare sites will have high cover of colluvial boulders. Cryptogams may provide up to 30% cover. Soils are derived from sandstones and shales, eolian deposits and alluvium. They are deep, rapidly drained, fine sandy loams, loamy sands, and sandy clays. Parent materials include Dakota sandstone that eroded to eolian and sandsheet deposits, Morrison Formation and alluvium.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This shrubland occupies deep, fine soils within the recreation area. Total vegetation cover ranges from 6 to 29%; the shrub canopy is dominated by *Ephedra viridis* with 2 to 10% cover. Associated shrubs, all with sparse to low cover, include *Atriplex canescens, Acamptopappus sphaerocephalus, Coleogyne ramosissima, Ephedra torreyana, Gutierrezia* spp., *Opuntia* spp., and *Yucca angustissima*. The understory is dominated by the perennial bunchgrass *Pleuraphis jamesii* with between 2 and 12% cover. The remaining herbaceous layer is variable in composition and may include *Achnatherum hymenoides, Bouteloua gracilis, Bromus tectorum, Sporobolus cryptandrus, Sporobolus contractus, Sporobolus flexuosus*, and *Achnatherum, Hesperostipa*, and/or *Nassella* spp. (= *Stipa* spp.). Forbs are rare; the only forb noted with more than trace cover was *Calochortus nuttallii*. Biological soil crusts may be absent, but were noted with 70% cover in one example of this type.

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Global Vegetation: Stands of this *Ephedra viridis* association usually occur as patches of one to several hectares within a matrix of other sandy communities dominated by *Coleogyne ramosissima* or *Artemisia filifolia*, although occasionally it will be the matrix community. The appearance is that of a grassland containing large, low-growing clonal clumps of *Ephedra viridis*. The total vegetation cover ranges from 6 to 85% in these sparsely to moderately vegetated stands. This short-shrub association is characterized by an open to moderately dense canopy of *Ephedra viridis* that ranges in cover from 2 to 55% and the short bunchgrass *Pleuraphis jamesii* that ranges in cover from 1 to 15%. If *Achnatherum hymenoides* and *Hesperostipa comata* are present, it is with much less cover than *Pleuraphis jamesii*. Associated shrubs include *Atriplex canescens, Acamptopappus sphaerocephalus, Ephedra torreyana, Gutierrezia sarothrae* and other *Gutierrezia* species, *Opuntia polyacantha* and other *Opuntia* species, and *Yucca angustissima*. The herbaceous layer is diverse in terms of species composition and provides sparse to low cover (<20%). Associated graminoids include *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Sporobolus airoides, Sporobolus cryptandrus, Sporobolus contractus,* and *Sporobolus flexuosus*, as well as the annual exotic grass *Bromus tectorum* (up to 15% cover). Forb cover is low but may be diverse. Associated forbs include *Calochortus nuttallii, Cryptantha crassisepala, Eriogonum cernuum, Gilia inconspicua, Helianthus petiolaris, Lappula occidentalis, Lupinus pusillus, Mentzelia albicaulis, Packera multilobata (= Senecio multilobatus), Plantago patagonica,* and *Sphaeralcea parvifolia*.

Global Dynamics: *Ephedra viridis* takes the form of a clonal, unbranched shrub in this association, appearing almost grasslike in stature. It is known to sprout vigorously from roots or woody rootcrowns or establish by seed following fire (Anderson 2001b). These fire adaptations may favor it over more fire-sensitive species such as *Coleogyne ramosissima*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Pleuraphis jamesii*, *Sporobolus* spp.

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Achnatherum hymenoides, Ephedra viridis, Hesperostipa comata, Pleuraphis jamesii, Sphaeralcea parvifolia*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*, *Schismus barbatus* (High/Medium)
Global: Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (22-Mar-2005).

Related Concepts

Global Similar Types:

- *Ephedra viridis / (Achnatherum hymenoides, Hesperostipa comata)* Shrubland (CEGL002354)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. It is not clear what the habitat differences are that determine whether this association or *Ephedra viridis / (Achnatherum hymenoides, Hesperostipa comata)* Shrubland (CEGL002354) will occupy a site; both prefer relatively level sites with loose sandy soils. Yet they are distinct; on the Island in the Sky in Canyonlands National Park, there is a boundary between the two associations so sharp you can stand astride it.

Element Distribution

Glen Canyon National Recreation Area Range: This shrubland is distributed on deep, fine soils within the recreation area and was sampled on Waterhole Flat, Allen Dump, The Sand Hills, Lone Rock, near The Cove, in Wagon Box Canyon, Little Valley Canyon, Moody Canyon, and Cove Canyon.

Global Range: This association is known from the Colorado Plateau in southeastern Utah and likely occurs in adjacent states.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Deep, fine soils seem to contribute to this community's environment. Large, flat plateau, sandy substrate with a firm compacted surface layer. Perhaps a history of grazing/overgrazing.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, 2012, and 2013 field data (12 plots): (Plots: GLCA.0767, GLCA.1015, GLCA.1059, GLCA.2042, GLCA.2090, GLCA.5059, GLCA.5231, GLCA.5291, GLCA.5295, GLCA.5297, GLCA.5301, GLCA.5307).

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Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Anderson 2001b, Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.*

A0862 Poliomintha incana Shrubland Alliance
Alliance Summary Description: Vegetation included in this alliance is characterized by a sparse woody layer dominated by the xeromorphic evergreen shrub *Poliomintha incana* with *Artemisia filifolia* present to codominant on some sites. The two different habitats in which this alliance occurs, stabilized and shifting sands, produce stands with different associated species. Stabilized deep-sand sites in northern New Mexico have higher shrub diversity with scattered *Juniperus monosperma* and *Pinus edulis* trees. Common shrubs and dwarf-shrubs include *Brickellia californica, Ericameria nauseosa var. bigelovii (= Chrysothamnus nauseosus ssp. bigelovii, Gutierrezia sarothrae,* and the cacti *Opuntia phaeacantha* and *Opuntia polyacantha*. The perennial grasses *Bouteloua gracilis, Pleuraphis jamesii, Schizachyrium scoparium,* and *Sporobolus cryptandrus* are the most common dominants in the herbaceous layer. The stands described from the dune area have a sparse herbaceous layer that is dominated by perennial graminoids such as *Sporobolus flexuosus* or by annual forbs such as *Chamaesyce parryi* that are seasonally present to abundant in wet years. Weedy annual forbs such as *Amaranthus* spp., *Dimorphocarpa wislizeni (= Dithyrea wislizeni),* and the exotic *Conyza canadensis* are common. This shrubland alliance occurs on sandy sites in the Colorado Plateau in southeastern Utah and northern Arizona, to northern New Mexico. Stands occur in both stabilized deep sand and areas near active dunes.

[CEGL002418] Poliomintha incana - Artemisia filifolia - Vanclevea stylosa Shrubland
Translated Name: Frosted Mint - Sand Sagebrush - Pillar False Gumweed Shrubland
Common Name:

USNVC Classification

Division: estern North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Poliomintha incana* Shrubland Alliance (A0862)

Element Concept

Global Summary: This Colorado Plateau shrubland is characterized by a mixed open canopy consisting of a combination of *Poliomintha incana, Artemisia filifolia,* and *Vanclevea stylosa*. One of these shrubs may be absent, but at a minimum either *Poliomintha incana* or *Vanclevea stylosa* is always present. Associated shrubs commonly include *Atriplex canescens, Ephedra viridis, Eriogonum leptocladon, Gutierrezia sarothrae, Opuntia polyacantha,* and/or *Yucca harrimaniae*. If *Coleogyne ramosissima* is present, it is with very low cover relative to the diagnostic species. The herbaceous layer has moderate to high species diversity with sparse to low cover. Consistent grasses include *Achnatherum hymenoides, Aristida purpurea,* and *Muhlenbergia pungens*. Forb composition varies greatly among stands, but species tend to be sand specialists such as *Abronia fragrans, Ambrosia*

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acanthicarpa, Cryptantha crassisepala, Chamaesyce parryi (= Euphorbia parryi), Hymenopappus filifolius, Iva acerosa, Oenothera pallida, Stephanomeria exigua, and *Streptanthella longirostris*. Total vegetation cover ranges from 5 to 55%. Stands occur on loose deep sand of dunes, benches, and sandsheets, as well as on stabilized dunes or intermittent washes on valley floors. Stands are flat to steep (up to 30%), occur between 1102 and 1900 m (3615-6235 feet) elevation and tend to be oriented to southern or eastern aspects. Soils are poorly developed, rapidly drained sands and sandy loams derived from eolian sands.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland occurs on active and stabilized sand dunes, on climbing and falling dunes lying against a steep canyon side or in canyon bottom, also on hills, plateaus, and terraces. Sites are flat to moderately sloping (up to 28°), oriented to all (or variable) aspects, and lie between 1102 and 1900 m elevation. Sand and bare soil cover most of the unvegetated surface, with lesser cover by litter, gravel, dark cyanobacteria, or bedrock. Soils are rapidly drained to well-drained sandy loams, silt loams, loams, sands or loamy sands derived from eolian deposits.

Global Environment: This short-shrub association occurs where there is loose, blowing sand on dunes, benches, and sandsheets, or on stabilized dunes on steep canyonsides, as well as on intermittent channels in southeastern Utah. Stands are generally located on flat to steep slopes (up to 48%) between 1102 and 1900 m (3615-6235 feet) elevation and tend to be oriented to southern or eastern aspects. The ground surface has low amount of litter and moderate to high cover of sand, bare soil, or exposed bedrock. Biological soil crusts range from absent to moderate with up to 25% cover. Soils are poorly developed, rapidly drained sands, sandy loams, silt loams, loams, or loamy sands derived from eolian sands and sandy alluvium. Parent materials include Navajo and Entrada sandstone formations.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This unusual mixed sand shrubland is widespread on sandy blowouts within the recreation area. Total vegetation does not exceed 35% and may be as low as 1-2% in areas with actively blowing sand. This short-shrub association is characterized by a mixed, sparse to moderately dense canopy consisting of a combination of *Poliomintha incana, Artemisia filifolia*, and *Vanclevea stylosa*. One of these shrubs may be absent, but at a minimum either *Poliomintha* or *Vanclevea* is always present. The shrub layer is dominated by *Poliomintha incana* (absent to 3% cover), *Artemisia filifolia* (absent to 8% cover), and *Vanclevea stylosa* (absent to 7% cover). In most stands, *Ephedra viridis* or *Ephedra cutleri* was also codominant in the shrub layer. Other associated shrubs include *Atriplex canescens, Brickellia longifolia, Eriogonum leptocladon, Ephedra torreyana, Ericameria nauseosa, Krascheninnikovia lanata, Psoralidium junceum, Quercus havardii var. tuckeri, Psorothamnus fremontii, Gutierrezia* spp., and *Yucca baileyi*. *Achnatherum hymenoides* is almost always present in the understory, with up to 10% cover. Other graminoids with sparse to low cover may include *Muhlenbergia pungens, Pleuraphis jamesii, Sporobolus contractus, Sporobolus flexuosus, Bouteloua gracilis, Schismus barbatus*, and *Bromus tectorum*. Forbs include species typical of sandy soils: *Abronia fragrans, Mentzelia albicaulis, Hymenopappus filifolius, Salsola tragus*, and *Penstemon ambiguus*.

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Global Vegetation: This short-shrub association is characterized by a mixed, sparse to moderately dense canopy consisting of a combination of *Poliomintha incana, Artemisia filifolia,* and *Vanclevea stylosa*. One of these shrubs may be absent, but at a minimum either *Poliomintha* or *Vanclevea* is always present. Associated shrubs commonly include *Atriplex canescens, Brickellia microphylla, Dalea flavescens, Ephedra cutleri, Ephedra viridis, Ephedra torreyana, Ericameria nauseosa, Eriogonum leptocladon, Gutierrezia sarothrae, Krascheninnikovia lanata, Psoralidium junceum, Quercus havardii var. tuckeri, Psorothamnus fremontii, Opuntia polyacantha,* and *Yucca harrimaniae*. If *Coleogyne ramosissima* is present, it is with very low cover relative to the diagnostic species. The herbaceous layer is moderate to high in terms of species diversity and typically provides sparse to low cover, except in cases where the exotic annual forb *Salsola tragus* may have up to 15% cover. *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Muhlenbergia pungens, Sporobolus cryptandrus, Sporobolus flexuosus,* and *Vulpia octoflora* are the most consistent grasses other than the exotic annual *Bromus tectorum*. Forb composition varies greatly among stands, but species tend to be sand specialists such as *Abronia fragrans, Ambrosia acanthicarpa, Astragalus mollissimus, Cryptantha crassisepala, Cryptantha flava, Chamaesyce parryi (= Euphorbia parryi), Hymenopappus filifolius, Ipomopsis gunnisonii, Iva acerosa, Mentzelia albicaulis, Oenothera pallida, Penstemon ambiguus, Plantago patagonica, Salsola tragus, Sphaeralcea parvifolia, Stephanomeria exigua,* and *Streptanthella longirostris*. Cryptogams are absent from some stands but can provide up to 30% cover. Isolated *Juniperus osteosperma* occur in some stands where the sand is shallow over bedrock. Total vegetation cover ranges from 5 to 55%. This association often occurs as small patches in a matrix of other sand dune communities typical of the Colorado Plateau often dominated by *Coleogyne ramosissima* or *Artemisia filifolia*.

Global Dynamics: Of all the associations on the Colorado Plateau associated with sand dunes, this association is generally on the most active sites, with blowing sand and little perennial ground cover between shrubs. As the dunes stabilize they are subject to invasion by blackbrush and/or sand sage.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Artemisia filifolia*, *Eriogonum leptocladon*, *Vanclevea stylosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra cutleri*, *Ephedra viridis*
Herb (field)	Flowering forb	*Salsola tragus*
Herb (field)	Graminoid	*Achnatherum hymenoides*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Artemisia filifolia*, *Eriogonum leptocladon*, *Poliomintha incana*, *Vanclevea stylosa*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Muhlenbergia pungens*

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Characteristic Species

Glen Canyon National Recreation Area:
Global: *Abronia fragrans, Achnatherum hymenoides, Artemisia filifolia, Atriplex canescens, Ephedra viridis, Eriogonum leptocladon, Mentzelia multiflora, Muhlenbergia pungens, Oenothera pallida, Opuntia polyacantha, Poliomintha incana, Vanclevea stylosa*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Psoralidium junceum* (G3), *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus tectorum* (High), *Elymus repens* (High/Medium), *Salsola tragus*, *Schismus barbatus* (High/Medium)

Global: Vulnerable Plants: *Psoralidium junceum* (G3), *Quercus havardii* var. *tuckeri* (G4T3?Q), *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*, *Tamarix chinensis*

Conservation Status Rank

Global Rank & Reasons: GNR (24-Mar-2005).

Related Concepts

Global Similar Types:
- *Artemisia filifolia* Colorado Plateau Shrubland (CEGL002697)
- *Eriogonum leptocladon* Sparse Vegetation (CEGL002822)
- *Poliomintha incana / (Pleuraphis jamesii)* Shrubland (CEGL002930)
- *Poliomintha incana / Muhlenbergia pungens* Shrubland (CEGL002672)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This shrubland association is widespread on deep sandy blowout areas within the recreation area and was sampled in Big Spring Canyon, Millard Canyon, Moqui Canyon, Coyote Gulch, Willow Gulch, Hurricane Wash, Cane Springs Desert, above Tapestry Wall, near Wahweap, Warm Creek Bay, Hall's Crossing, Allen Dump, Bullfrog, Hole-in-the-Rock, on Burr Trail and on Muley Point.

Global Range: This association has been documented from the Colorado Plateau in southeastern Utah.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC

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Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Wind-blown sand dune habitat. Vegetation is denser in the swales between sand ridges. Some shrubs have exposed bases. Patches of cyanobacteria hold the soil in place.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, and 2012 field data (22 plots): (Plots: GLCA.0721, GLCA.0726, GLCA.1056, GLCA.2041, GLCA.4043, GLCA.4129, GLCA.4131, GLCA.4136, GLCA.4310, GLCA.5024, GLCA.5029, GLCA.5032, GLCA.5097, GLCA.5101, GLCA.5175, GLCA.5199, GLCA.5212, GLCA.5217, GLCA.5230, GLCA.5262, GLCA.5272, GLCA.5437).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.*

A2654 Quercus havardii var. tuckeri Shrubland Alliance

Alliance Summary Description: The vegetation is dominated by patches of *Quercus havardii var. tuckeri* shrubs that range in cover from 5 to 85%. Because shrub roots anchor the sandy soil in this erosive habitat, *Quercus havardii var. tuckeri* shrubs often occupy hummocks of sand as much as a meter high. Associated shrubs include *Coleogyne ramosissima, Ephedra viridis, Gutierrezia sarothrae, Opuntia polyacantha*, and *Shepherdia rotundifolia*. The herbaceous layer provides sparse cover. Graminoids present often include *Achnatherum hymenoides, Muhlenbergia pungens, Pleuraphis jamesii*, and *Vulpia octoflora*. Scattered forbs may include *Cryptantha* sp., *Hymenopappus filifolius, Lepidium montanum*, and *Streptanthella longirostris*. Scattered *Juniperus osteosperma* trees are present in some stands. This Colorado Plateau shrubland alliance is currently known from Utah but may extend into western Colorado. Stands are restricted to dunes, sandsheets and pockets of sand on mesas, plateaus and valley bottoms. Sites are generally on flat, gentle slopes, with a few sites on moderately steep (50%) slopes. Elevations range between 1335 and1772 m, and aspect is not a major factor in determining the distribution of this association. Bare ground or loose sand cover most of the unvegetated surface, although in less-disturbed sites biological soil crusts can have as much as 30% cover. Soils are rapidly drained, deep loamy sands and sandy loams derived from alluvium or eolian deposits.

[CEPP005692] Quercus havardii var. tuckeri - Eriogonum leptocladon - Artemisia filifolia Sandsheet Shrubland
Translated Name: Tucker Sand Shinnery Oak - Sand Buckwheat - Sand Sagebrush Sandsheet Shrubland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)

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Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Quercus havardii var. tuckeri* Shrubland Alliance (A2654)

Element Concept

Global Summary: This shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely in sandy areas in the Colorado Plateau. It is characterized by a mixed, sparse to moderately dense canopy of *Quercus havardii*, *Artemisia filifolia*, and *Eriogonum leptocladon*, usually with less than 10% cover each. One of these shrubs may be absent, but at a minimum either *Quercus* or *Eriogonum* is always present. In many stands, *Ephedra viridis, Ephedra cutleri*, and/or *Psorothamnus fremontii* share dominance in the shrub layer. Many other associated shrubs may be present with sparse to low cover. The herbaceous layer has sparse to low cover and is dominated by native grasses *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Sporobolus contractus, Sporobolus flexuosus*, and *Sporobolus giganteus*. Sparse to low cover of the exotic annual grass *Bromus tectorum* may be present. Forb cover is sparse. Total vegetation cover is between 5 and 32%. Stands occur on plateaus, mesas, sand dunes, and valley floors between 1160 and 1550 m elevation. Sites are flat to moderately sloping and are generally oriented to the southwest and west. Bare soil and sand cover are abundant, with lesser cover by bedrock. Soils are sandy loams, silts, loamy sands, and sands derived from eolian deposits or from sandstones.

Environmental Description

Glen Canyon National Recreation Area Environment: This dune-like shrubland association occurs on plateaus, mesas, sand dunes, and valley floors. Sites are flat to moderately sloping (up to 25°), are generally oriented to the southwest and west, and lie between 1160 and 1550 m elevation. Bare soil and sand cover most of the unvegetated surface, with lesser cover by bedrock, and sparse to low cover of dark cyanobacteria, litter, gravel, and live vegetation wood. Soils are well-drained to rapidly drained sandy loams, silts, loamy sands, and sands derived from eolian deposits or from sandstones of the Page or Navajo formations.

Global Environment: This shrubland association occurs in the Colorado Plateau on plateaus, mesas, sand dunes, and valley floors between 1160 and 1550 m elevation. Sites are flat to moderately sloping (up to 25°), are generally oriented to the southwest and west. Bare soil and sand cover are abundant, with lesser cover by bedrock. Soils are well-drained to rapidly drained sandy loams, silts, loamy sands, and sands derived from eolian deposits or from sandstones of the Page or Navajo formations.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sand-loving shrubland has total vegetation cover between 5 and 32%. This short-shrub association is characterized by a mixed, sparse to moderately dense canopy consisting of a combination of *Quercus havardii, Artemisia filifolia*, and *Eriogonum leptocladon*. One of these shrubs may be absent, but at a minimum either *Quercus* or *Eriogonum* is always present. The shrub layer is dominated by *Quercus havardii* (absent to 10% cover), *Artemisia filifolia* (absent to 4% cover), and *Eriogonum leptocladon* (absent to 6% cover). In many stands, *Ephedra viridis, Ephedra cutleri*, and/or *Psorothamnus fremontii* share dominance in the

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shrub layer. Other associated shrubs with sparse to low cover may include *Artemisia bigelovii, Atriplex canescens, Coleogyne ramosissima, Ephedra torreyana, Gutierrezia* spp., *Opuntia* spp., *Vanclevea stylosa*, and *Yucca angustissima*. The understory consists of sparse to low cover of the native grasses *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Sporobolus contractus, Sporobolus flexuosus, Sporobolus giganteus,* and *Vulpia octoflora (= Festuca octoflora)*. It may also include sparse to low cover of the exotic annual grass *Bromus tectorum*. Forbs noted with more than trace cover include *Cordylanthus wrightii, Lepidium montanum, Oenothera pallida,* and *Plantago patagonica*.

Global Vegetation: This sandsheet shrubland association is characterized by a mixed, sparse to moderately dense canopy of *Quercus havardii, Artemisia filifolia*, and *Eriogonum leptocladon,* usually with less than 10% cover each. One of these shrubs may be absent, but at a minimum either *Quercus* or *Eriogonum* is always present. In many stands, *Ephedra viridis, Ephedra cutleri*, and/or *Psorothamnus fremontii* share dominance in the shrub layer. Many other associated shrubs may be present with sparse to low cover, such as *Artemisia bigelovii, Atriplex canescens, Coleogyne ramosissima, Ephedra torreyana, Gutierrezia* spp., *Opuntia* spp., *Vanclevea stylosa*, and *Yucca angustissima*. The herbaceous layer has sparse to low cover and is dominated by native grasses *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Sporobolus contractus, Sporobolus flexuosus, Sporobolus giganteus,* and *Vulpia octoflora*. Sparse to low cover of the exotic annual grass *Bromus tectorum* may be present. Forb cover is generally sparse and includes *Cordylanthus wrightii, Lepidium montanum, Oenothera pallida*, and *Plantago patagonica*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Artemisia filifolia*, *Eriogonum leptocladon*, *Quercus havardii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Artemisia filifolia*, *Eriogonum leptocladon*, *Quercus havardii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Artemisia filifolia, Eriogonum leptocladon, Quercus havardii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*
Global: Invasive/Exotic Plants: *Bromus tectorum* (High)

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Conservation Status Rank

Global Rank & Reasons: GNR (18-Aug-2016).

Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon shrubland occurs above Davis Gulch, above The Rincon, above Fiftymile Gulch, near Egypt, Glen Canyon Dam, Hole-in-the Rock Road, and in Indian Creek.

Global Range: This shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely in sandy areas in the Colorado Plateau.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Local depression surrounded by slightly higher elevation slickrock segments to the west, north, and east. This segment has relatively deeper soil and receives runoff from those surrounding areas.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, 2013, and 2015 field data (3 plots, 4 accuracy assessment points): (Plots: GLCA.4343, GLCA.5233, GLCA.5582; AA Points: GLCA_AA.1799, GLCA_AA.1803, GLCA_AA.2090, GLCA_AA.3057).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEGL002486] Quercus havardii var. tuckeri Shrubland
Translated Name: Tucker Sand Shinnery Oak Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Alliance: *Quercus havardii var. tuckeri* Shrubland Alliance (A2654)

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Element Concept

Global Summary: Total vegetation cover ranges from 10 to 110% in these sparsely to moderately vegetated stands. The vegetation is dominated by patches of *Quercus havardii var. tuckeri* shrubs that range in cover from 5 to 85%. Because shrub roots anchor the sandy soil in this erosive habitat, *Quercus havardii var. tuckeri* shrubs often occupy hummocks of sand as much as a meter high. Associated shrubs include *Artemisia filifolia, Amelanchier utahensis, Coleogyne ramosissima, Ephedra cutleri, Ephedra torreyana, Ephedra viridis, Gutierrezia sarothrae, Shepherdia rotundifolia, Opuntia polyacantha,* and *Vanclevea stylosa,*. The herbaceous layer provides sparse cover. Graminoids present often include *Achnatherum hymenoides, Muhlenbergia pungens, Pleuraphis jamesii*, and *Vulpia octoflora*. Scattered forbs may include *Cryptantha* sp., *Streptanthella longirostris, Hymenopappus filifolius,* and *Lepidium montanum*. Scattered *Juniperus osteosperma* trees are present in some stands. This short-shrub association is restricted to dunes, sandsheets and pockets of sand on mesas, plateaus and valley bottoms in southeastern Utah. Sites are generally on flat or gentle slopes, with a few sites on moderately steep (50%) slopes. Elevations range between 1222 and 1772 m, and aspect is not a major factor in determining the distribution of this association. Bare ground or loose sand cover most of the unvegetated surface, although in less-disturbed sites biological soil crusts can have as much as 30% cover. Soils are rapidly drained, deep loamy sands and sandy loams derived from alluvium or eolian deposits.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland association occurs on deep sand deposits and stabilized and active sand dunes on slickrock mesatops and along washes. Sites are flat or moderately sloping (up to 13°), include variable aspects, and lie between 1222 and 1579 m elevation. Bare soil, sand, or bedrock cover most of the unvegetated surface, with lesser cover by litter and gravel. Soils are well-drained sandy loams or loamy sands derived from Navajo sandstone, Cedar Mesa sandstone, or eolian deposits.

Global Environment: This short-shrub association is restricted to dunes, sandsheets and pockets of sand on mesas, plateaus and valley bottoms in southeastern Utah. Sites are generally on flat or gentle slopes, with a few sites on moderately steep (50%) colluvial slopes. Elevations range between 1222 and 1772 m, and aspect is not a major factor in determining the distribution of this association. Bare ground or sand cover most of the unvegetated surface, although in less-disturbed sites biological soil crusts can have as much as 30% cover. Soils are rapidly drained, deep loamy sands and sandy loams derived from Navajo sandstone, Cedar Mesa, Dakota, Entrada or Morrison formation sandstones that have eroded and been distributed to alluvium or eolian deposits.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This rare shrubland has a total vegetation cover ranging between 6 and 53%. The shrub canopy is dominated by clumps of *Quercus havardii var. tuckeri* with between 2 and 30% cover. Associated shrubs include *Vanclevea stylosa, Coleogyne ramosissima, Artemisia filifolia, Ephedra torreyana, Ephedra cutleri, Amelanchier utahensis, Gutierrezia sarothrae*, and *Yucca angustissima*. Scattered *Juniperus osteosperma* trees provide sparse cover in some stands. The herbaceous layer may have trace to low cover. Grasses present include

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Achnatherum hymenoides, Muhlenbergia pungens, Sporobolus cryptandrus, Vulpia octoflora (= Festuca octoflora), and *Bromus tectorum*. Forbs include *Hymenopappus filifolius, Cordylanthus wrightii,* and *Psoralidium junceum.*

Global Vegetation: This uncommon shrubland association has total vegetation cover ranging from 10 to 110% in these sparsely to densely vegetated stands. This shrubland is dominated by patches of *Quercus havardii var. tuckeri* shrubs that range in cover from 5 to 85%. Because shrub roots anchor the sandy soil in this erosive setting, *Quercus havardii var. tuckeri* shrubs often occupy hummocks of sand as much as a meter high. Associated shrubs include *Artemisia filifolia, Amelanchier utahensis, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Eriogonum microthecum, Ephedra cutleri, Ephedra torreyana, Ephedra viridis, Fraxinus anomala, Gutierrezia sarothrae, Shepherdia rotundifolia, Opuntia erinacea, Opuntia polyacantha, Purshia stansburiana, Shepherdia rotundifolia, Vanclevea stylosa,* and *Yucca angustissima*. The herbaceous layer provides sparse cover. Graminoids present often include *Achnatherum hymenoides, Muhlenbergia pungens, Pleuraphis jamesii,* and *Vulpia octoflora*; forbs may include *Cryptantha* sp., *Streptanthella longirostris, Hymenopappus filifolius,* and *Lepidium montanum*. Scattered *Juniperus osteosperma* trees are present in some stands. The herbaceous layer tends to be sparse and depauperate. Grasses present may include *Achnatherum hymenoides, Aristida purpurea, Muhlenbergia pungens, Pleuraphis jamesii, Sporobolus cryptandrus, Vulpia octoflora,* and the exotic *Bromus tectorum*. Scattered forbs *Chenopodium album, Chenopodium atrovirens, Comandra umbellata, Cryptantha* sp., *Eriogonum shockleyi, Hymenopappus filifolius, Lepidium montanum, Packera multilobata (= Senecio multilobatus), Rumex hymenosepalus, Streptanthella longirostris,* and *Tetraneuris acaulis* may be present. Biological soil crusts do not exceed 20% cover and tend to be in an early stage of development (mostly mosses and dark cyanobacteria). Occasional *Juniperus osteosperma* and *Pinus edulis* may be present, and *Juniperus osteosperma* seedlings were observed near one stand.

Global Dynamics: Sites are constantly exposed to erosion by wind and between dune areas may be scoured to alluvial surfaces. This vegetation is well-adapted to its dynamic environment.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Artemisia filifolia*, *Quercus havardii* var. *tuckeri*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Muhlenbergia pungens*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Quercus havardii* var. *tuckeri*

Characteristic Species

Glen Canyon National Recreation Area:

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Global: *Achnatherum hymenoides*, *Coleogyne ramosissima*, *Muhlenbergia pungens*, *Pleuraphis jamesii*, *Quercus havardii* var. *tuckeri*, *Shepherdia rotundifolia*, *Streptanthella longirostris*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Psoralidium junceum* (G3), *Quercus havardii* var. *tuckeri* (G4T3?Q), *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus tectorum* (High)

Global: Vulnerable Plants: *Quercus havardii* var. *tuckeri* (G4T3?Q), *Shepherdia rotundifolia* (G3G4), *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus tectorum* (High); Other Plants: *Ephedra viridis* (G5)

Conservation Status Rank

Global Rank & Reasons: GNR (29-Mar-2005).

Related Concepts

Global Similar Types:

- *Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri* Shrubland (CEGL002348)
- *Pinus edulis - Juniperus osteosperma / Quercus havardii var. tuckeri* Woodland (CEGL002497)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This rare shrubland association occurs in small patches within the recreation area. It was sampled in Davis Gulch, Clyde Wash, Steer Gulch, and near Hole-in-the-Rock.

Global Range: This association occurs in southeastern Utah.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Area consists of tall sand dunes with slickrock at its eastern border and a terrace above a broad drainage at its western border. Soil is deep and loose, dunes are held in place by *Quercus havardii* mostly.

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Glen Canyon National Recreation Area Plots: The description is based on 2012, 2014, and 2015 field data (2 plots, 3 accuracy assessment points): (Plots: GLCA.4343, GLCA.5267; AA Points: GLCA_AA.0397, GLCA_AA.1800, GLCA_AA.1867).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and K.A. Schulz
References: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.*

G311. Intermountain Semi-Desert Grassland
Group Summary Description: This widespread group includes semi-arid to arid grasslands found throughout the intermountain western U.S. The dominant perennial bunchgrasses and shrubs within this group are all drought-resistant plants. Dominant or codominant species are *Achnatherum hymenoides, Achnatherum lettermanii, Achnatherum nelsonii, Achnatherum speciosum, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii, Poa cusickii, Poa secunda, Pseudoroegneria spicata*, and *Sporobolus cryptandrus.* Scattered shrubs and dwarf-shrubs often are present, especially *Artemisia tridentata ssp. tridentata, Artemisia tridentata ssp. wyomingensis, Atriplex* spp., *Coleogyne ramosissima, Ephedra* spp., *Gutierrezia sarothrae*, and *Krascheninnikovia lanata,* which are the typical dominant species of adjacent shrublands. Stands occur on sites on a variety of landforms, including swales, playas, mesas, alluvial flats, and plains over an elevational range of approximately 1100 to 3290 m in most of its range and 350 to 425 m in the Columbia Basin. This group may constitute the matrix over large areas of intermountain basins, and also may occur as large patches in mosaics with semi-desert shrublands. Grasslands in areas of higher precipitation, at higher elevation, typically belong to other groups. Substrates are often well-drained sandy or loam soils derived from sedimentary parent materials but are quite variable and may include fine-textured soils derived from igneous and metamorphic rocks.

A1262 Achnatherum hymenoides - Pseudoroegneria spicata - Muhlenbergia pungens Grassland Alliance
Alliance Summary Description: Vegetation of this alliance is characterized by a sparse to moderately dense herbaceous layer of graminoids, the most of common of which include *Achnatherum hymenoides, Muhlenbergia pungens,* and *Pseudoroegneria spicata*. Other common graminoid associates may include *Hesperostipa comata (= Stipa comata), Koeleria macrantha, Leucopoa kingii, Pascopyrum smithii, Pleuraphis jamesii (= Hilaria jamesii), Poa fendleriana, Poa secunda, Redfieldia flexuosa,* and *Schizachyrium scoparium*. Scattered shrubs may be found throughout stands. Forbs are rarely important, although cushion plants may be a prominent feature in some stands. These grasslands occur throughout the southern and middle Rocky Mountains and Colorado Plateau, into adjacent ecoregions. Habitats are variable and may include sand dunes and deposits, shale barrens, rocky or badland slopes, foothills, mesas, ridgetops, plateaus and saddles. Sites are flat to gently sloping between 1220 and 2700 m elevation.

[CEGL001652] Achnatherum hymenoides - Sporobolus contractus Grassland
Translated Name: Indian Ricegrass - Spike Dropseed Grassland
Common Name:

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USNVC Classification

Division: estern North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Grassland (G311)
Alliance: *Achnatherum hymenoides - Pseudoroegneria spicata - Muhlenbergia pungens* Grassland Alliance (A1262)

Element Concept

Global Summary: Total vegetation cover of this grassland association in upland sites with blowing sand is usually quite sparse, rarely exceeding 10%. Sites on sandy terraces and point bars may have up to 30% cover by vascular plants, with another 25% cover provided by biological soil crusts. *Achnatherum hymenoides* is the dominant species, ranging in cover between 3 and 15%. A scattering of shrubs may be present, with no species exceeding 1% cover and the total not exceeding 5% cover. Associated shrubs include *Amsonia tomentosa, Artemisia filifolia, Atriplex canescens, Ephedra torreyana, Ephedra viridis, Poliomintha incana, Vanclevea stylosa, Gutierrezia sarothrae,* and *Opuntia polyacantha*. Some stands may contain scattered *Juniperus osteosperma* trees or saplings. Associated graminoids include the short bunchgrasses *Aristida purpurea, Sporobolus cryptandrus,* and *Pleuraphis jamesii*. Forbs present include *Abronia fragrans* and *Sphaeralcea parvifolia*. This grassland association usually occurs in small patches (<1 ha) on upland eolian sand deposits, as well as on sandy alluvial terraces and point bars along intermittent washes in eastern Utah and northwestern Colorado. It is likely to occur in small patches throughout the Colorado Plateau. Disturbance is usually a factor; upland sites often have blowing sand, and wash sites are subject to periodic flooding. Sites are flat to gently sloping (not exceeding 10%) between 1220 and 1815 m elevation. The unvegetated surface has high cover by bare soil or sand, low cover by litter, and biological soil crusts may have up to 30% cover. Soils are rapidly drained sands or sandy loams derived from alluvium or eolian deposits.

Environmental Description

Glen Canyon National Recreation Area Environment: This herbaceous association occurs on deep, sandy soils of canyon sideslopes, dunes, bajadas, benches, and mesatops. Stands occur on moderately to steeply sloping sites (up to 36°), rarely on flat sites, at cooler aspects (oriented mainly to the north and east), and lie between 1153 and 1544 m. The unvegetated surface has moderate to high exposure of bare soil or sand, low to moderate cover of dark cyanobacteria, mosses, and litter, and sparse to low cover of large rocks and bedrock. Soils are well-drained sands or sandy loams derived from eolian or alluvial deposits or from Navajo sandstone or the Kayenta Formation.

Global Environment: This grassland association occurs on upland eolian sand deposits, as well as on sandy alluvial terraces and point bars along intermittent washes in eastern Utah and northwestern Colorado. It is likely to occur in small patches throughout the Colorado Plateau. Sites are flat to gently sloping (not exceeding 10%) between 1220 and 1815 m elevation. The unvegetated surface has high cover by bare soil or sand, low cover by litter, and biological soil crusts may have up to 30% cover. Soils are rapidly drained sands or sandy loams derived from alluvium or eolian deposits.

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Vegetation Description

Glen Canyon National Recreation Area Vegetation: This grassland becomes established on deep sandy soils of generally cool aspect, moderately steep canyon slopes throughout the recreation area. Total vegetation cover ranges from 8 to 38% and is characterized the codominance of the medium-tall bunchgrasses *Achnatherum hymenoides* (with 1-12% cover) and *Sporobolus contractus* (with 1-20% cover). One stand is dominated by the forb *Sphaeralcea leptophylla*, with 12% cover, and codominated by the two grasses in the association name. Other graminoid species contribute low to moderate cover and include *Pleuraphis jamesii, Sporobolus cryptandrus, Sporobolus flexuosus, Sporobolus giganteus, Bromus rubens,* and Poaceae sp. Forbs present with low cover include *Plantago patagonica* and *Machaeranthera canescens.* Shrubs occur scattered throughout this association but generally do not have high enough cover to constitute a layer. The more common associated shrubs include *Atriplex canescens, Artemisia filifolia, Ericameria nauseosa, Ephedra torreyana, Ephedra viridis, Ephedra cutleri, Eriogonum leptocladon, Psorothamnus fremontii, Vanclevea stylosa, Gutierrezia* spp., and *Opuntia* spp. *Juniperus osteosperma* trees and tall *Quercus gambelii* shrubs may occur on the margins of the community or as a few scattered individuals. Biological soil crust cover varies, with some stands having none, and others having cover as high as 40%.

Global Vegetation: Small patches (usually less than 1 ha) of this distinctive grassland type occur sporadically in the Colorado Plateau of southeastern Utah. Total vegetation cover in upland sites with blowing sand is usually quite sparse, rarely exceeding 10%. Sites on sandy terraces and point bars may have up to 30% cover by vascular plants, with another 25% cover provided by biological soil crusts. *Achnatherum hymenoides* is the dominant species, ranging in cover between 3 and 15%. A scattering of shrubs may be present, with no species exceeding 1% cover and the total not exceeding 5% cover. Associated shrubs include *Amsonia tomentosa, Artemisia filifolia, Atriplex canescens, Ephedra torreyana, Ephedra viridis, Gutierrezia sarothrae, Opuntia polyacantha, Poliomintha incana*, and *Vanclevea stylosa*. Some stands may contain scattered *Juniperus osteosperma* trees or saplings. Associated graminoids include the short bunchgrasses *Aristida purpurea, Sporobolus cryptandrus*, and *Pleuraphis jamesii*. Forbs present include *Abronia fragrans* and *Sphaeralcea parvifolia*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Sporobolus contractus*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Achnatherum hymenoides*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Achnatherum hymenoides, Sporobolus cryptandrus*

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Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus rubens*
Global: Vulnerable Plants: *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: G2G4 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Achnatherum hymenoides - Psoralidium lanceolatum* Grassland (CEGL001650)
- *Achnatherum hymenoides* Colorado Plateau Grassland (CEGL002343)

Global Related Concepts:

- *Oryzopsis hymenoides-Sporobolus contractus* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:V.B.4.b. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: Compare this association with *Achnatherum hymenoides - Psoralidium lanceolatum* Grassland (CEGL001650).

Element Distribution

Glen Canyon National Recreation Area Range: This herbaceous association occurs on sandy soils of canyon slopes throughout the recreation area. Areas sampled include Rock Creek Bay, Peshliki Fork, north of Harris Wash, and along the Escalante River.

Global Range: This association is documented from eastern Utah and northwestern Colorado. It is likely to occur in small stands, 0.1 to 1 ha in size, scattered throughout the Colorado Plateau.

Nations: US
States/Provinces: AZ, CO, NM?, UT:S2S4
TNC Ecoregions: 9:C, 11:C, 19:C
USFS Ecoregions (1994/95): 313B:CC, 341B:CC, M331E:CC
Federal Lands: NPS (Arches, Canyon de Chelly, Canyonlands, Capitol Reef, Dinosaur, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This is a steep slope coming off of a tall red sheer wall that casts an early afternoon shadow on this community. Loose, sandy soil defines this segment.

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Glen Canyon National Recreation Area Plots: The description is based on 2011, 2012, and 2015 field data (3 plots, 3 accuracy assessment points): (Plots: GLCA.1074, GLCA.4316, GLCA.4328; AA points: GLCA_AA.1208, GLCA_AA.1654, GLCA_AA.1937).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles
References: Bourgeron and Engelking 1994, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Driscoll et al. 1984, Romme et al. 1993, Thomas et al. 2010, Van Pelt 1978, Western Ecology Working Group n.d.*

[CEGL002343] *Achnatherum hymenoides* Colorado Plateau Grassland
Translated Name: Indian Ricegrass Colorado Plateau Grassland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Grassland (G311)
Alliance: *Achnatherum hymenoides - Pseudoroegneria spicata - Muhlenbergia pungens* Grassland Alliance (A1262)

Element Concept

Global Summary: This herbaceous vegetation association occurs in eastern Utah and northwestern Colorado. It is likely to occur in small patches throughout the Colorado Plateau. Total vegetation cover in upland sites with blowing sand is usually quite sparse, rarely exceeding 10%. Sites on sandy terraces and point bars may have up to 30% cover by vascular plants, with another 25% cover provided by biological soil crusts. *Achnatherum hymenoides* is the dominant species, ranging in cover between 3 and 15%. A scattering of shrubs may be present, with no species exceeding 1% cover and the total not exceeding 5% cover. Associated shrubs include *Amsonia tomentosa, Artemisia filifolia, Atriplex canescens, Ephedra torreyana, Ephedra viridis, Poliomintha incana, Vanclevea stylosa, Gutierrezia sarothrae,* and *Opuntia polyacantha*. Some stands may contain scattered *Juniperus osteosperma* trees or saplings. Associated graminoids include the short bunchgrasses *Aristida purpurea, Sporobolus cryptandrus*, and *Pleuraphis jamesii*. Forbs present include *Abronia fragrans* and *Sphaeralcea parvifolia*. Stands usually occur in small patches (<1 hectare) on upland eolian sand deposits, as well as on sandy alluvial terraces and point bars along intermittent washes. Disturbance is usually a factor; upland sites often have blowing sand, and wash sites are subject to periodic flooding. Sites are flat to gently sloping (not exceeding 10%) and between 1108 and 1815 m elevation. The unvegetated surface has high cover by bare soil or sand, low cover by litter, and biological soil crusts may have up to 30% cover. Soils are rapidly drained sands or sandy loams derived from alluvium or eolian deposits.

Environmental Description

Glen Canyon National Recreation Area Environment: This herbaceous association occurs in deep, sandy soils of low-lying areas, including benches, sand dunes, stream terraces, valley sides and canyon sides. Stands occur on flat to moderately sloping sites (up 21°), include all aspects, and lie between

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1108 and 1625 m. The unvegetated surface has moderate to high exposure of bare soil or sand, low to moderate cover of biological soil crusts, and sparse to low cover of litter and small rocks. Soils are rapidly drained to well-drained sands or loams derived from eolian, alluvial, or talus/colluvial deposits.

Global Environment: This herbaceous vegetation association occurs on upland eolian sand deposits, as well as on sandy alluvial terraces and point bars along intermittent washes in eastern Utah and northwestern Colorado. It is likely to occur in small patches throughout the Colorado Plateau. Sites are flat to gently sloping (not exceeding 10%), between 1108 and 1815 m elevation and include benches, sand dunes, stream terraces, valley sides and canyon sides. The unvegetated surface has high cover by bare soil or sand, low cover by litter, and biological soil crusts may have up to 30% cover. Soils are rapidly drained sands or sandy loams that are usually derived from alluvium or eolian deposits, but include talus/colluvium below sandstone cliffs.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This grassland becomes established on deep sandy soils in low-lying areas throughout the recreation area. Total vegetation cover ranges from 4 to 53% and is characterized by 3 to 37% cover of the medium-tall bunchgrass *Achnatherum hymenoides*. Other graminoid species contribute low to moderate cover and include *Pleuraphis jamesii, Sporobolus cryptandrus, Sporobolus flexuosus, Sporobolus airoides, Sporobolus contractus, Aristida purpurea, Hesperostipa comata, Schismus barbatus, Bromus tectorum,* and *Bromus rubens*. Forbs present with low cover include *Salsola tragus, Plantago patagonica, Machaeranthera canescens*, and *Cryptantha* spp. Shrubs occur scattered throughout this association but generally do not have high enough cover to constitute a layer. The more common associated shrubs include *Atriplex canescens, Artemisia filifolia, Acamptopappus sphaerocephalus, Ephedra cutleri, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Gutierrezia* spp., and *Opuntia* spp. *Juniperus osteosperma* trees may occur on the margins of the community or as a few scattered individuals. Biological soil crust cover varies, with some stands having none, and others having cover as high as 35%.

Global Vegetation: Small patches (usually less than 1 hectare) of this distinctive grassland type occur sporadically in the Colorado Plateau of southeastern Utah. Total vegetation cover in upland sites with blowing sand is usually quite sparse, rarely exceeding 10%. Sites on sandy terraces and point bars may have up to 55% cover by vascular plants, often with another 25% cover provided by biological soil crusts, although crusts can vary from 0-35 % cover. *Achnatherum hymenoides* is the dominant species, ranging in cover between 3 and 25%. A scattering of shrubs may be present, with no species exceeding 1% cover and the total not exceeding 5% cover. Associated shrubs include *Acamptopappus sphaerocephalus, Amsonia tomentosa, Artemisia filifolia, Atriplex canescens, Ephedra cutleri, Ephedra torreyana, Ephedra viridis, Gutierrezia sarothrae, Opuntia polyacantha, Poliomintha incana,* and *Vanclevea stylosa*. Some stands may contain scattered *Juniperus osteosperma* trees or saplings. Associated graminoids include the short bunchgrasses *Aristida purpurea, Pleuraphis jamesii, Sporobolus airoides*, and *Sporobolus cryptandrus*. Forbs present include *Abronia fragrans* and *Sphaeralcea parvifolia*.

Global Dynamics: Most stands are subject to soil movement because of wind erosion or catastrophic flooding. Without periodic disturbance, the community is likely to shift toward a shrubland type, such

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as *Ephedra viridis / (Achnatherum hymenoides, Hesperostipa comata*) Shrubland (CEGL002354). The bunch grasses are deeply rooted and even intense flooding, such as occurred at Natural Bridges National Monument in September 2003, fails to remove them completely from a point bar at stream level.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Short shrub/sapling	Dwarf-shrub	*Ephedra* spp., *Gutierrezia* spp.
Short shrub/sapling	Succulent shrub	*Opuntia* spp.
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Pleuraphis jamesii*, *Sporobolus* spp.

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Achnatherum hymenoides*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Achnatherum hymenoides*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Salsola tragus, Schismus barbatus* (High/Medium)

Global: Vulnerable Plants: *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: GNR (16-Mar-2005).

Related Concepts

Global Similar Types:

- *Achnatherum hymenoides - Sporobolus contractus* Grassland (CEGL001652)
- *Hesperostipa comata* Great Basin Grassland (CEGL001705)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

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Element Distribution

Glen Canyon National Recreation Area Range: This herbaceous association occurs on sandy soils in low-lying areas throughout the recreation area. Areas sampled include The Sand Hills, Cornerstone Canyon, Gunsight Canyon, Middle Moody Canyon, East Moody Canyon, Wagon Box Canyon, Padre Canyon, Waterhole Flat, Romana Mesa, west fork of Big Water Canyon, and along the Escalante River.

Global Range: This association is documented from eastern Utah and northwestern Colorado. It is likely to occur in small stands, 0.1 to 1 ha in size, scattered throughout the Colorado Plateau.

Nations: US
States/Provinces: AZ, CO, NM?, UT
TNC Ecoregions: 9:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, M331E:CC
Federal Lands: NPS (Arches, Canyon de Chelly, Canyonlands, Capitol Reef, Dinosaur, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Stabilized sand dune with a protective crust. Relatively flat dune field extends bench-like below the slickrock and cliff wall to the west.

Glen Canyon National Recreation Area Plots: The description is based on 2011, 2012, 2014, and 2015 field data (5 plots, 7 accuracy assessment points): (Plots: GLCA.1062, GLCA.1085, GLCA.2067, GLCA.2095, GLCA.4080; AA points: GLCA_AA.0072, GLCA_AA.256, GLCA_AA.1168, GLCA_AA.1169, GLCA_AA.1367, GLCA_AA.1550, GLCA_AA.3077).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and K.A. Schulz
References: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Romme et al. 1993, Thomas et al. 2010, Western Ecology Working Group n.d.*

[CEGL002363] *Muhlenbergia pungens* Grassland
Translated Name: Sandhill Muhly Grassland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Grassland (G311)
Alliance: *Achnatherum hymenoides - Pseudoroegneria spicata - Muhlenbergia pungens* Grassland Alliance (A1262)

Element Concept

Global Summary: This sandsheet association occurs in the Colorado Plateau in Utah and western Colorado and at Great Sand Dunes National Park and Preserve in south-central Colorado.

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Muhlenbergia pungens is the dominant or codominant grass, although other grasses may be important in terms of cover, including *Bouteloua gracilis, Achnatherum hymenoides, Sporobolus cryptandrus,* and *Aristida purpurea*. At Zion National Park, the community is codominated by montane grasses such as *Muhlenbergia montana* and *Poa fendleriana*. Forbs are diverse but contribute little total cover and vary widely among sites. *Machaeranthera canescens, Mentzelia multiflora, Senecio spartioides,* and *Heterotheca villosa* are common species. Scattered shrubs, such as *Atriplex confertifolia, Gutierrezia sarothrae,* and *Opuntia* spp., are often present but do not total more than 10% cover. Total vegetation cover is somewhat sparse, rarely exceeding 50% and usually closer to 25%. Stands occur locally on sand deposits, sand flats and dunes. It is dependent on a certain degree of disturbance to maintain the mid-seral species *Muhlenbergia pungens*. Elevations range from 1560 to 2256 m (5120-7400 feet), and slopes are flat to gentle. Soils are sands derived from local sandstone, eolian sands or alluvium. In areas protected from grazing, the unvegetated ground surface supports cryptobiotic crusts; in disturbed areas, bare ground cover is high.

Environmental Description

Glen Canyon National Recreation Area Environment: This association occurs on sandy flats and dunes on mesatops at elevations ranging from 1560 to 1773 m. Sand and bare soils cover most of the unvegetated surface, with sparse to low cover of litter. Soils are well-drained sands derived from eolian deposits.

Global Environment: This association occurs locally on sandy flats and dunes in southern Utah and northwestern Colorado. Elevations range from 1560 to 2256 m (5120-7400 feet), and slopes are flat to gentle. Soils are sands derived from local sandstone, eolian sands or alluvium. In areas protected from grazing, the unvegetated ground surface supports cryptobiotic crusts; in disturbed areas, bare ground cover is high.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This rare and sparse association (3-21% total cover) is dominated by *Muhlenbergia pungens,* with up to 14% cover. Scattered *Juniperus osteosperma* trees and shrubs such as *Coleogyne ramosissima, Ephedra cutleri*, and *Gutierrezia sarothrae* may be present with sparse to low cover. No other grass species are present with more than trace cover and only weedy forbs occur, including *Ambrosia acanthicarpa* and *Mentzelia multiflora*.

Global Vegetation: This association is somewhat rare and local in the Colorado Plateau of Colorado and Utah. Total vegetation cover is somewhat sparse, rarely exceeding 50% and usually closer to 25%. *Muhlenbergia pungens* is the dominant or codominant grass, although other grasses may be important in terms of cover, including *Bouteloua gracilis, Achnatherum hymenoides, Sporobolus cryptandrus,* and *Aristida purpurea*. At Zion National Park, the community includes montane grasses such as *Muhlenbergia montana* and *Poa fendleriana*. Forbs are diverse but contribute little total cover and vary widely among sites. *Ambrosia acanthicarpa, Heterotheca villosa, Machaeranthera canescens, Mentzelia multiflora,* and *Senecio spartioides* are among the more common species. Scattered shrubs, such as *Atriplex confertifolia, Coleogyne ramosissima, Ephedra cutleri, Gutierrezia sarothrae,* and *Opuntia* spp., are often present in Colorado Plateau stands, but do not total more than 10% cover.

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Global Dynamics: Stands of this association often occur in dune and sandsheet systems that are subject to blowouts. *Muhlenbergia pungens* acts to stabilize the sands, but when reduced in vigor by grazing, blowouts become more common and shrubs and forbs increase in cover. Conversely, in highly stabilized sites, *Bouteloua gracilis* or other grasses may eventually replace the *Muhlenbergia*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Muhlenbergia pungens*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Muhlenbergia pungens*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Muhlenbergia pungens*

Other Noteworthy Species

Global: Vulnerable Plants: *Yucca elata* var. *utahensis* (G5T3?, endemic variety)

Conservation Status Rank

Global Rank & Reasons: GNR (22-Mar-2005).

Related Concepts

Global Similar Types:

- *Pinus edulis - Juniperus osteosperma / Muhlenbergia pungens* Woodland (CEGL002373)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. The sites used in this description are varied in composition and structure. Now that we have more data on this broadly defined type, analysis is needed to determine if some of the stands, such as the higher elevation stands codominated by montane grasses in Zion, should be split out into a separate association.

Element Distribution

Glen Canyon National Recreation Area Range: This rare association was only sampled north of Hans Flat and on Andy Miller Flats.

Global Range: This sandsheet and dune association occurs in the Colorado Plateau in Utah and western Colorado and at Great Sand Dunes National Park and Preserve in south-central Colorado.

Nations: US
States/Provinces: CO, UT
TNC Ecoregions: 9:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331E:CC, M331F:CC
Federal Lands: NPS (Capitol Reef, Dinosaur, Glen Canyon, Great Sand Dunes, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Deep sand, shifting sand. Plants that prefer sand dunes will grow here.

Glen Canyon National Recreation Area Plots: The description is based on 2013 and 2014 field data (1 plot, 1 accuracy assessment point): (Plots: GLCA.5318; AA Points: GLCA_AA.0317).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and K.A. Schulz
References: Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Romme et al. 1993, Salas et al. 2010b, Western Ecology Working Group n.d.*

A1270 Hesperostipa comata Grassland Alliance

Alliance Summary Description: Grasslands included in this alliance are characterized by a sparse to moderately dense herbaceous layer dominated by *Aristida purpurea, Bouteloua gracilis, Hesperostipa comata*, or *Sporobolus cryptandrus*. Other common to codominant graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Carex filifolia, Koeleria macrantha, Pleuraphis jamesii (= Hilaria jamesii), Poa secunda, Sporobolus contractus*, and *Sporobolus giganteus*. The invasive species *Bromus tectorum* is common in disturbed stands. Forb cover is also sparse, but can be relatively diverse. Common forbs are *Gaura coccinea, Lappula occidentalis (= Lappula redowskii), Lithophragma glabrum, Lithophragma glabrum, Lupinus pusillus, Opuntia aurea (= Opuntia basilaris var. aurea), Opuntia polyacantha, Plantago patagonica*, or *Pediomelum argophyllum (= Psoralea argophylla)*. Cryptogams are important in some stands with up to 40% ground cover on sites in the Colorado Plateau. This grassland alliance is found primarily from Wyoming Basins, Colorado Plateau, and Great Basin. Sites are on flat to moderately steep, often south-facing slopes, but can occur on any aspect. Soils are shallow to moderately deep, well-drained, coarse-textured, and non-saline. Sites include intermountain basins, alluvial flats, alluvial terraces of large rivers, sandy upper stream terraces along intermittent washes, and on sand deposits on mesas and plains.

[CEGL001705] *Hesperostipa comata* Great Basin Grassland
Translated Name: Needle-and-Thread Great Basin Grassland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Grassland (G311)
Alliance: *Hesperostipa comata* Grassland Alliance (A1270)

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Element Concept

Global Summary: This semi-arid grassland occurs on the Great Basin and Colorado Plateau and high plateaus of southern Utah, east into the western slope of the southern Rocky Mountains. The vegetation is characterized by a relatively sparse to moderate herbaceous layer (10-40% cover) that is strongly dominated by the medium-tall, cool-season bunchgrass *Hesperostipa comata*, but it may also include stands with less than 10% total vegetation cover. Low cover of other grasses, such as *Achnatherum hymenoides, Achnatherum lettermanii, Aristida purpurea, Elymus elymoides, Koeleria macrantha, Leymus salinus, Pleuraphis jamesii, Poa fendleriana,* or *Sporobolus cryptandrus,* may be present. However, *Bouteloua eriopoda* is not present. Forb cover ranges from sparse to moderate and may be diverse. Associated forbs include *Balsamorhiza sagittata, Hymenopappus filifolius, Machaeranthera canescens, Sphaeralcea coccinea, Vicia americana,* and species of *Antennaria, Astragalus, Cryptantha, Eriogonum, Gilia,* and *Lappula*. Scattered shrubs and dwarf-shrubs may be present with less than 5% total cover. Common species include *Artemisia tridentata, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia polyacantha,* and *Symphoricarpos oreophilus*. The widespread introduced annual grass *Bromus tectorum* often contributes significant cover in disturbed stands. Some stands have high cover of biological soil crusts. Stands are found on a variety of sites, such as on point bars, stream terraces, in sand-filled potholes in slickrock washes, on plains, valleys, canyon floors, gentle hillslopes, knolls and bluffs, mesatops, and plateau parks. Sites are generally flat to gently sloping, but occasionally are steep (to 53% slope). Soils are variable and range from sand to silty clay. The unvegetated surface has moderate to high cover of bare soil with sparse to moderate cover of litter. Fires may be important in maintaining these grasslands by reducing woody cover, but burning during the growing season could also damage *Hesperostipa comata* plants.

Environmental Description

Glen Canyon National Recreation Area Environment: This grassland type occurs on plateaus, plains, mesas, terraces, benches, canyon sides, and stabilized dunes. Sites are flat to moderately sloping (up to 17°), include all aspects, and occur between 1417 to 1679 m elevation. Most of the unvegetated surface is bare soil, with low to moderate cover of litter and biological soil crusts, and sparse to low cover of small rocks. Soils are rapidly drained to well-drained loamy sands or silt loams derived from eolian or alluvial deposits.

Global Environment: This grassland occurs on the Great Basin and Colorado Plateau east into the western slope of the southern Rocky Mountains. Stands are found a variety of sites, such as on point bars, stream terraces, in sand-filled potholes in slickrock washes, on plains, valleys, canyon floors, gentle hillslopes, knolls and bluffs, mesatops, and plateau parks. Sites are generally flat to gently sloping, but occasionally are steep (to 53% slope). Elevation ranges from 1250-2683 m. The unvegetated surface has moderate to high cover of bare soil with sparse to moderate cover of litter. Biological soil crusts are often present with low cover. Soils are variable and include sand, cobbles, sandy, silt and clay loams and silty clay. Common parent materials are sandstones and shale that have been eroded and redistributed in alluvial and eolian deposits, but include Tertiary volcanic rocks. Fires may be important in maintaining these grasslands by reducing woody cover, but burning during the growing season could also damage *Hesperostipa comata* plants.

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Vegetation Description

Glen Canyon National Recreation Area Vegetation: This needle-and-thread grassland becomes established on deep soils in areas that have escaped heavy livestock grazing. Total vegetation cover ranges from 8 to 63%. The vegetation is dominated by *Hesperostipa comata* with between 4 and 30% cover. Other grasses are commonly present and may be codominant, but needle-and-thread is the predominant indicator species in these communities. *Achnatherum hymenoides, Bouteloua gracilis, Pleuraphis jamesii, Sporobolus contractus, Sporobolus cryptandrus,* and *Muhlenbergia pungens* were common associated graminoid species. *Aristida purpurea* and *Bromus tectorum* were also present in some stands. Forbs provide sparse cover, rarely exceeding 5%, and include *Sphaeralcea* spp., *Hymenopappus filifolius, Cryptantha* spp., *Machaeranthera canescens, Salsola tragus,* and *Plantago patagonica*. Scattered shrubs may be present, but their total cover is always less than that of the grasses. Common shrub species may include *Atriplex canescens, Atriplex confertifolia, Krascheninnikovia lanata, Artemisia tridentata ssp. wyomingensis, Coleogyne ramosissima, Ephedra torreyana, Ephedra viridis, Ephedra cutleri, Gutierrezia* spp., *Vanclevea stylosa,* and *Opuntia* spp. Biological soil crusts are variable, from 0 to 90% cover, but tend to be in an early developmental stage dominated by moss and dark cyanobacteria. *Juniperus osteosperma* trees may be scattered around the margins of the grassland community.

Global Vegetation: This association is characterized by a relatively sparse to moderate herbaceous layer (10-40% cover) that is strongly dominated by the medium-tall, cool-season bunchgrass *Hesperostipa comata,* but it may also include stands with less than 10% total vegetation cover. Low cover of other grasses, such as *Achnatherum hymenoides, Achnatherum lettermanii, Aristida purpurea, Bouteloua gracilis, Elymus elymoides, Koeleria macrantha, Leymus salinus, Muhlenbergia pungens, Pleuraphis jamesii, Poa fendleriana, Poa secunda, Sporobolus airoides, Sporobolus contractus,* or *Sporobolus cryptandrus,* may be present. However, *Bouteloua eriopoda* is not present. Forb cover ranges from sparse to moderate and may be diverse. Associated species include *Artemisia campestris, Artemisia dracunculus, Artemisia ludoviciana, Balsamorhiza sagittata, Cirsium arizonicum, Cryptantha crassisepala, Hymenopappus filifolius, Machaeranthera canescens, Sphaeralcea coccinea, Vicia americana,* and species of *Antennaria, Astragalus, Eriogonum, Gilia,* and *Lappula*. Scattered shrubs and dwarf-shrubs may present with less than 5% total cover. *Artemisia tridentata ssp. tridentata, Artemisia tridentata ssp. vaseyana, Atriplex canescens, Chrysothamnus depressus, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia polyacantha, Purshia tridentata, Ribes cereum,* and *Symphoricarpos oreophilus* have been reported from this grassland. The widespread introduced annual grass *Bromus tectorum* often contributes significant cover in disturbed stands. Several other exotic species may be present to abundant and include *Salsola tragus, Bassia scoparia (= Kochia scoparia), Poa pratensis, Sisymbrium altissimum,* and *Tragopogon dubius*. Some stands have high cover of cryptogams on the soil, including *Collema tenax, Tortula ruralis, Buellia papillata,* and *Fulgensia bracteata* (Kleiner and Harper 1977).

Global Dynamics: These grasslands are dominated by relatively deep-rooted grasses that use soil moisture below 0.5 m during the typically dry summers. The coarse-textured soils allow for rapid infiltration and storage of winter and summer precipitation (Kleiner 1968, Daubenmire 1970, Kleiner

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and Harper 1977, Thilenius et al. 1995). However, during the severe drought of 2002, there was widespread die-off of *Hesperostipa comata* throughout the northern Colorado Plateau (J. Coles pers. obs. 2005). Fires when the grasses are dormant may be important in maintaining these grasslands by reducing woody cover. However, burning during the growing season generally kills or severely damages *Hesperostipa comata* plants. After fire, regeneration of this non-rhizomatous bunchgrass is by seed and may take many years to reach pre-fire densities (FEIS 1998).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Dwarf-shrub	*Gutierrezia* spp.
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*, *Ephedra viridis*
Short shrub/sapling	Succulent shrub	*Opuntia* spp.
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Bouteloua gracilis*, *Hesperostipa comata*, *Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Hesperostipa comata*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Hesperostipa comata*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Global: Vulnerable Plants: *Arabis crandallii* (G2), *Astragalus anisus* (G2G3, CO endemic), *Cirsium arizonicum* (G5, UT state-rare); Invasive/Exotic Plants: *Bassia scoparia* (Low), *Bromus tectorum* (High), *Poa pratensis* (Medium), *Salsola tragus*, *Sisymbrium altissimum*, *Tragopogon dubius* (Medium/Low)

Conservation Status Rank

Global Rank & Reasons: G2G4 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Achnatherum hymenoides* Colorado Plateau Grassland (CEGL002343)
- *Elymus lanceolatus - Hesperostipa comata* Grassland (CEGL001746)
- *Hesperostipa comata - (Bouteloua eriopoda, Pleuraphis jamesii)* Grassland (CEGL002997)

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- *Hesperostipa comata - Achnatherum hymenoides* Grassland (CEGL001703)
- *Hesperostipa comata - Carex filifolia* Grassland (CEGL001700)
- *Hesperostipa comata - Poa secunda* Grassland (CEGL001704)
- *Muhlenbergia montana - Hesperostipa comata* Grassland (CEGL001647) has a substantial component of *Hesperostipa comata*, but *Muhlenbergia montana* is codominant.
- *Pseudoroegneria spicata - Hesperostipa comata* Grassland (CEGL001679)

Global Related Concepts:
- *Stipa comata* dominated grassland (Kleiner and Harper 1977) =
- *Stipa comata*-West (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:V.B.4.b. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. It is composed of relatively pure *Hesperostipa comata* grasslands in the Intermountain West. The similar associations are distinguished by the codominance by other grass species or presence of a shrub layer.

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon herbaceous association is of limited distribution within the recreation area. It was sampled in Waterhole Flat, Waterhole Canyon, Calf Canyon, Millard Canyon, Harris Wash, and East Moody Canyon.

Global Range: This grassland is found on the west slope of the Colorado Rocky Mountains, on the Colorado Plateau and in the Great Basin in Colorado and Utah, and probably occurs in adjacent states.

Nations: US
States/Provinces: AZ, CO:S2, NV, UT:S2S4
TNC Ecoregions: 9:C, 10:C, 11:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341A:CC, 341B:CC, 341C:CC, 342G:??, M331E:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Arches, Black Canyon of the Gunnison, Bryce Canyon, Canyonlands, Capitol Reef, Colorado, Curecanti, Dinosaur, Glen Canyon, Golden Spike, Grand Canyon, Natural Bridges, Zion); USFWS (Ouray)

Element Sources

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, 2014, and 2015 field data (3 plots, 11 accuracy assessment points): (Plots: GLCA.0582, GLCA.5243, GLCA.5247; AA Points: GLCA_AA.0044, GLCA_AA.0060, GLCA_AA.0065, GLCA_AA.0067, GLCA_AA.0074, GLCA_AA.0635, GLCA_AA.0636, GLCA_AA.0637, GLCA_AA.0639, GLCA_AA.0659, GLCA_AA.3032).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and J. Coles

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Subset: GLCA; Glen Canyon National Recreation Area

References: Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2009a, Coles et al. 2010, Coles et al. 2011, Coles pers. comm., Daubenmire 1970, Driscoll et al. 1984, FEIS 1998, Kleiner 1968, Kleiner 1983, Kleiner and Harper 1977, Peterson 2008, Reid and Hall 2010, Romme et al. 1993, Tendick et al. 2010, Tendick et al. 2011b, Thilenius et al. 1995, Von Loh et al. 2002, Von Loh et al. 2007, Western Ecology Working Group n.d.*

[CEGL002691] *Sporobolus cryptandrus* Great Basin Grassland
Translated Name: Sand Dropseed Great Basin Grassland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Grassland (G311)
Alliance: *Hesperostipa comata* Grassland Alliance (A1270)

Element Concept

Global Summary: The association is found on terraces of large rivers in the Colorado Plateau and Uinta Basin and likely occurs elsewhere in the southwestern U.S. The vegetation is dominated by the warm-season perennial graminoid *Sporobolus cryptandrus*. Other graminoids such as *Achnatherum hymenoides, Equisetum variegatum, Hesperostipa comata (= Stipa comata), Pleuraphis jamesii, Sporobolus contractus*, or *Sporobolus giganteus* frequently occur in low abundance. Low cover of native forbs such as *Sphaeralcea grossulariifolia* or *Chamaesyce fendleri* may be present. The introduced annual grass *Bromus tectorum* and several other exotic or invasive species such as *Bromus rigidus, Schismus barbatus, Salsola kali, Helianthus annuus, Sisymbrium altissimum*, or *Tribulus terrestris* may be present to abundant, especially on disturbed riparian stands. Occasional *Brickellia* spp. or other shrubs may occur, but they are not dense enough to form a shrub layer. This plant association is described from the Uinta Basin and Colorado Plateau where it occurs on alluvial terraces of major rivers, sandy upper stream terraces along intermittent washes, and on sand deposits on mesas and plains. Elevation ranges from 1158 to 1630 m. Soils are loamy sands and sandy loams derived from alluvium, eolian deposits or sandstone residuum. Sites have generally been disturbed by flooding, shifting sands, livestock grazing, or human recreation.

Environmental Description

Glen Canyon National Recreation Area Environment: This grassland association occurs on terraces, plateaus, and hills, on gently to moderately sloping sites (4-16°), oriented to all aspects, and occurs between 1158 and 1619 m elevation. Bare soil dominates the unvegetated surface, with lesser cover by litter, and sparse to low cover by gravel and biological soil crusts. Soils are sandy and derived from Cedar Mesa sandstone and eolian deposits.

Global Environment: This grassland is described from the Uinta Basin and Colorado Plateau where it occurs on alluvial terraces of large rivers, sandy upper stream terraces along intermittent washes, and on sand deposits on mesas and plains. Elevation ranges from 1158 -1630 m. Sites are flat to gently

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sloping valley bottoms, plains or plateaus. Soils are loamy sands and sandy loams derived from alluvium, eolian deposits or sandstone residuum. Biological soil crusts are generally present and may provide up to 30% cover. Stands have generally been disturbed by flooding, shifting sands, livestock grazing, or human recreation.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This open grassland type has low to moderate total cover (9-40%) and is dominated by *Sporobolus cryptandrus*, with 5-12% cover. Scattered shrubs may be present with low cover, including *Atriplex canescens, Ephedra cutleri, Ephedra torreyana, Opuntia* spp., and *Psorothamnus fremontii*. Other grasses may be present with sparse to low cover, including *Achnatherum hymenoides, Pleuraphis jamesii*, *Schismus barbatus*, and *Sporobolus flexuosus*. Forbs are often present with low to moderate cover, including *Ambrosia acanthicarpa, Cryptantha* spp., *Eriogonum inflatum, Oenothera pallida*, and *Salsola tragus.*

Global Vegetation: The sparse to moderately dense (10-40% cover) herbaceous layer is characterized by the dominance of the warm-season perennial graminoid *Sporobolus cryptandrus*. Other graminoids such as *Achnatherum hymenoides, Equisetum variegatum, Hesperostipa comata (= Stipa comata), Pleuraphis jamesii, Sporobolus contractus, Sporobolus flexuosus*, or *Sporobolus giganteus* may occur in low abundance. Low cover of native forbs, such as *Abronia fragrans, Ambrosia acanthicarpa, Chamaesyce fendleri, Cryptantha* spp., *Eriogonum inflatum, Oenothera pallida, Plantago patagonica, Sphaeralcea grossulariifolia, Sphaeralcea parvifolia*, or the succulent *Opuntia polyacantha* may be present. The widespread introduced annual grass *Bromus tectorum* and several other exotic or invasive species such as *Bromus rigidus, Schismus barbatus, Salsola kali, Helianthus annuus, Sisymbrium altissimum*, or *Tribulus terrestris* may be present to abundant, especially on disturbed riparian stands. An occasional *Brickellia* spp. or other shrubs such as *Atriplex canescens, Ephedra cutleri, Ephedra torreyana, Opuntia* spp., or *Psorothamnus fremontii* may occur, but they are not dense enough to form a shrub layer. Moss is important in some stands.

Global Dynamics: Disturbance is present and appears to be important in the maintenance of this vegetation. *Sporobolus cryptandrus* occurs throughout the western U.S. as a minor species, occasionally becoming locally dominant in disturbed or sandy sites in the midgrass prairie (Weaver and Albertson 1956). This perennial grass produces prolific seeds that are long-lived in the soil (20 years), and is observed to increase in abundance on disturbed and grazing-depleted ranges (USFS 1937).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Sporobolus cryptandrus*

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Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Sporobolus cryptandrus*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Sporobolus cryptandrus*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Salsola tragus, Schismus barbatus* (High/Medium)

Global: Invasive/Exotic Plants: *Bromus rigidus, Bromus tectorum* (High), *Salsola kali, Schismus barbatus* (High/Medium), *Sisymbrium altissimum, Tribulus terrestris*; Other Plants: *Helianthus annuus* (G5, weedy native)

Conservation Status Rank

Global Rank & Reasons: GNR (26-Jul-2001).

Related Concepts

Global Similar Types:

- *Aristida purpurea var. longiseta - Pseudoroegneria spicata - Sporobolus cryptandrus* Grassland (CEGL001589) similar vegetation and environmental conditions except codominated by *Aristida purpurea var. longiseta - Pseudoroegneria spicata*.
- *Aristida purpurea var. longiseta - Sporobolus cryptandrus* Grassland (CEGL001515) similar vegetation and environmental conditions except codominated by *Aristida purpurea var. longiseta*.
- *Artemisia tridentata / Sporobolus cryptandrus - Achnatherum hymenoides* Shrub Grassland (CEGL001545)
- *Bouteloua gracilis - Sporobolus cryptandrus* Grassland (CEGL001761) also supports a strong *Sporobolus cryptandrus* component and may occur in similar habitats; however, *Bouteloua gracilis* strongly codominates.
- *Ephedra viridis / Achnatherum hymenoides - Sporobolus cryptandrus* Shrub Grassland (CEGL001649) sandy site grasslands with shrub layer.
- *Schizachyrium scoparium - Aristida basiramea - Sporobolus cryptandrus - Eragrostis trichodes* Grassland (CEGL005221) central Great Plains type.
- *Sporobolus cryptandrus - Poa secunda* Grassland (CEGL001516) similar vegetation and environmental conditions except codominated by *Poa secunda*.
- *Sporobolus cryptandrus* Shrub Grassland (CEGL001514) similar vegetation except with significant shrub component.

Global Related Concepts:

- Palustrine (Cowardin et al. 1979) >

Classification

Status: Standard
Classification Confidence: 1 - Strong

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Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. The association is broadly defined to include *Sporobolus cryptandrus*-dominated stands from both riparian and sandy upland sites in the Colorado Plateau and Great Basin. This plant association is similar to the threatened, regionally endemic *Sporobolus cryptandrus* plant associations from the Columbia Basin and lower Snake River that have declined significantly due to loss of habitat from hydroelectric dam construction and conversion of land to cultivation. Many of the riparian stands in these associations are in poor condition because of past management and invasion of introduced species.

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon grassland association was sampled in Waterhole Canyon, Stanton Canyon, and Wahweap Bay.

Global Range: The association is found on terraces of large rivers in the Colorado Plateau and Uinta Basin in northern Arizona and southern Utah and likely occurs elsewhere in the southwestern U.S.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 9:C, 10:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 341B:CC, 341C:CC, M331E:CC
Federal Lands: NPS (Arches, Canyonlands, Dinosaur, Glen Canyon, Grand Canyon, Grand Canyon-Parashant, Petrified Forest, Zion); USFWS (Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Heavily impacted by cattle, lots of *Salsola tragus* skeletons.

Glen Canyon National Recreation Area Plots: The description is based on 2014 and 2015 field data (3 accuracy assessment points): (AA Points: GLCA_AA.0066, GLCA_AA.1590, GLCA_AA.1660).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2009a, Cowardin et al. 1979, Reid and Hall 2010, Thomas et al. 2009a, USFS 1937, Von Loh et al. 2002, Western Ecology Working Group n.d.*

A1287 Pleuraphis jamesii Grassland Alliance

Alliance Summary Description: The vegetation is characterized by an herbaceous layer with sparse to moderately dense cover of perennial grasses that is usually dominated or codominated by *Bouteloua eriopoda, Bouteloua gracilis, Pleuraphis jamesii,* or *Sporobolus airoides*. Other common perennial grasses may include *Achnatherum hymenoides (= Oryzopsis hymenoides), Aristida purpurea, Bouteloua curtipendula, Buchloe dactyloides, Elymus elymoides, Hesperostipa neomexicana (= Stipa neomexicana), Muhlenbergia porteri, Muhlenbergia torreyi, Pascopyrum smithii,* and *Sporobolus cryptandrus*. The sparse forb layer may include *Artemisia carruthii, Artemisia dracunculus,*

Astragalus spp., *Chaenactis stevioides, Cryptantha* sp., *Cymopterus newberryi, Grindelia squarrosa, Lappula occidentalis, Machaeranthera pinnatifida, Plantago patagonica, Ratibida* spp., *Scleropogon brevifolius, Sphaeralcea coccinea*, and *Zinnia grandiflora*. This alliance occurs in arid and semi-arid regions in the southwestern Great Plains, Colorado Plateau, Great Basin, and northern Chihuahuan Desert. These grasslands occur on a variety of landforms, including plains, mesas, alluvial flats, floodplains, swales, hillslopes, dunes, badlands and bajadas. Soils are variable and range from sand to clay textures. Stands occur on all slopes and aspects. Substrates are variable and range from sand- to clay-textured soils. Parent materials include alluvium, colluvium and eolian deposits derived from igneous, metamorphic and, most commonly, sedimentary rocks, especially shale and sandstone. Elevation ranges from 1200-2800 m.

[CEGL001760] *Bouteloua gracilis* Grassland
Translated Name: Blue Grama Grassland
Common Name: Blue Grama Grassland

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Grassland (G311)
Alliance: *Pleuraphis jamesii* Grassland Alliance (A1287)

Element Concept

Global Summary: This plant association occurs in the intermountain western U.S. and is reported from Arizona, Colorado, New Mexico, Utah and Wyoming. It does not occur in the western Great Plains. The vegetation is characterized by a moderate to dense (25-80% cover) herbaceous layer that is strongly dominated by the warm-season, perennial shortgrass *Bouteloua gracilis.* Associated grasses are *Bouteloua curtipendula, Elymus elymoides, Muhlenbergia* spp., *Pascopyrum smithii, Pleuraphis jamesii (= Hilaria jamesii), Sporobolus cryptandrus,* and the introduced annual grass *Bromus tectorum*. Forb cover is sparse but may be diverse over the range of the type. Scattered *Ericameria nauseosa, Tetradymia canescens,* and *Gutierrezia sarothrae* shrubs and an occasional *Pinus edulis, Juniperus* spp., or *Pinus ponderosa* tree (in montane stands) may be present. Sites are flat to gently sloping and include plains, plateaus and montane meadows at elevations ranging from 1660 to 2780 m (5420-9115 feet). Substrates are variable and range from coarse-textured soils derived from sand, gravel, old lava flows, kipukas, alluvium, limestone, sandstone, granite or cinder to silty clay loam soils.

Environmental Description

Glen Canyon National Recreation Area Environment: This very rare grassland association occurs on mesatops in the Orange Cliffs section of the recreation area. The sampled sites slope gently and occur between 1799 m and 1968 m elevation. The unvegetated surface has high exposure of bare ground and low to moderate cover of litter. The deep soils are derived from eolian deposits.

Global Environment: This minor plant association is reported from Arizona, western Colorado, New Mexico, Utah and Wyoming. Elevation ranges from 1660-2780 m (5420-9115 feet). Sites are flat to

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moderately sloping and include plains, old lavaflows, kipukas, valley bottoms, sand and limestone hills, plateaus, and montane meadows and parks. Substrates are variable and range from coarse-textured soils derived from sand, gravel, granite or cinder to silty clay loam soils. Montane *Bouteloua gracilis*-dominated grasslands included in this association are typically the result of heavy grazing by wildlife and/or livestock that select out less grazing-tolerant midgrasses.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This blue grama grassland association is rare and is characterized by low (8-15%) cover of *Bouteloua gracilis*. A few scattered shrubs of *Ephedra cutleri, Coleogyne ramosissima, Gutierrezia sarothrae,* and *Opuntia polyacantha* are present. Other grass species present can include *Achnatherum hymenoides* and *Pleuraphis jamesii*. Forbs include *Eriogonum cernuum, Descurainia pinnata*, and *Plantago patagonica*. An occasional *Juniperus osteosperma* tree may be present.

Global Vegetation: This association is characterized by a moderate to dense (10-80% cover) herbaceous layer that is strongly dominated by the warm-season, perennial shortgrass *Bouteloua gracilis*. Associated grasses are *Achnatherum hymenoides, Bouteloua curtipendula, Elymus elymoides, Koeleria macrantha, Muhlenbergia montana, Muhlenbergia richardsonis, Muhlenbergia torreyi, Pascopyrum smithii, Pleuraphis jamesii (= Hilaria jamesii), Sporobolus cryptandrus,* and the introduced annual grass *Bromus tectorum*. Forb cover is sparse but may be diverse over the range of the type. Associated forbs include *Artemisia carruthii, Artemisia dracunculus, Eriogonum* spp., and *Sphaeralcea coccinea*. Scattered *Ericameria nauseosa, Tetradymia canescens*, and *Gutierrezia sarothrae* shrubs and an occasional *Juniperus* spp., *Pinus edulis,* or *Pinus ponderosa* tree (in montane stands) may be present.

Global Dynamics: *Bouteloua gracilis* is an extremely drought- and grazing-tolerant shortgrass species. It is one of the most widely distributed grasses in the interior western U.S. and is present in many different grassland, shrubland and woodland communities. It evolved with grazing by large herbivores and generally forms a short sod. However, in some stands ungrazed plants develop the upright physiognomy of a bunchgrass. *Bouteloua gracilis* is a warm-season grass and relatively unaffected by spring grazing while it is dormant. Montane *Bouteloua gracilis*-dominated stands are often seral to midgrass associations dominated by species of *Achnatherum, Danthonia, Festuca, Hesperostipa,* or *Muhlenbergia* and are the result of inappropriate stocking rates or season of use by large herbivores.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Bouteloua gracilis*

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Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Bouteloua gracilis*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Bouteloua gracilis*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: G4Q (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Bouteloua eriopoda - Bouteloua gracilis* Grassland (CEGL001748)
- *Bouteloua gracilis - Bouteloua curtipendula* Grassland (CEGL001754)
- *Bouteloua gracilis - Bouteloua hirsuta* Grassland (CEGL001755)
- *Bouteloua gracilis - Buchloe dactyloides* Grassland (CEGL001756)
- *Bouteloua gracilis - Eragrostis intermedia* Grassland (CEGL001758)
- *Bouteloua gracilis - Hesperostipa neomexicana* Grassland (CEGL001763)
- *Bouteloua gracilis - Pleuraphis jamesii* Grassland (CEGL001759)
- *Bouteloua gracilis - Sporobolus cryptandrus* Grassland (CEGL001761)
- *Bouteloua gracilis - Sporobolus flexuosus* Grassland (CEGL001762)
- *Hesperostipa comata - Bouteloua gracilis - Carex filifolia* Grassland (CEGL002037)
- *Pleuraphis mutica - Bouteloua gracilis* Grassland (CEGL001638)

Global Related Concepts:

- *Bouteloua gracilis* (Shortgrass Prairie) (Bourgeron and Engelking 1994) =
- Blue Grama/Monotypic Stand PA (Muldavin et al. 2000b) =
- DRISCOLL FORMATION CODE:V.C.5.a. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau and Southern Rocky Mountains. It is a low-confidence association that often represents disturbed semi-arid grasslands in the intermountain western U.S. and degraded montane grasslands and *Bouteloua gracilis*-dominated grasslands that lack other diagnostic species. *Bouteloua gracilis* is often able to persist after other species are eliminated because it is an extremely drought- and grazing-tolerant species.

Element Distribution

Glen Canyon National Recreation Area Range: This association is rare and of limited distribution within the recreation area. It was sampled on Gordon Flats and north of Hans Flat.

Global Range: This plant association occurs in the intermountain western U.S. and is reported from Arizona, Colorado, New Mexico, Utah and Wyoming. It is not the widespread Great Plains shortgrass prairie community.

Nations: US
States/Provinces: AZ, CO:S4, NM, UT, WY
TNC Ecoregions: 19:C, 20:C, 21:C, 24:C, 28:C
USFS Ecoregions (1994/95): 311:C, 313B:CC, 313D:CC, 315A:CC, 321:C, 341B:CC, M313A:CC, M313B:CC, M331F:CC, M331I:CC
Federal Lands: DOD (White Sands Missile Range); NPS (Canyon de Chelly, Chaco Culture, El Malpais, El Morro, Glen Canyon, Great Sand Dunes, Mesa Verde, Natural Bridges, Petrified Forest, Rocky Mountain, Sunset Crater Volcano, Walnut Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Community has grown on deep soil. Historic grazing has selected for *Bouteloua gracilis*, in addition to a dry exposure. Wind erosion and desiccation are prevalent.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2014 field data (1 plot, 2 accuracy assessment points): (Plots: GLCA.0526; AA Points: GLCA_AA.0314, GLCA_AA.0577).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Coles and M.E. Hall
References: Bourgeron and Engelking 1994, Bradley et al. 1992, CNHP 2003, CNHP 2015, Coles et al. 2008c, Driscoll et al. 1984, Dwyer and Pieper 1967, Fisser 1970, Fisser et al. 1965, Hansen et al. 2004a, Hansen et al. 2004c, Muldavin 1987, Muldavin et al. 2000b, Muldavin et al. 2013c, Pieper 1968, Salas and Bolen 2010a, Salas et al. 2005, Salas et al. 2010b, Salas et al. 2011, Thomas et al. 2009a, Thomas et al. 2009b, Thomas et al. 2010, WNDD unpubl. data, Western Ecology Working Group n.d.*, Williams 1961, Zimmerman 1967

[CEGL001778] Pleuraphis jamesii - Sporobolus airoides Grassland
Translated Name: James' Galleta - Alkali Sacaton Grassland
Common Name:

USNVC Classification

Division: estern North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Grassland (G311)
Alliance: *Pleuraphis jamesii* Grassland Alliance (A1287)

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Element Concept

Global Summary: This once-extensive grassland of the northern Chihuahuan Desert, Colorado Plateau and Great Basin has been described in New Mexico from White Sands Missile Range and the upper Rio Puerco watershed, as well as in north-central Arizona and southeastern Utah. It has, however, experienced significant declines throughout its range. The vegetation is characterized by a sparse to moderately dense perennial herbaceous layer that is dominated by *Pleuraphis jamesii (= Hilaria jamesii)* with *Sporobolus airoides* as a subdominant. Total vegetation cover in grazed sites generally does not exceed 20% but may be as high as 50% in protected areas. Occasionally, *Sporobolus airoides* may be codominant or dominant over *Pleuraphis jamesii*. This association usually has a sparse but diverse shrub layer that may include scattered *Atriplex canescens, Atriplex confertifolia, Atriplex obovata, Coleogyne ramosissima, Ephedra torreyana, Ericameria nauseosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia imbricata, Opuntia macrorhiza, Opuntia phaeacantha, Sarcobatus vermiculatus*, and *Yucca angustissima*. The key graminoid species dominate the herbaceous layer and account for more than 80% of the total plant cover. Associated herbaceous species, such as *Achnatherum hymenoides, Bouteloua gracilis, Muhlenbergia porteri, Muhlenbergia pungens, Muhlenbergia torreyi, Pascopyrum smithii, Scleropogon brevifolius, Sphaeralcea coccinea*, and *Sporobolus cryptandrus*, may be present with low cover. Biological soil crusts may be extensive in undisturbed examples of this association. It primarily occurs in swales within open valley bottoms and alluvial flats, although sandsheets and dunes also can support the association. Sites are on level to gentle slopes (<15%) at elevations between 1300-2075 m (4260-6800 feet). Soils are generally deep, with surface textures ranging from loamy sands, fine loams to silty clay loams and clays, derived from substrates that include lava flows, cinders, eolian sands, alluvium and relict Pleistocene river cobbles.

Environmental Description

Glen Canyon National Recreation Area Environment: This grassland association occurs on flat to gently sloping alluvial terraces in canyon bottoms at 1413 to 1627 m elevation. The unvegetated surface is dominated by bare soil, with low to moderate cover of bedrock, litter, and gravel. Soils are rapidly drained sandy loams derived from alluvium.

Global Environment: This grassland association is described in New Mexico from White Sands Missile Range and the upper Rio Puerco watershed, as well as in north-central Arizona and southeastern Utah. It primarily occurs in swales within open valley bottoms and alluvial flats, although sandsheets and dunes also can support the association. Sites are on level to gentle slopes (<15%) at elevations between 1300-2075 m (4260-6800 feet). Soils are generally deep, with surface textures ranging from loamy sands, fine loams to silty clay loams and clays, derived from substrates that include lava flows, cinders, eolian sands, alluvium and relict Pleistocene river cobbles.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This association is characterized by a sparse to moderately dense perennial herbaceous layer that is codominated by *Pleuraphis jamesii (= Hilaria jamesii)* (with 3-5% cover) and *Sporobolus airoides* (with 5-8% cover). Total vegetation cover ranges from17 to 25%. A variety of shrubs may be present with sparse to low cover, including *Atriplex confertifolia, Coleogyne ramosissima, Ephedra torreyana, Ericameria nauseosa*, and

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Krascheninnikovia lanata. Other species noted in the herbaceous layer with low cover are *Bromus tectorum, Salsola tragus*, and *Suaeda moquinii (= Suaeda torreyana)*. *Pinus edulis* and *Juniperus osteosperma* trees may be present on the margins of the community.

Global Vegetation: This association is characterized by a sparse to moderately dense perennial herbaceous layer that is codominated by *Pleuraphis jamesii (= Hilaria jamesii)* and *Sporobolus airoides*. Total vegetation cover generally does not exceed 20% in grazed sites but may be as high as 75% in protected areas. Occasionally, *Sporobolus airoides* may be codominant or dominant over *Pleuraphis jamesii*. This association usually has a sparse but diverse shrub layer that may include scattered *Atriplex canescens, Atriplex confertifolia, Atriplex obovata, Coleogyne ramosissima, Ephedra torreyana, Ericameria nauseosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia imbricata, Opuntia macrorhiza, Opuntia phaeacantha, Opuntia polyacantha, Sarcobatus vermiculatus*, and *Yucca angustissima*. The key graminoid species dominate the herbaceous layer and typically account for more than 80% of the total plant cover. Associated herbaceous species, such as *Achnatherum hymenoides, Chaenactis stevioides, Cryptantha* sp., *Cymopterus newberryi, Bouteloua gracilis, Ipomopsis gunnisonii (= Gilia gunnisonii), Lappula occidentalis, Muhlenbergia porteri, Muhlenbergia pungens, Muhlenbergia torreyi, Pascopyrum smithii, Plantago patagonica, Scleropogon brevifolius, Sphaeralcea coccinea*, and *Sporobolus cryptandrus*, may be present with low cover (Francis 1986, Muldavin et al. 2000b). Biological soil crusts may be extensive in undisturbed examples of this association.

Global Dynamics: Many stands are on sandy, alkaline bottomlands that could easily support *Atriplex* spp. or *Sarcobatus vermiculatus* shrublands. Soil texture, moisture-holding capacity and depth to water table may determine which of these communities occurs in a valley bottom.

Most Abundant Species

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Pleuraphis jamesii*, *Sporobolus airoides*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Achnatherum hymenoides, Atriplex canescens, Atriplex confertifolia, Bouteloua gracilis, Pleuraphis jamesii, Sporobolus airoides*

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: G2G3 (14-Nov-2005). This once-extensive grassland of the Great Basin and Chihuahuan Desert ecoregions has been described in New Mexico from the Upper Rio Puerco watershed and White Sands Missile Range, as well as isolated areas in north-central Arizona and southeastern Utah. It has experienced significant declines throughout its range. Remaining examples

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that have not been negatively impacted by grazing and/or invaded by shrubs are rare. However, this grassland is probably more widespread than is documented and hence the rank of G2G3.

Related Concepts

Global Similar Types:

- *Gutierrezia sarothrae / Sporobolus airoides - Pleuraphis jamesii* Shrub Grassland (CEGL001776)
- *Pleuraphis jamesii* Grassland (CEGL001777)
- *Sporobolus airoides* Southern Plains Wet Meadow (CEGL001685)

Global Related Concepts:

- *Hilaria jamesii-Sporobolus airoides* (Bourgeron and Engelking 1994) =
- *Hilaria jamesii-Sporobolus airoides* Plant Association (Muldavin et al. 1998b) =
- *Pleuraphis jamesii / Sporobolus airoides* Plant Community (Francis 1986) <
- *Sporobolus airoides / Pleuraphis jamesii* Plant Community (Francis 1986) <
- DRISCOLL FORMATION CODE:V.C.5.a. (Driscoll et al. 1984) >
- Galleta-Alkali Sacaton PA (Muldavin et al. 2000b) =

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: In the classification of the plant communities of the upper Rio Puerco watershed, Francis (1986) described two plant communities codominated by *Pleuraphis jamesii - Sporobolus airoides* that were separated by the relative dominance of the key species. Both plant communities were combined into this association.

Element Distribution

Glen Canyon National Recreation Area Range: This rare grassland was only sampled in two locations within the recreation area: Deadhorse Canyon and Clearwater Canyon.

Global Range: This once-extensive grassland of the northern Chihuahuan Desert, Colorado Plateau and Great Basin is reported in New Mexico from White Sands Missile Range and the upper Rio Puerco watershed. More recently, it has been documented in north-central Arizona and southeastern Utah. It has experienced significant declines throughout its range.

Nations: US
States/Provinces: AZ, CO:SU, NM:S2S3, UT
TNC Ecoregions: 19:C, 21:?, 24:?
USFS Ecoregions (1994/95): 313B:CC, 313D:CC, 321A:??, 341B:CC, M313A:??
Federal Lands: DOD (White Sands Missile Range); NPS (Arches, Capitol Reef, Chaco Culture, Glen Canyon, Petrified Forest, Wupatki)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plot documents a small community that is defined by the limits of a low stream terrace in a tributary gully; possibly subsurface geology helps pool groundwater here - certainly it is a spot where the steeper upstream gullies descending off colluvial slopes lose their grade and broaden into a small, flat "valley" area.

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Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2014 field data (1 plot, 1 accuracy assessment point): (Plots: GLCA.0735; AA Points: GLCA_AA.0111).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): Y. Chauvin, K.A. Schulz and J. Coles
References: Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Clark et al. 2009, Coles et al. 2003, Coles et al. 2009a, Driscoll et al. 1984, Francis 1986, Hansen et al. 2004b, Muldavin et al. 1998b, Muldavin et al. 2000b, Romme et al. 1993, Salas et al. 2011, Thomas et al. 2009a, West et al. 1972, Western Ecology Working Group n.d.*

[CEGL001777] *Pleuraphis jamesii* Grassland
Translated Name: James' Galleta Grassland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Grassland (G311)
Alliance: *Pleuraphis jamesii* Grassland Alliance (A1287)

Element Concept

Global Summary: This is a widespread grassland in the Colorado Plateau and elsewhere in the southwestern U.S. Vegetation is characterized by a relatively sparse to moderately dense (10-60% cover) perennial herbaceous layer that is strongly dominated by the warm-season bunchgrass *Pleuraphis jamesii*. Low cover of other grasses, such as *Achnatherum hymenoides, Bouteloua eriopoda, Bouteloua gracilis, Hesperostipa comata, Muhlenbergia porteri, Sporobolus airoides,* or *Sporobolus cryptandrus*, may be present. Forb cover is usually sparse and includes species of *Plantago, Gilia, Lappula*, and prickly pear cacti (*Opuntia* spp.). Many species of shrubs and dwarf-shrubs may be present; however, they are not dense enough to form a shrub layer. Stands are found on alluvial flats, plateau parks, mesas and plains. Sites are flat to moderately steep (up to 53%) slopes. Elevation commonly ranges from 1050 to 1930 m, with a few sites on the western edge of the southern Rocky Mountains extending into montane zone. Landforms vary from mesatops and slopes to basin floors. Stands may be small woodland parks or more extensive grasslands on the plains. Soils in bottomland stands tend to be fine-textured; however, stands also occur on a variety of substrates. Biological soil crusts are common and may have high cover on the soil surface.

Environmental Description

Glen Canyon National Recreation Area Environment: This grassland type occurs on valley bottoms, benches, plateaus, mesas, and terraces. Sites are mostly flat, but occasionally moderately sloping (up to 16°), include all aspects, and lie between 1112 and 1693 m elevation. Soils are somewhat poorly drained to rapidly drained and highly variable in texture, ranging from sands to loams to silts to clay loams. They are derived from a wide range of parent materials, including sandstones, shales, eolian deposits, and alluvium.

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Global Environment: This widespread grassland association is found on a variety of sites, including alluvial flats, toeslopes, valley floors, benches, hillsides, washes, colluvial slopes, plateau parks, mesas and plains in the Colorado Plateau and elsewhere in the southwestern U.S. Elevation typically ranges from 1050 to 1930 m, with a few sites on the western edge of the southern Rocky Mountains extending to 2400 m. Landforms vary from mesatops and slopes to basin floors. Sites are flat to moderately steep (up to 53% slope). Stands may be small woodland parks or more extensive on the plains. Soils are variable. In bottomland stands, soils tend to be fine-textured; however, stands also occur on sandy loams derived from sandstone, remnant lava flow, basaltic cobbles, black or red cinders, or alluvium derived from relict Pleistocene river cobbles, sandstone, sand, or clay soils.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This grassland association grows on deep, fine-textured soils within the recreation area. Total vegetation cover ranges from 7 to 42% and is characterized by *Pleuraphis jamesii* with between 2 and 40% cover. Associated grasses include *Achnatherum hymenoides, Bromus tectorum, Sporobolus cryptandrus,* and occasionally *Hesperostipa comata*. Forbs are present with trace to low cover and may include *Chenopodium album, Salsola tragus, Streptanthella longirostris, Lappula occidentalis,* and *Calochortus nuttallii*. Scattered shrubs are generally present and may include *Atriplex canescens, Krascheninnikovia lanata, Ephedra torreyana, Ephedra viridis, Atriplex confertifolia, Coleogyne ramosissima, Psorothamnus fremontii, Ericameria nauseosa, Gutierrezia microcephala,* and *Opuntia* spp. Biological soil crust cover, mostly in the form of dark cyanobacteria and especially moss, ranges from 0 to 65%.-

Global Vegetation: This association is characterized by a sparse to moderately dense perennial herbaceous layer (5-60% cover) that is strongly dominated by the warm-season bunchgrass *Pleuraphis jamesii*. Low cover of other grasses, such as *Aristida* spp., *Achnatherum hymenoides, Achnatherum speciosum, Bouteloua eriopoda, Bouteloua gracilis, Hesperostipa comata, Muhlenbergia porteri, Sporobolus airoides,* or *Sporobolus cryptandrus,* may be present. Forb cover is usually sparse and includes *Artemisia campestris, Chenopodium album, Cymopterus newberryi, Eriogonum inflatum, Lappula occidentalis, Phacelia crenulata, Plantago patagonica, Sphaeralcea parvifolia,* and *Townsendia annua* along with species of *Gilia, Lappula, Zinnia,* and prickly-pear cacti (*Opuntia* spp.). Many species of shrubs and dwarf-shrubs may be present, but they are not abundant enough to form a shrub layer. Woody species may include *Artemisia bigelovii, Artemisia filifolia, Atriplex canescens, Atriplex confertifolia, Brickellia oblongifolia, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Fallugia paradoxa, Gutierrezia* spp., *Krascheninnikovia lanata, Tetradymia* spp., and occasional *Juniperus* spp. trees. The widespread introduced annual grass *Bromus tectorum* and several other exotic species, such as *Salsola kali, Bassia scoparia (= Kochia scoparia),* and *Sisymbrium altissimum,* may be present to abundant, especially on disturbed sites. Some stands have high cover of cryptogams on the soil, including *Collema tenax, Tortula ruralis, Buellia papillata,* and *Fulgensia bracteata*.

Global Dynamics: *Pleuraphis jamesii* is both drought- and grazing-resistant (USFS 1937, Weaver and Albertson 1956, West et al. 1972). This grass is favored in mixed-grass stands because it is only moderately palatable to livestock; however, it decreases when heavily grazed during drought and in the

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more arid portions of its range where it is the dominant grass (West et al. 1972). This grass reproduces extensively from scaly rhizomes. These rhizomes make the plant resistant to trampling by livestock and have good soil-binding properties (USFS 1937, Weaver and Albertson 1956, West et al. 1972).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*, *Ephedra viridis*
Short shrub/sapling	Succulent shrub	*Opuntia* spp.
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Pleuraphis jamesii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Chenopodium album*, *Salsola tragus*

Global: Invasive/Exotic Plants: *Bassia scoparia* (Low), *Bromus tectorum* (High), *Salsola kali*, *Sisymbrium altissimum*

Conservation Status Rank

Global Rank & Reasons: G2G4 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Artemisia nova / Pleuraphis jamesii* Shrubland (CEGL001420)
- *Atriplex canescens / Pleuraphis jamesii* Shrubland (CEGL001288)
- *Atriplex confertifolia / Pleuraphis jamesii* Shrubland (CEGL001304)
- *Atriplex gardneri / Pleuraphis jamesii* Dwarf-shrubland (CEGL001441)
- *Atriplex obovata / Sporobolus airoides - Pleuraphis jamesii* Shrub Grassland (CEGL001775)
- *Bouteloua eriopoda - Pleuraphis jamesii* Grassland (CEGL001751)
- *Bouteloua gracilis - Pleuraphis jamesii* Grassland (CEGL001759)
- *Coleogyne ramosissima / Pleuraphis jamesii* Shrubland (CEGL001334)
- *Gutierrezia sarothrae / Sporobolus airoides - Pleuraphis jamesii* Shrub Grassland (CEGL001776)
- *Krascheninnikovia lanata / Pleuraphis jamesii* Dwarf-shrubland (CEGL001322)
- *Opuntia polyacantha / Pleuraphis jamesii* Shrubland (CEGL002299)
- *Pleuraphis jamesii - Sporobolus airoides* Grassland (CEGL001778)

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- *Pleuraphis rigida* Grassland (CEGL003051) is found on similar landforms (although typically at lower elevations) and hosts a similar set of common species; however, *Pleuraphis rigida* rather than *Pleuraphis jamesii* is dominant.

Global Related Concepts:
- *Hilaria jamesii* (Bourgeron and Engelking 1994) =
- *Hilaria jamesii* Habitat Type (Francis and Aldon 1983) =
- *Hilaria jamesii* Series (Francis 1986) >
- *Hilaria jamesii* cover type (Collins 1984) =
- *Hilaria jamesii*-dominated stands (Kleiner and Harper 1977) =
- *Pleuraphis jamesii* (Evens et al. 2014) =
- DRISCOLL FORMATION CODE:V.C.5.a. (Driscoll et al. 1984) >
- Pure *Hilaria jamesii* (Cannon 1960) =

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. It is defined by the dominance of *Pleuraphis jamesii* in the graminoid layer without codominance of other grass species or the presence of a shrub layer.

Element Distribution

Glen Canyon National Recreation Area Range: This grassland association is common throughout the recreation area. It was sampled near Bagpipe Butte, Waterhole Flat, Red Point, Andy Miller Flats, Muley Point, in Cove Canyon, Trachyte Canyon, North Wash, Middle Moody Canyon, and across from Good Hope Mesa.

Global Range: This widespread grassland association is found on alluvial flats, plateau parks and plains in the Colorado Plateau and elsewhere in the southwestern U.S. It is common in Utah and surrounding states.

Nations: US
States/Provinces: AZ:S2, CA, CO:S1, NM, NV, UT:S2S4
TNC Ecoregions: 9:C, 10:C, 11:C, 17:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 322A:CC, 341B:CC, 341C:CC, 341D:CC, 341E:CC, M331E:CC, M331G:CC
Federal Lands: NPS (Arches, Aztec Ruins, Black Canyon of the Gunnison, Canyonlands, Capitol Reef, Colorado, Curecanti, Dinosaur, Glen Canyon, Grand Canyon, Hovenweep, Mojave, Natural Bridges, Petroglyph, Pipe Spring, Wupatki, Zion); USFWS (Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plants are distributed according to how *Pleuraphis jamesii* would occupy a sandy substrate. The grasses and shrubs here have been grazed and cheatgrass is on the rise.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, and 2013 field data (14 plots): (Plots: GLCA.0562, GLCA.0762, GLCA.0778, GLCA.4057, GLCA.4077, GLCA.4079, GLCA.5065, GLCA.5281, GLCA.5298, GLCA.5304, GLCA.5315, GLCA.5316, GLCA.5405, GLCA.5506).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz, J. Coles and G. Kittel
References: Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Cannon 1960, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2003, Coles et al. 2008a, Coles et al. 2008b, Coles et al. 2008c, Coles et al. 2009a, Coles et al. 2010, Collins 1984, Driscoll et al. 1984, Evens et al. 2014, Francis 1986, Francis and Aldon 1983, Hansen et al. 2004b, Helm 1981, Kleiner 1968, Kleiner 1983, Kleiner and Harper 1972, Kleiner and Harper 1977, Marr et al. 1973a, Muldavin et al. 2012f, Nichol 1937, Peterson 2008, Reid and Hall 2010, Romme et al. 1993, Salas et al. 2009, Stewart et al. 1940, Tendick et al. 2010, USFS 1937, Utah Environmental and Agricultural Consultants 1973, Von Loh et al. 2002, Von Loh et al. 2007, Von Loh et al. 2008, Weaver and Albertson 1956, West et al. 1972, Western Ecology Working Group n.d.*

G310. Intermountain Semi-Desert Steppe & Shrubland

Group Summary Description: This group occurs throughout the semi-arid western U.S., including areas in the western Great Plains. This group can either be shrub-, dwarf-shrub-, or grass-dominated with an open (5-25% cover) woody layer. Stands dominated by *Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia microcephala,* and *Gutierrezia sarothrae* are often associated with disturbance. Other common shrubs may include *Chamaebatiaria millefolium, Chrysothamnus albidus, Ephedra viridis, Ephedra torreyana, Glossopetalon spinescens, Ericameria nana, Ericameria parryi, Ericameria teretifolia, Krascheninnikovia lanata, Mahonia fremontii, Opuntia fragilis, Opuntia polyacantha, Opuntia phaeacantha,* and *Tetradymia canescens*. Herbaceous species include *Achnatherum hymenoides, Aristida purpurea, Hesperostipa comata,* and *Pleuraphis jamesii*. Scattered *Juniperus* spp. are common, but rarely attain more than 5% cover. Landforms include alluvial flats and fans, talus slopes, plateaus, and bluffs. Slopes range from gentle to steep, and substrates are variable and include sandstone talus, fine-textured alluvium, sand, clay, loams, cinder, cobbles, and coarse gravels. Disturbance and grazing have impacted many occurrences, and in some cases may be important in maintaining these communities.

A3195 Chrysothamnus viscidiflorus Steppe & Shrubland Alliance

Alliance Summary Description: The vegetation is characterized by an open to moderate shrub layer dominated by *Chrysothamnus viscidiflorus* with 3-35% cover. Other shrub species may be present with low cover, such as *Amelanchier utahensis, Artemisia bigelovii, Artemisia tridentata, Atriplex canescens, Atriplex confertifolia, Eriogonum corymbosum, Ephedra viridis, Ericameria nauseosa, Gutierrezia sarothrae, Mahonia fremontii, Shepherdia rotundifolia, Symphoricarpos oreophilus, Tetradymia canescens,* and *Yucca baccata*. The herbaceous layer is variable and ranges from being moderately dense, diverse and bunchgrass-dominated to sparse and often depauperate. In some stands the herbaceous layer is dominant over shrubs. Dominant and common grasses may include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Elymus elymoides,*

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Hesperostipa comata, Koeleria macrantha, Leymus salinus ssp. salinus, Pascopyrum smithii, Poa fendleriana, Poa secunda, Pseudoroegneria spicata, and the introduced annuals *Bromus briziformis* and *Bromus tectorum*. *Leymus cinereus* may be present in mesic gully bottoms in Utah. Scattered forbs are present, such as *Antennaria* spp., *Astragalus bisulcatus, Castilleja* spp., *Cirsium undulatum, Cryptantha humilis, Leptodactylon pungens*, and *Leptodactylon watsonii*. Stands of the alliance occur in the southern San Luis Valley of Colorado, the lower slopes of mountains in western Wyoming and northern Utah, and on mesas and high plateaus of the Colorado Plateau. Stands occur on a variety of sites and range from level to moderately sloping, disturbed sites on ridges and in valleys. Elevations range from 1300 to 2440 m (4250-8000 feet). Substrates include eolian sands, alluvium, metamorphic rocks, granite or limestone, and the soil is likewise variable, with textures ranging from silt loam, sandy loam, loamy sand and silty clay loam.

[CEGL002799] Chrysothamnus viscidiflorus / Hesperostipa comata Shrubland

Translated Name: Yellow Rabbitbrush / Needle-and-Thread Shrubland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Steppe & Shrubland (G310)
Alliance: *Chrysothamnus viscidiflorus* Steppe & Shrubland Alliance (A3195)

Element Concept

Global Summary: This association occurs on disturbed ridges and valleys in the northern Colorado Plateau of Colorado and Utah and into the southern Rocky Mountains. The total vegetation cover rarely exceeds 60% and is characterized by an open shrub canopy of *Chrysothamnus viscidiflorus* with between 5 and 35% cover. The native bunchgrass *Hesperostipa comata* contributes 10 to 20% cover. Other short shrubs providing sparse cover include *Symphoricarpos oreophilus, Artemisia nova*, and *Tetradymia canescens*. The herbaceous layer is diverse in terms of species composition. Associated graminoids include *Achnatherum hymenoides, Bouteloua gracilis, Elymus elymoides, Pascopyrum smithii, Poa fendleriana*, and *Poa secunda*. Forbs are diverse but contribute very little cover, including *Chenopodium leptophyllum, Crepis acuminata, Cryptantha cinerea var. jamesii, Erigeron engelmannii, Eriogonum umbellatum, Lupinus caudatus, Opuntia fragilis, Packera tridenticulata, Sedum lanceolatum, Senecio spartioides, Leptodactylon pungens, Heterotheca villosa (= Chrysopsis villosa)*, and *Schoenocrambe linifolia*. This association occurs between 1800 and 2440 m (5900-8000 feet) elevation. Slopes range from gentle to moderately steep. Soils have textures ranging from silt loam to sandy loam to loamy sand, and bare soil covers most of the unvegetated ground surface. This community generally occurs in areas that have experienced significant disturbance (such as fire) or on-going natural disturbance such as season-long grazing.

Environmental Description

Glen Canyon National Recreation Area Environment: This association occurs on flat to gently sloping sites on plateaus and mesatops between 2244 and 2258 m elevation. Bare soil, litter, and live

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vegetation litter cover the unvegetated soil surface. The soil is a moderately well-drained sandy loam derived from the Straight Cliffs Formation.

Global Environment: This association occurs on level to moderately sloping disturbed sites on ridges and in valleys between 1800 and 2440 m (5900-8000 feet) elevation. Substrates include eolian sands, metamorphic rocks, granite or limestone, and the soil is likewise variable, with textures ranging from silt loam to sandy loam to loamy sand. Bare soil covers most of the unvegetated ground surface.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Total vegetation cover ranges from 12-45% and is characterized by an open shrub canopy of *Chrysothamnus viscidiflorus* with between 2 and 10% cover. The native bunchgrass *Hesperostipa comata* contributes 2-4% cover. An occasional *Pinus edulis* tree and *Amelanchier utahensis* tall shrub were recorded with low cover on the margins of the community. Stands are common in disturbed sites (previously burned areas), so *Bromus tectorum* may be abundant in the understory, with up to 15% cover. Other herbaceous species noted with sparse to low cover include *Machaeranthera canescens, Elymus trachycaulus,* and *Eriogonum racemosum*.

Global Vegetation: The total vegetation cover rarely exceeds 60% and is characterized by an open shrub canopy of *Chrysothamnus viscidiflorus* with between 5 and 35% cover. The native bunchgrass *Hesperostipa comata* contributes 10 to 20% cover. Other short shrubs providing sparse cover include *Symphoricarpos oreophilus, Artemisia nova,* and *Tetradymia canescens.* The herbaceous layer is diverse in terms of species composition. Associated graminoids include *Achnatherum hymenoides, Bouteloua gracilis, Elymus elymoides, Pascopyrum smithii, Poa fendleriana,* and *Poa secunda*. The non-native *Bromus tectorum* may also be present. Forbs are diverse but contribute very little cover, including *Chenopodium leptophyllum, Crepis acuminata, Cryptantha cinerea var. jamesii, Erigeron engelmannii, Eriogonum umbellatum, Lupinus caudatus, Opuntia fragilis, Packera tridenticulata, Sedum lanceolatum, Senecio spartioides, Leptodactylon pungens, Heterotheca villosa (= Chrysopsis villosa),* and *Schoenocrambe linifolia*.

Global Dynamics: This community generally occurs in areas that have experienced significant disturbance (such as fire) or on-going natural disturbance such as season-long grazing. At least one site was documented as being a sagebrush-dominated stand that burned and recovered to this association. Although rabbitbrush will temporarily dominate this association, if the source of disturbance is removed, other shrubs such as *Artemisia tridentata ssp. wyomingensis* will replace it.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Chrysothamnus viscidiflorus*
Herb (field)	Graminoid	*Bromus tectorum*, *Hesperostipa comata*

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Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Chrysothamnus viscidiflorus*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Hesperostipa comata*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Chrysothamnus viscidiflorus*, *Hesperostipa comata*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (23-Jun-2005).

Related Concepts

Global Similar Types:
- *Chrysothamnus viscidiflorus - Ericameria parryi* Shrub Grassland (CEGL002781)
- *Chrysothamnus viscidiflorus / Leymus salinus ssp. salinus* Shrub Grassland (CEGL001501)
- *Chrysothamnus viscidiflorus / Poa pratensis* Ruderal Shrub Grassland (CEGL002933)
- *Chrysothamnus viscidiflorus* Talus Shrubland (CEGL002347)

Classification

Status: Standard
Classification Confidence: 3 - Weak
Glen Canyon National Recreation Area Classification Comments: Only 1 plot was sampled; therefore, no local description has been written.

Element Distribution

Glen Canyon National Recreation Area Range: This very rare association was only sampled on Navajo Point / Bull Ridge.

Global Range: This association is apparently relatively uncommon and has been documented from western Colorado and Utah. It is likely to occur throughout the interior western U.S. in sandy, disturbed areas that normally support sagebrush shrublands.

Nations: US
States/Provinces: CO, ID, MT, UT
TNC Ecoregions: 6:C, 9:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 342D:CC, M331E:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Bryce Canyon, Craters of the Moon, Curecanti, Dinosaur, Glen Canyon); USFWS (Camas)

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Element Sources

Glen Canyon National Recreation Area Inventory Notes: Fire-affected area, high intensity, all trees killed. *Quercus gambelii* is re-sprouting, other plants in early succession 5-10 years?. Soil is loose, held in place by high cover of grasses, forbs, and shrubs (few).

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (1 plot, 1 accuracy assessment point): (Plots: GLCA.4205; AA Points: GLCA_AA.1484).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and G. Kittel
References: Bell et al. 2009, Coles et al. 2008a, Coles et al. 2010, MTNHP 2002b, Tendick et al. 2010, Tendick et al. 2011b, Western Ecology Working Group n.d.*

[CEPP005695] *Chrysothamnus viscidiflorus* / Disturbed Understory Shrubland
Translated Name: Yellow Rabbitbrush / Disturbed Understory Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Steppe & Shrubland (G310)
Alliance: *Chrysothamnus viscidiflorus* Steppe & Shrubland Alliance (A3195)

Element Concept

Global Summary: This shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely in the Colorado Plateau. It is characterized by an open to moderately dense shrub canopy layer dominated by *Chrysothamnus viscidiflorus*. Associated shrubs with sparse to low cover include *Amelanchier utahensis, Artemisia tridentata, Atriplex canescens, Ephedra viridis, Gutierrezia sarothrae, Purshia mexicana*, and *Purshia tridentata*. Because of disturbance, the herbaceous layer often has moderately high cover and is dominated by exotic *Bromus tectorum* with other weedy species such as *Lappula occidentalis, Machaeranthera canescens*, and *Salsola tragus*. Other species usually present with low to moderate cover include native grasses *Bouteloua gracilis, Elymus trachycaulus, Leymus salinus, Muhlenbergia asperifolia*, and *Poa fendleriana*. *Pinus edulis* and *Juniperus osteosperma* trees may have low cover on the margins of the community. Total vegetation cover in these disturbed shrublands ranges from 9 to 52%. Stands occur on disturbed sites on mesatops, ridges, canyon bottoms, basins, and along intermittent streams between 1522 and 2258 m elevation. Sites are flat to gently sloping with west and northwest aspects. Soils are sands and silt loams derived from alluvial or eolian deposits, from shales or sandstones. The unvegetated surface is dominated by bare soil, with lesser cover of litter.

Environmental Description

Glen Canyon National Recreation Area Environment: This uncommon shrubland association occurs on disturbed sites on mesatops, ridges, canyon bottoms, basins, and along intermittent streams. Sites are flat to gently sloping (up to 8°), are mostly west- and northwest-facing, and lie between 1522

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and 2258 m elevation. Soils are moderately well-drained to well-drained sands and silt loams derived from alluvial or eolian deposits, from shales of the Chinle or Straight Cliffs formations, or from Kayenta sandstone. The unvegetated surface is dominated by bare soil, with lesser cover of litter, and sparse to low cover of gravel and live vegetation litter.

Global Environment: This shrubland association occurs in the Colorado Plateau on disturbed sites on mesatops, ridges, canyon bottoms, basins, and along intermittent streams between 1522 and 2258 m elevation. Sites are flat to gently sloping (up to 8°) with west and northwest aspects. Soils are moderately well-drained to well-drained sands and silt loams derived from alluvial or eolian deposits, from shales of the Chinle or Straight Cliffs formations, or from Kayenta sandstone. The unvegetated surface is dominated by bare soil, with lesser cover of litter, and sparse to low cover of gravel and live vegetation litter.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Total vegetation cover in these disturbed shrublands ranges from 9-52%. The shrub canopy layer is dominated by *Chrysothamnus viscidiflorus*, with 4-18% cover. Associated shrubs with sparse to low cover include *Amelanchier utahensis, Artemisia tridentata, Atriplex canescens, Ephedra viridis, Gutierrezia sarothrae, Purshia mexicana*, and *Purshia tridentata*. Because stands are common in disturbed sites, the understory often has moderately high cover and is generally dominated by *Bromus tectorum*, with up to 13% cover. Other common species in the understory with low to moderate cover include the grasses *Bouteloua gracilis, Elymus trachycaulus, Leymus salinus,* and *Muhlenbergia asperifolia*, and the forbs *Lappula occidentalis, Machaeranthera canescens* (with up to 11% cover), and *Salsola tragus*. *Ambrosia acanthicarpa, Artemisia ludoviciana, Eriogonum umbellatum, Lepidium montanum, Sphaeralcea parvifolia, Wyethia scabra, Achnatherum hymenoides,* and *Poa fendleriana* are present with more than trace cover. *Pinus edulis* and *Juniperus osteosperma* trees may have low cover on the margins of the community.

Global Vegetation: This shrubland association is characterized by an open to moderately dense shrub canopy layer dominated by *Chrysothamnus viscidiflorus*. Associated shrubs with sparse to low cover include *Amelanchier utahensis, Artemisia tridentata, Atriplex canescens, Ephedra viridis, Gutierrezia sarothrae, Purshia mexicana,* and *Purshia tridentata.* Because of disturbance, the herbaceous layer often has moderately high cover and is dominated by exotic *Bromus tectorum* with other weedy species such as *Lappula occidentalis, Machaeranthera canescens,* and *Salsola tragus.* Additional species usually present with low to moderate cover include native grasses *Bouteloua gracilis, Elymus trachycaulus, Leymus salinus, Muhlenbergia asperifolia,* and *Poa fendleriana*. *Ambrosia acanthicarpa, Artemisia ludoviciana, Eriogonum umbellatum, Lepidium montanum, Sphaeralcea parvifolia, Wyethia scabra,* and *Achnatherum hymenoides* are present with more than trace cover. Scattered *Pinus edulis* and *Juniperus osteosperma* trees may be present with low cover on the margins of the community. Total vegetation cover in these disturbed shrublands ranges from 9 to 52%.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Chrysothamnus viscidiflorus*
Herb (field)	Graminoid	*Bromus tectorum*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Chrysothamnus viscidiflorus*
Herb (field)	Graminoid	*Bromus tectorum*

Characteristic Species

Glen Canyon National Recreation Area: Bromus tectorum, Chrysothamnus viscidiflorus
Global: Bromus tectorum, Chrysothamnus viscidiflorus

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: GNR (18-Aug-2016).

Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak
Global Classification Comments: This may be a degraded example of *Chrysothamnus viscidiflorus / Leymus salinus ssp. salinus* Shrub Grassland (CEGL001501).

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon shrubland association was sampled on disturbed sites, such as near a housing area/solar panel array, on a drill pad, near drainages and on scoured floodplains, and in previously burned areas. It was found to occur on Bull Ridge, the Purple Hills, near the Hans Flat Ranger Station, on Silver Falls Creek, and on a drill pad above Happy Canyon.

Global Range: This shrubland association is known from Glen Canyon National Recreation Area and likely occurs more widely in the Colorado Plateau.

Nations: US
States/Provinces: UT

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TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This site has been disturbed by past mineral explorations and cleared for a drill pad. This opening is surrounded by pinyon-juniper woodland and has not recovered tree cover. A light physical crust occurs on soil surface and may inhibit seed germination. Abundant ant colonies and heavy browsing by deer may also be limiting forb cover. Soil structure was probably heavily impacted by drilling and appears not to have recovered.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, and 2015 field data (4 plots, 2 accuracy assessment points): (Plots: GLCA.4213, GLCA.5048, GLCA.9503, GLCA.9505; AA Points: GLCA_AA.1362, GLCA_AA.2043).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

A3196 Ericameria nauseosa Steppe & Shrubland Alliance

Alliance Summary Description: The vegetation is characterized by a sparse to moderately dense, short-shrub layer (5-60% cover) that is dominated by *Ericameria nauseosa*. Depending on geography, associated shrubs may include scattered *Artemisia filifolia, Artemisia tridentata, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Opuntia* spp., *Prunus virginiana, Rhus trilobata, Symphoricarpos occidentalis*, and *Yucca* spp. The herbaceous layer can vary from sparse moderately dense, being more prominent in some stands than shrubs, and dominated by graminoids. Common native grasses include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua* spp., *Elymus trachycaulus ssp. trachycaulus, Leymus flavescens (= Elymus flavescens), Pascopyrum smithii, Pleuraphis jamesii, Pseudoroegneria spicata*, and *Sporobolus cryptandrus*. Native forbs generally have low cover. Disturbed stands typically have high cover of introduced annual *Bromus* species. This alliance includes both natural and semi-natural stands from localized areas across the northern Great Plains and throughout the western U.S. Elevations range from 1100 to 2200 m. Soils are variable but generally well-drained and coarse-textured. Sites are flat to gently sloping, occurring on all aspects. The semi-natural stands included in this alliance are seral shrubland communities resulting from overgrazing by livestock, road building, or other cultural disturbance of typically grass-dominated communities.

[CEGL002918] Ericameria nauseosa / Sporobolus airoides Shrubland

Translated Name: Rubber Rabbitbrush / Alkali Sacaton Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)

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Group: Intermountain Semi-Desert Steppe & Shrubland (G310)
Alliance: *Ericameria nauseosa* Steppe & Shrubland Alliance (A3196)

Element Concept

Global Summary: This sandy site association is found in the Colorado Plateau and the Great Sand Dunes National Park and Preserve in south-central Colorado. Vegetation is characterized by an open to closed shrub layer dominated by *Ericameria nauseosa* that ranges in cover from 5 to 60%, with a sparse to moderately dense understory dominated by the tall bunchgrass *Sporobolus airoides* (1-10% cover). Associated shrubs contribute little in the way of cover and can include *Atriplex canescens, Atriplex confertifolia, Ephedra torreyana, Eriogonum leptocladon*, and *Gutierrezia sarothrae*. The herbaceous layer is diverse and provides sparse to low cover. The most common associated graminoid is *Achnatherum hymenoides*. Forbs typically provide only trace cover; those present at greater than 1% cover include *Astragalus moencoppensis, Dicoria canescens, Psoralidium lanceolatum,* and *Wyethia scabra*. Total vegetation cover ranges from 15 to 65%. This short-shrub association occurs on stream terraces in the Colorado Plateau and sandsheets and dunes in the Great Sand Dunes National Park and Preserve. Sandsheet shrubland stands cover vast areas, whereas the stream terrace stands are more patchy, occurring in isolated stands on the floodplains of small or intermittent streams and often forming a mosaic with other wash associations, such as *Atriplex canescens* Shrubland (CEGL001281) and *Artemisia tridentata* Shrubland (CEGL000991). Sites slope gently (1-2%) and occur between 1263 and 1829 m (4145-6000 feet) elevation. Aspect is not important in determining the distribution of stands. The unvegetated surface has high exposure of bare soil and sparse cover by litter. The soils are well-drained sandy loams derived from alluvium and eolian sand.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrub association occurs on flat to gently sloping (up to 4°) stream terraces and channels between 1116 and 1528 m elevation. The unvegetated surface has high exposure of bare soil and litter and sparse cover of sand and biological soils crusts. The soils are derived from alluvium or White Rim sandstone.

Global Environment: This short-shrub association occurs on stream terraces in the Colorado Plateau and sandsheets and dunes in the Great Sand Dunes National Park and Preserve. Sites slope gently (1-2%) and occur between 1116 and 1829 m (4145-6000 feet) elevation. Aspect is not important in determining the distribution of stands. The unvegetated surface has high exposure of bare soil and sparse cover by litter. The soils are well-drained sandy loams derived from alluvium.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This uncommon shrubland association occurs in isolated stands on the floodplains of small or intermittent streams. Total vegetation cover, in these moderately dense to dense stands, ranges from 34 to 95%. The vegetation is characterized by open to moderate stands of *Ericameria nauseosa* shrubs that range in cover from 9 to 37%, with a patchy understory of the tall bunchgrass *Sporobolus airoides,* with between 4 and 8% cover. Associated shrubs generally contribute little in the way of cover and can include *Atriplex canescens.* The most common associated graminoid is *Distichlis spicata*. Forbs typically provide only trace cover; those

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present with greater than 1% cover include *Artemisia ludoviciana, Apocynum cannabinum, Psoralidium lanceolatum*, and *Iva acerosa*. Because this vegetation type often occurs in small pockets within a matrix of riparian vegetation, *Populus fremontii, Celtis laevigata var. reticulata (= Celtis reticulata),* and *Juniperus osteosperma* trees and *Quercus gambelii, Rhus trilobata var. trilobata (= Rhus aromatica var. trilobata),* and *Tamarix chinensis* tall shrubs may have low to moderate cover on the margins of the community.

Global Vegetation: This shrubland association is uncommon within its range, occurring in isolated stands on the floodplains of small or intermittent streams. It often forms a mosaic with other wash associations, such as *Atriplex canescens* Shrubland (CEGL001281) and *Artemisia tridentata* Shrubland (CEGL000991). Total vegetation cover ranges from 15 to 65%. The vegetation is characterized by open to closed stands of *Ericameria nauseosa* shrubs that range in cover from 5 to 60%, with a sparse to moderately dense understory dominated by the tall bunchgrass *Sporobolus airoides* with between 1 and 10% cover. Associated shrubs contribute little in the way of cover and can include *Atriplex canescens, Atriplex confertifolia, Ephedra torreyana, Eriogonum leptocladon,* and *Gutierrezia sarothrae*. The herbaceous layer is diverse and provides sparse to low cover. The most common associated graminoid is *Achnatherum hymenoides*. Forbs typically provide only trace cover; those present at greater than 1% cover include *Astragalus moencoppensis, Dicoria canescens, Psoralidium lanceolatum*, and *Wyethia scabra*.

Global Dynamics: Most stands are on low terraces that flood occasionally. The presence of *Sporobolus airoides* indicates an intermittently high water table and some degree of salinity of the soil. *Ericameria nauseosa* indicates tolerance for periodic flooding and other disturbances. Domestic livestock grazing tends to severely reduce the cover of *Sporobolus airoides* in favor of more grazing-tolerant or weedy species such as *Bromus tectorum*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Herb (field)	Graminoid	*Distichlis spicata*, *Sporobolus airoides*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Herb (field)	Graminoid	*Sporobolus airoides*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex canescens, Ericameria nauseosa, Sporobolus airoides*

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Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Tamarix chinensis*
Global:

Conservation Status Rank

Global Rank & Reasons: G3Q (28-Oct-2002).

Related Concepts

Global Similar Types:

- *Ericameria nauseosa* Desert Wash Shrubland (CEGL002261)
- *Ericameria nauseosa* Sand Deposit Sparse Shrubland (CEGL002980)
- *Ericameria nauseosa* Shrubland (CEGL002713)

Global Related Concepts:

- *Ericameria nauseosa / Sporobolus airoides* (Sawyer et al. 2009) **?**

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. It is characterized by two common species that occur in two different environments and dominant ecological processes. It may be possible to distinguish the alluvial sand deposits shrublands from upland eolian sandsheet shrubland stands by the presence of mesic indicator species.

Element Distribution

Glen Canyon National Recreation Area Range: This rare shrub-herbaceous type was sampled in Big Water Canyon and Grand Gulch.

Global Range: This sandsheet association is found in the Colorado Plateau from southeastern Utah and from the Great Sand Dunes National Park and Preserve in south-central Colorado. It is likely to occur in small, isolated patches throughout the Colorado Plateau.

Nations: US
States/Provinces: CO:S3, UT
TNC Ecoregions: 19:C, 20:C
USFS Ecoregions (1994/95): 341B:CC, M331F:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Glen Canyon, Great Sand Dunes)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: *Sporobolus airoides* is codominant with *Ericameria nauseosa*.

Glen Canyon National Recreation Area Plots: The description is based on 2014 and 2015 field data (2 accuracy assessment points): (GLCA_AA.0252, GLCA_AA.1981).

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Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and K.A. Schulz
References: Clark et al. 2009, Romme et al. 1993, Salas et al. 2010b, Sawyer et al. 2009, Western Ecology Working Group n.d.*

[CEGL003967] *Mahonia fremontii* Shrubland
Translated Name: Fremont's Mahonia Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Steppe & Shrubland (G310)
Alliance: *Ericameria nauseosa* Steppe & Shrubland Alliance (A3196)

Element Concept

Global Summary: This unusual shrubland is rare and is only known from Glen Canyon National Recreation Area in Utah. Total vegetation cover is 24%. *Mahonia fremontii* shrubs form an open canopy with 10% cover. Associated shrubs include *Ericameria nauseosa, Ephedra viridis, Atriplex canescens,* and *Gutierrezia sarothrae*. Herbaceous species contribute low cover and may include *Sporobolus airoides, Pleuraphis jamesii, Achnatherum hymenoides, Bromus tectorum, Artemisia ludoviciana,* and *Comandra umbellata*. Biological soil crust cover is moderate to high (to 51%). Stands occur on washbanks or terraces 2 to 3 m above the channel. The slope of the sampled stand is moderate, oriented to the south and lies at 1575 m elevation. Exposed soil covers most of the unvegetated surface, with low cover by litter. A well-developed biological soil crust community covers more than half the sampled plot. The soil is a rapidly drained silt loam derived from alluvium rich in shale.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland occurs on wash banks or terraces in canyon bottoms that are 2 to 3 m above the channel. The slope is flat to moderate (up to 15°), oriented to the south or west, and lies between 1155 m and 1575 m elevation. Exposed soil, litter, and biological soil crusts cover most of the unvegetated surface. The soil is a moderately well-drained to rapidly drained silt loam or loamy sand derived from alluvium.

Global Environment: This association is documented from a single occurrence found on washbanks or terraces 2 to 3 m above the channel. The slope of the sampled stand is moderate, oriented to the south and lies at 1575 m elevation. Exposed soil covers most of the unvegetated surface, with low cover by litter. A well-developed biological soil crust community covers more than half the sampled plot. The soil is a rapidly drained silt loam derived from alluvium rich in shale.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This unusual shrubland is rare within the recreation area. Total vegetation cover is 16-24%. *Mahonia fremontii* shrubs form an open canopy with 3-14% cover. Associated shrubs include *Ericameria nauseosa* and *Ephedra viridis*. The understory is

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often quite grassy and may include low to moderate cover of *Sporobolus airoides, Sporobolus contractus, Sporobolus flexuosus,* and *Pleuraphis jamesii*, as well as the forbs *Artemisia ludoviciana, Sphaeralcea grossulariifolia, Salsola tragus,* and *Datura wrightii*. Biological soil crusts may be absent or have moderately high cover (up to 51%).

Global Vegetation: This association is documented from a single occurrence and will require further documentation to develop a thorough global description.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Mahonia fremontii*
Herb (field)	Graminoid	*Sporobolus* spp.

Characteristic Species

Glen Canyon National Recreation Area:
Global:

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Salsola tragus*
Global:

Conservation Status Rank

Global Rank & Reasons: GNR (12-Jul-2006).

Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak
Global Classification Comments: This association is known and described because of the National Park Service inventory efforts in the Colorado Plateau. *Mahonia fremontii* is more commonly found in the understory of woodlands or forming a dwarf-shrub layer in taller shrublands. With only one plot to represent it, this type is very provisional, and with further classification work, could be merged into some other association.

Element Distribution

Glen Canyon National Recreation Area Range: This very rare association in a wash tributary to Big Water Canyon, in Fiftymile Gulch and Harris Wash.

Global Range: This association is represented by a single plot in Glen Canyon National Recreation Area in southern Utah.

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Nations: US
States/Provinces: UT
TNC Ecoregions:
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: The *Mahonia fremontii* stand is growing at least 2-3 m above the wash. Deep, loamy soils covered by very well-developed crusts. Some dieback/dead branches on some of the *Mahonia fremontii*, but overall, stand looks healthy.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2012 field data (3 plots): (Plots: GLCA.0128, GLCA.4331, GLCA.5236).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): M.E. Hall and K.A. Schulz
References: Western Ecology Working Group n.d.*

A3203 Gutierrezia sarothrae - Gutierrezia microcephala Dwarf-shrubland Alliance

Alliance Summary Description: The vegetation is characterized by an open (10-30% cover) woody layer dominated by *Gutierrezia sarothrae* with a sparse to luxuriant perennial graminoid layer. *Atriplex canescens* and *Krascheninnikovia lanata* may codominate the shrub layer in some stands. Other shrub associates may include *Artemisia tridentata, Ephedra viridis, Eriogonum corymbosum, Ericameria nauseosa, Fallugia paradoxa, Isocoma drummondii*, and *Opuntia* spp. Trees are absent or represented by scattered individuals of *Juniperus monosperma* or *Pinus edulis*, mostly as seedlings or saplings. The most common dominant graminoids include *Bouteloua gracilis, Bouteloua eriopoda, Elymus elymoides, Pleuraphis jamesii*, and *Sporobolus airoides*. Other herbaceous associates include *Aristida purpurea, Hesperostipa comata, Muhlenbergia porteri, Pleuraphis rigida (= Hilaria rigida), Sphaeralcea coccinea*, and *Sporobolus cryptandrus*. Introduced species such as *Bromus tectorum* or *Salsola kali* may dominate the herbaceous layer of some disturbed stands. This alliance represents shrub and shrub herbaceous vegetation of the Colorado Plateau and southern Rocky Mountains. It most commonly occurs on level to gently sloping sites, including gently rolling mesatops, terraces, hillslopes, plateaus, sand deposits, bluffs and occasionally along canyon footslopes on sites with moderate solar exposure. Elevation ranges from 1300 to 2230 m.

[CEPP005693] Gutierrezia (microcephala, sarothrae) - (Encelia frutescens, Brickellia microphylla) / Stephanomeria pauciflora Dwarf-shrubland

Translated Name: (Threadleaf Snakeweed, Broom Snakeweed) - (Button Brittlebush, Littleleaf Brickellbush) / Brown-plume Wire-lettuce Dwarf-shrubland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Steppe & Shrubland (G310)

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Subset: GLCA; Glen Canyon National Recreation Area

Alliance: *Gutierrezia sarothrae - Gutierrezia microcephala* Dwarf-shrubland Alliance (A3203)

Element Concept

Global Summary: This sparse slickrock dwarf-shrubland association is known from Glen Canyon National Recreation Area and is likely more widespread in the Colorado Plateau. It is characterized by a sparse dwarf-shrub canopy dominated by *Gutierrezia microcephala* or *Gutierrezia sarothrae* with the perennial forb *Stephanomeria pauciflora* dominating the herbaceous layer with up to 3% cover. Sometimes *Encelia frutescens* and/or *Brickellia microphylla* are codominant in the shrub canopy layer with less than 2% individual cover. Several other associated shrubs may be present with sparse to low cover. The sparse herbaceous cover may include native, perennial grasses *Achnatherum hymenoides, Aristida purpurea, Pleuraphis jamesii*, and *Sporobolus cryptandrus*, and the exotic annual grasses *Bromus rubens, Bromus tectorum*, and *Schismus barbatus*. This sparse dwarf-shrubland has total vegetation cover of 1 to 11%. Stands occur on slickrock benches, lakeshores, piedmont slopes, sideslopes, canyon sides, and mesas between 1101 and 1213 m elevation, all in close proximity to the lakeshore. Sites range from flat to moderately sloping, occurring on all aspects. Bedrock covers most of the unvegetated surface, with lesser cover by bare soil, sand, gravel, and large rocks. Soils are sands, loamy sands, and silt loams derived from eolian or alluvial deposits, from sandstones or shales.

Environmental Description

Glen Canyon National Recreation Area Environment: This uncommon dwarf-shrubland association occurs on slickrock benches, lakeshores, piedmont slopes, sideslopes, canyon sides, and mesas, all in close proximity to the lakeshore. Sites range from flat to moderately sloping (up to 12°), are oriented to all aspects, and lie between 1101 and 1213 m elevation. Bedrock covers most of the unvegetated surface, with lesser cover by bare soil, sand, gravel, and large rocks, and sparse to low cover by biological soil crusts, litter, and dead wood. Soils are moderately well-drained to rapidly drained sands, loamy sands, and silt loams derived from eolian or alluvial deposits, from sandstones of the Cedar Mesa, Navajo or Kayenta formations, or from shales of the Carmel Formation.

Global Environment: This sparse dwarf-shrubland association occurs in the Colorado Plateau on slickrock benches, lakeshores, piedmont slopes, sideslopes, canyon sides, and mesas between 1101 and 1213 m elevation, all in close proximity to the lakeshore. Sites range from flat to moderately sloping (up to 12°), occurring on all aspects. Bedrock covers most of the unvegetated surface, with lesser cover by bare soil, sand, gravel, and large rocks. Soils are moderately well-drained to rapidly drained sands, loamy sands, and silt loams derived from eolian or alluvial deposits, from sandstones of the Cedar Mesa, Navajo or Kayenta formations, or from shales of the Carmel Formation.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse slickrock dwarf-shrubland has total vegetation cover of 1-11%. The dwarf-shrub canopy is dominated by *Gutierrezia microcephala* or *Gutierrezia sarothrae* (with trace to 8% cover). Sometimes codominant in the shrub canopy layer are *Encelia frutescens* and/or *Brickellia microphylla*, both with less than 2% individual cover. The understory is characterized by the presence and dominance of the perennial forb *Stephanomeria pauciflora*, with up to 3% cover. Associated shrubs with sparse to low cover may include *Brickellia*

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longifolia, Coleogyne ramosissima, Ephedra cutleri, Ephedra torreyana, and *Eriogonum corymbosum*. *Tamarix chinensis* saplings or short shrubs are a common component of the shrub layer due to the close proximity to the lakeshore and in some cases because stands occur below the high water mark. The sparse understory may include the native, perennial grasses *Achnatherum hymenoides, Aristida purpurea, Pleuraphis jamesii*, and *Sporobolus cryptandrus*, and the exotic annual grasses *Bromus rubens, Bromus tectorum*, and *Schismus barbatus*. Additional forbs noted with more than trace cover include *Sphaeralcea leptophylla* and *Thymophylla pentachaeta*.

Global Vegetation: This sparse slickrock dwarf-shrubland association is characterized by a sparse dwarf-shrub canopy dominated by *Gutierrezia microcephala* or *Gutierrezia sarothrae* with the perennial forb *Stephanomeria pauciflora* dominating the herbaceous layer with up to 3% cover. Sometimes *Encelia frutescens* and/or *Brickellia microphylla* are codominant in the shrub canopy layer with less than 2% individual cover. Associated shrubs with sparse to low cover may include *Brickellia longifolia, Coleogyne ramosissima, Ephedra cutleri, Ephedra torreyana*, and *Eriogonum corymbosum*. *Tamarix chinensis* saplings or short shrubs are a common component of the shrub layer due to the close proximity to the lakeshore and in some cases because stands occur below the high water mark. The sparse herbaceous cover may include the native, perennial grasses *Achnatherum hymenoides, Aristida purpurea, Pleuraphis jamesii*, and *Sporobolus cryptandrus*, and the exotic annual grasses *Bromus rubens, Bromus tectorum*, and *Schismus barbatus*. Additional forbs noted with more than trace cover include *Sphaeralcea leptophylla* and *Thymophylla pentachaeta*. This sparse dwarf-shrubland has total vegetation cover of 1 to 11%.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Brickellia microphylla*, *Encelia frutescens*, *Gutierrezia microcephala*, *Gutierrezia sarothrae*
Herb (field)	Flowering forb	*Stephanomeria pauciflora*
Herb (field)	Graminoid	*Bromus rubens*, *Schismus barbatus*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Brickellia microphylla*, *Encelia frutescens*, *Gutierrezia microcephala*, *Gutierrezia sarothrae*
Herb (field)	Flowering forb	*Stephanomeria pauciflora*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Gutierrezia microcephala*, *Gutierrezia sarothrae*, *Stephanomeria pauciflora*

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Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Schismus barbatus* (High/Medium), *Tamarix chinensis*

Global: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Schismus barbatus* (High/Medium), *Tamarix chinensis*

Conservation Status Rank

Global Rank & Reasons: GNR (18-Aug-2016).

Related Concepts

Classification

Status: Provisional
Classification Confidence: 3 - Weak

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon dwarf shrubland was sampled on Antelope Island, the Sand Hills, Halls Creek Bay, near Dangling Rope, the confluence of the Escalante and Colorado rivers, Hite, the Dirty Devil, and in Moqui Canyon.

Global Range: This dwarf-shrubland association is known from Glen Canyon National Recreation Area and is likely more widespread in the Colorado Plateau.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Very sandy soil, small knoll among exposed sandstone slickrock surroundings. Appears to be slightly above old lake level, but higher ground moisture from proximity to lake could have promoted tamarisk intrusion.

Glen Canyon National Recreation Area Plots: The description is based on 2011, 2012, and 2015 field data (9 plots, 4 accuracy assessment points): (Plots: GLCA.1052, GLCA.1060, GLCA.1061, GLCA.1070, GLCA.1082, GLCA.1083, GLCA.2054, GLCA.4256, GLCA.4288; AA Points: GLCA_AA.1644, GLCA_AA.1647, GLCA_AA.1704, GLCA_AA.1880).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEPP009523] Gutierrezia (microcephala, sarothrae) Dwarf-shrubland
Translated Name: (Threadleaf Snakeweed, Broom Snakeweed) Dwarf-shrubland
Common Name:

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USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Steppe & Shrubland (G310)
Alliance: *Gutierrezia sarothrae - Gutierrezia microcephala* Dwarf-shrubland Alliance (A3203)

Element Concept

Global Summary: This dwarf-shrubland association is known from Glen Canyon National Recreation Area and Grand Canyon National Park and is likely widespread throughout the interior western U.S. The sparse to open dwarf-shrub canopy is characterized and dominated by *Gutierrezia sarothrae* and/or *Gutierrezia microcephala*. Total shrub cover is variable, ranging from 15-20% for open stands with 8-18% cover of *Gutierrezia* spp. to sparse stands with 3-10% shrub cover (*Gutierrezia sarothrae* with 1-7% cover and/or *Gutierrezia microcephala* with 3-5%). Trees are generally lacking although occasional *Tamarix chinensis* or *Juniperus osteosperma* may be present with trace cover. Other shrubs present with sparse to low cover may include scattered *Acacia greggii, Artemisia filifolia, Atriplex confertifolia, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra fasciculata, Ericameria nauseosa, Lycium andersonii, Opuntia phaeacantha, Opuntia polyacantha,* or *Yucca baccata*. If present the herbaceous layer is generally sparse and composed of weedy, often exotic annual and short-lived perennial species. Stands occur on plateaus, benches, hills, slopes, valley bottoms, and along washes/drainage channels. Sites are flat to gently sloping and between 1100 and 1900 m elevation. Soils are variable, ranging from sands to silty clay loams derived from eolian or alluvial deposits, shales or sandstone.

Environmental Description

Glen Canyon National Recreation Area Environment: This dwarf-shrubland association occurs on plateaus, benches, hills, valley bottoms, and along washes/drainage channels. Sites are flat to gently sloping (up to 10°), are generally west-facing, and lie between 1106 and 1559 m elevation. Bare soil covers most of the unvegetated surface, with lesser cover of gravel, and sparse to low cover of litter, large rocks, and biological soil crusts. Soils are well-drained to rapidly drained sands, loamy sands, sandy loams, and silty clay loams derived from eolian or alluvial deposits, shales of the Chinle or Carmel formations, or Dakota sandstone.

Global Environment: This dwarf-shrubland association is known from Glen Canyon National Recreation Area and Grand Canyon National Park and is likely widespread throughout the interior western U.S. Stands occur on plateaus, benches, hills, slopes, valley bottoms, and along washes/drainage channels. Sites are flat to gently sloping (up to 15°) and between 1100 and 1900 m elevation. Aspects are frequently westerly but are variable. Soils are well-drained to rapidly drained sands, loamy sands, sandy loams, and silty clay loams derived from eolian or alluvial deposits, shales or sandstone. Bare soil covers most of the unvegetated surface, with lesser cover of gravel, and sparse to low cover of litter, large rocks, and biological soil crusts.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Trees and tall shrubs are essentially lacking in this dwarf-shrubland association; however, scattered *Tamarix chinensis* (3%) rarely occur. Total shrub

cover in these sparse shrublands averages 3-10% (though one example of this type has 35% total cover), and is characterized and dominated by one or both of the dwarf-shrubs *Gutierrezia sarothrae* (with 1-7% cover) and/or *Gutierrezia microcephala* (with 3-5%, but one stand has cover of 18%). Other shrubs present with sparse to low cover may include *Artemisia filifolia, Atriplex confertifolia, Chrysothamnus viscidiflorus, Lycium andersonii*, and *Opuntia* spp. The understory is generally absent to sparsely vegetated and, where present, is dominated by weedy, annual species, including *Ambrosia acanthicarpa, Erodium cicutarium, Salsola tragus, Schismus barbatus*, and *Tiquilia latior*; *Cryptantha flava* is present with more than trace cover.

Global Vegetation: This dwarf-shrubland association has a sparse to open dwarf-shrub canopy characterized and dominated by *Gutierrezia sarothrae* and/or *Gutierrezia microcephala*. Total shrub cover is variable, ranging from 15-20% for open stands with 8-18% cover of *Gutierrezia* spp. to sparse stands with 3-10% shrub cover (*Gutierrezia sarothrae* with 1-7% cover and/or *Gutierrezia microcephala* with 3-5%). Trees are generally lacking although occasional *Tamarix chinensis* or *Juniperus osteosperma* may be present with trace cover. Other shrubs present with sparse to low cover may include scattered *Acacia greggii, Artemisia filifolia, Atriplex confertifolia, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra fasciculata, Ericameria nauseosa, Lycium andersonii, Opuntia phaeacantha, Opuntia polyacantha*, or *Yucca baccata*. If present the herbaceous layer is generally sparse and composed of weedy, often exotic annual and short-lived perennial species, including *Ambrosia acanthicarpa, Bromus rubens, Cryptantha flava, Dasyochloa pulchella, Erodium cicutarium, Salsola tragus, Schismus barbatus, Tiquilia latior*, and *Vulpia octoflora*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Gutierrezia microcephala*, *Gutierrezia sarothrae*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Gutierrezia microcephala*, *Gutierrezia sarothrae*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Gutierrezia microcephala*, *Gutierrezia sarothrae*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Erodium cicutarium* (Medium/Low), *Salsola tragus*, *Schismus barbatus* (High/Medium)

Global: Invasive/Exotic Plants: *Bromus rubens*, *Erodium cicutarium* (Medium/Low), *Salsola tragus*, *Schismus barbatus* (High/Medium), *Tamarix chinensis*

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Conservation Status Rank

Global Rank & Reasons: GNR (23-Jun-2010).

Related Concepts

Global Similar Types:

- *Gutierrezia (sarothrae, microcephala) - Ephedra* spp. - *Agave utahensis* Dwarf-shrubland (CEGL005130) is also dominated by *Gutierrezia sarothrae* along with *Agave utahensis* but contains much more *Ephedra* spp.

Classification

Status: Provisional

Classification Confidence:

Glen Canyon National Recreation Area Classification Comments: *Gutierrezia (sarothrae, microcephala) - Ephedra* spp. - *Agave utahensis* Shrubland (CEGL005130) is also dominated by *Gutierrezia sarothrae*. However, *Gutierrezia (microcephala, sarothrae)* Dwarf-shrubland (CEPP009523) does not support *Agave utahensis* and contains much less *Ephedra* spp.

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon association was sampled near Wahweap, in West Canyon, Gunsight Canyon, Warm Creek Bay, and on the Purple Hills.

Global Range: This dwarf-shrubland association is known from Glen Canyon National Recreation Area and Grand Canyon National Park and is likely widespread throughout the interior western U.S.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon, Grand Canyon, Grand Canyon-Parashant)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Unusual substrate - essentially weathered shale that has become a dark, powdery, sand-like soil. Sun and wind exposure is high; plants are stunted and sparse. Area hosts several small, ephemeral drainage channels and appears to experience sheetflow during flooding events.

Glen Canyon National Recreation Area Plots: This description is based on 2011, 2012, and 2015 field data (6 plots, 1 accuracy assessment point): (Plots: GLCA.1008, GLCA.1073, GLCA.2027, GLCA.5017, GLCA.5049, GLCA.5053; AA Points: GLCA_AA.1574).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

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Subset: GLCA; Glen Canyon National Recreation Area

[CEGL002690] Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii Dwarf-shrubland

Translated Name: Broom Snakeweed - (Prickly-pear species) / James' Galleta Dwarf-shrubland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)

Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)

Group: Intermountain Semi-Desert Steppe & Shrubland (G310)

Alliance: *Gutierrezia sarothrae* - *Gutierrezia microcephala* Dwarf-shrubland Alliance (A3203)

Element Concept

Global Summary: This dwarf-shrubland is found in Utah and northern Arizona, mostly in the Colorado Plateau, but likely occurs more widely. This association is characterized by an open dwarf-shrub canopy (10-30% cover) that is dominated by *Gutierrezia sarothrae*, frequently with *Opuntia* spp. and an herbaceous layer with *Pleuraphis jamesii* present to abundant (1-30% cover). Some stands have a diverse woody layer that includes low cover of several shrub species and occasional *Pinus edulis* or *Juniperus osteosperma* trees. The herbaceous layer is typically dominated by graminoids with several species present in addition to *Pleuraphis jamesii*, including *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Elymus elymoides, Hesperostipa comata*, or *Pascopyrum smithii*. There is usually only sparse cover of native forbs such as *Chamaesyce* spp. or *Sphaeralcea coccinea*. Introduced species such as *Bromus tectorum* or *Salsola kali* may dominate the herbaceous layer of some disturbed stands. Stands occur on level to moderately sloping hillslopes, plateaus and bluffs. Aspects are reported from the southeast, south and southwest. Soils are variable and range from sandy to clayey texture and may occur over gravel and cobbles or talus. Disturbance may be important in maintaining this vegetation community as some stands have been created by chaining of trees and improper grazing by livestock.

Environmental Description

Glen Canyon National Recreation Area Environment: This disturbed dwarf-shrubland occurs on flats, valley floors, canyon sides and bottoms, alluvial fans, terraces, benches, and hills with up to 10° slopes and west-facing aspects. It occurs between 1111 and 1671 m elevation. Most of the unvegetated surface is bare soil, with low to moderate cover by gravel, and trace to low cover by sand, biological soil crusts, large rocks, and bedrock. The soil is a rapidly drained loamy sand, loam, or sandy clay derived from alluvium or from shales of the Chinle Formation.

Global Environment: This association is described from Utah and northern Arizona where it occurs on level to moderately sloping hillslopes, plateaus, sand deposits and bluffs. Elevations range from 1350-2000 m. Aspects are reported from the southeast, south and southwest. Soils are variable and range from sandy to clayey texture and may occur over gravel and cobbles or talus. Disturbance may be important in maintaining this vegetation community as some stands may have been created by chaining of trees and improper grazing by livestock.

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Vegetation Description

Glen Canyon National Recreation Area Vegetation: This degraded dwarf-shrubland has total vegetation cover between 3 and 32% and is characterized by a canopy of *Gutierrezia sarothrae* (with 3-22% cover) (or in one case a canopy of *Gutierrezia microcephala*) with or without *Opuntia* spp. present (up to 5% cover), and an understory where *Pleuraphis jamesii* is present to abundant (trace to 13% cover) but not always the dominant graminoid species. Another common to dominant graminoid species is *Achnatherum hymenoides*. The only other grass species noted with more than trace cover was *Sporobolus cryptandrus*. Other shrubs present may include *Atriplex confertifolia, Coleogyne ramosissima, Ephedra torreyana, Ephedra viridis, Lycium andersonii, Psorothamnus thompsoniae, Ericameria nauseosa*, and *Gutierrezia microcephala* with sparse to low cover. A few forbs were recorded in the understory with more than trace cover, including *Abronia fragrans, Stephanomeria pauciflora, Thelesperma subnudum*, and *Sphaeralcea ambigua*. Scattered individuals of *Juniperus osteosperma* (up to 6% cover) occur on the peripheries of some stands.

Global Vegetation: This broadly defined association is characterized by an open dwarf-shrub canopy (10-30% cover) dominated by *Gutierrezia sarothrae*, frequently with *Opuntia* spp. and an herbaceous layer with *Pleuraphis jamesii* present to abundant (0-30% cover). Some stands have a diverse woody layer that includes low cover of *Artemisia nova, Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra* spp., *Eriogonum* spp., *Grayia spinosa, Lycium pallidum, Purshia tridentata*, or occasional *Pinus edulis* or *Juniperus osteosperma* trees. The herbaceous layer is typically dominated by graminoids with several species present including *Pleuraphis jamesii, Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Elymus elymoides, Hesperostipa comata*, or *Pascopyrum smithii*. There is usually only sparse cover of native forbs like *Chamaesyce* spp. or *Sphaeralcea coccinea*; however, introduced species such as *Bromus tectorum, Erodium cicutarium, Lepidium montanum, Sisymbrium altissimum*, or *Salsola kali* may dominate the herbaceous layer of some disturbed stands.

Global Dynamics: *Gutierrezia sarothrae* occurs in many natural grassland and steppe communities in the western U.S. and is known to increase when these communities are disturbed mechanically or by over-grazing (Stubbendieck et al. 1992, USFS 1937). The role of disturbance in this association needs further study to understand its successional nature.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Ephedra torreyana*, *Ephedra viridis*, *Gutierrezia sarothrae*
Short shrub/sapling	Succulent shrub	*Opuntia* spp.
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Pleuraphis jamesii*

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Global

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Short shrub/sapling	Succulent shrub	*Opuntia* spp.
Herb (field)	Graminoid	*Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Gutierrezia sarothrae, Opuntia* spp., *Pleuraphis jamesii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Psorothamnus thompsoniae* (G3?)
Global:

Conservation Status Rank

Global Rank & Reasons: GNR (26-Jul-2001).

Related Concepts

Global Similar Types:

- *Gutierrezia sarothrae - Krascheninnikovia lanata - Atriplex canescens / Bouteloua eriopoda* Shrub Grassland (CEGL001733) rare grassland endemic to Grand Canyon National Park.
- *Gutierrezia sarothrae / Pleuraphis rigida* Shrub Grassland (CEGL001543) possibly an anthropogenically disturbed *Pleuraphis rigida* grassland.
- *Gutierrezia sarothrae / Sporobolus airoides - Pleuraphis jamesii* Shrub Grassland (CEGL001776) described from northwestern New Mexico.
- *Opuntia polyacantha / Pleuraphis jamesii* Shrubland (CEGL002299)

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. This broadly defined dwarf-shrubland includes stands that could also be classified as a dwarf-shrub herbaceous association. Because it may be the result of disturbance, it occurs on a variety of sites.

Element Distribution

Glen Canyon National Recreation Area Range: This fairly uncommon association was sampled on flats and low hills near Waterhole Canyon, in White Canyon, Big Spring Canyon, Coyote Gulch, Middle Moody Canyon, and in the Purple Hills.

Global Range: This association is described from Utah and northern Arizona, but is likely more widespread throughout the semi-arid western U.S.

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Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 10:C, 19:C, 21:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 341C:CC, M313A:CC
Federal Lands: NPS (Canyonlands, Glen Canyon, Petrified Forest, Walnut Canyon, Zion); USFWS (Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Deep, fine soils in a broad valley. Grazing history probably has affected species mix.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, and 2015 field data (4 plots, 5 accuracy assessment points): (Plots: GLCA.0719, GLCA.0777, GLCA.4300, GLCA.5055; AA Points: GLCA_AA.1097, GLCA_AA.1102, GLCA_AA.1159, GLCA_AA.1165, GLCA_AA.1179).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Cogan et al. 2004, Hansen et al. 2004a, Stubbendieck et al. 1992, Thomas et al. 2009a, USFS 1937, Von Loh et al. 2002, Western Ecology Working Group n.d.*

A3202 Krascheninnikovia lanata Steppe & Dwarf-shrubland Alliance

Alliance Summary Description: This alliance includes dwarf-shrublands dwarf-shrub herbaceous vegetation scattered across the interior western U.S. Shrub layers are characterized by a sparse to moderately dense dwarf-shrub layer dominated by *Krascheninnikovia lanata*. Other woody species may include scattered *Artemisia frigida, Artemisia nova*, *Artemisia tridentata, Chrysothamnus* spp., *Gutierrezia sarothrae*, *Opuntia polyacantha, Rhus trilobata*, and *Yucca glauca*. In the Mojave Desert, *Ambrosia dumosa, Atriplex polycarpa, Larrea tridentata*, and *Lycium andersonii* may also be present. The herbaceous layer has sparse to very dense cover dominated by graminoids with scattered perennial forbs which in some stands may take prominence over shrubs. Graminoids such as *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Hesperostipa comata (= Stipa comata), Pascopyrum smithii, Pleuraphis jamesii (= Hilaria jamesii), Poa secunda*, and *Pseudoroegneria spicata* are most abundant. Perennial forbs may include *Achillea millefolium, Astragalus purshii, Calochortus macrocarpus, Erigeron* spp., *Phlox hoodii, Sphaeralcea coccinea*, and *Sphaeralcea munroana*. Annuals may be seasonally present to abundant depending on precipitation and disturbance. Exotic annuals, such as *Bromus tectorum*, can be abundant. Elevations range from 100-2700 m. Stands occur on plateaus, plains, mesas, hillslopes, alkaline flats around playas and along drainages. Some habitats are intermittently flooded wetlands. Sites are typically flat to gently sloping, occurring on any aspect, but stands have also been reported from moderately steep slopes. Soils are calcareous, moderately alkaline and sometimes saline. Soil texture is typically stony, sandy loam, but may be coarser textured. The ground cover is mostly bare soil.

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Subset: GLCA; Glen Canyon National Recreation Area

[CEGL001327] Krascheninnikovia lanata / Hesperostipa comata Dwarf-shrubland
Translated Name: Winterfat / Needle-and-Thread Dwarf-shrubland
Common Name: Winterfat / Needle-and-Thread Dwarf-shrubland

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Steppe & Shrubland (G310)
Alliance: *Krascheninnikovia lanata* Steppe & Dwarf-shrubland Alliance (A3202)

Element Concept

Global Summary: This association is known from the Colorado Plateau in western Colorado, Utah and northern Arizona and in the northwestern Great Plains in northeastern Montana, and reported from Washington and Wyoming; it may also occur in Saskatchewan, Canada. Vegetation is characterized by an open to moderate (10-60% cover) dwarf-shrub layer dominated by *Krascheninnikovia lanata* with an open to moderate herbaceous layer dominated by *Hesperostipa comata*. On the Colorado Plateau, other shrubs occurring with minimal cover include *Artemisia tridentata ssp. wyomingensis, Chrysothamnus viscidiflorus*, and *Gutierrezia sarothrae*. The herbaceous layer is dominated by *Hesperostipa comata*; other grasses, such as *Bromus tectorum, Poa secunda, Poa fendleriana,* and *Achnatherum hymenoides*, may occur with few forbs. In the northwestern Great Plains, constant associates are *Artemisia frigida, Bouteloua gracilis*, and *Carex filifolia* with *Atriplex nuttallii, Artemisia tridentata, Gutierrezia sarothrae, Koeleria macrantha*, and *Poa secunda*. Forbs such as *Phlox hoodii, Plantago patagonica*, and *Sphaeralcea coccinea* are inconspicuous and contribute little cover. Introduced species *Bromus japonicus, Bromus tectorum*, and *Melilotus officinalis* are often present but not abundant. In the Colorado Plateau, stands occur on colluvial slopes at around 2000 m elevation and canyon bottoms at 1635 m elevation. Soils are moderately deep and sandy. In northeastern Montana, it is a minor type that occurs on the periphery of badlands and breaks usually on alluvial flats and gently sloping footslopes.

Environmental Description

Glen Canyon National Recreation Area Environment: This association occurs on level mesatops between 1635 and 1684 m elevation. The unvegetated surface is codominated by bare soil and litter; soils are derived from Cedar Mesa sandstone.

Global Environment: This association is known from the Colorado Plateau in northwestern Colorado and eastern Utah and the northwestern Great Plains in northeastern Montana. It has also been reported from Washington and may occur in Saskatchewan. In the Colorado Plateau, stands occur on colluvial slopes at around 2000 m and canyon bottoms at 1635 m elevation. Exposed soil covers most of the unvegetated surface with low to moderate litter cover. Biological soil crusts have up to 13% cover. Soils include sandy loam and silty clay loam. In northeastern Montana, it is a minor type that occurs on the periphery of badlands and breaks usually on alluvial flats and gently sloping footslopes.

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Vegetation Description

Glen Canyon National Recreation Area Vegetation: This association is characterized by moderately dense total vegetation cover (41-56%) and is dominated by *Krascheninnikovia lanata*, with 8-11% cover, and a moderately dense herbaceous layer characterized and sometimes dominated by *Hesperostipa comata*, with 6-8% cover. Associated shrubs with low cover include *Atriplex canescens, Ephedra torreyana, Ephedra cutleri*, and *Opuntia phaeacantha*. The moderately dense herbaceous layer may include significant cover of *Pleuraphis jamesii* and *Sporobolus cryptandrus*, and lesser cover of *Achnatherum hymenoides*. Forbs with low cover may include *Machaeranthera canescens, Sphaeralcea ambigua*, and *Sphaeralcea parvifolia*. Introduced species *Bromus tectorum, Lappula occidentalis*, and *Plantago patagonica* are often present but not abundant.

Global Vegetation: This association is characterized by an open to moderately dense (10-60% cover) dwarf-shrub layer dominated by *Krascheninnikovia lanata* with an open to moderate herbaceous layer dominated by *Hesperostipa comata*. On the Colorado Plateau, other shrubs occurring with minimal cover include *Artemisia tridentata ssp. wyomingensis, Chrysothamnus viscidiflorus*, and *Gutierrezia sarothrae*. The herbaceous layer is dominated by *Hesperostipa comata*. Other grasses present include *Bromus tectorum, Poa secunda, Poa fendleriana, Bouteloua gracilis*, and *Achnatherum hymenoides* with few forbs such as *Delphinium andersonii, Helianthus annuus, Mentzelia albicaulis, Plantago patagonica, Oenothera albicaulis*, and *Sphaeralcea coccinea*. In the northwestern Great Plains, DeVelice et al. (1995) reported constant associates as *Artemisia frigida, Bouteloua gracilis*, and *Carex filifolia*. Other common taxa include *Atriplex nuttallii, Artemisia tridentata, Gutierrezia sarothrae, Koeleria macrantha, Nassella viridula, Poa secunda*, and *Pseudoroegneria spicata*. Scattered forbs such as *Phlox hoodii, Plantago patagonica*, and *Sphaeralcea coccinea* are typically present and contribute little cover. Introduced species *Bromus japonicus, Bromus tectorum*, and *Melilotus officinalis* are often present but not abundant.

Global Dynamics: This association is uncommon on the Colorado Plateau; when it does occur, it is likely to be as small stands occurring in a matrix with other shrublands, grasslands or pinyon-juniper woodlands. The grazing sensitive species *Krascheninnikovia lanata, Pseudoroegneria spicata*, and *Nassella viridula* are more abundant in lightly or ungrazed stands, and it is thought that this *Hesperostipa comata*-codominated association is an early-seral type resulting from heavy grazing by livestock (DeVelice et al. 1995).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Krascheninnikovia lanata*
Herb (field)	Graminoid	*Hesperostipa comata*

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Global

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Krascheninnikovia lanata*
Herb (field)	Graminoid	*Hesperostipa comata*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Hesperostipa comata*, *Krascheninnikovia lanata*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Invasive/Exotic Plants: *Bromus japonicus*, *Bromus tectorum* (High), *Melilotus officinalis* (Medium/Low)

Conservation Status Rank

Global Rank & Reasons: G3 (1-Feb-1996). This association is reported from small, widely scattered occurrences over a large part of the interior West.

Related Concepts

Global Similar Types:

- *Krascheninnikovia lanata / Achnatherum hymenoides* Dwarf-shrubland (CEGL001323)
- *Krascheninnikovia lanata / Bouteloua gracilis* Dwarf-shrub Grassland (CEGL001321)
- *Krascheninnikovia lanata / Phlox* spp. Dwarf-shrubland (CEGL001325)
- *Krascheninnikovia lanata / Pleuraphis jamesii* Dwarf-shrubland (CEGL001322)
- *Krascheninnikovia lanata / Poa secunda* Dwarf-shrubland (CEGL001326)
- *Krascheninnikovia lanata* Dwarf-shrubland (CEGL001320)

Global Related Concepts:

- *Ceratoides lanata / Stipa comata* Community Type (DeVelice et al. 1995) =
- *Ceratoides lanata/Stipa comata* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 1 - Strong
Global Classification Comments: This association is closely related to *Krascheninnikovia lanata / Pleuraphis jamesii* Dwarf-shrubland (CEGL001322) in the Colorado Plateau. DeVelice et al. (1995) suggested a putative *Krascheninnikovia lanata / Pseudoroegneria spicata* plant association that would represent the late-seral stage of this type in the northwestern Great Plains. Stands in the Colorado Plateau and northwestern Great Plains have significant differences in associated species. More data and analysis are needed to determine if they should be classified together or separated into distinct associations.

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Subset: GLCA; Glen Canyon National Recreation Area

Element Distribution

Glen Canyon National Recreation Area Range: This rare association was only sampled on Waterhole Flat and Dry Mesa.

Global Range: This association is known from the Colorado Plateau in western Colorado, Utah and northern Arizona and in the northwestern Great Plains in northeastern Montana, and reported from Washington and Wyoming; it may also occur in Saskatchewan, Canada.

Nations: CA?, US
States/Provinces: AZ, CO:S1, MT:S3, SK?, UT, WA:S1
TNC Ecoregions: 6:C, 9:C, 19:C, 26:C
USFS Ecoregions (1994/95): 313A:CC, 331D:CC, 331E:CC, 331F:C?, 331G:CC, 342I:??, M331E:CC
Federal Lands: NPS (Canyonlands, Dinosaur, Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Plots: The description is based on 2014 field data (2 accuracy assessment points): (AA Points: GLCA_AA.0048, GLCA_AA.0050).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and K.A. Schulz
References: Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Coles et al. 2008a, DeVelice et al. 1991, DeVelice et al. 1995, Driscoll et al. 1984, MTNHP 2002b, Reid and Hall 2010, Western Ecology Working Group n.d.*

[CEGL001322] Krascheninnikovia lanata / Pleuraphis jamesii Dwarf-shrubland
Translated Name: Winterfat / James' Galleta Dwarf-shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Steppe & Shrubland (G310)
Alliance: *Krascheninnikovia lanata* Steppe & Dwarf-shrubland Alliance (A3202)

Element Concept

Global Summary: This minor dwarf-shrubland association is reported from throughout the Colorado Plateau. Vegetation is characterized by a sparse to moderately dense dwarf-shrub layer dominated by *Krascheninnikovia lanata* and sometimes codominated by *Gutierrezia sarothrae*. Other woody species may include scattered *Artemisia tridentata, Artemisia bigelovii, Chrysothamnus viscidiflorus, Opuntia imbricata, Opuntia polyacantha*, or *Yucca glauca*. The herbaceous layer has sparse to moderately dense cover that is dominated or codominated by *Pleuraphis jamesii (= Hilaria jamesii)* with scattered perennial forbs. Associated graminoids may include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Elymus elymoides, Hesperostipa comata (= Stipa comata),* and *Sporobolus airoides*. Scattered perennial forbs may be present, such as *Chaetopappa ericoides,*

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Helianthus petiolaris, Machaeranthera pinnatifida, and *Sphaeralcea* spp. Exotic annuals may include *Bromus tectorum, Salsola kali*, and *Sisymbrium altissimum*. Stands typically occur on alluvial flats and plains. Sites are typically flat to gently sloping, occurring on any aspect. Soils are generally moderately deep, calcareous, moderately alkaline and derived from sandstone, shale or alluvium. Soil texture ranges from sandy loam to silty clay. The ground surface has high cover of bare soil (70-90%).

Environmental Description

Glen Canyon National Recreation Area Environment: This rare dwarf-shrubland occurs on the deep soils of canyon bottoms, benches, and plateaus. Sites are on flat to moderate slopes (up to 12°) and occur between 1554 and 1681 m elevation. Exposed soil covers most of the unvegetated surface, with low to moderate cover of litter and dark cyanobacteria or moss. Biological soil crust cover varies from low to moderate depending on the substrate and degree of disturbance. Soils are rapidly drained loamy sands or sandy loams derived from alluvium or from Cedar Mesa Sandstone.

Global Environment: This minor dwarf-shrubland association is reported from northwestern New Mexico, western Colorado and eastern Utah, but likely occurs throughout the Colorado Plateau. Elevations range from 1400-2050 m. Climate is temperate and semi-arid. Annual precipitation ranges from 20-30 cm with most occurring during the growing season, often as short-duration, convectional thunderstorms. Stands occur on plains, alluvial flats, valley floors, canyon bottoms, benches, alluvial fans and stabilized sand dunes. Sites are flat to moderately sloping, occurring on any aspect. Soils are generally moderately deep, calcareous, moderately alkaline and derived from sandstone, shale or alluvium, but include rapidly drained sandy loam derived from eolian sands and sheetwash deposits.. Soil texture ranges from sand to silty clay. The ground surface has high cover of bare soil (70-90%).

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This dwarf-shrubland is restricted to deep soils within the recreation area, in isolated areas where it has managed to persist despite livestock grazing pressure. Total vegetation cover ranges from 13 to 41%. Stands are characterized by a shrub canopy dominated by *Krascheninnikovia lanata* with between 5 and 11% cover. *Pleuraphis jamesii* dominates the herbaceous layer with between 2 and 10%. Associated shrubs include *Atriplex canescens, Ephedra viridis*, and *Opuntia* spp. Additional graminoids include *Achnatherum hymenoides, Sporobolus cryptandrus*, and *Hesperostipa comata* with sparse to low cover, and the weedy annual grass *Bromus tectorum* with low to moderate cover. Forbs tend to be weedy and include *Salsola tragus, Plantago patagonica, Sphaeralcea grossulariifolia, Chenopodium fremontii*, and *Machaeranthera canescens*.

Global Vegetation: This association is characterized by a sparse to moderately dense dwarf-shrub layer dominated by *Krascheninnikovia lanata* and sometimes codominated by *Gutierrezia sarothrae*, and a sparse to moderately dense herbaceous layer dominated by the perennial graminoid *Pleuraphis jamesii (= Hilaria jamesii)*. Scattered *Artemisia tridentata, Atriplex canescens, Artemisia bigelovii, Chrysothamnus viscidiflorus, Ephedra viridis, Opuntia imbricata, Opuntia polyacantha*, or *Yucca glauca* may also be present in the woody layer. Other graminoids present in minor amounts may include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Elymus elymoides, Hesperostipa comata (= Stipa comata), Sporobolus airoides*, and *Sporobolus cryptandrus*. Scattered perennial forbs may be present, such as *Chaetopappa ericoides, Helianthus petiolaris,*

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Machaeranthera canescens, *Machaeranthera pinnatifida*, *Oenothera pallida*, *Sphaeralcea coccinea*, and *Sphaeralcea parvifolia*. Exotic annuals may include *Bromus tectorum*, *Salsola kali*, and *Sisymbrium altissimum*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Krascheninnikovia lanata*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Short shrub/sapling	Succulent shrub	*Opuntia* spp.
Herb (field)	Flowering forb	*Plantago patagonica*
Herb (field)	Graminoid	*Bromus tectorum*, *Pleuraphis jamesii*, *Sporobolus cryptandrus*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*, *Krascheninnikovia lanata*
Herb (field)	Graminoid	*Bromus tectorum*, *Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Atriplex canescens*, *Gutierrezia sarothrae*, *Krascheninnikovia lanata*, *Pleuraphis jamesii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Plantago patagonica*, *Salsola tragus*

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola kali*, *Sisymbrium altissimum*

Conservation Status Rank

Global Rank & Reasons: G3G4 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Gutierrezia sarothrae - Krascheninnikovia lanata - Atriplex canescens / Bouteloua eriopoda* Shrub Grassland (CEGL001733)
- *Krascheninnikovia lanata / Achnatherum hymenoides* Dwarf-shrubland (CEGL001323)
- *Krascheninnikovia lanata / Bouteloua gracilis* Dwarf-shrub Grassland (CEGL001321)
- *Krascheninnikovia lanata / Hesperostipa comata* Dwarf-shrubland (CEGL001327)
- *Krascheninnikovia lanata / Poa secunda* Dwarf-shrubland (CEGL001326)
- *Pleuraphis jamesii* Grassland (CEGL001777)

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Global Related Concepts:
- *Ceratoides lanata - Gutierrezia sarothrae/Hilaria jamesii* plant association (Francis 1986) =
- *Ceratoides lanata/Hilaria jamesii* (Bourgeron and Engelking 1994) =
- *Krascheninnikovia lanata / Pleuraphis jamesii* Dwarf-shrubland (Von Loh 2000) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Stands described by Francis (1986) were generally too sparse to be classified as dwarf-shrublands and may be better classified in a shrub herbaceous association. Current and past livestock management can have a large impact on cover and composition of the woody and herbaceous layers. Both *Krascheninnikovia lanata* (winterfat) and *Pleuraphis jamesii* are valuable livestock forage and are negatively impacted by heavy use. *Gutierrezia sarothrae* increases under heavy livestock use. Significant small mammal burrows and plant pedestalling caused by wind erosion were reported from the Utah stands.

Element Distribution

Glen Canyon National Recreation Area Range: This rare dwarf-shrubland is of limited extent within the recreation area and was only sampled on Waterhole Flat, in Easter Pasture Canyon and upper Calf Canyon.

Global Range: This dwarf-shrubland association is reported from alluvial flats in northwestern New Mexico in the upper Rio Puerco basin, in western Colorado on the margins of the Grand Valley and in eastern Utah in flats above the Green River floodplain. It likely occurs throughout the Colorado Plateau.

Nations: US
States/Provinces: CO, NM:S3S4, UT
TNC Ecoregions: 10:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, 341C:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Colorado, Glen Canyon); USFWS (Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Deep, fine soils and a grazing history contribute to this community as it is today.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2014 field data (2 plots, 3 accuracy assessment points): (Plots: GLCA.0576, GLCA.0763; AA Points: GLCA_AA.0048, GLCA_AA.0050, GLCA_AA.0077).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and J. Coles

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References: Bourgeron and Engelking 1994, Clark et al. 2009, Coles et al. 2009a, Driscoll et al. 1984, Francis 1986, Gates et al. 1956, Romme et al. 1993, Von Loh 2000, Von Loh et al. 2002, Von Loh et al. 2007, Western Ecology Working Group n.d.*

[CEGL001320] *Krascheninnikovia lanata* Dwarf-shrubland
Translated Name: Winterfat Dwarf-shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Steppe & Shrubland (G310)
Alliance: *Krascheninnikovia lanata* Steppe & Dwarf-shrubland Alliance (A3202)

Element Concept

Global Summary: This dwarf-shrubland association is known from Colorado Plateau west into to the Great Basin and northern Mojave Desert and east into the northern panhandle of Texas; it is likely to be more widespread in similar habitats in the southwestern Great Plains. Total vegetation cover ranges from 5 to 45% and is characterized by the dwarf-shrub *Krascheninnikovia lanata* with cover between 5 and 30%. In southern Nevada, scattered *Ambrosia dumosa, Atriplex polycarpa, Larrea tridentata, Lycium andersonii, Sphaeralcea ambigua,* and *Suaeda moquinii (= Suaeda fruticosa)* may be present. The herbaceous layer is poorly developed but may contain tufts of the grass *Achnatherum hymenoides*. Forbs commonly present include *Eriogonum* spp., *Opuntia polyacantha, Oenothera pallida, Plantago patagonica, Sphaeralcea grossulariifolia,* and *Sphaeralcea parvifolia*. Biological soil crusts may provide up to 45% cover. Introduced annuals *Bromus tectorum, Bromus rubens*, and *Salsola tragus* may be abundant on some sites. This is an alkaline dwarf-shrubland that occurs primarily on sandsheets, slopes and plains often on eolian deposits near canyon walls and in alkaline flats in and around playas and along washes. Sites are flat to steep (up to 40% slope) and occur between 800 and 1770 m (2620-5800 feet) elevation. Soils are rapidly drained loamy sands or sandy loams derived from alluvium from a variety of parent materials and sandstones that have eroded and been redeposited by wind and water. It occurs in areas with low to high levels of soil salinity and alkalinity.

Environmental Description

Glen Canyon National Recreation Area Environment: This dwarf-shrub association occurs on gently sloping canyon floors between 1546 and 1602 m elevation. The unvegetated surface is composed primarily of bare soil, with lesser cover by moss. Soils are derived from Cedar Mesa sandstone.

Global Environment: This association is known from the Colorado Plateau west into the Great Basin and northern Mojave Desert and in the panhandle of Texas. It is an alkaline dwarf-shrub association that occurs primarily on sandsheets, slopes and plains often on eolian deposits near canyon walls and in alkaline flats in and around playas and along washes. Sites are gentle to steep (up to 40% slope) and occur between 800 and 1770 m (2620-5800) feet elevation. Soils are rapidly drained loamy sands from alluvium derived from a mixture of rocks such as granodiorite, quartzite, latite, limestone and basalt in

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southern Nevada (Faden 1977), and sandy loams derived from Navajo and Entrada sandstones in southeastern Utah that have eroded and been redeposited by wind and water. It occurs in areas with low to high levels of soil salinity and alkalinity.

In Texas, this community occurs on shallow soils on ridges and on footslopes along the Canadian River. In general, the soils are redbed-derived and shallow in nature. It would seem that this shrub is able to grow on a variety of soils but prefers the more shallow, rocky areas. It is often found growing in association with other shrubs but may grow alone in small colonies. When this community is found, it is never extensive and rarely occupies more than a third of an acre. There is usually some evidence of deer browsing on this species, and in areas where it is accessible, domestic livestock will browse it as well.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Total vegetation cover ranges from 25 to 34% and is dominated by the dwarf-shrub *Krascheninnikovia lanata* with cover between 6 and 14%. Associated shrubs with low cover include *Atriplex canescens* and *Opuntia macrorhiza*. The herbaceous layer is poorly developed but may contain sparse to low cover of the grasses *Pleuraphis jamesii, Sporobolus cryptandrus,* and *Sporobolus contractus*, and the exotic annual *Bromus tectorum*. Forbs commonly present include *Lappula occidentalis, Plantago patagonica*, and *Sphaeralcea grossulariifolia*.

Global Vegetation: On the Colorado Plateau, total vegetation cover ranges from 5 to 45% and is characterized by the dwarf-shrub *Krascheninnikovia lanata* with cover between 5 and 30%. In southern Nevada, scattered *Ambrosia dumosa, Atriplex polycarpa, Larrea tridentata, Lycium andersonii, Sphaeralcea ambigua,* and *Suaeda moquinii (= Suaeda fruticosa)* may be present (Faden 1977). The herbaceous layer is poorly developed but may contain tufts of the grasses *Achnatherum hymenoides, Pleuraphis jamesii, Sporobolus contractus,* and *Sporobolus cryptandrus*. Forbs commonly present include *Eriogonum* spp., *Opuntia polyacantha, Oenothera pallida, Plantago patagonica, Sphaeralcea grossulariifolia*, and *Sphaeralcea parvifolia*. Biological soil crusts provide up to 45% cover. Introduced annuals *Bromus tectorum, Bromus rubens*, and *Salsola tragus* may be abundant on some sites.

In Texas, this small community is dominated by *Krascheninnikovia lanata,* with some other short shrubs also being present in lesser amounts. Associated shrubs present in the community include *Dalea formosa, Mimosa borealis, Atriplex canescens,* and occasionally small *Prosopis glandulosa*. The community gives the appearance of being droughty and forbs are few. *Tetraneuris scaposa, Gutierrezia sarothrae, Chaetopappa ericoides (= Leucelene ericoides), Paronychia jamesii*, and *Eriogonum longifolium* are the most common. The most common grasses are *Aristida purpurea, Hesperostipa neomexicana (= Stipa neomexicana), Bouteloua gracilis*, and *Bouteloua curtipendula*.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Krascheninnikovia lanata*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Krascheninnikovia lanata*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Krascheninnikovia lanata, Plantago patagonica*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High), *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: G5? (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Krascheninnikovia lanata / Hesperostipa comata* Dwarf-shrubland (CEGL001327)
- *Krascheninnikovia lanata / Poa secunda* Dwarf-shrubland (CEGL001326)

Global Related Concepts:

- *Ceratoides lanata* (Bourgeron and Engelking 1994) =
- *Eurotia lanata* Community (Faden 1977) =
- *Krascheninnikovia lanata* (Evens et al. 2014) =
- *Krascheninnikovia lanata* (Sawyer et al. 2009) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >
- Winterfat Community (Mitchell et al. 1966) =

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This is a broadly defined association that includes stands from the Colorado Plateau, Great Basin and northern Mojave Desert characterized by the dominance of *Krascheninnikovia lanata* without a notable herbaceous layer. The herbaceous layer is typically absent or sparse or dominated by introduced species such as *Bromus tectorum* or *Salsola tragus*. This is a very-small-patch association as presently defined from Lake Meredith National Recreation Area, Texas. The concept will need further review to determine if it is a viable association or should be considered as patches within a broader association.

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Element Distribution

Glen Canyon National Recreation Area Range: This very rare association was only sampled in and near Easter Pasture Canyon.

Global Range: This dwarf-shrubland association is known from Colorado Plateau west into to the Great Basin and northern Mojave Desert and east into the northern panhandle of Texas; it is likely to be more widespread in similar habitats in the southwestern Great Plains.

Nations: US
States/Provinces: AZ, CA, CO, NV:S5, TX, UT
TNC Ecoregions: 11:C, 17:C, 19:C, 28:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 315B:CC, 322A:CC, 341B:CC, 341D:CC, 342B:CC

Federal Lands: NPS (Alibates, Arches, Canyonlands, Capitol Reef, Death Valley, Glen Canyon, Grand Canyon, Great Basin, Lake Mead, Lake Meredith, Mojave, Petrified Forest)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: *Krascheninnikovia lanata* here is not a dwarf-shrub.

Glen Canyon National Recreation Area Plots: The description is based on 2014 field data (2 accuracy assessment points): (AA Points: GLCA_AA.0078, GLCA_AA.0547).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and J. Drake
References: Bourgeron and Engelking 1994, Clark et al. 2009, Coles et al. 2009a, Driscoll et al. 1984, Evens et al. 2014, Faden 1977, Fenton et al. 2007, Mitchell et al. 1966, Peterson 2008, Reid and Hall 2010, Romme et al. 1993, Sawyer et al. 2009, Schulz and Hall 2011, Thomas et al. 2009a, Western Ecology Working Group n.d.*

A2650 Opuntia spp. Colorado Plateau Shrubland Alliance
Alliance Summary Description: Clumps of *Opuntia* cacti dominate the community, with sparse to moderate cover by grasses and forbs growing within and between clumps. *Bromus tectorum* is the most common and abundant herbaceous species in this community, but even disturbed examples generally include some cover of native grasses and forbs, including *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii*, and *Sphaeralcea* spp. Cryptobiotic soil crusts may be well-developed in undisturbed sites. This alliance occurs throughout the Colorado Plateau in disturbed or extremely xeric sites with coarse soils. Many stands occur on eolian or alluvial deposits on gentle to moderate slopes.

[CEGL004009] Opuntia (fragilis, polyacantha, phaeacantha) Shrubland
Translated Name: (Brittle Prickly-pear, Plains Prickly-pear, Tulip Prickly-pear) Shrubland
Common Name:

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USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Steppe & Shrubland (G310)
Alliance: *Opuntia* spp. Colorado Plateau Shrubland Alliance (A2650)

Element Concept

Global Summary: This succulent-dominated dwarf-shrubland is known only from Canyon de Chelly National Monument in northeastern Arizona in the southern Colorado Plateau. It occurs in canyons on terraces and alluvial fans at the base of cliffs from 1755 to 1787 m (5758-5863 feet) elevation. Stands occur on gentle slopes (1-11%) with generally hot, south-facing aspects. One stand is seasonally flooded. The soils are sandy loam in texture. There is moderate to high cover of bare ground. The vegetation is characterized by an open to moderately dense succulent dwarf-shrub layer dominated by *Opuntia* species. *Opuntia phaeacantha, Opuntia polyacantha,* or *Opuntia whipplei* may dominate solely or in combination with the others. Other shrubs may be present, including *Artemisia filifolia, Artemisia tridentata,* and *Gutierrezia sarothrae*. The sparse to moderately dense herbaceous layer has a diversity of species. Common herbaceous species are *Astragalus lentiginosus, Bouteloua gracilis, Chaetopappa ericoides, Conyza canadensis, Croton texensis, Hesperostipa comata ssp. comata, Heterotheca villosa, Lappula occidentalis, Solanum elaeagnifolium,* and *Sphaeralcea fendleri*. The native annual forb *Plantago patagonica* may dominate after good spring precipitation. The annual exotic grass *Bromus tectorum* is generally abundant with 1-5% cover. Other exotic species include *Cynodon dactylon, Erodium cicutarium,* and *Salsola kali*.

Environmental Description

Global Environment: This succulent-dominated dwarf-shrubland is known only from Canyon de Chelly National Monument in northeastern Arizona in the southern Colorado Plateau. It occurs in canyons on terraces and alluvial fans at the base of cliffs from 1755 to 1787 m (5758-5863 feet) elevation. Stands occur on gentle slopes (1-11%) with generally hot, south-facing aspects. One stand is seasonally flooded. The soils are sandy loam in texture. There is moderate to high cover of bare ground.

Vegetation Description

Global Vegetation: The vegetation is characterized by an open to moderately dense succulent dwarf-shrub layer dominated by *Opuntia* species. *Opuntia phaeacantha, Opuntia polyacantha,* or *Opuntia whipplei* may dominate solely or in combination with the others. Other shrubs may be present, including *Artemisia filifolia, Artemisia tridentata,* and *Gutierrezia sarothrae*. The sparse to moderately dense herbaceous layer has a diversity of species. Common herbaceous species are *Astragalus lentiginosus, Bouteloua gracilis, Chaetopappa ericoides, Conyza canadensis, Croton texensis, Hesperostipa comata ssp. comata, Heterotheca villosa, Lappula occidentalis, Solanum elaeagnifolium,* and *Sphaeralcea fendleri*. The native annual forb *Plantago patagonica* may dominate after good spring precipitation. The annual exotic grass *Bromus tectorum* is generally abundant with 1-5% cover. Other exotic species include *Cynodon dactylon, Erodium cicutarium,* and *Salsola kali*.

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Most Abundant Species

Global

Stratum	Lifeform	Species
Short shrub/sapling	Succulent shrub	*Opuntia phaeacantha*, *Opuntia polyacantha*

Characteristic Species

Global: *Astragalus lentiginosus, Bouteloua gracilis, Bromus tectorum, Chaetopappa ericoides, Hesperostipa comata ssp. comata, Heterotheca villosa, Opuntia phaeacantha, Opuntia polyacantha, Opuntia whipplei, Solanum elaeagnifolium, Sphaeralcea fendleri*

Other Noteworthy Species

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Cynodon dactylon* (Medium/Low), *Erodium cicutarium* (Medium/Low), *Salsola kali*; Other Plants: *Conyza canadensis* (G5, weedy native), *Croton texensis* (G5), *Plantago patagonica* (G5)

Conservation Status Rank

Global Rank & Reasons: GNR (20-Jul-2006).

Related Concepts

Global Similar Types:

- *Opuntia polyacantha / Pleuraphis jamesii* Shrubland (CEGL002299)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Global Classification Comments: One stand at Canyon de Chelly National Monument has an open tree layer 5-10 m in height, dominated by *Celtis laevigata var. reticulata*, which covers 10-25%, and with one dbh measurement at 44.2 cm. A "subcanopy" 2-5 m tall with <5% cover is dominated *Juniperus osteosperma* and <1% cover of *Pinus edulis*. This stand (CACH-136) may be better classified as an open canopy *Celtis laevigata var. reticulata* woodland.

Element Distribution

Global Range: This dwarf-shrubland is known only from Canyon de Chelly National Monument in northeastern Arizona in the southern Colorado Plateau.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:C?, 313B:CC, 341B:??
Federal Lands: NPS (Canyon de Chelly, Glen Canyon)

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Element Sources

Global Description Author(s): K.A. Schulz
References: Thomas et al. 2010, Western Ecology Working Group n.d.*

[CEGL002299] Opuntia polyacantha / Pleuraphis jamesii Shrubland
Translated Name: Plains Prickly-pear / James' Galleta Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Semi-Desert Steppe & Shrubland (G310)
Alliance: *Opuntia* spp. Colorado Plateau Shrubland Alliance (A2650)

Element Concept

Global Summary: This low-succulent association occurs in the northern Colorado Plateau. Total vegetation cover is between 15 and 30% and is characterized by patches of *Opuntia polyacantha*, with clumps of *Pleuraphis jamesii* between the shrubs. Other drought-tolerant shrubs may occur in the canopy with low cover, including *Artemisia tridentata ssp. wyomingensis, Atriplex confertifolia, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra* spp., *Gutierrezia sarothrae, Grayia spinosa*, and *Sarcobatus vermiculatus*. The herbaceous layer is dominated by grasses, with *Achnatherum hymenoides* and *Hesperostipa comata* often present in addition to *Pleuraphis jamesii*. *Juniperus osteosperma* trees are scattered throughout the community but do not form a stratum. Cryptogams are absent in gravelly sites but may have up to 25% cover in sandy sites. Stands occur on hot, dry, relatively undisturbed sites on benches, valley floors, and on gentle to steep (4-72%) slopes between 1457 and 1628 m (4780-5340 feet) elevation. Substrates may be fine- or coarse-textured soils derived from eolian sand, alluvium and colluvium.

Environmental Description

Glen Canyon National Recreation Area Environment: This association was documented on valley bottom fill, in canyon bottoms, on flats, benches, and terraces. Sites are flat and occur between 1465 and 1673 m elevation. Exposed soil covers most of the unvegetated surface, with low to moderate cover by dark cyanobacteria, and lesser cover by litter. Soils are rapidly drained to well-drained silty loams, loams, sandy loams, or loamy sands derived from alluvium with a shale subcomponent (noted parent material of the Chinle Formation) or from eolian deposits.

Global Environment: These prickly-pear dwarf-shrublands tend to be characteristic of rocky sites that are too dry for most vegetation. Sites include small ridges in canyons, benches, midslopes, toeslopes, alluvial fans, stream terraces, valley floors, plains and flats in the northern Colorado Plateau. Stands occur on gentle to steep (4-72%) slopes with are oriented to eastern and southern aspects between 1457 and 1673 m (4780-5340 feet) elevation. The unvegetated surface has moderate to high cover of bare soil and large and small rocks. Litter is variable but can be as high as 45%. Cryptogamic cover can approach 20%. Soils may be fine- or coarse-textured and range from rapidly drained sand or sandy loams, to somewhat poorly drained silty loams or sandy clays derived from eolian sand,

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alluvium and colluvium. Parent materials are variable and include sandstone, shale, Precambrian gneiss, and deposits of eolian, sheetwash, and rockfall material.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This prickly-pear dwarf-shrubland is somewhat uncommon within the recreation area. Total vegetation cover ranges from 8-42%. Stands are characterized by clumps of *Opuntia polyacantha, Opuntia erinacea,* or *Opuntia phaeacantha* (with 3-20% cover) with openings dominated by *Pleuraphis jamesii* (with trace to 9% cover). Scattered *Juniperus osteosperma* trees and seedlings may be present. Associated shrubs include *Atriplex canescens, Ephedra cutleri, Krascheninnikovia lanata,* and *Gutierrezia sarothrae*. Associated native herbaceous species include *Hesperostipa comata, Achnatherum hymenoides, Sporobolus cryptandrus, Sporobolus airoides,* and *Sphaeralcea coccinea*. The understories are often otherwise dominated by weedy or non-native, annual species including *Bromus tectorum, Salsola tragus, Lappula occidentalis*, and *Plantago patagonica*. Biological soil crusts are generally in an early stage of development and cover up to 25% of the soil surface.

Global Vegetation: This succulent-dominated dwarf-shrubland is characteristic of rocky sites that are too dry for most vegetation. Total vegetation cover tends to be somewhat sparse, between 13 and 30%. This association is characterized by an open, patchy canopy of *Opuntia polyacantha,* with between 2 and 25% cover, and low to moderate cover of the bunchgrass *Pleuraphis jamesii,* usually with between 2 and 10% cover. The shrub layer is low in cover and may be diverse, with scattered short and dwarf-shrubs such as *Artemisia tridentata ssp. wyomingensis, Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Ephedra cutleri, Ephedra torreyana, Ephedra viridis, Eriogonum microthecum, Grayia spinosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia phaeacantha, Sarcobatus vermiculatus,* or *Sclerocactus whipplei*, but none will have higher cover than *Opuntia polyacantha,* and usually have much less. *Juniperus osteosperma* trees may be scattered through the community but do not form a stratum. The herbaceous layer is sparse or contributes low cover, usually less than 10% total cover. Graminoids associates may include *Achnatherum hymenoides, Hesperostipa comata, Sporobolus cryptandrus, Vulpia octoflora,* and the exotic annual *Bromus tectorum*. Forb cover is sparse and variable. Forbs may include *Astragalus nuttallianus, Cryptantha flava, Hymenopappus filifolius, Lappula occidentalis, Lepidium densiflorum, Lepidium montanum, Sphaeralcea coccinea, Sphaeralcea leptophylla, Streptanthella longirostris,* and the exotic annual *Salsola tragus*. Biological soil crusts may be absent or range up to 25% cover.

Global Dynamics: This association occurs on the hottest, driest sites. Unlike other *Opuntia*-dominated associations, this community is the result of environmental conditions, not chronic disturbance.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Short shrub/sapling	Succulent shrub	*Opuntia* spp.

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Stratum	Lifeform	Species
Herb (field)	Flowering forb	*Plantago patagonica*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Bromus tectorum*, *Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Succulent shrub	*Opuntia polyacantha*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Achnatherum hymenoides, Astragalus nuttallianus, Atriplex canescens, Chrysothamnus viscidiflorus, Hesperostipa comata, Opuntia polyacantha, Pleuraphis jamesii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Plantago patagonica, Salsola tragus*

Global: Vulnerable Plants: *Sclerocactus whipplei* (G2G3); Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: GNR (11-Jan-2005).

Related Concepts

Global Similar Types:

- *Gutierrezia sarothrae* - (*Opuntia* spp.) / *Pleuraphis jamesii* Dwarf-shrubland (CEGL002690)
- *Opuntia (fragilis, polyacantha, phaeacantha)* Shrubland (CEGL004009)
- *Pleuraphis jamesii* Grassland (CEGL001777) is also dominated by *Pleuraphis jamesii* and supports *Ephedra torreyana* and *Opuntia polyacantha*, but it is a strictly herbaceous type that supports much more grass cover and much less shrub cover.

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. A number of cactus dwarf-shrublands have been identified in the northern Colorado Plateau through the NPS vegetation mapping program. A careful analysis of the aggregate data is necessary to determine which types are consistent.

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Element Distribution

Glen Canyon National Recreation Area Range: This low-succulent association is somewhat uncommon within the recreation area and was sampled in Middle Moody Canyon, Calf Canyon, on Waterhole Flat and Andy Miller Flats.

Global Range: This association occurs on xeric sites in the northern Colorado Plateau of Colorado and Utah and southern Colorado Plateau in northern Arizona and is likely more widespread.

Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Canyonlands, Colorado, Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Deep, fine soils probably once made this a rich grassland. Recent cattle grazing no doubt predestined its present weedy state.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, 2013, 2014, and 2015 field data (4 plots, 3 accuracy assessment points): (Plots: GLCA.0574, GLCA.0760, GLCA.4078, GLCA.5309; AA Points: GLCA_AA.0626, GLCA_AA.0628, GLCA_AA.1180).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and K.A. Schulz
References: Reid and Hall 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.*

G775. Intermountain Sparsely Vegetated Dune Scrub & Grassland

Group Summary Description: This group occurs on sandy sites in the intermountain western U.S. from the Columbia Basin, Great Basin, and Centennial Valley in Montana, Wyoming Basins, Colorado Plateau and the San Luis Valley of southern Colorado. This group is characterized by open to sparse (<15% total cover) shrub and/or herbaceous vegetation. Characteristic shrubs include *Ericameria nauseosa, Eriogonum leptocladon*, or *Tetradymia tetrameres*. Diagnostic herbaceous species are *Achnatherum hymenoides, Leymus flavescens, Muhlenbergia pungens, Psoralidium lanceolatum*, and *Redfieldia flexuosa*, which may dominate solely or in a combination. There are several associated species, including graminoids such as *Calamovilfa gigantea, Hesperostipa comata (= Stipa comata), Schizachyrium scoparium*, and forbs *Heliotropium convolvulaceum, Machaeranthera canescens (= Aster canescens), Oxytheca dendroidea (= Eriogonum dendroideum), Polanisia dodecandra ssp. trachysperma, Polanisia jamesii, Reverchonia arenaria, Sophora stenophylla, Wyethia scabra*, and the annual forb *Eriogonum deflexum*. Stands occur on active and stable dunes and sandsheets. Elevations range from 1500-2400 m. All sites have cool, semi-arid continental climates. Substrates are eolian sand.

A4149 Ericameria nauseosa - Eriogonum leptocladon - Tetradymia tetrameres Sparse Scrub Alliance

Alliance Summary Description: This sparse shrubland alliance of the western U.S. has open and low vegetative cover from 15 to 50%. Dominant diagnostic shrub species are *Ericameria nauseosa*,

Eriogonum leptocladon, and/or *Tetradymia tetrameres*. Dominant and consistently present understory herbaceous species include *Achnatherum hymenoides, Leymus flavescens, Muhlenbergia pungens*, and/or *Psoralidium lanceolatum*. This sparse community is characteristic of flat to rolling areas of sandsheets, stabilized or moving sand dunes, sand blowouts, or colluvial slopes, between 1220 and 2505 m (4000-8218 feet) elevation. Sites include valley floors, floodplains, and stream terraces, are gentle to moderately sloping, but range from flat to steep and may occur on any aspect. Soils are sands, loamy sands and sandy loams derived from local eroding sandstone or eolian sands. Most of the unvegetated surface is bare soil, although incipient biological soil crusts (consisting mostly of dark cyanobacteria) may cover up to 20% of the ground in more stable sites.

[CEGL002980] *Ericameria nauseosa* Sand Deposit Sparse Shrubland

Translated Name: Rubber Rabbitbrush Sand Deposit Sparse Shrubland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Sparsely Vegetated Dune Scrub & Grassland (G775)
Alliance: *Ericameria nauseosa - Eriogonum leptocladon - Tetradymia tetrameres* Sparse Scrub Alliance (A4149)

Element Concept

Global Summary: This association occurs on sandsheets and dune systems in southern and eastern Utah, northeastern Arizona and western Colorado, but is likely more common in similar habitats throughout the interior western U.S. *Ericameria nauseosa* is most likely to dominate a community where there has been chronic or severe disturbance, such as grazing, fire or, in rare instances, flooding. Elevation ranges from 1430-2000 m (4700-6560 feet). At Zion National Park, a stand was described from a colluvial slope below a sandstone cliff. In other areas it occurs on sand dunes and on sandsheets in flatter areas such as floodplains, stream terraces and valley floors. Sites are generally gentle to moderately sloping, but range from flat to steep and may occur on any aspect. Soils are sandy and may be derived from local sandstone, eolian sands, or alluvium. This association is characterized by a typically sparse short-shrub layer 5-20% cover (but may range up to 30% cover) that is dominated by *Ericameria nauseosa* (at least half the cover). Other shrubs or dwarf-shrubs are often present and may include *Artemisia bigelovii, Atriplex* spp., *Chrysothamnus viscidiflorus, Ephedra torreyana, Eriogonum corymbosum, Ipomopsis congesta, Gutierrezia sarothrae, Opuntia polyacantha*, or *Yucca elata var. utahensis*. The herbaceous layer is generally sparse and is dominated by perennial graminoids such as *Achnatherum hymenoides, Aristida purpurea, Hesperostipa comata, Muhlenbergia pungens*, and *Sporobolus* spp. Forbs associates may include *Chamaesyce glyptosperma, Cirsium* spp., *Heterotheca villosa, Penstemon palmeri, Phacelia heterophylla, Sphaeralcea coccinea, Streptanthella longirostris*, and *Sophora stenophylla*.

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Environmental Description

Global Environment: This association occurs on sandsheets and dune systems in southern and eastern Utah, northeastern Arizona and western Colorado, but is likely more common in similar habitats throughout the interior western U.S. Elevation ranges from 1430-2000 m (4700-6560 feet). At Zion National Park, a stand was described from a colluvial slope below a sandstone cliff. In other areas it occurs on sand dunes and on sandsheets in flatter areas such as floodplains, stream terraces and valley floors (e.g., Von Loh et al. 2002). Sites are generally gentle to moderately sloping, but range from flat to steep and may occur on any aspect. Soils are sandy and may be derived from local sandstone, eolian sands, or alluvium.

Vegetation Description

Global Vegetation: This association is characterized by a typically sparse short-shrub layer 5-20% cover (but may range up to 30% cover) that is dominated by *Ericameria nauseosa* (at least half the cover). Other shrubs or dwarf-shrubs are often present and may include *Artemisia bigelovii, Atriplex confertifolia, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra torreyana, Eriogonum corymbosum, Ipomopsis congesta, Gutierrezia sarothrae, Opuntia polyacantha*, or *Yucca elata var. utahensis*. The herbaceous layer is generally sparse and is dominated by perennial graminoids such as *Achnatherum hymenoides, Aristida purpurea, Hesperostipa comata, Muhlenbergia pungens, Sporobolus airoides,* and *Sporobolus cryptandrus*. Forbs associates may include *Chamaesyce glyptosperma, Cirsium* spp., *Heterotheca villosa, Penstemon palmeri, Phacelia heterophylla, Sphaeralcea coccinea, Streptanthella longirostris,* and *Sophora stenophylla*.

Global Dynamics: The sandy substrate is an important environmental variable whether created by active eolian processes or from sandstone residuum. *Ericameria nauseosa* is a common species in sandy habitats. It is most likely to dominate a community where there has been chronic or severe disturbance, such as grazing, fire or, in rare instances, flooding.

Most Abundant Species

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Short shrub/sapling	Succulent shrub	*Opuntia polyacantha*
Herb (field)	Flowering forb	*Heterotheca villosa*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Aristida purpurea*, *Hesperostipa comata*, *Sporobolus cryptandrus*

Characteristic Species

Global: *Achnatherum hymenoides, Ericameria nauseosa, Hesperostipa comata, Sporobolus cryptandrus*

Other Noteworthy Species

Global: Vulnerable Plants: *Yucca elata* var. *utahensis* (G5T3?, endemic variety); Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (22-Jan-2002).

Related Concepts

Global Similar Types:

- *Ericameria nauseosa / Bromus tectorum* Ruderal Shrubland (CEGL002937)
- *Ericameria nauseosa / Sporobolus airoides* Shrubland (CEGL002918)
- *Ericameria nauseosa* Shrubland (CEGL002713)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Glen Canyon National Recreation Area Classification Comments: Only 1 plot was sampled; therefore, no local description has been written.

Global Classification Comments: This association is distinguished as much by its setting as its floristics, and as such is floristically fairly diverse.

Element Distribution

Global Range: This association has been described from southern and eastern Utah, northeastern Arizona and western Colorado but is likely more common in similar habitats throughout the interior western U.S.

Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 9:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331E:CC, M331F:CC, M341C:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Dinosaur, Glen Canyon, Great Sand Dunes, Navajo, Zion); USFWS (Ouray)

Element Sources

Global Description Author(s): J. Coles
References: Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Romme et al. 1993, Salas et al. 2010a, Salas et al. 2010b, Von Loh et al. 2002, Western Ecology Working Group n.d.*

A4011 Redfieldia flexuosa - Leymus flavescens - Achnatherum hymenoides Grassland Alliance
Alliance Summary Description: This herbaceous alliance occurs on sandy sites in the intermountain western U.S. from the Columbia Basin, Great Basin, Centennial Valley in Montana, Wyoming Basins, Colorado Plateau and the San Luis Valley of southern Colorado. This herbaceous layer is characterized by a sparsely vegetated to open herbaceous layer composed of *Redfieldia flexuosa, Leymus flavescens, Achnatherum hymenoides,* and *Psoralidium lanceolatum,* which may dominate solely or in

combination. There are several associated species, including graminoids *Muhlenbergia pungens, Hesperostipa comata (= Stipa comata), Schizachyrium scoparium, Calamovilfa gigantea*, forbs *Heliotropium convolvulaceum, Machaeranthera canescens (= Aster canescens), Oxytheca dendroidea (= Eriogonum dendroideum), Polanisia dodecandra ssp. trachysperma, Polanisia jamesii, Reverchonia arenaria, Sophora stenophylla, Wyethia scabra*, and the annual forb *Eriogonum deflexum*. Stands occur on active and stable dunes and sandsheets. Elevations range from 1500-2400 m. All sites have semi-arid climates. Substrates are eolian sands.

[CEGL001650] Achnatherum hymenoides - Psoralidium lanceolatum Grassland
Translated Name: Indian Ricegrass - Lemon Scurfpea Grassland
Common Name: Indian Ricegrass - Lemon Scurfpea Mixedgrass Prairie

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Intermountain Sparsely Vegetated Dune Scrub & Grassland (G775)
Alliance: *Redfieldia flexuosa - Leymus flavescens - Achnatherum hymenoides* Grassland Alliance (A4011)

Element Concept

Global Summary: This herbaceous association ranges from Colorado and Utah north to Idaho and Montana and may also extend into Saskatchewan, Canada. This description is based on information from Great Sand Dunes National Park and Preserve in Colorado, and the following description is based on occurrences there. It is also reported from Idaho, Montana, Utah, Wyoming and possibly Saskatchewan. Additional global information will be added as it becomes available. This association occurs on dunefields and sandsheets at 2320 to 2355 m elevation. Stands are generally flat to slightly rolling. Soils are rapidly drained sands, and ground cover is dominated by bare soil. The majority of stands are located near stabilized dunefields. This is a sparsely vegetated (<30% total cover) community of active or stabilized dunes. *Achnatherum hymenoides* (10-30%) is dominant to codominant with *Psoralidium lanceolatum* (<10%). The few other species present may include scattered *Ericameria nauseosa* shrubs and trace amounts of graminoids and forbs such as *Hesperostipa comata, Redfieldia flexuosa, Sporobolus* spp., *Helianthus* spp. *Salsola* spp., and *Lygodesmia juncea*.

Environmental Description

Vegetation Description

Most Abundant Species

Global

Stratum	Lifeform	Species
Herb (field)	Flowering forb	*Psoralidium lanceolatum*
Herb (field)	Graminoid	*Achnatherum hymenoides*

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Subset: GLCA; Glen Canyon National Recreation Area

Characteristic Species

Global:

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: G3Q (1-Feb-1996).

Related Concepts

Global Similar Types:

- *Achnatherum hymenoides - Sporobolus contractus* Grassland (CEGL001652)
- *Redfieldia flexuosa - (Psoralidium lanceolatum)* Grassland (CEGL002917)

Global Related Concepts:

- *Oryzopsis hymenoides-Psoralidium lanceolatum* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:V.B.4.b. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Element Distribution

Global Range: This herbaceous association ranges from Colorado and Utah north to Idaho and Montana and may also extend into Saskatchewan, Canada.

Nations: CA?, US
States/Provinces: CO:S1, ID:S3, MT, SK?, UT:S2S4, WY
TNC Ecoregions: 6:C, 19:C, 20:C
USFS Ecoregions (1994/95): 342D:CC, M331F:CC
Federal Lands: NPS (Glen Canyon, Great Sand Dunes)

Element Sources

Global Description Author(s): K.E. Sabo and K. Decker
References: Bourgeron and Engelking 1994, Bowers 1982, CNHP 2003, CNHP 2015, Castle 1954, Driscoll et al. 1984, MTNHP 2002b, Marr et al. 1980, Pammel 1924, Ramaley 1937, Ramaley 1939b, Ramaley 1942, Salas et al. 2010b, WNDD unpubl. data, Western Ecology Working Group n.d.*

G296. Mojave Mid-Elevation Mixed Desert Scrub

Group Summary Description: This group represents the extensive desert scrub in the transition zone above *Larrea tridentata - Ambrosia dumosa* desert scrub and below the lower montane woodlands at mid-elevations in the eastern and central Mojave Desert. It is also common on lower piedmont slopes in the transition zone into the southern Great Basin. The vegetation in this group is quite variable. *Larrea tridentata* may be absent or present to codominant in some examples, but typically does not

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dominate. Characteristic and dominant species include *Ambrosia eriocentra, Arctostaphylos patula, Coleogyne ramosissima, Ericameria cooperi, Eriogonum fasciculatum, Ephedra californica, Ephedra nevadensis, Ephedra torreyana, Ephedra viridis, Eriogonum corymbosum, Grayia spinosa, Lycium andersonii, Menodora spinescens, Nolina bigelovii, Nolina microcarpa, Nolina parryi, Opuntia acanthocarpa, Purshia glandulosa, Purshia stansburiana, Salazaria mexicana, Thamnosma montana, Viguiera parishii, Yucca brevifolia*, or *Yucca schidigera*. Less common are stands with scattered *Yucca brevifolia* and a saltbush short-shrub layer dominated by *Atriplex canescens, Atriplex confertifolia*, or *Artemisia tridentata*. In some areas in the western Mojave, shrubby *Juniperus californica* is common with the yuccas. *Grayia spinosa* is a common codominant shrub in disturbed stands. Desert grasses, including *Achnatherum hymenoides, Achnatherum speciosum, Muhlenbergia porteri, Pleuraphis jamesii, Pleuraphis rigida, Poa secunda*, or *Pseudoroegneria spicata*, may form an herbaceous layer. Scattered *Juniperus osteosperma* or warm desert scrub species may also be present. This shrubland group is found in the Mojave Desert of southeastern California and southern Nevada and forms a cool-temperate elevational belt on desert ranges (700-1800 m) elevation. It also occurs at the longitudinal transition zone between the Mojave and southern Great Basin, generally at mid-elevations. Landforms include valleys, bajadas, mountain slopes, ridges, mesas or alluvial fans bordering intermountain basins. The climate is semi-arid and characterized by hot, dry summers and cold winters with precipitation ranging from 5-30 cm annually. Temperatures are continental, with large annual and diurnal ranges. Soils are highly variable across the large range of this vegetation type and are generally shallow, well-drained, coarse-textured loams or sand with rock fragments, but include finer-textured substrates such as silt.

A3144 Coleogyne ramosissima Mojave Desert Scrub Alliance

Alliance Summary Description: These communities are characterized by a sparse to moderately dense shrub layer of *Coleogyne ramosissima*. Associated species include *Ambrosia* spp., *Encelia resinifera, Eriogonum fasciculatum, Ephedra nevadensis, Menodora spinescens, Grayia spinosa, Larrea tridentata, Purshia stansburiana*, and *Thamnosma montana*. Occasionally, scattered individuals of *Yucca brevifolia* may be emergent through the shrub layer. Scattered *Juniperus osteosperma* or *Pinus monophylla* trees are present in some stands. The herbaceous layer is typically sparse with perennial grasses and forbs commonly present. This shrubland alliance occurs in the Mojave Desert of southeastern California and southern Nevada and forms an elevational belt on desert ranges and an latitudinal belt in the transition zone with the southern Great Basin. Stands occur at elevations of 850-1600 m, usually on mountain slopes, mesas or alluvial fans bordering intermountain basins. Soils are highly variable across the large range of this vegetation type and are generally coarse-textured and well-drained, but include finer-textured substrates as well.

[CEGL005297] *Coleogyne ramosissima - Ephedra* spp. Warm Desert Shrubland

Translated Name: Blackbrush - Joint-fir species Warm Desert Shrubland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)

Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)

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Group: Mojave Mid-Elevation Mixed Desert Scrub (G296)
Alliance: *Coleogyne ramosissima* Mojave Desert Scrub Alliance (A3144)

Element Concept

Global Summary: This blackbrush shrubland association is currently described from Grand Canyon National Park and Glen Canyon National Recreation Area in northern Arizona and southern Utah. When it occurs, this vegetation type often forms vast expanses across these environments with an open short-shrub layer dominated by *Coleogyne ramosissima* with *Ephedra* spp. as associates. The common species of *Ephedra* are *Ephedra fasciculata, Ephedra torreyana*, and *Ephedra viridis*, with *Ephedra cutleri* less prevalent. Many other shrubs may be present with low cover. The herbaceous layer is typically sparse but may be diverse. Common graminoids include *Achnatherum hymenoides, Aristida purpurea, Bouteloua barbata, Dasyochloa pulchella, Pleuraphis jamesii, Sporobolus contractus, Sporobolus cryptandrus, Tridens muticus, Vulpia octoflora*, and exotics *Bromus rubens, Bromus tectorum*, and *Schismus barbatus*. Forbs may be diverse. Biological soil crusts, mostly in the form of dark cyanobacteria and moss, may have up to 40% cover. Trees and tall shrubs are essentially absent. Stands occur on eolian deposits/dunes, alluvial fans, arroyos, basins, benches, canyon rims, sides, and bottoms, along drainage channels, on hills, mesas, plateaus, ridges, rims, terraces, sideslopes and valley floors. It generally occurs from approximately 850 to 1613 m (2750-5290 feet) elevation. While predominantly found on flat or low-gradient settings (0-15°), this association occasionally occurs on moderate to steep slopes (30-40°) as well. Sand or bare soil cover most of the unvegetated surface, with low to moderate cover by small rocks, large rocks, litter, and bedrock. Soils are predominantly rapidly drained sands, loamy sands, loams, and sandy loams, but include moderately well-drained to somewhat poorly drained silt loams, silty clay loams, clay loams, silts, or clays. Soils are derived from eolian deposits, alluvium, sandstones, shales or limestone. Dark cyanobacteria and moss, if present, have sparse to low cover.

Environmental Description

Glen Canyon National Recreation Area Environment: This mixed shrubland association occurs on eolian deposits/dunes, alluvial fans, arroyos, basins, benches, canyon rims, sides, and bottoms, along drainage channels, on hills, mesas, plateaus, ridges, rims, terraces, and valley floors. Sites are flat to moderately sloping (up to 15°, though one site had a slope of 36°), oriented to all aspects, and lie between 1070 and 1613 m elevation. Sand or bare soil cover most of the unvegetated surface, with low to moderate cover by small rocks, large rocks, litter, and bedrock. Dark cyanobacteria and moss, if present, have sparse to low cover. Soils are somewhat poorly drained to moderately well-drained to rapidly drained sands, loamy sands, loams, sandy loams, silt loams, silty clay loams, clay loams, silts, or clays derived from eolian deposits, alluvium, sandstones of the Navajo, Kayenta, Entrada, or White Rim formations, or shales of the Carmel, Halgaito, Moenkopi, Morrison, or Shinarump formations.

Global Environment: Stands occur on eolian deposits/dunes, alluvial fans, arroyos, basins, benches, canyon rims, sides, and bottoms, along drainage channels, on hills, mesas, plateaus, ridges, rims, terraces, sideslopes and valley floors. It generally occurs from approximately 850 to 1613 m (2750-5290 feet) elevation. While predominantly found on flat or low-gradient settings (0-15°), this association occasionally occurs on moderate to steep slopes (30-40°) as well. Sand or bare soil cover

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most of the unvegetated surface, with low to moderate cover by small rocks, large rocks, litter, and bedrock. Soils are predominantly rapidly drained sands, loamy sands, loams, sandy loams, but include moderately well-drained to somewhat poorly drained silt loams, silty clay loams, clay loams, silts, or clays. Soils are derived from eolian deposits, alluvium, sandstones of the Navajo, Kayenta, Entrada, or White Rim formations; shales of the Carmel, Halgaito, Moenkopi, Morrison, or Shinarump formations; or limestone. Dark cyanobacteria and moss, if present, have sparse to low cover.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This mixed shrubland occurs throughout the recreation area. Total vegetation cover ranges from 3 to 23% and is characterized by an open short-shrub canopy of *Coleogyne ramosissima* (with 1-10% cover) codominated by either or a combination of *Ephedra torreyana, Ephedra viridis*, or less commonly *Ephedra cutleri* (with 1-7% individual cover). A variety of other shrubs are often present with low cover, including *Atriplex canescens, Atriplex confertifolia, Atriplex obovata, Artemisia bigelovii, Ericameria nauseosa var. juncea (= Chrysothamnus nauseosus var. junceus), Encelia frutescens, Eriogonum corymbosum, Glossopetalon spinescens, Grayia spinosa, Rhus aromatica, Krascheninnikovia lanata, Psorothamnus fremontii, Polygala acanthoclada, Gutierrezia microcephala, Gutierrezia sarothrae, Shepherdia rotundifolia, Yucca angustissima, Opuntia polyacantha, Opuntia erinacea,* and *Xylorhiza tortifolia*. The herbaceous layer may be diverse but contributes only sparse to low cover. Common graminoids include *Achnatherum hymenoides, Sporobolus cryptandrus, Sporobolus contractus, Pleuraphis jamesii, Aristida purpurea, Dasyochloa pulchella, Vulpia octoflora, Schismus barbatus, Bouteloua barbata, Bromus rubens*, and *Bromus tectorum*. Forbs may be diverse but contribute only trace cover and may include *Abronia fragrans, Chamaesyce serpyllifolia, Grindelia fastigiata, Lepidium montanum, Penstemon ambiguus, Plantago patagonica, Salsola tragus, Sphaeralcea grossulariifolia,* and *Tiquilia latior*. Biological soil crusts, mostly in the form of dark cyanobacteria and moss, may have up to 40% cover.

Global Vegetation: This vegetation type often forms vast expanses across these environments and typically lacks trees and tall shrubs. An open short-shrub layer dominated by *Coleogyne ramosissima* with *Ephedra* spp. as associates characterizes this association. The three common species of *Ephedra* are *Ephedra fasciculata, Ephedra torreyana,* and *Ephedra viridis*, with *Ephedra cutleri* less prevalent. A variety of other shrubs may be present with low cover, including *Atriplex canescens, Atriplex confertifolia, Atriplex obovata, Artemisia bigelovii, Ericameria nauseosa var. juncea (= Chrysothamnus nauseosus var. junceus), Encelia frutescens, Eriogonum corymbosum, Glossopetalon spinescens, Grayia spinosa, Rhus aromatica, Krascheninnikovia lanata, Psorothamnus fremontii, Polygala acanthoclada, Gutierrezia microcephala, Gutierrezia sarothrae, Shepherdia rotundifolia, Yucca angustissima, Opuntia polyacantha, Opuntia erinacea, Xylorhiza tortifolia,* and *Yucca baccata*. The herbaceous layer is typically sparse but may be diverse. Common graminoids include *Achnatherum hymenoides, Aristida purpurea, Bouteloua barbata, Dasyochloa pulchella, Pleuraphis jamesii, Sporobolus contractus, Sporobolus cryptandrus, Tridens muticus, Vulpia octoflora*, and exotics *Bromus rubens, Bromus tectorum*, and *Schismus barbatus*. Forbs may be diverse but contribute only trace cover and may include *Abronia fragrans, Chamaesyce serpyllifolia, Grindelia fastigiata, Lepidium montanum, Penstemon ambiguus, Plantago patagonica, Salsola tragus, Sphaeralcea*

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grossulariifolia, and *Tiquilia latior*. Biological soil crusts, mostly in the form of dark cyanobacteria and moss, may have up to 40% cover.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*, *Coleogyne ramosissima*, *Ephedra cutleri*, *Psorothamnus fremontii*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*, *Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia microcephala*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Coleogyne ramosissima*, *Ephedra fasciculata*, *Ephedra torreyana*, *Ephedra viridis*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Grindelia fastigiata* (G3); Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Salsola tragus*, *Schismus barbatus* (High/Medium)

Global: Vulnerable Plants: *Ephedra fasciculata* (G3?), *Grindelia fastigiata* (G3); Invasive/Exotic Plants: *Bromus rubens*, *Erodium cicutarium* (Medium/Low)

Conservation Status Rank

Global Rank & Reasons: GNR (2-Jul-2010).

Related Concepts

Global Similar Types:

- *Coleogyne ramosissima* Shrubland (CEGL001332) contains a similar suite of shrub species and is dominated by *Coleogyne ramosissima*, but *Ephedra* spp. are not common associates.

Global Related Concepts:

- *Coleogyne ramosissima - Ephedra nevadensis* Association (Evens et al. 2012) =
- *Coleogyne ramosissima-Ephedra* spp. Warm Desert (Evens et al. 2014) =
- Black Brush Series (Sawyer and Keeler-Wolf 2005) >

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Classification

Status: Standard
Classification Confidence:
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau and Mojave Desert. The concept of this association is broad, including stands in both the Mojave Desert and Colorado Plateau. This association needs review to determine if stands from the Colorado Plateau should be moved to a new association in Colorado Plateau Blackbrush - Mormon-tea Shrubland Group (G312).

Element Distribution

Glen Canyon National Recreation Area Range: This very common shrubland association is widely distributed throughout the recreation area, and was sampled on Ahlstrom Point, Billy Flat Top, Brown's Rim, near Castle Rock, below Muley Point, in Cottonwood Canyon, Coyote Gulch, Davis Gulch, Deadhorse Canyon, Dry Rock Creek, North Wash, Rock Canyon, Sooner Gulch, Stanton Canyon, Willow Gulch, Dungeon Canyon, Wetherhill Canyon, near Ekker Butte, above Fiftymile Creek, off the Hall's Crossing Road, near Hole-in-the-Rock, Hoksininni Mesa, Lee's Ferry, Lone Rock, on the Millard Canyon Benches, northeast of Bullfrog, on Ticaboo Mesa, near Turk's Head, Buttes of the Cross, and Wahweap.

Global Range: This association is currently known from Grand Canyon National Park, Grand Canyon-Parashant National Monument, and Glen Canyon National Recreation Area in northern Arizona and southern Utah.

Nations: US
States/Provinces: AZ, CA, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Death Valley, Glen Canyon, Grand Canyon, Grand Canyon-Parashant, Joshua Tree, Mojave)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Depth of sand will be a large factor in these pockets as some species (*Yucca angustissima, Eriogonum alatum*) prefer shallow sand and others *(Ephedra, Coleogyne*) prefer deeper sand. Sun exposure is another factor, as some of the smaller pockets have more shady microhabitats. This plot represents full exposure pockets. This pocket is a poorly drained basin, so it may have a higher content of annuals appearing such as *Bouteloua barbata* and *Erodium cicutarium.*

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, 2012, and 2013 field data (55 plots): (Plots: GLCA.0116, GLCA.0117, GLCA.0324, GLCA.0325, GLCA.0327, GLCA.0330, GLCA.0739, GLCA.1032, GLCA.1065, GLCA.1076, GLCA.4017, GLCA.4018, GLCA.4024, GLCA.4034, GLCA.4036, GLCA.4038, GLCA.4039, GLCA.4040, GLCA.4059, GLCA.4106, GLCA.4122, GLCA.4123, GLCA.4139, GLCA.4143, GLCA.4341, GLCA.4346, GLCA.5025, GLCA.5027, GLCA.5041, GLCA.5042, GLCA.5134, GLCA.5149, GLCA.5154,

GLCA.5179, GLCA.5197, GLCA.5209, GLCA.5550, GLCA.5554, GLCA.5557, GLCA.5570, GLCA.5571, GLCA.5575, GLCA.5580, GLCA.5581, GLCA.6102, GLCA.6104, GLCA.6109, GLCA.6112, GLCA.6115, GLCA.6118, GLCA.6121, GLCA.6122, GLCA.9311, GLCA.9702, GLCA.9703).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): R. Meszaros and K.A. Schulz
References: Evens et al. 2012, Evens et al. 2014, Reid and Hall 2010, Sawyer and Keeler-Wolf 2005, Western Ecology Working Group n.d.*

A3142 Lycium andersonii - Lycium cooperi Scrub Alliance
Alliance Summary Description: This alliance includes semi-desert shrublands from the Great Basin, Colorado Plateau, Mojave Desert, Sonoran Desert and possibly Chihuahuan Desert where *Lycium andersonii* or *Lycium cooperi* is the constant dominant species. The vegetation is characterized by an open canopy dominated or codominated by *Ephedra torreyana* that ranges between 2 and 25% cover. Associated shrubs and cacti include *Adenophyllum porophylloides, Ambrosia dumosa, Atriplex canescens, Atriplex confertifolia, Echinocereus triglochidiatus, Encelia californica, Ephedra californica, Ephedra nevadensis, Ephedra viridis, Eriogonum fasciculatum, Opuntia polyacantha, Grayia spinosa, Gutierrezia sarothrae, Salazaria mexicana, Viguiera parishii*, and *Yucca harrimaniae*. *Coleogyne ramosissima* is absent or has low cover. If present, the understory may include a sparse to moderately dense herbaceous layer composed mostly of dry grasses. Stands occur on moderate to steep rocky slopes and rocky intermittently flooded drainages/washes. Elevation ranges from 500-1100 m in the Mojave Desert and 750-1250 m in the Colorado Plateau. Soils are loams.

[CEGL005150] Lycium andersonii - Ephedra (torreyana, viridis) Shrubland
Translated Name: Water Jacket - (Torrey's Joint-fir, Mormon-tea) Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Mojave Mid-Elevation Mixed Desert Scrub (G296)
Alliance: *Lycium andersonii - Lycium cooperi* Scrub Alliance (A3142)

Element Concept

Global Summary: This shrubland association is currently described from Grand Canyon National Park in Arizona and Glen Canyon National Recreation Area in the Colorado Plateau. Vegetation is characterized by the codominance of the short shrubs *Lycium andersonii* and *Ephedra torreyana*. In rare stands in which *Ephedra torreyana* is not present, *Ephedra viridis* occurs in its place. Tall shrubs are absent. The short-shrub layer also commonly includes *Encelia farinosa*; however, at least 20 different short-shrub associates can occur at low individual covers. A sparse dwarf-shrub layer of *Gutierrezia* spp. and *Opuntia polyacantha* occasionally occurs. The graminoid understory is well-developed and can be particularly dense in some stands with *Pleuraphis jamesii* frequently dominant with other grasses such as *Aristida purpurea, Bromus rubens* (exotic), *Dasyochloa*

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pulchella, and *Muhlenbergia porteri*. *Bouteloua eriopoda* does not occur frequently, but can be dominant in some stands. A somewhat sparse forb understory occasionally includes *Cryptantha* spp., *Eriogonum inflatum, Erodium cicutarium* (exotic), *Porophyllum gracile*, and *Sphaeralcea grossulariifolia*. Stands typically occur on sideslopes at 925 to 1447 m (3075-4750 feet) elevation, but can be found as low as 750 m (2450 feet). It is primarily found on moderately steep gradients (20-32°), but is also occasionally found on gentler slopes (7-16°). It shows some preference for north- and east-facing slopes, but can also occur on west-facing aspects. Soils are rapidly drained sandy loams, and the underlying geology is typically sandstone or, less frequently, limestone or shale.

Environmental Description

Glen Canyon National Recreation Area Environment: This association occurs on talus slopes, hills, plateaus, and canyon bottoms, on moderate to very steep slopes (7-36°), on warmer aspects (south- and southwest-facing), and at elevations ranging from 1168-1447 m. The unvegetated surface is composed mainly of gravel and bare soil, with lesser cover of large rocks. Soils are rapidly drained loams derived from talus/colluvial deposits.

Global Environment: Stands occur in the Colorado Plateau on sideslopes at 925 to 1447 m (3075-4750 feet) elevation, but can be found as low as 750 m (2450 feet). It is primarily found on moderately steep gradients (20-32°), but is also occasionally found on gentler slopes (7-16°). It shows some preference for north- and east-facing slopes, but can also occur on west-facing aspects. Soils are rapidly drained sandy loams derived from talus/colluvial deposits. Parent materials are typically sandstone or, less frequently, limestone or shale. The unvegetated surface is composed mainly of gravel and bare soil, with lesser cover of large rocks.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This association is characterized by a shrub layer dominated by *Lycium andersonii* (with 2-4% cover) and codominated by *Ephedra torreyana* (with 2-3% cover). Total vegetation cover ranges from 6 to 16%. Associated shrubs may include *Coleogyne ramosissima, Atriplex confertifolia, Atriplex obovata, Picrothamnus desertorum (= Artemisia spinescens), Psorothamnus thompsoniae, Xylorhiza tortifolia*, and *Gutierrezia sarothrae*. The understory is sparse and may include *Bouteloua eriopoda, Sphaeralcea ambigua, Abronia elliptica*, and *Tiquilia latior*.

Global Vegetation: Vegetation is characterized by the codominance of the short shrubs *Lycium andersonii* and *Ephedra torreyana*. In rare stands in which *Ephedra torreyana* is not present, *Ephedra viridis* occurs in its place. Tall shrubs are absent. The short-shrub layer also commonly includes *Encelia farinosa*; however, at least 20 different short-shrub associates can occur at low individual covers including *Atriplex confertifolia, Atriplex obovata, Coleogyne ramosissima, Picrothamnus desertorum (= Artemisia spinescens), Psorothamnus thompsoniae*, and *Xylorhiza tortifolia*. A sparse dwarf-shrub layer of *Gutierrezia* spp. and *Opuntia polyacantha* occasionally occurs. The graminoid understory is often well-developed and can be particularly dense in some stands. *Pleuraphis jamesii* is most common with other grasses such as *Aristida purpurea, Bromus rubens* (exotic), *Dasyochloa pulchella*, and *Muhlenbergia porteri*. *Bouteloua eriopoda* does not occur frequently, but can be dominant in some stands. A somewhat sparse forb understory occasionally includes *Abronia elliptica,*

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Cryptantha spp., *Erodium cicutarium* (exotic), *Eriogonum inflatum*, *Porophyllum gracile*, *Sphaeralcea ambigua*, *Sphaeralcea grossulariifolia*, and *Tiquilia latior*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Lycium andersonii*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*, *Xylorhiza tortifolia*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Lycium andersonii*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*, *Ephedra viridis*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Ephedra torreyana*, *Ephedra viridis*, *Lycium andersonii*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Psorothamnus thompsoniae* (G3?)
Global: Vulnerable Plants: *Psorothamnus thompsoniae* (G3?); Invasive/Exotic Plants: *Bromus rubens*, *Erodium cicutarium* (Medium/Low)

Conservation Status Rank

Global Rank & Reasons: GNR (23-Jun-2010).

Related Concepts

Global Similar Types:

- *Ephedra (torreyana, viridis)* / Mixed Semi-Desert Grasses Shrubland (CEGL005113) is also codominated by *Ephedra torreyana*, but *Lycium andersonii* occurs much less frequently and at lower cover.

Classification

Status: Standard
Classification Confidence:
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This rare mixed shrub association was sampled along the San Juan River and in Blue Notch Canyon.

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Global Range: This shrubland association is known from Grand Canyon National Park in northern Arizona and Glen Canyon National Recreation Area in southern Utah. More survey work is needed to fully document its global range.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Rocky slope side, above floodplain, dry desert vegetation.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (1 plot, 3 accuracy assessment points): (Plots: GLCA.5117; AA Points: GLCA_AA.1104, GLCA_AA.1109, GLCA_AA.1687).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): R. Meszaros and K.A. Schulz
References: Reid and Hall 2010, Western Ecology Working Group n.d.*

A0833 Purshia stansburiana Scrub Alliance

Alliance Summary Description: This alliance consists of shrublands dominated by Purshia stansburiana. Associated shrubs include Agave utahensis, Artemisia nova, Artemisia tridentata, Coleogyne ramosissima, Ephedra viridis, Ericameria nauseosa (= Chrysothamnus nauseosus), Mortonia utahensis, and Yucca baccata. The herbaceous ground layer is typically sparse and includes Achnatherum speciosum, Poa secunda, Pseudoroegneria spicata, and Sporobolus cryptandrus. Emergent Juniperus osteosperma and Pinus monophylla trees may be present. Stands occur throughout the Intermountain West at middle elevations (800-2000 m) on edges of intermittent watercourses, canyons, hills, steep slopes, and cliffs. Soils are well-drained, shallow, rocky, rapidly permeable, and usually calcareous, but it is known to occur on limestone. Precipitation averages 20-45 cm annually. The alliance in California is restricted to mountains of the eastern Mojave Desert and adjacent Great Basin. It occurs in small, scattered stands on relatively steep slopes, which are often adjacent to Pinus monophylla stands or Artemisia tridentata or Purshia tridentata shrublands. Virtually all stands observed occur on limestone or marble. Disturbance from flooding is likely in the canyon bottom stands.

[CEGL002957] *Purshia stansburiana* Shrubland
Translated Name: Stansbury's Cliffrose Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)

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Macrogroup: Great Basin-Intermountain Dry Shrubland & Grassland (M171)
Group: Mojave Mid-Elevation Mixed Desert Scrub (G296)
Alliance: *Purshia stansburiana* Scrub Alliance (A0833)

Element Concept

Global Summary: This cliffrose shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It occurs near the edge of canyon rims, and often occurs adjacent to pinyon-juniper or ponderosa pine woodlands. It typically occurs at 1800 to 2000 m (5950-6775 feet) elevation, but can be found as high as 2425 m (7975 feet). This association favors xeric south- or west-facing exposures on the high-level plateau or upper sideslopes below the rim. It typically occurs on flat ground (1-4°), but can be found on steeper gradients (18°) when occurring on sideslopes. Limestone is a common parent material, and exposed bedrock occurs in most stands. Trees are usually absent; however, scattered *Pinus edulis* or *Juniperus osteosperma* may sporadically occur in some stands. The shrub *Purshia stansburiana* dominates and characterizes this association, while other components of the shrub and understory strata often vary. The short shrubs *Ephedra viridis* and *Artemisia tridentata* are common. Dwarf-shrub cover and composition are somewhat variable; *Gutierrezia sarothrae* occurs in most stands, while various *Opuntia* species are also common. The graminoid understory is typically well-developed; however, stands lacking a graminoid understory are not uncommon. Either *Poa fendleriana* or *Bouteloua gracilis* usually dominates this layer, while various other native bunchgrasses, such as *Elymus elymoides, Sporobolus cryptandrus, Hesperostipa comata, Bouteloua curtipendula*, and *Aristida arizonica*, can occur. The exotic *Bromus tectorum* is commonly present. Forbs are typically well-represented, although again, composition varies among stands. *Sanvitalia abertii* and *Artemisia ludoviciana* commonly occur.

Environmental Description

Vegetation Description

Most Abundant Species

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Purshia stansburiana*

Characteristic Species

Global: *Purshia stansburiana*

Other Noteworthy Species

Global: Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (16-Oct-2001).

Related Concepts

Global Similar Types:

- *Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland (CEGL000782) occurs in similar environments and supports a well-developed woodland canopy of *Pinus edulis* and *Juniperus osteosperma*, as well as a strong component of *Purshia stansburiana*.
- *Pinus ponderosa / Purshia stansburiana* Woodland (CEGL000854) occurs in similar environments and supports a similar tall-shrub component; however, it also supports a *Pinus ponderosa* overstory.

Global Related Concepts:

- *Purshia stansburiana* (Sawyer et al. 2009) =
- *Purshia stansburiana* (Evens et al. 2014) =

Classification

Status: Standard
Classification Confidence: 3 - Weak
Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Element Distribution

Global Range: This association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.

Nations: US
States/Provinces: AZ, CA, UT
TNC Ecoregions: 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC, 341B:??
Federal Lands: NPS (Death Valley, Glen Canyon, Grand Canyon, Grand Canyon-Parashant)

Element Sources

Global Description Author(s): K. Christie
References: Evens et al. 2014, Reid and Hall 2010, Sawyer et al. 2009, Western Ecology Working Group n.d.*

M170. Great Basin-Intermountain Dwarf Sagebrush Steppe & Shrubland

G308. Intermountain Low & Black Sagebrush Steppe & Shrubland

Group Summary Description: This broadly defined semi-arid dwarf-shrubland and steppe occurs throughout much of the intermountain western U.S. The vegetation in this broadly defined shrubland and steppe group includes an open to moderately dense shrub or dwarf-shrub layer with a sparse to dense herbaceous layer. Several different taxa of sagebrush may dominate depending on location and by habitat. *Artemisia nova* is most widespread, occurring throughout most of the region on mid- to low-elevation, gravelly, calcareous soils. *Artemisia arbuscula ssp. arbuscula* occurs on low- to high-elevation sites often on shallow, fine-textured soils with a dense clay layer that impedes drainage in spring. *Artemisia arbuscula ssp. longiloba* is widespread in the Columbia Basin and Great Basin into southwestern Wyoming and badlands in the western Great Plains. It occurs on shallow, alkaline,

calcareous soils derived from shale. *Artemisia bigelovii* occurs throughout much of the Colorado Plateau and extends across northern New Mexico and southeastern Colorado on shallow soils on limestone hills and shale outcrops. Several other more restricted taxa include *Artemisia tripartita ssp. rupicola, Artemisia arbuscula ssp. longicaulis, Artemisia arbuscula ssp. thermopola,* and *Artemisia frigida*. Other shrubs present to codominant may include *Artemisia tridentata ssp. wyomingensis, Artemisia tridentata ssp. vaseyana, Ephedra torreyana, Ephedra viridis, Grayia spinosa,* or *Purshia tridentata,* depending on habitat. The herbaceous layer, if present, ranges from sparse cushion plants such as *Arenaria hookeri, Eriogonum brevicaule,* and *Phlox hoodii* to moderate to dense cover of perennial grasses. Characteristic grasses include *Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus, Festuca idahoensis, Hesperostipa comata, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana, Poa secunda,* and *Pseudoroegneria spicata*. Some stands have significant biological crust formation on the soil surface. Sites are generally xeric and may be wind-blown ridges and benches, gravelly alluvial fans, hilltops, canyons, gravelly draws, and dry flats. Substrates are typically shallow, gravelly or finer-textured alkaline, calcareous soils. Most stands occur from 1000 to 3000 m elevation with some extending to 3800 m in subalpine and alpine habitats of the Sierra Nevada. Substrates are variable, but are typically alluvium derived from limestone, shale, basalt, rhyolite or volcanics.

A3223 Artemisia bigelovii Steppe & Shrubland Alliance

Alliance Summary Description: The structure of this vegetation may be shrub-herbaceous or shrub-dominated. The shrub layer is characterized by a sparse to moderately dense dwarf-shrub layer that is dominated or codominated by *Artemisia bigelovii*. Dwarf-shrub associates from the shortgrass steppe include *Frankenia jamesii, Glossopetalon spinescens var. meionandrum, Krascheninnikovia lanata,* and *Yucca glauca,* which may be present to codominant. On the Colorado Plateau, stands may be codominated by *Ephedra* spp., *Eriogonum corymbosum, Parryella filifolia,* or *Purshia stansburiana*. *Gutierrezia sarothrae* and species of *Atriplex* are common in most stands. Scattered *Juniperus* spp. and *Pinus edulis* trees are occasionally present. A sparse to dense graminoid layer is usually present. Dominant grasses include *Aristida purpurea, Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Hesperostipa neomexicana (= Stipa neomexicana), Pleuraphis jamesii (= Hilaria jamesii), Sporobolus cryptandrus,* or less commonly *Pascopyrum smithii*. On the Colorado Plateau, forbs are generally sparse. However, cushion plants are common on shortgrass steppe slopes. Other forbs, such as *Astragalus missouriensis, Heterotheca villosa, Melampodium cinereum, Picradeniopsis oppositifolia, Stanleya pinnata,* and *Zinnia grandiflora*, may be present. Exotic annuals, such as *Bromus japonicus, Bromus tectorum, Descurainia sophia,* and *Salsola kali*, may be present to common depending on disturbance and the amount of seasonal precipitation. This alliance is reported from the Tularosa Basin of southern New Mexico and the Colorado Plateau in southwestern Utah and northern Arizona and near canyon rims and along escarpments in southeastern Colorado. Sites include gentle to moderately steep shale hillslopes and mesas in Arizona and Utah and escarpment and canyon breaks and shaly plains in the shortgrass steppe west to the foothills near the Colorado Front Range. Soils are typically shallow, well-drained, calcareous loams, clay loams, and clays derived from limestone, sandstone, shale and alluvium. The soil surface has high cover of bare soil and rock.

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[CEGL000276] *Artemisia bigelovii* Shrubland
Translated Name: Bigelow's Sagebrush Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Dwarf Sagebrush Steppe & Shrubland (M170)
Group: Intermountain Low & Black Sagebrush Steppe & Shrubland (G308)
Alliance: *Artemisia bigelovii* Steppe & Shrubland Alliance (A3223)

Element Concept

Global Summary: The vegetation is dominated by *Artemisia bigelovii*, and other shrub species are always present, including *Atriplex confertifolia, Ephedra torreyana, Gutierrezia sarothrae, Purshia stansburiana,* and *Yucca harrimaniae*. The total cover of the associated shrubs may exceed that of *Artemisia bigelovii*. The herbaceous understory is sparse, rarely exceeding 10% cover. *Pleuraphis jamesii* is often present in the otherwise graminoid-poor understory; other herbaceous species may include *Arenaria fendleri, Calochortus flexuosus, Chaenactis stevioides, Oenothera pallida*, and *Rumex hymenosepalus*. Cryptobiotic soil crusts may have high cover. Scattered individuals of *Juniperus osteosperma* may be present. This association occurs most commonly on ledgy slopes, canyon rims and ridges in the east-central part of the Colorado Plateau (southeastern Utah and northern Arizona). Slopes are gentle and elevations range from 1552 to 1900 m (5090-6234 feet). Substrates include alluvial and eolian deposits that have weathered into coarse loamy sands. These soils are often thin and overlie sandstone bedrock.

Environmental Description

Glen Canyon National Recreation Area Environment: This sparse shrubland association occurs on slickrock rims and mesas. Sites are located on flat to steep (up to 22°) slopes between 1167 and 1413 m elevation. The unvegetated surface has moderate to high cover of bedrock, small rocks, and bare soil, and sparse to low cover of biological soil crusts. Soils are rapidly drained sandy loams derived from White Rim sandstone or the Entrada Formation.

Global Environment: This short shrubland association occurs most often on ledgy slopes, canyon rims and ridges and less often on valley floors in the east-central part of the Colorado Plateau (southeastern Utah and northern Arizona). Slopes are gentle and elevations range from 1167to 1900 m (3828-6234 feet). Substrates include alluvial and eolian deposits derived from sandstones and shales that have weathered into coarse loamy sands. These soils are often thin and overlie sandstone bedrock. A high percentage of the unvegetated surface may be covered by cryptobiotic soil crusts.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This rare, sparse shrubland occurs on sometimes steep slopes, with total vegetation cover less than 8%. Characteristic of this association is a mix of xeric shrubs, among which *Artemisia bigelovii* is the most conspicuous and generally dominant. Many other shrub species are usually present, including *Ericameria nauseosa, Ephedra torreyana,*

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Atriplex confertifolia, Gutierrezia sarothrae, Coleogyne ramosissima, Symphoricarpos longiflorus, and *Xylorhiza tortifolia*. The herbaceous layer may include *Pleuraphis jamesii* and *Achnatherum* spp.

Global Vegetation: This association occurs primarily in sites where the coarse sandy soils are thin and overlie sandstone bedrock. The total vegetation cover, therefore, is generally somewhat sparse, rarely exceeding 25%. The shrub layer is dominated by *Artemisia bigelovii*, but other shrub species are always present, including *Atriplex confertifolia, Coleogyne ramosissima, Ephedra torreyana, Ericameria nauseosa, Gutierrezia sarothrae, Purshia stansburiana, Symphoricarpos longiflorus, Xylorhiza tortifolia,* and *Yucca harrimaniae*. The total cover of the associated shrubs may exceed that of *Artemisia bigelovii*. The herbaceous understory is sparse, rarely exceeding 5-10% cover, and variable from stand to stand. *Pleuraphis jamesii* is often present in the otherwise graminoid-poor understory; other herbaceous species may include *Achnatherum* spp., *Arenaria fendleri, Calochortus flexuosus, Chaenactis stevioides, Oenothera pallida*, and *Rumex hymenosepalus*. Scattered individuals of *Juniperus osteosperma* may be present, but total tree cover is usually less than 5%, and there is little chance that trees will take over the community because of the lack of suitable sites for establishment of deep-rooted species such as juniper.

Global Dynamics: These are stable, if somewhat sparse, communities.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii*, *Ephedra torreyana*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*, *Xylorhiza tortifolia*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii*

Characteristic Species

Glen Canyon National Recreation Area: *Gutierrezia sarothrae*
Global: *Artemisia bigelovii*, *Atriplex confertifolia*, *Pleuraphis jamesii*

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (7-Jan-2003).

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Related Concepts

Global Similar Types:

- *Artemisia bigelovii - Ephedra (viridis, torreyana)* Talus Shrubland (CEGL003755)
- *Artemisia bigelovii / Bouteloua gracilis* Dwarf-shrub Grassland (CEGL001742) is also dominated by *Artemisia bigelovii* but with a characteristically dense graminoid understory of *Bouteloua gracilis.*

Global Related Concepts:

- *Artemisia bigelovii* Shrubland (Thomas et al. 2003b) =

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. A closely related association, *Artemisia bigelovii - Ephedra (viridis, torreyana)* Talus Shrubland (CEGL003755), occurs on colluvial slopes, sometimes below the rim habitats that support *Artemisia bigelovii* Shrubland (CEGL000276). It is possible that these associations should be combined.

Element Distribution

Glen Canyon National Recreation Area Range: This sparse shrubland association is rare within the recreation area and was sampled in Deadhorse Canyon, Gunsight Canyon, Warm Creek, and Oley Knolls.

Global Range: This association has been documented from northern Arizona and adjacent parts of southeastern Utah.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313D:CC, 341B:CC
Federal Lands: NPS (Capitol Reef, Glen Canyon, Grand Canyon, Hovenweep)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This plot is located in a depression carved by water on White Rim sandstone. Soil has developed and supports a relatively diverse plant assemblage. In some places, clumps of plants have inhibited erosion and form small mounds. Water has pooled here recently, which is quickly shed from the surrounding White Rim slick rock.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2015 field data (1 plot, 3 accuracy assessment points): (Plots: GLCA.0546; AA Points: GLCA_AA.1560, GLCA.1828, GLCA.1850).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and G. Kittel

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Subset: GLCA; Glen Canyon National Recreation Area

References: Clark et al. 2009, Reid and Hall 2010, Romme et al. 1993, Thomas et al. 2003b, Von Loh et al. 2008, Western Ecology Working Group n.d.*

M169. Great Basin-Intermountain Tall Sagebrush Steppe & Shrubland

G303. Intermountain Dry Tall Sagebrush Steppe & Shrubland

Group Summary Description: This widely distributed, matrix-forming shrubland group is concentrated in the drier, more southerly portions of the interior western U.S., especially in the Great Basin and Colorado Plateau, but extends into more xeric portions of the Columbia Plateau, Wyoming steppe, Rocky Mountains, and northeast into the northwestern Great Plains. Stands are dominated by *Artemisia tridentata ssp. wyomingensis* and *Artemisia tridentata ssp. tridentata* and, in some cases, codominated by xeric shrubs such as *Atriplex canescens, Atriplex confertifolia, Ephedra nevadensis, Ephedra viridis, Ericameria nauseosa, Grayia spinosa,* or *Sarcobatus vermiculatus*. Other common shrubs include *Amelanchier utahensis, Artemisia frigida, Atriplex gardneri, Chrysothamnus* spp., *Ericameria* spp., *Peraphyllum ramosissimum, Purshia tridentata,* and *Tetradymia* spp. If present, the herbaceous layer ranges from sparse and patchy to moderately dense and is typically dominated by dry-site graminoids with low cover of forbs. Characteristic graminoids include *Achnatherum hymenoides, Achnatherum lettermanii (= Stipa lettermanii), Achnatherum pinetorum, Achnatherum thurberianum, Bouteloua gracilis, Bromus tectorum, Carex filifolia, Distichlis spicata, Elymus albicans, Elymus elymoides, Hesperostipa comata (= Stipa comata), Leymus ambiguus, Leymus salinus, Pleuraphis jamesii, Poa fendleriana, Poa secunda, Pseudoroegneria spicata, Sporobolus airoides,* and *Sporobolus cryptandrus*. A sparse layer of cold-deciduous needle-leaved or scale-leaved evergreen trees may occasionally be emergent over the shrubs. This group occurs on flat to steeply sloping upland slopes on alluvial fans and terraces, toeslopes, lower and middle slopes, draws, badlands, and foothills. Stands are found at elevations as low as 500 m in the northwestern Great Plains to 2500 m in the Rocky Mountains and Colorado Plateau. Sites with little slope tend to have deep soils, while those with steeper slopes have shallow to moderately deep soils. Climate is mostly semi-arid but ranges from semi-arid in the western Great Basin to subhumid in the northern Great Plains and Rocky Mountains with much of the precipitation falling primarily as snow. The amount and reliability of growing-season moisture increase eastward and with increasing elevation.

A3194 Artemisia tridentata ssp. tridentata - Artemisia tridentata ssp. xericensis Dry Steppe & Shrubland Alliance

Alliance Summary Description: This semi-arid alliance occurs throughout much of the Intermountain West, especially in the Great Basin and Colorado Plateau. Stands in have a mixed shrub canopy dominated by *Artemisia tridentata ssp. tridentata* or *Artemisia tridentata ssp. xericensis*. Other shrubs have low cover, except species that increase with disturbance such as *Gutierrezia sarothrae, Chrysothamnus viscidiflorus,* and *Ericameria nauseosa*. Characteristic dry shrubland understory species include *Achnatherum hymenoides, Achnatherum lettermanii, Bouteloua gracilis, Distichlis spicata, Pascopyrum smithii, Pleuraphis jamesii, Poa secunda, Sporobolus airoides,* and *Sporobolus cryptandrus*. The non-native, invasive annual grass *Bromus tectorum* may be present and dominant in disturbed stands. Sites supporting this alliance include sloping fans, footslopes, rolling hills, swales, draws, and deep, well-drained alluvial bottomlands. Soils are deep, fine- to medium-textured alluvial soils with some source of subirrigation during the summer season, but moderately deep upland soils

with ample moisture storage also support these shrublands. Some stands occur on deep, sandy soils, or soils that are highly calcareous.

[CEGL000991] *Artemisia tridentata* Shrubland
Translated Name: Big Sagebrush Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Tall Sagebrush Steppe & Shrubland (M169)
Group: Intermountain Dry Tall Sagebrush Steppe & Shrubland (G303)
Alliance: *Artemisia tridentata ssp. tridentata - Artemisia tridentata ssp. xericensis* Dry Steppe & Shrubland Alliance (A3194)

Element Concept

Global Summary: This broadly defined sagebrush shrubland is described from eastern California, Nevada, and Utah, but likely occurs throughout much of the western U.S. Elevations range from 1340-2225 m. This association is used to describe any *Artemisia tridentata*-dominated shrubland where the subspecies is not known and the herbaceous layer is generally sparse. The herbaceous layer may be limited by substrate or disturbance. Stands in Utah and California have moderate cover (25-50%) of *Artemisia tridentata* often with scattered individuals of *Ephedra cutleri, Ericameria nauseosa (= Chrysothamnus nauseosus), Grayia spinosa, Gutierrezia sarothrae, Opuntia polyacantha,* or *Sarcobatus vermiculatus*. If present, the herbaceous layer typically consists of low cover of graminoids such as *Distichlis spicata* and *Elymus elymoides*. Landforms include canyon bottom drainage channels, dunes, basins and slopes. Substrates are variable; soil texture ranges from sand to clay.

Environmental Description

Glen Canyon National Recreation Area Environment: This association occurs along canyon bottom drainage channels, on flat sites between 1422 and 1548 m elevation. The unvegetated surface is composed mostly of bare soil or sand and litter, with sparse to low cover of soil crusts (mostly dark cyanobacteria and/or mosses) and downed wood. Soils are moderately well-drained to rapidly drained sands or silt loams derived from alluvium.

Global Environment: This broadly defined sagebrush shrubland is reported from the Colorado Plateau, Great Basin and Uinta Basin but is likely more widespread. Elevations range from 1340-2225 m. Landforms include canyon bottom drainage channels, dunes, basins, and slopes. Substrates are variable; soil texture ranges from sand to clay.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This rare basin big sagebrush shrubland is found on a couple of canyon bottoms in the recreation area. Total vegetation cover ranges from 24 to 53%, and the shrub canopy is dominated by *Artemisia tridentata ssp. tridentata* with 20-50% cover. Only a couple of other shrubs are present with trace to low cover, including *Ephedra cutleri* and

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Atriplex canescens. There is no developed herbaceous understory present, though many forbs and grasses may be present with trace cover.

Global Vegetation: This broadly defined association is used to describe any *Artemisia tridentata*-dominated shrubland where the subspecies is not known and the herbaceous layer is generally sparse. The herbaceous layer may be limited by substrate or disturbance. Stands in Utah and California had a moderately dense short-shrub layer (25-70%) dominated by *Artemisia tridentata*. Associated shrub species may codominate, but more typically occur as scattered individuals including *Ephedra cutleri, Ericameria nauseosa (= Chrysothamnus nauseosus), Sarcobatus vermiculatus, Grayia spinosa, Gutierrezia sarothrae,* or *Opuntia polyacantha*. If present, the herbaceous layer typically consists of low cover of graminoids such as *Distichlis spicata* and *Elymus elymoides.*

Global Dynamics: Ecological processes vary among sites.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *tridentata*, *Atriplex canescens*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Artemisia tridentata*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Global:

Conservation Status Rank

Global Rank & Reasons: G5? (23-Feb-1994).

Related Concepts

Global Similar Types:
- *Artemisia tridentata / Bouteloua gracilis* Shrubland (CEGL000995)
- *Artemisia tridentata / Elymus elymoides* Shrubland (CEGL001001)
- *Artemisia tridentata ssp. tridentata / Distichlis spicata* Shrubland (CEGL001000) This is one of many similar *Artemisia tridentata* associations without variety of *Artemisia tridentata* specified.

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Global Related Concepts:
- *Artemisia tridentata* (Bourgeron and Engelking 1994) =
- *Artemisia tridentata* (Evens et al. 2014) =
- *Artemisia tridentata* Association (Leary and Peterson 1984) <
- *Artemisia tridentata* Shrubland (Von Loh 2000) =
- *Artemisia tridentata* Vegetation Zone VIII (Ralston 1969) <
- DRISCOLL FORMATION CODE:III.A.2.b. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. This is a broadly defined, low-confidence association that could be split into several associations with more information. There are many associations defined for all subspecies of *Artemisia tridentata*. It has been used to classify often depauperate big sagebrush-dominated stands at the edge of its range that lack a significant understory layer. Leary and Peterson (1984) identified *Artemisia tridentata* in their stands to *ssp. tridentata*; however, their stands were almost pure *Artemisia tridentata* with little else to classify into a less general association.

Element Distribution

Glen Canyon National Recreation Area Range: This very rare shrubland association was only sampled along the Escalante River and in Cove Canyon.

Global Range: This sagebrush shrubland is reported from the Colorado Plateau, Great Basin, and Mojave Desert in northern Arizona, eastern California, Nevada, and Utah, but likely occurs throughout much of the Intermountain West.

Nations: US
States/Provinces: AZ, CA:S5, NV:S5, UT
TNC Ecoregions: 6:C, 10:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, 341C:CC, 342B:CC
Federal Lands: NPS (Death Valley, Glen Canyon, Grand Canyon, Grand Canyon-Parashant, Mojave); USFWS (Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: The location in a canyon bottom with deep sand allows for sand-loving plants that need a moderate amount of water to exist.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2013 field data (2 plots): (Plots: GLCA.4320, GLCA.5302).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz

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References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Evens et al. 2014, Leary and Peterson 1984, Ralston 1969, Reid and Hall 2010, Von Loh 2000, Von Loh et al. 2002, Western Ecology Working Group n.d.*

A3184 Artemisia tridentata ssp. wyomingensis Dry Steppe & Shrubland Alliance

Alliance Summary Description: This broadly distributed semi-arid shrubland alliance is found in the western United States on dry sites with core distribution in the Great Basin, Colorado Plateau and Wyoming. Stands have open to moderately dense shrub canopy dominated by *Artemisia tridentata ssp. wyomingensis*. *Artemisia tridentata ssp. tridentata* may be present in some stands. Other shrubs have low cover, except species that increase with disturbance such as *Gutierrezia sarothrae, Chrysothamnus viscidiflorus*, and *Ericameria nauseosa*. This understory is a sparse to moderately dense herbaceous layer characterized by dry-site graminoids such as *Achnatherum hymenoides, Achnatherum pinetorum, Achnatherum thurberianum, Bouteloua gracilis, Carex filifolia, Distichlis spicata, Elymus albicans, Elymus elymoides, Elymus lanceolatus, Hesperostipa comata, Leymus ambiguus, Leymus salinus, Pleuraphis jamesii*, and *Poa fendleriana*. The non-native, invasive species *Agropyron cristatum, Bromus tectorum*, and *Psathyrostachys juncea* may be present and dominant in disturbed stands. This alliance occurs on flat to steeply sloping sites with southerly aspects. Sites with little slope tend to have deep soils, while those with steeper slopes have shallow to moderately deep soils. Soil texture is loamy sand, loam, sandy loam, or clay loam.

[CEGL001046] Artemisia tridentata ssp. wyomingensis / Achnatherum hymenoides Shrubland

Translated Name: Wyoming Big Sagebrush / Indian Ricegrass Shrubland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Tall Sagebrush Steppe & Shrubland (M169)
Group: Intermountain Dry Tall Sagebrush Steppe & Shrubland (G303)
Alliance: *Artemisia tridentata ssp. wyomingensis* Dry Steppe & Shrubland Alliance (A3184)

Element Concept

Global Summary: This sagebrush shrubland association is known from the Gunnison River Valley and the Piceance Basin in western Colorado and the Columbia Basin in Oregon and Idaho, and possibly California. This shrubland association occurs on slopes and terraces above drainages and ridges. Sites are gentle to steep (4-100%) colluvial slopes and alluvial benches often on warmer southeast to southwest aspects between 1830 and 2710 m (6000-8900 feet) elevation. Substrates are variable but are typically moderately deep, well-drained soils with sandy clay loam, sandy loam and loam textures. The ground surface has high cover of large and small rocks, low to moderate cover of litter, and occasionally high cover of bare ground. The vegetation is characterized by an open to dense (10-75% cover) short-shrub canopy (to 1 m tall) dominated by *Artemisia tridentata ssp. wyomingensis*, with the bunchgrass *Achnatherum hymenoides* dominant in a patchy open herbaceous layer. Other shrub species present include *Artemisia frigida, Chrysothamnus viscidiflorus, Krascheninnikovia lanata, Purshia tridentata, Symphoricarpos oreophilus, Yucca harrimaniae*, and the succulent *Opuntia*

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polyacantha. The herbaceous layer is diverse and provides low to moderate cover. Associated graminoids include *Achnatherum pinetorum, Bouteloua gracilis, Elymus elymoides, Hesperostipa comata, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana,* and introduced grasses *Bromus tectorum* and *Poa pratensis.* Forbs are variable, provide sparse cover, and include *Erigeron* spp., *Penstemon teucrioides, Phlox* spp., and *Sphaeralcea coccinea*. *Juniperus scopulorum* trees are occasionally present.

Environmental Description

Global Environment: This sagebrush shrubland association is known from the Gunnison River Valley and the Piceance Basin in western Colorado and the Columbia Basin in Oregon and Idaho, and possibly California. This shrubland association occurs on slopes and terraces above drainages and ridges. Sites are gentle to steep (4-100%) colluvial slopes and alluvial benches often on warmer southeast to southwest aspects between 1830 and 2710 m (6000-8900 feet) elevation. Substrates are variable but are typically moderately deep, well-drained soils with sandy clay loam, sandy loam and loam textures. Parent materials are Tertiary volcanic rocks (breccia, tuff), metamorphic/granitic rocks (granite, gneiss, felsite, schist), Mesozoic sandstone, mudstone and shale. The ground surface has high cover of large and small rocks, low to moderate cover of litter, and occasionally high cover of bare ground. Cryptobiotic soil crusts may provide sparse to low cover.

Vegetation Description

Global Vegetation: This association is characterized by an open to dense (10-75% cover) short-shrub canopy (to 1 m tall) dominated by *Artemisia tridentata ssp. wyomingensis,* with the bunchgrass *Achnatherum hymenoides* dominant in a patchy open herbaceous layer. Other shrub species present include *Artemisia frigida, Chrysothamnus viscidiflorus, Krascheninnikovia lanata, Purshia tridentata, Symphoricarpos oreophilus, Yucca harrimaniae*, and the succulent *Opuntia polyacantha*. The herbaceous layer is diverse and provides low to moderate cover. Associated graminoids include *Achnatherum pinetorum, Bouteloua gracilis, Elymus elymoides, Hesperostipa comata, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana,* and introduced grasses *Bromus inermis, Bromus tectorum*, and *Poa pratensis*. Forbs are variable, provide sparse cover, and include *Erigeron concinnus, Erigeron subtrinervis, Penstemon teucrioides, Phlox hoodii, Phlox longifolia, Phlox multiflora*, and *Sphaeralcea coccinea*. *Juniperus scopulorum* trees are occasionally present providing sparse cover. Mosses and lichens provide sparse to low cover, up to 10%.

Most Abundant Species

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	Graminoid	*Achnatherum hymenoides*

Characteristic Species

Global: Achnatherum hymenoides, Artemisia tridentata ssp. wyomingensis

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Other Noteworthy Species

Global: Vulnerable Plants: *Astragalus anisus* (G2G3), *Penstemon teucrioides* (G2G3Q); Invasive/Exotic Plants: *Bromus inermis* (High/Medium), *Bromus tectorum* (High), *Melilotus officinalis* (Medium/Low), *Poa pratensis* (Medium)

Conservation Status Rank

Global Rank & Reasons: G5 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Artemisia tridentata / Achnatherum hymenoides* Shrubland (CEGL001006)
- *Artemisia tridentata ssp. wyomingensis / Bouteloua gracilis* Shrubland (CEGL001041)

Global Related Concepts:

- *Artemisia tridentata ssp. wyomingensis - Symphoricarpos oreophilus / Oryzopsis hymenoides* Plant Association (Baker 1982b) =
- *Artemisia tridentata ssp. wyomingensis / Oryzopsis hymenoides* Plant Association (Johnston 1987) =
- *Artemisia tridentata ssp. wyomingensis/Oryzopsis hymenoides* (Bourgeron and Engelking 1994) =
- Big Sagebrush (Ferchau 1973) =
- Big Sagebrush Community (Thorne Ecological Institute 1973a) >
- DRISCOLL FORMATION CODE:III.A.2.b. (Driscoll et al. 1984) >
- Wyoming big sagebrush/Indian rice grass-Aridic soils Ecological Type (Johnston 2001) >

Classification

Status: Standard

Classification Confidence: 3 - Weak

Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Global Classification Comments: The current list of plant associations of Oregon (Kagan et al. 2004) does not include this type. The most similar type listed is *Purshia tridentata - Artemisia tridentata ssp. wyomingensis / Oryzopsis hymenoides - Hesperostipa comata* Shrubland that occurs on inland dunes and is based on Poulton (1955). Further clarification is needed on the extent of this type in the Columbia Basin.

Element Distribution

Global Range: This sagebrush shrubland association is known from the Gunnison River Valley and the Piceance Basin in western Colorado and the Columbia Basin in Oregon and Idaho, and possibly California and elsewhere within the range of these common western species.

Nations: US

States/Provinces: CA?, CO:SU, ID, NV, OR:S5, UT

TNC Ecoregions: 6:C, 10:C, 19:C, 20:C

USFS Ecoregions (1994/95): 313A:CC, 341B:CC, 342C:CC, 342D:CC, 342G:CC, M331G:CC, M341B:CC

Federal Lands: NPS (Craters of the Moon, Curecanti, Glen Canyon, Great Basin, Hagerman Fossil Beds)

Element Sources

Global Description Author(s): K.A. Schulz
References: Baker 1982b, Bell et al. 2009, Bourgeron and Engelking 1994, CNHP 2003, CNHP 2015, Coles et al. 2010, Driscoll et al. 1984, Erixson and Cogan 2009, Ferchau 1973, Johnston 1987, Johnston 2001, Kagan et al. 2004a, Peterson 2008, Poulton 1955, Schulz and Hall 2011, Tendick et al. 2010, Thorne Ecological Institute 1973a, Thorne Ecological Institute 1973b, Western Ecology Working Group n.d.*

[CEGL001041] Artemisia tridentata ssp. wyomingensis / Bouteloua gracilis Shrubland
Translated Name: Wyoming Big Sagebrush / Blue Grama Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Tall Sagebrush Steppe & Shrubland (M169)
Group: Intermountain Dry Tall Sagebrush Steppe & Shrubland (G303)
Alliance: *Artemisia tridentata ssp. wyomingensis* Dry Steppe & Shrubland Alliance (A3184)

Element Concept

Global Summary: Artemisia tridentata ssp. wyomingensis dominates the shrub layer, which may also include lesser amounts of Artemisia cana, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra viridis, Ephedra cutleri, Gutierrezia sarothrae, Opuntia polyacantha, Rhus trilobata, and Sarcobatus vermiculatus. The understory usually is dominated by Bouteloua gracilis together with a combination of Pascopyrum smithii, Pseudoroegneria spicata, Hesperostipa comata, Koeleria macrantha, Poa secunda, Pleuraphis jamesii, Achnatherum hymenoides, Sporobolus cryptandrus, and Elymus elymoides. A mix of herbs, including Artemisia frigida, Cordylanthus wrightii, Gutierrezia sarothrae, Packera multilobata (= Senecio multilobatus) Phlox hoodii, and Sphaeralcea coccinea, contribute little cover. The combination of relatively high cover by sagebrush and dominance of the understory by a grazing increaser such as Bouteloua gracilis indicate that this association may represent degraded forms of other Wyoming big sagebrush / native grass associations. This common sagebrush association occurs on ridges, plateaus and benches, and valleys in Wyoming, western Colorado and southeastern Utah. Elevations range from 1840 to 2430 m (6030-7975 feet). Sites are on gentle to steep slopes and may be oriented to any aspect. Substrates include sandstone, granite and metamorphic rocks, and soils range from clay to sandy loam. The cover of bare ground is high in areas that are grazed by domestic livestock. Total vegetation cover may be sparse to moderately dense, depending on site conditions and grazing history.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland occurs on deep soils of mesas and plains. Sites are flat to gently sloping (up to 4°), oriented to all aspects, and are located between 1936 and 1986 m elevation. Bare soil covers most of the unvegetated surface, with low to

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moderate cover of litter, and sparse to low cover of downed wood and biological soil crusts. Soils are rapidly drained silt loams or sandy loams and are derived from alluvium or eolian deposits.

Global Environment: This common sagebrush shrubland occurs on the slopes of ridges and valleys and on plateaus, plains and benches. Elevations range from 1840 to 2430 m (6030-7975 feet). Sites are on gentle to steep slopes and may be oriented to any aspect. Substrates are variable and include clay to sandy loam soils derived from granite and metamorphic rocks, sandstone, shale, alluvium or eolian deposits. The cover of bare ground is high in areas that are grazed by domestic livestock.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Wyoming big sagebrush shrubland occurs on deep soils within the recreation area. Total vegetation cover ranges from 11 to 73% and is dominated by an open canopy of *Artemisia tridentata ssp. wyomingensis* with 10 to 38% cover. Scattered *Juniperus osteosperma* and/or *Pinus edulis* trees may be present with low cover. The understory may be sparse to moderately dense but is always dominated by the perennial grass *Bouteloua gracilis* (with 1-35% cover). Associated shrubs include *Ephedra viridis, Ephedra cutleri, Opuntia* spp., *Gutierrezia sarothrae,* and *Chrysothamnus viscidiflorus*. Additional grasses with low cover may include *Hesperostipa comata* and *Achnatherum hymenoides*. Forbs vary among stands; most commonly noted were *Packera multilobata (= Senecio multilobatus)* and *Cordylanthus wrightii*.

Global Vegetation: Total vegetation cover may be sparse to moderately dense, depending on site conditions and grazing history. *Artemisia tridentata ssp. wyomingensis* dominates the shrub layer, which may also include lesser amounts of *Artemisia cana, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra viridis, Ephedra cutleri, Gutierrezia sarothrae, Opuntia polyacantha, Rhus trilobata,* and *Sarcobatus vermiculatus*. The understory usually is dominated by *Bouteloua gracilis* together with a combination of *Achnatherum hymenoides, Carex filifolia, Elymus elymoides, Hesperostipa comata, Koeleria macrantha, Pascopyrum smithii, Pleuraphis jamesii, Poa secunda, Pseudoroegneria spicata, Sporobolus cryptandrus,* and *Vulpia octoflora (= Festuca octoflora)*. The introduced grasses *Bromus tectorum* and *Bromus japonicus* are often present but generally contribute less cover. A mix of herbs, including *Artemisia frigida, Cordylanthus wrightii, Gutierrezia sarothrae, Packera multilobata (= Senecio multilobatus) Phlox hoodii*, and *Sphaeralcea coccinea*, often are present but generally contribute little cover. Scattered *Juniperus osteosperma* and/or *Pinus edulis* trees may be present with low cover.

Global Dynamics: These shrublands are often heavily grazed; the combination of relatively high cover by sagebrush and dominance of the understory by a grazing increaser such as *Bouteloua gracilis* indicate that this association may represent degraded forms of other Wyoming sagebrush / native grass associations.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *wyomingensis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Short shrub/sapling	Succulent shrub	*Opuntia* spp.
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Bouteloua gracilis*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	Graminoid	*Bouteloua gracilis*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Artemisia tridentata* ssp. *wyomingensis*, *Bouteloua gracilis*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)

Global: Vulnerable Plants: *Arabis crandallii* (G2), *Penstemon teucrioides* (G2G3Q); Invasive/Exotic Plants: *Bromus japonicus*, *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: G5 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Artemisia tridentata ssp. wyomingensis / Achnatherum hymenoides* Shrubland (CEGL001046)
- *Artemisia tridentata ssp. wyomingensis / Carex filifolia* Shrubland (CEGL001042)
- *Artemisia tridentata ssp. wyomingensis / Elymus elymoides* Shrubland (CEGL001043)
- *Artemisia tridentata ssp. wyomingensis / Hesperostipa comata* Shrubland (CEGL001051)
- *Artemisia tridentata ssp. wyomingensis* / Mixed Grasses Shrub Grassland (CEGL001534)
- *Artemisia tridentata ssp. wyomingensis / Pascopyrum smithii* Shrub Grassland (CEGL001047)
- *Artemisia tridentata ssp. wyomingensis / Poa secunda* Shrubland (CEGL001049)
- *Artemisia tridentata ssp. wyomingensis / Pseudoroegneria spicata* Shrubland (CEGL001009)

Global Related Concepts:

- *Artemisia tridentata / Bouteloua gracilis - Hilaria jamesii* Plant Community (Francis 1986) >
- *Artemisia tridentata ssp. wyomingensis / Bouteloua gracilis* Community (Jones 1992b) =
- *Artemisia tridentata ssp. wyomingensis/Bouteloua gracilis* (Bourgeron and Engelking 1994) =
- Big Sagebrush Steppe (Knight et al. 1987) >
- DRISCOLL FORMATION CODE:III.A.2.b. (Driscoll et al. 1984) >

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Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. This association may represent a situation in which *Bouteloua gracilis* is dominant in the understory because other grasses have been removed by grazing. Jones (1992b) states that some stands of this type may represent degraded forms of *Artemisia tridentata ssp. wyomingensis / Pascopyrum smithii* or *Artemisia tridentata ssp. wyomingensis / Pseudoroegneria spicata* shrublands.

Element Distribution

Glen Canyon National Recreation Area Range: This shrubland association is somewhat rare and limited to the mesatops of the Orange Cliffs section of the recreation area and was only sampled near the Hans Flat Ranger Station and on Gordon Flats.

Global Range: This Wyoming big sagebrush type is found in the Colorado Plateau and Great Basin regions of northern Arizona, eastern Utah, western Colorado and Wyoming, lower elevation areas in the Rocky Mountains, and may extend into the western fringe of the northwestern Great Plains.

Nations: US
States/Provinces: AZ, CO, MT, ND, UT:S3S5, WY:S5
TNC Ecoregions: 10:C, 11:C, 19:C, 20:C, 26:?
USFS Ecoregions (1994/95): 313B:CC, 331F:C?, 331G:CC, 341B:CC, 342A:CC, 342F:CC, M331G:CC
Federal Lands: NPS (Bighorn Canyon, Canyon de Chelly, Canyonlands, Capitol Reef, Curecanti, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: There is no evidence of past burning. The sagebrush are mature with some crown die-out. Utah juniper and pinyon pine are invading from all sides. The community is controlled by the deep sand deposition and grazing, at least historically.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2014 field data (3 plots, 12 accuracy assessment points): (Plots: GLCA.0300, GLCA.0501, GLCA.0518; AA Points: GLCA_AA.0178, GLCA_AA.0179, GLCA_AA.0180, GLCA_AA.0186, GLCA_AA.0187, GLCA_AA.0188, GLCA_AA.0189, GLCA_AA.0226, GLCA_AA.0231, GLCA_AA.0282, GLCA_AA.0572, GLCA_AA.0575).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Bighorn Coal Mine n.d., Bourgeron and Engelking 1994, Clark et al. 2009, Coles et al. 2010, Driscoll et al. 1984, Fisser 1964, Fisser 1970, Francis 1986, Jones 1992b, Keammerer 1987, Knight et al. 1987, MTNHP 2002b, NDNHI unpubl. data, Nichols 1964a, Nichols 1964b, Romme et al.

1993, Smith n.d.b, Stoecker-Keammerer Consultants n.d.a, Tendick et al. 2010, Thomas et al. 2010, Van Pelt 1978, Western Ecology Working Group n.d.*

[CEGL002761] Artemisia tridentata ssp. wyomingensis / Hesperostipa comata Colorado Plateau Shrubland
Translated Name: Wyoming Big Sagebrush / Needle-and-Thread Colorado Plateau Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Tall Sagebrush Steppe & Shrubland (M169)
Group: Intermountain Dry Tall Sagebrush Steppe & Shrubland (G303)
Alliance: *Artemisia tridentata ssp. wyomingensis* Dry Steppe & Shrubland Alliance (A3184)

Element Concept

Global Summary: This shrubland association occurs throughout the Colorado Plateau in northern Arizona, eastern Utah, and western Colorado. The type likely occurs in southwestern Wyoming as well. Total vegetation cover ranges from 25 to 75% and is dominated by *Artemisia tridentata ssp. wyomingensis*. Other shrubs provide little additional cover but may include *Atriplex canescens, Chrysothamnus greenei, Chrysothamnus viscidiflorus, Ephedra cutleri, Gutierrezia sarothrae, Leptodactylon pungens, Opuntia polyacantha,* and *Yucca harrimaniae*. *Hesperostipa comata* dominates or codominates the sparse to moderately dense herbaceous layer. Other grass species present depend on the soil texture, with *Achnatherum hymenoides, Elymus elymoides*, and *Koeleria macrantha* more common on sandy soils, whereas *Bouteloua gracilis, Pleuraphis jamesii,* and *Poa fendleriana* are more common on silty soils. Forbs provide little total cover but may include *Arenaria fendleri, Calochortus gunnisonii, Lepidium montanum, Linum lewisii, Packera* sp., *Phlox hoodii, Penstemon teucrioides,* and *Sphaeralcea coccinea*. *Bromus tectorum* may be codominant in heavily disturbed sites. Scattered young *Juniperus osteosperma* and *Pinus edulis* trees are often present. Cryptobiotic soil crusts are common in this type, but development is uneven and tends to be sparse. Stands occur on deep soils on the slopes and summits of plateaus, ridges, hills and mesas. Elevations range from 1450 to 2419 m (4750-7940 feet). Slopes are level to moderately steep (0-50%). Substrates include eolian sands, loess and landslide deposits; most often soils are not residual but develop from these secondary sources. Soils are deep and fine, derived from sandstone, alluvial or eolian deposits. Most of the unvegetated surface is bare soil with low to moderate cover of litter and biological soil crusts. Biological soil crusts are generally in an early stage of development especially in sites that have had long-term grazing by livestock.

Environmental Description

Glen Canyon National Recreation Area Environment: This association occurs on gently sloping (up to 5°) mesatops between 1914 and 1929 m elevation. Bare soil covers most of the unvegetated surface, with low to moderate cover of litter and biological soil crusts. Soils are deep and fine, derived from sandstone, alluvial or eolian deposits.

Global Environment: This widespread shrubland association occurs on deep soils on the slopes and summits of plateaus, ridges, hills and mesas throughout the Colorado Plateau in eastern Utah and

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western Colorado. The type is likely to occur in southwestern Wyoming as well. Elevations range from 1450 to 2419 m (4750-7940 feet). Slopes are level to moderately steep (0-50%). Substrates include eolian sands, loess and landslide deposits; most often soils are not residual but develop from these secondary sources. In sparsely vegetated stands, there is usually an abundance of exposed soil on the ground surface, whereas in denser stands litter covers most of the ground.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This rare Wyoming big sagebrush shrubland has total vegetation cover between 28 and 62% cover. The shrub canopy is dominated by *Artemisia tridentata ssp. wyomingensis* with between 11 and 28% cover and an understory dominated by *Hesperostipa comata* with 5 to 13% cover. *Achnatherum hymenoides* may be codominant in the understory, with up to 13% cover. Associated shrubs include *Ephedra cutleri, Atriplex canescens, Chrysothamnus greenei, Coleogyne ramosissima, Gutierrezia sarothrae*, and the succulent *Opuntia* sp. The only other species noted with more than trace cover in the understory was *Packera* sp. Scattered *Juniperus osteosperma* trees and seedlings may be present. Biological soil crusts are generally in an early stage of development and may have up to 26% cover.

Global Vegetation: This sagebrush association is widespread throughout the northern Colorado Plateau and is abundant in northwestern Colorado. Total vegetation cover ranges from 14 to 75% and is dominated by *Artemisia tridentata ssp. wyomingensis* with between 5 and 65% cover. Other shrubs provide little additional cover but may include *Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Leptodactylon pungens, Opuntia polyacantha*, and *Yucca harrimaniae*. Scattered *Pinus edulis* and *Juniperus osteosperma* trees and seedlings may be present but do not form a layer. *Hesperostipa comata* dominates the sparse to moderately dense herbaceous layer. Other grass species present depend on the soil texture, with *Achnatherum hymenoides, Elymus elymoides*, and *Koeleria macrantha* more common on sandy soils, whereas *Pleuraphis jamesii, Bouteloua gracilis*, and *Poa fendleriana* are more common on silty soils. Forbs provide little total cover but may include *Arenaria fendleri, Calochortus gunnisonii, Eriogonum cernuum, Lepidium montanum, Linum lewisii, Machaeranthera canescens, Oenothera albicaulis, Phlox hoodii, Penstemon teucrioides*, and *Sphaeralcea coccinea*. *Bromus tectorum* may be codominant in heavily disturbed sites. Scattered young *Juniperus osteosperma* and *Pinus edulis* trees are often present. Cryptobiotic soil crusts are common in this type, but development is uneven and tends to be sparse in sites that have been grazed by domestic livestock.

Global Dynamics: This association is subject to periodic fire. When burned, it generally converts to a grassland dominated by *Hesperostipa comata* and *Achnatherum hymenoides* [see *Hesperostipa comata - Achnatherum hymenoides* Grassland (CEGL001703)]. Without additional disturbance, sagebrush will generally re-invade and regain canopy dominance within 20 to 50 years. This association is also subject to invasion by cheatgrass when grazed heavily, and in these stands, fire will generally convert the community more or less permanently to *Bromus tectorum* Ruderal Grassland (CEGL003019).

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *wyomingensis*, *Ephedra cutleri*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Hesperostipa comata*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	Graminoid	*Hesperostipa comata*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Achnatherum hymenoides, Artemisia tridentata* ssp. *wyomingensis, Hesperostipa comata, Opuntia polyacantha, Poa fendleriana, Sphaeralcea coccinea*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Vulnerable Plants: *Lupinus ammophilus* (G3G4), *Penstemon teucrioides* (G2G3Q)

Conservation Status Rank

Global Rank & Reasons: GNR (12-Apr-2005).

Related Concepts

Global Similar Types:

- *Artemisia tridentata ssp. wyomingensis / Hesperostipa comata* Shrubland (CEGL001051)

Global Related Concepts:

- *Artemisia tridentata* ssp. *wyomingensis / Stipa comata* Plant Association (Baker 1984a) >

Classification

Status: Standard
Classification Confidence: 1 - Strong
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. A similar association, *Artemisia tridentata ssp. wyomingensis / Hesperostipa comata* Shrubland (CEGL001051), describes a shrubland type of the Columbia River Basin of Oregon and Washington and the Snake River Plain of Idaho that is restricted to dry calcareous hardpan sites. However, little is known of the specifics of this association and its possible relationship to the Colorado Plateau shrubland. Baker's (1984a) concept of *Artemisia tridentata ssp. wyomingensis / Stipa comata* Association includes both the Colorado and Columbia Basin/Snake River Plain communities. As more data become available, and especially as the range of

the Colorado Plateau shrubland type is better known, these two associations should be revisited and compared to justify their separation.

Element Distribution

Glen Canyon National Recreation Area Range: This very rare shrubland association is of very limited distribution and was only sampled on Cedar Mesa/Muley Point.

Global Range: This shrubland association occurs on deep soils on the slopes and summits of plateaus, ridges, hills and mesas throughout the Colorado Plateau in northern Arizona, eastern Utah and western Colorado, and may extend into Wyoming.

Nations: US
States/Provinces: AZ, CO, UT, WY?
TNC Ecoregions: 9:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331E:CC, M331G:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Canyonlands, Colorado, Curecanti, Dinosaur, Glen Canyon, Mesa Verde, Navajo)

Element Sources

Glen Canyon National Recreation Area Plots: The description is based on 2015 field data (3 accuracy assessment points): (AA Points: GLCA_AA.1852, GLCA_AA.1854, GLCA_AA.1855).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and K.A. Schulz
References: Baker 1984a, Coles et al. 2008a, Coles et al. 2010, Salas et al. 2010a, Tendick et al. 2010, Thomas et al. 2009b, Von Loh et al. 2007, Western Ecology Working Group n.d.*

[CEGL002775] Artemisia tridentata ssp. wyomingensis / Poa fendleriana Shrubland
Translated Name: Wyoming Big Sagebrush / Muttongrass Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Tall Sagebrush Steppe & Shrubland (M169)
Group: Intermountain Dry Tall Sagebrush Steppe & Shrubland (G303)
Alliance: *Artemisia tridentata ssp. wyomingensis* Dry Steppe & Shrubland Alliance (A3184)

Element Concept

Global Summary: This sagebrush shrubland association is widespread throughout the northern Colorado Plateau, occurring on ridges, mesas and hills between 1600 and 2400 m (5250-7875 feet) elevation. Stands may cover entire plateaus or less than an acre in small openings in pinyon-juniper woodlands. Slopes range from 3% to more than 50% and are oriented to all aspects. Soils are deep and often derived from eolian loess or sand, although some stands are on residual soils derived from the underlying sandstone or shale. Total vegetation cover ranges widely, from 10 to 80%. The shrub layer is sparse in hot, dry sites (around 10% cover) but may cover more than 50% in sheltered areas. Other

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Subset: GLCA; Glen Canyon National Recreation Area

shrubs are usually present and may include *Purshia tridentata, Atriplex confertifolia, Symphoricarpos oreophilus, Amelanchier utahensis,* and *Chrysothamnus viscidiflorus*. The herbaceous understory is generally well-developed and is dominated by *Poa fendleriana* with around 3% cover in sparse shrublands and up to 35% cover in denser shrublands. Associated herbaceous species vary but generally include a number of grass species, especially *Achnatherum hymenoides, Hesperostipa comata, Koeleria macrantha, Pseudoroegneria spicata, Bouteloua gracilis,* and *Achnatherum pinetorum*. Forbs are inconsistent and usually contribute 1% cover or less. Some stands will have scattered *Pinus edulis* and *Juniperus osteosperma* trees.

Environmental Description

Global Environment: This sagebrush shrubland is widespread throughout the northern Colorado Plateau, occurring on ridges, mesas and hills between 1600 and 2400 m (5250-7875 feet) elevation. Stands may cover hundreds of acres or less than an acre in small openings in pinyon-juniper woodlands. Slopes range from 3% to more than 50% and are oriented to all aspects. Soils are deep and often derived from eolian loess or sand, although some stands are on residual soils derived from the underlying sandstone or shale.

Vegetation Description

Global Vegetation: This type of Wyoming big sagebrush shrubland is common in the northern Colorado Plateau. The total vegetation cover ranges widely from 10 to 80%. The shrub layer ranges from sparse in hot, dry sites (around 10% cover) to more than 50% in sheltered sites. Other shrubs are usually present and may include *Purshia tridentata, Atriplex confertifolia, Symphoricarpos oreophilus, Amelanchier utahensis,* and *Chrysothamnus viscidiflorus*. The herbaceous understory is generally well-developed and is dominated by *Poa fendleriana* with around 3% cover in sparse shrublands and up to 35% cover in denser shrublands. Associated herbaceous species vary but generally include a number of grass species, especially *Achnatherum hymenoides, Hesperostipa comata, Koeleria macrantha, Pseudoroegneria spicata, Bouteloa gracilis,* and *Achnatherum pinetorum*. Forbs are inconsistent and usually contribute 1% cover or less. Some stands will have scattered trees of *Pinus edulis* and *Juniperus osteosperma*.

Most Abundant Species

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	Graminoid	*Poa fendleriana*

Characteristic Species

Global: Artemisia tridentata ssp. wyomingensis, Chrysothamnus viscidiflorus, Elymus elymoides, Poa fendleriana

Other Noteworthy Species

Global: Vulnerable Plants: *Penstemon teucrioides* (G2G3Q); Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (13-Apr-2005).

Related Concepts

Global Similar Types:

- *Artemisia tridentata ssp. wyomingensis / Balsamorhiza sagittata* Shrubland (CEGL000994)
- *Artemisia tridentata ssp. wyomingensis / Elymus elymoides* Shrubland (CEGL001043)
- *Artemisia tridentata ssp. wyomingensis / Poa secunda* Shrubland (CEGL001049)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Element Distribution

Global Range: This association is widespread within the sagebrush shrublands of the Colorado Plateau. It has been documented from western Colorado and eastern Utah.

Nations: US
States/Provinces: CO, UT
TNC Ecoregions: 9:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331E:CC, M331G:CC
Federal Lands: NPS (Colorado, Curecanti, Dinosaur, Glen Canyon, Hovenweep)

Element Sources

Global Description Author(s): J. Coles
References: Coles et al. 2008a, Coles et al. 2010, Tendick et al. 2010, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.*

[CEGL002768] *Artemisia tridentata ssp. wyomingensis* / Sparse Understory Shrubland
Translated Name: Wyoming Big Sagebrush / Sparse Understory Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Tall Sagebrush Steppe & Shrubland (M169)
Group: Intermountain Dry Tall Sagebrush Steppe & Shrubland (G303)
Alliance: *Artemisia tridentata ssp. wyomingensis* Dry Steppe & Shrubland Alliance (A3184)

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Element Concept

Global Summary: This association is intended to represent sagebrush shrublands where the sparse understory is the result of edaphic conditions, not grazing or other disturbance. Total vegetation cover is somewhat sparse in these sagebrush communities, rarely exceeding 40% and usually closer to 25%. The shrub layer consists of dwarfed *Artemisia tridentata ssp. wyomingensis* shrubs, sometimes accompanied by *Purshia tridentata, Atriplex confertifolia, Ephedra viridis*, or *Ericameria nauseosa*. The understory of dwarf-shrubs and herbaceous species has less than 5% cover, and usually much less. Common species include *Gutierrezia sarothrae, Achnatherum hymenoides, Pleuraphis jamesii*, and *Bouteloua gracilis*. Cryptobiotic crusts may be well-developed in sandy sites. It occurs in scattered patches throughout the sagebrush zone of the Colorado Plateau and western Rocky Mountains of Colorado and Utah. Elevations range from 1590 to 2390 m (5215-7840 feet), and sites occur on level to moderately steep slopes. There is a slight tendency toward hot western and southern exposures. Soils may be thin over bedrock, or loose, unstable sands, or tight clays, or extremely well-drained gravels; all of these situations tend to discourage herbaceous growth.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland association occurs on deep soils of plateaus, mesatops, and alluvial fans. Sites are flat to gently sloping (up to 5°), are mostly north-facing, and occur between 1906 and 2230 m elevation. Bare soil and litter cover most of the unvegetated surface. The soils are rapidly drained to moderately well-drained silt loams or sands.

Global Environment: This shrubland association occurs on deep soils of plateaus, mesatops, and alluvial fans. Elevations range from 1590 to 2390 m (5215-7840 feet), and sites occur on level to moderately steep slopes. There is a slight tendency toward hot western and southern exposures. Soils may be thin over bedrock, or loose, unstable sands, or tight clays, or extremely well-drained gravels; all of these situations tend to discourage herbaceous growth.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This rare Wyoming big sagebrush association has a total vegetation cover of 8-39%. The shrub layer is dominated by *Artemisia tridentata ssp. wyomingensis* with between 2 and 35% cover, with additional sparse to low cover provided by *Ephedra viridis, Ephedra cutleri, Ericameria nauseosa, Gutierrezia microcephala*, and *Opuntia* spp. Scattered *Juniperus osteosperma* and *Pinus edulis* trees are present with sparse to low cover in most stands of this type. The herbaceous layer contributes less than 3% cover and includes *Bouteloua gracilis, Elymus elymoides*, and *Packera multilobata (= Senecio multilobatus)*.

Global Vegetation: Total vegetation cover is relatively low in these sagebrush communities, rarely exceeding 40% and usually closer to 25%. The shrub layer consists of dwarfed *Artemisia tridentata ssp. wyomingensis* shrubs, sometimes accompanied by *Atriplex confertifolia, Ephedra viridis, Ephedra cutleri, Ericameria nauseosa, Gutierrezia microcephala, Opuntia* spp., and/or *Purshia tridentata*. The understory of dwarf-shrubs and herbaceous species has less than 5% cover, and usually much less. Common species include *Achnatherum hymenoides, Bouteloua gracilis, Elymus elymoides, Packera multilobata (= Senecio multilobatus),* and *Pleuraphis jamesii*. While cryptobiotic crusts may be

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well-developed in sandy sites, in general substrates are thin, loose, unstable sands, or tight clays, or extremely well-drained gravels; all of which tends to discourage herbaceous growth.

Global Dynamics: This association is relatively rare, in that the understory is sparse because of edaphic conditions, not disturbance history. The majority of Wyoming sagebrush stands with little understory result from grazing disturbance.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *wyomingensis*, *Ephedra viridis*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *wyomingensis*

Characteristic Species

Glen Canyon National Recreation Area: *Artemisia tridentata* ssp. *wyomingensis*
Global: *Artemisia tridentata* ssp. *wyomingensis*

Other Noteworthy Species

Global: Vulnerable Plants: *Penstemon teucrioides* (G2G3Q), *Physaria rollinsii* (G1)

Conservation Status Rank

Global Rank & Reasons: GNR (13-Apr-2005).

Related Concepts

Global Similar Types:

- *Artemisia tridentata ssp. wyomingensis* / Disturbed Understory Ruderal Shrubland (CEGL002083)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. This association is intended to represent sagebrush shrublands in which the substrate is such that few herbaceous species can grow. Situations in which the understory has been removed by grazing or other disturbance should be assigned to *Artemisia tridentata ssp. wyomingensis* / Disturbed Understory Ruderal Shrubland (CEGL002083). Peterson (2008) is cited as the source for stands in Nevada.

Element Distribution

Glen Canyon National Recreation Area Range: This shrubland association is rare within the recreation area and sampled on Flint Flat, Gordon Flat, Muley Point, and Navajo Point.

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Global Range: This association is scattered widely over the Colorado Plateau of Utah and Colorado and extends west into the Great Basin and east into the southern Rocky Mountains.

Nations: US
States/Provinces: CO, NV, UT
TNC Ecoregions: 9:C, 11:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331E:CC, M331G:CC
Federal Lands: NPS (Curecanti, Dinosaur, Glen Canyon, Hovenweep)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plant community is controlled by deposition of eolian sands and silt. It is recovering from grazing pressure. There is no evidence of fire. Exposure is hot and site is subject to wind erosion and desiccation.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2012 field data (6 plots): (Plot: GLCA.0508, GLCA.0509, GLCA.4049, GLCA.4050, GLCA.4054, GLCA.4217).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and G. Kittel
References: Coles et al. 2008a, Coles et al. 2010, Peterson 2008, Tendick et al. 2010, Von Loh et al. 2008, Western Ecology Working Group n.d.*

G304. Intermountain Mountain Big Sagebrush Steppe & Shrubland

Group Summary Description: This **Group:** includes sagebrush communities occurring at foothills (in Wyoming) to montane and subalpine elevations across the western U.S. from 1000 m in eastern Oregon and Washington to over 3000 m in the Southern Rockies. In Montana, it occurs on mountain "islands" in the north-central portion of the state and possibly along the Boulder River south of Absarokee and at higher elevations. In British Columbia, it occurs between 450 and 1650 m in the southern Fraser Plateau and the Thompson and Okanagan basins. Across its range of distribution, this is a compositionally diverse group. It is composed primarily of *Artemisia tridentata ssp. vaseyana*, and related taxon *Artemisia tridentata ssp. spiciformis* often with *Symphoricarpos* spp. present to codominant. Also included, but less common, are stands dominated by *Artemisia cana ssp. bolanderi, Artemisia cana ssp. viscidula*, and *Artemisia rothrockii* (a California endemic). Additionally there are mixed shrub stands codominated by *Amelanchier* spp., *Chamaebatiaria millefolium, Chrysothamnus viscidiflorus, Ericameria nauseosa, Peraphyllum ramosissimum, Purshia tridentata*, and *Ribes cereum*. *Artemisia tridentata ssp. wyomingensis* may be present to codominant if the stand is clearly montane as indicated by montane indicator species such as *Artemisia tridentata ssp. vaseyana, Danthonia intermedia, Festuca thurberi*, or *Leucopoa kingii*.

Most stands have an abundant perennial herbaceous layer (over 25% cover, and in many cases over 50% cover), but this group also includes *Artemisia tridentata ssp. vaseyana* shrublands that lack a significant herbaceous layer. Other common graminoids include *Achnatherum lettermanii, Achnatherum occidentale, Achnatherum pinetorum, Bromus carinatus, Calamagrostis rubescens*, Carex geyeri, *Elymus trachycaulus, Festuca arizonica, Festuca campestris, Festuca idahoensis,*

Hesperostipa comata, Leucopoa kingii, Muhlenbergia montana, Pascopyrum smithii, Poa fendleriana, Poa secunda, and *Pseudoroegneria spicata*. In many areas, wildfires can maintain an open herbaceous-rich steppe condition, although at most sites, shrub cover can be unusually high for a steppe system (>40%), with the moisture providing equally high grass and forb cover.

A3208 Artemisia tridentata ssp. vaseyana - Mixed Steppe & Shrubland Alliance

Alliance Summary Description: This alliance is widespread in mountainous areas across the western U.S. The vegetation included in this alliance is characterized by an open to dense (10-70% cover) shrub layer in which *Artemisia tridentata ssp. vaseyana* is codominant, usually with 40-60% relative cover with non-sagebrush shrub species such as *Amelanchier utahensis, Holodiscus dumosus, Purshia tridentata*, or *Symphoricarpos oreophilus*. Perennial graminoids typically dominate the open to moderately dense herbaceous layer. The most widespread species are *Pseudoroegneria spicata* and *Festuca idahoensis*, which occur from the Columbia Basin to the northern Rockies, although they may not be the most abundant species in individual stands. Other locally important species may include *Achnatherum occidentale (= Stipa occidentalis), Bouteloua gracilis, Bromus carinatus, Elymus trachycaulus, Festuca thurberi, Festuca viridula, Koeleria macrantha, Leucopoa kingii (= Festuca kingii), Leymus cinereus, Pascopyrum smithii, Poa fendleriana*, and *Poa secunda*. The forb layer is variable and can be very diverse. Species of *Castilleja, Potentilla, Erigeron, Phlox, Astragalus, Geum, Lupinus*, and *Eriogonum* are characteristic. The alliance forms large, continuous stands on mid-elevation mountain slopes and foothills, and can extend above the lower treeline as patches within montane or subalpine coniferous forests. Sites are variable and range from flats to steep slopes to ridgetops with deep to shallow rocky soil.

[CEGL002820] Amelanchier utahensis - Artemisia tridentata (ssp. vaseyana, ssp. wyomingensis) Shrubland

Translated Name: Utah Serviceberry - (Mountain Big Sagebrush, Wyoming Big Sagebrush) Shrubland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Tall Sagebrush Steppe & Shrubland (M169)
Group: Intermountain Mountain Big Sagebrush Steppe & Shrubland (G304)
Alliance: *Artemisia tridentata ssp. vaseyana* - Mixed Steppe & Shrubland Alliance (A3208)

Element Concept

Global Summary: This association is occurs in the highlands of northwestern Colorado and northeastern and southeastern Utah. It also is found southwestern Wyoming and in east-central Nevada. The vegetation is characterized by the codominance in the canopy of *Artemisia tridentata* (ssp. *vaseyana* or ssp. *wyomingensis*, or sometimes a hybrid of the two) and *Amelanchier utahensis* with 15 to 75% total cover. It often takes the appearance of a tall shrubland in which clumps of serviceberry grow in a matrix of sagebrush. *Symphoricarpos oreophilus* may also have high cover in some stands. *Chrysothamnus viscidiflorus, Mahonia repens*, and *Purshia tridentata* may be minor components of the shrub canopy. *Quercus gambelii*, if present, has less than 1% cover. Graminoids

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tend to dominate the well-developed herbaceous layer; typical species are *Achnatherum lettermanii (= Stipa lettermanii), Achnatherum nelsonii ssp. dorei (= Stipa columbiana), Carex geyeri, Hesperostipa comata (= Stipa comata), Koeleria macrantha, Pascopyrum smithii (= Agropyron smithii),* and *Poa fendleriana*. The forb component of the understory is usually diverse and may contribute significant cover, especially in stands that have been grazed. *Achillea millefolium, Balsamorhiza sagittata, Comandra umbellata, Crepis acuminata, Eriogonum umbellatum, Lathyrus lanszwertii var. leucanthus (= Lathyrus leucanthus), Lupinus argenteus, Penstemon caespitosus, Sphaeralcea coccinea,* and *Viola nuttallii* are common species. *Poa pratensis* may be the dominant grass in areas that have a history of grazing. Sites are on level to moderately sloping hills, valleys and benches. Elevation ranges from 1848 to 2600 m, and stands may be oriented to any aspect. The deep, well-drained soils are derived from sandstone, shale, loess or limestone and range in texture from clay loam and silt loam to loamy sand. Organic litter is typically a significant component of the ground surface cover.

Environmental Description

Glen Canyon National Recreation Area Environment: This rare shrubland association occurs on steep talus/colluvial slopes, benches, and plateaus. Sites are moderately to steeply sloping (7-43° slopes), oriented mostly to the north and northeast, and are located between 1848 and 1989 m elevation. The unvegetated surface is mostly composed of bare soil and litter, with lesser cover by large rocks and small rocks, and sparse to low cover of litter and bedrock. The soils are derived from talus/colluvial deposits or from the Straight Cliffs Formation.

Global Environment: This association occurs on level to moderately sloping hills, plateaus, valleys, ridgetops and benches and on steep talus/colluvial slopes. Sites are gentle to steep (2-43° slopes), occur at elevation ranges from 1848 to 2600 m (6060-8530 feet), and may be oriented to any aspect, although it is more common on cooler north- and northeast-facing slope at lower elevation sites. The deep, well-drained soils are derived from sandstone, shale, loess or limestone and range in texture from clay loam and silt loam to loamy sand. Organic litter is typically a significant component of the ground surface cover.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This shrubland is geographically limited within the recreation area, occurring only around Fiftymile Bench. Total vegetation cover ranges from 30 to 45% and is characterized by a mixed shrub canopy, typically 1 to 5 m tall, of *Amelanchier utahensis*, with 5 to 25% cover, and *Artemisia tridentata (ssp. vaseyana, ssp. wyomingensis)*, with 3 to 17% cover. Scattered individuals of 2- to 5-m tall *Juniperus osteosperma* trees occur in some stands. The remaining shrub layer provides sparse to low cover and may include *Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Shepherdia rotundifolia, Eriogonum corymbosum, Hesperodoria scopulorum,* and *Gutierrezia sarothrae*. The herbaceous layer may have low to moderate cover and includes *Leymus salinus, Pleuraphis jamesii,* and *Bromus tectorum*, as well as the forb *Artemisia ludoviciana*.

Global Vegetation: This mountain shrubland association is characterized by the codominance in the canopy of *Artemisia tridentata ssp. vaseyana* or *Artemisia tridentata ssp. wyomingensis* and

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Amelanchier utahensis with 15 to 75% total cover. It often takes the appearance of a tall shrubland type in which clumps of serviceberry grow in a matrix of sagebrush. Although serviceberry and sagebrush are visually dominant, in some stands *Symphoricarpos oreophilus* may have the highest cover of the three shrub species. *Chrysothamnus viscidiflorus, Mahonia repens*, and *Purshia tridentata* may be minor components of the shrub canopy. *Quercus gambelii*, if present, has less than 1% cover. Graminoids tend to dominate the well-developed herbaceous layer; typical species are *Pascopyrum smithii (= Agropyron smithii), Melica spectabilis (= Bromelica spectabilis), Carex geyeri, Koeleria macrantha, Poa fendleriana, Achnatherum nelsonii ssp. dorei (= Stipa columbiana), Hesperostipa comata (= Stipa comata)*, and *Achnatherum lettermanii (= Stipa lettermanii)*. The forb component of the understory is usually diverse and may contribute significant cover, especially in stands that have been grazed. *Achillea millefolium, Balsamorhiza sagittata, Comandra umbellata, Crepis acuminata, Eriogonum umbellatum, Lathyrus lanszwertii var. leucanthus (= Lathyrus leucanthus), Lupinus argenteus, Penstemon caespitosus, Sphaeralcea coccinea*, and *Viola nuttallii* are common species. *Poa pratensis* may be the dominant grass in areas that have a history of grazing.

Global Dynamics: This association appears to be stable once it is established. Fire destroys the sagebrush, but serviceberry will generally resprout following fire. According to Keammerer and Peterson (1981), this association occupies slightly more mesic sites than shrublands dominated by *Artemisia tridentata* and *Symphoricarpos oreophilus* but lacking *Amelanchier utahensis*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*
Short shrub/sapling	Broad-leaved deciduous shrub	*Eriogonum corymbosum*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Herb (field)	Graminoid	*Bromus tectorum*, *Leymus salinus*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos oreophilus*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *vaseyana*, *Artemisia tridentata* ssp. *wyomingensis*

Characteristic Species

Glen Canyon National Recreation Area:

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Global: *Amelanchier utahensis*, *Artemisia tridentata* ssp. *vaseyana*, *Artemisia tridentata* ssp. *wyomingensis*, *Eriogonum umbellatum*, *Lupinus argenteus*, *Pascopyrum smithii*, *Symphoricarpos oreophilus*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global:

Conservation Status Rank

Global Rank & Reasons: GNR (12-Jul-2005).

Related Concepts

Global Similar Types:

- *Artemisia tridentata ssp. vaseyana - Symphoricarpos oreophilus / Bromus carinatus* Shrubland (CEGL001035)
- *Artemisia tridentata ssp. vaseyana - Symphoricarpos oreophilus / Elymus trachycaulus ssp. trachycaulus* Shrubland (CEGL001034)
- *Artemisia tridentata ssp. vaseyana - Symphoricarpos oreophilus / Hesperostipa comata* Shrubland (CEGL001039)
- *Artemisia tridentata ssp. vaseyana - Symphoricarpos oreophilus / Poa secunda* Shrubland (CEGL001037)
- *Artemisia tridentata ssp. vaseyana - Symphoricarpos oreophilus / Pseudoroegneria spicata* Shrubland (CEGL001038)

Global Related Concepts:

- Mixed Montane Shrublands (Keammerer and Stoecker 1975) >
- Serviceberry - Sagebrush Shrubland (Keammerer and Peterson 1981) =
- Upland Sagebrush Community (Keammerer and Stoecker 1975) >

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau and at Great Basin National Park. There is some overlap between this community and the various sagebrush - snowberry associations in the IVC, but the codominance of *Artemisia tridentata* and *Amelanchier utahensis* distinguishes it from them. This association is not ecotonal between sagebrush shrublands and mixed mountain shrublands; instead, it appears to occupy its own habitat and can cover extensive areas.

Element Distribution

Glen Canyon National Recreation Area Range: This rare rocky slope shrubland was only sampled on Fiftymile Bench and the slopes below it.

Global Range: This association is known from the highlands of the Colorado Plateau at Dinosaur National Monument and Black Canyon of the Gunnison National Park, as well as the Roan Plateau and Piceance Basin in northwestern Colorado and northeastern Utah and in Glen Canyon National

Recreation Area in southeastern Utah. It also occurs at Fossil Butte National Monument in southwestern Wyoming and in Great Basin National Park in east-central Nevada.

Nations: US
States/Provinces: CO, NV, UT, WY
TNC Ecoregions: 9:C, 10:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 342E:CC, M331E:CC, M331G:CC, M341A:CC, M341B:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Curecanti, Dinosaur, Fossil Butte, Glen Canyon, Great Basin)

Element Sources

Glen Canyon National Recreation Area Plots: The description is based on 2015 field data (4 accuracy assessment points): (AA Points: GLCA_AA.1371, GLCA_AA.1805, GLCA_AA.1885, GLCA_AA.2026).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and K.A. Schulz
References: Coles et al. 2008a, Coles et al. 2010, Friesen et al. 2010, Keammerer and Peterson 1981, Keammerer and Stoecker 1975, Schulz and Hall 2011, Tendick et al. 2010, Western Ecology Working Group n.d.*

M095. Great Basin-Intermountain Xeric-Riparian Scrub

G559. Great Basin-Intermountain Shrub & Herb Wash-Arroyo

Group Summary Description: This is a sparsely to densely vegetated group that occurs along dry watercourses that experience periodic flash flooding. These are shrublands dominated by *Atriplex canescens, Atriplex confertifolia, Brickellia* spp., *Ephedra* spp., *Ericameria nauseosa*, and/or *Fraxinus anomala*. Other associated shrubs include *Artemisia filifolia, Artemisia tridentata, Atriplex gardneri, Gutierrezia sarothrae, Lycium andersonii, Purshia stansburiana, Quercus havardii, Rhus trilobata, Sarcobatus vermiculatus*, and/or *Suaeda moquinii (= Suaeda torreyana)*. Herbaceous cover is sparse (<10% cover) with a variety of grasses and forbs; non-native annuals can be abundant. This group is known from eastern Washington, eastern Oregon, the Columbia Basin, and throughout the Great Basin. Elevations range from 500-2500 m. Stands occur along the banks or edges of, in or near temporary watercourses (aka washes, dry streambeds, gullies and the like). Surfaces occupied include sandy terraces, wash bottoms, point bars, as well as basin floors that are flat or gently sloping. Substrates are rapidly drained and coarse, such as sandy or gravelly soils derived from alluvium, gneiss, shale, cinder and sandstone, that are often very rocky as well.

A3266 Atriplex canescens - Ericameria nauseosa Desert Wash Alliance

Alliance Summary Description: This alliance covers desert wash shrublands dominated by Atriplex canescens and/or Ericameria nauseosa. Associated shrubs include Artemisia filifolia, Artemisia tridentata, Atriplex confertifolia, Atriplex gardneri, Brickellia longifolia, Ephedra torreyana, Ephedra viridis, Fraxinus anomala, Gutierrezia sarothrae, Lycium andersonii, Purshia stansburiana, Rhus trilobata, Sarcobatus vermiculatus, and Suaeda moquinii (= Suaeda torreyana). The herbaceous stratum has sparse to moderate cover of Achnatherum hymenoides, Artemisia dracunculus,

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Descurainia pinnata, Elymus elymoides, Glycyrrhiza lepidota, Hesperostipa comata, Hordeum jubatum, Sphaeralcea parvifolia, Sporobolus contractus, and Sporobolus cryptandrus. These shrubland are short-statured (<2 m in height), mixed species with fairly open canopy coverage. They can be found in cold desert washes of northern Arizona, Colorado, Nevada and Utah.

[CEGL003470] Atriplex canescens Desert Wash Shrubland

Translated Name: Fourwing Saltbush Desert Wash Shrubland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)

Macrogroup: Great Basin-Intermountain Xeric-Riparian Scrub (M095)

Group: Great Basin-Intermountain Shrub & Herb Wash-Arroyo (G559)

Alliance: *Atriplex canescens - Ericameria nauseosa* Desert Wash Alliance (A3266)

Element Concept

Global Summary: This desert wash shrubland is known from the Colorado Plateau and northern Mojave Desert, extending into the southern Great Basin. Total vegetation cover is 6-30% and is dominated by a scattered to open canopy of *Atriplex canescens*. Associated shrubs include *Artemisia filifolia, Atriplex gardneri, Brickellia longifolia, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Gutierrezia sarothrae, Fraxinus anomala, Lycium andersonii, Rhus trilobata*, and *Suaeda moquinii (= Suaeda torreyana)*. Herbaceous cover is sparse (<10% cover) with a variety of grasses and forbs such as *Achnatherum hymenoides, Artemisia dracunculus, Muhlenbergia porteri, Sporobolus cryptandrus, Sphaeralcea parvifolia, Sporobolus contractus, Stanleya pinnata,* and *Wyethia scabra*. Non-native annuals such as *Bromus rubens, Bromus tectorum* and *Salsola tragus* are sometimes present. Stands occur on sandy terraces and wash bottoms at 1110 to 1600 m elevation. Sites are flat to gently sloping and occur in and along intermittent washes. Substrates are rapidly drained, sandy or gravelly soils derived from alluvium, cinder and sandstone. Scattered large rocks, gravel and bare ground cover most of the unvegetated surface.

Environmental Description

Glen Canyon National Recreation Area Environment: This desert wash shrubland occurs on sandy terraces and dry wash bottoms that lie between 1110 and 1302 m elevation. Sites are flat to moderately sloping (up to 10°), oriented to all aspects, and occur along intermittent washes in canyon bottoms. The unvegetated surface is mostly sand and bare soil, with lesser cover of litter, and sparse to low cover of gravel and biological soil crusts. Substrates are well-drained sandy loams derived from alluvium.

Global Environment: Stands occur on sandy terraces and wash bottoms at 1110 to 1600 m elevation. Sites are flat to gently sloping and occur in and along intermittent washes. Substrates are rapidly drained, sandy or gravelly soils derived from alluvium, cinder and sandstone. Scattered large rocks, gravel and bare ground cover most of the unvegetated surface.

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Vegetation Description

Glen Canyon National Recreation Area Vegetation: Vegetation has sparse to low total cover (6-29% total cover) and is characterized by a scattered to open canopy of *Atriplex canescens*, with 2-8% cover. Stands are often codominated by *Ericameria nauseosa, Lycium andersonii,* and *Suaeda moquinii (= Suaeda torreyana)*. Other associated shrubs may include *Acamptopappus sphaerocephalus, Atriplex confertifolia, Chrysothamnus linifolius, Ephedra torreyana, Fraxinus anomala,* and the exotic invasive *Tamarix chinensis*. Herbaceous cover is low to moderate with a variety of species present, including the grasses *Achnatherum hymenoides, Aristida purpurea, Bromus rubens, Bromus tectorum, Hesperostipa comata, Pleuraphis jamesii,* and *Sporobolus flexuosus,* and forbs such as *Ambrosia acanthicarpa, Artemisia ludoviciana, Iva acerosa (= Oxytenia acerosa), Salsola tragus,* and *Stanleya pinnata*.

Global Vegetation: Vegetation is sparse to low cover (6-25% total vegetation cover) and is characterized by a scattered to open canopy of *Atriplex canescens*. Associated shrubs include *Artemisia filifolia, Atriplex gardneri, Brickellia longifolia, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Gutierrezia sarothrae, Fraxinus anomala, Lycium andersonii, Rhus trilobata,* and *Suaeda moquinii (= Suaeda torreyana)*. Herbaceous cover is sparse (<10% cover) with a variety of species, including scattered grasses and forbs such as *Achnatherum hymenoides, Artemisia dracunculus, Muhlenbergia porteri, Sporobolus cryptandrus, Sphaeralcea parvifolia, Sporobolus contractus, Stanleya pinnata,* and *Wyethia scabra*. Occasional sapling *Populus fremontii* may be present along the channel banks. Non-native annuals such as *Bromus tectorum* and *Salsola tragus* are sometimes present.

Global Dynamics: *Atriplex canescens* is tolerant of saline or alkaline soils, but is not restricted to those soils. Therefore, it is not a reliable indicator of those conditions (USFS 1937). This species is also intolerant of high water tables. This shrub is considered good forage for deer and many classes of livestock because it is highly nutritious and palatable (USFS 1937).

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*, *Suaeda moquinii*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Fraxinus anomala*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*

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Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex canescens*, *Ericameria nauseosa*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Salsola tragus*, *Tamarix chinensis*

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*; Other Plants: *Achnatherum hymenoides* (G5)

Conservation Status Rank

Global Rank & Reasons: GNR (14-Apr-2003).

Related Concepts

Global Similar Types:
- *Fallugia paradoxa* Colorado Plateau Desert Wash Shrubland (CEGL002357)

Global Related Concepts:
- *Atriplex canescens* Desert Wash (Evens et al. 2014) =
- *Atriplex canescens* Desert Wash Shrubland (Howard 2003) =

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This desert wash shrubland was sampled in Wahweap Creek, Horsethief Canyon, Last Chance Creek, and on Hall Mesa.

Global Range: This desert wash shrubland is known from the Colorado Plateau and northern Mojave Desert, extending into the southern Great Basin.

Nations: US
States/Provinces: AZ, CA, NV, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313D:CC, 341B:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Death Valley, Glen Canyon, Lake Mead, Wupatki)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Segment made up of a local drainage channel, a sloping soil bar next to it, and steep rocky walls on either side. Most moisture effects would be limited to the wash.

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Glen Canyon National Recreation Area Plots: The description is based on 2013, 2014, and 2015 field data (1 plot, 5 accuracy assessment points): (Plots: GLCA.6230; AA Points: GLCA_AA.1584, GLCA_AA.1845, GLCA_AA.1896, GLCA_AA.4020, GLCA_AA.4021).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Clark et al. 2009, Coles et al. 2003, Evens et al. 2014, Hansen et al. 2004b, Howard 2003, Romme et al. 1993, USFS 1937, Western Ecology Working Group n.d.*

[CEGL002261] *Ericameria nauseosa* Desert Wash Shrubland
Translated Name: Rubber Rabbitbrush Desert Wash Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Great Basin-Intermountain Xeric-Riparian Scrub (M095)
Group: Great Basin-Intermountain Shrub & Herb Wash-Arroyo (G559)
Alliance: *Atriplex canescens - Ericameria nauseosa* Desert Wash Alliance (A3266)

Element Concept

Global Summary: This shrubland association has sparse to moderate total vegetation cover (1-65%), and is characterized by an open short-shrub layer distributed in linear rows along the intermittent drainages. *Ericameria nauseosa* is the dominant shrub with 1-15% cover. Other shrubs are typically present but contribute little cover. These include *Artemisia tridentata, Atriplex canescens, Atriplex confertifolia, Ephedra viridis, Fraxinus anomala, Gutierrezia sarothrae, Purshia stansburiana, Quercus havardii*, and *Sarcobatus vermiculatus*. The herbaceous stratum has sparse to moderate cover. The exotic *Bromus tectorum* is often abundant. Other herbaceous species commonly found are *Achnatherum hymenoides, Descurainia pinnata, Elymus elymoides, Glycyrrhiza lepidota, Hesperostipa comata, Hordeum jubatum,* and *Pleuraphis jamesii*. This association is found in or near temporary watercourses on point bars, basin floors, and low stream terraces in western Colorado and eastern Utah. Stands have been found between 1189 and 2104 m (3900-6900 feet) elevation. Sites are flat to gently sloping (<3°) and of any aspect. There is usually little litter, but sometimes woody debris can be deposited by floods. Parent materials are variable, but sandstone, shale, and gneiss are most common on sampled stands. Soils are rapidly drained to well-drained sands or sandy loams.

Environmental Description

Glen Canyon National Recreation Area Environment: This common shrubland occurs on intermittently flooded canyon bottoms, washes, banks, bars, and terraces. Sites are flat or slope gently (up to 5°) and lie between 1020 and 1598 m elevation. Most of the unvegetated surface is bare soil or sand, with low to moderate cover by gravel, large rocks, or litter, and sparse cover by downed wood or bedrock. Soils are well-drained to rapidly drained sands or loamy sands (rarely silts) derived from alluvium.

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Global Environment: This association is found in or adjacent to temporary watercourses on point bars, basin floors, and low stream terraces. Stands have been found between 1020 and 2104 m (3346-6900 feet) elevation. Sites are flat to gently sloping (<3°) and of any aspect. The unvegetated surface is mostly bare soil, sand, and/or loose rocks. There is usually little litter, but sometimes woody debris can be deposited by floods. Parent materials are variable, but sandstone, shale, and gneiss are most common on sampled stands. Soils are rapidly drained to well-drained sands, sandy loams or silt loams derived from alluvium. Biological soil crusts may be present but do not provide much cover.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This desert wash shrubland occupies drainage channels and other dynamic, low-lying areas within the recreation area. Total vegetation cover ranges from 2 to 68%, with a shrub canopy layer dominated by *Ericameria nauseosa* with between 2 and 60% cover. Associated shrubs are typical of desert washes and include *Atriplex canescens, Atriplex confertifolia, Artemisia filifolia, Baccharis salicina, Brickellia longifolia, Brickellia oblongifolia, Chrysothamnus viscidiflorus, Ephedra viridis, Ephedra torreyana, Fallugia paradoxa, Gutierrezia* spp., *Lycium andersonii, Psorothamnus fremontii, Purshia mexicana, Rhus aromatica, Salix exigua*, and *Tamarix chinensis*. The herbaceous layer is diverse but contributes only sparse cover. Common graminoids include *Bromus tectorum, Bromus rubens, Distichlis spicata, Achnatherum hymenoides, Pleuraphis jamesii*, and *Sporobolus airoides*. Forbs vary among sites; *Salsola tragus, Amsonia tomentosa, Plantago patagonica, Cryptantha* spp., *Stephanomeria pauciflora*, and *Astragalus* sp. were recorded in the sample plots.

Global Vegetation: This shrubland association has sparse to moderate total vegetation cover (1-65%). This association is characterized by an open to moderately dense short-shrub layer distributed in linear rows along the intermittent drainages. Ericameria nauseosa is the dominant shrub with 1-15% cover. In sparse or patchy stands, *Ericameria nauseosa* acts as an indicator species. Other shrubs are typically present, but contribute little cover. These include *Artemisia tridentata, Atriplex canescens, Atriplex confertifolia, Baccharis salicina, Brickellia oblongifolia, Ephedra torreyana, Ephedra viridis, Fraxinus anomala, Gutierrezia sarothrae, Psorothamnus fremontii, Purshia mexicana, Purshia stansburiana, Quercus havardii, Rhus aromatica, Sarcobatus vermiculatus, Salix exigua*, and *Tamarix chinensis*. The herbaceous stratum has sparse to moderate cover. The exotic *Bromus tectorum* is often abundant. Other herbaceous species commonly found are *Achnatherum hymenoides, Amsonia tomentosa, Astragalus* sp., *Cryptantha* spp., *Descurainia pinnata, Distichlis spicata, Elymus elymoides, Glycyrrhiza lepidota, Hesperostipa comata, Hordeum jubatum, Plantago patagonica, Pleuraphis jamesii, Salsola tragus*, and *Stephanomeria pauciflora*.

Global Dynamics: This association results from a combination of usually dry conditions, coarse-textured substrates and intermittent severe disturbance by flash floods. The vegetation is usually scattered, occurring in parts of the channel protected from the worst flooding, and shrubs have extensive root systems to allow them to resprout quickly when damaged or partially uprooted by flooding.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Ericameria nauseosa*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: Bromus rubens, Bromus tectorum (High), *Plantago patagonica, Salsola tragus, Tamarix chinensis*

Global: Vulnerable Plants: *Parryella filifolia* (G3G4), *Quercus havardii* var. *tuckeri* (G4T3?Q), *Shepherdia rotundifolia* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus, Tamarix chinensis*

Conservation Status Rank

Global Rank & Reasons: GNR (10-Jan-2005).

Related Concepts

Global Similar Types:

- *Ericameria nauseosa / Sporobolus airoides* Shrubland (CEGL002918)
- *Ericameria nauseosa* Shrubland (CEGL002713)
- *Fallugia paradoxa* Colorado Plateau Desert Wash Shrubland (CEGL002357)

Global Related Concepts:

- *Ericameria nauseosa* Desert Wash (Evens et al. 2014) =

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: In sparse or patchy stands, *Ericameria nauseosa* acts as an indicator species. This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau and Mojave Desert.

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Element Distribution

Glen Canyon National Recreation Area Range: This shrubland is distributed along low-lying areas along drainage channels within the recreation area and was sampled in Big Water Canyon, Millard Canyon, Crosby Canyon, Middle Moody Canyon, Red Canyon, Trachyte Canyon, Coyote Gulch, and Willow Gulch, along Last Chance Creek, Fiftymile Creek, the San Juan River, near Lee's Ferry, Ekker Butte, The Soda, and northeast of Bullfrog.

Global Range: This association occurs in the Colorado Plateau in western Colorado and eastern Utah and northern Mojave Desert in southeastern California. It is likely found in other places of the arid western U.S.

Nations: US
States/Provinces: AZ, CA, CO, UT
TNC Ecoregions: 9:C, 10:C, 17:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 341B:CC, M331E:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Colorado, Death Valley, Dinosaur, Glen Canyon, Grand Canyon, Mojave, Petrified Forest)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This section of the wash is 6-8 m wide and 0.5-1 m deep with small amounts of bedrock exposed along the edges. Wash bottom is sandy with some pebbles on a small interfluve and large boulders scattered about. *Ericameria nauseosa* is dominant in the wash, but there is a greater diversity along the banks/terraces. Vegetation is obviously influenced by intermittent flooding, evidenced by mounding and debris piles on up-wash sides of the shrubs.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, 2012, and 2013 field data (25 plots): (Plots: GLCA.0127, GLCA.0130, GLCA.0559, GLCA.0728, GLCA.1001, GLCA.1011, GLCA.1012, GLCA.1027, GLCA.2011, GLCA.2013, GLCA.2018, GLCA.2034, GLCA.4082, GLCA.4086, GLCA.4220, GLCA.4292, GLCA.4344, GLCA.4349, GLCA.5116, GLCA.5253, GLCA.5424, GLCA.5426, GLCA.5505, GLCA.6236, GLCA.9506).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Drake, J. Coles, K.A. Schulz and G. Kittel
References: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Evens et al. 2014, Reid and Hall 2010, Romme et al. 1993, Thomas et al. 2009a, Von Loh et al. 2007, Western Ecology Working Group n.d.*

M118. Intermountain Basins Cliff, Scree & Badland Sparse Vegetation

G570. Intermountain Basins Cliff, Scree & Badland Sparse Vegetation

Group Summary Description: This group consists of barren and sparsely vegetated cliffs, scree slopes, badlands and other similar areas from a variety of landscapes in the interior western U.S. from eastern Washington and Oregon, the Columbia Plateau south to the Great Basin and Colorado Plateau, east into Wyoming basins and plains. Characteristic shrub species in lower elevation semi-desert, lava

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field, and badland areas include *Artemisia pedatifida, Artemisia tridentata, Atriplex canescens, Atriplex confertifolia, Atriplex corrugata, Atriplex gardneri, Ephedra* spp., *Eriogonum corymbosum, Eriogonum heermannii, Eriogonum ovalifolium, Fallugia paradoxa, Grayia spinosa, Purshia tridentata, Salvia dorrii,* and *Sarcobatus vermiculatus*. Characteristic herbs include species of *Achnatherum, Camissonia, Cleome, Eriogonum,* and *Mentzelia*. Foothill sites include *Pinus edulis* and *Pinus ponderosa* (Colorado Plateau), *Pinus monophylla, Pinus longaeva* (Great Basin), *Juniperus osteosperma, Cercocarpus intricatus,* and *Cercocarpus ledifolius.* At montane and subalpine elevations, scattered trees may be present, such as *Abies concolor, Picea engelmannii, Pinus flexilis, Pinus ponderosa,* and *Pseudotsuga menziesii*. Shrubs may include *Arctostaphylos patula, Artemisia tridentata, Cercocarpus ledifolius, Ephedra* spp., *Holodiscus* spp., *Ivesia* sp., and *Purshia tridentata*. Landforms include cliffs and canyon sides, mesas and plateaus, and mountains. Sparse vegetation also occurs on special substrates such as shale outcrops, badlands and volcanic deposits such as lava, cinder, ash, tuff and basalt dikes. Rock substrates include bedrock, slickrock, and unstable talus and scree slopes. Some substrates, such as marine shales, are strongly alkaline and/or saline which chemically limits plant growth. Active substrates such as scree slopes are difficult sites for plants to grow. Physical properties of substrates may also limit plant growth. Some massive rock substrates lack cracks where vascular plants can root. Badland sites often have heavy clay soils that reduce water infiltration increasing erosion rates and reducing soil moisture for plants. Vegetation is variable depending on environmental variables of the sites, which range from relatively low-elevation semi-desert to subalpine cliffs and rock outcrops. Lower elevation sites often have herbaceous or shrub species present, whereas foothill, montane and subalpine sites may also include trees. Most of the species also occur in non-sparse vegetation groups. However, some of the sites with harsh soil properties have a high number of endemic perennial species.

A4050 Ephedra viridis - Chrysothamnus viscidiflorus - Rhus trilobata Talus Sparse Scrub Alliance

Alliance Summary Description: This alliance consists of very open to sparse shrubs (<10% vascular plant cover); typical species include *Artemisia bigelovii, Atriplex canescens, Brickellia* spp., *Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Fallugia paradoxa*, and/or *Rhus trilobata*. It occupies sparsely vegetated talus and colluvial slopes. Sites range from dry and warm through some cooler aspects. Many types occur on tablelands and cliffs with talus and colluvial slopes below them. Substrates are predominantly sedimentary rocks, such as sandstone, shale, and limestone. These species are utilizing moisture from cracks and pockets where soil accumulates, and can tolerate rock-fall and movement since generally these are unstable substrates. These alliance occurs throughout the intermountain western U.S.

[CEGL003755] Artemisia bigelovii - Ephedra (viridis, torreyana) Talus Shrubland

Translated Name: Bigelow's Sagebrush - (Mormon-tea, Torrey's Joint-fir) Talus Shrubland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)

Macrogroup: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (M118)

Group: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)

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Alliance: *Ephedra viridis - Chrysothamnus viscidiflorus - Rhus trilobata* Talus Sparse Scrub Alliance (A4050)

Element Concept

Global Summary: The vegetation is characterized by a sparse mixed short-shrub canopy scattered among boulders, which often are larger than the vegetation. Total vegetation cover ranges from 2 to 25% but is usually less than 15%. *Artemisia bigelovii* is always present and the most abundant single shrub species, but often less then the combined cover of several other shrub species present. As many as 15 species of shrub may be associated with this community, none with more than a few percent cover, including *Atriplex canescens, Atriplex confertifolia, Brickellia grandiflora, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Echinocereus triglochidiatus, Ericameria nauseosa, Eriogonum corymbosum*, and *Gutierrezia sarothrae*. *Rhus trilobata* and *Fraxinus anomala* are generally absent but may be present with very low relative cover. Only scattered herbaceous species are present, providing sparse cover. Common graminoids include *Achnatherum hymenoides, Aristida purpurea*, and *Pleuraphis jamesii*. Forbs occasionally present include *Chamaesyce fendleri, Eriogonum inflatum, Lepidium montanum*, and *Stanleya pinnata*. Biological soil crusts are absent or provide sparse cover. *Juniperus osteosperma* sapling or dwarf-trees are often present with too little cover to constitute a stratum. This mixed colluvial slope shrubland is known from eastern Utah and throughout the canyonlands of the Colorado Plateau. This sparse mixed shrubland occurs on the colluvial deposits that form on the lower slopes of canyons and valleys and on mesatops, steep canyon sides, benches, hills and escarpments. Most stands are on steep slopes (2-80%) between 1193 and 1673 m elevation and tend to occur on warmer exposures. Most of the unvegetated surface is covered by large rocks, gravel and bare soil. The substrate is complex and variable and often consists of an underlying shale covered by fragments of sandstone fallen from cliffs above. Soils are rapidly drained stony sandy loams, loamy sands, and clay loams.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland association occurs on rocky canyon sides, talus slopes, benches, mesas, plateaus, and arroyos. Sites are located on gentle to steep (4-21°) slopes between 1281 and 1673 m elevation. The unvegetated surface has moderate to high cover of bare soil, small rocks, and large rocks, and sparse to low cover of bedrock, litter, and biological soil crusts. Soils are well-drained to rapidly drained sandy loams, sandy clay loams, silt loams, sands, or loamy sands derived from the Moenkopi Formation, Navajo sandstone, Salt Wash Member of the Morrison Formation, Halgaito Shale, or talus/colluvium.

Global Environment: This sparse mixed shrubland occurs on the colluvial deposits that form the lower slopes of canyons and valleys and on mesatops, steep canyon sides, benches, hills and escarpments. Stands are on gentle to more typically steep slopes (2-80%) between 1193 and 1673 m elevation and tend to occur on warmer exposures. Most of the ground surface is covered by large rocks, gravel and bare soil with sparse cover of litter, downed wood and cryptogamic soil crust. The substrate is complex and variable and often consists of an underlying shale covered by fragments of sandstone fallen from cliffs above. Soils vary in texture and parent materials. Most are rapidly drained, stony or

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sandy loam, loamy sand and clay loam in texture and are derived from Cedar Mesa sandstone, Chinle shale, Moenkopi shale and Honaker Trail Formation.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse shrubland occurs on often steep slopes, with total vegetation cover less than 15%. Characteristic of this association is a mix of xeric shrubs, among which *Artemisia bigelovii* and *Ephedra torreyana* or *Ephedra viridis* are conspicuous, although not always dominant. Many other shrub species are usually present, including *Ericameria nauseosa, Atriplex confertifolia, Chrysothamnus viscidiflorus var. stenophyllus, Eriogonum corymbosum, Gutierrezia microcephala, Coleogyne ramosissima,* and *Xylorhiza tortifolia*. *Rhus trilobata* and *Fraxinus anomala* are absent or have no more than trace cover. The herbaceous layer may include *Pleuraphis jamesii, Achnatherum hymenoides, Aristida arizonica,* and *Cryptantha flava*. Biological soil crust formation is rare on these active slopes.

Global Vegetation: Total vegetation cover ranges from 2 to 25% but is usually less than 15%. It is a mix of xeric shrubs, among which *Artemisia bigelovii* and *Ephedra torreyana* or *Ephedra viridis* are conspicuous, although not always dominant. Many other shrub species are usually present, including *Atriplex canescens, Atriplex confertifolia, Brickellia grandiflora, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Echinocereus triglochidiatus, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Gutierrezia microcephala, Gutierrezia sarothrae,* and/or *Xylorhiza tortifolia*. *Rhus trilobata* and *Fraxinus anomala* are absent or have no more than trace cover. The herbaceous layer may include many species or few species but is always sparse and includes species such as *Achnatherum hymenoides, Aristida arizonica, Aristida purpurea, Chamaesyce fendleri, Cryptantha flava, Eriogonum inflatum, Lepidium montanum, Pleuraphis jamesii*, and/or *Stanleya pinnata*. Biological soil crust formation is rare on active slopes, but may provide sparse cover on gentle slopes. *Juniperus osteosperma* sapling or dwarf-trees are often present with too little cover to constitute a stratum.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*, *Eriogonum corymbosum*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii*, *Ephedra torreyana*, *Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Xylorhiza tortifolia*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii*, *Ephedra torreyana*, *Ephedra viridis*

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Characteristic Species

Glen Canyon National Recreation Area:
Global: *Artemisia bigelovii, Ephedra viridis*

Other Noteworthy Species

Global: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4)

Conservation Status Rank

Global Rank & Reasons: GNR (13-Mar-2006).

Related Concepts

Global Similar Types:

- *Artemisia bigelovii* Shrubland (CEGL000276)
- *Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia)* Sparse Vegetation (CEGL005801)
- *Ephedra torreyana - Artemisia bigelovii* Sparse Vegetation (CEGL002350)
- *Pinus edulis - Juniperus osteosperma* / Mixed Shrubs Talus Woodland (CEGL002328) also occurs on steep, eroded talus slopes and can share a somewhat similar composition of shrub species, but supports a notable amount of *Pinus edulis* and *Juniperus osteosperma*.

Classification

Status: Standard
Classification Confidence:
Global Classification Comments: This colluvial slope shrubland association is broadly defined by low cover of common shrub species. The colluvial slope appears to be a defining characteristic as *Artemisia bigelovii, Ephedra torreyana, Ephedra viridis,* and *Gutierrezia sarothrae* are also common on mesatops and ridges. Additional classification work is needed to clarify these colluvial slope types from similar sparsely vegetated types. This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This sparse shrubland association occurs on shaley or talus slopes in the recreation area and was sampled in Wagon Box Canyon, Horse Canyon, on Muley Point, near Buttes of the Cross, and Lee's Ferry.

Global Range: This association is widespread throughout the canyonlands of the Colorado Plateau in eastern Utah and northern Arizona.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Glen Canyon, Grand Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This is a lower-angled colluvial slope. Soils tend to be slightly deeper and finer (less rocky) here than on the more typical steep colluvium found below Wingate along the Orange Cliffs escarpment. This colluvium is pretty stable and inactive.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, and 2012 field data (6 plots): (Plots: GLCA.0318, GLCA.0746, GLCA.2037, GLCA.4056, GLCA.5014, GLCA.9307).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and G. Kittel
References: Coles et al. 2009a, Reid and Hall 2010, Western Ecology Working Group n.d.*

[CEGL001287] Atriplex canescens - Ephedra viridis Talus Shrubland
Translated Name: Fourwing Saltbush - Mormon-tea Talus Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (M118)
Group: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)
Alliance: *Ephedra viridis - Chrysothamnus viscidiflorus - Rhus trilobata* Talus Sparse Scrub Alliance (A4050)

Element Concept

Global Summary: This shrubland has a somewhat sparse shrub canopy with cover ranging between 3 and 30%. The shrub layer is codominated by *Atriplex canescens* and *Ephedra viridis*, and often has several other shrubs present such as *Artemisia bigelovii, Ephedra torreyana, Chrysothamnus viscidiflorus,* and *Gutierrezia sarothrae*. Total vegetative cover ranges from 8 to 35%. The herbaceous layer is diverse but cover rarely exceeds 5%. The most consistent species are the natives *Achnatherum hymenoides, Aristida purpurea*, and *Hesperostipa comata*. Forbs are rare. Scattered *Juniperus osteosperma* trees may occur but with cover not exceeding 5%. This association is known from the Colorado Plateau, and occurs on talus slopes. Sites are on moderately steep to steep talus slopes (21-86%), occur between 1217 and 1865 m (4000-6140 feet) elevation, and tend to occur on southeast aspects. The underlying substrate is usually shale, covered by a layer of sandstone talus.

Environmental Description

Glen Canyon National Recreation Area Environment: This sparse mixed shrubland occurs on canyon sides and talus slopes covered by colluvium fallen from sandstone cliffs upslope. Slopes are steep (24-30°), oriented to the southeast, and lie between 1217 and 1865 m elevation. Most of the unvegetated surface is covered by large boulders, bare soils, and small rocks. The soil is a rapidly drained loamy sands or silt loam derived from the Wingate Formation or from eolian deposits.

Global Environment: This shrubland occurs on warm talus slopes. Sites are on moderately steep to steep talus slopes (21-86%), occur between 1217and 1865 m (4000-6140 feet) elevation, and tend to

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occur on southeast aspects. The underlying substrate is usually shale, covered by a layer of sandstone talus. Ninety percent or more of the ground surface may be covered by rocks and boulders. Soils tend to be sand or silt loams.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparsely vegetated colluvial slope shrubland is rare within the recreation area. Total vegetation cover is 2-5%, and the vegetation is characterized by a mix of shrubs, among which *Atriplex canescens* and *Ephedra viridis* are codominant, with up to 3% individual cover. *Psorothamnus fremontii* and the dwarf-shrub *Gutierrezia sarothrae* may also be present. The herbaceous layer contributes sparse cover and may include *Bromus tectorum, Leymus salinus, Sporobolus cryptandrus,* and *Achnatherum hymenoides.*

Global Vegetation: This shrubland association is typical of warm, southeast-facing talus slopes in eastern Utah and western Colorado. Total vegetation cover is somewhat sparse, ranging between 8 and 35%. The shrub layer is generally diverse, while being codominated by *Atriplex canescens* and *Ephedra viridis*. Other common shrubs include *Ephedra torreyana, Artemisia bigelovii, Chrysothamnus viscidiflorus,* and *Gutierrezia sarothrae*. Total shrub cover ranges from 3 to 30%. The herbaceous layer is similarly diverse, but cover rarely exceeds 5%. The most consistent species the natives *Achnatherum hymenoides, Aristida purpurea, Leymus salinus, Hesperostipa comata,* and *Sporobolus cryptandrus*. The exotic grass *Bromus tectorum* can be abundant. Forbs are sparse. Scattered *Juniperus osteosperma* trees occur throughout many stands, but with cover not exceeding 5%.

Global Dynamics: This talus slope shrubland is associated with warm (not hot) southeast exposures. The combination of shale substrate, aspect and talus "mulch" results in this unique combination of shrub species.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*, *Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*, *Ephedra viridis*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Atriplex canescens*, *Bromus tectorum*, *Ephedra viridis*, *Juniperus osteosperma*

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Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: G4 (23-Feb-1994).

Related Concepts

Global Similar Types:

- *Atriplex canescens* Shrubland (CEGL001281)

Global Related Concepts:

- *Atriplex canescens-Ephedra viridis* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. The shrublands occurring on talus slopes in the Colorado Plateau form a continuum. All tend to be very diverse in their cover of shrubs, and most have scattered *Juniperus osteosperma*. Aspect, the underlying slope substrate, and the degree of cover by sandstone talus determine which shrubs are dominant. This association is only sampled from three sites. More data are needed to fully characterize this type.

Element Distribution

Glen Canyon National Recreation Area Range: This extremely rare shrubland association was sampled on Land's End and in Coyote Gulch.

Global Range: This sparse shrubland occurs throughout the Colorado Plateau, northern Arizona, western Colorado and southeastern Utah and extends into the northern Mojave Desert.

Nations: US
States/Provinces: AZ:S4, CA?, CO, UT
TNC Ecoregions: 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC, 341B:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Colorado, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Steep SSE-facing slope that sees sun all day, no canyon walls blocking light. Soil is covered in gravel but is deep and easily disturbed, especially on steep drainage sides. Slope could be considered talus from sandstone cliffs above. Plot has some scattered/patchy primordial crust.

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Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2012 field data (2 plots): (Plot: GLCA.0587, GLCA.5223).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Bourgeron and Engelking 1994, Clark et al. 2009, Driscoll et al. 1984, Romme et al. 1993, Von Loh et al. 2007, Western Ecology Working Group n.d.*

[CEGL002347] *Chrysothamnus viscidiflorus* Talus Shrubland
Translated Name: Yellow Rabbitbrush Talus Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (M118)
Group: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)
Alliance: *Ephedra viridis - Chrysothamnus viscidiflorus - Rhus trilobata* Talus Sparse Scrub Alliance (A4050)

Element Concept

Global Summary: This shrubland association occurs on moderately steep to steep colluvial or talus slopes in the eastern part of the Colorado Plateau. Continually shifting slopes and occasional rockfall tend to maintain this association in early- to mid-seral succession, and fire may also be an important factor. Elevations range from 1489 to 2300 m (4885-7545 feet). The substrate is generally softer sedimentary rocks such as limestone and shale overlain by sandstone colluvium. *Chrysothamnus viscidiflorus* dominates this community. Other shrubs are generally present, including *Artemisia bigelovii, Artemisia tridentata ssp. wyomingensis, Atriplex canescens, Atriplex confertifolia, Ericameria nauseosa, Eriogonum corymbosum, Ephedra viridis, Gutierrezia sarothrae, Shepherdia rotundifolia, Xylorhiza glabriuscula,* and *Zuckia brandegeei*. The herbaceous layer tends to reflect the rocky substrate also and is often sparse. Typical species may include *Stenotus acaulis, Leptodactylon pungens, Leymus salinus, Pleuraphis jamesii,* and *Poa secunda,* although in some stands *Bromus tectorum* is the dominant.

Environmental Description

Global Environment: This shrubland association occurs on moderately steep to steep colluvial or talus slopes in the eastern part of the Colorado Plateau. Elevations range from 1489 to 2300 m (4885-7545 feet), and stands may occur on slopes oriented to any aspect. Most of the unvegetated ground surface is covered by large loose rocks. The substrate is generally softer sedimentary rocks such as limestone and shale overlain by sandstone colluvium.

Vegetation Description

Global Vegetation: *Chrysothamnus viscidiflorus* dominates this community, where chronic downslope movement tends to maintain it in an early-seral condition. Other shrubs are generally present, including *Artemisia bigelovii, Artemisia tridentata ssp. wyomingensis, Atriplex canescens,*

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Subset: GLCA; Glen Canyon National Recreation Area

Atriplex confertifolia, Ericameria nauseosa, Eriogonum corymbosum, Ephedra viridis, Gutierrezia sarothrae, Shepherdia rotundifolia, Xylorhiza glabriuscula, and *Zuckia brandegeei*. The herbaceous layer tends to reflect the rocky substrate also and is often sparse. Typical species may include *Stenotus acaulis, Leptodactylon pungens, Leymus salinus, Pleuraphis jamesii*, and *Poa secunda*, although in some stands *Bromus tectorum* is the dominant.

Global Dynamics: Continually shifting slopes and occasional rockfall tend to maintain this association in early- to mid-seral succession. One plot was located in a recent burn; fire can be important in maintaining this association. *Pinus edulis* will eventually invade most stands in the absence of fire.

Most Abundant Species

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Chrysothamnus viscidiflorus*

Characteristic Species

Global: Chrysothamnus viscidiflorus

Other Noteworthy Species

Global: Vulnerable Plants: *Shepherdia rotundifolia* (G3G4); Invasive/Exotic Plants: *Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (21-Mar-2005).

Related Concepts

Global Similar Types:

- *Artemisia tridentata / Chrysothamnus viscidiflorus / Poa secunda* Shrubland (CEGL000999)
- *Chrysothamnus viscidiflorus - Ericameria parryi* Shrub Grassland (CEGL002781)
- *Chrysothamnus viscidiflorus / Hesperostipa comata* Shrubland (CEGL002799)
- *Chrysothamnus viscidiflorus / Leymus salinus ssp. salinus* Shrub Grassland (CEGL001501)
- *Chrysothamnus viscidiflorus* Shrub Grassland (CEGL002530)

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Global Classification Comments: *Chrysothamnus viscidiflorus* Talus Shrubland (CEGL002347) may have comparable species composition to some of the associations listed as Similar Associations, but it is distinct because continually shifting slopes and occasional rockfall tend to maintain this association in early- to mid-seral succession.

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Element Distribution

Global Range: This association is documented from sites in southeastern Utah and western Colorado. It is likely to be locally distributed throughout the Colorado Plateau.

Nations: US
States/Provinces: CO, UT
TNC Ecoregions: 9:C, 19:C
USFS Ecoregions (1994/95): 341B:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Dinosaur, Glen Canyon)

Element Sources

Global Description Author(s): J. Coles and K.A. Schulz
References: Clark et al. 2009, Coles et al. 2008a, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEGL003961] Ericameria nauseosa - (Xylorhiza tortifolia) Talus Sparse Shrubland
Translated Name: Rubber Rabbitbrush – (Mojave Woody-aster) Talus Sparse Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (M118)
Group: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)
Alliance: *Ephedra viridis - Chrysothamnus viscidiflorus - Rhus trilobata* Talus Sparse Scrub Alliance (A4050)

Element Concept

Global Summary: This sparse shrubland occurs in the Colorado Plateau and is known from Canyonlands National Park and Glen Canyon National Recreation Area in southeastern Utah. Total vegetation cover ranges from 2 to 14%. The vegetation is characterized by a sparse shrub canopy dominated by *Ericameria nauseosa var. juncea* with up to 8% cover. Associated shrubs, dwarf-shrubs and succulents include scattered *Ephedra viridis, Ephedra torreyana, Chrysothamnus viscidiflorus var. stenophyllus, Gutierrezia sarothrae, Xylorhiza tortifolia, Yucca angustissima,* and *Opuntia erinacea*. Occasional *Juniperus osteosperma* trees and seedlings may be present with less than 1% cover. The sparse herbaceous layer has variable composition, depending on the substrate. Species such as *Pleuraphis jamesii, Achnatherum hymenoides, Tiquilia latior, Cryptantha* sp., *Stanleya pinnata, Lepidium montanum var. jonesii,* and *Eriogonum inflatum* are commonly present. The introduced annual grass *Bromus tectorum* is common in some stands. Although biological soil crusts provide little cover (because most of the surface is rock-covered), they are well-developed and include *Collema* sp., *Fulgensia* sp., *Toninia* sp., mosses, and dark cyanobacteria. Stands occur on colluvium in canyons on gentle to steep slopes (5-34°) between 1142 and 1549 m elevation. Rocks and gravel cover most of the unvegetated surface, with low cover by bare soil. Soils are rapidly drained sands, loams, and sandy clay loams derived from talus/colluvial or alluvial deposits,

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Environmental Description

Glen Canyon National Recreation Area Environment: This sparse talus shrubland occurs on canyon sideslopes and benches. Sites are gently to steeply sloping (5-33°), oriented mostly to the north and east, and lie between 1142 and 1535 m elevation. The unvegetated surface is composed primarily of large rocks, bare soil, and sand, with moderate cover of gravel, and low cover of mosses, dark cyanobacteria, dead wood, and bedrock. Soils are rapidly drained loams or sands derived from talus/colluvial or alluvial deposits, from White Rim sandstone, or Carmel Formation.

Global Environment: This sparse shrubland is only known from Canyonlands National Park and Glen Canyon National Recreation Area in eastern Utah. Stands occur on colluvial deposits in canyons on gentle to steep slopes (5-34°) between 1142 and 1549 m elevation. Rocks and gravel cover most of the unvegetated surface, with low cover by bare soil. Soils are rapidly drained sands, loams, sandy clay loams derived from talus/colluvial or alluvial deposits, from White Rim sandstone, and Carmel, Moenkopi and Organ Rock formations.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Total vegetation cover in these sparse stands ranges from 10 to 12%. The vegetation is characterized by a sparse shrub canopy dominated by *Ericameria nauseosa var. juncea*, with 3-4% cover, and *Xylorhiza tortifolia*, absent to 4% cover. Associated shrubs include *Atriplex confertifolia, Ephedra viridis, Ephedra torreyana, Gutierrezia sarothrae, Quercus turbinella*, and *Psorothamnus fremontii*. The herbaceous understory has sparse to low cover and may include *Bromus tectorum, Pleuraphis jamesii, Achnatherum* sp.? (= *Stipa* sp.), *Lepidium fremontii*, and *Salsola tragus*.

Global Vegetation: Total vegetation cover ranges from 2 to 14%. The vegetation is characterized by a sparse shrub canopy dominated by *Ericameria nauseosa var. juncea* with up to 8% cover. Associated shrubs, dwarf-shrubs and succulents include scattered *Atriplex confertifolia, Chrysothamnus viscidiflorus var. stenophyllus, Ephedra torreyana, Ephedra viridis, Gutierrezia sarothrae, Opuntia erinacea, Xylorhiza tortifolia,* and *Yucca angustissima*. Occasional *Juniperus osteosperma* trees and seedlings may be present with less than 1% cover. The sparse herbaceous layer has variable composition, depending on the substrate. Species such as *Pleuraphis jamesii, Achnatherum hymenoides, Tiquilia latior, Cryptantha* sp., *Stanleya pinnata, Lepidium montanum var. jonesii,* and *Eriogonum inflatum* are commonly present. The introduced annual grass *Bromus tectorum* is common in some stands. Although biological soil crusts provide little cover (because most of the surface is rock-covered), they are well-developed and include *Collema* sp., *Fulgensia* sp., *Toninia* sp., mosses, and dark cyanobacteria.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa* var. *juncea*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*, *Ephedra viridis*

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Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*, *Xylorhiza tortifolia*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa* var. *juncea*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*, *Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Ericameria nauseosa* var. *juncea*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Ericameria nauseosa* var. *juncea* (G5T3T4); Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Global: Vulnerable Plants: *Ericameria nauseosa* var. *juncea* (G5T3T4); Invasive/Exotic Plants: *Bromus tectorum* (High); Other Plants: *Pleuraphis jamesii* (G5)

Conservation Status Rank

Global Rank & Reasons: GNR (12-Jun-2006).

Related Concepts

Classification

Status: Standard
Classification Confidence:
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This sparse talus shrubland was sampled in Annie's Canyon, Ticaboo Creek, near Ekker Camp, and Bullfrog Bay.

Global Range: This sparse shrubland occurs in the Colorado Plateau and is known from Canyonlands National Park and Glen Canyon National Recreation Area in southeastern Utah.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 341B:CC
Federal Lands: NPS (Canyonlands, Glen Canyon)

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Element Sources

Glen Canyon National Recreation Area Inventory Notes: The segment is dominated by large boulders that have fallen off canyon walls. Steep east-facing slope, sandy soil, pretty flowers.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, 2013, and 2015 field data (3 plots, 1 accuracy assessment point): (Plots: GLCA.4272, GLCA.5419, GLCA.9310; AA Points: GLCA_AA.1041).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

[CEGL003776] Rhus trilobata - Ephedra (viridis, torreyana) Talus and Slickrock Shrubland
Translated Name: Skunkbush Sumac - (Mormon-tea, Torrey's Joint-fir) Talus and Slickrock Shrubland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (M118)
Group: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)
Alliance: *Ephedra viridis - Chrysothamnus viscidiflorus - Rhus trilobata* Talus Sparse Scrub Alliance (A4050)

Element Concept

Global Summary: This Colorado Plateau mixed shrub assemblage tends to be slightly more mesic than most other talus type vegetation. Total vegetation cover is sparse, not exceeding 25%. It is characterized by a scattered mixture of shrubs, among which *Rhus trilobata var. trilobata* and *Ephedra torreyana* or *Ephedra viridis* are conspicuous and either dominant or codominant. As many as ten other species of shrubs may also be present, including *Amelanchier utahensis, Artemisia bigelovii, Atriplex confertifolia, Brickellia microphylla, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ericameria nauseosa, Eriogonum corymbosum,* and *Philadelphus microphyllus. Fraxinus anomala* is absent, and if *Pinus edulis* or *Juniperus osteosperma* are present, cover is less than 1%. Herbaceous cover is sparse and variable. Biological soil crust formation is rare on these active slopes. Stands occur on steep, rocky colluvial slopes and bedrock canyon rims associated with mesas, canyons, benches, ravines, hills, hogbacks, escarpments and valley sides. Slopes are typically moderate and range from level to steep (0-70%), occur between 1238 and 1700 m (4000-5580 feet) elevation, and tend to occur on southerly to westerly aspects (less often east-facing slopes). Soils are shallow and rocky and range from rapidly drained clay loams to sandy loams derived from shales and sandstones. It tends to be slightly more mesic than most other talus type vegetation.

Environmental Description

Glen Canyon National Recreation Area Environment: This mixed shrubland association occurs on steep, rocky colluvial slopes and bedrock canyon rims associated with mesatops, canyon bottoms,

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terraces, hills, and ridges. Sites are located on level to steep (0-30°) slopes at more northerly aspects, and occur between 1119 and 1626 m elevation. Large and small rocks, bedrock and bare soil cover most of the unvegetated surface. There is little sand, biological soil crust, or litter present. Soils are moderately well-drained to rapidly drained sands, loamy sands, loams, sandy loams, or sandy clays derived from shales of the Moenkopi, Carmel, Chinle, or Morrison (Salt Wash Member) formations.

Global Environment: This Colorado Plateau mixed shrub assemblage occurs on steep, rocky colluvial slopes and bedrock canyon rims associated with mesas, canyons, benches, ravines, hills, hogbacks, escarpments and valley sides. Slopes are typically moderate and range from level to steep (0-70%), occur between 1119 and 1700 m (3670-5580 feet) elevation, and tend to occur on southerly to westerly aspects (less often east-facing slopes). Soils are shallow and range from rapidly drained clay loams to sandy loams. Parent materials include shales (Carmel, Chinle, Moenkopi, or Morrison (Salt Wash Member) formations) and sandstones (Cedar Mountain, Navajo, Wingate formations). Most of the unvegetated surface is covered by gravel, talus, bedrock and large rocks, and occasionally petrified wood. There is little dead wood, biological soil crust or litter. It tends to be slightly more mesic than most other talus type vegetation.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This mixed shrubland occurs on steep colluvial slopes or more rarely on thin soils near canyon rims. Total vegetation cover ranges from 2 to 39%. Characteristic of this association is a mix of xeric shrubs, among which *Rhus trilobata* and *Ephedra torreyana* or *Ephedra viridis* are conspicuous and usually dominant, with trace to 7% individual cover. Many other shrub species are usually present, including *Artemisia bigelovii, Amelanchier utahensis, Atriplex confertifolia, Coleogyne ramosissima, Brickellia* spp., *Ericameria nauseosa, Eriogonum corymbosum, Shepherdia rotundifolia, Lycium andersonii, Chrysothamnus viscidiflorus var. stenophyllus, Acamptopappus sphaerocephalus, Gutierrezia microcephala, Glossopetalon spinescens, Symphoricarpos longiflorus,* and *Gutierrezia* spp. If *Fraxinus anomala* is present, it is with no more than trace cover and is by no means a codominant. The herbaceous layer may include many species, such as *Pleuraphis jamesii, Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Aristida purpurea, Stephanomeria pauciflora, Sporobolus cryptandrus, Xylorhiza tortifolia, Amsonia tomentosa, Stanleya pinnata,* and *Bromus* spp. Biological soil crust formation is rare on these active slopes.

Global Vegetation: This shrubland association has sparse to low cover of vegetation, not exceeding 25% total cover. It is characterized by a scattered mixture of shrubs, among which *Rhus trilobata var. trilobata* and *Ephedra torreyana* or *Ephedra viridis* are conspicuous and either dominant or codominant. As many as ten other species of shrubs may also be present, including *Acamptopappus sphaerocephalus, Amelanchier utahensis, Artemisia bigelovii, Atriplex confertifolia, Brickellia microphylla, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ericameria nauseosa, Eriogonum corymbosum, Glossopetalon spinescens, Lycium andersonii, Philadelphus microphyllus,* and *Shepherdia rotundifolia*. *Fraxinus anomala* is absent or has trace cover, and if *Pinus edulis* or *Juniperus osteosperma* are present, cover is less than 1%. The herbaceous layer may include many species but never provides more than a few percent cover. *Achnatherum hymenoides, Achnatherum*

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speciosum (= Stipa speciosa), Aristida purpurea, Elymus elymoides, Pleuraphis jamesii, Leymus salinus, Sporobolus cryptandrus, and exotic annuals *Bromus rubens* or *Bromus tectorum* are common grasses. Forbs compositions are variable with frequent species including *Artemisia ludoviciana, Chaetopappa ericoides, Cryptantha crassisepala, Plantago patagonica, Stephanomeria pauciflora,* and *Stanleya pinnata*. Biological soil crust formation is rare on these active slopes.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Rhus trilobata*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*, *Eriogonum corymbosum*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii*, *Ephedra torreyana*
Herb (field)	Flowering forb	*Amsonia tomentosa*, *Xylorhiza tortifolia*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*, *Rhus trilobata* var. *trilobata*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Amelanchier utahensis, Ephedra torreyana, Ephedra viridis, Rhus trilobata* var. *trilobata*

Other Noteworthy Species

Global: Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNR (20-Mar-2006).

Related Concepts

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This mixed shrubland association is widespread in the recreation area. Sites sampled include north of Deadhorse Canyon, in Deadhorse Canyon, Middle Moody Canyon, Little Valley Canyon, Dry Rock Creek, Dungeon Canyon, Croton Canyon, on Millard Canyon Benches, Anderson Bottom, West Sit Down Bench, and along the San Juan River.

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Global Range: This association is known from Arches National Park, Canyonlands National Park, Glen Canyon National Recreation Area, and Petrified Forest National Park and is likely widespread in the canyonlands of the Colorado Plateau in southeastern Utah and northern Arizona.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Glen Canyon, Petrified Forest)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Erosion in the steep-sided drainages dissecting the slope. Boulders provide microhabitat. Steep, north-facing slope.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, and 2012 field data (12 plots): (Plots: GLCA.0538, GLCA.0539, GLCA.0549, GLCA.0732, GLCA.1077, GLCA.2020, GLCA.2070, GLCA.4003, GLCA.4006, GLCA.4064, GLCA.5112, GLCA.5151).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): G. Kittel and K.A. Schulz
References: Coles et al. 2009a, Thomas et al. 2009a, Western Ecology Working Group n.d.*

A4052 Ephedra spp. - Leymus salinus - Eriogonum corymbosum Badlands Cold Desert Sparse Vegetation Alliance

Alliance Summary Description: This alliance consists of sparsely vegetated (<10% vascular cover) areas with varied characteristic species such as *Enceliopsis nudicaulis, Eriogonum brevicaule, Leymus salinus ssp. salinus, Leymus salinus ssp. salmonis, Lupinus argenteus, Pseudoroegneria spicata*, and/or *Zuckia brandegeei*. Other species include dwarf-shrubs such as *Atriplex confertifolia, Gutierrezia* spp., and *Chrysothamnus viscidiflorus var. stenophyllus*. Characteristic forbs and grasses include *Achnatherum hymenoides, Arenaria hookeri, Astragalus* spp., *Cryptantha* spp., *Eriogonum pauciflorum, Machaeranthera grindelioides, Pleuraphis jamesii, Platyschkuhria integrifolia, Poa secunda*, and/or *Xylorhiza venusta*. This alliance occurs throughout the Intermountain West. Habitats are badlands of marine shales, siltstones and mudstones (clay). Landforms are typically rounded hills and plains that form a rolling topography, but at time can be steep and highly eroded. The harsh soil properties and high rate of erosion and deposition are driving environmental variables.

[CEGL002349] *Ephedra torreyana* - (*Atriplex* spp.) / Nonvascular Gypsum Sparse Vegetation
Translated Name: Torrey's Joint-fir - (Saltbush species) / Nonvascular Gypsum Sparse Vegetation
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (M118)
Group: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)

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Alliance: *Ephedra* spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Cold Desert Sparse Vegetation Alliance (A4052)

Element Concept

Global Summary: This sparse shrubland is restricted to the barren slopes of badlands, ridges, hills and gullies with gypsum soils in the northern Colorado Plateau of eastern Utah and western Colorado. Sites are flat to moderately steep (0-36° slopes), occur between 1280 and 1845 m (4200-6050 feet) elevation, and are oriented to all aspects. The unvegetated surface has up to 95% cover of ground lichens or bare soil. Litter and rocks are scarce, but surface erosion may expose a layer of gravel. Parent materials are gypsiferous shales of the Paradox, Moenkopi or Carmel formations. Soils are rapidly drained and range in texture from sandy loam to silty clay, although the sand often consists entirely of unweathered gypsum crystals. The vegetation is characterized by the moderate to near-total cover by gypsophilous ground lichens. The total vascular vegetation cover ranges from 1 to 10% and rarely as high as 30%. It consists of a scattering of *Ephedra torreyana* shrubs that ranges in cover from 1 to 15%. Other shrubs may be present, including *Atriplex canescens, Atriplex confertifolia, Ericameria nauseosa*, and *Opuntia polyacantha*. The herbaceous layer is absent to extremely sparse in terms of cover, but some plots may contain occasional plants of *Achnatherum hymenoides, Poa fendleriana, Pleuraphis jamesii*, and the forbs *Eriogonum inflatum, Lepidium montanum, Lappula occidentalis*, and *Sphaeralcea parvifolia*.

Environmental Description

Global Environment: This sparse shrubland is restricted to the barren slopes of badlands, ridges, hills and gullies with gypsum soils in the northern Colorado Plateau of eastern Utah and western Colorado. Sites are flat to moderately steep (0-36° slopes), occur between 1280 and 1845 m (4200-6050 feet) elevation, and are oriented to all aspects. The unvegetated surface has up to 95% cover of ground lichens or bare soil. Litter and rocks are scarce, but surface erosion may expose a layer of gravel. Parent materials are gypsiferous shales of the Paradox, Moenkopi or Carmel formations. Soils are rapidly drained and range in texture from sandy loam to silty clay, although the sand often consists entirely of unweathered gypsum crystals.

Vegetation Description

Global Vegetation: This unusual sparse shrubland is limited by soils within the Colorado Plateau. This association is characterized by the moderate to near-total cover by gypsophilous ground lichens. The total vascular vegetation cover ranges from 1 to 10% and rarely as high as 30%. It consists of a scattering of *Ephedra torreyana* shrubs that ranges in cover from 1 to 15%. Other shrubs may be present, including *Atriplex canescens, Atriplex confertifolia, Ericameria nauseosa*, and *Opuntia polyacantha*. The herbaceous layer is absent to extremely sparse in terms of cover, but some plots may contain occasional plants of *Achnatherum hymenoides, Poa fendleriana, Pleuraphis jamesii*, and the forbs *Eriogonum inflatum, Lepidium montanum, Lappula occidentalis*, and *Sphaeralcea parvifolia*.

Global Dynamics: Because gypsum erodes easily, these are inherently unstable habitats. The nearly complete ground coverage by gypsiferous lichens retards erosion and gives a cement-like feel to the ground surface.

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Most Abundant Species

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*

Characteristic Species

Global: Atriplex canescens, Atriplex confertifolia, Ephedra torreyana, gypsophilous lichens

Other Noteworthy Species

Global: Invasive/Exotic Plants: Bromus tectorum (High), Descurainia pinnata, Salsola tragus

Conservation Status Rank

Global Rank & Reasons: GNR (21-Mar-2005).

Related Concepts

Global Similar Types:

- *Ephedra torreyana* Sparse Vegetation (CEGL002353)

Global Related Concepts:

- *Ephedra torreyana-(Atriplex* spp.*)* / Nonvascular Gypsum Sparse (Evens et al. 2014) =

Classification

Status: Standard
Classification Confidence: 1 - Strong
Glen Canyon National Recreation Area Classification Comments: Only 1 or 2 plots were sampled; therefore, no local description has been written.

Element Distribution

Global Range: This association is known from gypsum outcrops and soils in eastern Utah and western Colorado.

Nations: US
States/Provinces: NV, UT
TNC Ecoregions: 9:C, 19:C
USFS Ecoregions (1994/95): 341B:CC, M331E:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Dinosaur, Glen Canyon, Lake Mead)

Element Sources

Global Description Author(s): J. Coles
References: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Evens et al. 2014, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEGL002353] *Ephedra torreyana* Sparse Vegetation
Translated Name: Torrey's Joint-fir Sparse Vegetation
Common Name:

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USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (M118)
Group: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)
Alliance: *Ephedra* spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Cold Desert Sparse Vegetation Alliance (A4052)

Element Concept

Global Summary: This very sparse shrub association is locally common in eastern Utah and likely extends into northern Arizona. Total vegetation cover ranges from 1 to 15% but is generally less than 10%. The vegetation is dominated or codominated by a sparse canopy of *Ephedra torreyana* with between 1 and 10% cover. Associated shrubs may include *Atriplex confertifolia, Coleogyne ramosissima, Eriogonum corymbosum, Eriogonum leptocladon, Ericameria nauseosa, Gutierrezia sarothrae, Opuntia* spp., and *Xylorhiza* spp. The herbaceous layer may have as much cover as the shrubs but will rarely exceed a few percent and may often be nearly absent. Common herbaceous species include *Pleuraphis jamesii, Eriogonum inflatum*, and *Sphaeralcea* spp. *Achnatherum hymenoides* is absent or has only trace cover. Exotic species *Bromus tectorum, Salsola tragus*, or *Schismus barbatus* may be present to abundant in disturbed sites. This very sparse shrub association is locally common in eastern Utah, occurring on alluvial fans, pediments, terraces, benches, mesas, rocky canyon slopes and stabilized dunes. This community occupies sites that are often actively eroding steep slopes, with pedestalled shrubs and gullies. A few stands are on level to gently sloping sandsheets that are subject to blowouts. Sampled stands are located between 997 and 1780 m (3270-5840 feet) elevation. Bare ground, rocks and gravel cover most of the unvegetated surface, although biological soil crusts may cover up to 50% of the surface in sandier sites. Soils are moderately well-drained to rapidly drained and variable in texture depending on the parent material. Soil textures range from sands and loam sands to silt loams, silty clay loams, and silty clays derived from shales.

Environmental Description

Glen Canyon National Recreation Area Environment: This sparsely vegetated association occurs on talus/colluvial slopes, canyon sides, plains, hills, terraces, alluvial fans, and plateaus. Sites are flat to very steep (0-40° slopes), include all aspects, and lie between 997 and 1711 m elevation. Bare soil and small rocks cover most of the unvegetated surface, with lesser cover by large rocks, sand, and bedrock. Soils are moderately well-drained to rapidly drained and variable in texture depending on the parent material, which includes loamy sands, sands, and loams derived from alluvial deposits or Navajo sandstone, and silt loams, silty clay loams, and silty clays derived from shales of the Chinle, Moenkopi, Morrison, or Organ Rock formations.

Global Environment: This very sparse shrub association occurs in patches scattered throughout the northern Colorado Plateau on a broad range of landforms, including alluvial fans, pediments, terraces, benches, mesas, rocky canyon slopes and stabilized dunes. Stands are located on level to moderately steep slopes (to 50%) between 997 and 1780 m (3270-5840 feet) elevation. Most sampled plots are on cooler north or east aspects, with few plots on south or west aspects. Bare ground, rocks and gravel cover most of the unvegetated surface, although biological soil crusts may cover up to 50% of the

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surface in sandier sites. There is little litter. Soils are moderately well-drained to rapidly drained and variable in texture depending on the parent material. Soil textures include loamy sands, sands, and loams derived from alluvial deposits or Navajo sandstone, and silt loams, silty clay loams, and silty clays derived from shales of the Chinle, Cutler, Moenkopi, Morrison, Organ Rock, and Summerville formations.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This very sparsely vegetated desert shrubland is widely established throughout the recreation area. Total vegetation does not exceed 5%. The shrub layer is dominated by sparsely scattered *Ephedra torreyana* with up to 2% cover. Associated shrubs include *Gutierrezia microcephala, Xylorhiza tortifolia, Opuntia polyacantha*, and *Psorothamnus* spp. The herbaceous layer is sparse and may include *Amsonia tomentosa, Salsola tragus, Astragalus* sp., and *Schismus barbatus*. Biological soil crust cover is variable, but generally is low. Occasionally, *Pinus edulis* trees may be present with trace cover.

Global Vegetation: This sparse shrub association is locally common in eastern Utah. Total vegetation cover ranges from 1 to 15% but is generally less than 10%. The vegetation is dominated or codominated by a sparse canopy of *Ephedra torreyana* with between 1 and 10% cover. Associated shrubs may include *Atriplex confertifolia, Coleogyne ramosissima, Eriogonum leptocladon, Eriogonum corymbosum, Ericameria nauseosa, Gutierrezia sarothrae, Opuntia* spp., *Psorothamnus* spp., and *Xylorhiza* spp. The herbaceous layer may have as much cover as the shrubs but will rarely exceed a few percent and may often be nearly absent. Diversity is moderate considering the sparse nature of the community and often includes *Pleuraphis jamesii, Eriogonum inflatum, Phacelia crenulata*, and *Sphaeralcea* spp. *Achnatherum hymenoides* is absent or has only trace cover. Exotic species *Bromus tectorum, Salsola tragus,* or *Schismus barbatus* may be present to abundant in disturbed sites.

Global Dynamics: This community occupies sites that are often actively eroding, with pedestalled shrubs and gullies in many plots. A few plots are on sandsheets that are subject to blowouts.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia microcephala*, *Xylorhiza tortifolia*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Short shrub/sapling	Dwarf-shrub	*Eriogonum leptocladon*

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Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex confertifolia, Ephedra torreyana, Gutierrezia sarothrae*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Salsola tragus, Schismus barbatus* (High/Medium)

Global: Vulnerable Plants: *Ericameria nauseosa* var. *juncea* (G5T3T4); Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: GNR (21-Mar-2005).

Related Concepts

Global Similar Types:
- *Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia)* Sparse Vegetation (CEGL005801)
- *Ephedra torreyana* - (*Atriplex* spp.) / Nonvascular Gypsum Sparse Vegetation (CEGL002349)
- *Ephedra torreyana - Artemisia bigelovii* Sparse Vegetation (CEGL002350)
- *Ephedra torreyana / Achnatherum hymenoides - Pleuraphis jamesii* Shrubland (CEGL002352)
- *Ephedra torreyana / Bouteloua gracilis - Pleuraphis jamesii* Shrubland (CEGL002351)

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. All *Ephedra torreyana* shrubland types are relatively sparse, and many have some degree of graminoid understory. This association is distinguished from others by having only *Pleuraphis jamesii* in the understory and lacking any significant cover by *Bouteloua gracilis* or *Achnatherum hymenoides*. However, there is relatively little quantitative data and no literature to support these associations; as additional data become available, it may be necessary to revisit and revise association concepts.

Element Distribution

Glen Canyon National Recreation Area Range: This sparsely vegetated association is somewhat common within the recreation area and was sampled in Big Water Canyon, Stanton Canyon, White Canyon, Red Canyon, on Anderson Bottom, Alstrom Point, Hoksininni Mesa, the Purple Hills, near Hall's Crossing and Lee's Ferry.

Global Range: This Colorado Plateau association has been documented from southeastern Utah and may occur in northern Arizona, although it is likely to be fairly restricted in both its range and in the size of occurrences.

Nations: US
States/Provinces: AZ?, UT

TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Relatively steep slope intercut by many deep drainage channels, evidence of high runoff flows. Soil surface covered in desert pavement-like layer of gravel firmly seated to the ground, ostensibly preventing new plant growth.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, 2012, and 2013 field data (12 plots): (Plots: GLCA.0208, GLCA.0558, GLCA.1028, GLCA.1030, GLCA.4035, GLCA.4068, GLCA.4126, GLCA.4127, GLCA.4142, GLCA.5015, GLCA.5077, GLCA.5425).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and K.A. Schulz
References: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEGL002979] *Eriogonum corymbosum* Badlands Sparse Vegetation
Translated Name: Crispleaf Buckwheat Badlands Sparse Vegetation
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (M118)
Group: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)
Alliance: *Ephedra* spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Cold Desert Sparse Vegetation Alliance (A4052)

Element Concept

Global Summary: This association is found in the Colorado Plateau. It is a very open short shrubland where the vegetation is characterized by an open canopy of *Eriogonum corymbosum* that ranges in foliar cover from 5 to 20%. Associated shrubs include *Atriplex confertifolia, Ephedra torreyana, Ericameria nauseosa, Coleogyne ramosissima, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Psorothamnus fremontii, Salvia dorrii,* and *Xylorhiza glabriuscula*. The herbaceous layer is low in species diversity and provides sparse cover; no single species provides greater than 1% cover. Graminoid species include *Achnatherum hymenoides, Aristida purpurea, Elymus elymoides, Hesperostipa comata, Leymus salinus,* and *Pleuraphis jamesii*. Forbs include *Astragalus kentrophyta, Lomatium minimum, Machaeranthera canescens, Sphaeralcea coccinea, Chamaesyce fendleri, Amsonia tomentosa, Thelesperma subnudum var. subnudum,* and *Cryptantha tenuis*. *Pinus edulis* and *Juniperus osteosperma* saplings provide sparse cover in some stands. This shrubland is found exclusively on shale badlands. Sites are flat to steep slopes, occur between 1054 and 2670 m (3548-8760 feet) elevation, and are oriented to all aspects. The ground surface is up to 88% bare soil,

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and litter is sparse. Parent materials are shales and sandstones. Vegetation has difficulty taking hold of the highly erosive surface. Soils are rapidly drained clay loam or silty clay.

Environmental Description

Glen Canyon National Recreation Area Environment: This sparse dwarf-shrubland occurs on windswept badlands of Moenkopi shale, or more rarely on Organ Rock shale or Entrada Formation. Sites are located on gentle to steep (2-35°) slopes, on mostly warmer aspects (south- or west-facing), between 1054 and 1605 m elevation. Rocks, gravel, and bare soil cover most of the unvegetated surface, with sparse to low cover of litter and biological soil crusts. Soils are moderately well-drained to rapidly drained sandy loams or sandy clay loams.

Global Environment: This unusual sparse short-shrub association occurs on barren shale badlands. Sites are flat to gentle to moderately steep, occur between 1054 and 2670 m (3458-8760 feet) elevation, and are oriented to all aspects. Bare soil is high, up to 88% cover, while some slopes have a moderate cover of colluvial boulders. Litter is sparse. Parent materials are Moenkopi, Morrison, Mancos, Tropic or Chinle shales and Clarion Formation that erode to badlands deposits. Vegetation has difficulty taking hold on the highly erosive surface. Soils are rapidly drained sandy clays or silty clays.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This badlands sparse shrubland is rare within the recreation area. Total vegetation cover ranges from 1-11% and consists primarily of scattered *Eriogonum corymbosum* shrubs (with 1-4% cover). Other shrubs present with sparse to low cover include *Ephedra torreyana, Ericameria nauseosa, Atriplex confertifolia,* and *Xylorhiza glabriuscula*. The herbaceous layer is sparse and inconsistent; graminoids present may include *Pleuraphis jamesii, Achnatherum hymenoides,* and *Bromus rubens,* and the forb *Amsonia tomentosa*.

Global Vegetation: Total vascular vegetation cover for this association rarely exceeds 20% and is often closer to 10%. The vegetation is characterized by an open canopy of *Eriogonum corymbosum* that ranges in foliar cover from 5 to 20%. Associated shrubs include *Amsonia tomentosa, Atriplex confertifolia, Ephedra torreyana, Ericameria nauseosa, Psorothamnus fremontii, Salvia dorrii, Gutierrezia sarothrae, Chrysothamnus viscidiflorus, Xylorhiza glabriuscula,* and *Coleogyne ramosissima*. The herbaceous layer is low in species diversity and provides sparse cover. No species of graminoid or forb provides greater than 1% cover. Graminoids recorded include *Achnatherum hymenoides, Aristida purpurea, Elymus elymoides, Hesperostipa comata, Leymus salinus,* and *Pleuraphis jamesii*. Forbs include *Amsonia tomentosa, Astragalus kentrophyta, Chamaesyce fendleri, Cryptantha tenuis, Lomatium minimum, Machaeranthera canescens, Sphaeralcea coccinea,* and *Thelesperma subnudum var. subnudum. Pinus edulis* and *Juniperus osteosperma* saplings provide sparse cover in some stands.

Global Dynamics: Heavy clay soils derived from Moenkopi or Chinle shales do not hold water and are difficult for plant roots to penetrate, resulting in widely spaced plants.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Eriogonum corymbosum*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Short shrub/sapling	Dwarf-shrub	*Xylorhiza glabriuscula*
Herb (field)	Flowering forb	*Amsonia tomentosa*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Eriogonum corymbosum*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex confertifolia*, *Eriogonum corymbosum*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens*
Global: Vulnerable Plants: *Lomatium minimum* (G3); Invasive/Exotic Plants: *Bromus tectorum* (High), *Halogeton glomeratus* (High/Medium)

Conservation Status Rank

Global Rank & Reasons: GNR (22-Jan-2002).

Related Concepts

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This sparse shrubland association occurs on shaley slopes in the recreation area and was sampled in Croton Canyon, Rock Canyon, the west fork of Big Water Canyon, near Cleopatra's Chair, and Lee's Ferry.

Global Range: This association has been described from the Colorado Plateau of southern and eastern Utah, western Colorado and northern Arizona.

Nations: US
States/Provinces: AZ, CO, UT

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TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M341C:CC
Federal Lands: NPS (Arches, Bryce Canyon, Canyonlands, Capitol Reef, Glen Canyon, Grand Canyon, Mesa Verde, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Eroded red bed alluvial slope mostly devoid of vegetation. Badland topography.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, 2014, and 2015 field data (4 plots, 3 accuracy assessment points): (Plots: GLCA.0323, GLCA.1031, GLCA.2031, GLCA.6107; AA Points: GLCA_AA.0211, GLCA_AA.0212, GLCA_AA.1422).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and G. Kittel
References: Clark et al. 2009, Cogan et al. 2004, Coles et al. 2009a, Reid and Hall 2010, Romme et al. 1993, Tendick et al. 2011b, Thomas et al. 2009b, Western Ecology Working Group n.d.*

[CEGL002745] *Leymus salinus* Shale Sparse Vegetation
Translated Name: Saline Wildrye Shale Sparse Vegetation
Common Name: Saline Wildrye Tableland

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (M118)
Group: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)
Alliance: *Ephedra* spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Cold Desert Sparse Vegetation Alliance (A4052)

Element Concept

Global Summary: This generally sparse association is found in the Colorado Plateau of southeastern Utah, northern Arizona and western Colorado. Total vegetation cover is characteristically sparse (<10%) but ranges widely, from 3 to 55% depending on aspect and slope. The tall bunchgrass *Leymus salinus* is visually dominant, with between 2 and 10% cover. Freeze-thaw, shrink-swell action, frequent rolling rocks and sheet erosion of the clay soils tend to create bare areas between the scattered bunches of *Leymus salinus* and dwarf-shrubs such as *Chrysothamnus viscidiflorus var. stenophyllus*, *Gutierrezia sarothrae*, and *Atriplex confertifolia*, which total between 1 and 5% cover. Stands typically occur on cool, sparsely vegetated badland slopes of Chinle, Mancos, Morrison, or other shale formations. Elevations range between 1341 and 1971 m (4400-6465 feet), and slopes tend to be north- to east-facing and moderately steep to steep (38-71% slope). The physical appearance of the community is characterized by a moderate cover of colluvial rocks and blocks fallen from sandstone ledges above the stand.

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Environmental Description

Glen Canyon National Recreation Area Environment: This sparse grassland occurs on steep talus/colluvial slopes, canyon walls, and slumps. Sites are on steep slopes (16-35°), oriented generally to the north, and lie between 1495 and 1891 m elevation. Large and small rocks and exposed soil cover most of the unvegetated surface, with lesser cover by litter. Soils are rapidly drained loamy sands, silt loams, sandy loams, or sandy clays derived from a variety of parent materials, including the Chinle and Kayenta formations, White Rim sandstone, or from talus/colluvium deposits.

Global Environment: This association typically occurs on sparsely vegetated shale slopes in the Colorado Plateau of southeastern Utah and western Colorado between 1341 and 1971 m (4400-6465 feet). Slopes tend to be moderately steep to steep (38-71%) and are generally north- to east-facing. The soil surface usually has moderate cover of colluvial rocks and blocks from sandstone ledges above the stand. Soil textures range from clays to clay loams, and the effects of shrink-swell action and sheet erosion in these soils is evident in the high percentage of bare ground. Parent materials include Chinle, Kayenta, Mancos, and Morrison formation shales, including the Brushy Basin, Tidwell, and Salt Wash members, White Rim sandstone, or from talus/colluvium deposits.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse grassland is found on steep slopes within the recreation area. Total vegetation cover ranges from 11 to 23%. Stands are visually dominated by *Leymus salinus* with between 3 and 13% cover. Shrubs are generally present and may have almost as much cover as the grasses. Common species include scattered individuals of *Ephedra viridis, Ephedra cutleri, Atriplex confertifolia, Ericameria nauseosa, Chrysothamnus viscidiflorus, Artemisia bigelovii, Xylorhiza tortifolia, Gutierrezia sarothrae, Amelanchier utahensis, Shepherdia rotundifolia, Eriogonum corymbosum*, and *Mahonia fremontii*. *Pleuraphis jamesii* was the only other grass noted with more than trace cover. *Pinus edulis* and *Juniperus osteosperma* trees may be present with trace to low cover.

Global Vegetation: This generally sparse herbaceous association occurs throughout the northern Colorado Plateau in its characteristic habitat of steep, northerly shale slopes. Total vegetation cover is characteristically sparse (<10%) but ranges widely, from 3 to 55% locally depending on aspect and slope, with cooler north-facing slopes tending to support denser vegetation. The tall bunchgrass *Leymus salinus* is visually dominant, with between 2 and 13% cover. Other grasses and forbs may be present, usually with less than 1% cover except in wet years. Short and dwarf-shrubs may have nearly equal cover to the grass and include species such as *Chrysothamnus viscidiflorus var. stenophyllus, Artemisia bigelovii, Atriplex confertifolia, Eriogonum corymbosum, Ephedra* spp., *Gutierrezia sarothrae*, and *Xylorhiza tortifolia*,. In some stands, scattered individuals of *Pinus edulis* and *Juniperus osteosperma* may be present.

Global Dynamics: Rockfall, soil movement and erosion are important processes in this community. Blocks of colluvial sandstone create stable microsites for the establishment of both grasses and shrubs. Freeze-thaw and shrink-swell action, as well as sheet erosion of the clay soils, tend to lever out many species, limiting the community composition to those plants that can tolerate significant soil

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movement. Grazing may affect some stands, but many examples are on dangerously steep and loose slopes. The vegetation is generally too sparse to carry fire.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*, *Ericameria nauseosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Short shrub/sapling	Dwarf-shrub	*Xylorhiza tortifolia*
Herb (field)	Graminoid	*Leymus salinus*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Atriplex confertifolia*
Herb (field)	Graminoid	*Leymus salinus*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Atriplex confertifolia, Chrysothamnus viscidiflorus* var. *stenophyllus, Ephedra torreyana, Ephedra viridis, Leymus salinus, Pleuraphis jamesii*

Other Noteworthy Species

Global:

Conservation Status Rank

Global Rank & Reasons: GNR (26-Jun-2001).

Related Concepts

Global Similar Types:

- *Juniperus osteosperma / Leymus salinus* Open Woodland (CEGL003109)

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This sparsely vegetated association occurs on steep slopes within the recreation area. It was sampled in upper Millard Canyon, Flint Cove, Deadhorse Canyon, Circle Cliffs, and on Waterhole Flat.

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Global Range: This association typically occurs on cool, sparsely vegetated badland slopes of Mancos, Morrison, or other shale formations in the Colorado Plateau of southeastern Utah, northern Arizona and western Colorado.

Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 9:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331E:CC, M331G:CC
Federal Lands: NPS (Arches, Black Canyon of the Gunnison, Canyonlands, Capitol Reef, Colorado, Dinosaur, Glen Canyon, Hovenweep)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Steep, rocky colluvium creates unstable soils, but large rocks and boulders create microhabitats protecting grasses and shrubs.

Glen Canyon National Recreation Area Plots: The description is based on 2004 and 2015 field data (4 plots, 1 accuracy assessment points): (Plots: GLCA.0103, GLCA.0113, GLCA.0738, GLCA.0766; AA Points: GLCA_AA.1148).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and K.A. Schulz
References: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Coles et al. 2010, Comer pers. comm., Romme et al. 1993, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.*

[CEGL002493] *Zuckia brandegeei* Sparse Vegetation
Translated Name: Siltbush Sparse Vegetation
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (M118)
Group: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)
Alliance: *Ephedra* spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Cold Desert Sparse Vegetation Alliance (A4052)

Element Concept

Global Summary: This sparsely vegetated association is common in the Colorado Plateau of northern Arizona and southern and eastern Utah. The vegetation has a sparse canopy consisting of *Zuckia brandegeei* with scattered *Atriplex confertifolia* and *Gutierrezia microcephala*. The herbaceous layer is low in diversity and provides sparse cover. The bunchgrasses *Leymus salinus* and *Pleuraphis jamesii* are present. Forbs include *Platyschkuhria integrifolia* and *Xylorhiza venusta*. Stands are found on plateaus, plains, alluvial fans, steep colluvial and badlands slopes or shale hogbacks. It is also found on eroding shales of the high plateaus of southern Utah. Elevation ranges from 1341-2078 m (4397-6815

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feet). The soil is rapidly drained clay loam derived from shales such as the Salt Wash Member of the Morrison Formation or Chinle, Moenkopi, Tropic Shale and Curtis formations. The unvegetated surface typically has high cover of shale chips, sandstone rocks, basalt gravel, conglomerate or petrified wood forming a desert pavement surface. Exposure of bare soil is low.

Environmental Description

Glen Canyon National Recreation Area Environment: This dwarf-shrubland is very restricted in its habitat, occurring only on the Chinle Formation. It occurs on badlands, benches, talus slopes and gullies. Sites tend to be steep (15-25° slopes), are oriented mostly to the south, and 1218 and 1874 m elevation. The unvegetated surface is composed primarily of bare soil and small rocks, with lesser cover by large rocks and bedrock. Soils are rapidly drained sandy clay loams, silty clays, or clays derived from the Chinle Formation.

Global Environment: This sparsely vegetated association is common on plains, alluvial fans, steep colluvial and badlands slopes or shale hogbacks in the Colorado Plateau and High Plateaus. Elevation ranges from 1218 to 2078 m (3996-6815 feet). The soil is a rapidly drained clay loam derived from shales. Parent material include the Salt Wash Member of the Morrison Formation, or Chinle, Moenkopi, Tropic Shale and Curtis formations or mixed colluvium. The unvegetated surface typically has high cover of shale chips, sandstone rocks, basalt gravel, conglomerate or petrified wood forming a desert pavement surface. Exposure of bare soil is low to high.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse dwarf-shrubland is restricted to steep badland slopes within the recreation area. Total vegetation cover does not exceed 15%, but is usually less than 6%, and consists of *Zuckia brandegeei* with up to 4% cover. Commonly associated shrubs include *Atriplex confertifolia, Chrysothamnus viscidiflorus, Ericameria nauseosa, Eriogonum corymbosum, Ephedra viridis, Ephedra torreyana, Shepherdia rotundifolia, Lycium andersonii, Opuntia polyacantha*, and *Gutierrezia sarothrae*. The herbaceous layer provides sparse cover and may include *Leymus salinus, Pleuraphis jamesii, Eriogonum inflatum, Eriogonum bicolor*, and *Salsola tragus*. *Pinus edulis* and *Juniperus osteosperma* trees may be present with very low cover in some stands or near the margins of the community.

Global Vegetation: This association has a sparse canopy consisting of *Zuckia brandegeei* with scattered *Artemisia bigelovii, Atriplex canescens, Atriplex confertifolia, Atriplex obovata, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum leptocladon, Ephedra torreyana, Ephedra viridis, Gutierrezia microcephala, Gutierrezia sarothrae, Opuntia polyacantha, Lycium andersonii, Sarcobatus vermiculatus, Shepherdia rotundifolia*, and *Xylorhiza glabriuscula*. The herbaceous layer is low in diversity and provides sparse cover. The bunchgrasses *Achnatherum hymenoides, Elymus elymoides, Leymus salinus*, and *Pleuraphis jamesii* are present. Forbs include *Arabis holboellii, Cryptantha* sp., *Cymopterus acaulis, Eriogonum inflatum, Galium coloradoense, Machaeranthera canescens, Mentzelia multiflora, Penstemon barbatus, Platyschkuhria integrifolia*, and *Xylorhiza venusta*. The exotics *Bromus tectorum* and *Salsola tragus* may be present in some stands.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa*, *Zuckia brandegeei*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Zuckia brandegeei*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Atriplex confertifolia, Zuckia brandegeei*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Salsola tragus*
Global: Vulnerable Plants: *Zuckia brandegeei* var. *arizonica* (G4T3, endemic to northeastern AZ and the southern Colorado Plateau); Invasive/Exotic Plants: *Bromus tectorum* (High), *Salsola tragus*

Conservation Status Rank

Global Rank & Reasons: GNR (29-Mar-2005).

Related Concepts

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This dwarf-shrubland was sampled on steep badland areas in Red Cove, Horse Canyon, Red Canyon, the south fork of Happy Canyon, near Teapot Rock and Sunset Pass.

Global Range: This association is widespread in the Painted Desert and Canyonlands regions of the Colorado Plateau of Utah and northern Arizona, and High Plateaus of southern Utah.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 341B:CC, M341C:CC

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Federal Lands: NPS (Arches, Bryce Canyon, Canyonlands, Capitol Reef, Glen Canyon, Petrified Forest)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Plot is located on an exposure of the blue-gray band of the Chinle Formation. Some colluvium from higher layers, including some Wingate boulders, overlies sections of this exposure, but the colluvium doesn't appear to contribute much to the root layer of the vegetation. This is a badlands type of environment - steep, sparsely vegetated clay soils that must shed nearly all moisture. Plants tend to be associated with erosional pockets or colluvial materials that help to pool runoff.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2014, and 2015 field data (4 plots, 5 accuracy assessment points): (Plots: GLCA.0333, GLCA.0744, GLCA.0755, GLCA.0773; AA Points: GLCA_AA.0120, GLCA_AA.0598, GLCA_AA.0601, GLCA_AA.0615, GLCA_AA.1695).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz and G. Kittel
References: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Tendick et al. 2011b, Thomas et al. 2009a, Western Ecology Working Group n.d.*

A4051 Pinus ponderosa - Cercocarpus intricatus Bedrock Cliff & Canyon Wooded Scrub Alliance
Alliance Summary Description: This alliance consists of widely scattered trees and shrubs (with <10% vascular plant cover), including *Atriplex* spp., *Cercocarpus intricatus, Cercocarpus montanus, Coleogyne ramosissima, Juniperus* spp., and *Pinus ponderosa*. Other shrubs present may include *Amelanchier utahensis, Arctostaphylos patula, Artemisia bigelovii, Cercocarpus montanus, Glossopetalon spinescens var. meionandrum (= Forsellesia meionandra)*, or *Ephedra viridis*. The herbaceous layer is diverse, variable and low in cover. Occasional dwarfed individuals (often only 1-1.5 m tall) of *Pinus edulis* or *Juniperus osteosperma* may occur. Colorful lichens may cover much of the surface of the exposed bedrock. This alliance ranges from Wyoming and Utah west across the intermountain western U.S. Sites are found from foothill to lower montane elevations and include steep cliff faces, narrow canyons, and smaller rock outcrops of various igneous, sedimentary, and metamorphic bedrock types.

[CEGL002977] *Cercocarpus intricatus* Slickrock Sparse Vegetation
Translated Name: Littleleaf Mountain-mahogany Slickrock Sparse Vegetation
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (M118)
Group: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)
Alliance: *Pinus ponderosa - Cercocarpus intricatus* Bedrock Cliff & Canyon Wooded Scrub Alliance (A4051)

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Element Concept

Global Summary: This sparse shrubland association occurs on exposed sandstone slickrock in the Colorado Plateau. Total vegetation cover is less than 15% and often less than 5%. *Cercocarpus intricatus* is dominant or codominant, with lesser cover by other shrubs such as *Amelanchier utahensis, Arctostaphylos patula, Artemisia bigelovii, Cercocarpus montanus, Glossopetalon spinescens var. meionandrum (= Forsellesia meionandra), Ephedra viridis,* or *Fraxinus anomala*. The herbaceous layer is diverse, variable and low in cover. Occasional dwarfed individuals (often only 1-1.5 m tall) of *Pinus edulis* or *Juniperus osteosperma* may occur with low cover. The herbaceous cover is sparse and frequently includes *Achnatherum hymenoides, Bouteloua gracilis,* and *Pleuraphis jamesii*. Forbs are variable among plots and only have trace cover. Stands are restricted to exposures of massive sandstones such as on the Colorado Plateau. Elevations range between 1196 and 2348 m (3920-7700 feet), while slopes and aspects vary widely. The density of the vegetation is limited by the availability of crevices and shallow depressions where sandy soil collects and plants can root. Soils are rapidly drained loamy sands derived from Navajo sandstone, White Rim sandstone of the Cutler Group, or Cedar Mesa sandstone. Most of the surface is sandstone, sometimes with high cover of lichens. Litter and biological soil crusts have sparse to low cover.

Environmental Description

Glen Canyon National Recreation Area Environment: This sparsely vegetated association occurs on slickrock exposures on canyon rims and mesatops. Sites are flat to gently sloping (up to 6°) and lie between 1196 and 1532 m elevation. Sandstone bedrock covers most of the unvegetated surface, with lesser cover by bare soil. Litter and biological soil crusts have sparse to low cover. Soils are rapidly drained loamy sands derived from Navajo sandstone, White Rim sandstone of the Cutler **Group:**, or Cedar Mesa sandstone.

Global Environment: This sparse shrubland association is restricted to exposures of massive sandstones such as the Navajo, Weber, Cedar Mesa, White Rim, Kayenta and Wingate formations on the Colorado Plateau. Elevations range between 1196 and 3920m (4630-7700 feet), slopes range from level to vertical, and all aspects are possible. The vegetation roots in crevices where sandy soil collects. Up to 99% of the surface is exposed bedrock or rock and gravel from fractured bedrock, sometimes nearly covered by lichens. Soils are rapidly drained loamy sands derived from Navajo sandstone, White Rim sandstone of the Cutler Group, or Cedar Mesa sandstone. Litter and biological soil crusts have sparse to low cover.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse slickrock vegetation type's total vegetation cover is limited by a lack of rooting sites for woody species; it ranges from 2 to 11%. The vegetation is characterized by scattered *Cercocarpus intricatus* shrubs with 1-2% total cover. *Pinus edulis* and *Juniperus osteosperma*, if present, never have more than trace cover. Scattered individuals of *Fraxinus anomala* occur in some stands, as do *Coleogyne ramosissima, Artemisia bigelovii, Ephedra viridis,* and *Amelanchier utahensis.* The herbaceous layer contributes only a few percent cover but may be relatively diverse. Graminoids include *Pleuraphis jamesii, Achnatherum hymenoides,* and *Bouteloua gracilis*. Forbs were variable among plots and only had trace cover.

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Global Vegetation: This *Cercocarpus intricatus* sparse shrub association is restricted to exposures of sandstone. Germination sites for vascular plant species are limited to cracks and small depressions in the bedrock where soil collects. Total vegetation cover is less than 20% and often is 5% or less. *Cercocarpus intricatus* is dominant or codominant, with between 1 and 20% cover. Most stands contain other shrubs as well, including *Amelanchier utahensis, Arctostaphylos patula, Artemisia bigelovii, Cercocarpus montanus, Coleogyne ramosissima* (minor, if present), *Ephedra viridis, Fraxinus anomala*, or *Glossopetalon spinescens var. meionandrum (= Forsellesia meionandra)*. The herbaceous layer is diverse, variable and low in cover. Grasses such as *Achnatherum hymenoides, Bouteloua gracilis,* and *Pleuraphis jamesii* are most common, with trace cover of a variety of forbs. Occasional dwarfed individuals (often only 1-1.5 m tall) of *Pinus edulis* or *Juniperus osteosperma* may occur. Colorful lichens may cover much of the surface of the exposed bedrock.

Global Dynamics: This community exists because soil is held in cracks in the bedrock and precipitation runoff also tends to concentrate in these cracks. The structure and density of the community is controlled by the degree of fracturing of the sandstone.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Fraxinus anomala*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Cercocarpus intricatus*
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*
Herb (field)	Graminoid	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Cercocarpus intricatus*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Achnatherum hymenoides, Amelanchier utahensis, Artemisia bigelovii, Cercocarpus intricatus, Ephedra viridis, Fraxinus anomala, Juniperus osteosperma, Poa fendleriana*

Other Noteworthy Species

Global: Vulnerable Plants: Glossopetalon spinescens var. meionandrum (G5T3), Helianthella microcephala (G3G4)

Conservation Status Rank

Global Rank & Reasons: GNR (22-Jan-2002).

Related Concepts

Global Similar Types:

- *Cercocarpus intricatus* Montane Shrubland (CEGL002587)
- *Pinus ponderosa* Slickrock Sparse Vegetation (CEGL002972)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau.

Element Distribution

Glen Canyon National Recreation Area Range: This rare, sparse shrubland was sampled near Ekker Butte, the Dirty Devil, above Rock Canyon, and in Harris Wash.

Global Range: This Colorado Plateau association has been described from several National Park Service units in southern and eastern Utah and western Colorado with extensive exposures of massive sandstones.

Nations: US
States/Provinces: CO, UT
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M341C:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Colorado, Glen Canyon, Natural Bridges, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This vegetation is growing on eolian deposits that have formed on White Rim sandstone. The clumps of vegetation inhibit erosion and facilitate soil establishment. Water runoff would be very rapid and pool up in areas of soil development, providing a resource pulse to the diverse plant assemblages here.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2014, and 2015 field data (1 plot, 3 accuracy assessment points): (Plots: GLCA.0547; AA Points: GLCA_AA.0521, GLCA_AA.0556, GLCA_AA.1776).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and K.A. Schulz
References: Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008c, Romme et al. 1993, Von Loh et al. 2007, Western Ecology Working Group n.d.*

[CEGL003834] *Coleogyne ramosissima* Sparse Shrubland
Translated Name: Blackbrush Sparse Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)

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Macrogroup: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (M118)
Group: Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)
Alliance: *Pinus ponderosa - Cercocarpus intricatus* Bedrock Cliff & Canyon Wooded Scrub Alliance (A4051)

Element Concept

Global Summary: This sparse blackbrush shrubland occurs in canyonlands of the Colorado Plateau in southeastern Utah. Total vegetation cover is less than 5%, and is limited by poor growing conditions or a lack of rooting substrate in bedrock-dominated sites. The canopy consists of scattered *Coleogyne ramosissima*, usually accompanied by *Ephedra torreyana, Artemisia bigelovii, Gutierrezia sarothrae, Yucca angustissima*, and *Opuntia polyacantha*. The herbaceous layer contributes little to the community in terms of either diversity or cover. *Pleuraphis jamesii, Aristida purpurea, Bromus tectorum, Chamaesyce fendleri, Tetraneuris acaulis (= Hymenoxys acaulis), Amsonia tomentosa, Mirabilis linearis, Salsola tragus, Heterotheca villosa*, and *Comandra umbellata* are the most commonly reported species. This association occurs on canyon rims, hills, ridges, mesas, plateaus, canyon sides, badlands and valley bottoms. Sites are flat to moderately sloping, oriented to all aspects, and lie between 1134 and 1470 m elevation. The unvegetated surface is often more than 95% of the community and consists primarily of bedrock or gravel, with lesser cover by bare soil and litter. Soils are often rapidly drained sandy loams, loamy sands, or sands derived from sandstone, but include loams, silt loams, sandy clay loams, or clay loams derived from shales.

Environmental Description

Glen Canyon National Recreation Area Environment: This sparse shrubland occurs on hills, canyon rims, ridges, mesas, plateaus, canyon sides, badlands, and valley bottoms. Sites are flat to moderately sloping, oriented to all aspects, and lie between 1134 and 1470 m elevation. The unvegetated surface is often more than 95% of the community and consists primarily of bedrock, with other sites dominated by bare soil and gravel, and a few sites have low cover of large rocks. Soils are moderately well-drained to rapidly drained sandy loams, loamy sands, or sands derived from eolian or alluvial deposits, or sandstones of the White Rim, Navajo, or Cedar Mesa formations, or are loams, silt loams, sandy clay loams, or clay loams derived from shales of the Moenkopi, Morrison, or Organ Rock formations.

Global Environment: This sparse shrubland occurs in canyonlands of the Colorado Plateau on canyon rims, hills, ridges, mesas, plateaus, canyon sides, badlands and valley bottoms. Sites are flat to moderately sloping, oriented to all aspects, and lie between 1134 and 1470 m elevation. The unvegetated surface is often more than 95% of the community and consists primarily of bedrock or gravel, with lesser cover by bare soil and litter. Soils are moderately well-drained to rapidly drained sandy loams, loamy sands, or sands derived from eolian or alluvial deposits, or sandstones of the White Rim, Navajo, or Cedar Mesa formations, or are loams, silt loams, sandy clay loams, or clay loams derived from shales of the Moenkopi, Morrison, or Organ Rock formations.

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Vegetation Description

Glen Canyon National Recreation Area Vegetation: This sparse blackbrush type has total vegetation cover of less than 11%, generally less than 5%, limited by poor growing conditions or a lack of rooting substrate in bedrock-dominated sites. The canopy consists of scattered *Coleogyne ramosissima* (with trace to 3% cover), often accompanied by sparse to low cover of *Ephedra torreyana, Ephedra viridis, Ephedra cutleri, Artemisia bigelovii, Fraxinus anomala, Eriogonum leptocladon, Rhus aromatica, Psorothamnus fremontii, Brickellia longifolia, Brickellia microphylla, Gutierrezia* spp., *Yucca angustissima,* and *Opuntia polyacantha*. The herbaceous may be relatively diverse and include the graminoids *Pleuraphis jamesii, Hesperostipa comata, Achnatherum hymenoides, Sporobolus cryptandrus, Bouteloua eriopoda, Schismus barbatus,* and *Bromus tectorum*. Forbs are rarer; *Plantago patagonica, Heterotheca villosa,* and *Enneapogon desvauxii* were the only species recorded with more than trace cover.

Global Vegetation: This rare blackbrush association has total vegetation cover of less than 5%, limited by poor growing conditions or a lack of rooting substrate in bedrock-dominated sites. The canopy consists of scattered *Coleogyne ramosissima*, usually accompanied by *Ephedra torreyana, Artemisia bigelovii, Gutierrezia sarothrae, Yucca angustissima*, and *Opuntia polyacantha*. The herbaceous layer contributes little to the community in terms of either diversity or cover. *Pleuraphis jamesii, Aristida purpurea, Bromus tectorum, Chamaesyce fendleri, Tetraneuris acaulis (= Hymenoxys acaulis), Amsonia tomentosa, Mirabilis linearis, Salsola tragus, Heterotheca villosa*, and *Comandra umbellata* are the most commonly reported species.

Global Dynamics: *Coleogyne ramosissima* is considered a climax community-forming species. Given the low competitive environment where this community is found and conditions which are not susceptible to destructive fire, this is likely to be a long-lived community.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Short shrub/sapling	Succulent shrub	*Yucca angustissima*
Herb (field)	Graminoid	*Aristida purpurea*, *Bromus tectorum*, *Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Coleogyne ramosissima*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High), *Halogeton glomeratus* (High/Medium), *Salsola tragus*, *Schismus barbatus* (High/Medium)
Global:

Conservation Status Rank

Global Rank & Reasons: GNR (12-Jun-2006).

Related Concepts

Global Similar Types:

- *Coleogyne ramosissima / Pleuraphis jamesii* Shrubland (CEGL001334)

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Samples from Glen Canyon expanded the concept of this association to include more diverse landforms and soils derived from shales such as loams, silt loams, sandy clay loams, or clay loams. Sparse examples of *Coleogyne ramosissima / Pleuraphis jamesii* Shrubland (CEGL001334) may be hard to distinguish from this association.

Element Distribution

Glen Canyon National Recreation Area Range: This sparsely vegetated association is widespread in the recreation area and was sampled on Millard Canyon Benches, Lone Rock Road, the Sand Hills, Oley Knolls, Brown's Rim, in Deadhorse Canyon, Navajo Canyon, Coyote Gulch, Hurricane Wash, Moqui Canyon, Blue Notch Canyon, near Cleopatra's Chair, Wahweap, Hite, Hole-in-the-Rock, Hite, east of Ekker Butte, and near the Dirty Devil River.

Global Range: This sparse shrubland occurs in canyonlands of the Colorado Plateau in southeastern Utah on canyon rims and valley bottoms.

Nations: US
States/Provinces: UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 341B:CC
Federal Lands: NPS (Canyonlands, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Segment consists largely of undulating sandstone with mounds of slickrock 6 m tall with pockets of soil in between. Soil is loose with small drainage channels running through and crust on higher slopes.

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Glen Canyon National Recreation Area Plots: The description is based on 2004, 2011, and 2012 field data (26 plots): (Plots: GLCA.0322, GLCA.0536, GLCA.0543, GLCA.0544, GLCA.0545, GLCA.0740, GLCA.1033, GLCA.2047, GLCA.2063, GLCA.2092, GLCA.4013, GLCA.4042, GLCA.4093, GLCA.4112, GLCA.4114, GLCA.4118, GLCA.4303, GLCA.4309, GLCA.5082, GLCA.5086, GLCA.5216, GLCA.5257, GLCA.5265, GLCA.9106, GLCA.9308, GLCA.9309).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Western Ecology Working Group n.d.*

M499. Western North American Cool Semi-Desert Ruderal Scrub & Grassland

G600. Great Basin-Intermountain Ruderal Dry Shrubland & Grassland

Group Summary Description: This semi-desert interior western U.S. ruderal shrubland and grassland group includes shrubland, shrub-steppe and grassland stands that are strongly dominated (>90% relative canopy cover) by invasive, exotic species. Diagnostic invasive shrubs include *Alhagi maurorum, Cytisus striatus, Zygophyllum fabago*, or other exotic shrubs. Herbaceous stands include open to dense grasslands and forblands composed of either exotic annual or biennial grasses or forbs with low cover of perennial species (<10% absolute cover) or stands with a significant perennial herbaceous layer (>10% absolute cover) strongly dominated by exotics (>90% relative cover) with or without annuals and biennials present to dominant. There are relatively few cool, semi-arid invasive perennial graminoids such as *Agropyron cristatum*. Relatively mesic, invasive perennial hay grasses such as *Bromus inermis, Dactylis glomerata*, and *Phleum pratense* are typically absent or have low cover and are restricted to mesic microsites as they are more common in higher elevation or higher latitude, temperate climates or relatively mesic sites. Numerous exotic perennial herbaceous species may compose these stands, such as *Acroptilon repens, Cardaria draba, Centaurea calcitrapa, Centaurea diffusa, Centaurea iberica, Centaurea biebersteinii (= Centaurea stoebe ssp. micranthos), Centaurea triumfettii (= Centaurea virgata), Euphorbia esula, Hypericum perforatum, Lepidium latifolium, Peganum harmala*, or a mixture of other exotic forbs and graminoids. Stands dominated by annuals may be composed of annual grasses such as *Bromus arvensis (= Bromus japonicus), Bromus hordeaceus, Bromus madritensis, Bromus tectorum, Taeniatherum caput-medusae*, or annual forbs, including *Bassia scoparia (= Kochia scoparia), Brassica nigra, Centaurea melitensis, Centaurea solstitialis, Crupina vulgaris, Cynoglossum officinale, Descurainia sophia, Erodium cicutarium, Hyoscyamus niger, Isatis tinctoria, Salsola tragus, Sisymbrium altissimum, Taraxacum officinale*, or a mixture of other exotic annual forbs and grasses. Additionally, this group contains semi-desert shrublands and shrub-steppe that are dominated or codominated by native shrub species such as *Artemisia tridentata* with a significant herbaceous understory (>10% absolute cover) that is strongly dominated (>90% relative canopy cover) by exotic herbaceous species such as *Agropyron cristatum* or *Bromus tectorum*. Stands occur in disturbed dry to mesic basins, alluvial fans, and foothills elevations up to 2200 m and are restricted to areas with the cool, semi-arid climate found in the intermountain western U.S. region. Stands can be large areas or narrow strips adjacent to roadsides or under powerlines and other disturbed areas. Soils are mostly mineral and well-drained. Due to disturbance, soils may be compacted. It is an early-successional type that may occur in areas disturbed by fire, grazing or mining. This group may grade into wetter areas and may have transition zones where mesic

forbs intermix with wetter forbs and graminoids found in Western North American Ruderal Marsh, Wet Meadow & Shrubland Group (G524). This group does not include the mesic introduced hay grasses such as *Bromus inermis, Dactylis glomerata*, and *Phleum pratense* that have escaped from improved pasture and irrigated meadow to invade montane grasslands. These grasslands are classified in the more temperate Western North American Interior Ruderal Grassland & Shrubland Group (G624).

A3253 Alhagi maurorum - Zygophyllum fabago Ruderal Shrubland Alliance

Alliance Summary Description: This interior western U.S. ruderal shrubland alliance has an open to dense shrub canopy (>10% absolute cover) that is strongly dominated (>90% relative canopy cover) by invasive, introduced shrub species such as *Alhagi maurorum, Cytisus striatus*, or *Zygophyllum fabago*. Additionally, this alliance includes shrublands dominated or codominated by native shrub species (>10% relative cover) with a significant herbaceous understory (>10% absolute cover) that is strongly dominated (>90% relative canopy cover) by exotic herbaceous species. Herbaceous layers are composed of either exotic annuals with low cover of perennial species, or high cover of exotic perennials. Numerous exotic herbaceous species may compose the introduced herbaceous layer such as *Bromus tectorum, Brassica nigra*, and *Agropyron cristatum* Stands occur in disturbed dry to mesic basins, alluvial fans, and foothills from sea level to 2200 m elevation throughout the cool, semi-arid intermountain western U.S. region. It is an early-successional type that may occur in areas disturbed by fire, grazing or mining.

[CEGL002784] *Alhagi maurorum* Ruderal Scrub

Translated Name: Camelthorn Ruderal Scrub

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Western North American Cool Semi-Desert Ruderal Scrub & Grassland (M499)
Group: Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600)
Alliance: *Alhagi maurorum - Zygophyllum fabago* Ruderal Shrubland Alliance (A3253)

Element Concept

Global Summary: This ruderal scrub association occurs in the Colorado Plateau and is currently known from Wupatki National Monument in Arizona and Glen Canyon National Recreation Area in Utah. Vegetation ranges from open to moderately dense stands (18-58% total cover) and is characterized by a tall-shrub canopy dominated by exotic invasive *Alhagi maurorum*, with 10-45% cover. Associated tall shrubs include *Ericameria nauseosa, Pluchea sericea, Salix exigua*, and exotic invasive *Tamarix chinensis*. The understory has sparse to low cover and is dominated by exotic annuals, including *Bromus diandrus, Bromus rubens, Bromus tectorum*, and *Salsola tragus*. Stands occur along flat to gently sloping (up to 7°) riverbanks between 1130 and 1300 m elevation. The unvegetated surface is composed mainly of bare soil and litter, with lesser cover of sand and live vegetation litter, and sparse to low cover of large rocks and dead wood. Soils are moderately well-drained to rapidly drained sands, loamy sands, and clays derived from alluvium.

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Environmental Description

Glen Canyon National Recreation Area Environment: This exotic invasive shrubland occurs along gently sloping (up to 7°) riverbanks between 1130 and 1179 m elevation. The unvegetated surface is composed mainly of bare soil and litter, with lesser cover of sand and live vegetation litter, and sparse to low cover of large rocks and dead wood. Soils are moderately well-drained to rapidly drained loamy sands derived from alluvium.

Global Environment: Stands occur along flat to gently sloping (up to 7°) riverbanks between 1130 and 1300 m elevation. The unvegetated surface is composed mainly of bare soil and litter, with lesser cover of sand and live vegetation litter, and sparse to low cover of large rocks and dead wood. Soils are moderately well-drained to rapidly drained sands, loamy sands, and clays derived from alluvium.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Vegetation in these moderately dense to dense stands (28-58% total cover) is characterized by a tall-shrub canopy dominated by exotic invasive *Alhagi maurorum*, with 10-45% cover. Associated tall shrubs include *Pluchea sericea, Salix exigua, Ericameria nauseosa*, and exotic invasive *Tamarix chinensis*. The understory has sparse to low cover and is dominated by exotic annuals, including *Bromus diandrus, Bromus rubens, Bromus tectorum*, and *Salsola tragus*.

Global Vegetation: Vegetation ranges from open to moderately dense stands (18-58% total cover) and is characterized by a tall-shrub canopy dominated by exotic invasive *Alhagi maurorum*, with 10-45% cover. Associated tall shrubs include *Ericameria nauseosa, Pluchea sericea, Salix exigua*, and exotic invasive *Tamarix chinensis*. The understory has sparse to low cover and is dominated by exotic annuals, including *Bromus diandrus, Bromus rubens, Bromus tectorum*, and *Salsola tragus*.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Alhagi maurorum*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Alhagi maurorum*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Alhagi maurorum*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Alhagi maurorum* (Medium/Low), *Bromus diandrus, Bromus rubens, Bromus tectorum* (High), *Salsola tragus, Tamarix chinensis*

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Global: Invasive/Exotic Plants: *Alhagi maurorum* (Medium/Low, state-level noxious weed), *Bromus diandrus*, *Bromus rubens*, *Bromus tectorum* (High), *Salsola tragus*, *Tamarix chinensis*

Conservation Status Rank

Global Rank & Reasons: GNA (invasive) (28-Aug-2002).

Related Concepts

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. The dominant species is a noxious deciduous shrub introduced for spring forage.

Element Distribution

Glen Canyon National Recreation Area Range: This very rare shrubland was only sampled along the banks of the San Juan River.

Global Range: This ruderal scrub association occurs in the Colorado Plateau and is currently known from Wupatki National Monument in northern Arizona and Glen Canyon National Recreation Area in southern Utah. It likely occurs elsewhere in the Colorado Plateau and western U.S.

Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313D:CC
Federal Lands: NPS (Glen Canyon, Wupatki)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Sandy soil, mild slope, just upslope from dense *Tamarix chinensis* thicket. Flood waters will soak in here. Uniform patch with dense vegetation throughout.

Glen Canyon National Recreation Area Plots: The description is based on 2012 field data (2 plots): (Plots: GLCA.5113, GLCA.5123).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): K.A. Schulz
References: Coles et al. 2003, Hansen et al. 2004b*, Kearney et al. 1969, Western Ecology Working Group n.d.

A4213 Artemisia spp. - Mixed Shrub Ruderal Understory Shrubland Alliance

Alliance Summary Description: This alliance covers those native shrublands that have had their herbaceous component completely replaced by non-native, invasive herbaceous species. Overstory shrubs include *Artemisia tridentata* (all subspecies), *Artemisia tridentata ssp. spiciformis (= Artemisia*

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spiciformis), Artemisia arbuscula, and *Artemisia tripartita*. Understory dominant herbaceous non-native species include graminoids *Bromus tectorum, Agropyron cristatum, Agrostis stolonifera, Taeniatherum caput-medusae, Poa bulbosa, Bromus diandrus,* and forbs *Sisymbrium altissimum, Descurainia pinnata, Onopordum acanthium, Cirsium* spp., *Centaurea* spp., *Lepidium* spp., and many others. Native herbaceous species may be present, but occur in very low abundance, less than 10% relative cover of all herbaceous cover. These stands occur in all areas where native sagebrush stands occur throughout the western US.

[CEGL002699] Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Ruderal Shrubland
Translated Name: Big Sagebrush - (Rubber Rabbitbrush) / Cheatgrass Ruderal Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Western North American Cool Semi-Desert Ruderal Scrub & Grassland (M499)
Group: Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600)
Alliance: *Artemisia* spp. - Mixed Shrub Ruderal Understory Shrubland Alliance (A4213)

Element Concept

Global Summary: This association is unfortunately quite common throughout the Colorado Plateau and throughout the range of big sagebrush in the western U.S. due to a history of heavy grazing pressure by domestic livestock. This shrubland has a canopy of *Artemisia tridentata ssp. tridentata* which is always present, often with a lesser component of *Ericameria nauseosa, Atriplex canescens,* or *Chrysothamnus viscidiflorus*. The non-native annual grass *Bromus tectorum* dominates the herbaceous undergrowth layer, and is frequently accompanied by other non-native grasses and forbs. Individuals or small patches of native grasses and forbs may occur, including *Leymus cinereus, Achnatherum hymenoides,* and *Sporobolus cryptandrus.* However, the natives are overwhelmed by the non-natives, such that it is impossible to determine what native association the stand may have been prior to conversion to a ruderal type. Stands occur in small to moderate-sized patches on alluvial terraces, floodplains, and point bars, mostly below 2000 m (6560 feet) elevation.

Environmental Description

Glen Canyon National Recreation Area Environment: This association occurs in canyon bottoms, drainage channels, on terraces and benches. Sites are flat to gently sloping (up to 4°) and occur between 1361 and 1592 m elevation. The unvegetated surface has sparse to high exposure of bare soil, low to high cover of litter and sand, and sparse to low cover of soil crusts (mostly dark cyanobacteria and/or mosses) and downed wood. Soils are rapidly drained to well-drained to somewhat poorly drained silt loams, sandy loams, or loamy sands derived from alluvium.

Global Environment: This association occurs on alluvial terraces, flats and fans or valley floors throughout the Colorado Plateau and extends into the Great Basin. Most stands occur on level to gently sloping sites below 2000 m (6560 feet) elevation, with documented elevations ranging from 1130-2045 m. Soils include sandy loams, silt loams, and clay loams, depending on the size of the stream and the geology of the area. Parent materials is frequently alluvium but includes sandstones, shale, limestone,

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eolian deposits and Precambrian gneiss. The ground surface often has high litter and bare soil cover and low cover of rocks. Cryptobiotic soil crusts can be abundant (up to 15% in some stands).

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This disturbed basin big sagebrush shrubland is somewhat uncommon within the recreation area. Total vegetation cover ranges from 9 to 73%, and the shrub canopy is dominated by *Artemisia tridentata ssp. tridentata* with 6-35% cover, usually accompanied by *Ericameria nauseosa* (with up to 11% cover), *Atriplex canescens, Rhus aromatica*, and *Yucca angustissima*. The non-native annual grass *Bromus tectorum* dominates the herbaceous layer with up to 6% cover or the non-native forb *Salsola tragus* dominates with up to 45% cover. Relict native herbaceous species include *Sporobolus cryptandrus, Achnatherum hymenoides, Distichlis spicata, Sporobolus contractus, Poa fendleriana, Lepidium montanum, Machaeranthera canescens, Ambrosia acanthicarpa, Bassia scoparia (= Kochia scoparia),* and *Boerhavia* sp.

Global Vegetation: This big sagebrush association is widespread within areas of the Colorado Plateau that have been subject to heavy grazing by domestic livestock. *Artemisia tridentata ssp. tridentata* is always present in the sparse to dense shrub canopy (10-70% cover) with cover of between 5 and 70% and up to 2 m in height. *Ericameria nauseosa* is not always present but is often present in the vicinity. *Artemisia tridentata ssp. wyomingensis* may be present in some stands. Other shrubs that occur in this community consistently include *Atriplex canescens, Chrysothamnus viscidiflorus, Rhus aromatica, Sarcobatus vermiculatus*, and *Yucca angustissima*. Less common shrubs are *Artemisia nova, Brickellia microphylla, Ephedra viridis, Gutierrezia sarothrae, Opuntia* spp., or *Tetradymia canescens*. In some stands there may be scattered trees of *Pinus edulis, Juniperus osteosperma, Juniperus scopulorum*, and *Populus angustifolia*. The herbaceous layer reflects a long history of disturbance and is dominated by exotic annual *Bromus* species, especially *Bromus tectorum*. Other common exotic herbaceous species include *Bromus rigidus, Ceratocephala testiculata (= Ranunculus testiculatus), Erodium cicutarium, Lactuca serriola, Salsola tragus*, and *Sisymbrium altissimum*. Because it is dominated by annual species, the total herbaceous cover varies depending on seasonal precipitation. Exotic perennial species have also been documented, such as *Acroptilon repens, Agropyron cristatum, Bromus inermis, Cardaria draba*, and *Carduus nutans ssp. macrolepis*. Remnant native herbaceous vegetation may include scattered individuals or patches of *Ambrosia acanthicarpa, Achnatherum hymenoides, Boerhavia* spp., *Descurainia pinnata, Distichlis spicata, Elymus elymoides, Hesperostipa comata, Heterotheca villosa, Lepidium montanum, Lappula occidentalis, Leptodactylon watsonii, Machaeranthera canescens, Oenothera caespitosa, Poa fendleriana, Senecio spartioides, Sporobolus contractus, Sporobolus cryptandrus, Stenotus acaulis*, and others.

Global Dynamics: This association represents *Artemisia tridentata ssp. tridentata* shrublands in degraded condition, in which the native herbaceous understory has been removed by grazing and replaced by a suite of non-native species, especially *Bromus tectorum*. That fact that these degraded stands are frequently located on stream terraces and floodplains may be due to easier access by livestock in canyon country which coincides with *Artemisia tridentata ssp. tridentata* stands on lowlands with deep alluvial soils.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *tridentata*, *Atriplex canescens*
Herb (field)	Flowering forb	*Salsola tragus*
Herb (field)	Graminoid	*Bromus tectorum*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	Graminoid	*Bromus tectorum*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Artemisia tridentata* ssp. *tridentata*, *Bromus tectorum*, *Ericameria nauseosa*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bassia scoparia* (Low), *Bromus tectorum* (High), *Salsola tragus*

Global: Invasive/Exotic Plants: *Acroptilon repens* (High/Medium), *Agropyron cristatum* (Medium/Low), *Bromus inermis* (High/Medium), *Bromus rigidus*, *Bromus tectorum* (High), *Cardaria draba*, *Carduus nutans* ssp. *macrolepis*, *Ceratocephala testiculata*, *Erodium cicutarium* (Medium/Low), *Lactuca serriola* (Low/Insignificant), *Salsola tragus*, *Sisymbrium altissimum*

Conservation Status Rank

Global Rank & Reasons: GNA (ruderal) (14-Aug-2001).

Related Concepts

Global Similar Types:

- *Artemisia tridentata - Purshia stansburiana* Shrubland [Park Special] (CEPS009534)
- *Artemisia tridentata / Ericameria nauseosa* Shrubland (CEGL000998)
- *Artemisia tridentata ssp. wyomingensis* / Disturbed Understory Ruderal Shrubland (CEGL002083)
- *Populus fremontii / Ericameria nauseosa* Riparian Woodland (CEGL002465)

Classification

Status: Standard

Classification Confidence: 1 - Strong

Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Stands of this ruderal association may be

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confused with poor-condition natural types. It has been poorly sampled outside the Colorado Plateau, although it likely occurs widely within the range of basin big sagebrush shrublands.

Element Distribution

Glen Canyon National Recreation Area Range: This shrubland association is somewhat uncommon within the recreation area and was sampled in Waterhole Canyon, Harris Wash, and along the Escalante River.

Global Range: This association is well-sampled in the Colorado Plateau in southern Utah, northern Arizona and western Colorado and Great Basin. It likely occurs on disturbed sites throughout the range of big sagebrush in the western U.S.

Nations: US
States/Provinces: AZ, CO, ID, NV, UT
TNC Ecoregions: 9:C, 11:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341A:CC, 341B:CC, M331E:CC, M341:C
Federal Lands: NPS (Arches, Black Canyon of the Gunnison, Canyonlands, Capitol Reef, Colorado, Dinosaur, Glen Canyon, Golden Spike, Grand Canyon, Grand Canyon-Parashant, Great Basin, Hovenweep, Mesa Verde, Natural Bridges, Zion); USFWS (Camas)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This segment occupies a low-lying area that is farther from the river. It probably receives less groundwater from the river than places adjacent. Being on the inside of the curve of the river probably results in decreased hyporheic flow in this area. Thus, there are no willow, cottonwood and only a single *Tamarix chinensis* in the segment. Further inland from the segment, the soils are more shallow and rocky.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, and 2015 field data (4 plots, 5 accuracy assessment points): (Plots: GLCA.0775, GLCA.4322, GLCA.5239, GLCA.5242; AA Points: GLCA_AA.1764, GLCA_AA.1766, GLCA_AA.1779, GLCA_AA.1988, GLCA_AA.4005).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2009a, Coles et al. 2010, Coles et al. 2011, Reid and Hall 2010, Romme et al. 1993, Schulz and Hall 2011, Thomas et al. 2009b, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.*

[CEGL002083] *Artemisia tridentata ssp. wyomingensis* / Disturbed Understory Ruderal Shrubland
Translated Name: Wyoming Big Sagebrush / Disturbed Understory Ruderal Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)

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Macrogroup: Western North American Cool Semi-Desert Ruderal Scrub & Grassland (M499)
Group: Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600)
Alliance: *Artemisia* spp. - Mixed Shrub Ruderal Understory Shrubland Alliance (A4213)

Element Concept

Global Summary: This sagebrush shrubland occurs in northern Arizona, eastern Utah, western Colorado, and southwestern Wyoming. This shrubland association has a moderately open to dense shrub layer with an herbaceous layer dominated by non-native invasive species. The dominant shrub is *Artemisia tridentata ssp. wyomingensis* with low to moderate cover. Other shrubs that may be present include *Ericameria nauseosa, Ephedra viridis, Gutierrezia sarothrae, Sarcobatus vermiculatus,* and succulents such as *Opuntia* species. The herbaceous stratum is dominated by a suite of non-native species, such as *Bromus tectorum, Chenopodium album*, and *Erodium cicutarium*. No single species is consistently dominant, so any of these may be the most abundant, or many invasive species occur as a mix in the herbaceous layer. Stands occur on flat to moderately steep slopes, currently known from between 1455 and 2372 m (4770-7777 feet) in elevation, and are likely to occur throughout the range of *Artemisia tridentata ssp. wyomingensis*. Soils are typically loamy sands to clay loams.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrubland was sampled on valley bottom fill, ridges, and plateaus. Sites are flat to gently sloping (up to 5°), oriented mostly to the north, and are located between 2199 and 2263 m elevation. Bare soil or litter cover most of the unvegetated surface, with low cover by small rocks, biological soil crusts, and downed wood. Soils are rapidly drained to well-drained silt loams, loams, sandy loams, sandy clays, or loamy sands derived from alluvium or eolian.

Global Environment: This association has been found on a variety of landscape features, including mesatops, mid- and low slopes of canyons, hills, valleys, stream terraces and alluvial flats on the Colorado Plateau and in southwestern Wyoming. Sites can be flat to moderately steep (0-15°) and have any aspect. Sampled sites have elevations between 1455 and 2372 m (4770-7777 feet). The ground surface can be composed of variable amounts of litter, bare soil, and large or small rocks. Soils are typically eolian, alluvial, or colluvial loamy sands to clay loams. Finer-textured soils may include rapidly drained silt loams or clay loams derived from alluvium. Biological soil crust cover is absent to low (up to 15%).

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This degraded Wyoming big sagebrush community is rare within the recreation area. Total vegetation cover ranges from 16-42% and consists almost solely of *Artemisia tridentata ssp. wyomingensis* with 10-30% cover. Scattered *Juniperus osteosperma* and/or *Pinus edulis* trees may be present with low cover. Scattered individual shrubs of *Chrysothamnus viscidiflorus, Ericameria nauseosa, Purshia tridentata*, and *Amelanchier utahensis* may be present. The herbaceous layer is dominated by *Bromus tectorum* (with up to 9% cover), but *Poa fendleriana* may have nearly as much cover in some stands. Other herbaceous species noted include *Achnatherum hymenoides, Elymus elymoides*, and *Heterotheca villosa*.

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Global Vegetation: This shrubland association has moderately open to dense herbaceous cover (28-89%) with an open to closed short-shrub layer. The dominant shrub, *Artemisia tridentata ssp. wyomingensis*, typically has 5-45% cover, though some stands may have more or less. Scattered *Pinus edulis, Juniperus osteosperma*, and *Juniperus scopulorum* trees (2-5 m tall) may provide up to 5-10% cover. In addition to *Artemisia tridentata ssp. wyomingensis*, other tall, short, and dwarf-shrubs that may be found are *Atriplex gardneri, Chrysothamnus viscidiflorus, Ericameria nauseosa, Ephedra viridis, Gutierrezia sarothrae, Sarcobatus vermiculatus*, and succulents such as *Opuntia* spp. The herbaceous stratum varies in cover and diversity but is always dominated by non-native, invasive species, especially *Bromus tectorum*. Other non-native species present to abundant include *Alyssum desertorum, Ceratocephala testiculata (= Ranunculus testiculatus), Chenopodium album*, *Erodium cicutarium*, non-native *Lepidium* species and *Taraxacum officinale*. Native herbaceous species are often present, but in such relatively small amounts that the native association cannot be determined. Common native graminoids that may be present in small amounts include *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Vulpia octoflora, Elymus elymoides, Elymus lanceolatus, Hesperostipa comata, Pascopyrum smithii, Poa fendleriana*, and *Pleuraphis jamesii*. Native forbs that may be present in small amounts include *Astragalus nuttallianus, Descurainia pinnata, Erigeron concinnus, Heterotheca villosa, Phacelia crenulata, Plantago patagonica, Sphaeralcea coccinea*, and *Trifolium gymnocarpon*. Biological soil crust cover is sparse.

Global Dynamics: Stands of this association have been disturbed, either by heavy domestic livestock grazing, or frequent wildfires, or both. Species composition and abundances reflect this, with non-native grazing-induced increasers often abundant.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	Graminoid	*Bromus tectorum*, *Poa fendleriana*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata* ssp. *wyomingensis*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Artemisia tridentata* ssp. *wyomingensis, Astragalus nuttallianus, Bromus tectorum, Ceratocephala testiculata, Chenopodium album, Erodium cicutarium, Lappula occidentalis, Taraxacum officinale*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)

Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Ceratocephala testiculata, Chenopodium album, Erodium cicutarium* (Medium/Low), *Taraxacum officinale*

Conservation Status Rank

Global Rank & Reasons: GNA (invasive) (14-Dec-2004).

Related Concepts

Global Similar Types:

- *Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Ruderal Shrubland (CEGL002699)
- *Artemisia tridentata ssp. wyomingensis* / Sparse Understory Shrubland (CEGL002768)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. Stands of this ruderal association may be confused with poor-condition natural types. It has been poorly sampled outside the Colorado Plateau, and likely occurs widely within the range of Wyoming big sagebrush shrublands. The herbaceous understory must be dominated by non-native species. Native invasive species may be present, but to be truly "ruderal" by USNVC standards, it is the non-native understory that defines this association. This association is closely related to *Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Ruderal Shrubland (CEGL002699), and there may be overlap between the two. Clear criteria need to be developed to distinguish these associations from one another.

Element Distribution

Glen Canyon National Recreation Area Range: This shrubland is rare within the recreation area and was sampled only on Fiftymile Bench/Navajo Point in such locations as Corral Ridge and Bull Ridge.

Global Range: This association has been well-sampled in the Colorado Plateau and southern Rocky Mountains in northern Arizona, western Colorado, eastern Utah and southwestern Wyoming. It is very likely to occur in other parts of the interior western U.S.

Nations: US
States/Provinces: AZ, CO, NV, UT, WY
TNC Ecoregions: 9:C, 10:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313B:CC, 341B:CC, 342E:CC, M331E:CC, M331G:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Canyon de Chelly, Capitol Reef, Colorado, Curecanti, Dinosaur, Fossil Butte?, Glen Canyon, Great Basin, Hovenweep)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Surrounded by higher ridge pinyon-juniper communities to the west, north and east, leading to runoff collecting in this area, as well as deeper soils.

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Subset: GLCA; Glen Canyon National Recreation Area

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (5 plots, 1 accuracy assessment point): (Plots: GLCA.4200, GLCA.4204, GLCA.4214, GLCA.6125, GLCA.6129; AA Points: GLCA_AA.1816).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Drake, J. Coles, K.A. Schulz and G. Kittel
References: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2010, Friesen et al. 2010, Romme et al. 1993, Schulz and Hall 2011, Tendick et al. 2010, Thomas et al. 2010, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.*

[CEGL002355] Ephedra viridis / Bromus tectorum Ruderal Shrubland
Translated Name: Mormon-tea / Cheatgrass Ruderal Shrubland
Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Western North American Cool Semi-Desert Ruderal Scrub & Grassland (M499)
Group: Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600)
Alliance: *Artemisia* spp. - Mixed Shrub Ruderal Understory Shrubland Alliance (A4213)

Element Concept

Global Summary: This ruderal association occurs in the Colorado Plateau and has been reported from northwestern Colorado and southeastern Utah. *Ephedra viridis* dominates the open shrub layer in this association; few other shrubs are present or contribute more than 1% cover. The herbaceous layer is dominated by exotic invasive *Bromus tectorum*, although it is usually accompanied by native grasses, including *Hesperostipa comata, Poa fendleriana*, and *Poa secunda*. Other weedy herbaceous species may also be present, such as *Erodium cicutarium*. Stands result from disturbance of other shrubland types, either by persistent grazing or by fire. It occurs on hills, plateaus, ridges and canyon walls in western Colorado and southern Utah. Elevations range from 1124 to 1650 m (3690-5415 feet), and slopes range from gentle to steep. Soils range from sandy loams to silt loams and may be derived from eolian or alluvial deposits.

Environmental Description

Glen Canyon National Recreation Area Environment: This shrub association occurs on canyon sides, canyon bottoms, ridges, and talus slopes. Sites are gently to steeply sloping (7-25°), oriented mostly to the northwest, and range from 1124 to 1156 m elevation. The unvegetated surface is composed primarily of bare soil, litter, and large rocks, with low cover of gravel and sand. Soils are rapidly drained loams and silt loams derived from eolian, talus/colluvial, or alluvial deposits.

Global Environment: This shrub association occurs on hills, plateaus, ridges and canyon walls in western Colorado and southern Utah. Elevations range from 1124 to 1650 m (3690-5415 feet), and slopes range from gentle to steep. Soils are rapidly drained sandy loams or silt loams derived from eolian, talus/colluvial, or alluvial deposits.

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Vegetation Description

Glen Canyon National Recreation Area Vegetation: Vegetation in these stands is dominated by generally high cover of exotic invasive *Bromus tectorum*, with 5-65% cover, forming a dense mat underneath a patchy shrub layer in which *Ephedra viridis* is diagnostic but not always dominant, with trace to 12% cover. Total vegetation cover ranges from 24-75%. The shrub layer is often dominated or codominated by *Glossopetalon spinescens*. Other shrubs commonly present, with low cover, include *Atriplex canescens, Coleogyne ramosissima, Ephedra torreyana*, and *Psorothamnus fremontii*. There is rarely much else able to compete with *Bromus tectorum* in the herbaceous layer, except occasional tufts of *Achnatherum hymenoides* and *Pleuraphis jamesii*, and often weedy forbs, such as *Machaeranthera canescens, Plantago patagonica*, and *Sphaeralcea grossulariifolia*.

Global Vegetation: *Ephedra viridis* dominates the open shrub layer in this association. Scattered *Atriplex canescens, Atriplex confertifolia, Coleogyne ramosissima, Ephedra torreyana, Glossopetalon spinescens*, or *Psorothamnus fremontii* may occur in a stand, but few other shrubs are present or contribute more than 1% cover. The herbaceous layer is dominated by exotic invasive *Bromus tectorum*, although it is usually accompanied by sparse native grasses, including *Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii, Poa fendleriana*, and *Poa secunda*. Other weedy herbaceous species may also be present, such as *Erodium cicutarium*.

Global Dynamics: Some stands occur in a matrix of *Coleogyne ramosissima* shrublands and represent degraded forms of *Ephedra viridis / (Achnatherum hymenoides, Hesperostipa comata)* Shrubland (CEGL002354) or *Ephedra viridis / Pleuraphis jamesii* Shrubland (CEGL002356). Others represent burned mixed shrublands occurring on colluvial slopes.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Glossopetalon spinescens*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*, *Ephedra viridis*
Herb (field)	Graminoid	*Bromus tectorum*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Herb (field)	Graminoid	*Bromus tectorum*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Bromus tectorum*, *Ephedra viridis*

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Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus tectorum* (High)
Global: Invasive/Exotic Plants: *Bromus tectorum* (High), *Erodium cicutarium* (Medium/Low)

Conservation Status Rank

Global Rank & Reasons: GNA (ruderal) (21-Mar-2005).

Related Concepts

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau. There is little quantitative information for this ruderal association.

Element Distribution

Glen Canyon National Recreation Area Range: This uncommon disturbed shrubland type was sampled in Cottonwood Canyon, Annie's Canyon, and Coyote Gulch.

Global Range: This ruderal association occurs in the Colorado Plateau and has been reported from northwestern Colorado and southeastern Utah and is likely to be widespread in the southwestern U.S. within the range of *Ephedra viridis*.

Nations: US
States/Provinces: CO, UT
TNC Ecoregions: 9:C, 19:C
USFS Ecoregions (1994/95): 341B:CC, M331E:CC
Federal Lands: NPS (Capitol Reef, Dinosaur, Glen Canyon)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: Soil is easily disturbed, but stabilized by *Bromus tectorum*, crust and mosses.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (3 plots, 1 accuracy assessment point): (Plots: GLCA.5182, GLCA.5184, GLCA.5195; AA Points: GLCA_AA.1923).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles and K.A. Schulz
References: Clark et al. 2009, Coles et al. 2008a, Romme et al. 1993, Western Ecology Working Group n.d.*

[CEGL002937] Ericameria nauseosa / Bromus tectorum Ruderal Shrubland
Translated Name: Rubber Rabbitbrush / Cheatgrass Ruderal Shrubland
Common Name:

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USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Western North American Cool Semi-Desert Ruderal Scrub & Grassland (M499)
Group: Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600)
Alliance: *Artemisia* spp. - Mixed Shrub Ruderal Understory Shrubland Alliance (A4213)

Element Concept

Global Summary: This ruderal shrubland occurs throughout much of the interior western U.S. in disturbed situations. Total vegetation cover is relatively sparse to dense, depending primarily on the density of cheatgrass in any given year. The shrub canopy is open to moderately dense, consisting of *Ericameria nauseosa* with 10-60% cover. Scattered individuals of other shrub species, such as *Artemisia tridentata, Rhus trilobata, Atriplex canescens,* and *Atriplex confertifolia*, may be present. The herbaceous layer contains many species but is overwhelmingly dominated by the non-native annual *Bromus tectorum*. Relict native herbaceous grasses include *Aristida purpurea, Achnatherum hymenoides, Elymus elymoides, Poa fendleriana,* and *Sporobolus cryptandrus*. Native herbaceous species are also common but contribute only sparse cover and may include *Cleome lutea, Eriogonum inflatum,* and *Heterotheca villosa*. Weedy forbs are more abundant in most stands, including *Lappula occidentalis*, and *Salsola tragus*. Stands occur on gentle to steep slopes with elevations ranging from 1110 to 2085 m (3640-6840 feet). Sites include intermittently flooded drainages, stream terraces and broad floodplains, basins and upland slopes. Soils are variable; most stands occur on well-drained sandy loams that are often rocky, but others occur on loam or gravely clay or clay loam soils. Most stands are the result of fire burning sagebrush or other types of shrublands, but some derive from other forms of disturbance, including overgrazing.

Environmental Description

Glen Canyon National Recreation Area Environment: This short shrubland occurs on disturbed canyon sides or canyon bottoms on benches and terraces. Sampled sites are flat to moderately sloping (up to 23° slope), oriented to the north, and occur between at 1112 and 1231 m elevation. Bare soil, litter and live vegetation litter cover most of the unvegetated surface with lesser cover by sand, mosses, and gravel. The soils are rapidly drained loamy sands or loams derived from alluvium or talus/landslide deposits.

Global Environment: This ruderal shrubland occurs widely in the interior western U.S. in disturbed situations, especially in the Colorado Plateau, Great Basin and Columbia Plateau. Sites include intermittently flooded drainages, stream terraces and broad floodplains, basins and moderate to steep upland slopes. Elevations range from 1110 to 2085 m (3640-6840 feet), and sites occur on gentle to steep slopes that may be oriented to any aspect. Soils are variable; most sampled stands occur on sandy loams that are well-drained and often rocky, but other stands occur on loam or gravely clay or clay loam soils. Litter and bare soil cover most of the ground surface. Parent materials are variable and include sandstones and shale that have eroded and deposited as alluvium, limestone, and Pleistocene lake deposits.

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Vegetation Description

Glen Canyon National Recreation Area Vegetation: This disturbed shrubland is rare within the park and has total vegetation cover of between 19 and 92%. The vegetation is characterized by a 1- to 2-m tall-shrub canopy of *Ericameria nauseosa* (4-55% cover), occasionally codominated by *Glossopetalon spinescens*, and an understory dominated by the non-native annual grasses *Bromus tectorum* (up to 15% cover) or *Bromus rubens* (up to 7% cover). *Ephedra cutleri, Ephedra viridis, Artemisia filifolia, Atriplex canescens, Gutierrezia microcephala, Vanclevea stylosa, Opuntia polyacantha, Psorothamnus fremontii, Xylorhiza tortifolia*, and *Yucca angustissima* contribute diversity but little cover. Relict bunchgrasses in the understory include *Achnatherum hymenoides, Pleuraphis jamesii,* and *Sporobolus flexuosus*. The only forbs noted with more than trace cover are *Lappula occidentalis, Machaeranthera canescens,* and *Plantago patagonica*.

Global Vegetation: Total vegetation cover is relatively sparse to dense, depending primarily on the density of cheatgrass in any given year. The shrub canopy is open to moderately dense, consisting of *Ericameria nauseosa* with 10-60% cover. Scattered individuals of other shrub species such as *Artemisia tridentata, Rhus trilobata, Gutierrezia sarothrae, Atriplex canescens,* and *Atriplex confertifolia* may be present. Cover of *Yucca elata var. utahensis* and *Opuntia* spp. may be more abundant. Occasional non-native *Elaeagnus angustifolia* or *Tamarix chinensis* trees are present in some stands in riparian settings. Native trees such as *Juniperus* spp. may also be present. The herbaceous layer contains many species but is overwhelmingly dominated by the non-native annual *Bromus tectorum* providing up to 90% cover. Non-native forbs can be abundant, including *Salsola tragus, Rumex crispus, Sonchus asper,* and *Tragopogon dubius*. Relict native herbaceous grasses include *Aristida purpurea, Achnatherum hymenoides, Elymus elymoides, Poa fendleriana,* and *Sporobolus cryptandrus*. Native herbaceous species are also usually present but contribute only sparse cover and may include *Cleome lutea, Eriogonum inflatum, Lappula occidentalis* and *Heterotheca villosa*.

Global Dynamics: Most stands are the result of fire burning sagebrush or other types of shrublands. Others derive from other forms of disturbance, including grazing.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*, *Glossopetalon spinescens*
Herb (field)	Graminoid	*Bromus rubens*, *Bromus tectorum*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Herb (field)	Graminoid	*Bromus tectorum*

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Characteristic Species

Glen Canyon National Recreation Area:
Global: *Bromus tectorum*, *Ericameria nauseosa*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Vanclevea stylosa* (G3); Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High)
Global: Vulnerable Plants: *Yucca elata* var. *utahensis* (G5T3?, endemic variety); Invasive/Exotic Plants: *Bromus tectorum* (High), *Elaeagnus angustifolia* (High), *Lepidium latifolium* (High), *Rumex crispus* (Low/Insignificant), *Salsola tragus*, *Sonchus asper*, *Tamarix chinensis*, *Tragopogon dubius* (Medium/Low)

Conservation Status Rank

Global Rank & Reasons: GNA (ruderal) (14-Aug-2001).

Related Concepts

Global Similar Types:
- *Ericameria nauseosa* Sand Deposit Sparse Shrubland (CEGL002980)
- *Ericameria nauseosa* Shrubland (CEGL002713)
- *Juniperus osteosperma / Bromus tectorum* Ruderal Woodland (CEGL002817)
- *Populus fremontii / Ericameria nauseosa* Riparian Woodland (CEGL002465)

Classification

Status: Standard
Classification Confidence: 2 - Moderate
Global Classification Comments: This association is largely known and described from National Park Service inventory efforts in the Colorado Plateau and Great Basin.

Element Distribution

Glen Canyon National Recreation Area Range: This rare shrubland was sampled in Croton Canyon, Cottonwood Canyon, Cottonwood Gulch, Ribbon Canyon, and Ticaboo Creek.

Global Range: This widespread ruderal association occurs in the interior western U.S. in disturbed areas. It has been well-sampled in the Colorado Plateau, Columbia Plateau and Great Basin and is reported from other areas that support sagebrush shrublands.

Nations: US
States/Provinces: AZ, CO, NV, UT, WA
TNC Ecoregions: 9:C, 11:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341A:CC, 341B:CC, M331E:CC, M341A:CC
Federal Lands: NPS (Canyon de Chelly, Canyonlands, Capitol Reef, Dinosaur, Glen Canyon, Golden Spike, Great Basin, Lake Roosevelt, Navajo, Zion)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This shrubland is on a fairly loose-soiled, sloping bench. Northern border is a stream channel. Its southern border is a 100-m tall sandstone cliff

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face. There is also a deep side channel (dry) dividing the segment. The soils are stabilized by *Bromus rubens*.

Glen Canyon National Recreation Area Plots: The description is based on 2012 and 2015 field data (4 plots, 1 accuracy assessment point): (Plots: GLCA.4002, GLCA.4252, GLCA.5185, GLCA.5415; AA Point: GLCA_AA.3062).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): J. Coles, K.A. Schulz and G. Kittel
References: Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2011, Erixson et al. 2011b, Romme et al. 1993, Salas et al. 2010a, Schulz and Hall 2011, Thomas et al. 2010, Western Ecology Working Group n.d.*

A1814 Bromus tectorum - Taeniatherum caput-medusae Ruderal Annual Grassland Alliance
Alliance Summary Description: This interior western U.S. ruderal annual grassland alliance is strongly dominated (>90% relative canopy cover) by invasive, exotic annual grass species such as *Bromus tectorum*, and less commonly *Bromus arvensis (= Bromus japonicus), Bromus hordeaceus, Bromus madritensis, Taeniatherum caput-medusae*, or a mixture of other exotic annual grasses. Cover of perennials is low (<5% absolute cover). Stands occur in disturbed dry to mesic basins, alluvial fans, and foothills at elevations up to 2200 m throughout the cool, semi-arid interior western U.S. region. It is an early-successional type that may occur in areas disturbed by fire, grazing or mining.

[CEGL003019] *Bromus tectorum* Ruderal Grassland
Translated Name: Cheatgrass Ruderal Grassland
Common Name: Ruderal Cheatgrass Annual Grassland

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Western North American Cool Semi-Desert Ruderal Scrub & Grassland (M499)
Group: Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600)
Alliance: *Bromus tectorum - Taeniatherum caput-medusae* Ruderal Annual Grassland Alliance (A1814)

Element Concept

Global Summary: This herbaceous vegetation type is found throughout much of the intermountain western and southwestern U.S. It occurs most often after disturbance of a natural shrub- or grass-dominated community that results in the replacement of the natural vegetation by non-native, annual grass species of *Bromus*. *Bromus tectorum* typically dominates the community with over 80-90% of the total vegetation cover, making it difficult to determine what natural community was formerly present. This vegetation also includes grasslands dominated or codominated by other Eurasian introduced annual *Bromus* species such as *Bromus hordeaceus, Bromus madritensis, Bromus japonicus, Bromus rigidus*, or *Bromus rubens*. It is distinct from the annual *Bromus* communities found along the Pacific Coast typical of the Mediterranean or maritime climates. Sites are variable as it occurs on a wide variety of semi-arid landscapes. Elevation ranges from near sea level to 2200 m. In

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the Great Basin, *Bromus tectorum* grasslands have invaded large areas of burned-over sagebrush steppe. *Bromus tectorum* increases the fire frequency of steppe communities, which eventually eliminates sagebrush.

Environmental Description

Glen Canyon National Recreation Area Environment: This non-native grassland association occurs on broad, open flats on plateaus, mesas, and in other valley or canyon bottoms, as well as along drainage channels, beaches, and dunes. Sites slope gently to moderately (2-11°), in general, though one site sampled was at 34°, are oriented to all aspects, and occur between 1097 and 2253 m elevation. The unvegetated surface has moderate to high exposure of bare soil or sand, low to moderate cover of litter, absent to moderate cover of biological soil crusts, and occasionally some small rock and live vegetation litter cover. Soils are somewhat poorly drained to rapidly drained loamy sands, sandy loams, sands, loams, or silt loams derived from alluvial, eolian, or talus/colluvium deposits.

Global Environment: This herbaceous vegetation type is found throughout much of the intermountain western and southwestern U.S. Elevation ranges from near sea level to 2200 m. Stands occur after disturbance of a natural shrub- or grass-dominated community, resulting in the replacement of the natural vegetation by non-native, annual grass species of *Bromus,* although invasion of undisturbed sites has also been reported (e.g., Evans et al. 2001). In the Great Basin, *Bromus tectorum* grasslands have invaded large areas of burned-over sagebrush steppe. *Bromus tectorum* increases the fire frequency of steppe communities, which eventually eliminates sagebrush (FEIS 2001).

Vegetation Description

Glen Canyon National Recreation Area Vegetation: Total vegetation cover in cheatgrass grasslands is highly variable and ranges between 2 and 87%, depending on site conditions and spring precipitation. *Bromus tectorum* forms a near monoculture (1-80%), although in a couple of stands either *Bromus rubens* or *Schismus barbatus* was dominant. Scattered tufts of remnant native grass species may also be present, including *Achnatherum hymenoides, Sporobolus airoides, Poa fendleriana,* and *Elymus elymoides*. Scattered shrubs may be present, including *Fraxinus anomala, Fallugia paradoxa, Tamarix chinensis, Artemisia tridentata, Ephedra viridis, Krascheninnikovia lanata, Atriplex confertifolia, Atriplex canescens, Ericameria nauseosa, Gutierrezia microcephala, Yucca angustissima,* and the succulent *Opuntia phaeacantha*. *Juniperus osteosperma* seedlings and trees occasionally provided sparse cover. Forb cover is sparse to low and includes *Sphaeralcea parvifolia, Salsola tragus, Machaeranthera canescens, Streptanthella longirostris, Lappula occidentalis, Artemisia ludoviciana, Heterotheca villosa,* and *Lepidium montanum*.

Global Vegetation: This vegetation type is characterized by a sparse to dense, short, annual graminoid layer that is typically dominated by *Bromus tectorum* with over 80-90% of the total vegetation cover. Other Eurasian introduced annual species of *Bromus* which may alternatively dominate or codominate are *Bromus carinatus, Bromus hordeaceus, Bromus madritensis, Bromus japonicus, Bromus rigidus,* or *Bromus rubens*. Although there may be remnant species of the former native vegetation, the high cover of annual bromes makes it difficult to determine what natural community was formerly present. Weedy and exotic annual forbs may also have significant cover in some stands. Scattered shrubs and

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Subset: GLCA; Glen Canyon National Recreation Area

dwarf-shrubs, especially *Chrysothamnus viscidiflorus, Ericameria nauseosa, Ephedra viridis, Gutierrezia sarothrae*, and *Opuntia polyacantha*, may be present with low cover.

Global Dynamics: *Bromus tectorum* is an annual grass able to germinate in cool temperatures and complete its lifecycle in the spring before drying out mid-summer. Its fine structure makes it extremely flammable when dry, and it will increase the fire frequency of a site (FEIS 2001). Frequent fires favor *Bromus tectorum* because they eliminate competing perennial vegetation, but do not kill all the *Bromus tectorum* seeds, which survive in the unburned organic material (FEIS 2001). This altered ecological process has promoted the spread of *Bromus tectorum* and other exotic annual bromes at the expense of sagebrush shrublands in large parts of the western U.S. (Young and Evans 1973, 1978, Daubenmire 1975).

T. Naumann (pers. comm. 2005) reported successful restoration of cheatgrass-invaded systems by the use of prescribed fire, timed and controlled so as to destroy the seeds of *Bromus tectorum* while stimulating growth in remnant native warm-season grasses. She also reported that prescribed fire was least successful in areas of shallow soils, presumably because native grasses cannot develop sufficient root mass to compete with cheatgrass. Work by Redente and others (e.g., Redente et al. 1992) indicates that, under some circumstances, native grass and shrub species can regain competitive advantage over annuals such as *Bromus tectorum* if a source of carbon, such as sugar or sawdust, is added to the system. Amending the soil with carbon increases the activity of soil microbes and results in the reduction of plant-available nitrogen.

This type is most common where disturbances have eliminated or largely set back the native vegetation. Where the brome grasses are invading native vegetation, the types may still be tracked as native types, since the native species may still persist. A recent study (Karl et al. 1999) found that, despite strong seed and seedling production by the exotic brome grasses (*Bromus japonicus, Bromus tectorum*), the large amount of herbaceous biomass produced by the two vegetatively propagating native grasses *Bouteloua gracilis* and *Pascopyrum smithii* suggests that these native grasses may well maintain their ecological importance in the stands.

Evans et al. (2001) studied the invasion by cheatgrass of an undisturbed native grassland in Canyonlands National Park (Virginia Park). Their study showed that *Bromus* may cause a short-term decrease in nitrogen loss by decreasing substrate availability and denitrification enzyme activity, but in the long term, nitrogen loss is likely to be greater in invaded sites because of increased fire frequency and greater nitrogen volatilization during fire. A study by Englund (2004) at the same site showed decreasing levels of soil organic carbon as *Bromus tectorum*, with its shallow root systems, replaced perennial grasses with their more massive root systems.

In Nevada, Beatley (1976) found dense stands of the introduced winter annual grass *Bromus tectorum* growing in disturbed *Artemisia* shrublands. *Bromus rubens* is more common in lower elevation sites, and *Bromus tectorum* is most common in higher elevation sagebrush and pinyon-juniper communities.

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Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Herb (field)	Flowering forb	*Lappula occidentalis*
Herb (field)	Graminoid	*Bromus rubens*, *Bromus tectorum*, *Schismus barbatus*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Bromus carinatus*, *Bromus hordeaceus*, *Bromus japonicus*, *Bromus madritensis*, *Bromus rigidus*, *Bromus rubens*, *Bromus tectorum*

Characteristic Species

Glen Canyon National Recreation Area:

Global: *Bromus carinatus, Bromus hordeaceus, Bromus japonicus, Bromus madritensis, Bromus rigidus, Bromus rubens, Bromus tectorum*

Other Noteworthy Species

Glen Canyon National Recreation Area: Invasive/Exotic Plants: *Bromus rubens, Bromus tectorum* (High), *Salsola tragus, Schismus barbatus* (High/Medium), *Tamarix chinensis*

Global: Vulnerable Plants: *Lupinus ammophilus* (G3G4); Invasive/Exotic Plants: *Bromus hordeaceus, Bromus japonicus, Bromus madritensis, Bromus rigidus, Bromus rubens, Bromus tectorum* (High)

Conservation Status Rank

Global Rank & Reasons: GNA (invasive) (1-Dec-1997).

Related Concepts

Global Similar Types:

- *Juniperus osteosperma / Bromus tectorum* Ruderal Woodland (CEGL002817)

Global Related Concepts:

- *Bromus tectorum* Semi-natural (Evens et al. 2014) =
- *Bromus tectorum* zootic climax (Daubenmire 1975) =
- Cheatgrass series (Sawyer and Keeler-Wolf 1995) <

Classification

Status: Standard

Classification Confidence: 2 - Moderate

Global Classification Comments: This alliance in which this association is placed also includes grasslands dominated or codominated by other Eurasian introduced annual *Bromus* species. It is distinct from the annual *Bromus* communities found along the Pacific Coast with Mediterranean or maritime climates because it does not have the introduced annual oatgrass (*Avena barbata* and *Avena fatua*), or other species typical of the California annual grassland (Sawyer and Keeler-Wolf 1995).

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Subset: GLCA; Glen Canyon National Recreation Area

Element Distribution

Glen Canyon National Recreation Area Range: Though it is common in small, often dense patches and as a component in other associations occupying disturbed sites, larger, homogenous stands of cheatgrass are also common throughout the recreation area. It was sampled on Waterhole Flat, Corral Ridge, Flint Flat, near Red Point, Hite, Rock Creek Bay, in Neanderthal Cove, Moqui Canyon, Iceberg Canyon, Slickrock Canyon, Cottonwood Gulch, Coyote Gulch, and Knowles Canyon.

Global Range: This broadly defined herbaceous vegetation type is found throughout much of western North America, but primarily in the intermountain western and southwestern U.S.

Nations: US
States/Provinces: AZ, CA, CO, ID, NV, UT, WA
TNC Ecoregions: 6:C, 9:C, 10:C, 11:C, 13:C, 18:C, 19:C, 20:C, 21:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341A:CC, 341B:CC, 341C:CC, 342D:CC, M261:C, M313A:CC, M331E:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Arches, Black Canyon of the Gunnison, Canyon de Chelly, Canyonlands?, Capitol Reef, Colorado, Craters of the Moon, Curecanti, Death Valley, Dinosaur, Glen Canyon, Golden Spike, Grand Canyon, Grand Canyon-Parashant, Great Basin, Hovenweep, Lake Roosevelt, Mesa Verde, Walnut Canyon, Zion); USFWS (Ouray)

Element Sources

Glen Canyon National Recreation Area Inventory Notes: This slightly sloping area was once heavily grazed, as evidenced by the exotic plant abundance, the *Opuntia* density, and cow pies. Although once heavily disturbed, this area is large and distinct.

Glen Canyon National Recreation Area Plots: The description is based on 2004, 2012, and 2013 field data (16 plots): (Plots: GLCA.0591, GLCA.0595, GLCA.4206, GLCA.4222, GLCA.4234, GLCA.4235, GLCA.4290, GLCA.5057, GLCA.5084, GLCA.5177, GLCA.5191, GLCA.5192, GLCA.5224, GLCA.5515, GLCA.6127, GLCA.9501).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): D. Faber-Langendoen, K.A. Schulz and J. Coles
References: Beatley 1976, Bell et al. 2009, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2009a, Coles et al. 2010, Coles et al. 2011, Daubenmire 1975, Englund 2004, Erixson et al. 2011b, Evans et al. 2001, Evens et al. 2014, FEIS 2001, Hansen et al. 2004a, Karl et al. 1999, Marriott pers. comm., Naumann pers. comm., Peterson 2008, Redente et al. 1992, Reid and Hall 2010, Romme et al. 1993, Sawyer and Keeler-Wolf 1995, Schulz and Hall 2011, Tendick et al. 2010, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2002, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.*, Young and Evans 1973, Young and Evans 1978

A3257 Centaurea solstitialis - Isatis tinctoria - Salsola tragus Ruderal Annual Forb Alliance
Alliance Summary Description: This ruderal herbaceous alliance occurs in the interior western U.S. Vegetation is strongly dominated (>90% relative canopy cover) by invasive, exotic annual forb species such as *Brassica nigra, Centaurea melitensis, Centaurea solstitialis, Crupina vulgaris, Cynoglossum*

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officinale, Hyoscyamus niger, Isatis tinctoria, Salsola tragus or a mixture of other exotic annual forbs. Other exotic annual forbs are often present to dominant in disturbed stands, including *Bassia scoparia (= Kochia scoparia), Descurainia sophia, Erodium cicutarium, Lepidium perfoliatum, Sisymbrium altissimum,* and *Taraxacum officinale*. Cover of perennials is low (<5% absolute cover). Stands occur in disturbed dry to mesic basins, alluvial fans, and foothills at elevations up to 2200 m throughout the cool, semi-arid intermountain western U.S. region. It is an early-successional type that may occur in areas disturbed by fire, grazing or mining.

[CEGL004004] *Salsola* spp. Ruderal Grassland

Translated Name: Russian-thistle species Ruderal Grassland

Common Name:

USNVC Classification

Division: Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup: Western North American Cool Semi-Desert Ruderal Scrub & Grassland (M499)
Group: Great Basin-Intermountain Ruderal Dry Shrubland & Grassland (G600)
Alliance: *Centaurea solstitialis - Isatis tinctoria - Salsola tragus* Ruderal Annual Forb Alliance (A3257)

Element Concept

Global Summary: This herbaceous association is widespread on disturbed areas in semi-arid regions of the interior western U.S. Vegetation is dominated by exotic annual weedy species, especially *Salsola tragus* and, less frequently, other species such as *Salsola collina, Salsola kali,* or *Salsola paulsenii*. Scattered native shrubs may be present, including *Atriplex canescens, Atriplex confertifolia, Ephedra torreyana, Krascheninnikovia lanata, Ericameria nauseosa, Opuntia polyacantha, Opuntia phaeacantha var. major, Sarcobatus vermiculatus,* and *Sclerocactus whipplei*. Remnant native herbaceous species contribute little cover but are usually present; *Sporobolus cryptandrus, Achnatherum hymenoides, Pleuraphis jamesii, Sporobolus airoides, Cryptantha* sp., *Sphaeralcea coccinea, Plantago patagonica, Cleome lutea, Ambrosia acanthicarpa, Eriogonum inflatum,* and *Lappula occidentalis* were recorded in sampled plots. *Bromus tectorum* generally has significant cover. Some areas with fine-textured soils lack biological soil crusts, but sandy sites can have as much as 60% cover. This herbaceous association occurs on floodplains, canyon bottoms, playas, and on active sand dunes. Sites are on flat to steep slopes. Sand or bare soil covers most of the unvegetated surface, although some sites have moderate cover of litter representing the previous crop of annual weeds. Biological soil crusts provide sparse to moderate cover depending on whether the site is being grazed or otherwise disturbed. Soils are moderately well-drained to rapidly drained sands, silt loams, or clays derived from alluvium.

Environmental Description

Glen Canyon National Recreation Area Environment: This weedy annual herbaceous association occurs on valley bottom fill, canyon bottoms, and on active sand dunes. Sites are flat to gently sloping (up to 4°) and lie between 1089 and 1344 m elevation. Sand or bare soil cover most of the unvegetated surface, although some sites have moderate cover of litter and/or live vegetation litter representing the

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previous crop of annual weeds. Soils are poorly drained to moderately well-drained to rapidly drained sands, loamy sands, loams, silt loams, or silty clays derived from eolian or alluvial deposits.

Global Environment: This herbaceous association is widespread on disturbed areas in semi-arid regions of the interior western U.S. Stands occur on floodplains, canyon bottoms, playas, and on active sand dunes. Sites are on flat to steep slopes. Where sampled in the Colorado Plateau and San Luis Valley, elevations range from 1089 and 2297 m. Sand or bare soil cover most of the unvegetated surface, although some sites have moderate cover of litter representing the previous crop of annual weeds. Biological soil crusts provide sparse to moderate cover depending on whether the site is being grazed or otherwise disturbed. Soils are moderately well-drained to rapidly drained sands, silt loams, or clays derived from alluvium.

Vegetation Description

Glen Canyon National Recreation Area Vegetation: This Russian-thistle weedy herbaceous association occurs in disturbed areas within the recreation area. Total vegetation cover varies depending on spring precipitation and the time of year the site is sampled, ranging from 3 to 61%. The vegetation is dominated by exotic annual weedy species, especially *Salsola tragus*, with 1-15% cover. Scattered *Ericameria nauseosa* and the exotic *Tamarix chinensis* shrubs may be present with low cover. Other forbs present with low to high cover include *Cryptantha* sp., *Ambrosia acanthicarpa, Eriogonum palmerianum, Portulaca oleracea, Datura wrightii, Erigeron religiosus, Chamaesyce parryi, Reverchonia arenaria, Oenothera pallida,* and *Munroa squarrosa*. Weedy, annual grasses with low to moderate cover include *Bromus tectorum, Bromus rubens, Bouteloua barbata,* and *Schismus barbatus*.

Global Vegetation: Vegetation is dominated by exotic annual weedy species, especially *Salsola tragus*. Scattered native shrubs may be present, including *Atriplex canescens, Atriplex confertifolia, Ephedra torreyana, Krascheninnikovia lanata, Ericameria nauseosa, Opuntia polyacantha, Opuntia phaeacantha var. major, Sarcobatus vermiculatus,* and *Sclerocactus whipplei*. Remnant native herbaceous species contribute little cover but are usually present; *Sporobolus cryptandrus, Achnatherum hymenoides, Pleuraphis jamesii, Sporobolus airoides, Cryptantha* sp., *Sphaeralcea coccinea, Plantago patagonica, Cleome lutea, Ambrosia acanthicarpa, Eriogonum inflatum,* and *Lappula occidentalis* were recorded in the sample plots. *Bromus tectorum* generally has significant cover. Other exotic annual grasses include *Bromus rubens, Bouteloua barbata*, and *Schismus barbatus*. Some areas with fine-textured soils lack biological soil crusts, but sandy sites can have as much as 60% cover.

Most Abundant Species

Glen Canyon National Recreation Area

Stratum	Lifeform	Species
Herb (field)	Flowering forb	*Salsola tragus*
Herb (field)	Graminoid	*Bouteloua barbata*, *Bromus tectorum*, *Munroa squarrosa*

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Global

Stratum	Lifeform	Species
Herb (field)	Flowering forb	*Salsola tragus*
Herb (field)	Graminoid	*Bromus tectorum*

Characteristic Species

Glen Canyon National Recreation Area:
Global: *Salsola tragus*

Other Noteworthy Species

Glen Canyon National Recreation Area: Vulnerable Plants: *Erigeron religiosus* (G2G3); Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Salsola tragus*, *Schismus barbatus* (High/Medium), *Tamarix chinensis*

Global: Vulnerable Plants: *Sclerocactus whipplei* (G2G3); Invasive/Exotic Plants: *Bromus rubens*, *Bromus tectorum* (High), *Salsola tragus*, *Schismus barbatus* (High/Medium)

Conservation Status Rank

Global Rank & Reasons: GNA (ruderal) (14-Jul-2006).

Related Concepts

Classification

Status: Standard
Classification Confidence: 3 - Weak
Global Classification Comments: Stand have also been observed on dunes at Petrified Forest National Park.

Element Distribution

Glen Canyon National Recreation Area Range: This weedy herbaceous association was sampled on sandy soils in low-lying areas and on sand dunes within the recreation area. It was sampled on Antelope Island, north Wilson Mesa, Rock Creek Bay, in Bullfrog Creek, Coyote Gulch, Little Valley Canyon, and near Red Well trailhead.

Global Range: This ruderal annual herbaceous association is widespread on disturbed areas in semi-arid regions of the interior western U.S. It has been sampled from the Colorado Plateau and San Luis Valley, but is often overlooked during vegetation studies because it is often ephemeral.

Nations: US
States/Provinces: AZ, CO, NV, UT
TNC Ecoregions: 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331F:CC
Federal Lands: NPS (Canyonlands, Glen Canyon, Grand Canyon-Parashant, Grand Canyon?, Great Sand Dunes, Petrified Forest)

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Element Sources

Glen Canyon National Recreation Area Inventory Notes: Likely once a corral for cattle. Still there are many cow pies here, and only annuals exist, primarily *Munroa squarrosa, Bouteloua barbata*, and *Salsola tragus*. The ground appears disturbed and compacted. Overgrazing impacts have controlled plant distribution. Sandy soil with little to no soil crust.

Glen Canyon National Recreation Area Plots: The description is based on 2011, 2012, and 2013 field data (9 plots): (Plots: GLCA.1050, GLCA.2053, GLCA.4133, GLCA.4224, GLCA.4293, GLCA.4298, GLCA.5148, GLCA.5222, GLCA.5573).

Glen Canyon National Recreation Area Description Author(s): A. Tendick
Global Description Author(s): M.E. Hall and K.A. Schulz
References: Peterson 2008, Reid and Hall 2010, Salas et al. 2010b, Western Ecology Working Group: n.d.*

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X. Not in hierarchy and no descriptions

Acer negundo - Salix gooddingii / Equisetum hyemale Woodland

Artemisia filifolia / Sporobolus flexuosus Shrubland

Chrysothamnus greenei - Gutierrezia sarothrae / Bouteloua gracilis - Pleuraphis jamesii Shrubland

Ephedra torreyana – Psorothamnus thompsoniae Shrubland

Ephedra torreyana / Sporobolus cryptandrus Shrubland

Ericameria nauseosa / Pleuraphis jamesii Shrubland

Gutierrezia sarothrae - Ephedra torreyana / Muhlenbergia porteri Herbaceous Shrubland

Juncus tenuis - Solidago canadensis Herbaceous Vegetation

Juniperus osteosperma / Achnatherum speciosum Wooded Herbaceous

Juniperus osteosperma / Aristida purpurea Woodland

Juniperus osteosperma / Ericameria nauseosa / Bromus tectorum Woodland

Juniperus osteosperma / Mixed Herbaceous Woodland

Oenothera pallida - Mixed Herbaceous Sand Dune Sparse Vegetation

Quercus gambelii / Mesic Herbaceous Woodland

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Subset: GLCA; Glen Canyon National Recreation Area

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Subset: GLCA; Glen Canyon National Recreation Area

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Appendix G. Plant Association Field Key

Glen Canyon National Recreation Area and Rainbow Bridge National Monument

National Park Service
U.S. Department of the Interior
Utah

Plant Association Field Key

November 2016



Plant Association Field Key

Prepared by and for:
National Park Service



Illustrated Key to the Plant Associations of Glen Canyon National Recreation area and Rainbow Bridge National Monument

A diverse assemblage of plant associations were characterized by field data collection conducted between 2011 and 2015 under the US Geological Survey and National Park Service Vegetation Mapping Program. This dichotomous key was developed to assist in the accurate field identification of the 184 plant associations described for Glen Canyon National Recreation Area and Rainbow Bridge National Monument. Hanging garden and seep/spring vegetation associations classified as part of this project (Appendix F) using data collected by GLCA/RABR park staff are not included in this key.

It is the intent of the key to allow identification of plant associations with one or more dominant species, in combination with a description of key habitat factors. Because of natural variation within plant associations and observer bias, it is possible that a community could be keyed to an association using more than one of the physiognomic keys. For stands in ecotones, it may be difficult to determine a definitive association name. The cover breaks used to distinguish between associations and between physiognmic types are based on field data collected as part of this project and should be used for guidance but not considered a firm determinant. Also, there are a number of associations with only one or two plots collected for them, hence the key will not necessarily account for the floristic, geologic, and environmental variation of the association if it occurs more widely in the Recreation Area.

How to Use the Key

The key approaches plant association identification at two levels. The first level is physiognomic, allowing the user to determine which major group is being evaluated, e.g., forest/woodland, shrubland, herbaceous (graminoid/forb). The second level allows identification to plant association based on dominant species foliar cover and to a lesser extent, habitat.

When using this key, you may have difficulty arriving at an association that precisely describes your community. There are several possible reasons for this problem and each has a solution:

1. You are observing vegetation that you think is an herbaceous or shrubland community, but it has some tree cover. In this case, try keying the vegetation through the forest/woodland key as well as the herbaceous or shrubland key. In general with any layer, if it does not cover at least 5% (tree layer) or 10% (shrub or herbaceous layers), it is ignored for naming purposes. The exception is in sparse communities, where relative cover becomes more important (See Key 1).

2. You are observing vegetation where the dominant cover is split nearly 50/50 between two diagnostic species. In this case, try keying based on one species being the dominant one. If you choose one and don’t like where you end up, try keying based on the other dominant species. Please refer to the hierarchy of diagnostic species listed below for help in choosing which species to key through first.

3. The diagnostic layer consists of woody plants that may appear in either a shrub or a tree form, depending on site conditions and age. For the purposes of this key, *Acer negundo, Acer grandidentatum, Celtis laevigata, Juniperus osteosperma, Ostrya knowltonii, Pinus edulis, Populus fremontii, Pseudotsuga menziesii,* and *Salix gooddingii* are ALWAYS considered to be trees; and *Betula occidentalis, Quercus gambelii,* and *Tamarix chinensis* are considered tall shrubs, regardless of their height or growth form.

4. You can follow a key to a certain point, but you clearly have something not described in the key. This is to be expected occasionally – very likely you have an association that was not found during the sampling phase of the project. In this case, you should name the community based on the dominant and diagnostic species.

5. Focus on the perennial species in the community even if they have low total cover, unless the community consists almost entirely of annuals or ephemerals or is highly disturbed or degraded.

Special instructions for AA Crews

There are many sparse community types occurring on exposed landscapes and talus slope habitats at Glen Canyon National Recreation Area and Rainbow Bridge National Monument. They tend to be characterized by a combination of species. Because no one species is consistently dominant in the community, these types are difficult to find in a floristic key such as this one. To key these types, it is important for you to understand that the NVC does not view all species as contributing equally to a classification. Species vary in their degree of habitat specialization; to a point, the more specialized and persistent a species (in the larger world, not just at GLCA/RABR), the more it is likely to be a "diagnostic" species that controls the assignment of a community to an association. For example, if you are on a slickrock outcrop with about equal cover of *Cercocarpus intricatus* and *Coleogyne ramosissima,* the community will be classified based on *Cercocarpus intricatus* not *Coleogyne ramosissima*. Generalist species such as *Ericameria nauseosa, Chrysothamnus viscidiflorus, Gutierrezia sarothrae,* and *Opuntia* spp. are only considered diagnostic if they are overwhelmingly dominant.

So-called "diagnostic" species are not all equal. There is a hierarchy, and it varies depending on the habitat. Some examples:

Uplands: CERMON > CERINT > ARTNOV > ARTTRIWYO > AMEUTA > PURTRI > COLRAM > EPHTOR

Salt desert: ZUCBRA > ATRGAR, ATRCOR > ATRCON > ARTSPI > ERICOR

Sand dunes: POLINC > VANSTY > QUEHAV > ERILEP > ARTFIL > EPHCUT

Alluvial flats and terraces: ARTTRITRI > SARVER > ATRCAN > ARTFIL > ERINAU

Grasses: Strong: MUHPUN, HESCOM, SPOAIR, BOUGRA; Medium: PLEJAM, ACHHYM; Weak: SPOCRY, BROTEC

When in doubt, record detailed field notes on your accuracy assessment field forms. These notes and the Vegetation Description information will be entered into a database to be evaluated in detail during the Accuracy Assessment meeting that will be held to determine the map accuracy by comparing the interpreted map unit to the association identified in the field.

Key I: A Key to the Major physiognomic Groups of GLEN CANYON National RECREATION AREA and Rainbow Bridge National Monument

1a) Vegetation (including trees, shrubs, and herbaceous vegetation) occupying wet meadows, canyon bottoms, washes, alluvial terraces/benches, stream banks, drainages, seeps, or other places that receive runoff and/or retain moisture, and may or may not be perennially moist [Hanging garden and seep/spring herbaceous associations are not included] - **Key II: A Key to the Palustrine, Drainage, Wash, and Seep Vegetation Associations of Glen Canyon National Recreation Area and Rainbow Bridge National Monument (Page G-8)**

1b) Vegetation occupying dry, upland habitats **(2)**

2a) (1b) Canopy cover of tree species regardless of their size class (i.e. T1, T2, T3, H4) is at least 5%, usually more. Wooded shrublands are shrublands with scattered trees where trees comprise at least 30% of the total vegetative cover - **Key III: A Key to the Upland Forest, Woodland, and Wooded Shrubland Associations of Glen Canyon National Recreation Area and Rainbow Bridge National Monument (Page G-39)**

2b) Vegetation is dominated by shrubs and/or herbaceous vegetation; scattered trees may be present with trace to low cover (always less than 5% total cover). *Note:* If total shrub cover is equal to total herbaceous cover (shrub-herbaceous vegetation), try keying through Keys IV and V **(3)**

3a) (2b) Shrub species, regardless of their size class (S1, S2, S3), comprise at least 10% cover, individually or in the aggregate; if the stand has reduced total cover (< 10%) or if the vegetation is mixed shrub and herbaceous, then the shrub component comprises more than 50% of the total vegetative cover. If tree species are present, they have low relative cover (always less than 30% of the total vegetative cover) - **Key IV: A Key to the Upland Shrubland and Shrub Herbaceous Vegetation Associations of Glen Canyon National Recreation Area and Rainbow Bridge National Monument (Page G-55)**

3b) Herbaceous species comprise at least 10% cover, individually or in the aggregate; if the stand has reduced total cover (<10%) or if the vegetation is mixed shrub and herbaceous, then the herbaceous component comprises more than 50% of the total vegetative cover - **Key V: A Key to the Upland Herbaceous Vegetation Associations of Glen Canyon Recreation Area and Rainbow Bridge National Monument (Page G-94)**

Key II: A Key to the Palustrine, Drainage, Wash, and Seep Vegetation ASSOCIATIONS of glen canyon National recreation area and Rainbow Bridge National Monument

1a) Herbaceous forb and/or graminoid communities **(2)**

1b) Forest, woodland, and shrubland communities **(9)**

2a) (1a) Lakeshores dominated by a variety of exotic or invasive (mostly forb) species. *Tamarix chinensis* seedlings or saplings are often present with sparse to low cover - **Tamarix chinensis Ruderal Lakeshore Scrub** [Common species include *Bromus* spp., *Mentzelia multiflora, Salsola tragus, Gutierrezia* spp., and *Tamarix chinensis* (mostly in seedling form).These communities are highly variable and transitional.]





2b) Graminoid communities **(3)**

3a) (2b) San Juan River shoreline communites dominated by *Phalaris arundinacea* - **Phalaris arundinacea Western Marsh** [Other species present with low cover include *Phragmites australis, Salix exigua,* and *Tamarix chinensis.*]





3b) Washes, seeps, springs or hanging gardens **(4)**

4a) (3b) Dominated by *Sporobolus airoides* **(5)**

4b) Dominated by *Distichlis spicata, Muhlenbergia asperifolia, Phragmites australis,* or *Typha domingensis* **(6)**

5a) (4a) Co-dominated by *Sporobolus airoides* and *Pleuraphis jamesii* **- Pleuraphis jamesii - Sporobolus airoides Grassland** [Occurs on low stream terraces. *Ephedra torreyana* may be present with low cover.]





5b) Dominated by *Sporobolus airoides* and lacking *Pleuraphis jamesii* **- Sporobolus airoides Southern Plains Wet Meadow** [Stands occur along drainages and low stream terraces.]





6a) (4b) Dominated by *Distichlis spicata* **- Distichlis spicata Alkaline Wet Meadow** [*Bromus tectorum* may be present to co-dominant. Stands occur along stream channels. Associated shrub species include *Chrysothamnus viscidiflorus* and *Gutierrezia sarothrae*.]





6b) Dominated by *Muhlenbergia asperifolia, Phragmites australis,* or *Typha domingensis* **(7)**

7a) (6b) Small stands of *Typha domingensis* **- Typha domingensis Western Marsh** [Stands occur in a mosaic with other mesic species on saturated soils in canyon bottom washes. Associated species include *Saccharum ravennae, Phragmites australis, Juncus balticus,* and *Juncus tenuis,* along with the shrubs *Baccharis salicina, Chrysothamnus nauseosus,* and *Salix exigua*.]





7b) Dominated by *Muhlenbergia asperifolia* or *Phragmites australis* **(8)**

8a) (7b) Dominated by *Phragmites australis* – **Phragmites australis Western Ruderal Wet Meadow** [Some stands have a wide variety of wetland species present with low to moderate cover, including *Juncus tenuis, Muhlenbergia asperifolia, Equisetum arvense, Solidago occidentalis,* the trees *Populus fremontii* and *Acer negundo,* and the tall shrubs *Rhus trilobata, Ericameria nauseosa, Quercus gambelii, Tamarix chinensis,* and *Baccharis salicina*.]





8b) Small stands of *Muhlenbergia asperifolia* – **Muhlenbergia asperifolia Wet Meadow** [Small patches in cottonwood woodland stands that are co-dominated by *Juncus* sp., *Equisetum* sp., and *Tyhpa domingensis*.]



9a) (1b) Forest and woodland communities **(10)**

9b) Shrubland communities **(35)**

10a) (9a) Evergreen woodlands **(11)**

10b) Cold-deciduous woodlands **(16)**

11a) (10a) Dominated by *Pseudotsuga menziesii* with an understory dominated by *Cornus sericea* **- Pseudotsuga menziesii / Cornus sericea Riparian Woodland** [These woodlands occur in small pockets below cliff bands, at the top of talus slopes, where there is some seep moisture and a north-facing, protected cool aspect.]

No photos available

11b) Dominated by *Juniperus osteosperma* and/or *Pinus edulis* **(12)**

12a) (11b) Co-dominated by *Pinus edulis* and *Juniperus osteosperma* **(13)**

12b) Dominated by *Juniperus osteosperma* alone*; Pinus edulis* is absent **(15)**

13a) (12a) Understory is dominated by *Symphoricarpos longiflorus* – **Pinus edulis – Juniperus osteosperma/Symphoricarpos longiflorus Woodland** [Occurs in mesic alcove sites. Associated shrubs include *Amelanchier utahensis, Ephedra viridis, Mahonia fremontii,* and *Cercocarpus intricatus*.]





13b) Understory is dominated by species of *Quercus* **(14)**

14a) (13b) Understory is dominated by clumps of *Quercus havardii* var. *tuckeri* – **Pinus edulis – Juniperus osteosperma/Quercus havardii var. tuckeri Woodland** [Stands occur on sandy wash banks. A variety of other shrubs typical of washes may be present with low cover. If *Purshia stansburiana* and/or *Coleogyne ramosissima* are present with more than trace cover, skip ahead to Key 3, couplet 10b.]





14b) Understory is dominated by *Quercus gambelii* – **Pinus edulis - Juniperus osteosperma/Quercus gambelii Woodland** [Stands occur along washes/drainages, on sheltered slopes, or at the base of slickrock outcrops. Associated shrubs include *Amelanchier utahensis, Ericameria nauseosa, Ephedra viridis,* and *Mahonia fremontii*.]





15a) (12b) Understory is dominated by *Mahonia fremontii* – **Juniperus osteosperma/ Mahonia fremontii Woodland** [Stands occur on deep sandy soils on drainage terraces or canyon floors. Associated shrubs include *Purshia stansburiana, Fraxinus anomala,* and *Ephedra viridis*. Herbaceous species provide sparse cover.]





15b) Understory is dominated by *Quercus gambelii* **- Juniperus osteosperma/ Quercus gambelii Woodland** [Stands occur in canyon bottom drainages and protected alcoves. Associated species include *Symphoricarpos longiflorus, Rhus trilobata, Ericameria nauseosa, Cirsium arizonicum, Poa fendleriana,* and *Sporobolus cryptandrus*.]





16a) (10b) Often sparse *Fraxinus anomala* woodlands occurring along ephemeral stream channels – **Fraxinus anomala Riparian Woodland** [Total cover is always less than 10% and often less than 5%. Other tree and shrub species present may include *Cercis occidentalis, Rhus trilobata, Brickellia longifolia,* and *Amelanchier utahensis*.]





16b) Cold-deciduous woodlands not dominated by *Fraxinus anomala* **(17)**

17a) (16b) Dominated by the non-native species *Elaeagnus angustifolia* and co-dominated by *Populus fremontii* – **Elaeagnus angustifolia Ruderal Riparian Woodland** [Stands occur in canyon bottom washes. Associated species include *Clematis ligusticifolia, Elymus trachycaulis, Bromus tectorum, Rhus trilobata, Tamarix chinensis,* and *Salix exigua*.]





17b) Dominated by native species, including *Acer* spp., *Celtis laevigata*, *Cercis occidentalis*, *Ostrya knowltonii*, *Populus fremontii* and/or *Salix gooddingii* **(18)**

18a) (17b) Dominated by *Acer grandidentatum* or *Acer negundo*; if *Populus fremontii* is co-dominant, go to couplet 25a **(19)**

18b) Not dominated by *Acer* spp. **(21)**

19a) (24a) Dominated by *Acer grandidentatum*, with an understory dominated by *Quercus gambelii* – **Acer grandidentatum/Quercus gambelii Forest** [Stands occur on well

shaded, north-facing canyon slopes near seeps. The understory is dominated by *Quercus gambelii*, along with *Pinus edulis* and *Symphoricarpos longiflorus*.]



19b) Dominated by *Acer negundo* **(20)**

20a) (19b) Understory is xeric and dominated by weedy species, most commonly *Bromus tectorum* – **Acer negundo Disturbed Understory Riparian Woodland** [*Populus fremontii* may accompany *Acer negundo* in the canopy layer, but is not co-dominant. Stands occur on canyon bottom terraces. A shrub layer, if present, is dominated by *Artemisia tridentata* or *Ericameria nauseosa*.]





20b) A tall shrub understory dominated by *Quercus gambelii*, which occur in tree form - **Acer negundo/Quercus gambelii Riparian Woodland** [Stands occur near seeps and springs. The understory may include a variety of short shrubs, though total understory cover is generally sparse.]

No photos available

21a) (18b) *Ostrya knowltonii* woodlands occurring in alcove seep areas - **Ostrya knowltonii Riparian Woodland** [One stand had *Quercus gambelii* co-dominant. A variety of other species are present with low to moderate cover, including *Populus fremontii, Chrysopsis*

villosa, Solidago canadensis, Sporobolus airoides, Symphoricarpos longiflorus, and *Rhus trilobata*.]





21b) Dominated by *Celtis laevigata, Cercis occidentalis, Populus fremontii* and/or *Salix gooddingii* **(22)**

22a) (21b) Co-dominated by *Celtis laevigata var. reticulata* and *Cercis orbiculata* – **Celtis laevigata var. reticulata - Quercus gambelii - Cercis orbiculata Slickrock Canyon Spring & Riparian Woodland** [Stands occur in deep slickrock canyons, along rocky drainages, and in alcoves. The understory may be dominated by Quercus gambelii tall shrubs or by a variety of short shrubs, including *Salix exigua, Baccharis salicina, Rhus aromatica, Rosa woodsii*, and *Ericameria nauseosa*.]





22b) Dominated byPopulus fremontii and/or Salix gooddingii **(23)**

23a) (22b) *Salix gooddingii* woodlands (often dense); *Populus fremontii* is absent.The understory is dominated by *Salix exigua,* with or without *Tamarix chinensis* present to co-dominant - **Salix gooddingii/Salix exigua Riparian Woodland.**





23b) *Populus fremontii* woodlands/forests with or without *Acer negundo* or *Salix gooddingii* co-dominant **(24)**

24a) (23b) Understory is dominated by shrubs (including *Baccharis salicina, Ericameria nauseosa, Frangula betulifolia, Quercus gambelii*, *Salix exigua*, and *Tamarix chinensis*). *Acer negundo* or *Salix gooddingii* may be co-dominant in the canopy layer **(25)**

24b) Understory is dominated by forbs and/or grasses **or** is undeveloped (scoured by flooding) or otherwise sparse **(32)**

25a) (24a) Co-dominated by *Populus fremontii* and *Acer negundo* **- Populus fremontii/ Acer negundo Riparian Forest** [*Salix gooddingii* may occasionally be co-dominant in the canopy layer. The understory is variable and includes low to moderate cover by *Baccharis salicina, Ericameria nauseosa, Quercus gambelii, Tamarix chinensis, Equisetum* spp., *Bromus tectorum,* and *Elymus trachycaulis.*]





25b) *Acer negundo* is not co-dominant (generally not even present) in the canopy layer **(26)**

26a) (25b) Co-dominated by *Populus fremontii* and *Salix gooddingii* **(27)**

26b) Dominated by *Populus fremontii* alone **(28)**

27a) (26a) *Salix gooddingii* is co-dominant in the canopy layer and the understory is dominated by *Salix exigua* – **Populus fremontii - Salix gooddingii/Salix exigua Riparian Forest** [A variety of other shrubs may be present, with sometimes notable cover, including *Rhus aromatica, Tamarix chinensis, Ericameria nauseosa,* and/or *Baccharis salicina.* The herbaceous layer may include moderate cover of *Equisetum* spp., *Juncus* spp., *Elymus trachycaulis, Artemisia ludoviciana,* and *Carex* spp.]







28a) (26b) Understory is dominated by the non-native shrub, *Tamarix chinensis* – **Populus fremontii/Tamarix sp. Ruderal Riparian Woodland** [The shrub understory may be otherwise diverse, but *Tamarix chinensis* is dominant. If there is an herbaceous understory, it is generally dominated by weedy, annual grasses. The exotic tree, *Elaeagnus angustifolia,* may be present in the canopy layer.]





28b) Understory is dominated by native shrubs (including *Baccharis salicina*, *Ericameria nauseosa*, *Frangula betulifolia*, *Quercus gambelii*, or *Salix exigua*) **(29)**

29a) (28b) Understory is dominated by *Baccharis salicina* or *Ericameria nauseosa* **(30)**

29b) Understory is dominated by *Salix exigua*, *Frangula betulifolia*, and/or *Quercus gambelii* **(31)**

30a) (29a) Understory is dominated by *Baccharis salicina* – **Populus fremontii/Baccharis (emoryi, salicina) Riparian Woodland** [Stands occur in stream channels or on low terraces near perennial water flows. One stand was dominated by *Salix gooddingii* instead of *Populus fremontii*. Associated species include *Pluchea sericea*, *Ericameria nauseosa*, *Salix exigua*, and *Distichlis spicata*.]





30b) Understory is dominated by *Ericameria nauseosa* – **Populus fremontii/ Ericameria nauseosa Riparian Woodland** [Stands occur on intermittently flooded sites that have become isolated from the water table. *Juniperus osteosperma* may be co-dominant as a subcanopy layer. Scattered shrubs such as *Artemisia tridentata* and *Rhus trilobata* may be present. The herbaceous layer is highly variable.]





31a) (29b) *Salix gooddingii* is absent from the canopy layer and the understory is dominated by *Salix exigua* – **Populus fremontii/Salix exigua Riparian Forest** [If *Acer negundo* is present in the canopy layer, it is with low cover. A variety of other shrubs may be present including *Ericameria nauseosa* and *Rhus aromatica.* The herbaceous layer may include *Muhlenbergia asperifolia, Artemisia campestris,* and *Artemisia ludoviciana*.]





31b) Understory is dominated by *Quercus gambelii*, with some amount of *Frangula betulifolia* and/or *Rhus trilobata* generally present to abundant **– Populus fremontii/ Frangula betulifolia – Quercus gambelii Spring and Riparian Woodland** [In some stands, the canopy layer has very low cover and the tall shrub layer (*Quercus gambelii* especially) dominates total cover. These wetland and riparian stands occur around hillslope springs and perennial streams and their upper terraces. *Acer negundo* and/or *Salix gooddingii* trees may be present in the canopy layer and *Phragmites australis* may dominate the understory. A variety of other mesic shrubs and graminoids may also be present in the understory.]









32a) (24b) Understory is sparse or undeveloped **(33)**

32b) Understory is dominated by forbs and/or grasses **(34)**

33a) (32a) Low cover generally, *Populus fremontii* woodlands with a sparse or undeveloped understory due to frequent flooding – **Populus fremontii/Scour Forest**



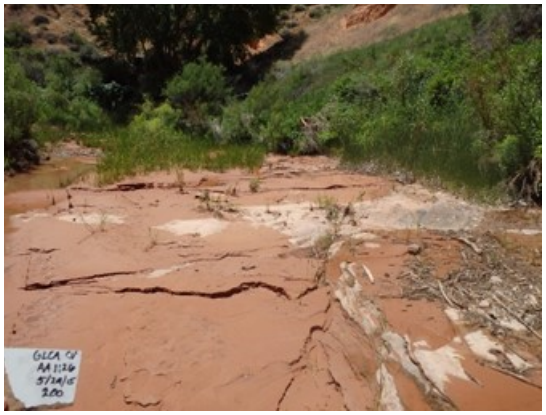


33b) Dense *Populus fremontii* woodlands with a sparse or undeveloped understory due to shading – **Populus fremontii/Sparse Riparian Forest** [Sites have relatively drier soils due to being elevated from the wash channel on terraces that are rarely flooded.]





34a) (32b) Understory is dominated by mixed mesic forbs, most notably by *Artemisia ludoviciana, Iva acerosa,* and *Solidago canadensis* – **Populus fremontii/Mesic Forbs Riparian Woodland** [Stands occur on saturated soils of intermittently flooded drainages. Scattered shrubs with trace to low cover may be present, including *Ericameria nauseosa, Rosa woodsii, Salix* spp., and *Baccharis salicina*.]





34b) The understory is dominated by mixed mesic graminoids – **Populus fremontii/Mesic Graminoids Riparian Woodland** [Understory graminoid species include *Equisetum arvense, Equisetum laevigatum, Elymus* spp., *Juncus* spp., *Panicum* spp., *Typha domingensis, Muhlenbergia asperifolia, Phragmites australis,* and *Poa* spp. *Salix gooddingii* may be co-dominant in the canopy layer. Scattered shrubs may be present.]





35a) (9b) Non-native shrublands (dominated by *Tamarix chinensis* or *Alhagi maurorum*) occurring along washes, rivers or lakeshores **(36)**

35b) Native shrublands occurring in canyon bottoms, washes, alluvial terraces/benches, stream banks, drainages, seeps, or other places that receive runoff and/or retain moisture, but may dry out later in the year **(38)**

36a) (25a) *Alhagi maurorum* shrublands – **Alhagi maurorum Ruderal Scrub** [Stands occur along the San Juan River. Associated species include *Pluchea sericea, Tamarix chinensis, Ericameria nauseosa,* and *Bromus* spp.]





36b) Dominated by *Tamarix chinensis* **(37)**

37a) (36b) *Tamarix chinensis* shrublands **– Tamarix spp. Ruderal Riparian Shrubland** [Stands may be open and associated with other species or a closed, dense monoculture; *Tamarix chinensis* shrubs may range from young saplings to large, older trees. Sites include lakeshores (receding, abandoned, and current), riverbanks, stock ponds, and tributary drainages.]





37b) Lakeshores dominated by a variety of exotic or invasive (mostly forb) species. *Tamarix chinensis* seedlings or saplings are often present with sparse to low cover – **Tamarix chinensis Ruderal Lakeshore Scrub** [Common species include *Bromus* spp., *Mentzelia multiflora, Salsola tragus, Gutierrezia* spp., and *Tamarix chinensis* (mostly in seedling form).These communities are highly variable and transitional.]





38a) (35b) Moist sites, where perennial water is present and soils are generally saturated **(39)**

38b) Drier sites that are intermittently flooded, receive runoff, and/or retain moisture, but are not perennially moist **(48)**

39a) (38a) Dominated by *Betula occidentalis, Frangula betulifolia, Parthenocissus vitacea,* and/or *Pluchea sericea* **(40)**

39b) Dominated by *Salix exigua, Baccharis salicina,* and/or *Quercus gambelii* **(42)**

40a) (39a) *Betula occidentalis* shrublands – **Betula occidentalis Desert Spring Shrubland** [Stands occur in alcoves near seeps or ponds or on slopes near seeps. Other species that may be present include *Cornus sericea, Quercus gambelii, Fraxinus anomala, Rosa woodsii, Equisetum arvense,* and *Aquilegia micrantha*.]



40b) Dominated by *Frangula betulifolia*, *Parthenocissus vitacea*, and/or *Pluchea sericea* **(41)**

41a) (40b) Dense, diverse riparian wooded shrublands where *Frangula betulifolia* and *Parthenocissus vitacea* are always present together (though not always the dominant species) – **Frangula betulifolia Wet Shrubland** [Stands occur in mesic canyon bottoms. Associated species with moderate to high cover include *Salix gooddingii*, *Populus fremontii*, *Acer negundo*, *Quercus gambelii*, *Rosa woodsii*, *Rhus trilobata*, *Equisetum* spp., *Typha* spp., *Cyperus* spp., and *Toxicodendron rydbergii*.]





41b) *Pluchea sericea* shrublands occurring along perennials streams **- Pluchea sericea Wet Shrubland** [Some stands are overwhelmingly dominated by *Pluchea sericea*, while others are a diverse assemblage of riparian species including some combination of *Salix exigua*, *Tamarix chinensis*, *Baccharis salicina*, *Quercus gambelii*, *Isocoma rusbyi*, *Chrysopsis villosa*, *Muhlenbergia asperifolia*, *Phragmites australis*, and *Schizachyrium scoparium*.]





42a) (43b) Dominated by *Quercus gambelii*, with *Rhus trilobata* or *Symphoricarpos* spp. present to co-dominant [If you are in a *Quercus gambelii* shrubland and it is not represented in couplet 43, go to Key IV, couplet 4a.] **(43)**

42b) Dominated by *Salix exigua* and/or *Baccharis* spp. **(44)**

43a) (42a) Co-dominated by*Quercus gambelii* and *Rhus trilobata* – **Quercus gambelii/ Rhus trilobata Shrubland** [Stands occur on mesic low slopes and flats of canyon bottoms near creeks, rivers, or seeps. Understories are variable and may be sparse to moderately dense and diverse; one stand had high cover of *Spartina gracilis*, another had high cover of *Bromus tectorum*.]





43b) *Quercus gambelii* shrublands, with an understory dominated by *Symphoricarpos longiflorus* **– Quercus gambelii/Symphoricarpos oreophilus Shrubland** [Stands occur on canyon side slopes. Note that the NVC name lists a different *Symphoricarpos* sp. which does not occur in GLCA.]





44a) (42b) *Baccharis salicifolia* shrublands **– Baccharis salicifolia Riparian Shrubland** [The only sampled stand in GLCA was co-dominated by *Tamarix chinensis* and had moderate cover of *Juncus* sp. in the understory. It was located in a narrow canyon bottom in an area which had previously been flooded by the lake.]





44b) Dominated by *Salix exigua* and/or *Baccharis salicina* **(45)**

45a) (44b *Baccharis salicina* shrublands (*Salix exigua* is absent) – **Baccharis salicina Shrubland** [Stands occur in mesic canyon bottoms near perennial creeks (beaver pond noted) or near the lakeshore in depression pockets. Some stands are homogenous patches of *Baccharis salicina*, whereas others include a mix of species including *Ericameria nauseosa, Rhus trilobata, Sporobolus giganteus,* and *Juncus tenuis*.]





45b) *Salix exigua* shrublands with or without *Baccharis salicina* co-dominant **(46)**

46a) (45b) *Salix exigua* shrublands with *Baccharis salicina* co-dominant – **Baccharis (emoryi, salicina) - Salix exigua Wet Shrubland** [Stands occur on intermittently flooded stream terraces in canyon bottoms. Associated species include *Ericameria nauseosa, Phragmites australis, Tamarix chinensis,* and *Typha domingensis*.]





46b) *Salix exigua* shrublands with no other shrub species co-dominant **(47)**

47a) (46b)Understory is sparse to undeveloped – **Salix exigua/Gravel Bar Wet Shrubland** [Stands occur on recently exposed banks and point bars along the lake, the Colorado River, and in recently (and/or frequently) scoured tributary washes.]





47b) Understory is dominated by a mix of mesic graminoids – **Salix exigua/Mesic Graminoids Western Wet Shrubland** [Stands occur along the banks of intermittently flooded stream channels. Understory species include *Juncus balticus, Carex* spp., *Phragmites australis, Muhlenbergia asperifolia,* and/or *Equisetum* spp.]





48a) (38b) Saline flats dominated by *Sarcobatus vermiculatus* and/or *Suaeda moquinii* **(49)**

48b) Sandy sites along wash channels, banks, and terraces dominated by *Artemisia* spp., *Atriplex canescens, Brickellia longifolia, Ericameria nauseosa, Fallugia paradoxa, Mahonia fremontii,* and/or *Rhus trilobata* **(53)**

49a) (48a) *Suaeda moquinii* shrublands **- Suaeda moquinii Wet Shrubland** [Stands occur on floodplain terraces. Associated species may include *Atriplex confertifolia* and *Achnatherum hymenoides*.]





49b) Saline flats dominated by *Sarcobatus vermiculatus* **(50)**

50a) (49b) Co-dominated by *Atriplex gardneri* or *Saueda moquinii* **(51)**

50b) Dominated by *Sarcobatus vermiculatus* alone, with a sparse, weedy, or grassy understory **(52)**

51a) (50a) Co-dominated by *Sarcobatus vermiculatus* and *Atriplex gardneri*, and occurring on alluvial flats **– Sarcobatus vermiculatus/Atriplex gardneri Wet Shrubland**



51b) Co-dominated by *Sarcobatus vermiculatus* and *Suaeda moquinii*, and occurring in canyon bottoms – **Sarcobatus vermiculatus/Suaeda moquinii Wet Shrubland**





52a) (50b) *Sarcobatus vermiculatus* shrublands with sparse or weedy understories – **Sarcobatus vermiculatus Disturbed Wet Shrubland** [Stands occur on floodplains and stream terraces. Total cover ranges from sparse to up to 60%. Scattered *Suaeda torreyana*, *Ericameria nauseosa*, *Atriplex canescens,* and *Krascheninnikovia lanata* may be present. Forbs tend to be weedy and generally dominate the understory.]





52b) *Sarcobatus vermiculatus* shrublands with an understory dominated by *Sporobolus airoides* – **Sarcobatus vermiculatus/Sporobolus airoides Wet Shrubland** [Stands occur on valley floor floodplains and terraces. Associated shrubs include *Atriplex* spp., *Chrysothamnus* spp., and *Tamarix chinensis*.]





53a) (48b) Dominated by *Fallugia paradoxa, Mahonia fremontii*, or *Rhus trilobata* **(54)**

53b) Dominated by *Artemisia* spp., *Atriplex canescens*, *Brickellia longifolia*, and/or *Ericameria nauseosa* **(56)**

54a) (53a) *Mahonia fremontii* shrublands – **Mahonia fremontii Shrubland** [Stands occur on high terraces of canyon bottoms. Some stands have high biological soil crust cover. Other species present may include *Ericameria nauseosa*, *Pleuraphis jamesii*, and *Salsola tragus*.]





54b) Dominated by *Fallugia paradoxa* or *Rhus trilobata* **(55)**

55a) (54b) *Fallugia paradoxa* shrublands – **Fallugia paradoxa Colorado Plateau Desert Wash Shrubland** [Stands occur along drainage channels. Often part of a diverse shrub community composed of both upland and somewhat mesic shrub species including *Atriplex canescens*, *Ericameria nauseosa*, *Rhus trilobata*, *Mahonia fremontii*, and *Purshia mexicana*.]





55b) *Rhus trilobata* shrublands occurring along drainage channels **– Rhus trilobata Moist Wet Shrubland** [Stands occur along drainage channels. Associated shrubs include *Ericameria nauseosa*, *Artemisia filifolia, Atriplex canescens*, and *Brickellia longifolia*.]





56a) (53b) Dominated by *Artemisia filifolia* **(57)**

56b) Dominated by *Artemisia tridentata, Atriplex canescens, Brickellia longifolia,* and/or *Ericameria nauseosa* **(58)**

57a) (56a) *Artemisia filifolia* shrublands – **Artemisia filifolia Colorado Plateau Shrubland** [Stands occur on benches, stream terraces, and valley bottoms and often have a weedy understory. *Atriplex canescens, Ericameria nauseosa, Ephedra viridis, Gutierrezia sarothrae,* and *Psorothamnus fremontii* are common associates.]





57b) Co-dominated by *Artemisia filifolia* and *Ephedra torreyana* (or more rarely *Ephedra viridis*) – **Artemisia filifolia - Ephedra (torreyana, viridis) Shrubland** [Stands occur on benches, stream terraces, and valley bottoms. *Atriplex canescens* and *Ericameria nauseosa* are common associates. Stands may have a diverse herbaceous layer.]





58a) (56b) *Brickellia longifolia* shrublands **– Brickellia longifolia Shrubland** [Stands occur in cobble-filled canyon bottom drainages. [Stands are generally sparse, though may have several shrub associates, including *Ericameria nauseosa, Ephedra* spp., *Rhus trilobata,* and *Tamarix chinensis.*]





58b) Dominated by *Artemisia tridentata, Atriplex canescens*, and/or *Ericameria nauseosa* **(59)**

59a) (58b) Dominated by *Atriplex canescens* with or without *Artemisia tridentata* co-dominant **(60)**

59b) Dominated by *Artemisia tridentata* and/or *Ericameria nauseosa* **(64)**

60a) (59a) Co-dominated by *Atriplex canescens* and *Artemisia tridentata ssp. tridentata* – **Atriplex canescens – Artemisia tridentata Shrubland** [Stands occur on benches, canyon floors, and stream terraces. *Ericameria nauseosa* and *Muhlenbergia asperifolia* may be present.]





60b) Dominated by *Atriplex canescens* alone in the shrub layer, with or without a developed understory **(61)**

61a) (60b) Understory is sparse or weedy, (if there is native grass cover, there is no dominant grass species) **(62)**

61b) Understory is grassy and dominated by *Achnatherum hymenoides* or *Pleuraphis jamesii* **(63)**

62a) (61b) Understory is sparse and/or dominated by weedy, annual species – **Atriplex canescens Shrubland** [Stands occur on deep soils of stream terraces and in canyon bottoms.]





62b) Understory is sparse or grassy; grass cover is low but may be diverse, with no species clearly dominant **– Atriplex canescens Desert Wash Shrubland** [Stands occur in and along intermittent wash channels. Associated shrubs include *Ericameria nauseosa, Lycium andersonii,* and *Suaeda moquinii*.]





63a) (61b) Understory is dominated by *Achnatherum hymenoides* – **Atriplex canescens/ Achnatherum hymenoides Shrubland** [Stands occur on steep canyon side slopes or canyon bottom terraces. Other shrubs with sparse cover may include *Ephedra torreyana* and *Coleogyne ramosissima.* Many weedy species are also present in the herbaceous layer, including *Bromus tectorum,* which may be abundant.]





63b) Understory is dominated by *Pleuraphis jamesii* **- Atriplex canescens /Pleuraphis jamesii Shrubland** [Stands occur on canyon bottom terraces. The substrate is often stabilized by moss and crypto cover. *Bromus tectorum* may be present with low cover.]





64a) (59b) Dominated by *Artemisia tridentata* with or without *Ericameria nauseosa* present to co-dominant **(65)**

64b) Dominated by *Ericameria nauseosa*; *Artemisia tridenata* is absent **(66)**

65a) (64a) *Artemisia tridentata* ssp. *tridentata* shrublands with *Ericameria nauseosa* occasionally present to co-dominant in the shrub canopy – **Artemisia tridentata – (Ericameria nauseosa)/Bromus tectorum Ruderal Shrubland** [Stands occur on stream terraces that have a history of anthropogenic disturbance (namely grazing). *Bromus tectorum* clearly dominates the understory, often with other weedy, annual species.]





65b) *Artemisia tridentata* ssp. *tridentata* shrublands with no co-dominants in the shrub layer and with a poorly developed or sparse understory – **Artemisia tridentata Shrubland** [Stands occur on stream terraces and canyon bottoms. The remaining shrub layer may include *Atriplex canescens, Ericameria nauseosa, Sarcobatus vermiculatus,* and cacti.]





66a) (64b) Understory is undeveloped or sparse and no other shrub species is present with consistent or notable cover – **Ericameria nauseosa Desert Wash Shrubland** [Stands occur on the banks of intermittent streams, in canyon bottoms, and along dry wash channels.]




66b) Understory is dominated by *Sporobolus airoides* or *Bromus* spp. **(67)**

67a) (66b) Understory is weedy and dominated by *Bromus tectorum* or *Bromus rubens* – **Ericameria nauseosa / Bromus tectorum Ruderal Shrubland** [*Glossopetalon spinescens, Atriplex canescens, Ephedra cutleri*, and *Psorothamnus fremontii* contribute diversity but little cover.]





67b) Understory is dominated by *Sporobolus airoides* – **Ericameria nauseosa/ Sporobolus airoides Shrubland** [Stands occur on the floodplains of intermittent streams. The only associated species noted were *Atriplex canescens* and *Distichlis spicata.*]





Key III: A Key to the UPLAND Forest, Woodland, and Wooded SHRUBLAND ASSOCIATIONS of glen canyon National recreation area and Rainbow Bridge national Monument

1a) *Pseudotsuga menziesii* woodlands – **Pseudotsuga menziesii Scree Woodland** [The understory may include sparse to low cover of *Amelanchier utahensis, Quercus gambelii, Fraxinus anomala, Mahonia fremontii,* and *Shepherdia rotundifolia*. Stands typically occur on steep colluvial slopes at the heads of canyon tributaries.]



1b) *Juniperus osteosperma* and/or *Pinus edulis* forests, woodlands or wooded shrublands **(2)**

2a) (1b) Canopy dominated by*Juniperus osteosperma*. *Pinus edulis* not co-dominant **(3)**

2b) Canopy dominated by *Pinus edulis*, often with *Juniperus osteosperma* present to co-dominant **(13)**

3a) (2a) Less than 3% understory cover – **Juniperus osteosperma/Sparse Understory Woodland** [Stands occur in xeric, exposed sites on soils of low water-holding capacity, on soils covered with well-developed biological crusts, or on thin soils covered by gravelly rocks. Common species that contribute trace to very low cover include *Fraxinus anomala, Ericameria nauseosa, Eriogonum microthecum, Gutierrezia sarothrae, Pleuraphis jamesii,* and *Ephedra viridis*.]





3b) Greater than 3% understory cover **(4)**

4a) (3b) Shrubs not dominant in the understory (<5% cover); grasses have higher total cover than shrubs **(5)**

4b) Shrubs dominant (>5% cover) in the understory **(7)**

5a) (4a) Understory is dominated by *Leymus salinus* – **Juniperus osteosperma/Leymus salinus Open Woodland** [Stands occur on moderate to steep colluvial slopes and scattered shrubs such as *Ephedra viridis, Shepherdia rotundifolia, Artemisia bigelovii, Ericameria nauseosa,* and *Chrysothamnus viscidiflorus* are usually present with low cover.]





5b) Understory is dominated by *Pleuraphis jamesii* or *Hesperostipa comata* **(6)**

6a) (5b) Understory is dominated by *Pleuraphis jamesii* – **Juniperus osteosperma/ Pleuraphis jamesii Open Woodland** [Stands occur on stream terraces, hills and other sandy sites. Scattered shrubs such as *Ephedra torreyana, Gutierrezia sarothrae, Artemisia bigelovii,* and *Ericameria nauseosa* are sometimes present with low cover.]





6b) Understory is dominated by *Hesperostipa comata,* with *Achnatherum hymenoides* often codominant **– Juniperus osteosperma/Hesperostipa comata Open Woodland** [Stands occur on mesatops, dunes, and in canyon bottoms. The shrub layer may be diverse and have nearly equal cover to the herbaceous layer, with no obvious or consistently dominant species.]





7a) (4b) Understory consists of a diverse and inconsistent mix of shrubs and stands ALWAYS occur on talus/colluvial slopes – **Juniperus osteosperma/Mixed Shrubs Talus Woodland** [Total vegetation cover is generally sparse and nearly always less than 15%. The shrub layer may include any combination of: *Artemisia bigelovii, Atriplex confertifolia, Brickellia microphylla, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra* spp., *Ericameria nauseosa, Eriogonum corymbosum, Fraxinus anomala, Gutierrezia sarothrae, Rhus trilobata, Amelanchier utahensis, Shepherdia rotundifolia,* and *Fendlera rupicola*.]





7b) Understory is clearly dominated by one or two shrub species and stands rarely occur on talus/colluvial slopes **(8)**

8a) (7b) Understory is dominated by *Coleogyne ramosissima* – **Juniperus osteosperma/ Coleogyne ramosissima Woodland** [Stands occur on a variety of substrates and environmental settings. If *Purshia stansburiana* and/or *Quercus havardii* var. *tuckeri* are present with more than trace cover, skip ahead to couplet 10b. Associated shrubs may include *Artemisia bigelovii*, *Ephedra* spp., *Fraxinus anomala*, *Gutierrezia* spp. and *Yucca* spp.]





8b) Understory is not dominated by *Coleogyne ramosissima*; though it is a common associate and may be co-dominant in some stands **(9)**

9a) (8b) Stands occur on slickrock exposures or other shallow rocky substrates **(10)**

9b) Stands do not occur on slickrock exposures but on deeper sandy soils of valley bottoms, broad mesa tops, or dunes **(11)**

10a) (9a) Understory is dominated by *Cercocarpus intricatus* – **Juniperus osteosperma/ Cercocarpus intricatus Woodland** [Woody plants tend to root in joints in the slickrock. The often diverse shrub layer may include *Artemisia bigelovii, Coleogyne ramosissima, Cercocarpus montanus, Ephedra viridis, Fraxinus anomala,* and *Glossopetalon spinescens.*]




10b) Understory is co-dominated by at least two of the following: *Coleogyne ramosissima, Purshia stansburiana,* and *Quercus havardii* var. *tuckeri* – **Juniperus osteosperma – (Pinus edulis)/Coleogyne ramosissima - Purshia stansburiana – Quercus havardii Wooded Shrubland** [Stands occur on thin soils overlying sandstone bedrock (more rarely, along wash channels in a sandstone matrix). *Pinus edulis* may be present.]




11a) (9b) Understory is dominated by *Quercus havardii* var. *tuckeri* and co-dominated by *Ephedra cutleri* and/or *Artemisia filifolia* – **Juniperus osteosperma/Quercus havardii - Artemisia filifolia - Ephedra cutleri Sandsheet Scrub** [Stands occur on sand dunes and sand sheets. *Achnatherum hymenoides* is consistently present and often co-dominant in the understory. Other species noted with more than trace cover include *Poliomintha incana, Atriplex canescens, Sporobolus* spp., and *Muhlenbergia pungens.*]





11b) Understory is dominated by *Artemisia tridentata* or *Mahonia fremontii* **(12)**

12a) (11b) Understory is dominated by *Mahonia fremontii* – **Juniperus osteosperma/ Mahonia fremontii Woodland** [Stands occur on deep soils of broad mesas or on valley bottoms. Associated shrubs include *Rhus trilobata, Ephedra viridis,* and *Atriplex canescens*. Herbaceous species provide sparse cover.]





12b) Understory is dominated by *Artemisia tridentata* ssp. *wyomingensis* – **Juniperus osteosperma/Artemisia tridentata Woodland** [Stands occur on high elevation mesa tops where deeper soils are stabilized by soil crust and moss cover. *Pinus edulis* may be present with trace cover.]





13a) (2b) Less than 3% understory cover, although the cover of biotic crusts may be high – **Pinus edulis – Juniperus osteosperma/Sparse Understory Woodland** [The understory may be sparse for any of a number of reasons, including (1) xeric shale or sand substrates with poor water- holding capacity, (2) a surface covered by rock or gravel, limiting germination sites, or (3) the stand is old growth and trees consume all the resources. A variety of shrubs may be present with trace to very low cover.]





13b) Greater than 3% understory cover **(14)**

14a) (13b) Shrubs not dominant in the understory (<5% cover); grasses have higher total cover than shrubs **(15)**

14b) Shrubs dominant (>5% cover) in the understory **(19)**

15a) (14a) The understory is dominated by *Poa fendleriana* – **Pinus edulis – Juniperus spp./Poa fendleriana Woodland** [Stands occur on high elevation mesa tops on level terrain. Other species present to co-dominant in the understory include *Petradoria pumila* and *Bromus tectorum*.]





15b) Understory is dominated by *Achnatherum hymenoides*, *Leymus salinus*, *Muhlenbergia pungens*, or *Pleuraphis jamesii* **(16)**

16a) (15b) Understory is dominated by *Achnatherum hymenoides* or *Muhlenbergia pungens* **(17)**

16b) Understory is dominated by *Leymus salinus* or *Pleuraphis jamesii* **(18)**

17a) (16a) Understory is dominated by *Achnatherum hymenoides* **– Pinus edulis – Juniperus osteosperma/Achnatherum hymenoides Woodland** [Stands occur on warmer (west and north-west facing) shale slopes and rolling sites. A variety of other native grasses may be present with low cover.]





17b) Understory is dominated by *Muhlenbergia pungens* – **Pinus edulis – Juniperus osteosperma/Muhlenbergia pungens Woodland** [Stands occur on sand dune deposits on mesa tops. Shrub cover is inconsistent: sparse to nearly co-dominant with herbaceous cover.]





18a) (16b) Understory is dominated by *Leymus salinus* – **Pinus edulis – Juniperus spp./ Leymus salinus Woodland** [Stands occur on cooler (north or east-facing) colluvial slopes with a shale substrate, and occasionally on canyon bottoms or along dry wash channels. Scattered individuals of *Fraxinus anomala, Purshia stansburiana, Ephedra viridis, Gutierrezia sarothrae, Artemisia bigelovii, Eriogonum microthecum,* and/or *Chrysothamnus viscidiflorus* var. *stenophyllus* are often present.]





18b) Understory is dominated *Pleuraphis jamesii* – **Pinus edulis - Juniperus osteosperma /Pleuraphis jamesii Woodland** [Stands occur on warmer (west-facing) colluvial slopes with a shale substrate, on high mesa tops, or on valley bottom benches.]





19a) (14b) Understory consists of a diverse and inconsistent mix of shrubs and stands ALWAYS occur on talus/colluvial slopes – **Pinus edulis – Juniperus osteosperma/Mixed Shrubs Talus Woodland** [Common understory species with sparse to low cover include any combination of: *Artemisia bigelovii, Atriplex confertifolia, Brickellia microphylla, Coleogyne ramosissima, Ephedra viridis, Ericameria nauseosa, Fraxinus anomala, Gutierrezia sarothrae, Rhus trilobata, Amelanchier utahensis, Fendlera rupicola,* and *Shepherdia rotundifolia*.]





19b) Understory clearly dominated by one or two shrub species and stands occur on a variety of substrates and environmental settings **(20)**

20a) (19b) Understory is dominated by clumps of *Quercus havardii* var. *tuckeri* – **Pinus edulis – Juniperus osteosperma/Quercus havardii var. tuckeri Woodland** [Stands occur on sand dunes and sandy wash banks. A variety of other shrubs typical of dunes and washes may be present with low cover. *Purshia stansburiana* and *Coleogyne ramosissima* are absent or have no more than trace cover (return to couplet 10b if these species are co-dominant with *Quercus havardii* var. *tuckeri*).]





20b) Understory is not dominated by *Quercus havardii* var. *tuckeri* **(21)**

21a) (20b) Understory is dominated by *Artemisia* spp. **(22)**

21b) Understory is dominated by *Artemisia* spp. **(24)**

22a) (21a) Understory is dominated by *Artemisia bigelovii* – **Pinus edulis – Juniperus osteosperma/Artemisia bigelovii Woodland** [Stands occur on shallow soils of mesa tops or on slickrock rims. The mixed shrub understory may include *Fraxinus anomala, Cercocarpus intricatus, Fendlera rupicola, Gutierrezia sarothrae*, and *Yucca baccata*.]




22b) Understory is dominated by *Artemisia tridentata* or *Artemisia nova* **(23)**

23a) (22b) Understory is dominated by *Artemisia tridentata* ssp. *wyomingensis* – **Pinus edulis - Juniperus osteosperma/Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland** [Stands occur on mesa tops, plains, and drainage terraces. Associated shrubs include *Amelanchier utahensis* and *Ephedra viridis.* The herbaceous layer is sparse and often has been affected by grazing.]




23b) Understory is dominated by *Artemisia nova* – **Pinus edulis – Juniperus osteosperma /Artemisia nova Woodland** [Stands occur on deeper soils of plateaus and mesa tops at higher elevations within the NRA.]




24a) (21b) Understory is dominated by *Coleogyne ramosissima* or *Purshia stansburiana* **(25)**

24b) Understory is not dominated by *Coleogyne ramosissima* or *Purshia stansburiana* **(26)**

25a) (24a) Understory is dominated by *Purshia stansburiana* – **Pinus edulis – Juniperus osteosperma/Purshia stansburiana Woodland** [Stands occur on slickrock outcrops or on shallow soils in a sandstone bedrock mosaic on plateaus, mesas, and canyon rims, more rarely along dry wash channels. *Coleogyne ramosissima* and *Quercus havardii* var. *tuckeri* are absent or have no more than trace cover (return to couplet 10b if these species are co-dominant with *Purshia stansburiana*).]





25b) Understory is dominated by *Coleogyne ramosissima* – **Pinus edulis – Juniperus osteosperma/Coleogyne ramosissima Woodland** [Stands occur on shallow to moderately deep soils of plateaus, canyon rims, and valley floors, ocassionally in a sandstone bedrock mosaic. *Purshia stansburiana* and *Quercus havardii* var. *tuckeri* are absent or have no more than trace cover (return to couplet 10b if these species are co-dominant with *Coleogyne ramosissima*).]





26a) (24b) Understory is dominated by *Cercocarpus intricatus* or *Cercocarpus montanus* **(27)**

26b) Understory is not dominated by *Cercocarpus* spp. **(28)**

27a) (26a) Understory is dominated by *Cercocarpus intricatus* – **Pinus edulis – Juniperus osteosperma/Cercocarpus intricatus Woodland** [Stands occur on level to sloping slickrock outcrops and canyon rims. Other shrubs often present include *Fraxinus anomala, Amelanchier utahensis, Ephedra viridis, Artemisia bigelovii, Rhus trilobata, Coleogyne ramosissima,* and *Ericameria nauseosa*.]





27b) Understory is dominated by *Cercocarpus montanus* – **Pinus edulis - Juniperus osteosperma/Cercocarpus montanus - Mixed Shrubs Woodland** [Stands occur on bedrock ledges and on sheltered colluvial slopes. The remainder of the shrub stratum may include scattered *Fraxinus anomala, Amelanchier utahensis, Quercus gambelii, Purshia stansburiana, Ephedra viridis, Artemisia bigelovii, Symphoricarpos longiflorus,* and *Eriogonum microthecum*.]





28a) (24b) Understory is dominated by *Quercus turbinella* – **Pinus edulis – Juniperus osteosperma/Quercus turbinella Woodland** [Stands occur on steep, bouldery slopes. *Shepherdia rotundifolia, Ericameria nauseosa,* and *Ephedra viridis* are common associates.]



28b) Understory is not dominated by *Quercus turbinella* **(29)**

29a) (28b) Understory is co-dominated by *Ephedra viridis* and *Gutierrezia spp., Opuntia* spp. may also be co-dominant. *Pinus edulis* is occasionally absent from the canopy layer **– Pinus edulis - Juniperus osteosperma/Ephedra viridis - Gutierrezia sarothrae Woodland** [Open woodlands on a variety of substrates and landforms. Total understory cover may be quite low. The herbaceous layer may have low to moderate cover and include a variety of native grasses.]





29b) Understory is dominated by *Amelanchier utahensis* and/or *Shepherdia rotundifolia* **(30)**

30a) (29b) Understory is dominated by *Amelanchier utahensis*; *Shepherdia rotundifolia* is absent, or if present, has no more than trace cover – **Pinus edulis – Juniperus osteosperma/Amelanchier utahensis Woodland** [Stands occur on moderate to steep slopes and on gravelly, talus, or slickrock substrates. Associated shrubs include *Fendlera rupicola, Fraxinus anomala, Coleogyne ramosissima, Ericameria nauseosa, Chrysothamnus viscidiflorus, Ephedra torreyana, Eriogonum corymbosum, Purshia mexicana,* and *Eriogonum microthecum*.]





30b) Understory is dominated by *Shepherdia rotundifolia*, with or without *Amelanchier utahensis* present to co-dominant **(31)**

31a) (30b) Understory is dominated by *Shepherdia rotundifolia; Amelanchier utahensis* is absent – **Pinus edulis – Juniperus osteosperma/Shepherdia rotundifolia Woodland** [Stands occur on level to rolling shale barrens, on slickrock outcrops of plains and mesa tops, or on moderate to steep, shale or talus slopes. *Ephedra viridis* may be present to co-dominant and *Leymus salinus* is often present.]




31b) Understory is co-dominated by*Shepherdia rotundifolia* and *Amelanchier utahensis* – **Pinus edulis – Juniperus osteosperma/(Shepherdia rotundifolia – Amelanchier utahensis) Wooded Shrubland** [Stands occur on cool aspect, often steep, shale or talus slopes. The shrub layer is diverse and may include *Fraxinus anomala, Ephedra viridis*, and *Eriogonum corymbosum; Leymus salinus* is a common grass.]


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Key IV: A Key to the UPLAND Shrubland and Shrub Herbaceous Vegetation Associations of glen canyon national recreation area and Rainbow bridge national monument

1a) Communities dominated by tall shrub species (generally ≥ 1.5 meters in height) including *Amelanchier*, *Cercocarpus*, *Fraxinus*, *Purshia*, *Quercus* (*gambelii* or *turbinella*), and/or *Rhus* **(2)**

1b) Communities dominated by short shrub species (generally ≤ 1.5 meters in height) including *Artemisia*, *Atriplex*, *Chrysothamnus*, *Coleogyne*, *Encelia*, *Ephedra*, *Ericameria*, *Eriogonum*, *Glossopetalon*, *Grayia*, *Gutierrezia*, *Krascheninnikovia*, *Opuntia*, *Poliomintha*, *Psorothamnus*, *Vanclevea*, or *Zuckia* **(12)**

2a) (1a) Dominated by *Quercus turbinella* or *Quercus gambelii* **(3)**

2b) Dominated by *Amelanchier*, *Cercocarpus*, *Fraxinus*, *Purshia*, and/or *Rhus* **(7)**

3a) (2a) Dominated by *Quercus turbinella* and **Rhus aromatica var. simplicifolia** and occurring on north-facing, rocky slopes - **Quercus turbinella - (Rhus trilobata, Artemisia tridentata) Shrubland**



3b) Dominated by *Quercus gambelii* **(4)**

4a) (3b) Dense monocultures of *Quercus gambelii* **- Quercus gambelii Shrubland** [No co-dominants in the shrub layer and lacking a developed understory, mainly due to shading and thick litter cover. Stands occur mostly on north-facing slopes.]





4b) Co-dominated by *Amelanchier utahensis* and/or *Artemisia tridentata* **(5)**

5a) (4b) Dominated by *Quercus gambelii* with both *Amelanchier utahensis* and *Artemisia tridentata* present to co-dominant in the shrub layer and with an understory dominated by *Poa fendleriana* **– Quercus gambelii/Poa fendleriana Shrubland** [Stands occur on high elevation mesa tops and on steep, north-facing slopes.]



5b) Co-dominated by either *Amelanchier utahensis* or *Artemisia tridentata* **(6)**

6a) (5b) Dominated by *Quercus gambelii* with *Amelanchier utahensis* always present to co-dominant – **Quercus gambelii / Amelanchier utahensis Shrubland** [Stands occur mostly on north-facing slopes. Associated species include *Artemisia ludoviciana*, *Ericameria nauseosa*, and *Symphoricarpos longiflorus*.]





6b) Dominated by *Quercus gambelii* with *Artemisia tridentata* always present to co-dominant – **Quercus gambelii/Artemisia tridentata Shrubland** [Stands occur on mesa tops. High cover of *Bromus tectorum* common in the understory.]

No photos available

7a) (2b) Dominated by *Amelanchier utahensis* with or without *Artemisia tridentata* present to codominant **(8)**

7b) Dominated by *Fraxinus anomala, Purshia stansburiana* and/or *Rhus trilobata* **(9)**

8a) (7a) Dominated by *Amelanchier utahensis* alone – **Amelanchier utahensis Shrubland** [Stands occur on steep, sheltered colluvial slopes. Other shrubs sometimes present include *Fendlera rupicola, Fraxinus anomala, Rhus trilobata, Chrysothamnus viscidiflorus, Ephedra* spp., *Eriogonum corymbosum, Coleogyne ramosissima,* and *Ericameria nauseosa.* Scattered *Pinus edulis* and *Juniperus osteosperma* may be present.]





8b) Co-dominated by *Amelanchier utahensis* and *Artemisia tridentata (ssp. wyomingensis)* – **Amelanchier utahensis - Artemisia tridentata (ssp. vaseyana, ssp. wyomingensis) Shrubland** [Stands occur on moderate to steep slopes at higher elevations. Scattered *Juniperus osteosperma* trees occur in some stands. A variety of shrubs and grasses may be present with low cover.]





9a) (7b) Dominated by *Purshia stansburiana* - **Purshia stansburiana Shrubland** [Stands occur on high elevation mesa tops on previously disturbed sites (i.e., drill pads). Associated species include *Artemisia tridentata* ssp. *wyomingensis, Ephedra viridis, Aristida purpurea,* and *Bouteloua gracilis*.]





9b) Dominated by *Fraxinus anomala*, *Cercocarpus intricatus,* and/or *Rhus trilobata* **(10)**

10a) (9b) Dominated by *Cercocarpus intricatus* – **Cercocarpus intricatus Slickrock Sparse Vegetation** [Stands occur on canyon rims and other slickrock exposures. Associated species with trace to low cover include *Artemisia bigelovii, Amelanchier utahensis, Coleogyne ramosissima, Ephedra viridis, Fraxinus anomala,* Rhus aromatica, *Achnatherum hymenoides,* and *Pleuraphis jamesii*.]





10b) Dominated by *Fraxinus anomala* and/or *Rhus trilobata* **(11)**

11a) (10b) Co-dominated by *Rhus trilobata* and *Fraxinus anomala* – **Fraxinus anomala - Rhus trilobata Dry Talus and Slickrock Shrubland** [Stands occur on talus slopes. Many other shrub species are usually present, including *Artemisia bigelovii, Atriplex confertifolia, Ephedra torreyana,* and *Chrysothamnus viscidiflorus* var. *stenophyllus*.]




11b) Co-dominated by *Rhus trilobata* and *Ephedra viridis* or *Ephedra torreyana* – **Rhus trilobata - Ephedra (viridis, torreyana) Talus and Slickrock Shrubland** [Stands occur on talus slopes. Many other shrub species are usually present, including *Artemisia bigelovii, Atriplex confertifolia, Ericameria nauseosa,* and *Eriogonum corymbosum*. If *Fraxinus anomala* is present, it is with no more than trace cover.]





12a) (1b) Shrublands on sand dunes and sand sheets, with typically loose, active soils **(13)**

12b) Shrublands on mostly stable, sometimes rocky, soils (not on dunes or otherwise active soils) **(23)**

13a) (12a) Dominated by a combination of: *Poliomintha incana, Artemisia filifolia*, and/or *Vanclevea stylosa* – **Poliomintha incana – Artemisia filifolia – Vanclevea stylosa Shrubland** [One of these shrubs may be absent, but at a minimum, either *Poliomintha incana* or *Vanclevea stylosa* is always present. *Eriogonum leptocladon* is generally present to nearly co-dominant in some stands. Associated species include *Ephedra cutleri, Ericameria nauseosa, Atriplex canescens, Achnatherum hymenoides, Muhlenbergia pungens,* and *Sporobolus* spp.]





13b) Not dominated by *Poliomintha incana* and/or *Vanclevea stylosa* **(14)**

14a) (13b) Dominated by *Artemisia filifolia* and/or *Ephedra cutleri* **(15)**

14b) Not dominated by *Artemisia filifolia* or *Ephedra cutleri* **(19)**

15a) (14a) Co-dominated by *Artemisia filifolia* and *Ephedra cutleri* – **Artemisia filifolia – Ephedra cutleri Sandsheet Shrubland** [Stands occur on stabilized sand dunes, sand sheets, or broad alluvial sand deposits. Associated species are varied and include *Atriplex canescens*, *Coleogyne ramosissima*, *Eriogonum leptocladon*, *Gutierrezia microcephala*,

Opuntia spp., *Psorothamnus fremontii*, *Yucca* spp., and the grasses *Achnatherum hymenoides* and *Sporobolus* spp.]





15b) Dominated by either *Artemisia filifolia* or *Ephedra cutleri* **(16)**

16a) (15b) Dominated by *Artemisia filifolia* **(17)**

16b) Dominated by *Ephedra cutleri* **(18)**

17a) (16a) Dominated by *Artemisia filifolia*, with an undeveloped or sparse understory – **Artemisia filifolia Colorado Plateau Shrubland** [Stands occur on benches, sand sheets, and valley bottoms and often have a weedy understory. *Atriplex canescens*, *Ericameria nauseosa*, *Ephedra viridis*, *Gutierrezia sarothrae*, and *Psorothamnus fremontii* are common associates.]





17b) Dominated by *Artemisia filifolia*, with a very grassy understory co-dominated by *Sporobolus flexuosus* and *Achnatherum hymenoides* **– Artemisia filifolia/Sporobolus flexuosus Shrubland** [One sampled site was on a stabilized sand sheet on a canyon side slope, with very high grass cover.]



18a) (16b) Dominated by*Ephedra cutleri,* with an undeveloped or sparse understory – **Ephedra cutleri Shrubland** [Stands occur on aeolian dunes, broad sandy plains, and side slopes. Associated shrubs may be present with trace to very low cover, including *Artemisia filifolia, Coleogyne ramossisima, Psorothamnus fremontii,* and *Vanclevea stylosa.*]





18b) Dominated by *Ephedra cutleri,* with an herbaceous understory dominated by one or more of the following: *Achnatherum hymenoides, Muhlenbergia pungens,* and *Oenothera pallida* – **Ephedra cutleri/Achnatherum hymenoides - Muhlenbergia pungens - Oenothera pallida Sandsheet Shrubland** [Stands occur on dunefields and mesa tops. A variety of shrubs and grasses may be present with low cover.]





19a) (14b) Dominated by *Ericameria nauseosa* – **Ericameria nauseosa Sand Deposit Sparse Shrubland** [Stands occur on active sand dunes and unstable sand sheets. Many other shrub and herbaceous species typical of sandy sites may be present with trace cover.]



19b) Not dominated by *Ericameria nauseosa* **(20)**

20a) (19b) Co-dominated by *Coleogyne ramosissima* and *Ephedra cutleri* – **Coleogyne ramosissima – Ephedra cutleri Sandsheet Shrubland** [Stands occur on deep sandy soils of stabilized dunes, valley sides, terraces, and plateaus. Associated species include *Artemisia filifolia, Gutierrezia sarothrae, Opuntia* spp., *Yucca* spp., *Pleuraphis jamesii,* and *Achnatherum hymenoides*.]





20b) Dominated by *Quercus havardii* var. *tuckeri*, with or without co-dominant shrub species **(21)**

21a) (20b) Dominated by *Quercus havardii* var. *tuckeri* alone – **Quercus havardii var. tuckeri Shrubland** [Stands occur on sand sheets, sand dunes, and wash banks. Associated species with trace to low cover may include *Artemisia filifolia, Vanclevea stylosa, Ephedra cutleri, Coleogyne ramosissima,* and *Achnatherum hymenoides*.]





21b) Dominated by *Quercus havardii var. tuckeri* and co-dominated by *Artemisia filifolia*, *Coleogyne ramosissima*, and/or *Eriogonum leptocladon* **(22)**

22a) (21b) Dominated by *Quercus havardii var. tuckeri* with either or both of *Artemisia filifolia* and *Eriogonum leptocladon* co-dominant – **Quercus havardii var. tuckeri - Eriogonum leptocladon - Artemisia filifolia Sandsheet Shrubland** [Stands occur on sand dunes, often in a bedrock-sand deposit mosaic. Coleogyne ramossisima is absent or present with no more than trace cover.]





22b) Co-dominated by *Quercus havardii* var. *tuckeri* and *Coleogyne ramossisima*; with or without *Purshia stansburiana* also co-dominant – **Coleogyne ramosissima - Purshia stansburiana – Quercus havardii var. tuckeri Shrubland** [Stands occur on stabilized dunes, sand sheets, and in a bedrock-sand deposit mosaic. *Fraxinus anomala, Ephedra* spp., *Artemisia bigelovii, Gutierrezia sarothrae, Yucca angustissima, Opuntia polyacantha,* and *Brickellia microphylla* may be present with trace to low cover.]





23a) (12b) Dominated by *Atriplex* spp. (all but *A. canescens*), *Eriogonum corymbosum,* or *Zuckia brandegeei.* Restricted to shaley or clayey substrates of the Chinle, Dakoda, Moenkopi, Morrison and Tropic Shale Formations **(24)**

23b) Dominated by species of *Artemisia* (not *A. filifolia*), *Atriplex canescens, Chrysothamnus, Coleogyne, Encelia, Ephedra, Ericameria, Grayia, Gutierrezia, Krascheninnikovia, Opuntia, Polygala,* or *Psorothamnus* and occurring on a variety of substrates and environmental settings **(35)**

24a) (23a) Very sparse stands dominated by *Eriogonum corymbosum* or *Zuckia brangegeei* **(25)**

24b) Dominated by *Atriplex* spp. (all but *A. canescens*) **(26)**

25a) (24a) Dominated by *Eriogonum corymbosum* – **Eriogonum corymbosum Badlands Sparse Vegetation** [Stands occur on desert pavements or badlands of the Moenkopi Formation.]





25b) Dominated by *Zuckia brandegeei* – **Zuckia brandegeei Sparse Vegetation** [Stands occur on Chinle Formation shale badlands.]





26a) (24b) Dominated by *Atriplex obovata* – **Atriplex obovata Talus Dwarf-shrubland**

[Stands occur on gentle to steep talus slopes. Associated species include *Brickellia atractyloides, Encelia frutescens, Coleogyne ramosissima, Ephedra torreyana, Opuntia polyacantha,* and *Pleuraphis jamesii*.]





26b) Dominated by *Atriplex confertifolia, A. gardneri,* or *A. corrugata* **(27)**

27a) (26b) Dominated by *Atriplex gardneri* or A. *corrugata,* with or without *Pleuraphis jamesii* dominant in the understory **(28)**

27b) Dominated by *Atriplex confertifolia,* may be accompanied by *Acamptopappus sphaerocephalus, Artemisia spinescens,* and/or *Ephedra torreyana,* and may have a sparse or grassy understory **(30)**

28a) (27a) Dominated by Atriplex corrugata with a sparse understory – **Atriplex corrugata Dwarf Shrubland** [Stands occur on Tropic Shale badlands. *Eriogonum inflatum, Salsola tragus,* and *Bromus rubens* may be present with low cover in the understory.]





28b) Dominated by *Atriplex gardneri,* with or without *Pleuraphis jamesii* dominant in the understory **(29)**

29a) (28b) Dominated by *Atriplex gardneri* with a sparse understory; *Pleuraphis jamesii* is absent – **Atriplex gardneri Dwarf-shrubland** [Stands occur on shaley soils of the Chinle or Moenkopi formations.]





29b) Dominated by *Atriplex gardneri* with *Pleuraphis jamesii* dominant in the understory – **Atriplex gardneri/Pleuraphis jamesii Dwarf-shrubland** [Stands occur on shaley soils or on colluvial slopes. Other species present with trace cover include *Atriplex confertifolia, Ephedra torreyana, Ericameria nauseosa, Xylorhiza tortifolia,* and *Achnatherum hymenoides.*]





30a) (27b) Dominated by *Atriplex confertifolia* and co-dominated by *Acamptopappus sphaerocephalus*, *Artemisia spinescens*, and/or *Ephedra torreyana* **(31)**

30b) Dominated by *Atriplex confertifolia* alone, with or without a developed understory **(32)**

31a) (30a) Dominated by a combination of: *Atriplex confertifolia*, *Acamptopappus sphaerocephalus*, and *Picrothamnus desertorum* (*Artemisia spinescens*) – **Atriplex confertifolia - (Acamptopappus sphaerocephalus, Picrothamnus desertorum)/(Pleuraphis jamesii) Scrub** [Not all three shrub species need to be present, but at least *Atriplex confertifolia* or *Acamptopappus sphaerocephalus* is always present. Stands occur on shale soils (Morrison Fm, Tropic Shale, occasionally Dakoda SS) on a variety of landforms .The understory may include low to moderate cover of *Pleuraphis jamesii*. Associated shrubs include *Ephedra* spp., *Lycium andersonii*, *Coleogyne ramossisima*, and *Opuntia* spp.]





31b) Co-dominated by *Atriplex confertifolia* and *Ephedra torreyana* (less commonly, co-dominated by *Atriplex canescens*) – **Ephedra torreyana – (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation** [Stands occur primarily on shale-derived substrates on a variety of landforms. Other shrubs with trace to low cover include *Ericameria nauseosa, Coleogyne ramosissima, Eriogonum corymbosum*, and *Xylorhiza tortifolia*.]





32a) (30b) Lacking a developed understory **(33)**

32b) Understory is dominated by *Achnatherum hymenoides* or *Pleuraphis jamesii* **(34)**

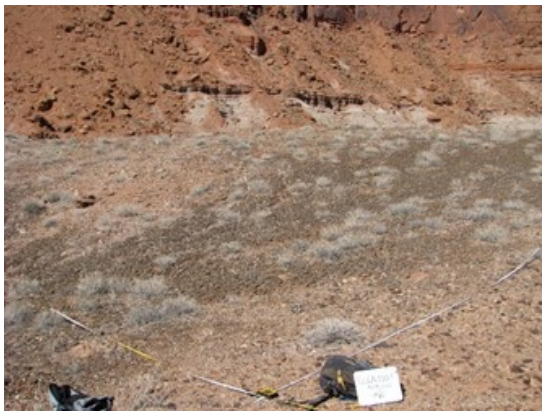
33a) (32a) Dominated by sparse *Atriplex confertifolia* (<3% cover) – **Atriplex confertifolia Sparse Shrubland** [No co-dominant shrub species and a sparse understory that may include a variety of forbs with trace cover.]





33b) Dominated by *Atriplex confertifolia* with >5% total cover **– Atriplex confertifolia Great Basin Shrubland** [No co-dominant shrub species and a sparse understory that may include a variety of forbs with trace cover.]





34a) (32b) Understory is dominated by *Achnatherum hymenoides* – **Atriplex confertifolia/Achnatherum hymenoides Shrubland**





34b) Understory is dominated by *Pleuraphis jamesii* (with at least 2% cover in sparse stands) – **Atriplex confertifolia/Pleuraphis jamesii Shrubland** [Scattered *Ephedra torreyana* and *Coleogyne ramosissima* may be present; however, if *Ephedra torreyana* is co-dominant with *Atriplex confertifolia*, skip ahead to couplet 67a.]





35a) (23b) Dominated by *Atriplex canescens*; *Ephedra viridis* may be co-dominant **(36)**

35b) Not dominated by *Atriplex canescens* **(39)**

36a) (34a) *Ephedra viridis* is co-dominant in the shrub layer, and the understory may be grassy or sparse **(37)**

36b) No shrubs are co-dominant and the understory is dominanted by the grasses *Achnatherum hymenoides* or *Pleuraphis jamesii* **(38)**

37a) (36a) Stands occur on colluvial/talus slopes – **Atriplex canescens – Ephedra viridis Talus Shrubland** [The herbaceous layer is variable and may be dominated by *Leymus salinus*.]





37b) Stands occur on stabilized sand dunes and sand sheets – **Atriplex canescens – Ephedra viridis Shrubland** [Associated shrubs with low cover may include *Coleogyne ramosissima, Ericameria nauseosa, Gutierrezia sarothrae*, and *Opuntia polyacantha*.]




38a) (36b) Understory is dominated by *Achnatherum hymenoides* – **Atriplex canescens/ Achnatherum hymenoides Shrubland** [Stands occur on steep canyon side slopes or canyon bottoms. Other shrubs contributing sparse cover include *Ephedra torreyana* and *Coleogyne ramosissima.* Weedy species may be present to abundant in the herbaceous layer, especially *Bromus tectorum*.]





38b) Understory is dominated by *Pleuraphis jamesii* – **Atriplex canescens/Pleuraphis jamesii Shrubland** [Stands occur on canyon bottom terraces. The understory is stabilized by moss and crypto cover and may have *Bromus tectorum* present with low cover.]





39a) (35b) Dominated by *Chrysothamnus viscidiflorus* or *Ericameria nauseosa* **(40)**

39b) Not dominated by *Chrysothamnus viscidiflorus* or *Ericameria nauseosa* **(43)**

40a) (39a) Dominated by *Ericameria nauseosa* with an understory dominated by the forb (or dwarf-shrub) *Xylorhiza tortifolia* – **Ericameria nauseosa - (Xylorhiza tortifolia) Talus Sparse Shrubland** [Stands occur on rocky slopes with a shaley substrate. Associated species include *Ephedra torreyana*, *Psorothamnus fremontii*, and *Pleuraphis jamesii*.]



40b) Dominated by *Chrysothamnus viscidiflorus* **(41)**

41a) (40b) Dominated by *Chrysothamnus viscidiflorus* and occurring on steep, talus slopes **– Chrysothamnus viscidiflorus Talus Shrubland** [The only other species noted with more than trace cover were *Achnatherum hymenoides* and *Bromus rubens.*]



41b) Dominated by *Chrysothamnus viscidiflorus* and occurring on flat sites **(42)**

42a) (41b) Understory is dominated by weedy species – **Chrysothamnus viscidiflorus/ Disturbed Understory Shrubland** [Stands generally occur on disturbed sites (drill pads, housing areas, post-fire areas, etc.) Weedy understory species include *Bromus tectorum, Elymus trachycaulis,* and *Lappula occidentalis.* Other species noted include *Bouteloua gracilis* and *Wyethia scabra*.]





42b) Understory is dominated by *Hesperostipa comata* – **Chrysothamnus viscidiflorus/ Hesperostipa comata Shrubland** [Stands occur on higher elevation mesa tops within the park, often where fires have destroyed pinyon- juniper woodlands. The understory may include moderate cover of *Bromus tectorum* and *Machaeranthera canescens*.]





43a) (39b) Dominated by *Grayia spinosa* – **Grayia spinosa Shrubland** [Stands occur on side slopes. The understory is dominated by *Pleuraphis jamesii*.]




43b) Not dominated by *Grayia spinosa* **(44)**

44a) (43b) Co-dominated by *Encelia frutescens, Gutierrezia* spp., and/or *Brickellia microphylla*, with an understory dominated by *Stephanomeria pauciflora* – **Gutierrezia (microcephala, sarothrae) - (Encelia frutescens, Brickellia microphylla)/Stephanomeria pauciflora Dwarf-shrubland** [Stands occur on slickrock exposures near lakeshores. A mix of other shrubs may be present including *Eriogonum corymbosum* and *Tamarix chinensis*, along with the grasses*Sporobolus cryptandrus, Aristida purpurea*, and *Bromus* spp., and the forb *Sphaeralcea leptophylla*.]





44b) Not dominated by *Encelia frutescens* **(45)**

45a) (44b) Dominated by *Coleogyne ramosissima*, with or without co-dominant shrubs, including *Acamptopappus*, *Ephedra*, *Purshia*, and *Quercus havardii* var. *tuckeri* **(46)**

45b) Not dominated by *Coleogyne ramosissima* **(52)**

46a) (45a) Sparse stands with <5% total cover – **Coleogyne ramosissima Sparse Shrubland** [Stands occur on bedrock exposures or otherwise shallow soils in a bedrock-sand deposit mosaic. *Ephedra torreyana*, *Artemisia bigelovii*, *Gutierrezia* spp., *Yucca angustissima*, and *Opuntia polyacantha* are common associates with sparse cover.]





46b) Stands with >5% total cover **(47)**

47a) (46b) Dominated by*Coleogyne ramosissima* alone in the shrub layer with a sparse understory – **Coleogyne ramosissima Shrubland** [Stands occur on a variety of substrates and landforms. Scattered shrubs with trace to very low cover include *Ephedra torreyana, Atriplex confertifolia, Ephedra viridis, Ericameria nauseosa,* and *Atriplex canescens*.]





47b) Any number of shrubs are co-dominant with *Coleogyne ramosissima* **or** *Coleogyne ramosissima* is the lone dominant in the shrub layer and has a grassy understory dominated by *Pleuraphis jamesii* **(48)**

48a) (47b) understory is dominated by *Pleuraphis jamesii* – **Coleogyne ramosissima / Pleuraphis jamesii Shrubland** [*Achnatherum hymenoides* is absent. Other shrubs may be present with trace to very low cover, including *Ephedra torreyana, Atriplex confertifolia, Ericameria nauseosa, Eriogonum corymbosum,* and *Ephedra viridis*.]





48b) One or many shrubs are co-dominant with *Coleogyne ramossisima*; the understory may or may not be grassy **(49)**

49a) (48b) Co-dominated by either or both of *Quercus havardii* var. *tuckeri* and *Purshia stansburiana* – **Coleogyne ramosissima - Purshia stansburiana – Quercus havardii var. tuckeri Shrubland** [Stands occur on stabilized dunes, sand sheets, and in a bedrock-sand deposit mosaic. The shrub layer may be mixed and include one or more of: *Fraxinus anomala, Ephedra* spp., *Artemisia bigelovii, Gutierrezia sarothrae, Yucca angustissima, Opuntia polyacantha,* and *Brickellia microphylla*.]




49b) *Acamptopappus sphaerocephalus* and/or *Ephedra* spp. are co-dominant **(50)**

50a) (49b) Co-dominated by *Coleogyne ramosissima, Acamptopappus sphaerocephalus,* and *Ephedra torreyana* **- Coleogyne ramosissima - Acamptopappus sphaerocephalus - Ephedra torreyana Shrubland** [Stands occur on a variety of sites ranging from gravelly, flat terraces to steep talus slopes. A variety of other shrubs may be present with low cover, and the understory may include low to moderate cover of *Pleuraphis jamesii, Bromus tectorum, Bromus rubens,* and *Schismus barbatus.*]




50b) Co-dominated by *Ephedra* spp. **(51)**

51a) (50b) *Ephedra cutleri* is co-dominant – **Coleogyne ramosissima - Ephedra cutleri Sandsheet Shrubland** [Stands occur on deep sandy soils of stabilized dunes, valley sides, terraces, and plateaus. Associated species include *Artemisia filifolia, Gutierrezia* spp., *Opuntia* spp., *Yucca* spp., *Pleuraphis jamesii,* and *Achnatherum hymenoides.*]





51b) *Ephedra* spp. (most commonly *Ephedra torreyana*, less commonly *Ephedra viridis*) are co-dominant – **Coleogyne ramosissima - Ephedra spp. Warm Desert Shrubland** [Stands occur on a variety of landforms. Many other species may occur with trace to low cover.]





52a) (45b) Dominated by species of *Artemisia* (not *A. filifolia*) or *Ephedra* **(53)**

52b) Dominated by *Gutierrezia*, *Krascheninnikovia*, *Opuntia*, *Polygala*, or *Psorothamnus* **(74)**

53a) (52a) Dominated by *Artemisia bigelovii* or *Artemisia tridentata* ssp. *wyomingensis* **(54)**

53b) Dominated by species of *Ephedra* **(61)**

54a) (53a) Dominated by *Artemisia tridentata* ssp. *Wyomingensis* **(55)**

54b) Dominated by *Artemisia bigelovii* **(60)**

55a) (54a) understory is dominated by native, perennial bunchgrasses **(56)**

55b) Understory is sparse or weedy **(59)**

56a) (55a) Understory is dominated by *Bouteloua gracilis* or *Poa fendleriana* **(57)**

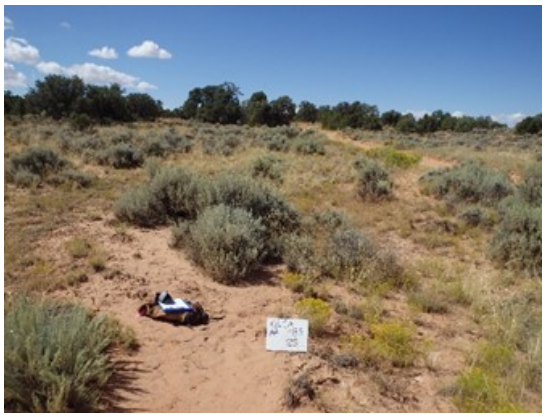
56b) Understory is dominated by *Achnatherum hymenoides* or *Hesperostipa comata* **(58)**

57a) (66a) Understory is dominated by *Bouteloua gracilis* – **Artemisia tridentata ssp. wyomingensis/Bouteloua gracilis Shrubland** [Stands occur on high elevation mesa tops.]





57b) Understory is dominated by *Poa fendleriana* – **Artemisia tridentata ssp. wyomingensis/Poa fendleriana Shrubland** [Stands occur on high elevation mesa tops.]



58a) (56b) Understory is dominated by *Achnatherum hymenoides* – **Artemisia tridentata ssp. wyomingensis/Achnatherum hymenoides Shrubland** [Stands occur on high elevation mesa tops. The understory had moderate cover of *Bromus tectorum.*]



58b) Understory is dominated by *Hesperostipa comata* **– Artemisia tridentata ssp. wyomingensis/Hesperostipa comata Colorado Plateau Shrubland** [Stands occur on high elevation mesa tops. *Achnatherum hymenoides* may be co-dominant in the understory; *Ephedra viridis* is a common associate in the shrub layer.]





59a) (55b) Understory is sparse and generally not weedy (less than 3% total understory cover) – **Artemisia tridentata ssp. wyomingensis / Sparse Understory Shrubland** [Associated species with low cover include *Ephedra viridis* or *cutleri, Ericameria nauseosa, Bouteloua gracilis,* and *Elymus elymoides*.]





59b) Understory is weedy – **Artemisia tridentata ssp. wyomingensis/Disturbed Understory Ruderal Shrubland** [*Bromus tectorum* and *Elymus elymoides* are usually present to dominant in understory. Associated species may include *Ericameria nauseosa, Purshia tridentata, Achnatherum hymenoides*, and *Poa fendleriana*.]





60a) (54b) Co-dominated by *Artemisia bigelovii, Ephedra viridis,* and/or *Ephedra torreyana* and occurring on talus slopes – **Artemisia bigelovii - Ephedra (viridis, torreyana) Talus Shrubland** [Many other shrub species typical of colluvial sites may be present to co-dominant.]





60b) Dominated by *Artemisia bigelovii* and occurring on slickrock rims – **Artemisia bigelovii Shrubland** [A diversity of other shrubs may be present with trace to very low cover. Plants occupy scattered, shallow, soil-filled depressions in the slickrock.]





61a) (53b) Dominated by one or more of the following species: *Ephedra cutleri, Ephedra viridis,* and/or *Ephedra torreyana* with *Psorothamnus fremontii* co-dominant **– Ephedra (torreyana, viridis) – Psorothamnus fremontii Shrubland** [Stands occur on gently to steeply sloping, sandy or gravelly sites on a variety of landforms. Many other shrubs may be present with low cover, and an herbaceous layer may be absent to diverse.]




61b) Dominated by *Ephedra cutleri, Ephedra viridis, or Ephedra torreyana* **(62)**

62a) (61b) Dominated by *Ephedra torreyana* **(63)**

62b) Dominated by *Ephedra viridis* or *Ephedra cutleri* **(68)**

63a) (62a) Sparse stands with less than 5% total cover and with a sparse understory – **Ephedra torreyana Sparse Vegetation** [Stands occur on colluvial slopes, badlands, and benches. Scattered shrubs with trace cover may include *Coleogyne ramosissima*, *Ericameria nauseosa*, *Atriplex confertifolia*, *Gutierrezia sarothrae*, and *Xylorhiza tortifolia*.]





63b) Stands with greater than 5% total cover **(64)**

64a) (63b) Dominated by *Ephedra torreyana* alone in the shrub layer and with a grassy understory **(65)**

64b) One or more shrubs are co-dominant with *Ephedra torreyana*, including *Atriplex* spp. and/or *Lycium andersonii* **(66)**

65a) (64a) Understory is co-dominated by *Achnatherum hymenoides* and *Pleuraphis jamesii* – **Ephedra torreyana / Achnatherum hymenoides - Pleuraphis jamesii Shrubland** [*Ericameria nauseosa* may be present to co-dominant in the shrub layer. Other associated shrubs may include *Coleogyne ramosissima, Atriplex confertifolia,* and *Opuntia* spp.]





65b) Understory is dominated by *Pleuraphis jamesii* – **Ephedra torreyana/Pleuraphis jamesii Shrubland** [If *Achnatherum hymenoides* is present, it is with only trace cover. *Ericameria nauseosa* may co-dominate the shrub layer, and *Coleogyne ramosissima, Atriplex confertifolia,* and *Opuntia* spp. may be present with low cover.]




66a) (64b) Co-dominated by *Lycium andersonii* – **Lycium andersonii - Ephedra (torreyana, viridis) Shrubland** [Stands occur on steep talus slopes. *Atriplex* spp. may be present to nearly co-dominant in the shrub layer.]




66b) Co-dominated by *Atriplex* spp. (generally *A. confertifolia*) **(67)**

67a) (66b) Co-dominated by *Atriplex confertifolia* and/or (more rarely) *Atriplex canescens*, with a sparse or undeveloped understory – **Ephedra torreyana – (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation** [Stands occur primarily on shale-derived substrates on a variety of landforms. Other shrubs present with trace to low cover may include *Ericameria nauseosa*, *Coleogyne ramosissima*, *Eriogonum corymbosum*, and *Xylorhiza tortifolia*.]





67b) *Atriplex* spp. (generally *A. confertifolia*) may or may not be co-dominant, and the understory is dominated by well-developed biological soil crusts **– Ephedra torreyana - (Atriplex spp.)/Nonvascular Gypsum Sparse Vegetation** [In the one sampled stand of this type, weedy, annual forbs and grasses had moderate to high cover.]



68a) (62b) Dominated by *Ephedra cutleri* [If *Artemisia filifolia* is co-dominant, return to couplet 14a.] **(69)**

68b) Dominated by *Ephedra viridis,* with or without *Acamptopappus sphaerocephalus* co-dominant **(70)**

69a) (68a) Dominated by*Ephedra cutleri* alone – **Ephedra cutleri Shrubland** [Stands occur on side slopes, mesas, and aeolian dunes. Associated shrubs may be present with low cover, including *Psorothamnus fremontii, Artemisia filifolia, Coleogyne ramossisima,* and *Vanclevea stylosa,* as well as the grasses *Sporobolus* spp., *Achnatherum hymenoides,* and *Pleuraphis jamesii*.]




69b) Co-dominated by*Ephedra cutleri* and *Opuntia* spp., with an understory dominated by *Sporobolus* spp., *Achnatherum hymenoides,* and/or *Pleuraphis jamesii* – **Ephedra cutleri - Opuntia spp./Mixed Grass Shrub-Steppe** [Stands occur on valley bottoms or sides, dunes, terraces, and mesa tops. Associated shrubs may include *Coleogyne ramosissima, Ephedra torreyana, Gutierrezia microcephala,* and *Yucca* spp. Other species in the understory may include *Bromus tectorum, Machaeranthera canescens,* and *Sphaeralcea* spp.]




70a) (68b) Co-dominated by *Acamptopappus sphaerocephalus* – **Acamptopappus sphaerocephalus – Ephedra spp. Shrubland** [Stands occur on plains, terraces, and bajadas. Associated shrubs may include *Atriplex canescens* and *Coleogyne ramosissima*. Understories are typically sparse or weedy, with *Bromus rubens* and *Schismus barbatus* often present.]





70b) Dominated by *Ephedra viridis* alone in the shrub layer, with or without a grassy understory **(71)**

71a) (70b) Understory is sparse or weedy – **Ephedra viridis/Bromus tectorum Ruderal Shrubland** [Stands occur on stabilized sand dunes, in canyon bottoms, or on side slopes. Associated shrubs may include *Atriplex canescens, Coleogyne ramosissima, Glossopetalon spinescens, Opuntia* spp., and *Psorothamnus fremontii.* Weedy understory species may include *Bromus rubens, Bromus tectorum, Salsola tragus,* and *Sporobolus* spp.]





71b) Understory is dominated by native grasses **(72)**

72a) (71b) Understory is dominated by *Achnatherum hymenoides* and/or *Hesperostipa comata* – **Ephedra viridis / (Achnatherum hymenoides, Hesperostipa comata) Shrubland** [Stands occur on deep soils of plateaus and mesa tops, on sand sheets, and on valley floors. Other grasses may be present with low cover including *Bouteloua gracilis, Pleuraphis jamesii, Muhlenbergia pungens, Sporobolus cryptandrus, Vulpia octoflora, Aristida purpurea*, and *Sporobolus airoides.*]




72b) Understory is dominated by *Bouteloua gracilis* or *Pleuraphis jamesii* **(73)**

73a) (72b) Understory is dominated by Bouteloua gracilis – **Ephedra viridis/ Bouteloua gracilis Shrubland** [Stands occur on deep soils of plateaus, mesa tops, and plains. This type was encountered only on the mesa tops in the Orange Cliffs. Other grasses may be present with low cover including *Achnatherum hymenoides*, *Pleuraphis jamesii*, *Hesperostipa comata*, and *Sporobolus airoides*.]




73b) Understory is dominated by *Pleuraphis jamesii* – **Ephedra viridis/Pleuraphis jamesii Shrubland** [Stands occur on deep soils of valleys, plains, benches, and plateaus. Other grasses may be present with low cover including *Achnatherum hymenoides, Aristida purpurea, Hesperostipa comata, Bouteloua gracilis, Bromus tectorum,* and *Sporobolus cryptandrus*.]





74a) (52b) Dominated by *Polygala acanthoclada* or *Psorothamnus fremontii* **(75)**

74b) Dominated by *Krascheninnikovia lanata*, *Gutierrezia*, or *Opuntia* **(76)**

75a) (81a) Dominated by *Polygala acanthoclada* with either or both of *Coleogyne ramosissima* and *Ephedra torreyana* co-dominant – **Polygala acanthoclada - Mixed Scrub**[Stands occur on gently sloping canyon benches or bottoms. The substrate may be dominated by bare soil and/or bedrock. A few other shrubs may occur with low cover, including Atriplex confertifolia, Psorothamnus fremontii, and Rhus trilobata.]





75b) Dominated by *Psorothamnus fremontii* **– Psorothamnus fremontii Shrubland** [Stands occur on quaternary terraces. *Atriplex confertifolia, Ericameria nauseosa, Ephedra torreyana, Gutierrezia sarothrae,* and/or *Opuntia* spp. are common associates.]




76a) (74b) Dominated by *Krascheninnikovia lanata* **(77)**

76b) Dominated by *Gutierrezia* or *Opuntia* spp. **(79)**

77a) (76a) Understory is sparse or weedy (but may be moderately diverse) – **Krascheninnikovia lanata Dwarf-shrubland** [Stands occur on canyon floors. Associated shrubs may include *Atriplex canescens* and *Opuntia* spp. Understory species may include *Sphaeralcea* spp., *Sporobolus cryptandrus,* and *Sporobolus contractus* and weedy species such as *Bromus tectorum* and *Lappula occidentalis.*]





77b) Understory is dominated by *Hesperostipa comata* or *Pleuraphis jamesii* **(78)**

78a) (77b) Understory is dominated by *Pleuraphis jamesii* – **Krascheninnikovia lanata/ Pleuraphis jamesii Dwarf-shrubland** [Stands occur on canyon bottom benches, plateaus, and mesa tops. Associated shrubs may include *Atriplex canescens*, *Ephedra* spp., and *Opuntia* spp. Associated understory species may include *Achnatherum hymenoides*, *Sporobolus cryptandrus*, *Hesperostipa comata*, *Plantago patagonica,* and *Salsola tragus.*]





78b) Understory is dominated by *Hesperostipa comata*, and if not dominant, it is at least present with low to moderate cover – **Krascheninnikovia lanata/Hesperostipa comata Dwarf-shrubland** [Associated grasses with nearly equal, and in some cases greater, cover than *Hesperostipa comata* include *Pleuraphis jamesii* and *Sporobolus cryptandrus*.]



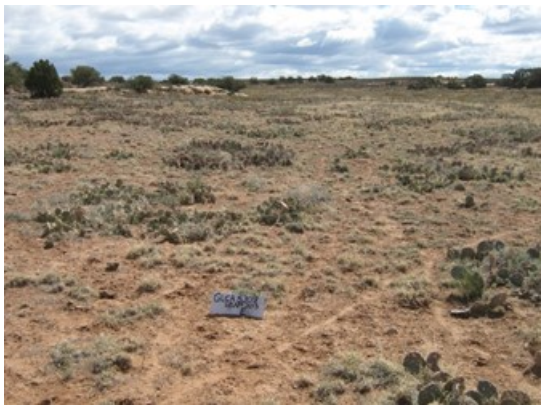


79a) (76b) Dominated by species of *Opuntia* **(80)**

79b) Dominated by species of *Gutierrezia* **(81)**

80a) (79a) Dominated by*Opuntia polyacantha* with *Pleuraphis jamesii* growing in the openings between cactus clumps – **Opuntia polyacantha/Pleuraphis jamesii Dwarf-shrubland** [Stands occur on alluvial fans and stream terraces. Associated shrubs may include *Atriplex canescens, Atriplex confertifolia,* and *Ephedra torreyana*. Associated grasses may include *Hesperostipa comata* and *Achnatherum hymenoides*.]





80b) Dominated by*Opuntia* spp. (*fragilis, polyacantha,* and/or *phaeacantha*) with a sparse understory – **Opuntia (fragilis, polyacantha, phaeacantha) Shrubland** [Stands occur on flat, gravelly plains with *Atriplex confertifolia* often present to co-dominant.]

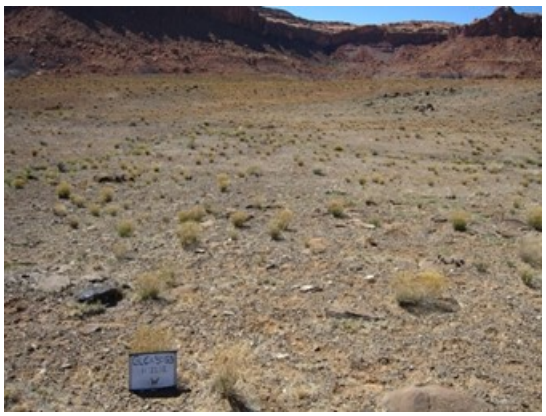


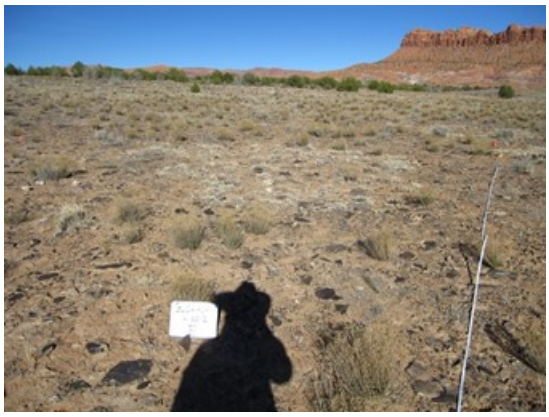
81a) (80b) Dominated by *Gutierrezia sarothrae* – **Gutierrezia sarothrae - (Opuntia spp.)/ Pleuraphis jamesii Dwarf-shrubland** [Stands occur on alluvial fans, slopes, and valley bottoms. *Opuntia* spp. are generally present to co-dominant, and *Pleuraphis jamesii* is often present in the understory. Associated species may include *Atriplex confertifolia, Psorothamnus fremontii, Bromus rubens,* and *Bromus tectorum*.]




81b) Dominated by *Gutierrezia microcephala* **(82)**

82a) (86b) Understory is sparse - **Gutierrezia (microcephala, sarothrae) Dwarf-shrubland** [Stands occur on valley bottom fill. Associated species may include *Opuntia* spp. and *Atriplex confertifolia*.]





82b) Understory is dominated by *Stephanomeria pauciflora* – **Gutierrezia (microcephala, sarothrae) - (Encelia frutescens, Brickellia microphylla)/Stephanomeria pauciflora Dwarf-shrubland** [Stands occur on slickrock exposures near lakeshores. A mix of other shrubs may be present including *Eriogonum corymbosum* and *Tamarix chinensis,* along with the grasses*Sporobolus cryptandrus, Aristida purpurea,* and *Bromus* spp., and the forb *Sphaeralcea leptophylla*.]





Key V: A Key to the UPLAND Herbaceous vegetation Associations of Glen Canyon Recreation Area and Rainbow Bridge National Monument

1a) Grassland communities, where grass species individually or in the aggregate have greater total cover than forbs **(2)**

1b) Weedy forb communities dominated by *Salsola tragus* – **Salsola spp. Ruderal Grassland** [Stands occur on valley and canyon bottoms, and sand dunes. Associated species with low to moderate cover include *Tamarix chinensis, Ambrosia acanthicarpa, Schismus barbatus, Bouteloua gracilis, Bouteloa barbata, Munroa squarrosa,* and *Erigeron religiosus*.]





2a) (1a) Annual grasslands dominated by *Bromus tectorum* – **Bromus tectorum Ruderal Grassland** [Stands occur on heavily disturbed, generally level sites. Scattered relict native grasses, forbs, and shrubs may be present.]





2b) Perennial grasslands **(3)**

3a) (2b) Dominated by *Leymus salinus* – **Leymus salinus Shale Sparse Vegetation** [Stands occur on cooler, north-facing colluvial slopes. Shrubs are generally present and may have almost as much combined cover as the grasses. Common associated species include

Fraxinus anomala, Ephedra spp., *Atriplex confertifolia, Ericameria nauseosa, Chrysothamnus viscidiflorus, Artemisia bigelovii,* and *Xylorhiza tortifolia*.]





3b) Not dominated by *Leymus salinus* **(4)**

4a) (3a) Dominated by *Poa fendleriana* – **Poa fendleriana Grassland** [Stands occur on warmer, west-facing colluvial slopes and flatter, high elevation mesa tops. Associated grasses and forbs may include *Festuca octoflora, Bromus tectorum*, *Achnatherum hymenoides,* and *Wyethia scabra*. Scattered shrubs may include *Fraxinus anomala, Mahonia fremontii*, and *Krascheninnikovia lanata*.]





4b) Not dominated by *Poa fendleriana* **(5)**

5a) (4b) Dominated by *Pleuraphis jamesii* or *Bouteloua gracilis* **(6)**

5b) Dominated by *Achnatherum hymenoides, Hesperostipa comata, Muhlenbergia pungens,* or *Sporobolus cryptandrus* **(7)**

6a) (5a) Dominated by *Pleuraphis jamesii* – **Pleuraphis jamesii Grassland** [Stands occur on plains, benches, and terraces. Associated grasses may include *Bromus tectorum, Achnatherum hymenoides,* and *Sporobolus airoides*. Scattered shrubs may include *Atriplex* spp., *Krascheninnikovia lanata,* and *Ephedra torreyana*.]





6b) Dominated by *Bouteloua gracilis* – **Bouteloua gracilis Grassland** [Stands occur primarily at higher elevation areas within the NRA on level to rolling terrain. A few scattered shrubs of *Gutierrezia sarothrae*, *Opuntia* spp., and *Krascheninnikovia lanata* may be present. Associated grasses may include *Achnatherum hymenoides* and *Pleuraphis jamesii*.]




7a) (5b) Dominated by *Hesperostipa comata*, *Muhlenbergia pungens*, or *Sporobolus cryptandrus* **(8)**

7b) Dominated by *Achnatherum hymenoides*, with or without *Sporobolus contractus* or *Psoralidium lanceolatum* co-dominant **(10)**

8a) (7a) Dominated by *Hesperostipa comata* – **Hesperostipa comata Great Basin Grassland** [Stands occur on valley floors and slopes. In some stands, *Pleuraphis jamesii* or *Achnatherum hymenoides* have significant cover. A variety of shrubs may be present with low cover.]





8b) Dominated by *Muhlenbergia pungens* or *Sporobolus cryptandrus* **(9)**

9a) (8b) Dominated by *Sporobolus cryptandrus* – **Sporobolus cryptandrus Great Basin Grassland** [The remaining herbaceous layer is often weedy and may include *Bromus tectorum, Salsola tragus, Rumex hymenosepalus, Mentzelia multiflora,* and *Plantago patagonica*. Scattered shrubs may include *Atriplex canescens, Krascheninnikovia lanata,* and *Gutierrezia sarot*hrae.]




9b) Dominated by *Muhlenbergia pungens* **– Muhlenbergia pungens Grassland** [Stands occur on sandy flats and dunes. Scattered *Juniperus osteosperma* trees and shrubs such as *Coleogyne ramosissima, Ephedra cutleri*, and *Gutierrezia sarothrae* may be present with sparse to low cover.]





10a) (7b) Dominated by *Achnatherum hymenoides* alone with no co-dominant species – **Achnatherum hymenoides Colorado Plateau Grassland** [Stands occur on sandy plains, dunes, stream terraces, and valley floors. Stands on unstable dunes may be very sparse. *Hesperostipa comata* is absent or has only trace cover. Shrubs may be present, but contribute little cover.]




10b) Co-dominated by *Sporobolus contractus* or *Psoralidium lanceolatum* **(11)**

11a) (10b) Co-dominated by *Achnatherum hymenoides* and *Sporobolus contractus* - **Achnatherum hymenoides - Sporobolus contractus Grassland** [Stands occur on loose, active sand dunes.]





11b) Co-dominated by *Achnatherum hymenoides* and *Psoralidium lanceolatum* – **Achnatherum hymenoides - Psoralidium lanceolatum Grassland** [Stands occur on stabilized dunes and canyon side slopes.]



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Leymus salinus Shale Sparse Vegetation G-95

Lycium andersonii - Ephedra (torreyana, viridis) Shrubland G-84

M

Mahonia fremontii Shrubland G-32

Muhlenbergia asperifolia Wet Meadow G-11

Muhlenbergia pungens Grassland G-97

O

Opuntia (fragilis, polyacantha, phaeacantha) Shrubland G-92

Opuntia polyacantha / Pleuraphis jamesii Dwarf-shrubland G-91

Ostrya knowltonii Riparian Woodland G-15

P

Phalaris arundinacea Western Marsh G-8

Phragmites australis Western Ruderal Wet Meadow G-10

Pinus edulis – Juniperus osteosperma / (Shepherdia rotundifolia – Amelanchier utahensis) Wooded Shrubland G-53

Pinus edulis – Juniperus osteosperma / Achnatherum hymenoides Woodland G-46

Pinus edulis – Juniperus osteosperma / Amelanchier utahensis Woodland G-52

Pinus edulis – Juniperus osteosperma / Artemisia bigelovii Woodland G-48

Pinus edulis – Juniperus osteosperma / Artemisia nova Woodland G-49

Pinus edulis - Juniperus osteosperma / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland G-49

Pinus edulis – Juniperus osteosperma / Cercocarpus intricatus Woodland G-51

Pinus edulis - Juniperus osteosperma / Cercocarpus montanus - Mixed Shrubs Woodland G-51

Pinus edulis – Juniperus osteosperma / Coleogyne ramosissima Woodland G-50

Pinus edulis - Juniperus osteosperma / Ephedra viridis - Gutierrezia sarothrae Woodland G-52

Pinus edulis – Juniperus osteosperma / Mixed Shrubs Talus Woodland G-47

Pinus edulis – Juniperus osteosperma / Muhlenbergia pungens Woodland G-46

Pinus edulis - Juniperus osteosperma / Pleuraphis jamesii Woodland G-47

Pinus edulis – Juniperus osteosperma / Purshia stansburiana Woodland G-50

Pinus edulis - Juniperus osteosperma / Quercus gambelii Woodland G-12

Pinus edulis – Juniperus osteosperma / Quercus havardii var. tuckeri Woodland G-12, G-48

Pinus edulis – Juniperus osteosperma / Quercus turbinella Woodland G-51

Pinus edulis – Juniperus osteosperma / Shepherdia rotundifolia Woodland G-53

Pinus edulis – Juniperus osteosperma / Sparse Understory Woodland G-45

Pinus edulis – Juniperus osteosperma / Symphoricarpos longiflorus Woodland G-12

Pinus edulis – Juniperus spp. / Leymus salinus Woodland G-46

Pinus edulis – Juniperus spp. / Poa fendleriana Woodland G-45
Pleuraphis jamesii - Sporobolus airoides Grassland G-9
Pleuraphis jamesii Grassland G-95
Pluchea sericea Wet Shrubland G-25
Poa fendleriana Grassland G-95
Poliomintha incana – Artemisia filifolia – Vanclevea stylosa Shrubland G-60
Polygala acanthoclada - Mixed Scrub G-89
Populus fremontii - Salix gooddingii / Salix exigua Riparian Forest G-18
Populus fremontii / Acer negundo Riparian Forest G-17
Populus fremontii / Baccharis (emoryi, salicina) Riparian Woodland G-19
Populus fremontii / Ericameria nauseosa Riparian Woodland G-19
Populus fremontii / Frangula betulifolia – Quercus gambelii Spring and Riparian Woodland G-20
Populus fremontii / Mesic Forbs Riparian Woodland G-22
Populus fremontii / Mesic Graminoids Riparian Woodland G-22
Populus fremontii / Salix exigua Riparian Forest G-20
Populus fremontii / Scour Riparian Forest G-21
Populus fremontii / Sparse Riparian Forest G-21
Populus fremontii / Tamarix sp. Ruderal Riparian Woodland G-18
Pseudotsuga menziesii / Cornus sericea Riparian Woodland G-11
Pseudotsuga menziesii Scree Woodland G-39
Psorothamnus fremontii Shrubland G-89
Purshia stansburiana Shrubland G-58

Q

Quercus gambelii / Amelanchier utahensis Shrubland G-56
Quercus gambelii / Artemisia tridentata Shrubland G-57
Quercus gambelii / Poa fendleriana Shrubland G-56
Quercus gambelii / Rhus trilobata Shrubland G-26
Quercus gambelii / Symphoricarpos oreophilus Shrubland G-26
Quercus gambelii Shrubland G-55
Quercus havardii var. tuckeri - Eriogonum leptocladon - Artemisia filifolia Sandsheet Shrubland G-64
Quercus havardii var. tuckeri Shrubland G-63
Quercus turbinella - (Rhus trilobata, Artemisia tridentata) Shrubland G-55

R

Rhus trilobata - Ephedra (viridis, torreyana) Talus and Slickrock Shrubland G-59
Rhus trilobata Moist Wet Shrubland G-32

S

Salix exigua / Gravel Bar Wet Shrubland G-28
Salix exigua / Mesic Graminoids Western Wet Shrubland G-29

Salix gooddingii / Salix exigua Riparian Woodland G-16
Salsola spp. Ruderal Grassland G-94
Sarcobatus vermiculatus / Atriplex gardneri Wet Shrubland G-30
Sarcobatus vermiculatus / Sporobolus airoides Wet Shrubland G-31
Sarcobatus vermiculatus / Suaeda moquinii Wet Shrubland G-30
Sarcobatus vermiculatus Disturbed Wet Shrubland G-31
Sporobolus airoides Southern Plains Wet Meadow G-9
Sporobolus cryptandrus Great Basin Grassland G-97
Suaeda moquinii Wet Shrubland G-29

T

Tamarix chinensis Ruderal Lakeshore Scrub G-24
Tamarix chinensis Ruderal Lakeshore Scrub G-8
Tamarix spp. Ruderal Riparian Shrubland G-23
Typha domingensis Western Marsh G-10

Z

Zuckia brandegeei Sparse Vegetation G-65

Appendix H. Accuracy Assessment Analysis Results

Introduction

This appendix contains the results of the analysis of accuracy assessment field data. Each of the 1,668 accuracy assessment field plots sampled at GLCA/RABR was compared with the polygon in which it occurred. If the field data matched the polygon label, the plot was deemed correct. If it did not, it was marked incorrect and underwent further analysis as to the type and pattern of error, and the best way to resolve the error.

We approached the error analysis with the idea that error can enter a map and into a data set from many sources, some of which are out of the photo-interpreter's control. These sources of error include:

- locational error in the field (e.g., canyons or dense forests where GPS doesn't work, OR small or narrow polygons, so sample is taken in a different polygon than was intended);
- field key is difficult to use (fault may lie with key or with classification);
- field key does not include all plant associations present within the park;
- field crew error, either by misidentifying diagnostic species in the field, or by not reading the key carefully, thus resulting in a bad call when the map is actually good;
- point falls within an ecotone, which is impossible to classify but which still has to get mapped as something;
- polygon includes patches of varying vegetation that are too small to map individually, the mapper had to choose the visually dominant type to name the polygon; and
- aerial imagery was flown and/or the plot data collected in a year or season either much drier or much wetter than the year/season in which AA work was done.

These types of error may affect the accuracy of a map even when the map concepts are good. We therefore felt justified in making adjustments to the map class definitions and association-map class crosswalks, and in some cases, the map polygon labels to account for what we considered to be "false" (i.e., not in control of the mapper) errors.

The initial (uncorrected) accuracy of the GLCA/RABR vegetation map was 70.2%. We therefore inspected the original AA plot data, plot photographs, and aerial imagery to create the table that follows. The final step in the process was to present the initial contingency table and the draft form of this results table in April 2016 to the Chief Scientist for GLCA/RABR (John Spence), ask for input, and develop potential resolutions to sources of error that we would apply to the final map.

Initial Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Original Map Class Concept	Error Source	Potential Resolution	Final Decision 4/2016
1	1	Tamarisk Shrublands	Tamarisk Shrublands	Continuous dense stands of tamarisk, sometimes mixed with coyote willow, on the banks of the big rivers or in tributary drainages, OR sparse, weedy stands along the lakeshore, OR patchy stands in canyon bottoms.	None	N/A	N/A
2	2	Coyote Willow Shrublands	Coyote Willow Shrublands	Continuous and dense OR patchy stands of coyote willow shrublands on the banks of the big rivers, or in tributary drainages near seeps and springs. These stands are submerged frequently when river or lake levels are high.	Very rare map class (somewhat over-mapped) with small polygons that were confused with map classes 1 and 3, mostly.	Merge most polygons of this map class with their neighboring polygon (if it is map classes 1 or 3). Keep only stands big or continuous enough to map independently and/or where there is point data to verify the presence and dominance of willow.	Yes to suggestion. Removed from final contingency table.
3	3	Fremont Cottonwood Woodlands	Fremont Cottonwood Woodlands	Cottonwood communities in tributary drainages; trees may be mature or young. Upland or mesic understories, depending on depth of water table, frequency of flooding, and proximity to perennial water source.	None	N/A	N/A
4	5	Gambel Oak Terrace or Alcove Shrublands	Relict Spring-supported Mixed Deciduous Woodlands & Shrublands	On high alluvial terraces primarily in tributary drainages or in alcoves under cliff bands in pour-off areas. Stands tend to be small and often dense, and are dominated by *Quercus gambelii*. Other mesic shrubs and PJ trees may be present with low cover.	Confused primarily with map classes 95 and 97. Too many overlapping associations with MC 97 (5). Oak stands are small and not reliably distinguished from stands that have other mesic shrub and tree species mixed in.	Combine with MC 97 (5) but save line-work for this original map class by adding a “QG” modifier to all polygons (to denote stands dominated by *Quercus gambelii* alone).	Yes to suggestion. Merged with MC 97 (5).

Initial Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Original Map Class Concept	Error Source	Potential Resolution	Final Decision 4/2016
97	5	Cliff and Alcove Mesic Woodland and Shrubland Complex	Relict Spring-supported Mixed Deciduous Woodlands & Shrublands	Small, dark green, dense-canopied woodlands or tall shrublands occurring below cliff ledges, in alcoves, and/or near seep/spring headwaters in canyons. Some areas include riparian shrub and herbaceous micro-communities within a woodland matrix. Birch, *Ostrya*, Maple, Oak, Hackberry. These communities are often very small but support high spp. diversity and are valuable to wildlife.	Confused mainly with map classes 3, 4, and 95 (27). Too many overlapping associations with MC 4, which makes this map class less distinct than originally conceived.	Absorb polygons of MC 4 into this MC (save line-work) and expand description to include terraces and alcove/pour-off areas that are dominated by QUEGAM (QG modifier).	Yes to suggestion. Absorbed all polygons of MC 4.
6	6	Greasewood Shrublands	Greasewood Shrublands	Tributary drainages supporting greasewood shrublands. Stands have a grassy, sparse, or weedy understory (or one dominated by SUAMOQ).	Very rare type, confused with other terrace shrubland and herbaceous types.	Minor remapping; leave polygons only where there is plot data to confirm the presence of SARVER.	Yes to suggestion. Removed from final contingency table.
90	7	Ephemeral Wash Tall Shrublands	Ephemeral Wash Tall Shrublands	Rocky wash channels with intermittent vegetation. One or more of the following tall shrub species are present to dominant: *Purshia mexicana, Fraxinus anomala, Fallugia paradoxa,* and *Rhus aromatica*.	Mostly over-mapped and confused with map class 11, the other wash channel shrubland type. Some issues due to over-mapping/pulling out wash channels from surrounding polygons when vegetation differences were slight to non-existent.	Broad relabeling of wash channels on mesa tops and plains to MC 11. Refine definition of this MC to be rockier wash channels in canyon bottoms. Could combine with MC 11, but would lose differentiation of these tall shrubs from rabbitbrush and sand sage.	Do not combine with MC 11. Yes to suggestion.
8	8	Basin Big Sagebrush Shrublands	Basin Big Sagebrush Shrublands	Alluvial terraces in canyon bottoms (mostly along the Escalante River) with a shrubland mix dominated or co-dominated by *Artemisia tridentata ssp. tridentata*.	Over-mapped and confused primarily with map class 17 because of a similar dark photo signature. Some confusion with map classes 11 and 18 as well.	Minor remapping in the Waterhole Flat area. Otherwise retain only where there is plot data to confirm the presence of this type.	Yes to suggestion. Removed from final contingency table.
9	9	Wyoming Sagebrush Shrublands	Wyoming Big Sagebrush Shrublands	High elevation Wyoming big sagebrush-dominated shrublands, common on the mesa tops of the Orange Cliffs, Muley Point, and Navajo Point.	None	N/A	N/A

Initial Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Original Map Class Concept	Error Source	Potential Resolution	Final Decision 4/2016
10	10	Blackbrush Shrublands	Blackbrush Shrublands	Generally dense and homogenous stands of blackbrush (though other shrubs may be present), on a variety of substrates and landscape positions. Low percentage tree cover can be indicated with "t" modifier. Some communities have a grassy understory (“g” modifier).	Under-mapped and confused with a variety of other map classes, especially those occurring on eolian, alluvial, or clayey substrates.	Review plot vegetation data and photos to see if another MC call is justified. Accept with lower accuracy and note that it is an under-mapped type in the NRA.	Yes to suggestion.
11	11	Rabbitbrush Wash and Sandsheet Shrublands	Rabbitbrush Wash and Sandsheet Shrublands	Sandy wash channels and their associated low terraces (moderately bright sand signature with dark brown or black spots) dominated by *Ericameria nauseosa* and/or *Artemisia filifolia*. May have a grassy understory (“g” modifier).	Both over-mapped and under-mapped and confused with a variety of other map classes. Some overlapping associations with upland dune communities, confusion with other wash and terrace shrublands, and over-mapping due to separating wash channels from surrounding polys when the vegetation was not different or distinct.	Broad relabeling of all polys of MC 11 not mapped along wash channels (upland mesa top sites) to MC 13. Also included are the remapping efforts to distinguish this type from MC 90 (7) (see above). Retain with lower accuracy.	Relabeled polygons away from wash channel settings. Retained with lower accuracy.
71	12	Winterfat Dwarf-shrublands	Winterfat Dwarf-shrublands	Winterfat shrublands, often with a native grass understory, but sometimes one dominated by annual weedy species. Rare type, mostly concentrated in the Imperial and Bull Valleys (upper NE portion of the NRA).	Somewhat over-mapped in the Waterhole Flat portion of the NRA. Most AA samples and polygons of this type were not visited during AA data collection efforts due to accessibility issues.	Remove from final contingency table due to inadequate accuracy assessment.	Yes to suggestion. Removed from final contingency table.
13	13	Desert and Semi-desert Sand / Coppice Dunes Complex	Desert and Semi-desert Sand / Coppice Dunes Complex	Represents semi-desert sands and coppice dune occurring on aeolian terraces in canyon bottoms or on broad mesa tops. Bright sand signature, often sparsely vegetated. Mixed shrub cover may be dominated by one or more of the following: POLINC, ARTFIL, ERILEP, QUEHAV, and VANSTY, with OENPAL, ACHHYM, and/or other grasses or weedy species in the understory.	None	N/A	N/A

Initial Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Original Map Class Concept	Error Source	Potential Resolution	Final Decision 4/2016
14	14	Green Mormon Tea Shrub Herbaceous Vegetation	Green Mormon Tea Shrub Herbaceous Vegetation	Signature is a variable mosaic of dark *Ephedra* shrubs and a smooth herbaceous background in shades of green and yellowish-tan. Stands generally occur on mesa tops, plains, or high terraces in valley bottoms, also, occasionally on coppice dunes ("e" modifier). Stands are dominated by *Ephedra viridis*, sometimes with a few other shrubs co-dominant, and have a grassy understory, or more rarely a weedy understory.	Slightly over-mapped and under-mapped and confused with neighboring shrublands and native grasslands. Some errors due to the patchy distribution of these communities on the landscape, occurring intermixed or "fingering" with blackbrush shrublands, dunes, and shaley sparse vegetation types.	Review plot vegetation data and photos to see if another MC call is justified. Accept with lower accuracy.	Yes to suggestion.
92	15	Tributary Mesic Herbaceous Complex	Spring-supported Herbaceous Vegetation	Includes all mesic herbaceous communities (i.e. rush, horsetail, reed grass, mesic grasses, sedges, cattails, etc.) along perennial streams or in wet canyon bottoms where water is at or near the surface for most of the year.	Very rare map class (somewhat over-mapped) with small polygons that were confused primarily with map classes 2 and 4.	Merge most polygons with neighboring polygons (if map classes 2, 3, or 4). Keep only stands big or continuous enough to map independently and/or where there is point data to verify the presence and dominance of mesic herbaceous vegetation.	Yes to suggestion. Removed from final contingency table.
16	16	Native Grasslands	Native Grasslands	Native grasslands (dominated by ACHHYM, HESCOM, PLEJAM, BOUGRA, and/or *Sporobolus* spp.) with a smooth greenish signature, sometimes dotted with shrubs, such as ATRCAN, KRALAN, and *Ephedra* spp. An "i" modifier can indicate an area being invaded by non-natives and/or annual weedy species.	Both over-mapped and under-mapped and confused with a variety of other neighboring map classes. Mostly over-mapped where shrub cover was actually higher than grass cover.	Broad remapping on Grand Bench using different imagery. Review plot vegetation data and photos to see if another MC call is justified. Accept with lower accuracy.	Yes to suggestion.
94	16	Sporobolus airoides Shrub Herbaceous Complex	Native Grasslands	Mainly an herbaceous community dominated by SPOAIR with a smooth, grey-green photo signature.	Extremely rare class, very few examples of this type were found during AA field work.	Merge with map class 16; add SPOAIR associations to crosswalk for MC 16.	Yes to suggestion. Merged with MC 16.

Initial Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Original Map Class Concept	Error Source	Potential Resolution	Final Decision 4/2016
17	17	Weedy Herbaceous Complex	Weedy Herbaceous Complex	Weedy, disturbed areas of canyon bottoms, mesa tops, or lake shores. Dark grey to grayish tan, smooth or mottled signature, with occasional low shrub cover. Cactus and snakeweed are common native species, as well as low cover by native grasses, especially *Sporobolus cryptandrus*.	Both over-mapped and under-mapped and confused primarily with map classes 1, 8, and 16.	Minor remapping for MC 8 fixed some errors. Review plot vegetation data and photos to see if another MC call is justified. Accept with lower accuracy.	Yes to suggestion.
18	18	Saltbush Shrub Herbaceous Vegetation	Saltbush Shrub Herbaceous Vegetation	Represents alluvial terraces and canyon bottoms, as well as wash channels, dominated by *Atriplex canescens* (sometimes accompanied by ERINAU) and commonly dissecting native grassland areas or weedy basins.	Both under-mapped and over-mapped and confused with other desert sand map classes (8, 11, 14, and 19). Found to be more uncommon than was originally mapped.	Leave as polygons only where there is data to prove it. Review plot vegetation data and photos to see if another MC call is justified. Accept with lower accuracy.	Keep separate and retain with lower accuracy. Remapping for MC 8, 12, and 19 improved accuracy.
19	19	Snakeweed – Prickly Pear Shrub Herbaceous Vegetation	Snakeweed – Prickly Pear Shrub Herbaceous Vegetation	Sparse, mostly weedy (grazing-impacted) vegetation of broad valleys or mesas. Dominated by *Gutierrezia, Opuntia, Ephedra,* HILJAM, and other grasses and weedy forbs.	Over-mapped and confused with many other map classes. Indistinct photo-signature from map classes 14 and 16 on sandier substrates.	Broad relabeling in the Waterhole Flat area to MC 14 or 16. Redefine MC concept. Retain where there is plot data to confirm the presence of this type.	Yes to suggestion. Removed from final contingency table.
20	20	Pinyon - Juniper / Blackbrush Woodland	Pinyon - Juniper / Blackbrush Woodland	PJ/COLRAM woodlands on sand sheets or rocky mesa tops. Tree cover should be greater than 10 percent and COLRAM cover should exceed 4%.	Slightly under-mapped and confused mostly with map classes 12 (22) and 25.	Review plot vegetation data and photos to see if another MC call is justified.	Yes to suggestion.

Initial Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Original Map Class Concept	Error Source	Potential Resolution	Final Decision 4/2016
21	21	Pinyon - Juniper High Elevation Mesa Top Woodland	Pinyon – Juniper High Elevation Mesa Top Woodlands	Higher elevation PJ woodlands occurring on mesa tops in the Orange Cliffs and Navajo Point, and on top of the Waterpocket Fold. Big tree crowns, higher tree canopy cover, and a fairly sparse understory are diagnostic. Often on shallow, rocky soils. Low understory cover dominated by SHEROT, ARTNOV, ARTBIG, PURMEX, POAFEN, and/or PETPUM.	None	N/A	N/A
12	22	Juniper - (Pinyon) / Sparse or Grassy Understory Woodland	Juniper – (Pinyon) Woodland Savannas	Open woodlands of canyon bottoms or mesa tops with grassy (or sparse) understory. Scattered shrubs like EPHVIR, GUTSAR, and OPUPOL may be present but grasses should dominate. Signature of understory is generally smooth.	Both over-mapped and under-mapped and confused with many of the other PJ map classes. Concept for this map class was a little fuzzy with overlapping environmental settings and sparse understories also common in other PJ map classes.	Broad relabeling on the Orange Cliffs mesa top to MC 21 (too much overlap with associations, different concepts). Some errors could be attributed to imagery. Many errors remain; accept with lower accuracy.	Yes to suggestion.
23	23	Pinyon - Juniper / Wyoming Sagebrush Woodland	Pinyon - Juniper / Wyoming Sagebrush Woodlands	PJ woodlands with ARTTRI ssp. *wyomingensis* dominant in the understory. Found on the high mesa tops of the Orange Cliffs, Navajo Point, and Muley Point.	Slightly over-mapped and confused primarily with map classes 21 and 29.	Review plot vegetation data and photos to see if another MC call is justified. Accept with lower accuracy.	Yes to suggestion.
32	24	Pinyon - Juniper Sandstone Woodland Complex	Pinyon - Juniper Sandstone Woodland Complex	Sparsely vegetated slickrock sandstone exposures (greater than 60-70% bedrock cover) with potholes or small solution features, as well as shallow to deep joints, which support PJ trees and a variety of shrubs. *Cercocarpus intricatus* is a diagnostic species for this type.	None	N/A	N/A

Initial Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Original Map Class Concept	Error Source	Potential Resolution	Final Decision 4/2016
25	25	Pinyon – Juniper Semi-Desert Sand Woodlands	Pinyon - Juniper Semi-Desert Sand Woodlands	Open PJ woodlands on undulating, active to somewhat stabilized sand dunes. Typically found on plateaus and benches where coarser sand deposits have accumulated. Common understory shrubs include sand shinnery oak and sand sagebrush, but many stands have a sparse understory.	Over-mapped and confused with map classes 12 (22), 20, and 28, with grassy understories or ones dominated by blackbrush. Some concept overlap with MC 12 (22) and signatures are similar, so some errors will remain there.	Review plot vegetation data and photos to see if another MC call is justified. Some errors could be attributed to imagery. Accept with lower accuracy.	Yes to suggestion.
7	26	Pinyon - Juniper / Mixed Shrubland Wash Woodland	Pinyon - Juniper / Mixed Shrubland Wash Woodlands	Dry washes where runoff is channeled with spotty junipers and pinyons and a variety of upland shrub species. Tree and shrub covers range from widely scattered to nearly continuous. A variety of shrubs in the understory including: cliffrose, oak, sumac, serviceberry, *Mahonia*, and snowberry.	Slightly over-mapped in areas where surroundings are also PJ woodlands and wash channels don't support different shrubs than the surrounding areas. Some confusion with MC 3.	Review plot vegetation data and photos to see if another MC call is justified. Accept with lower accuracy.	Yes to suggestion.
95	27	Pinyon - Juniper / Gambel oak Woodland	Pinyon – Juniper / Gambel Oak Woodlands	Represents pour-off sites where runoff is channeled, such as around the base of slickrock outcrops or against the base of cliffs on a high scree slope. Big tree crowns and tall shrubs (i.e. oak, MAHFRE, *Rhus*) are diagnostic of this MC.	Uncommon map class that was both under-mapped and over-mapped. Confused with other PJ map classes and pure Gambel oak stands. Many polygons are less than MMU size.	Combine with map class 4? Though this doesn't resolve the issues with the other pinyon-juniper map classes.	No to suggestion. Retain with lower accuracy.
22	28	Juniper - (Pinyon) / Ephedra - Snakeweed - Atriplex Woodland	Pinyon – Juniper / Green Mormon-tea – Snakeweed Woodlands	Vegetation similar to MC 19 except for the presence of Juniper trees. A grazed or otherwise disturbed version of MC 12 (22). Understory is dominated by *Ephedra* and/or *Gutierrezia* spp., *Opuntia* spp., and some native grass cover and/or weedy annuals.	Over-mapped and confused mostly with MC 12 (22); under-mapped (slightly) and confused with MC 24 and 25. Concept for this map class was a little fuzzy with overlapping environmental settings and understories common to other PJ map classes.	Broad remapping of all polygons not on Chinle Formation soils. Redefine map class concept to this more narrow definition.	Yes to suggestion.

Initial Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Original Map Class Concept	Error Source	Potential Resolution	Final Decision 4/2016
24	29	Pinyon-Juniper Cool Aspect Talus Woodland	Pinyon – Juniper Shale Scarps Complex	High elevation, north-facing, steep slopes with large talus chunks atop ledgy slickrock outcrops supporting scattered pinyon and juniper trees and mixed shrubs. *Cercocarpus montanus* is a diagnostic species for this type.	Too much overlap with map class 29, no unique vegetation associations or environmental settings.	Combine with MC 29 but save line-work for this original map class by adding a "CM" modifier to all polygons (to denote stands dominated by *Cercocarpus montanus*).	Yes to suggestion. Merged with MC 29.
29	29	Pinyon-Juniper Shale Scarps Mosaic	Pinyon – Juniper Shale Scarps Complex	Cooler aspects and/or concave, steep and very steep, residual or colluvial debris slopes. Widely scattered PJ trees with a variety of tall shrubs in the understory (AMEUTA, SHEROT, RHUARO, PURSTA, FRAANO, etc.) and some grasses (usually LEYSAL).	Under-mapped and confused primarily with map classes 21, 22, and 23. Many problems were due to field crews using P-J/Mixed Shrubs Talus name in areas that were not talus, but had a mixed shrub understory.	Review plot vegetation data and photos to see if another MC call is justified. Accept with lower accuracy.	Yes to suggestion.
30	30	Talus Escarpments Mixed Sparse Vegetation Complex	Talus Escarpments Mixed Sparse Vegetation Complex	More exposed, convex and/or warmer, steep and very steep, residual or colluvial debris slopes. Appear barren on the photo-signature but generally support a wide variety of desert shrubs with none generally dominant. Common species include *Atriplex* spp., ARTBIG, EPHTOR, COLRAM, ERINAU, RHUTRI, and FRAANO.	Vegetatively heterogeneous map class. Both over-mapped and under-mapped according to vegetation data and confused primarily with MC 15.	Review plot vegetation data, environmental data, and photos to see if another MC call is justified. Some errors will remain due to the heterogeneous nature of this class. Accept with lower accuracy.	Yes to suggestion.
5	31	Chinle Badlands Shadscale Scrub	Tropic Shale Badlands Mat Saltbush Sparse Vegetation	Barren looking blue-gray Tropic Shale badlands with very sparse cover dominated by *Atriplex corrugata*.	This MC was created after AA field work was done and at the recommendation of the park. All polygons of MC 5 mapped on Tropic Shale were relabeled to this new map class.	Relabel all polygons of map class 5 on Tropic Shale to pull out areas dominated by *A. corrugata*, not *A. confertifolia.*	Yes to suggestion.
5	32	Chinle Badlands Shadscale Scrub	Shadscale - Goldenhead Scrub	Common on Dakota and Morrison formations on the north side of the lake in the Warm Creek area, and dominated by sparse shrublands of ATRCON and ACASPH, with or without ARTSPI present to co-dominant.	This MC was created after AA field work was done and at the recommendation of the park. All polygons of MC 5 mapped south and west of Navajo Point (geologic break) were relabeled to this new map class.	Relabel all polygons of map class 5 on Dakota and Morrison formations (S and W of Navajo Point) to pull out areas co-dominated by *Acamptopappus sphaerocephalus.*	Yes to suggestion.

Initial Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Original Map Class Concept	Error Source	Potential Resolution	Final Decision 4/2016
15	33	Torrey's Joint-fir Shale Barrens Desert Scrub	Torrey's Joint-fir Shale Barrens Desert Scrub	Moenkopi or other shale barrens supporting a sparse mixed shrubland dominated by *Ephedra torreyana*, often associated with low cover by blackbrush and/or ATRCON. Low tree cover can be indicated with "t" modifier and grassy understories (mostly HILJAM) with a "g" modifier.	Somewhat under-mapped and confused primarily with map classes 10, 11 and 30. This class was defined principally by substrate with an indistinct vegetation signature.	Review plot vegetation data and photos to see if another MC call is justified. Accept with lower accuracy and note that it is an under-mapped type in the NRA.	Yes to suggestion.
34	34	Slickrock Sparse Shrublands	Slickrock Sparse Shrublands	Sparsely vegetated, relatively level sandstone exposures (generally greater than 60-70% bedrock cover) with potholes or small solution features which support sparse shrub and grass cover (generally lacking trees). Most common shrubs include COLRAM, ARTBIG, RHUTRI, FRAANO, and *Gutierrezia* spp.	None	N/A	N/A
35	35	Gardner Saltbush Sparse Vegetation	Gardner Saltbush Sparse Vegetation	Moenkopi (upper member, lighter color) formation benches and badlands with a smooth gray signature and very sparse shrub cover dominated by *Atriplex gardneri*.	This map class way over-mapped and confused with map classes 5, 10, and 15. Some errors could be attributed to the imagery.	Broad remapping using newer imagery would result in many fewer polygons and improved accuracy.	Yes to suggestion. Retain with lower accuracy.
5	36	Chinle Badlands Shadscale Scrub	Chinle Badlands Shadscale Scrub	Nearly barren blue-gray Chinle badlands and toeslopes with sparse shrub cover dominated by shadscale, or more rarely by *Zuckia brandegeei*. Can have a grassy understory ("g" modifier). Soil surface is often gravelly.	Somewhat under-mapped and confused with map classes 30, 32, and 33.	Review plot vegetation data and photos to see if another MC call is justified. Accept with lower accuracy and note that it is an under-mapped type in the NRA.	Yes to suggestion.
91	91	Seepweed Sparse Vegetation	Seepweed Sparse Vegetation	Generally small polygons on salt flats and mud flats nearly devoid of vegetation. Some weeds, otherwise just *Suaeda moquinii*.	Very rare type that occurs in polygons generally less than MMU size.	Leave polygons only where there is plot data to confirm the presence of SUAMOQ.	Yes to suggestion. Removed from final contingency table.

Initial Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Original Map Class Concept	Error Source	Potential Resolution	Final Decision 4/2016
96	96	Douglas-fir Scree Slope Woodland	Douglas-fir Scree Slope Woodlands	Very rare communities with Douglas-fir trees emergent on high scarps at the base of cliff bands in sheltered, mesic locations. Relict stands.	Very rare type that occurs in polygons generally less than MMU size.	Leave polygons only where there is plot data to confirm the presence of PSEMEN.	Yes to suggestion. Removed from final contingency table.
111	111	Rivers	Rivers / Lakes	Open water (river, lakes, etc.)	not AAed	N/A	N/A
113-A	113	Stock pond	Stock Ponds	Stock ponds	not AAed	N/A	N/A
114	114	Dam	Dam	Glen Canyon Dam	not AAed	N/A	N/A
136	136	Barren slickrock of any formation	Bare Sandstone / Slickrock	Cliffs, domes, buttes, mesas, etc. of bare rock or sandstone. Essentially unvegetated.	not AAed	N/A	N/A
200	200	Sand bars and sand islands	Sand Bar, Sand Islands, Badlands, and other Bare Dirt Areas	Bare dirt areas. Essentially unvegetated.	not AAed	N/A	N/A
212	212	Park Housing	Park Housing, Other Housing, and Campgrounds	Park Housing, Other Housing, and Campgrounds	not AAed	N/A	N/A
213	213	Facilities	Park Facilities	Maintenance Shop, Visitor Center, Cache Building, etc.	not AAed	N/A	N/A
226	226	Roads	Roadways	Roadways (paved = t, unpaved = u)	not AAed	N/A	N/A
310	310	Maintenance Yard, Gravel Pit	Maintenance Yards	Maintenance yards	not AAed	N/A	N/A
320	320	Heli-pad	Helicopter Pad	Helicopter pad	not AAed	N/A	N/A
4131	4131	Orchard	Orchard	Orchard	not AAed	N/A	N/A

Appendix I. Map Class Descriptions for Glen Canyon National Recreation Area and Rainbow Bridge National Monument

Introduction

This document provides a visual guide and description of the vegetation map classes for the Glen Canyon National Recreation Area and Rainbow Bridge National Monument Vegetation Mapping Project. Thirty-seven map classes are described in this guide. Eleven land use or otherwise unvegetated map classes are not included.

Each of the map classes included in this guide is documented by:

- ground photographs (if available)
- a list of component NVC associations
- common plant species
- examples of each map class photo signature taken from the ortho imagery with delineated polygons
- descriptions of the photo signature interpretation
- a description of the ecology and distribution of the map class within the mapping area
- a graphic showing distribution of the map class throughout the mapping area
- polygon statistics report (polygon number, size, and area)
- accuracy assessment results for each map class

This guide does not attempt to show all variations within each vegetation map class; only the most common or significant representations are included. These should be sufficient to give the user an understanding of the relationships among the vegetation classification, the imagery, and the mapping concepts.

Key to the Vegetated Map Classes of Glen Canyon National Recreation Area and Rainbow Bridge National Monument

1) What is the dominant surface cover?

- **Trees**.....go to.....Upland_Forests_and_Woodlands
- **Shrubs**.....go to.....Upland_Shrublands
- **Herbaceous**.....go to.....Upland_Herbaceous_Communities
- **Sparse vegetation** (1 – 10%) …….go to.....Sparse_Vegetation_Talus_Slope_Communities

2) **Trees:**

a. Tree canopy is dominated by evergreen trees (2c)
b. Tree canopy is dominated by deciduous trees and site is predominantly associated with a perennial watercourse or a seep or spring (2u)

c. Tree canopy is dominated by *Pinus edulis* and/or *Juniperus osteosperma* (2e)
d. Tree canopy is dominated by *Pseudotsuga menziesii* **(Douglas-fir Scree Slope Woodlands (W-PSME))**…go to Appendix I-36

e. Site is predominantly associated with an ephemeral watercourse or a pour-off area where water collects (2g)
f. Site is in an upland zone (2i)

g. Understory is dominated by *Quercus gambelii* **(Pinyon – Juniper / Gambel Oak Woodlands (W-PJQU))**…go to Appendix I-27
h. Understory is composed of tall, mixed shrubs including *Rhus trilobata*, *Purshia stansburiana*, *Quercus* spp., *Amelanchier utahensis*, *Fraxinus anomala*, and *Symphoricarpos longiflorus* **(Pinyon - Juniper / Mixed Shrubland Wash Woodlands (W-PJWA))**…go to Appendix I-24

i. Site is on a steep, talus slope **(Pinyon – Juniper Shale Scarps Complex (C-PJSC))**…go to Appendix I-33
j. Site is on flat to rolling terrain (2k)

k. Site has greater than 60% sandstone bedrock cover **(Pinyon - Juniper Sandstone Woodland Complex (W-PJSA))**…go to Appendix I-18
l. Site has less than 60% sandstone bedrock cover (2m)

m. Site has active soils and/or coppice dunes **(Pinyon - Juniper Semi-Desert Sand Woodlands (W-PJDU))**…go to Appendix I-21
n. Site has stabilized soils (2o)

o. Understory is grassy and/or sparse **(Juniper – (Pinyon) Woodland Savannas (W-PJGR))**…go to Appendix I-12

p. Understory is shrubby (2q)

q. Understory is dominated by *Artemisia tridentata ssp. wyomingensis* **(Pinyon – Juniper / Wyoming Sagebrush Woodlands (W-PJAR))**… go to Appendix I-15

r. Understory is **not** dominated by *Artemisia tridentata ssp. wyomingensis* (2s)

s. Understory is dominated by *Coleogyne ramosissima* **(Pinyon – Juniper / Blackbrush Woodlands (W-PJCO))**… go to Appendix I-6

t. Understory is **not** dominated by *Coleogyne ramosissima* (2u)

u. Site is on high elevation mesa top with shallow soils and a mixed shrub understory **(Pinyon – Juniper High Elevation Mesa Top Woodlands (W-MEPJ))**… go to Appendix I-9

v. Site is on clay soils with a sparse understory dominated by *Ephedra* spp., *Gutierrezia* spp., and/or *Opuntia* spp. **(Pinyon – Juniper / Green Mormon-tea – Snakeweed Woodlands (W-PJEP))**… go to Appendix I-30

w. Tree canopy is dominated by *Populus fremontii* (or more rarely by *Salix gooddingii* or *Acer negundo*) **(Fremont Cottonwood Woodlands (W-COTT))**… go to Appendix I-108

x. Tree canopy is mixed and may include *Acer grandidentatum, Celtis reticulata, Ostrya knowltonii,* and *Populus fremontii.* Tall shrubs may have higher cover than trees and include *Quercus gambelii, Betula occidentalis,* and *Frangula betulifolia* **(Relict Spring-supported Mixed Deciduous Woodlands & Shrublands (W-SPRI))**… go to AAppendix I-111

3) **Shrubs**:

a. Site is predominantly associated with an ephemeral or perennial watercourse (3c)

b. Site is in an upland zone (3i)

c. Site is predominantly associated with a perennial watercourse (3e)

d. Site is predominantly associated with an ephemeral watercourse (3g)

e. Site is dominated by *Tamarix chinensis* (TAMX) **(Tamarisk Shrublands (S-TAMX))**… go to Appendix I-102

f. Site is dominated by *Salix exigua, Pluchea sericea* and/or *Baccharis* spp. **(Coyote Willow Shrublands (S-WILL))**… go to Appendix I-105

g. Site is dominated by *Ericameria nauseosa* and/or *Artemisia filifolia* **(Rabbitbrush Wash and Sandsheet Shrublands (S-RABB))**… go to Appendix I-54
h. Site is dominated by *Fallugia paradoxa*, *Fraxinus anomala*, and/or *Rhus trilobata* **(Ephemeral Wash Tall Shrublands (S-WASH))**… go to Appendix I-42

i. Site is dominated by *Artemisia tridentata* (3k)
j. Site is **not** dominated by *Artemisia tridentata* (3m)

k. Site is on a high elevation mesa top **(Wyoming Big Sagebrush Shrublands (S-WYSA))**… go to Appendix I-48
l. Site is on a terrace or valley bottom bordering an ephemeral watercourse **(Basin Big Sagebrush Shrublands (S-SAGE))**… go to Appendix I-45

m. Site is dominated by *Sarcobatus vermiculatus* **(Greasewood Shrublands (S-SARV))**… go to Appendix I-39
n. Site is **not** dominated by *Sarcobatus vermiculatus* (3o)

o. Site is dominated by *Coleogyne ramosissima* **(Blackbrush Shrublands (S-BLAC))**… go to Appendix I-51
p. Site is **not** dominated by *Coleogyne ramosissima* (3q)

q. Site is dominated by *Atriplex canescens* **(Saltbush Shrub Herbaceous Vegetation (S-SALT))**… go to Appendix I-66
r. Site is **not** dominated by *Atriplex canescens* (3s)

s. Site is dominated by *Ephedra viridis* **(Green Mormon Tea Shrub Herbaceous Vegetation (S-EPVI))**… go to Appendix I-63
t. Site is **not** dominated by *Ephedra viridis* (3u)

u. Site has active soils and/or coppice dunes **(Desert and Semi-desert Sand/Coppice Dunes Complex (C-DUNE))**… go to Appendix I-60
v. Site has stabilized soils (3w)

w. Site is dominated by *Krascheninnikovia lanata* **(Winterfat Dwarf-shrublands (S-WINT))**… go to Appendix I-57
x. Site is dominated by *Gutierrezia* and/or *Opuntia* spp. **(Snakeweed – Prickly Pear Shrub Herbaceous Vegetation (C-CACT))**… go to Appendix I-69

4) **Herbaceous**:

a. Site is predominantly associated with a perennial watercourse or a seep or spring (**Spring-supported Herbaceous Vegetation (H-HERB))**… go to Appendix I-114
b. Site is in an upland zone (4c)

c. Site is dominated by native grasses **(Native Grasslands (H-GRAS))**… go to Appendix I-72

d. Site is dominated by non-native forbs and/or grasses **(Weedy Herbaceous Complex (C-WEED))**… go to Appendix I-75

5) **Sparse Vegetation**:

a. Site is predominantly associated with an ephemeral or perennial watercourse and is dominated by *Suaeda moquinii* **(Seepweed Sparse Vegetation (S-SEEP))**… go to Appendix I-99

b. Site is in an upland zone (5c)

c. Site is on a steep, talus slope **(Talus Escarpments Mixed Sparse Vegetation Complex (C-TALU))**… go to Appendix I-78

d. Site is on flat to rolling terrain (5e)

e. Site has greater than 60% sandstone bedrock cover **(Slickrock Sparse Shrublands (S-SLIC))**… go to Appendix I-90

f. Site has less than 60% sandstone bedrock cover (5g)

g. Site is dominated by *Ephedra torreyana* and predominantly occurs on Moenkopi Formation soils **(Torrey's Joint-fir Shale Barrens Desert Scrub (S-SCRU))**… go to Appendix I-87

h. Site is dominated by *Atriplex* spp. (5i)

i. Site is dominated by *Atriplex gardneri* or *Atriplex corrugata* (5k)

j. Site is dominated by *Atriplex confertifolia,* with or without *Acamptopappus sphaerocephalus* and *Picrothamnus desertorum* (m)

k. Site is dominated by *Atriplex gardneri* and stands occur on Chinle-Moenkopi Formation soils **(Gardner Saltbush Sparse Vegetation (S-GARD))**… go to Appendix I-93

l. Site is dominated by *Atriplex corrugata* and stands occur on Tropic Shale Formation soils **(Tropic Shale Badlands Mat Saltbush Sparse Vegetation (S-TROP))**… go to Appendix I-81

m. Site is dominated by *Atriplex confertifolia* and stands occur on Chinle Formation soils **(Chinle Badlands Shadscale Scrub (S-SHAD))**… go to Appendix I-96

n. Site is dominated by *Atriplex confertifolia* with or without *Acamptopappus sphaerocephalus* and *Picrothamnus desertorum* and stands occur on Dakota, Morrison, or Tropic Shale Formation soils **(Shadscale - Goldenhead Scrub (S-GOLD))**… go to Appendix I-84

Upland Forests and Woodlands

Map Class 20
Pinyon – Juniper / Blackbrush Woodlands (W-PJCO)



Photo credits: NPS

Associations

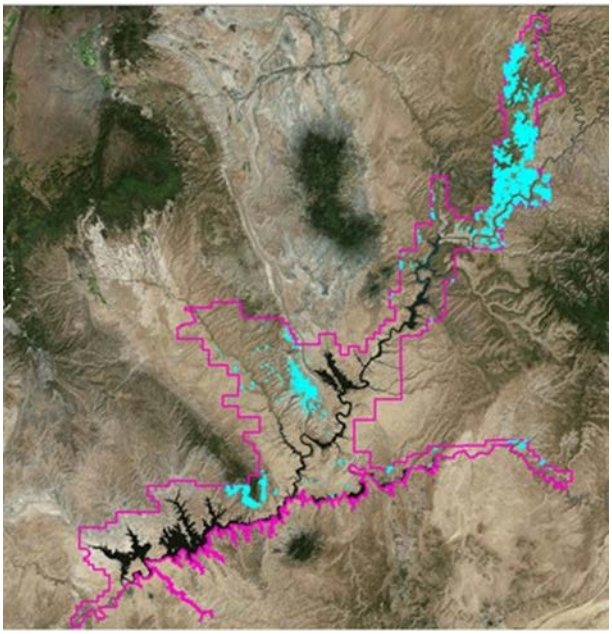
Juniperus osteosperma / Coleogyne ramosissima Woodland [CEGL002909]
Pinus edulis – Juniperus osteosperma / Coleogyne ramosissima Woodland [CEGL000781]

Common species

- *Pinus edulis*
- *Coleogyne ramosissima*
- *Ephedra viridis*
- *Juniperus osteosperma*
- *Gutierrezia sarothrae*
- *Opuntia* spp.

W-PJCO Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	1,134 total polygons
Total project area:	10,964 hectares / 27,093 acres
% of vegetated land surface:	2.8%
Average polygon size:	9.6 hectares / 24 acres
Producer's accuracy:	84% ± 8%
User's accuracy:	85% ± 8%



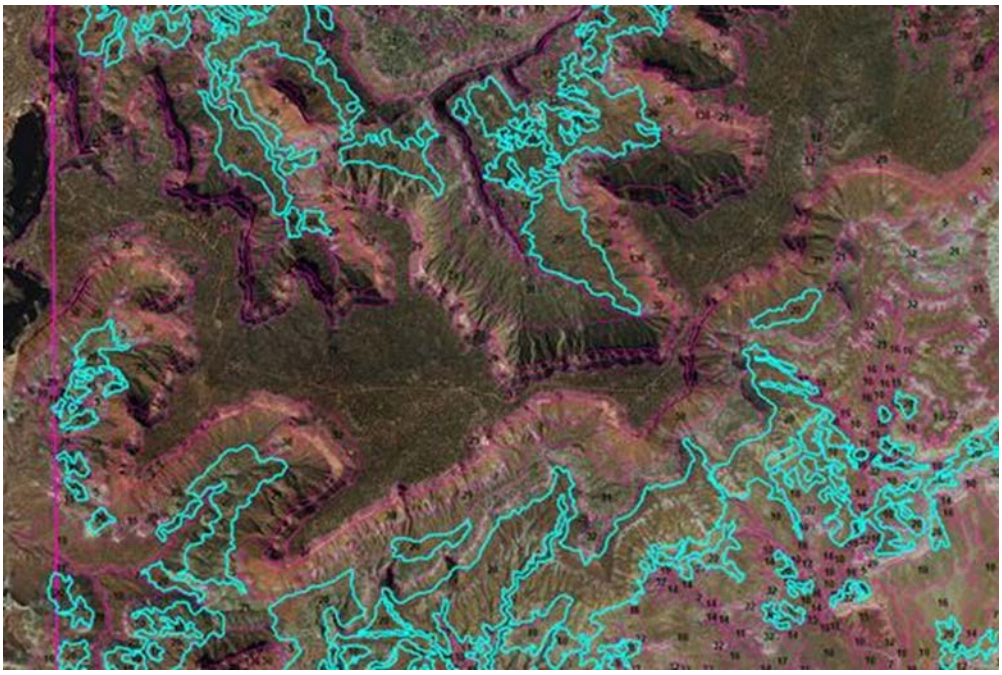
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur primarily on gentle to moderate slopes on canyon rims, plateaus, benches, sand dunes, canyon bottoms, and valley floors. *Pinus edulis* and *Juniperus osteosperma* are co-dominant in the canopy layer, or more rarely *Pinus edulis* is absent. Individual tree species cover generally exceeds 5%. The most common shrub in the understory is *Coleogyne ramosissima,* with cover generally exceeding 5%. The substrate is variable, ranging from aeolian sand deposits to shallow pockets of residuum on top of bedrock to a continuous pavement-like gravel coating. Biological soil crusts may be absent or present with moderate cover, though are generally not well-developed (early seral stages). A diversity of shrubs and grasses may be present with trace to low cover, including *Ephedra viridis, Artemisia bigelovii, Gutierrezia sarothrae, Yucca angustissima, Opuntia spp., Achnatherum hymenoides, Pleuraphis jamesii, Poa fendleriana,* and *Hesperostipa comata*. Stands most commonly occur in the Orange Cliffs, on the Waterpocket Fold, and on the toeslopes of Navajo Point.

Interpretation

This common map class appears as small to very large, irregular polygons on gentle slopes and flats throughout higher elevation areas of Glen Canyon NRA. The color is a tan to reddish-brown, reflecting the substrate, with regularly-spaced dark brown speckles of blackbrush, and scattered tree crowns producing dark green to black spots. Common neighbors include polygons of blackbrush shrublands (map class 10), pinyon-juniper sandstone woodlands (map class 24), and pinyon-juniper shale scarps (map class 29); however, because this map class is widespread, it may be adjacent to a variety of other map classes, especially other pinyon-juniper map classes.



Example of photo signature for map class W-PJCO (#20)

Map Class 21
Pinyon – Juniper High Elevation Mesa Top Woodlands (W-MEPJ)





Photo credits: NPS

Associations

Dominant:
Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland [CEGL00782]
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland [CEGL002148]

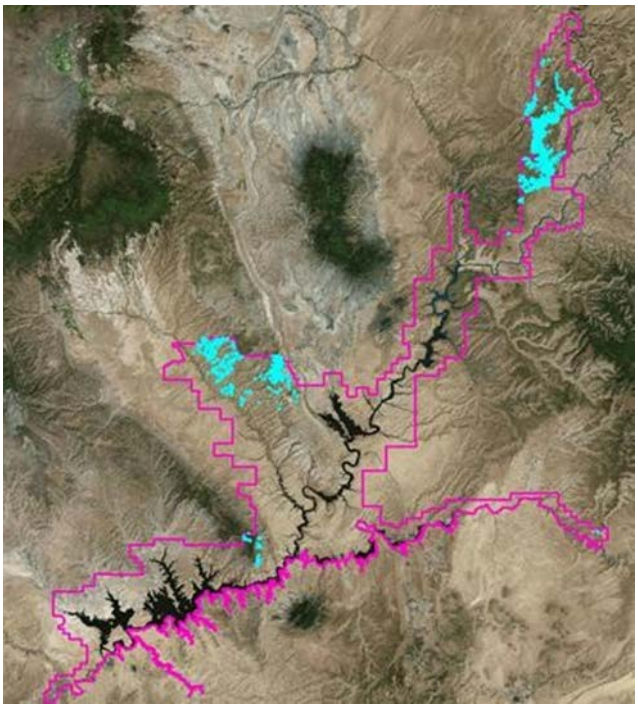
Less common:
Pinus edulis - Juniperus osteosperma / Artemisia nova Woodland [CEGL002331]
Pinus edulis - Juniperus osteosperma / Artemisia bigelovii Woodland [CEGL002118]
Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia Woodland [CEGL002335]
Pinus edulis - Juniperus spp. / Poa fendleriana Woodland [CEGL000787]

Common species

- *Pinus edulis*
- *Artemisia bigelovii*
- *Shepherdia rotundifolia*
- *Artemisia nova*
- *Petradoria pumila*
- *Juniperus osteosperma*
- *Purshia stansburiana*
- *Fraxinus anomala*
- *Ephedra viridis*
- *Gutierrezia sarothrae*

W-MEPJ Map Class Statistics

Statistic Name	Statistic Value
Frequency:	322 total polygons
Total project area:	7,328 hectares / 18,108 acres
% of vegetated land surface:	2%
Average polygon size:	22.8 hectares / 56 acres
Producer's accuracy:	89% ± 7%
User's accuracy:	83% ± 8%



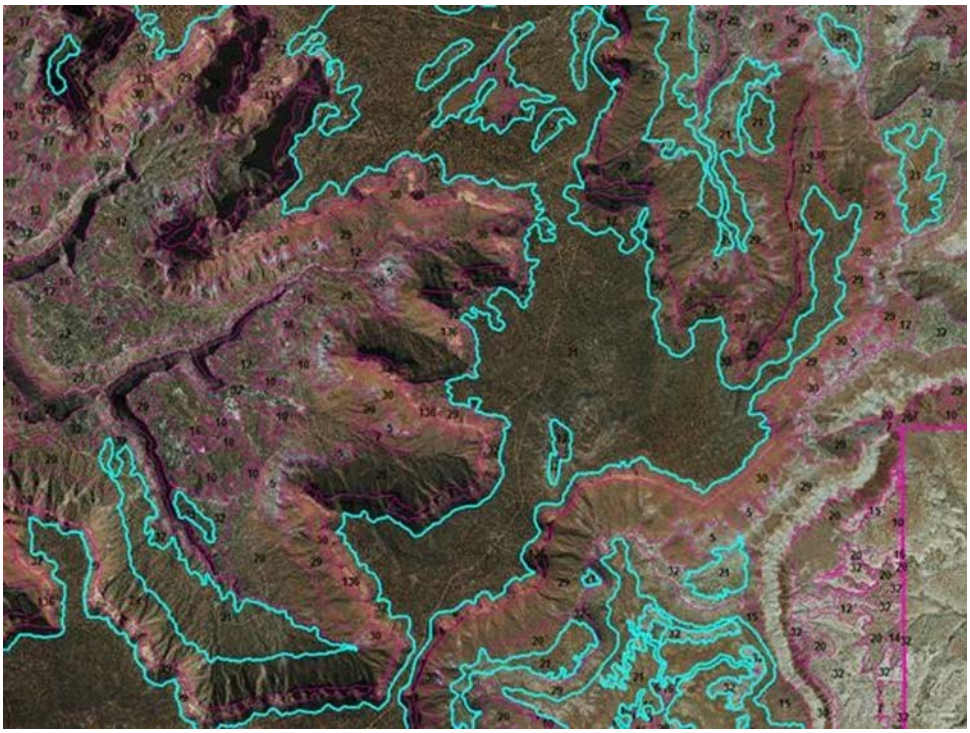
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur on flat mesa tops at high elevation areas within Glen Canyon NRA (1,628-2,233 m). Stands are characterized by open to somewhat closed *Pinus edulis* and *Juniperus osteosperma* woodlands with sparse to low cover understories (dominated by *Gutierrezia* spp. and/or *Petradoria pumila*). Stands with developed understories still have generally low total shrub cover, and may include some or all of the following shrubs: *Artemisia bigelovii, Artemisia nova, Purshia stansburiana, Shepherdia rotundifolia, Fraxinus anomala, Ephedra viridis,* and *Amelanchier utahensis.* Shallow residual soils on top of bedrock are common, less common are rocky or gravelly soils. Biological soil crusts may have low to high cover and are generally well-developed (later seral stages). Stands are found on the Orange Cliffs mesa tops, Circle Cliffs, Choprock Bench, Purple Hills, Fiftymile Mountain, and Muley Point.

Interpretation

This somewhat common map class appears as small to very large, irregular polygons on the high elevation mesa tops of Glen Canyon NRA. The color is a dark green to black, rough- or pebble-textured set against a smooth background of yellowish-tan to reddish-brown, depending on the substrate. Common neighbors include polygons of closely related types: pinyon – juniper / sparse or grassy understory woodlands (map class 22), pinyon - juniper shale scarps (map class 29), pinyon - juniper sandstone woodlands (map class 24), pinyon – juniper / blackbrush woodlands (map class 20), and pinyon – juniper / Wyoming sagebrush woodlands (map class 23).



Example of photo signature for map class W-MEPJ (#21)

Map Class 22
Juniper – (Pinyon) Woodland Savannas (W-PJGR)




Photo credits: NPS

Associations

Dominant:
Juniperus osteosperma / Pleuraphis jamesii Open Woodland [CEGL002379]
Juniperus osteosperma / Sparse Understory Woodland [CEGL000732]
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland [CEGL002148]

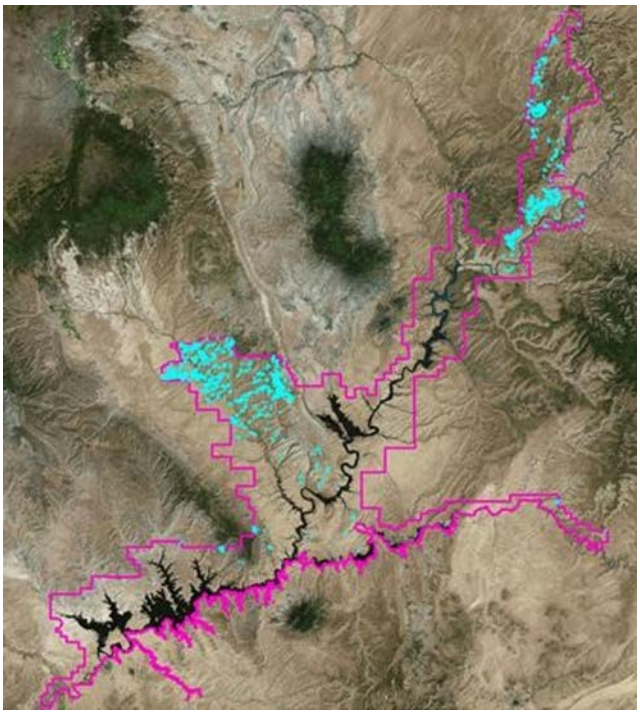
Less common:
Juniperus osteosperma / Hesperostipa comata Open Woodland [CEGL002815]
Juniperus osteosperma / Leymus salinus Open Woodland [CEGL003109]
Pinus edulis - Juniperus osteosperma / Achnatherum hymenoides Woodland [CEGL002364]
Pinus edulis - Juniperus osteosperma / Pleuraphis jamesii Woodland [CEGL002379]

Common species

- *Pinus edulis*
- *Ephedra viridis*
- *Hesperostipa comata*
- *Pleuraphis jamesii*
- *Juniperus osteosperma*
- *Achnatherum hymenoides*
- *Sporobolus* spp.
- *Gutierrezia sarothrae*

W-PJGR Map Class Statistics

Statistic Name	Statistic Value
Frequency:	630 total polygons
Total project area:	3,091 hectares / 7,639 acres
% of vegetated land surface:	0.8%
Average polygon size:	5 hectares / 12 acres
Producer's accuracy:	65% ± 13%
User's accuracy:	67% ± 13%



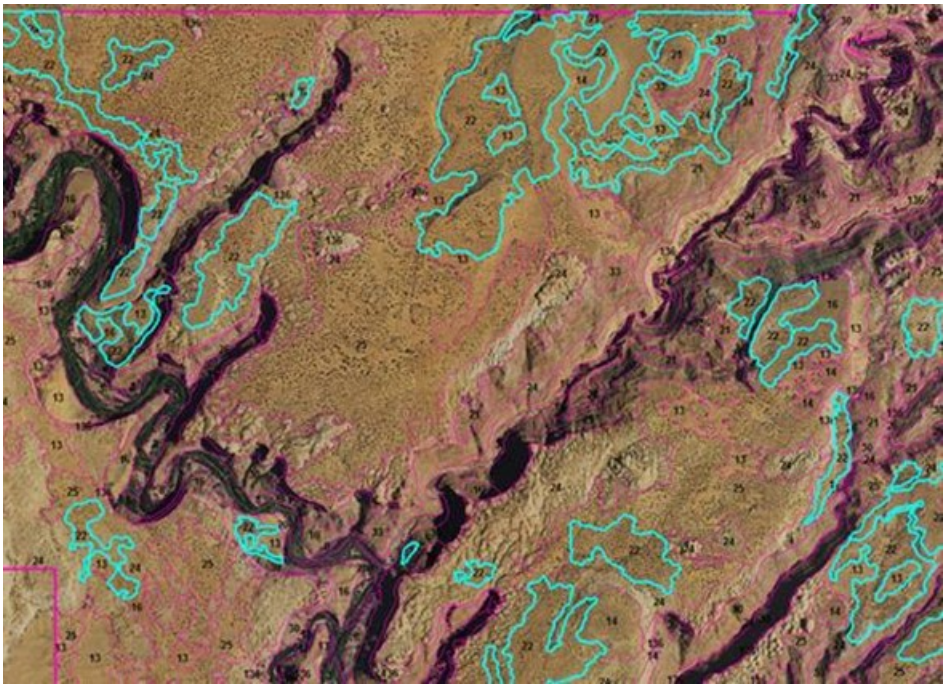
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur on toeslopes, low slopes, and flats in canyon bottoms and valley floors and on plateaus and mesa tops. Stands are characterized by open *Juniperus osteosperma* (sometimes accompanied by *Pinus edulis*) woodlands with a generally sparse understory (<5% total shrub cover) or an understory dominated by grass species (e.g. *Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii* and *Sporobolus* spp.). Scattered *Ephedra* spp., *Gutierrezia* spp., and *Opuntia* spp. are common, especially in previously disturbed areas. Understories may be sparse for a variety of reasons, including livestock grazing disturbances, xeric shale or sand substrates with poor water-holding capacity, or a surface covered by gravel limiting germination sites. These woodlands most commonly occur in the Orange Cliffs, Circle Cliffs, Purple Hills, upper Waterpocket Fold, and the Escalante River drainage system, including in the Moody Canyons.

Interpretation

This common map class appears as small to medium, regular polygons on gentle slopes and flats throughout Glen Canyon NRA; most commonly in the Orange Cliffs and Escalante drainages. The background color is a smooth grey-green (grasses) to tan and reddish-tan (substrate) with widely spaced tree crowns producing dark green to black spots. Because this map class is widespread in the park and occurs in heterogeneous sites (i.e. canyon bottoms), it is bordered by polygons of many other map classes.



Example of photo signature for map class W-PJGR (#22)

Map Class 23
Pinyon – Juniper / Wyoming Sagebrush Woodlands (W-PJAR)




Photo credits: NPS

Associations

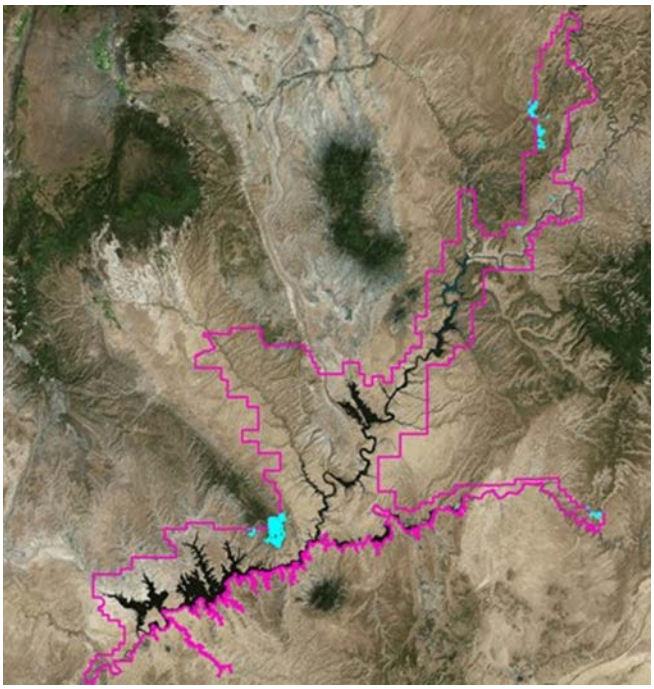
Pinus edulis - Juniperus osteosperma / Artemisia tridentata (ssp. *wyomingensis*, ssp. *vaseyana*) Woodland [CEGL005658]
Juniperus osteosperma / Artemisia tridentata Woodland [CEGL000730]

Common species

- *Pinus edulis*
- *Artemisia tridentata ssp. wyomingensis*
- *Ephedra viridis*
- *Juniperus osteosperma*
- *Gutierrezia sarothrae*
- *Opuntia* spp.

W-PJAR Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	64 total polygons
Total project area:	2,300 hectares / 5,683 acres
% of vegetated land surface:	0.6%
Average polygon size:	36 hectares / 89 acres
Producer's accuracy:	75% ± 10%
User's accuracy:	85% ± 9%



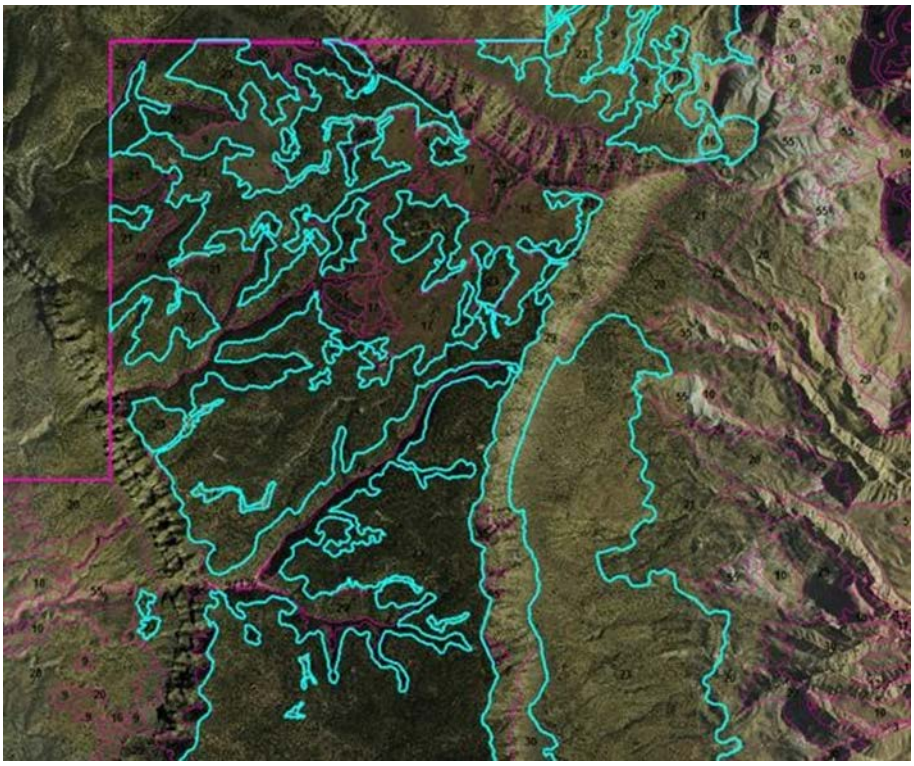
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur on mesa tops at high elevation areas within Glen Canyon NRA (1,709-2,260 m), and more rarely in canyon or valley bottoms (1,559-1,636 m). Stands are characterized by open to somewhat closed *Pinus edulis* and *Juniperus osteosperma* woodlands with an understory dominated by *Artemisia tridentata* ssp. *wyomingensis.* Associated shrubs include *Chrysothamnus viscidiflorus, Ephedra viridis, Gutierrezia* spp., *Opuntia polyacantha,* and *Mahonia fremontii*. Sites are generally flat with deep soils, and well-developed biological soil crusts cover most of the un-vegetated surface. Although characteristic of lower Fiftymile Mountain/Navajo Point, this rare woodland type is also found on the Orange Cliffs mesa tops, and on Muley Point.

Interpretation

This rare and restricted map class appears as small to very large, regular polygons on gentle slopes and flats on high elevation mesa tops of Glen Canyon NRA. The color is a dark green to black, rough- or pebble-textured set against a mottled background of tan (substrate) to gray to grayish-brown reflecting the sagebrush shrub understory. Common neighbors include polygons of pinyon-juniper / blackbrush woodlands (map class 20), pinyon-juniper mesa top woodlands (map class 21), pinyon-juniper shale scarps (map class 29), pinyon-juniper sandstone woodlands (map class 24), and Wyoming sagebrush shrublands (map class 9).



Example of photo signature for map class W-PJAR (#23)

Map Class 24
Pinyon - Juniper Sandstone Woodland Complex (W-PJSA)





Photo credits: NPS

Associations

Dominant:
Juniperus osteosperma / Cercocarpus intricatus Woodland [CEGL000733]
Juniperus osteosperma / Coleogyne ramosissima Woodland [CEGL002909]
Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland [CEGL000779]

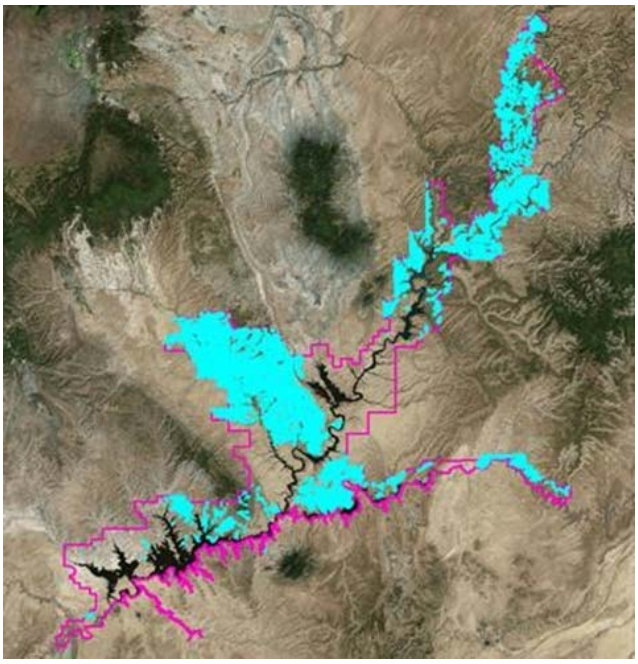
Less common:
Juniperus osteosperma / Sparse Understory Woodland [CEGL000732]
Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana – Quercus havardii var. tuckeri Wooded Shrubland [CEGL003774]
Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland [CEGL000782]

Common species

- *Pinus edulis*
- *Cercocarpus intricatus*
- *Purshia stansburiana*
- *Amelanchier utahensis*
- *Aristida purpurea*
- *Yucca angustissima*
- *Juniperus osteosperma*
- *Coleogyne ramosissima*
- *Quercus havardii var. tuckeri*
- *Fraxinus anomala*
- *Ephedra viridis*
- *Gutierrezia sarothrae*

W-PJSA Map Class Statistics

Statistic Name	Statistic Value
Frequency:	2,071 total polygons
Total project area:	76,373 hectares / 188,722 acres
% of vegetated land surface:	20%
Average polygon size:	37 hectares / 91 acres
Producer's accuracy:	87% ± 6%
User's accuracy:	89% ± 6%



Distribution in Mapping Area

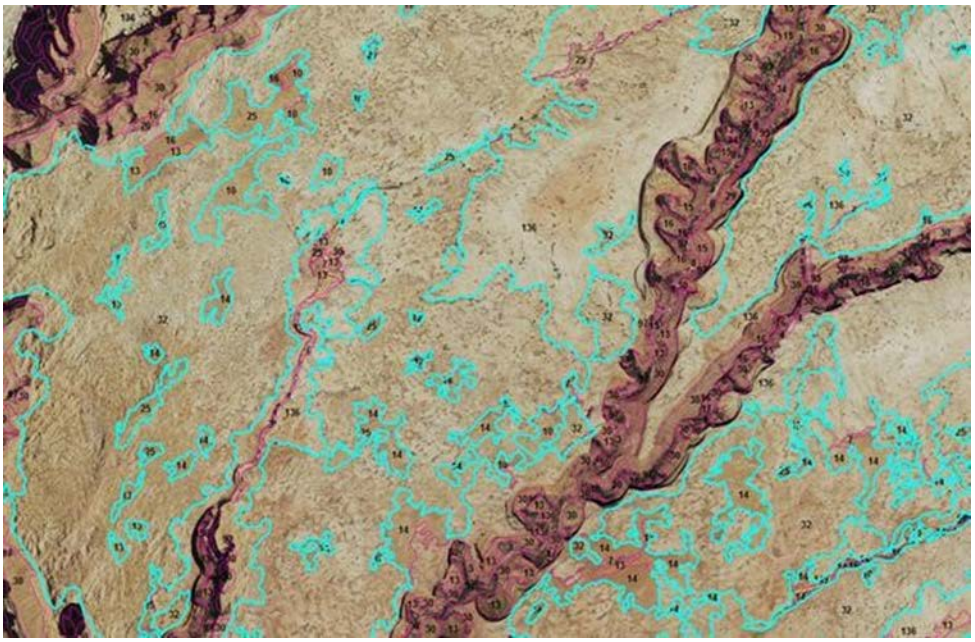
Distribution/Ecology/Composition

Stands occur on hard sandstone exposures with slickrock potholes, shallow soil depressions, and/or joints and cracks typical of the Navajo and Cedar Mesa geologic formations. Bedrock cover generally exceeds 70% and scattered, shallow pockets of sand support the majority of plant species. Vegetation consists of scattered *Pinus edulis* and *Juniperus osteosperma* trees with a sparse but diverse understory. *Cercocarpus intricatus* is usually present to dominant, and other common shrubs include *Coleogyne ramosissima*, *Purshia stansburiana*, *Fraxinus anomala*, *Amelanchier utahensis*, and *Ephedra viridis.* Forb and grass cover is sparse but diverse. This is the dominant vegetation type on the large slickrock exposures above the Escalante River drainage system; on Wilson Mesa, along the San Juan River; from Ticaboo Mesa north to the Dirty Devil River; and north from Hite to Horsethief Canyon.

Interpretation

This widespread and very common map class appears as medium to very large, regular, sometimes linear polygons covering large areas of Glen Canyon NRA where sandstone exposures dominate. The

signature is a smooth-textured, white to tan color of the underlying bedrock with scattered joints or soil pockets and dark green to black spots reflecting tree cover. Because this map class is widespread in the park, common neighbors include polygons of many other map classes, especially other pinyon-juniper woodlands and slickrock-dominated map classes.



Example of photo signature for map class W-PJSA (#24)

Map Class 25
Pinyon - Juniper Semi-Desert Sand Woodlands (W-PJDU)





Photo credits: NPS

Associations

Dominant:
Juniperus osteosperma / Quercus havardii - Artemisia filifolia - Ephedra cutleri Sandsheet Scrub [CEPP005694]

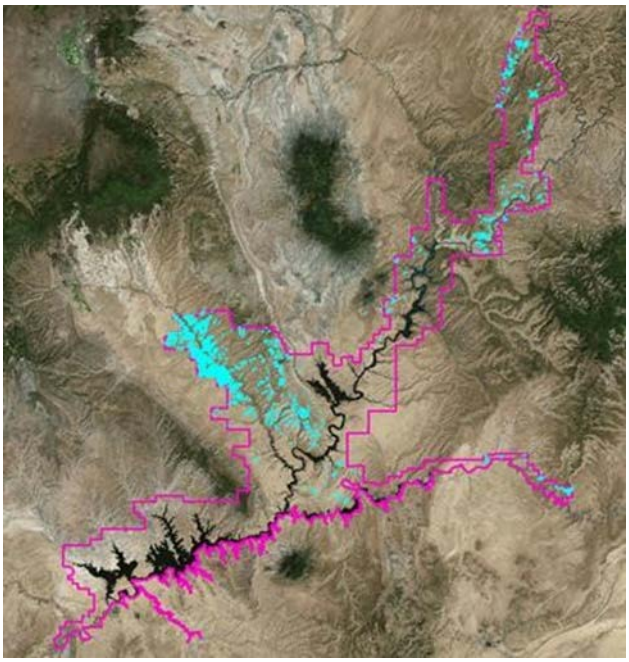
Less common:
Juniperus osteosperma / Sparse Understory Woodland [CEGL000732]
Pinus edulis - Juniperus osteosperma / Muhlenbergia pungens Woodland [CEGL002373]
Pinus edulis - Juniperus osteosperma / Quercus havardii var. tuckeri Woodland [CEGL002497]

Common species

- *Pinus edulis*
- *Quercus havardii var. tuckeri*
- *Yucca angustissima*
- *Artemisia filifolia*
- *Juniperus osteosperma*
- *Muhlenbergia pungens*
- *Ephedra cutleri*
- *Coleogyne ramosissima*

W-PJDU Map Class Statistics

Statistic Name	Statistic Value
Frequency:	721 total polygons
Total project area:	5,553 hectares / 13,723 acres
% of vegetated land surface:	1.5%
Average polygon size:	7.7 hectares / 19 acres
Producer's accuracy:	79% ± 11%
User's accuracy:	91% ± 10%



Distribution in Mapping Area

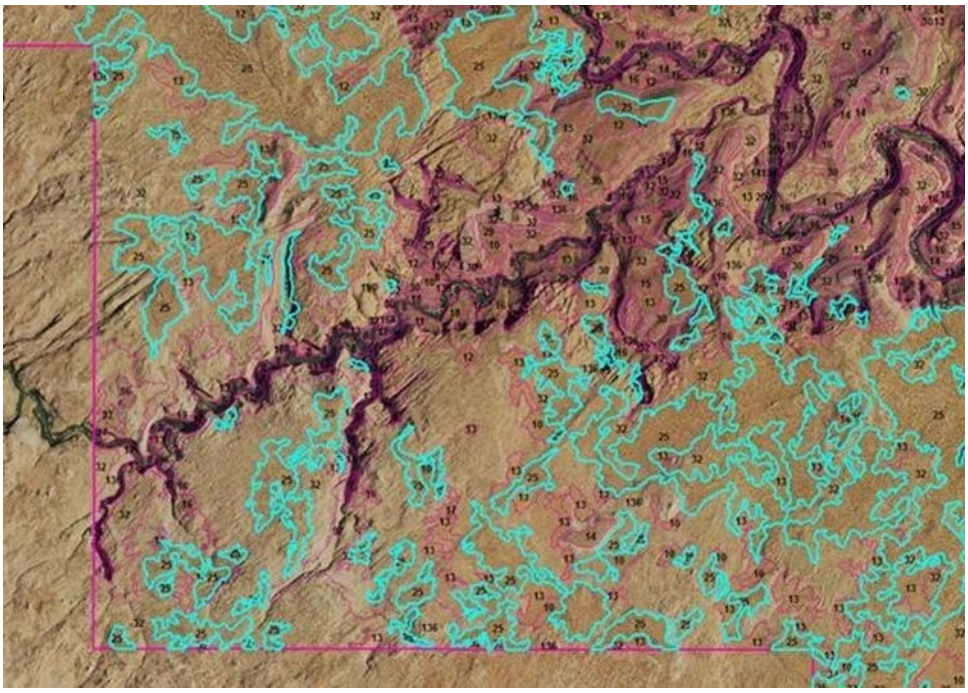
Distribution/Ecology/Composition

Stands occur primarily on plateaus, benches, and canyon rims where coarser, aeolian sand deposits have accumulated near sandstone bedrock outcrops. Stands are characterized by sparse to open woodlands (typically less than 10% tree cover) of *Pinus edulis* and/or *Juniperus osteosperma* on undulating dunes which vary in their degree of stabilization. The understory may contain sparse to low cover of *Quercus havardii var. tuckeri, Artemisia filifolia, Ephedra cutleri, Coleogyne ramosissima, Yucca angustissima,* and *Muhlenbergia pungens*; other dune-loving plant species may be present with low cover. This map class is widespread in areas of Glen Canyon NRA where Navajo Sandstone is the dominant geologic formation, but is also found on Cedar Mesa Sandstone outcrops. It is characteristic of the Navajo sandstone benches on the west side of the Escalante River.

Interpretation

This somewhat common map class appears as small to large, regular polygons on gentle slopes and undulating dunes on plateaus, benches, and canyon rims, and more rarely in canyon bottoms. The signature is a light tan to orangey-brown (substrate) with brown to gray-green speckles and/or

blotches representing shrubs (including oak hummocks) and tree crowns providing dark green to black spots. Common neighbors include polygons of pinyon-juniper sandstone woodlands (map class 24), blackbrush shrublands (map class 10), Mormon-tea shrublands (map class 14), and desert/semi-desert sand/coppice dunes complex (map class 13).



Example of photo signature for map class W-PJDU (#25)

Map Class 26
Pinyon - Juniper / Mixed Shrubland Wash Woodlands (W-PJWA)




Photo credits: NPS

Associations

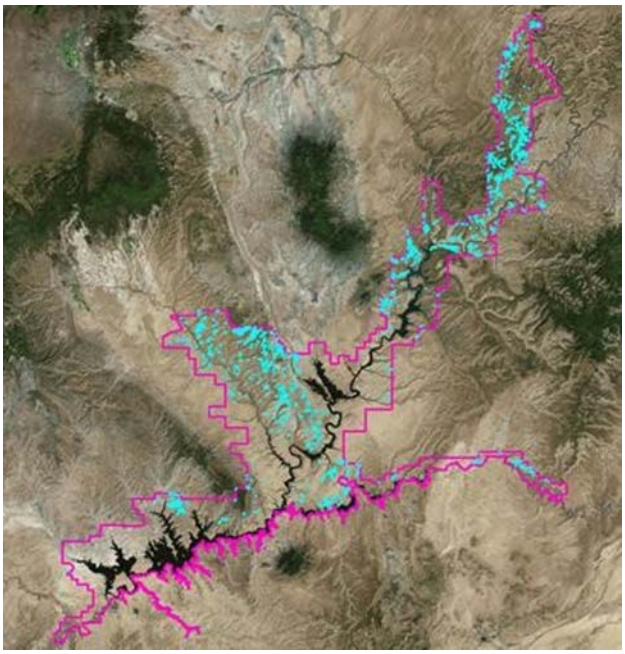
Juniperus osteosperma / Mahonia fremontii Woodland [CEGL003965]
Juniperus osteosperma / Quercus gambelii Woodland [CEPP005696]
Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland [CEGL000782]
Pinus edulis - Juniperus osteosperma / Symphoricarpos longiflorus Woodland [CEPP009635]
Pinus edulis - Juniperus osteosperma / Quercus havardii var. tuckeri Woodland [CEGL002497]
Pinus edulis - Juniperus osteosperma / Quercus gambelii Woodland [CEGL005659]

Common species

- *Pinus edulis*
- *Purshia stansburiana*
- *Quercus havardii var. tuckeri*
- *Symphoricarpos longiflorus*
- *Mahonia fremontii*
- *Amelanchier utahensis*
- *Juniperus osteosperma*
- *Quercus gambelii*
- *Rhus aromatica var. trilobata*
- *Fraxinus anomala*
- *Achnatherum hymenoides*
- *Coleogyne ramosissima*

W-PJWA Map Class Statistics

Statistic Name	Statistic Value
Frequency:	859 total polygons
Total project area:	1,958 hectares / 4,840 acres
% of vegetated land surface:	0.5%
Average polygon size:	2.3 hectares / 5.6 acres
Producer's accuracy:	74% ± 13%
User's accuracy:	91% ± 10%



Distribution in Mapping Area

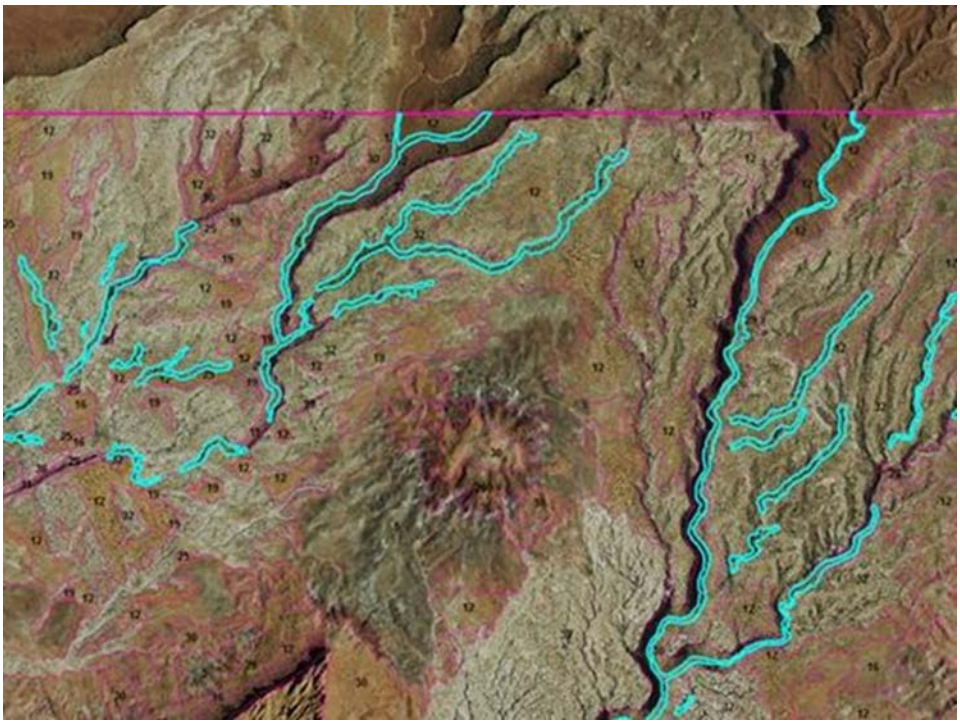
Distribution/Ecology/Composition

Stands occur on gentle slopes and flats at all aspects and following drainages where runoff is channeled on plateaus, mesas, benches, canyon bottoms, and broad valley bottoms. Stands are characterized by *Pinus edulis* and/or *Juniperus osteosperma* woodlands with mesic or xeric shrub understories in sandy or rocky, intermittently or seasonally flooded washes. Big tree crowns and low to moderate cover of *Rhus aromatica var. trilobata, Purshia stansburiana, Quercus* spp., *Amelanchier utahensis, Fraxinus anomala,* and *Symphoricarpos longiflorus* are characteristic of this map class. Tree and shrub cover can be widely scattered to nearly continuous along the edges of wash channels. The herbaceous layer is often diverse with no one species dominant.

Interpretation

This very common map class appears as short to long, very narrow, linear, sinuous polygons on gentle slopes and flats from mesa tops to canyon bottoms throughout Glen Canyon NRA. The signature is a white to brownish-tan meandering line of the scoured wash channel with scattered dark green to black spots (tree crowns) and a smooth, tan to greenish-gray representing the substrate

(biological soil crusts, grass and forb cover, etc.) of the wash banks. Because this map class is widespread throughout the park, neighboring polygons include those from nearly all of the other map classes; however, the most common neighbor is pinyon-juniper shale scarps (map class 29).



Example of photo signature for map class W-PJWA (#26)

Map Class 27
Pinyon – Juniper / Gambel Oak Woodlands (W-PJQU)




Photo credits: NPS

Associations

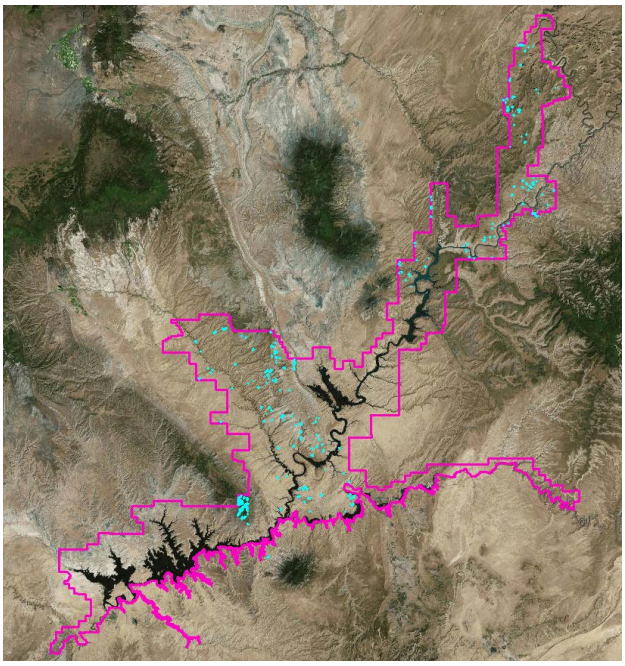
Dominant:
Juniperus osteosperma / Quercus gambelii Woodland [CEPP005696]
Pinus edulis - Juniperus osteosperma / Quercus gambelii Woodland [CEGL005659]

Common species

- *Pinus edulis*
- *Quercus gambelii*
- *Symphoricarpos longiflorus*
- *Artemisia tridentata ssp. wyomingensis*
- *Juniperus osteosperma*
- *Mahonia fremontii*
- *Rhus aromatica var. trilobata*
- *Amelanchier utahensis*

W-PJQU Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	257 total polygons
Total project area:	395 hectares / 977 acres
% of vegetated land surface:	0.1%
Average polygon size:	1.5 hectares / 3.8 acres
Producer's accuracy:	53% ± 15%
User's accuracy:	82% ± 16%



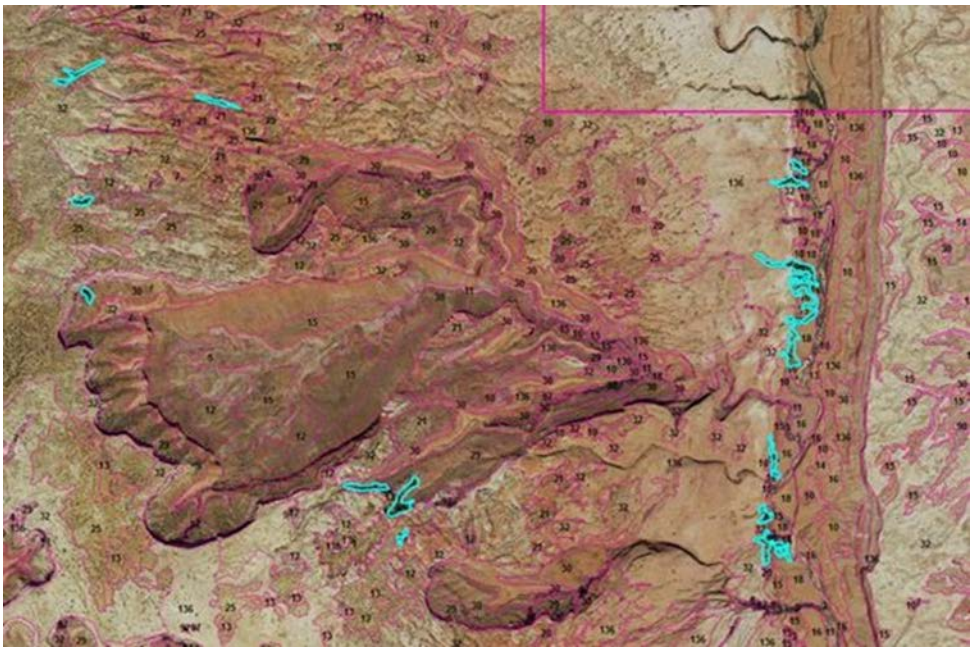
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur in “pour-over” sites where runoff is concentrated or pooled, including areas around the base of slickrock outcrops or cliffs, on the margins of sandy canyon bottoms, or more rarely on high mesa tops in drainages or ravines. Sites range from flat to steeply sloping. Dense or large-crowned *Pinus edulis* and *Juniperus osteosperma* trees form a narrow band around the base of slickrock outcrops with an understory of *Quercus gambelii*, *Amelanchier utahensis*, *Mahonia fremontii*, *Rhus aromatica var. trilobata* and *Artemisia tridentata ssp. wyomingensis.*

Interpretation

This rare map class appears as small to medium, narrow, linear polygons near the bases of cliffs or in high elevation ravines throughout Glen Canyon NRA. The signature is dark green to black (tree crowns) with a light to dark brown background (substrate) and scattered, smooth or blotchy mossy green oak hummocks. Common neighbors include bare slickrock domes (map class 136), pinyon-juniper sandstone woodlands (map class 24), or pinyon-juniper shale scarps (map class 29).



Example of photo signature for map class W-PJQU (#27)

Map Class 28
Pinyon – Juniper / Green Mormon-tea – Snakeweed Woodlands (W-PJEP)





Photo credits: NPS

Associations

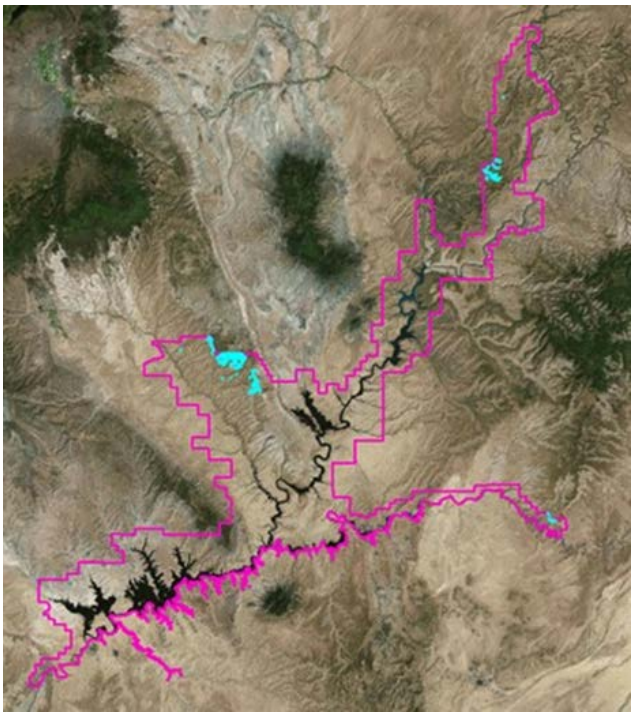
Pinus edulis - Juniperus osteosperma / Ephedra viridis - Gutierrezia sarothrae Woodland [CEGL002370]

Common species

- *Pinus edulis*
- *Ephedra viridis*
- *Gutierrezia microcephala*
- *Ephedra* spp.
- *Pleuraphis jamesii*
- *Bouteloua gracilis*
- *Juniperus osteosperma*
- *Gutierrezia sarothrae*
- *Opuntia* spp.
- *Chrysothamnus greenei*
- *Achnatherum hymenoides*
- *Sporobolus* spp.

W-PJEP Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	94 total polygons
Total project area:	1,380 hectares / 3,411 acres
% of vegetated land surface:	0.36%
Average polygon size:	14.7 hectares / 36 acres
Producer's accuracy:	80% ± 15%
User's accuracy:	69% ± 16%



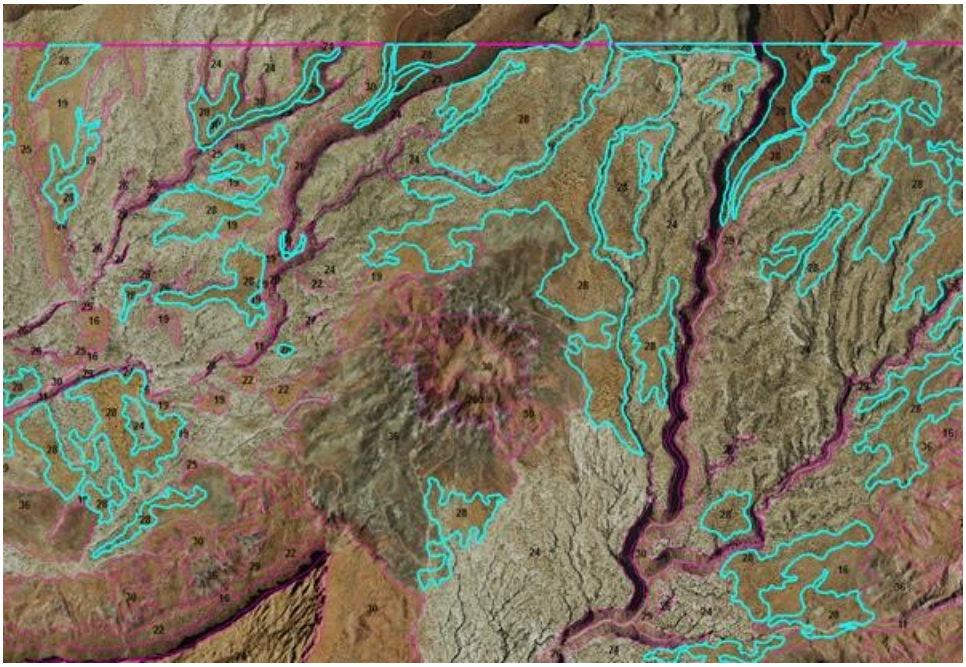
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur on flats and benches in canyon bottoms and valley floors and, more rarely, on mesa tops. Stands are characterized by open *Juniperus osteosperma* (sometimes accompanied by *Pinus edulis*) woodlands with a generally sparse understory that is dominated by *Ephedra viridis* (and/or other *Ephedra* species), *Gutierrezia* spp., and *Opuntia* spp., with or without native grass cover (e.g. *Achnatherum hymenoides, Bouteloua gracilis, Pleuraphis jamesii* and *Sporobolus* spp.). This map class is distinguished from map class 22 by having total understory cover above what is considered sparse (>5%) and having shrubs and dwarf shrubs, not grasses, dominant in the understory. The shrubs that do occur in the understory are typically more shallow rooted or have more dynamic root growth to tolerate the clayey soils of the Chinle geologic formation. These clayey soils hold water near the soil surface where it more quickly evaporates, meaning less water availability for more deeply rooted plants. Stands occur in the Purple Hills, Happy Canyon drainage system, and on Muley Point.

Interpretation

This rare map class appears as small to large, regular polygons on gentle slopes and flats where Chinle Formation soils dominate. The background color is a smooth grey-green to tan with widely spaced tree crowns producing dark green to black spots. Common neighbors include native grasslands (map class 16), weedy herbaceous vegetation (map class 17), snakeweed – prickly pear shrub herbaceous vegetation (map class 19), pinyon – juniper sandstone woodlands (map class 24), and Chinle badlands shadscale scrub (map class 36).



Example of photo signature for map class W-PJEP (#28)

Map Class 29
Pinyon – Juniper Shale Scarps Complex (C-PJSC)





Photo credits: NPS

Associations

Dominant:
Juniperus osteosperma / Leymus salinus Open Woodland [CEGL003109]
Juniperus osteosperma / Mixed Shrubs Talus Woodland [CEGL002266]
Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland [CEGL002328]
Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia Woodland [CEGL002335]

Less common:
Amelanchier utahensis - Artemisia tridentata (ssp. vaseyana, ssp. wyomingensis) Shrubland [CEGL002820]
Amelanchier utahensis Shrubland [CEGL001067]
Leymus salinus Shale Sparse Vegetation [CEGL002745]
Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia - Amelanchier utahensis) Wooded Shrubland [CEGL002334]
Pinus edulis - Juniperus osteosperma / Amelanchier utahensis Woodland [CEGL002329]
Pinus edulis - Juniperus osteosperma / Cercocarpus montanus - Mixed Shrubs Woodland [CEGL005657]
Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland [CEGL004007]
Pinus edulis – Juniperus spp. */ Leymus salinus* Woodland [CEGL002340]
Quercus turbinella - (Rhus trilobata, Artemisia tridentata) Shrubland [CEGL005168]

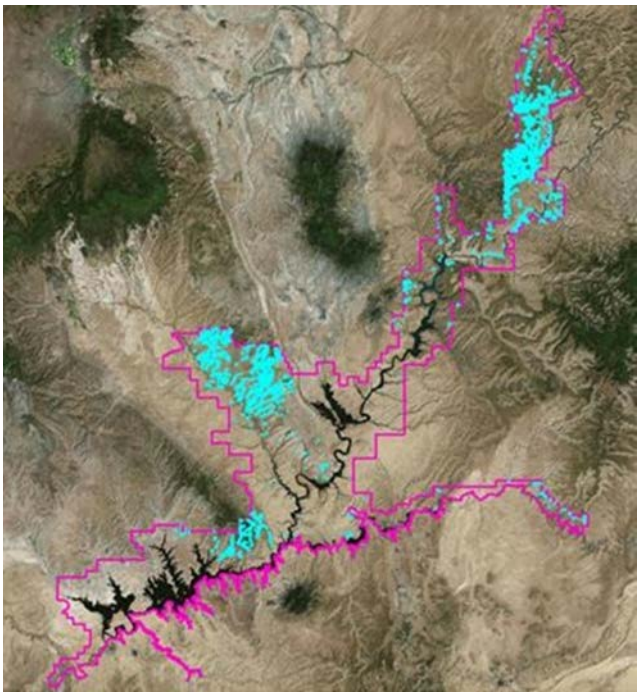
Common species

- *Amelanchier utahensis*
- *Pinus edulis*
- *Shepherdia rotundifolia*
- *Fraxinus anomala*
- *Quercus turbinella*

- *Ephedra spp.*
- *Achnatherum hymenoides*
- *Cercocarpus montanus*
- *Juniperus osteosperma*
- *Rhus aromatica var. trilobata*
- *Quercus gambelii*
- *Artemisia tridentata*
- *Leymus salinus*
- *Poa fendleriana*

C-PJSC Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	846 total polygons
Total project area:	11,575 hectares / 28,603 acres
% of vegetated land surface:	3%
Average polygon size:	13.7 hectares / 34 acres
Producer's accuracy:	94% ± 5%
User's accuracy:	73% ± 8%



Distribution in Mapping Area

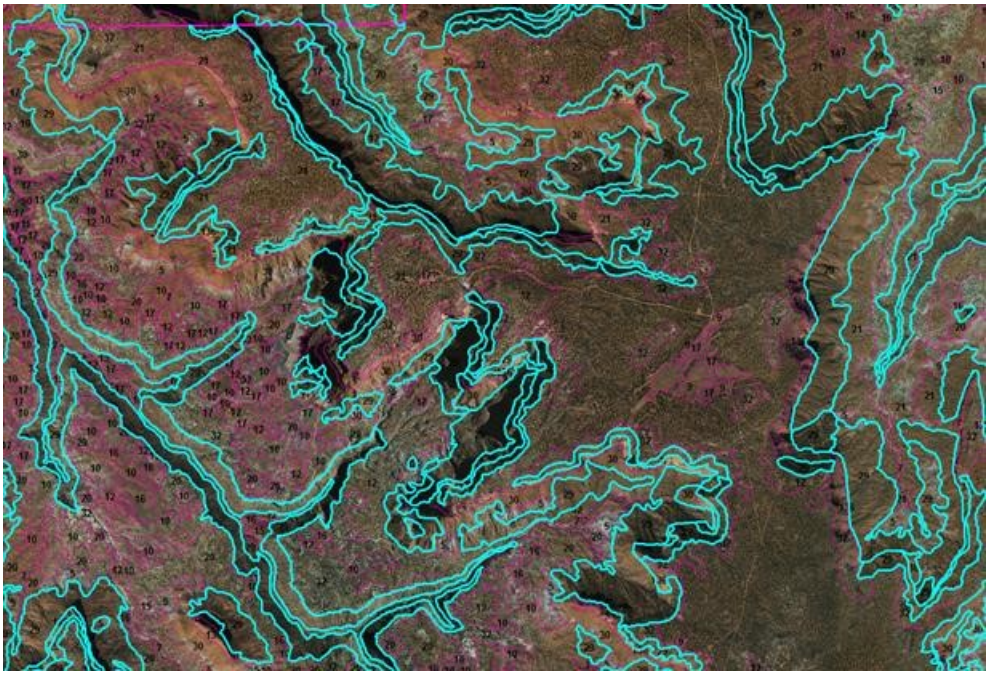
Distribution/Ecology/Composition

Stands occur on cool-aspect or more rarely warm-aspect talus slopes and in steep, rocky ravines on escarpments. Slopes are generally steep and subject to landslide disturbances, though not so often as

to inhibit mature plant establishment. The slopes support a mixed community that includes scattered *Pinus edulis* and/or *Juniperus osteosperma* and a variety of tall shrubs (e.g. *Amelanchier utahensis*, *Fraxinus anomala*, *Cercocarpus montanus*, *Rhus aromatica var. trilobata*, etc.), as well as a mixture of short shrubs. *Leymus salinus* is often present to abundant, and other native grasses may be present with low cover.

Interpretation

This very common map class appears as medium to large, regular, sometimes linear, polygons on moderately steep to very steep talus or shale or broken bedrock ledgy scarps throughout Glen Canyon NRA. The signature is a rough- or uneven-textured, white to brown to reddish-brown (substrate), sometimes dissected by dark shaded ravines/deep gullies running vertically down slope or by bedrock outcrops running horizontally along the slope. Scattered large boulders are often visible. Small to large tree crowns provide a rough- or pebble-textured, evenly to widely-spaced, dark green to black spots. Common neighbors include sparse talus slope shrublands (map class 30), bare slickrock domes (map class 136), pinyon-juniper sandstone woodlands (map class 24), and pinyon-juniper high elevation mesa top woodlands (map class 21).



Example of photo signature for map class C-PJSC (#29)

Map Class 96
Douglas-fir Scree Slope Woodlands (W-PSME)





Photo credits: NPS

Associations

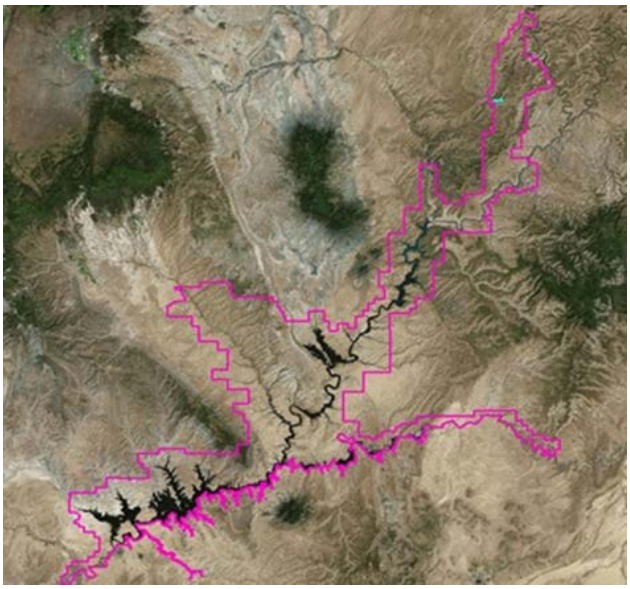
Pseudotsuga menziesii Scree Woodland [CEGL000911]

Common species

- *Pseudotsuga menziesii*
- *Pinus edulis*
- *Amelanchier utahensis*
- *Shepherdia rotundifolia*
- *Quercus gambelii*
- *Juniperus osteosperma*
- *Mahonia fremontii*
- *Purshia stansburiana*

W-PSME Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	4 total polygons
Total project area:	8.8 hectares / 21.7 acres
% of vegetated land surface:	0.002%
Average polygon size:	2.2 hectares / 5.4 acres
Producer's accuracy:	N/A
User's accuracy:	N/A



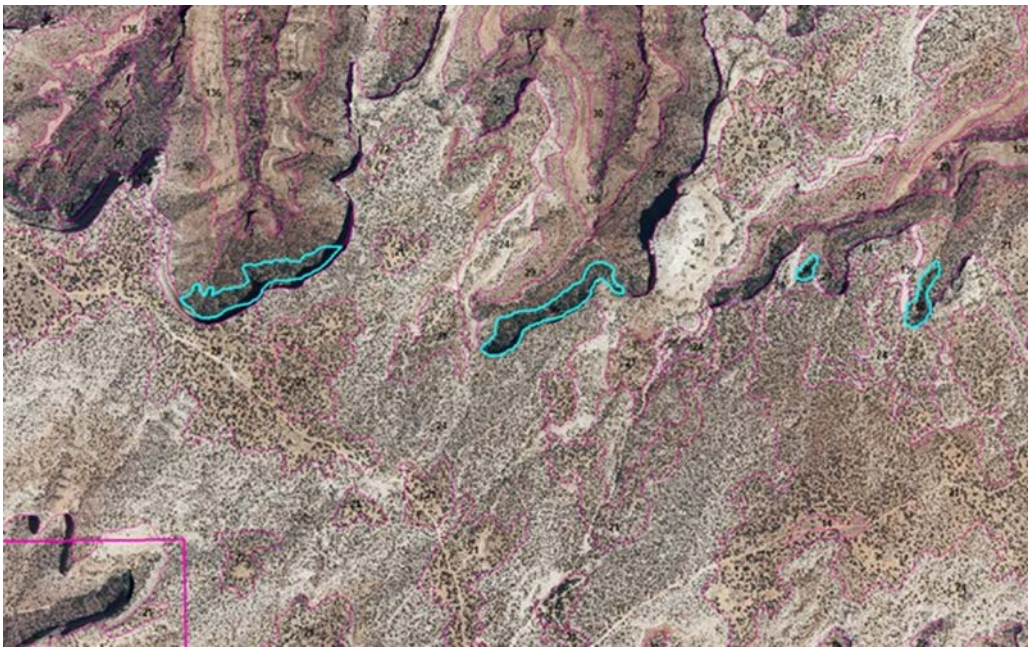
Distribution in Mapping Area

Distribution/Ecology/Composition

This map class is characterized by small, mesic woodlands of *Pseudotsuga menziesii* that occur near seeps, on the high slopes of escarpments just below cliff bands, in north-facing alcoves or sheltered sites. Understories vary and may include *Pinus edulis, Juniperus osteosperma, Amelanchier utahensis, Quercus gambelii, Mahonia fremontii, Shepherdia rotundifolia, Purshia stansburiana,* and *Ephedra viridis.* This type was found by field crews as part of this mapping effort only in the Millard Canyon drainage system; however, two other patches are known to occur in the NRA, in the French Spring Fork of Happy Canyon and in Miller Canyon, on the east side of the Waterpocket Fold.

Interpretation

This very rare map class appears as small, regular, and linear polygons on moderately steep to very steep slopes in the heads of canyons. The signature is a dark mossy green representing Gambel oak with a rough- or pebble-textured dark green to black (representing the emergent crowns of Douglas-fir trees). Common neighbors include polygons of pinyon-juniper high elevation mesa top woodlands (map class 21), bare slickrock cliff bands (map class 136), pinyon-juniper sandstone woodlands (map class 24), and pinyon-juniper shale scarps (map class 29).



Example of photo signature for map class W-PSME (#96)

Upland Shrublands

Map Class 6
Greasewood Shrublands (S-SARV)




Photo credits: NPS

Associations

Dominant:
Sarcobatus vermiculatus Disturbed Wet Shrubland [CEGL001357]

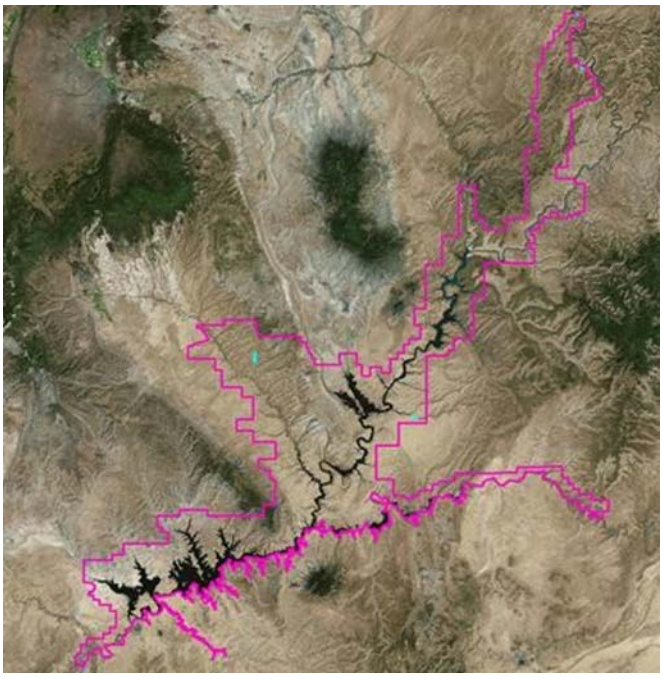
Less common:
Sarcobatus vermiculatus / Atriplex gardneri Wet Shrubland [CEGL001360]
Sarcobatus vermiculatus / Sporobolus airoides Wet Shrubland [CEGL001368]
Sarcobatus vermiculatus / Suaeda moquinii Wet Shrubland [CEGL001370]

Common species

- *Sarcobatus vermiculatus*
- *Atriplex canescens*
- *Bromus tectorum*
- *Sporobolus airoides*
- *Suaeda moquinii*
- *Atriplex confertifolia*
- *Ericameria nauseosa*
- *Sporobolus cryptandrus*
- *Gutierrezia sarothrae*
- *Opuntia* spp.

S-SARV Map Class Statistics

Statistic Name	Statistic Value
Frequency:	15 total polygons
Total project area:	28.6 hectares / 70.6 acres
% of vegetated land surface:	0.007%
Average polygon size:	1.9 hectares / 4.7 acres
Producer's accuracy:	N/A
User's accuracy:	N/A



Distribution in Mapping Area

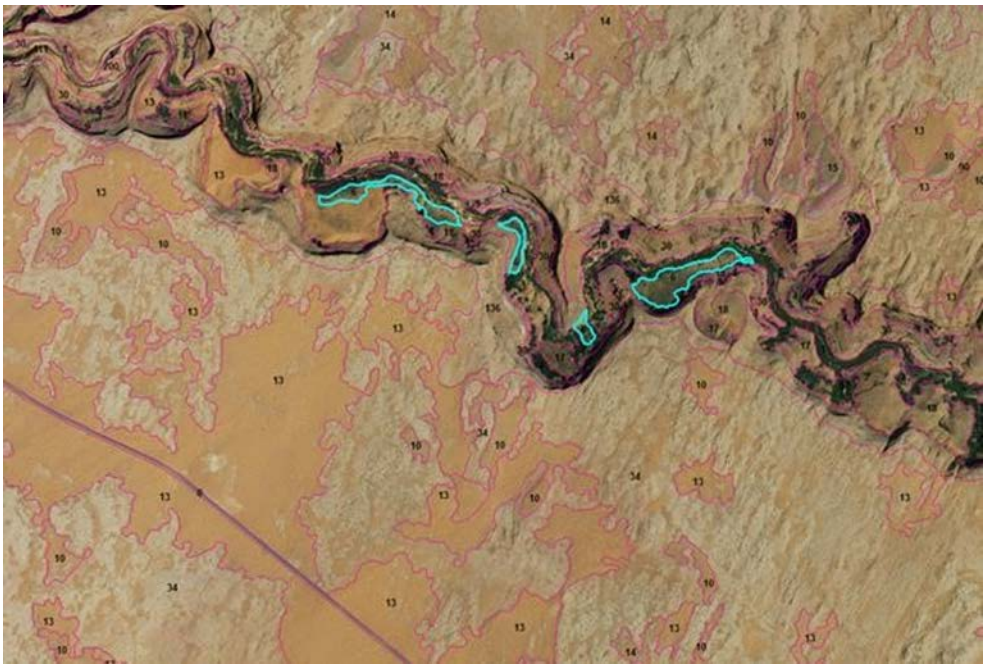
Distribution/Ecology/Composition

Small, isolated *Sarcobatus vermiculatus* shrublands that occur on riverine and tributary alluvial terraces. *Atriplex canescens* and/or *Ericameria nauseosa* may be present to nearly co-dominant and the understory may be sparse, weedy, or grassy (dominated by *Sporobolus* spp. or *Pleuraphis jamesii*). Some stands along the Green River corridor are co-dominated by the sub-shrub species *Suaeda moquinii*. Cryptobiotic soil crusts are sometimes present and may be extensive and well-developed. Greasewood shrublands were only documented by the field crews along the Green River corridor and in Moqui Canyon and Moody Creek.

Interpretation

This very rare and restricted map class appears as small, regular, often narrow and linear polygons on flat alluvial terraces. The signature is a soft and speckled-textured, gray-green to dark gray (greasewood shrubs) with a yellowish-tan, smooth background (sandy substrate). Common neighbors include polygons of saltbush shrub herbaceous vegetation (map classes 18), desert and semi-desert

sand/coppice dunes complex (map class 13), tamarisk shrublands (map class 1), rabbitbrush shrublands (map class 11), Fremont cottonwood woodlands (map class 3), and sparse talus slope shrublands (map class 30).



Example of photo signature for map class S-SARV (#6)

Map Class 7
Ephemeral Wash Tall Shrublands (C-WASH)




Photo credits: NPS

Associations

Dominant:
Fallugia paradoxa Colorado Plateau Desert Wash Shrubland [CEGL002357]

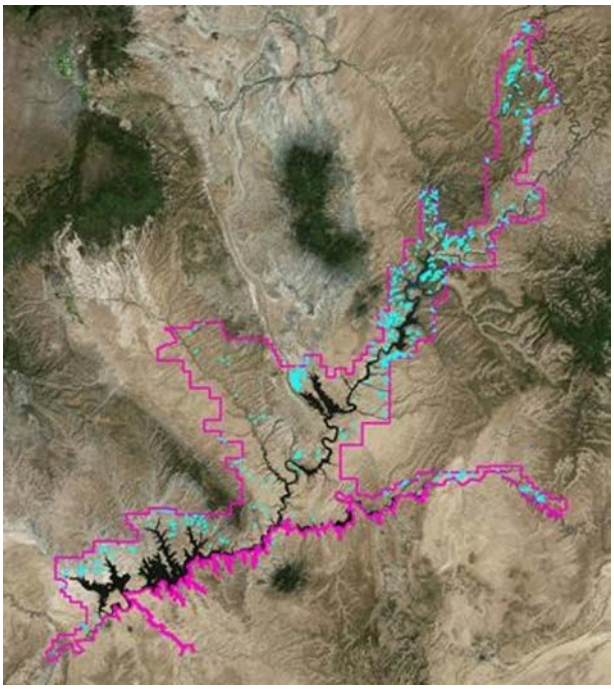
Less common:
Fraxinus anomala Riparian Woodland [CEGL002752]
Rhus trilobata Moist Wet Shrubland [CEGL001121]

Common species

- *Fallugia paradoxa*
- *Mahonia fremontii*
- *Rhus aromatica var. trilobata*
- *Brickellia* spp.
- *Artemisia ludoviciana*
- *Artemisia dracunculus*
- *Purshia stansburiana*
- *Fraxinus anomala*
- *Cercis occidentalis*
- *Achnatherum hymenoides*
- *Sporobolus* spp.
- *Artemisia campestris*

C-WASH Map Class Statistics

Statistic Name	Statistic Value
Frequency:	472 total polygons
Total project area:	1,102 hectares / 2,724 acres
% of vegetated land surface:	0.3%
Average polygon size:	2.3 hectares / 5.8 acres
Producer's accuracy:	64% ± 17%
User's accuracy:	86% ± 15%



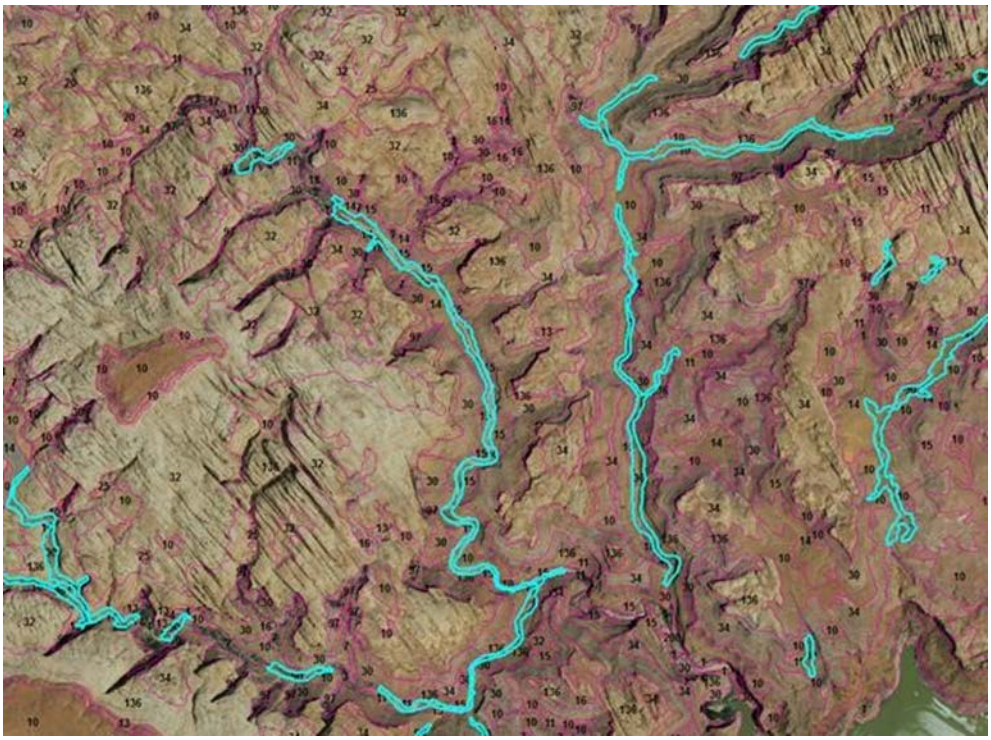
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur in dry, rocky or sandy, intermittently or ephemerally flooded wash channels throughout Glen Canyon NRA. The vegetation is generally sparse, growing along the banks of the active channel, and is dominated by one or more of the following: *Fraxinus anomala, Fallugia paradoxa, Purshia stansburiana, Cercis occidentalis, Rhus aromatica var. trilobata*, and *Mahonia fremontii.* Herbaceous species may include *Achnatherum hymenoides* and *Artemisia* spp.

Interpretation

This uncommon but widely distributed map class appears as short to long, very narrow, linear, or sinuous polygons on gentle to moderate slopes following drainages/wash channels throughout the park. The signature is a white to yellowish to brownish-tan meandering line of the scoured wash channel with scattered green to dark green spots or linear bands representing the tall shrub cover. Because wash channels occur in a variety of environmental settings, there are polygons of many different map classes adjacent to this map class.



Example of photo signature for map class C-WASH (#90)

Map Class 8
Basin Big Sagebrush Shrublands (S-SAGE)





Photo credits: NPS

Associations

Dominant:
Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Ruderal Shrubland [CEGL002699]

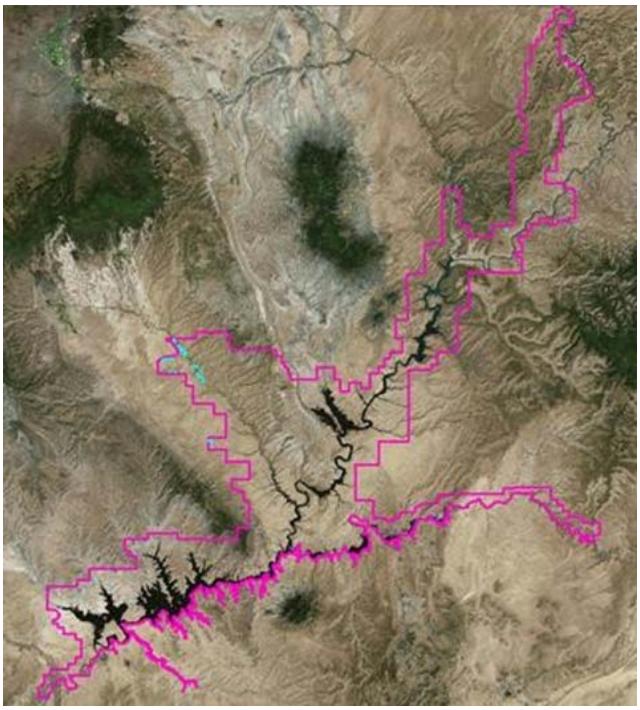
Less common:
Artemisia tridentata Shrubland [CEGL000991]
Atriplex canescens - Artemisia tridentata Shrubland [CEGL001282]
Mahonia fremontii Shrubland [CEGL003967]

Common species

- *Artemisia tridentata ssp. tridentata*
- *Atriplex canescens*
- *Sporobolus cryptandrus*
- *Achnatherum hymenoides*
- *Mahonia fremontii*
- *Ericameria nauseosa*
- *Ephedra viridis*
- *Muhlenbergia asperifolia*
- *Bromus tectorum*

S-SAGE Map Class Statistics

Statistic Name	Statistic Value
Frequency:	46 total polygons
Total project area:	53 hectares / 131.8 acres
% of vegetated land surface:	0.01%
Average polygon size:	1.2 hectares / 2.9 acres
Producer's accuracy:	N/A
User's accuracy:	N/A



Distribution in Mapping Area

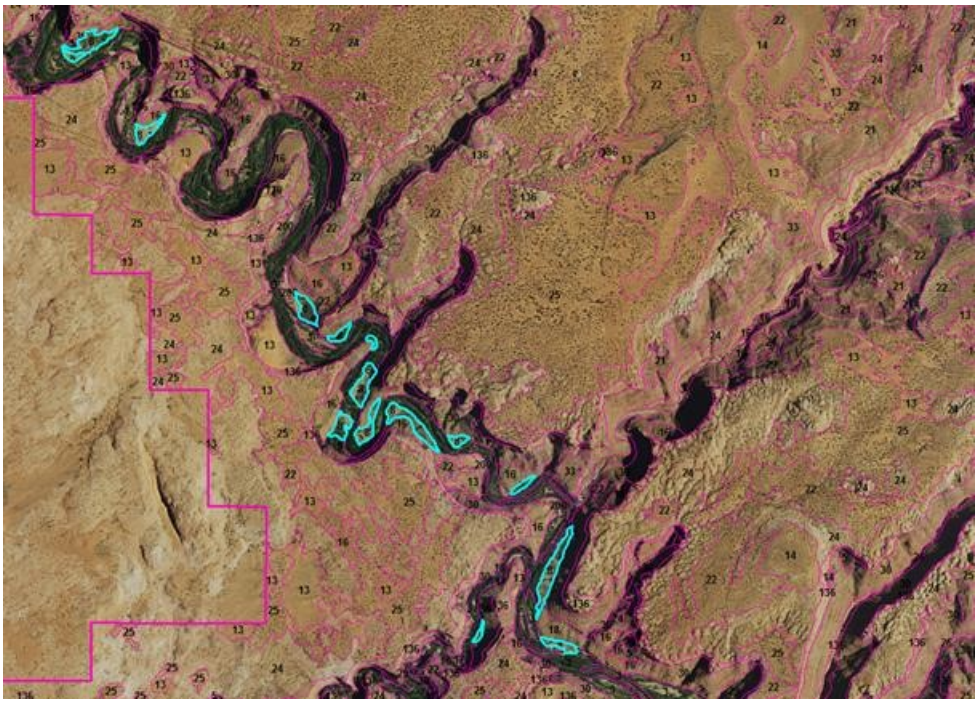
Distribution/Ecology/Composition

Stands occur on alluvial terraces of large tributary drainages and are dominated by *Artemisia tridentata* ssp. *tridentata*. *Ericameria nauseosa* and/or *Atriplex canescens* may be present to co-dominant and the understory may be sparse, weedy (dominated by *Bromus tectorum* or by annual, weedy forbs), or grassy (dominated by *Achnatherum hymenoides, Sporobolus cryptandrus,* or *Muhlenbergia asperifolia*). Stands generally occur on the lowest terraces closest to the wash. Other than a few scattered examples, this basin big sagebrush shrubland type is found only in the Escalante River drainage system.

Interpretation

This rare and restricted map class appears as small, regular, sometimes linear polygons on flat alluvial terraces. The shrub signature is a smooth to lightly speckled, medium gray to dark gray color (sagebrush), generally dense and continuous, though sometimes patchy, and with a smooth light

gray-green to reddish-tan background (grass cover or substrate). Common neighbors include polygons of native grasslands (map class 16), desert/semi-desert sand/coppice dunes (map class 13), and Fremont cottonwood woodlands (map class 3).



Example of photo signature for map class S-SAGE (#8)

Map Class 9
Wyoming Big Sagebrush Shrublands (S-WYSA)




Photo credits: NPS

Associations

Dominant:
Artemisia tridentata ssp. *wyomingensis / Bouteloua gracilis* Shrubland [CEGL001041]
Artemisia tridentata ssp. *wyomingensis /* Sparse Understory Shrubland [CEGL002768]

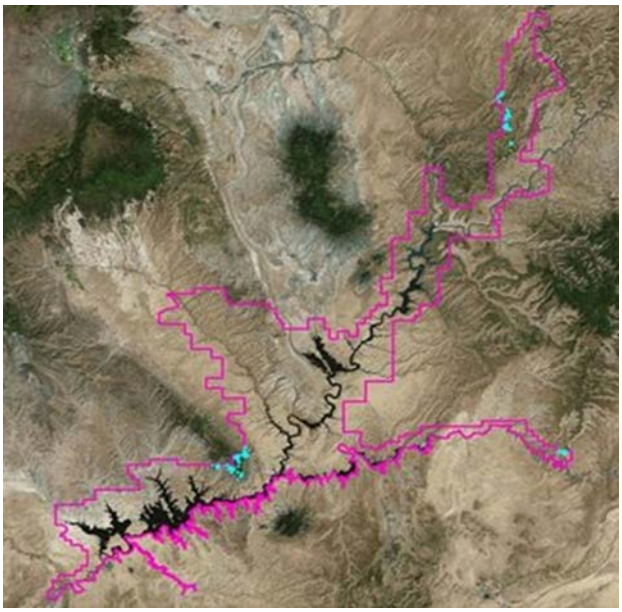
Less common:
Artemisia tridentata ssp. wyomingensis / Achnatherum hymenoides Shrubland [CEGL001046]
Artemisia tridentata ssp. wyomingensis / Disturbed Understory Ruderal Shrubland [CEGL002083]
Artemisia tridentata ssp. *wyomingensis / Hesperostipa comata* Colorado Plateau Shrubland [CEGL002761]
Artemisia tridentata ssp. wyomingensis / Poa fendleriana Shrubland [CEGL002775]
Purshia stansburiana Shrubland [CEGL002957]

Common species

- *Artemisia tridentata ssp. wyomingensis*
- *Amelanchier utahensis*
- *Gutierrezia sarothrae*
- *Achnatherum hymenoides*
- *Poa fendleriana*
- *Bromus tectorum*
- *Ephedra viridis*
- *Chrysothamnus viscidiflorus*
- *Purshia stansburiana*
- *Hesperostipa comata*
- *Bouteloua gracilis*

S-WYSA Map Class Statistics

Statistic Name	Statistic Value
Frequency:	88 total polygons
Total project area:	567.7 hectares / 1,403 acres
% of vegetated land surface:	0.15%
Average polygon size:	6.4 hectares / 16 acres
Producer's accuracy:	89% ± 11%
User's accuracy:	97% ± 7%



Distribution in Mapping Area

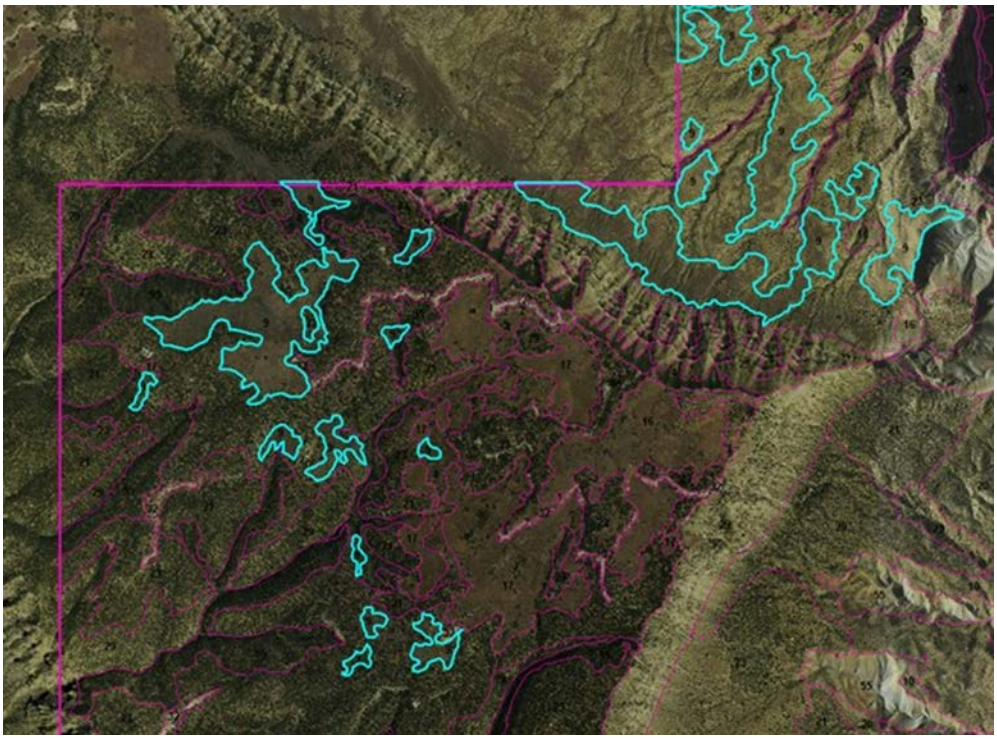
Distribution/Ecology/Composition

Stands of *Artemisia tridentata* ssp. *wyomingensis* are found only on high elevation mesa tops, plains, and toeslopes. Some stands may have *Amelanchier utahensis* co-dominant, but most stands have a homogenous Wyoming sagebrush shrub canopy layer. The understory is generally grassy, and dominated by *Bouteloua gracilis, Achnatherum hymenoides,* and/or *Hesperostipa comata.* In areas with livestock grazing disturbance or fire disturbance, the understory may be sparse or weedy (dominated by *Bromus tectorum*). This type was documented on Fiftymile Mountain/Navajo Point, Muley Point, and the Orange Cliffs mesa tops.

Interpretation

This rare map class appears as small to large, regular polygons on flat mesa tops and toeslopes at the highest elevation areas within Glen Canyon NRA. The signature is a smooth, tan to grey-green to orange-tan background (substrate or the herbaceous cover) with a speckled or blotchy grey-blue to dark gray representing the shrub cover. Because this map class occurs in clearings within pinyon-juniper woodlands, the most common neighbors include polygons of pinyon – juniper / Wyoming sagebrush woodlands (map class23), pinyon-juniper high elevation mesa top woodlands (map class

21), juniper – (pinyon) / sparse or grassy understory woodlands (map class 22), and green Mormon tea shrub herbaceous vegetation (map class 14).



Example of photo signature for map class S-WYSA (#9)

Map Class 10
Blackbrush Shrublands (S-BLAC)





Photo credits: NPS

Associations

Dominant:
Coleogyne ramosissima - Ephedra cutleri Sandsheet Shrubland [CEPP005687]
Coleogyne ramosissima - Ephedra spp. Warm Desert Shrubland [CEGL005297]
Coleogyne ramosissima / Pleuraphis jamesii Shrubland [CEGL001334]
Coleogyne ramosissima Shrubland [CEGL001332]

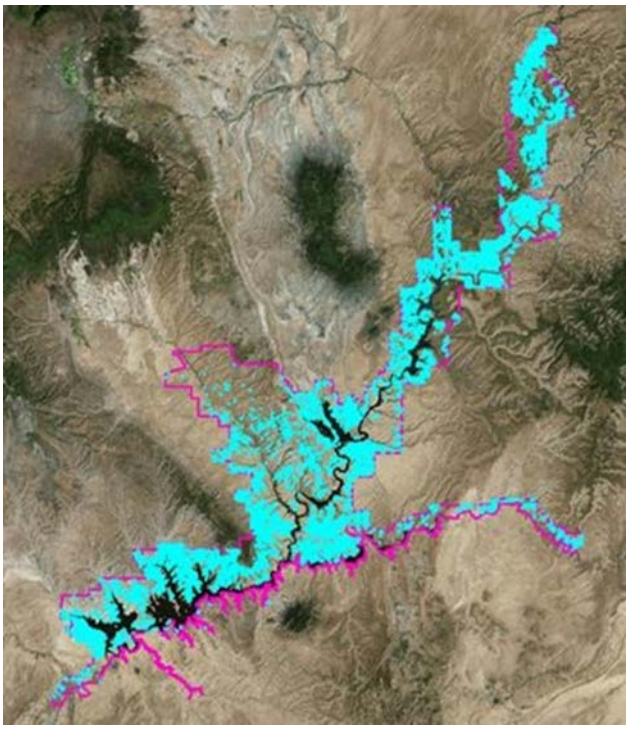
Less common:
Coleogyne ramosissima - Acamptopappus sphaerocephalus - Ephedra torreyana Shrubland [CEPP005688]
Grayia spinosa Shrubland [CEGL002358]
Polygala acanthoclada - Mixed Scrub [CEPP005698]

Common species

- *Coleogyne ramosissima*
- *Acamptopappus sphaerocephalus*
- *Ephedra viridis*
- *Glossopetalon spinescens*
- *Polygala acanthoclada*
- *Pleuraphis jamesii*
- *Gutierrezia sarothrae*
- *Ephedra torreyana*
- *Ephedra cutleri*
- *Grayia spinosa*
- *Achnatherum hymenoides*
- *Juniperus osteosperma*

S-BLAC Map Class Statistics

Statistic Name	Statistic Value
Frequency:	5,560 total polygons
Total project area:	55,022 hectares / 135,963 acres
% of vegetated land surface:	14.5%
Average polygon size:	10 hectares / 24.5 acres
Producer's accuracy:	88% ± 5%
User's accuracy:	75% ± 7%



Distribution in Mapping Area

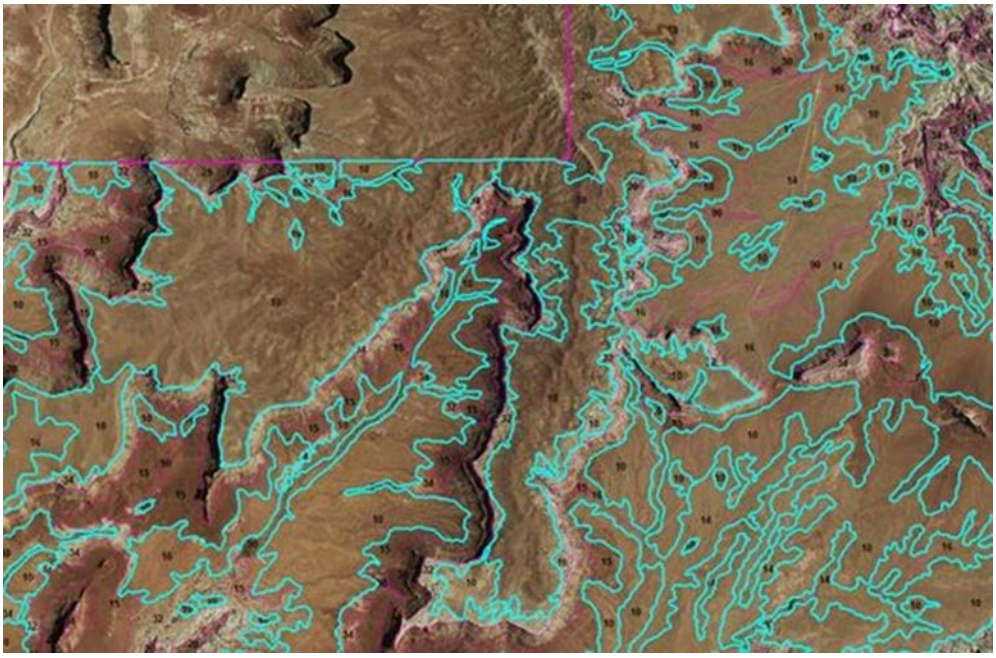
Distribution/Ecology/Composition

Stands of *Coleogyne ramosissima* with >10% cover on a variety of environmental setting. Although these communities tend to be fairly homogenous, other shrub species may be present, including *Ephedra* spp., *Acamptopappus sphaerocephalus, Grayia spinosa, Glossopetalon spinescens,* and *Atriplex confertifolia.* Scattered *Juniperus osteosperma* may be present as a minor component of the community (with less than 5% total cover). Some stands have an established native grass understory dominated by *Achnatherum hymenoides* and/or *Pleuraphis jamesii.* Blackbrush is tolerant of and/or finds suitable a variety of substrates, ranging from loose aeolian sands to pavement-like gravel to sands or loams well-stabilized by cryptobiotic soil crusts. Pure blackbrush shrublands and those mixed with *Ephedra torreyana* and/or *Atriplex confertifolia* are the most ubiquitous vegetation types in the park, and occur nearly everywhere **except** where slickrock exposures dominate (map class 34 represents sparse blackbrush shrubs in a slickrock mosaic), clayey soils dominate (derived from

shales of the Morrison, Chinle, Moenkopi, Tropic Shale, or Organ Rock formations), or at the highest elevations (above 1,850 m elevation).

Interpretation

This ubiquitous map class appears as small to large, regular or irregular polygons on flat to rolling to steep slopes on a variety of landscape positions throughout Glen Canyon NRA. Blackbrush has a distinct photo signature, appearing as evenly spaced, small, perfectly round, dark brown to black dots or speckles, resembling sandpaper. The background signature is highly variable depending on substrate and/or grass cover. Scattered juniper tree crowns are sometimes present and appear as large round black spots. Because this map class is widespread in the park, it is bordered by a variety of other map classes. The most common are green Mormon tea shrub herbaceous vegetation (map class 14), Torrey's joint-fir – shadscale shale barrens desert scrub (map class 33), pinyon-juniper / blackbrush woodlands (map class 20), and pinyon-juniper sandstone woodlands (map class 24).



Example of photo signature for map class S-BLAC (#10)

Map Class 11
Rabbitbrush Wash and Sandsheet Shrublands (S-RABB)





Photo credits: NPS

Associations

Dominant:
Artemisia filifolia - Ephedra (torreyana, viridis) Shrubland [CEGL002786]
Ericameria nauseosa Desert Wash Shrubland [CEGL002261]

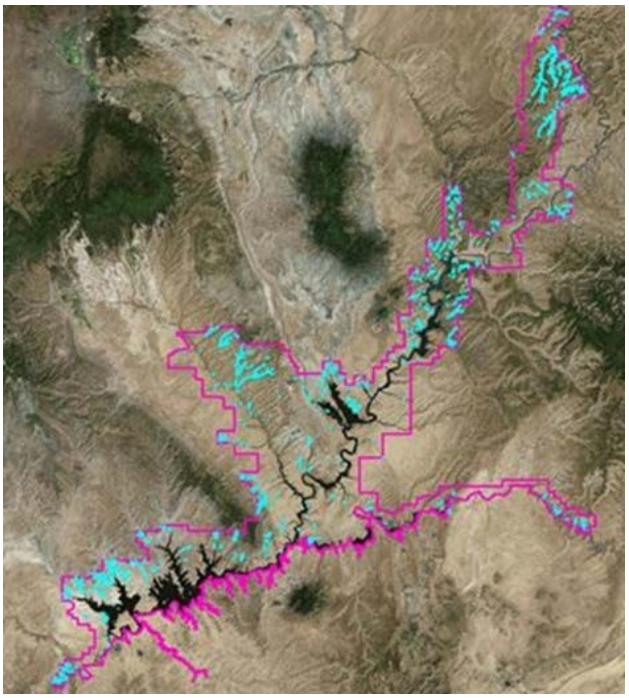
Less common:
Artemisia filifolia Colorado Plateau Shrubland [CEGL002697]
Atriplex canescens Desert Wash Shrubland [CEGL003470]
Brickellia longifolia Shrubland [CEGL005392]
Ericameria nauseosa / Bromus tectorum Ruderal Shrubland [CEGL002937]
Ericameria nauseosa / Sporobolus airoides Shrubland [CEGL002918]

Common species

- *Ericameria nauseosa*
- *Ephedra viridis*
- *Brickellia longifolia*
- *Atriplex canescens*
- *Bromus tectorum*
- *Achnatherum hymenoides*
- *Artemisia filifolia*
- *Ephedra torreyana*
- *Lycium andersonii*
- *Pleuraphis jamesii*
- *Sporobolus airoides*
- *Gutierrezia sarothrae*

S-RABB Map Class Statistics

Statistic Name	Statistic Value
Frequency:	824 total polygons
Total project area:	2,406 hectares / 5,946 acres
% of vegetated land surface:	0.6%
Average polygon size:	2.9 hectares / 7.2 acres
Producer's accuracy:	75% ± 12%
User's accuracy:	75% ± 12%



Distribution in Mapping Area

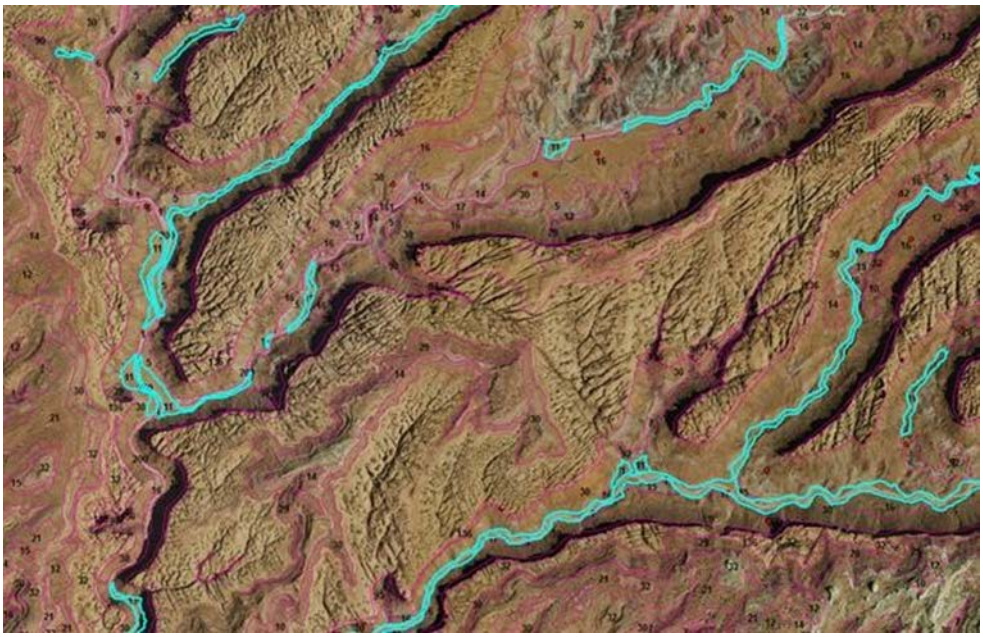
Distribution/Ecology/Composition

Stands occur on gentle slopes and flats along intermittently flooded drainages on plateaus, mesas, benches, canyon bottoms and broad valley bottoms. Grass cover is generally present but is not a major component of the community and is dominated by *Achnatherum hymenoides* and/or *Pleuraphis jamesii,* sometimes with *Sporobolus airoides, Sporobolus* spp., and *Bromus tectorum*. This map class is widespread wherever dry, sandy washes dissect the landscape throughout the park.

Interpretation

This somewhat common map class appears as short to long, very narrow, linear, sinuous polygons on gentle slopes and flats from mesa tops to canyon bottoms throughout the park. The signature is a yellowish to brownish-tan meandering line of the scoured wash channel with scattered to mottled, light to dark grey speckles of shrubs. Because these wash channels occur in a variety of environmental settings, there are polygons of many different map classes adjacent to this map class;

however, the most common neighbors include polygons of blackbrush shrublands (map class 10), native grasslands (map class 16), and pinyon-juniper shale scarps (map class 29).



Example of photo signature for map class S-RABB (#11)

Map Class 12
Winterfat Dwarf-shrublands (S-WINT)

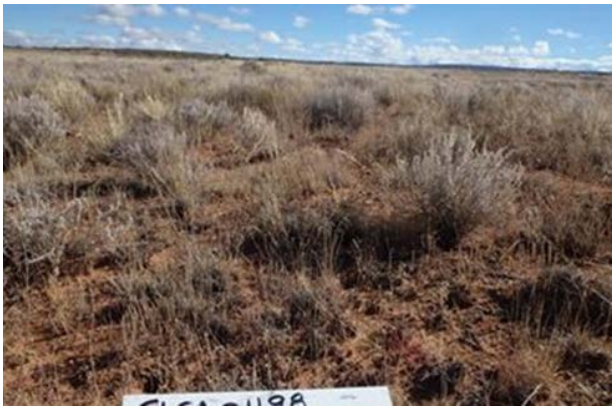



Photo credits: NPS

Associations

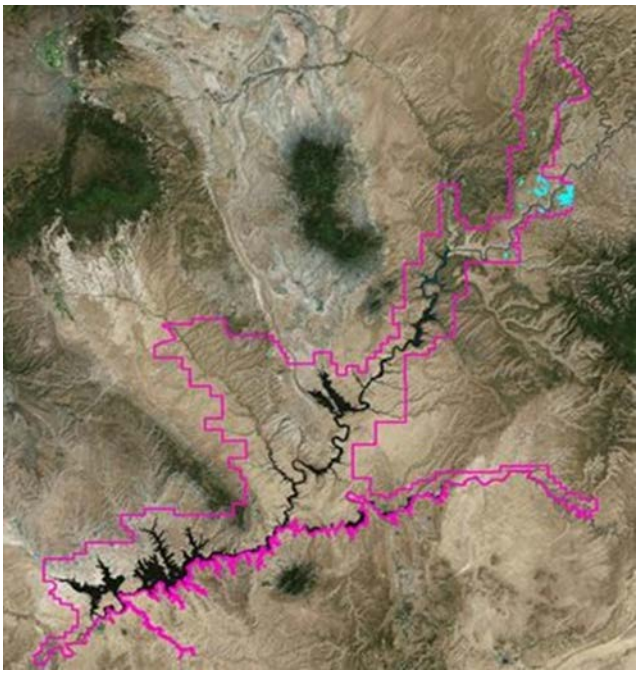
Krascheninnikovia lanata Dwarf-shrubland [CEGL001320]
Krascheninnikovia lanata / Hesperostipa comata Dwarf-shrubland [CEGL001327]
Krascheninnikovia lanata / Pleuraphis jamesii Dwarf-shrubland [CEGL001322]

Common species

- *Krascheninnikovia lanata*
- *Atriplex canescens*
- *Opuntia* spp.
- *Bromus tectorum*
- *Hesperostipa comata*
- *Coleogyne ramosissima*
- *Ephedra viridis*
- *Gutierrezia sarothrae*
- *Achnatherum hymenoides*
- *Pleuraphis jamesii*

S-WINT Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	102 total polygons
Total project area:	312 hectares / 771 acres
% of vegetated land surface:	0.08%
Average polygon size:	3 hectares / 7.5 acres
Producer's accuracy:	N/A
User's accuracy:	N/A



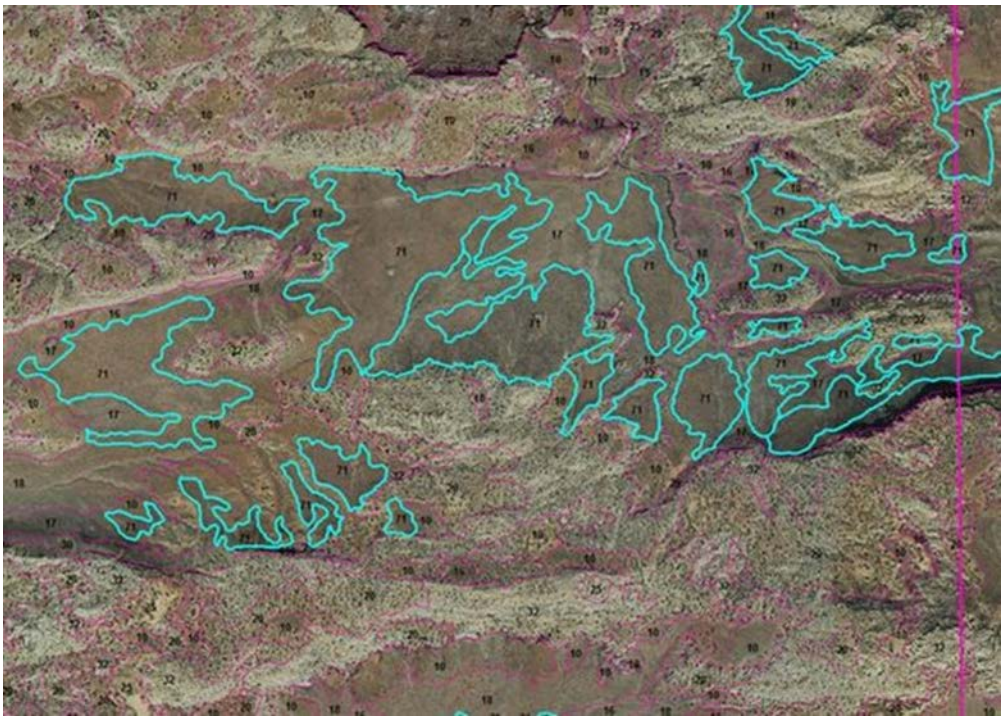
Distribution in Mapping Area

Distribution/Ecology/Composition

Open stands of *Krascheninnikovia lanata* on deep, sandy soils, often with a grassy or weedy understory and low to high cryptobiotic crust cover. Associated shrubs may include *Coleogyne ramosissima, Ephedra viridis, Atriplex canescens, Gutierrezia sarothrae,* and *Opuntia* spp. Dominant grasses include *Pleuraphis jamesii, Achnatherum hymenoides, Hesperostipa comata,* and *Sporobolus cryptandrus.* Stands occur on flat to moderately sloping sites on alluvial valley floors, mesa tops, grabens, plains, and rolling hills. This map class was most commonly found in Imperial Valley, Bull Valley, and Calf Canyon. Many winterfat communities in Glen Canyon NRA are marginal (low shrub cover) and have been affected by livestock overgrazing. Winterfat is preferred winter forage for livestock and other grazing animals, and thus, many stands have considerably weedy understories dominated by exotic annual forbs and *Bromus tectorum.*

Interpretation

This rare and restricted map class appears as small to medium, regular polygons on flat to gently sloping sites mostly in the northeast corner of Glen Canyon NRA. The color is a smooth, medium gray-green to beige with tiny grey speckles of winterfat shrubs generally only visible after zooming in to the 1:5,000 scale. Common neighbors include polygons of blackbrush shrublands (map class 10), native grasslands (map class 16), weedy herbaceous vegetation (map class 17), and saltbush shrub herbaceous vegetation (map class 18).



Example of photo signature for map class S-WINT (#12)

Map Class 13
Desert and Semi-desert Sand/Coppice Dunes Complex (C-DUNE)





Photo credits: NPS

Associations

Dominant:
Artemisia filifolia - Ephedra cutleri Sandsheet Shrubland [CEPP005686]
Poliomintha incana - Artemisia filifolia - Vanclevea stylosa Shrubland [CEGL002418]

Less common:
Artemisia filifolia Colorado Plateau Shrubland [CEGL002697]
Artemisia filifolia / Sporobolus flexuosus Shrubland [CEGL001547]
Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Shrubland [CEGL002348]
Ephedra (torreyana, viridis) - Psorothamnus fremontii Shrubland [CEPP005690]
Ephedra cutleri / Achnatherum hymenoides - Muhlenbergia pungens - Oenothera pallida Sandsheet Shrubland [CEPP005689]
Ericameria nauseosa Sand Deposit Sparse Shrubland [CEGL002980]
Muhlenbergia pungens Grassland [CEGL002363]
Quercus havardii var. tuckeri - Eriogonum leptocladon - Artemisia filifolia Sandsheet Shrubland [CEGL005692]
Quercus havardii var. tuckeri Shrubland [CEGL002486]

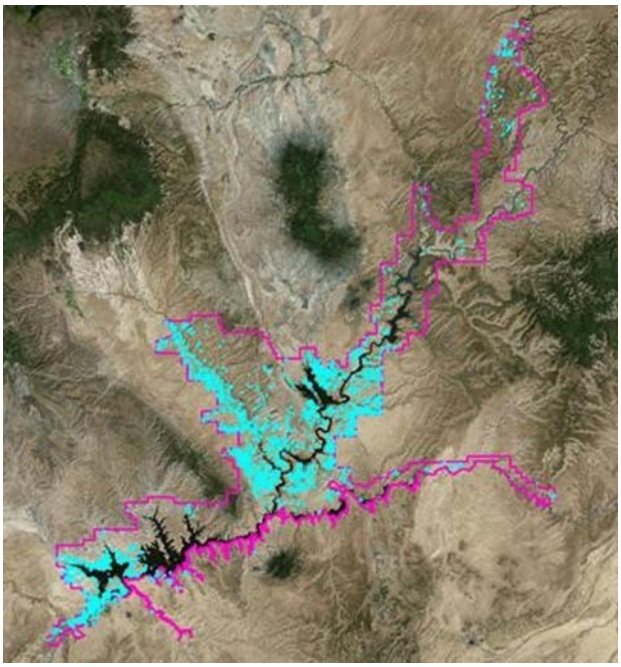
Common species

- *Poliomintha incana*
- *Artemisia filifolia*
- *Quercus havardii var. tuckeri*
- *Coleogyne ramosissima*
- *Ericameria nauseosa*
- *Achnatherum hymenoides*
- *Salsola tragus*

- *Oenothera pallida*
- *Eriogonum leptocladon*
- *Vanclevea stylosa*
- *Ephedra cutleri*
- *Psorothamnus fremontii*
- *Sporobolus* spp.
- *Muhlenbergia pungens*
- *Psoralidium junceum*

C-DUNE Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	2,071 total polygons
Total project area:	11,990 hectares / 29,629 acres
% of vegetated land surface:	3.2%
Average polygon size:	5.8 hectares / 14 acres
Producer's accuracy:	83% ± 7%
User's accuracy:	85% ± 7%



Distribution in Mapping Area

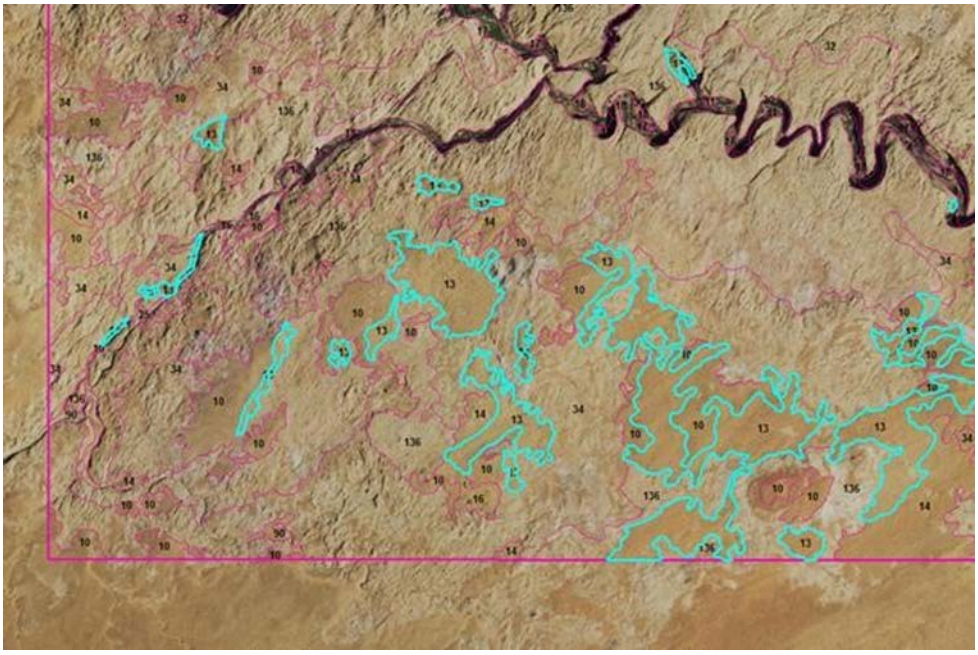
Distribution/Ecology/Composition

Stands occur on loose (coppice) dunes or sandy blowouts, often on aeolian terraces above drainages or in canyon bottoms. Stands may also be found near the mouths of canyons where aeolian sands have accumulated, on the rims of mesas, and on broad rolling plains in a slickrock sandstone mosaic. These are mostly active sands, but in some cases may be slightly stabilized by crust cover. Many of

these stands/areas were originally *Atriplex canescens*-grass- shrub-steppe, but long-term livestock grazing has altered them. A variety of shrubs and herbaceous species may occur on these sites, and the dominance of one shrub over another and/or presence or absence of one or more shrub species may depend on the degree of stabilization at the site. Characteristic shrubs include *Eriogonum leptocladon, Vanclevea stylosa, Artemisia filifolia, Poliomintha incana,* and *Quercus havardii var. tuckeri,* as well as *Coleogyne ramosissima, Ephedra cutleri,* and *Psorothamnus fremontii.* Common herbaceous species include *Achnatherum hymenoides, Muhlenbergia pungens, Oenothera pallida, Sporobolus* spp., and *Psoralidium junceum. Opuntia* spp. and weedy annual species (e.g. *Salsola tragus* and *Dicoria canescens*) may contribute low to moderate cover.

Interpretation

This map class is common and widely scattered in the park; however, it is restricted to Navajo Sandstone exposures and aeolian sand deposits. It occurs as small to large, regular or irregular polygons on flats to rolling terrain to steep slopes where loose aeolian sands have accumulated. The signature is a light yellowish-tan to light brown (sandy substrate) with a sparse mottled or speckled light to dark brown or grey (shrubs). Common neighbors include polygons of blackbrush shrublands (map class 10), green Mormon tea shrub herbaceous vegetation (map class 14), pinyon - juniper semi-desert sand woodlands (map class 25), pinyon-juniper sandstone woodlands (map class 24), and slickrock sparse shrublands (map class 34).



Example of photo signature for map class C-DUNE (#13)

Map Class 14
Green Mormon Tea Shrub Herbaceous Vegetation (S-EPVI)




Photo credits: NPS

Associations

Dominant:
Ephedra (torreyana, viridis) - Psorothamnus fremontii Shrubland [CEPP005690]
Ephedra cutleri - Opuntia spp. / Mixed Grass Shrub-Steppe [CEPP005691]
Ephedra viridis / (Achnatherum hymenoides - Hesperostipa comata) Shrubland [CEGL002354]
Ephedra viridis / Bouteloua gracilis Shrubland [CEGL003934]
Ephedra viridis / Pleuraphis jamesii Shrubland [CEGL002356]

Less common:
Acamptopappus sphaerocephalus - Ephedra spp. Shrubland [CEPP005684]
Chrysothamnus viscidiflorus / Disturbed Understory Shrubland [CEPP005695]
Chrysothamnus viscidiflorus / Hesperostipa comata Shrubland [CEGL002799]
Ephedra cutleri Shrubland [CEGL005804]
Ephedra viridis / Bromus tectorum Ruderal Shrubland [CEGL002355]

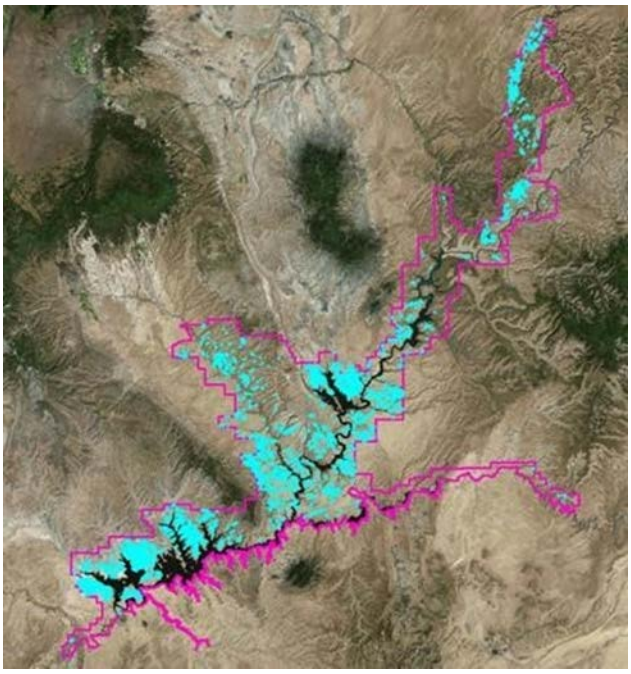
Common species

- *Ephedra viridis*
- *Psorothamnus fremontii*
- *Chrysothamnus viscidiflorus*
- *Opuntia spp.*
- *Achnatherum hymenoides*
- *Pleuraphis jamesii*
- *Muhlenbergia pungens*
- *Bromus tectorum*
- *Ephedra cutleri*
- *Acamptopappus sphaerocephalus*
- *Atriplex canescens*

- *Gutierrezia sarothrae*
- *Hesperostipa comata*
- *Bouteloua gracilis*
- *Sporobolus* spp.

S-EPVI Map Class Statistics

Statistic Name	Statistic Value
Frequency:	1,948 total polygons
Total project area:	18,924 hectares / 46,761 acres
% of vegetated land surface:	5%
Average polygon size:	9.7 hectares / 24 acres
Producer's accuracy:	77% ± 8%
User's accuracy:	80% ± 7%



Distribution in Mapping Area

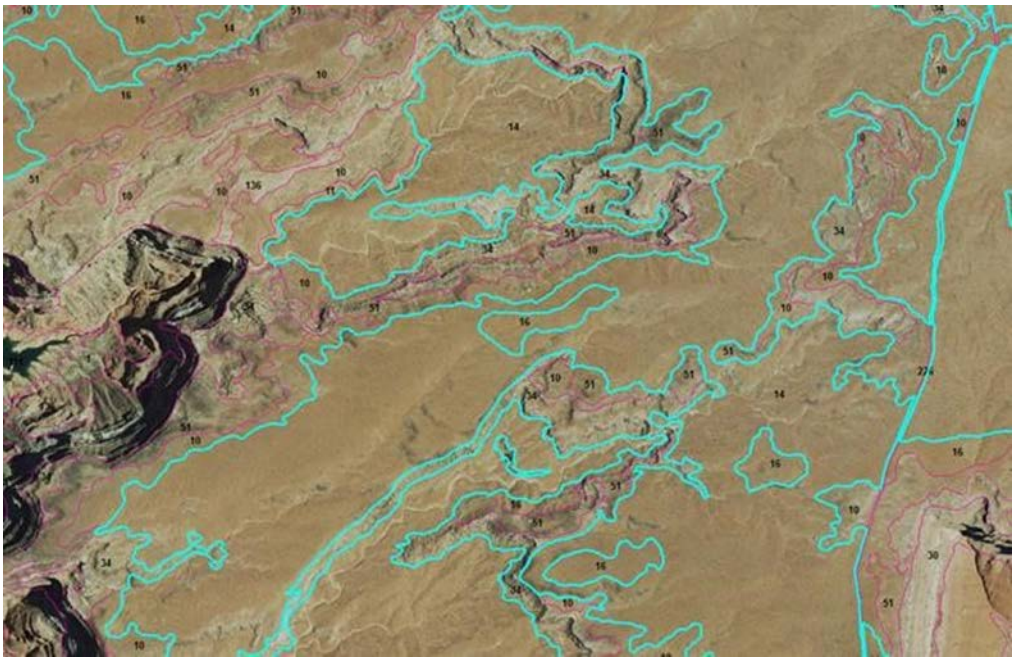
Distribution/Ecology/Composition

Stands occur on deep, sandy soils of flat to gently sloping sites on plateaus, mesa tops, coppice dunes, and in broad valley bottoms. The vegetation is characterized by the clump form of *Ephedra viridis* or *Ephedra cutleri* (with up to 25% cover) with up to equal (sometimes greater) cover of native grasses (some combination of *Achnatherum hymenoides*, *Hesperostipa comata*, *Bouteloua gracilis*, *Sporobolus cryptandrus*, *Sporobolus airoides*, and/or *Pleuraphis jamesii*). Some stands are co-dominated by the shrubs *Acamptopappus sphaerocephalus* or *Psorothamnus fremontii*. Disturbed sites (often heavily grazed) have an understory dominated by weedy species, notably *Bromus*

tectorum, and may have moderate to high cover of the dwarf shrubs *Gutierrezia* spp. and/or *Opuntia spp*.

Interpretation

This common and widespread map class occurs as small to very large, regular or irregular polygons on flat sites wherever aeolian or alluvial sands have accumulated to a depth great enough to support the deep tap roots of *Ephedra viridis* or *E. cutleri*. The signature is a smooth, light grey-green to yellowish-tan (grass and/or substrate cover) with mottled or speckled clones of *Ephedra viridis* or *E. cutleri* recognizable as darker grey to brown spots of various shapes and sizes. Common neighbors include polygons of blackbrush shrublands (map class 10), desert and semi-desert sand/coppice dunes (map class 13), native grasslands (map class 16), and slickrock sparse shrublands (map class 34).



Example of photo signature for map class S-EPVI (#14)

Map Class 18
Saltbush Shrub Herbaceous Vegetation (S-SALT)





Photo credits: NPS

Associations

Dominant:
Atriplex canescens - Ephedra viridis Shrubland [CEGL003828]
Atriplex canescens / Achnatherum hymenoides Shrubland [CEGL001289]
Atriplex canescens Shrubland [CEGL001281]

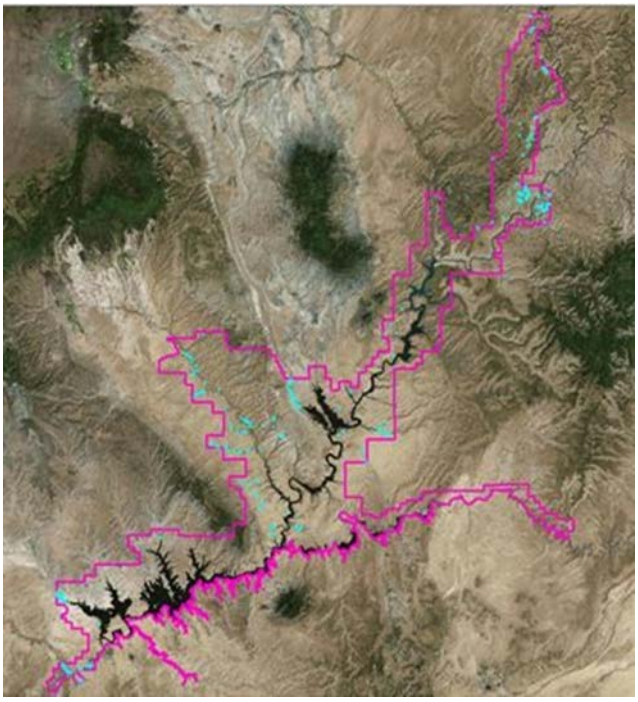
Less common:
Atriplex canescens / Pleuraphis jamesii Shrubland [CEGL001288]
Atriplex canescens Desert Wash Shrubland [CEGL003470]

Common species

- *Atriplex canescens*
- *Ephedra cutleri*
- *Ephedra torreyana*
- *Sporobolus contractus*
- *Sporobolus airoides*
- *Bromus tectorum*
- *Ericameria nauseosa*
- *Ephedra viridis*
- *Opuntia polyacantha*
- *Achnatherum hymenoides*
- *Hilaria jamesii*
- *Gutierrezia sarothrae*

S-SALT Map Class Statistics

Statistic Name	Statistic Value
Frequency:	297 total polygons
Total project area:	738 hectares / 1,824 acres
% of vegetated land surface:	0.2%
Average polygon size:	2.5 hectares / 6 acres
Producer's accuracy:	72% ± 11%
User's accuracy:	88% ± 9%



Distribution in Mapping Area

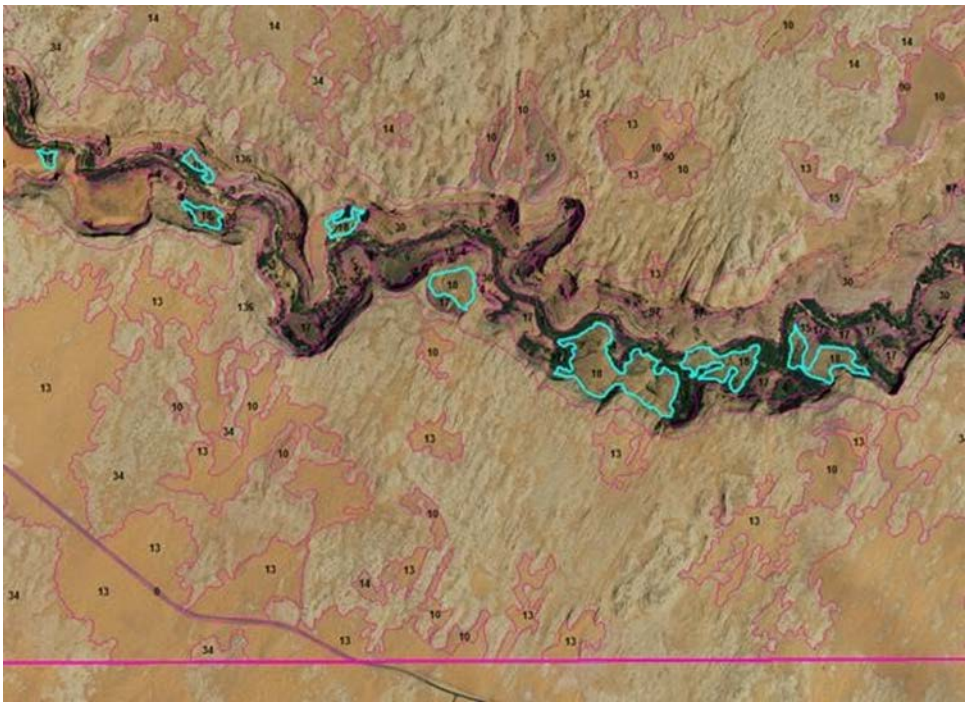
Distribution/Ecology/Composition

These shrublands occur on upper alluvial terraces, both in tributary drainages and broad valley bottoms, and are dominated by *Atriplex canescens* in combination with the following shrubs and grasses: *Ericameria nauseosa*, *Ephedra viridis*, *Opuntia* spp., *Sporobolus airoides*, *Sporobolus contractus*, *Achnatherum hymenoides*, and *Pleuraphis jamesii*. The understory may be dominated by weedy species such as *Bromus tectorum* or *Salsola tragus*. This type was most commonly found in Waterhole Flat, along Halls Creek, and in the Escalante River tributary drainages.

Interpretation

This uncommon map class appears as small to medium, regular polygons on gentle slopes and flat terraces along river corridors and in canyon or valley bottoms throughout Glen Canyon NRA. The signature is a smooth, light gray-green (grass or weedy forb cover) to reddish-tan to yellowish-tan (bare soil/substrate cover), with dark grey speckles representing the shrub cover. Because this map

class has a wide distribution in the park, neighboring polygons include those from many other map classes.



Example of photo signature for map class S-SALT (#18)

Map Class 19
Snakeweed – Prickly Pear Shrub Herbaceous Vegetation (C-CACT)

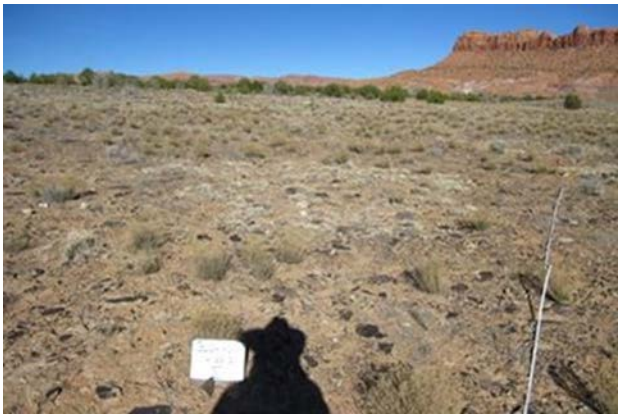



Photo credits: NPS

Associations

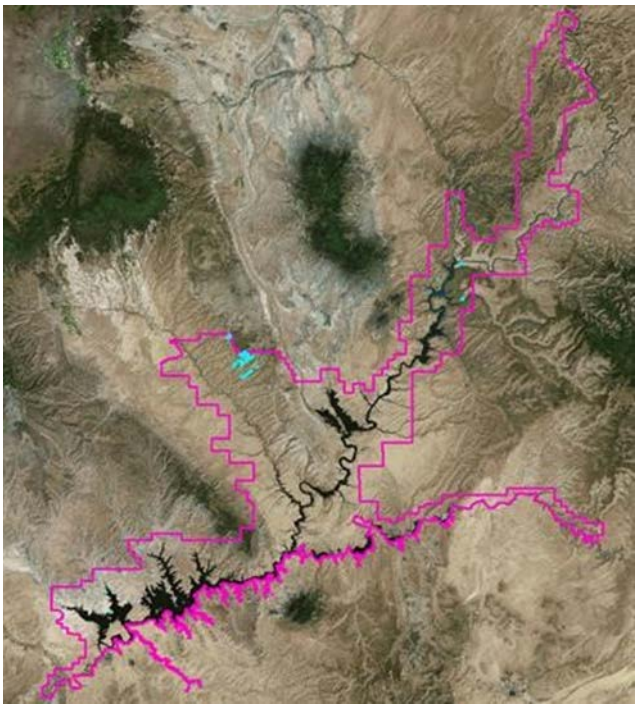
Gutierrezia sarothrae - (*Opuntia* spp.) / *Pleuraphis jamesii* Dwarf-shrubland [CEGL002690]
Gutierrezia (*microcephala, sarothrae*) Dwarf-shrubland [CEPP009523]
Opuntia (*fragilis, polyacantha, phaeacantha*) Shrubland [CEGL004009]
Opuntia polyacantha / Pleuraphis jamesii Dwarf-shrubland [CEGL002299]

Common species

- *Gutierrezia sarothrae*
- *Opuntia polyacantha*
- *Opuntia fragilis*
- *Gutierrezia microcephala*
- *Opuntia phaecantha*
- *Pleuraphis jamesii*

C-CACT Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	41 total polygons
Total project area:	248 hectares / 613.5 acres
% of vegetated land surface:	0.07%
Average polygon size:	6 hectares / 15 acres
Producer's accuracy:	N/A
User's accuracy:	N/A



Distribution in Mapping Area

Distribution/Ecology/Composition

Sparse vegetation of broad valleys where rocky or loamy/clayey soils support stands of *Gutierrezia sarothrae*, *Opuntia* spp., *Pleuraphis jamesii*, and other grasses and weedy forbs. The underlying geology is of the Chinle Formation or older alluvial gravel deposits. The dominant shrubs are typically shallow rooted or have dynamic root growth and can tolerate clayey soils which hold water near the soil surface where it more quickly evaporates and is less available for deeply rooted plants.

Interpretation

This very rare map class appears as small to medium, regular polygons on gravel deposits or Chinle shales. The signature is a smooth, light gray to yellowish tan to light orange color with regularly spaced speckles representing shrubs. Common neighbors include polygons of juniper - (pinyon) / sparse or grassy understory woodlands (map class 22), pinyon - juniper sandstone woodlands (map class 24), Torrey's joint-fir shale barrens desert scrub (map class 33), and Chinle badlands shadscale scrub (map class 36).



Example of photo signature for map class C-CACT (#19)

Upland Herbaceous Communities

Map Class 16
Native Grasslands (H-GRAS)

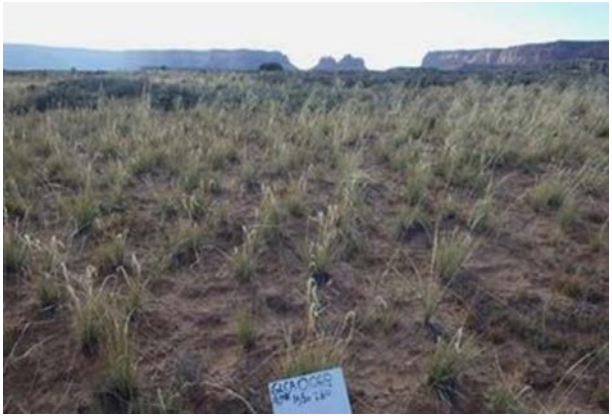



Photo credits: NPS

Associations

Dominant:
Achnatherum hymenoides Colorado Plateau Grassland [CEGL002343]
Hesperostipa comata Great Basin Grassland [CEGL001705]
Pleuraphis jamesii Grassland [CEGL001777]

Less common:
Achnatherum hymenoides - Psoralidium lanceolatum Grassland [CEGL001650]
Achnatherum hymenoides - Sporobolus contractus Grassland [CEGL001652]
Bouteloua gracilis Grassland [CEGL001760]
Pleuraphis jamesii - Sporobolus airoides Grassland [CEGL001778]
Poa fendleriana Grassland [CEGL001925]
Sporobolus airoides Southern Plains Wet Meadow [CEGL001685]
Sporobolus cryptandrus Great Basin Grassland [CEGL002691]

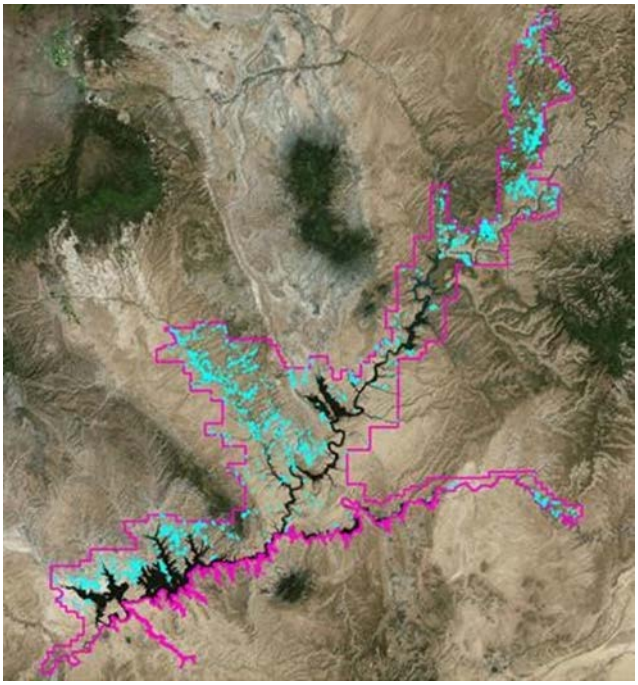
Common species

- *Achnatherum hymenoides*
- *Bouteloua gracilis*
- *Sporobolus flexuosus*
- *Sporobolus contractus*
- *Aristida purpurea*
- *Bromus tectorum*
- *Psoralidium lanceolatum*
- *Gutierrezia sarothrae*
- *Atriplex canescens*
- *Coleogyne ramosissima*

- *Hesperostipa comata*
- *Pleuraphis jamesii*
- *Sporobolus cryptandrus*
- *Sporobolus airoides*
- *Bromus rubens*
- *Sphaeralcea leptophylla*
- *Opuntia* spp.
- *Ephedra* spp.
- *Artemisia filifolia*
- *Krascheninnikovia lanata*

H-GRAS Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	1,412 total polygons
Total project area:	4,269 hectares / 10,549 acres
% of vegetated land surface:	1.1%
Average polygon size:	3 hectares / 7.5 acres
Producer's accuracy:	77% ± 10%
User's accuracy:	80% ± 10%



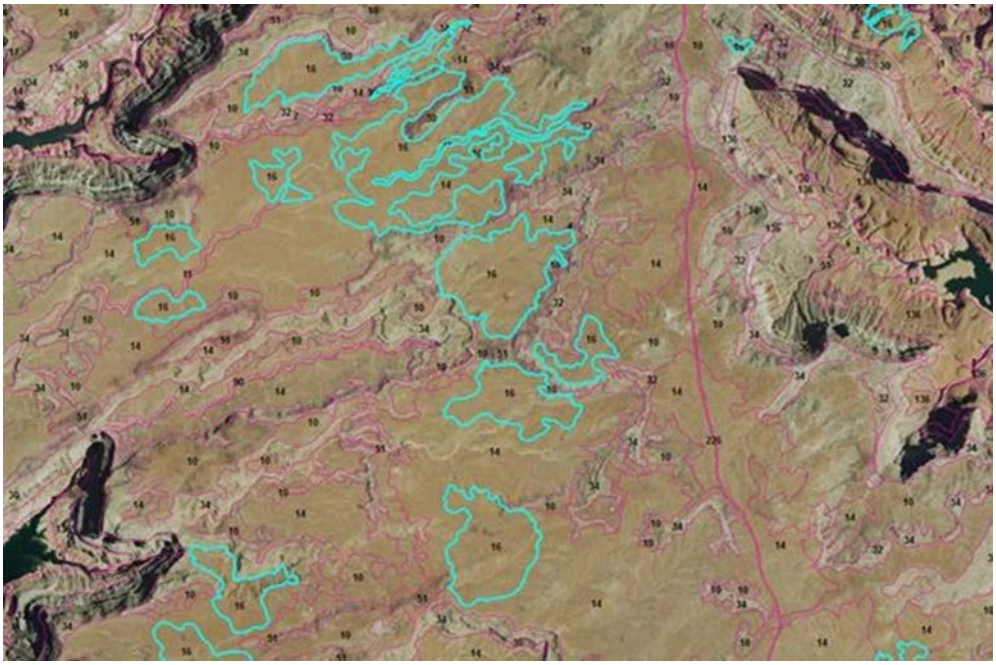
Distribution in Mapping Area

Distribution/Ecology/Composition

Native, perennial grasslands that occur on level to rolling sand sheets or older alluvium on broad plateaus, mesa tops, plains, benches, canyon bottoms, terraces, or in grabens or valley bottoms. Stands are dominated by one or more of: *Achnatherum hymenoides, Hesperostipa comata, Sporobolus* spp., *Pleuraphis jamesii,* and *Bouteloua gracilis*. The dwarf shrubs *Gutierrezia* spp. and *Opuntia* spp. are common. Scattered clumps of *Ephedra* spp., *Atriplex canescens, Artemisia filifolia, Coleogyne ramosissima,* and *Krascheninnikovia lanta* may be present but have <30% relative cover to the grasses. Biological soil crusts have varying degrees of development and have low to high cover.

Interpretation

This somewhat common and widespread map class appears as small to medium, regular polygons on alluvial and aeolian sand deposits derived from a variety of geologic types. The signature is a smooth, sometimes blotchy, light gray-green to yellowish-tan to greenish-brown with tree crowns occasionally providing black spots and dark brown, scattered to regularly-spaced speckles representing shrubs. A number of map classes occur adjacent to this map class; however, the most common neighbors include polygons of blackbrush shrublands (map class 10) and green Mormon-tea shrub herbaceous vegetation (map class 14).



Example of photo signature for map class H-GRAS (#16)

Map Class 17
Weedy Herbaceous Complex (C-WEED)





Photo credits: NPS

Associations

Dominant:
Salsola spp. Ruderal Grassland [CEGL004004]

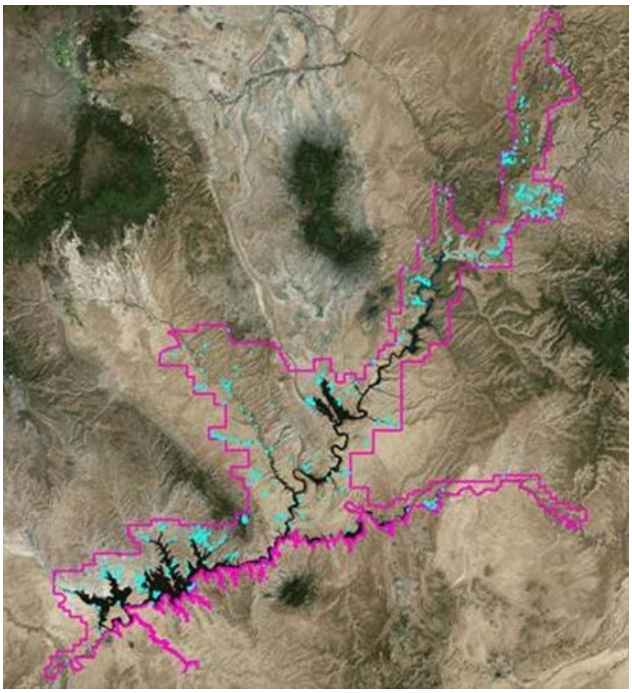
Less common:
Alhagi maurorum Ruderal Scrub [CEGL002784]
Bromus tectorum Ruderal Grassland [CEGL003019]
Tamarix chinensis Ruderal Lakeshore Scrub [CEPP005697]

Common species

- *Bromus tectorum*
- *Salsola tragus*
- *Ericameria nauseosa*
- *Opuntia* spp.
- *Rumex maritimus*
- *Bromus rubens*
- *Alhagi maurorum*
- *Tamarix chinensis*
- *Gutierrezia sarothrae*
- *Schismus barbatus*
- *Kochia americana*
- *Lappula occidentalis*

C-WEED Map Class Statistics

Statistic Name	Statistic Value
Frequency:	656 total polygons
Total project area:	1,841 hectares / 4,549.6 acres
% of vegetated land surface:	0.5%
Average polygon size:	2.8 hectares / 7 acres
Producer's accuracy:	76% ± 13%
User's accuracy:	85% ± 12%



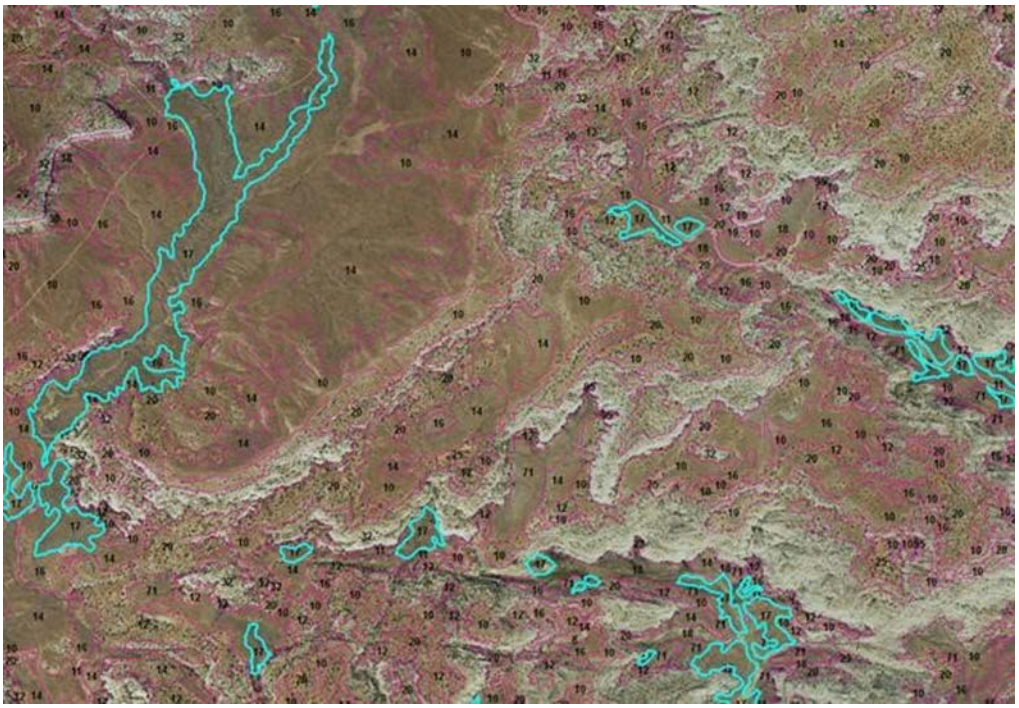
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur in areas that have been previously or are continuously disturbed by livestock grazing, wildfire, and fluctuating lake levels/flooding. Native, perennial species such as *Gutierrezia* spp., *Pleuraphis jamesii, Sporobolus cryptandrus*, and *Sphaeralcea* spp. may be present, but most stands are dominated by weedy, exotic species (e.g. *Salsola tragus*, *Bromus tectorum, Tamarix chinensis,* and *Alhagi maurorum*). Soils are variable as is the landscape position, occurring from lake shores to mesa tops throughout the park.

Interpretation

This uncommon but widely scattered map class appears as very small to medium, linear or regular polygons on flats, grabens, riverbanks, lakeshores, canyon bottom terraces, and broad valley bottoms. The signature is a smooth, sometimes blotchy, tan to grey-green to grey-brown with dark brown, speckles representing occasional shrubs. Because stands occur in a variety of environmental settings in the park, a number of map classes occur adjacent to this map class.



Example of photo signature for map class C-WEED (#17)

Sparse Vegetation & Talus Slope Communities

Map Class 30
Talus Escarpments Mixed Sparse Vegetation Complex (C-TALU)





Photo credits: NPS

Associations

Dominant:
Artemisia bigelovii - Ephedra (viridis, torreyana) Talus Shrubland [CEGL003755]
Rhus trilobata - Ephedra (viridis, torreyana) Talus and Slickrock Shrubland [CEGL003776]

Less common:
Atriplex obovata Talus Dwarf-shrubland [CEGL001789]
Atriplex canescens - Ephedra viridis Talus Shrubland [CEGL001287]
Chrysothamnus viscidiflorus Talus Shrubland [CEGL002347]
Ericameria nauseosa - (Xylorhiza tortifolia) Talus Sparse Shrubland [CEGL003961]
Fraxinus anomala - Rhus trilobata Dry Talus and Slickrock Shrubland [CEGL003963]
Coleogyne ramosissima - Acamptopappus sphaerocephalus - Ephedra torreyana Shrubland [CEPP005688]
Leymus salinus Shale Sparse Vegetation [CEGL002745]
Lycium andersonii - Ephedra (torreyana, viridis) Shrubland [CEGL005150]
Poa fendleriana Grassland [CEGL001925]

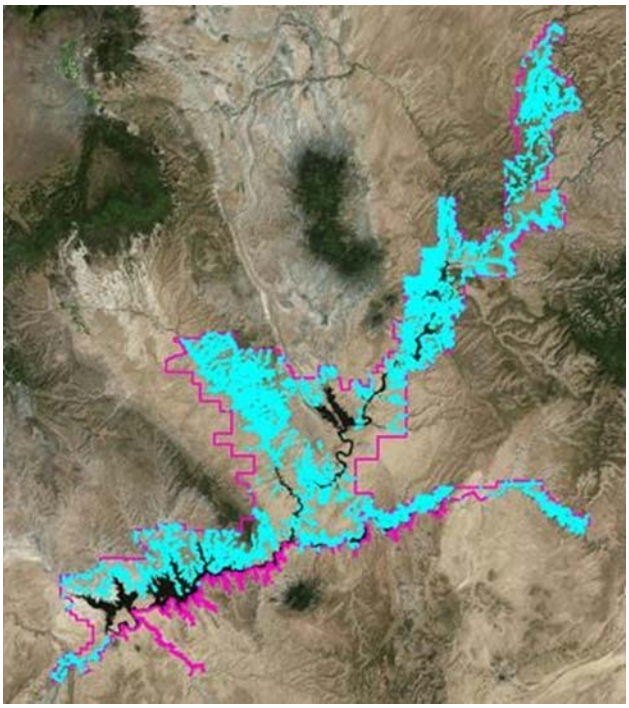
Common species

- *Ephedra torreyana*
- *Atriplex obovata*
- *Ephedra viridis*
- *Coleogyne ramosissima*
- *Lycium andersonii*
- *Fraxinus anomala*
- *Chrysothamnus viscidiflorus*
- *Poa fendleriana*

- *Ericameria nauseosa*
- *Atriplex confertifolia*
- *Atriplex canescens*
- *Acamptopappus sphaerocephalus*
- *Artemisia bigelovii*
- *Rhus aromatica var. trilobata*
- *Achnatherum hymenoides*
- *Leymus salinus*

C-TALU Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	2,995 total polygons
Total project area:	51,484 hectares / 127,219 acres
% of vegetated land surface:	13.6%
Average polygon size:	17 hectares / 42.5 acres
Producer's accuracy:	74% ± 13%
User's accuracy:	70% ± 13%



Distribution in Mapping Area

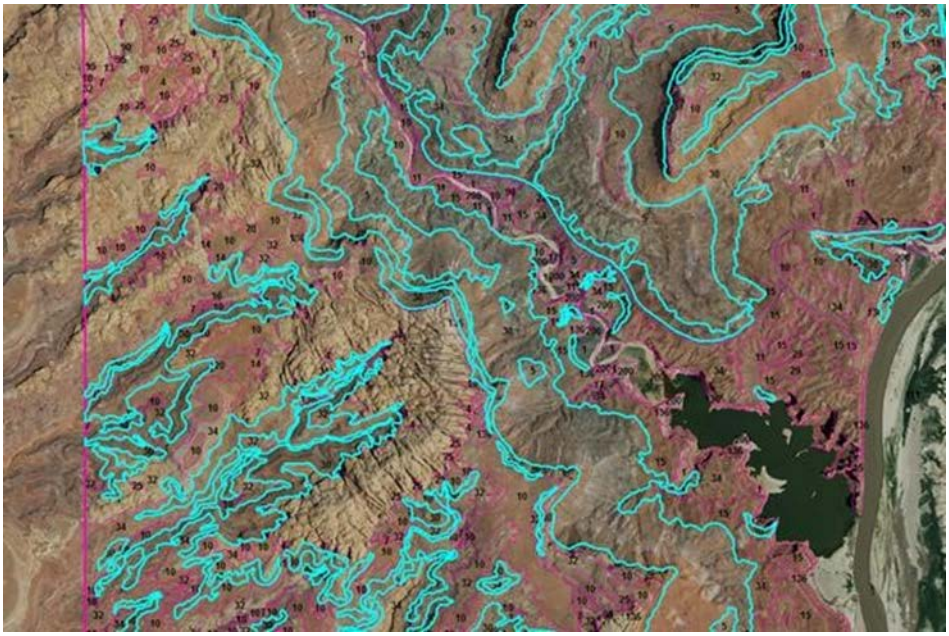
Distribution/Ecology/Composition

Stands occur on moderately steep to very steep, mostly south and west-facing talus slopes throughout the park. This map class is especially common along the deep canyons of the major river corridors

and their tributaries. Slopes are generally unstable and vegetation is vulnerable to rock slides, erosion, and downward slope movement. Slope environments often have high total species diversity with no single, well-defined plant community dominating. A diverse mix of shrub and grass species may occur on these slopes, including *Ephedra torreyana*, *Atriplex confertifolia*, *Atriplex obovata*, *Artemisia bigelovii*, *Ericameria nauseosa* var. *junceus*, *Chrysothamnus viscidiflorus*, *Fraxinus anomala*, *Rhus aromatica var. trilobata*, *Leymus salinus*, and *Poa fendleriana*, among others. Some of the species are the same dominants as are found in adjacent communities on flatter terrain, while others are most commonly associated with talus slope environments. Total vegetation cover is often less than 10%. Widely scattered and stunted *Juniperus osteosperma* trees may be present, though are not a common component of the community.

Interpretation

This common and widespread map class appears as small to very large, regular, sometimes linear or sinuous, polygons on steep, exposed slopes throughout the park. The signature ranges in color from tan to blue-gray to orange to dark reddish-brown, with scattered boulders visible, shadows produced by high ridgelines, slopes dissected by deep gullies and ravines, and a sparse shrub and grass signature obscured by the substrate. Because this map class occurs throughout the park, neighboring polygons include those from most all of the other map classes.



Example of photo signature for map class C-TALU (#30)

Map Class 31
Tropic Shale Badlands Mat Saltbush Sparse Vegetation (S-TROP)




Photo credits: NPS

Associations

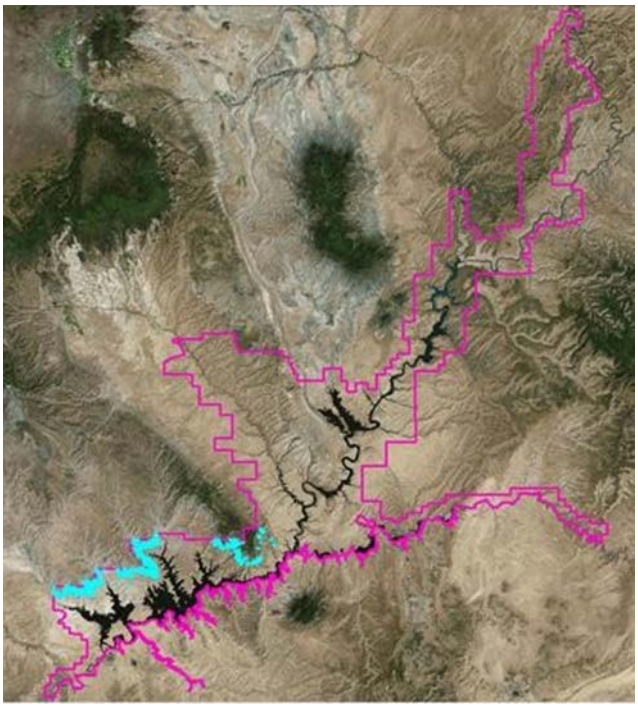
Atriplex corrugata Dwarf Shrubland [CEGL001437]

Common species

- *Atriplex corrugata*
- *Artemisia spinescens*
- *Pleuraphis jamesii*
- *Atriplex confertifolia*
- *Eriogonum inflatum*
- *Achnatherum hymenoides*

S-TROP Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	110 total polygons
Total project area:	4,877.5 hectares / 12,052 acres
% of vegetated land surface:	1.3%
Average polygon size:	44 hectares / 109.6 acres
Producer's accuracy:	100%
User's accuracy:	100%



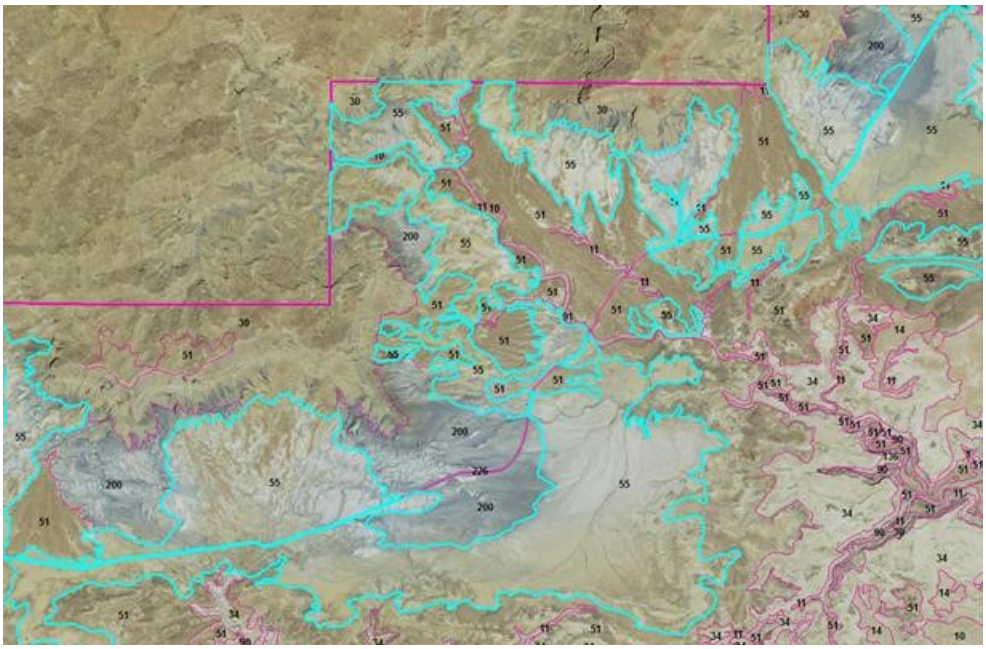
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur on Tropic Shale badlands, occasionally with landslide and slump deposits on top of the clay hills. Blue gray shale is exposed, sometimes with a gravel coating, and the terrain is generally undulating. Soils are clayey and vegetation is extremely sparse and dominated by *Atriplex corrugata*, with or without native grasses and forbs in the understory.

Interpretation

This uncommon map class appears as small to large, regular polygons on badlands and bajadas of the Tropic Shale formation. Stands are located predominantly in the southwest corner of Glen Canyon NRA. The signature is generally smooth to mottled, ranging from white to tan to blue-grey. Common neighbors include polygons of blackbrush shrublands (map class 10), shadscale-goldenhead dwarf-shrublands (map class 32), and sparse talus slope shrublands (map class 30).



Example of photo signature for map class S-TROP (#31)

Map Class 32
Shadscale - Goldenhead Scrub (S-GOLD)




Photo credits: NPS

Associations

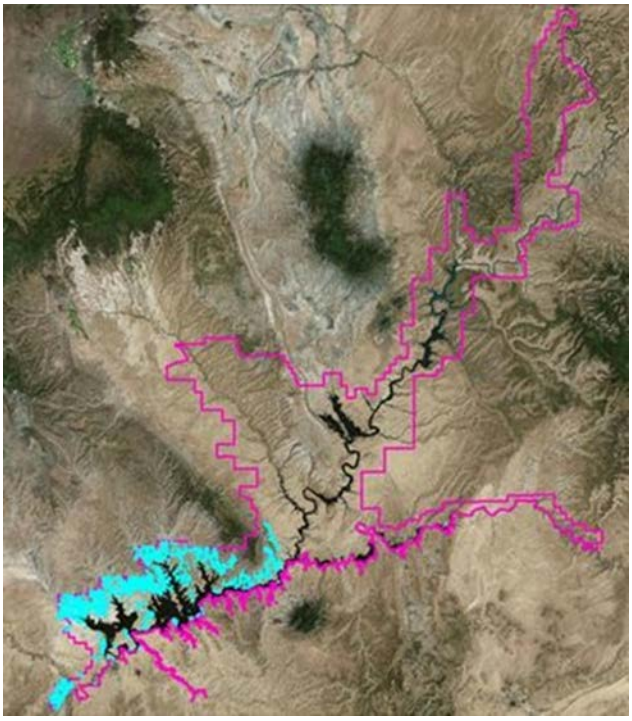
Atriplex confertifolia - (*Acamptopappus sphaerocephalus*, *Picrothamnus desertorum*) / (*Pleuraphis jamesii*) Scrub [CEPP005685]

Common species

- *Atriplex confertifolia*
- *Artemisia spinescens*
- *Coleogyne ramosissima*
- *Pleuraphis jamesii*
- *Acamptopappus sphaerocephalus*
- *Chrysothamnus viscidiflorus*
- *Ephedra* spp.
- *Achnatherum hymenoides*

S-GOLD Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	626 total polygons
Total project area:	9,446 hectares / 23,342 acres
% of vegetated land surface:	2.5%
Average polygon size:	15 hectares / 37 acres
Producer's accuracy:	73% ± 13%
User's accuracy:	96% ± 8%



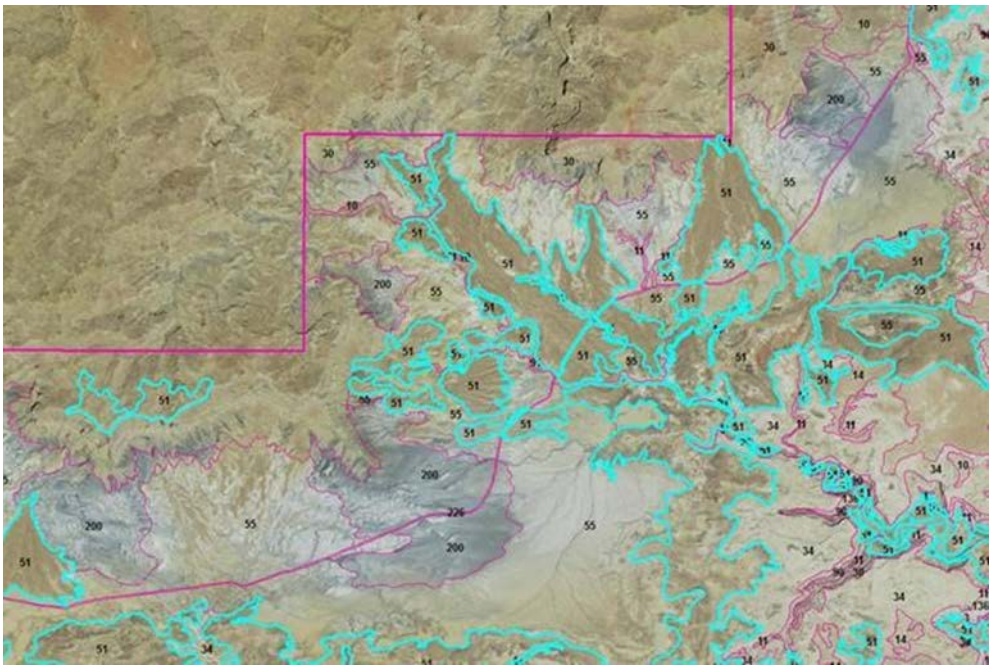
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur on flat to moderately sloping plains, bajadas, alluvial fans, hills, sideslopes, and valley floors typical of the Dakota Formation, but also found on shales of the Carmel, Tropic, and Morrison formations, and on Entrada sandstone. This map class is characterized by sparse mixed communities of *Atriplex confertifolia* with *Acamptopappus sphaerocephalus* and/or *Artemisia spinescens* co-dominant and a shaley or sand soil surface covered in small rocks/gravel (shaley/platey/pebbly). Other shrubs sometimes present include *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra* spp., *Lycium andersonii*, *Gutierrezia* spp., *Opuntia* spp., and *Suaeda moquinii*. The understory may be sparse or grassy (dominated by *Pleuraphis jamesii*).

Interpretation

This somewhat common but regional map class appears as small to very large, regular or irregular, sometimes linear, polygons on flat to rolling sites most common in the most southern portions of the park. It is the dominant vegetation type occurring on the Dakota Formation, but also occurs on neighboring geologic types. The signature is a smooth to sometimes mottled, white to beige to tan to brownish-gray color. Shrub cover is too sparse to be visible. Common neighbors include polygons of Tropic Shale badlands mat saltbush sparse vegetation (map class 31), blackbrush shrublands (map class 10), slickrock sparse vegetation (map class 34), and green Mormon-tea shrub herbaceous vegetation (map class 14).



Example of photo signature for map class S-GOLD (#32)

Map Class 33
Torrey's Joint-fir Shale Barrens Desert Scrub (S-SCRU)




Photo credits: NPS

Associations

Dominant:
Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation [CEGL005801]
Ephedra torreyana / Achnatherum hymenoides - Pleuraphis jamesii Shrubland [CEGL002352]
Ephedra torreyana / Pleuraphis jamesii Shrubland [CEGL003772]

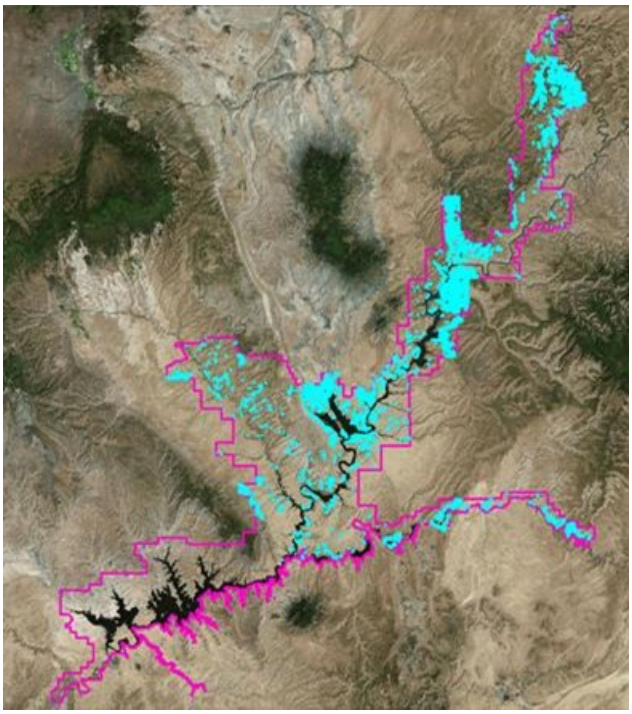
Less common:
Coleogyne ramosissima - Ephedra spp. Warm Desert Shrubland [CEGL005297]
Ephedra torreyana - (*Atriplex* spp.) / Nonvascular Gypsum Sparse Vegetation [CEGL002349]
Ephedra torreyana Sparse Vegetation [CEGL002353]
Ericameria nauseosa - (Xylorhiza tortifolia) Talus Sparse Shrubland [CEGL003961]
Eriogonum corymbosum Badlands Sparse Vegetation [CEGL002979]
Psorothamnus fremontii Shrubland [CEGL005154]

Common species

- *Ephedra torreyana*
- *Coleogyne ramosissima*
- *Opuntia* spp.
- *Xylorhiza tortifolia*
- *Pleuraphis jamesii*
- *Atriplex confertifolia*
- *Ericameria nauseosa*
- *Psorothamnus fremontii*
- *Eriogonum corymbosum*
- *Achnatherum hymenoides*

S-SCRU Map Class Statistics

Statistic Name	Statistic Value
Frequency:	1,741 total polygons
Total project area:	22,817 hectares / 56,382.5 acres
% of vegetated land surface:	6%
Average polygon size:	13 hectares / 32.4 acres
Producer's accuracy:	80% ± 8%
User's accuracy:	69% ± 8%



Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur on plateaus, mesa tops, benches, hills, and toeslopes typical of the Moenkopi Formation, but are also found on shales of the Organ Rock, Carmel, Morrison, and Halgaito formations. Stands are characterized by sparse mixed communities of *Ephedra torreyana*, sometimes with *Atriplex confertifolia, Coleogyne ramosissima, Ericameria nauseosa, Eriogonum corymbosum,* and *Opuntia* spp. present along with the grass *Pleuraphis jamesii*. The unvegetated surface is covered in small rocks (shaley/platey/pebbly) or by mudstone-like slopes and benches. Varying degrees of cryptobiotic soil crust development are present.

Interpretation

This common map class appears as small to very large, regular polygons on flat to rolling to moderately steep slopes most common in the northern half of the park. It is the dominant vegetation type occurring on the Moenkopi Formation. The signature is variable due to the variety of colors in

the underlying substrate (ranging from light tan to dark grey to medium reddish-brown). Shrubs are too small and their cover too sparse to be visible. Common neighbors include polygons of Chinle badlands shadscale scrub (map class 36), blackbrush shrublands (map class 10), rabbitbrush wash and sandsheet shrublands (map class 11), sparse talus slope shrublands (map class 30), slickrock sparse vegetation (map class 34), and Gardner saltbush sparse vegetation (map class 35).



Example of photo signature for map class S-SCRU (#33)

Map Class 34
Slickrock Sparse Shrublands (S-SLIC)




Photo credits: NPS

Associations

Dominant:
Coleogyne ramosissima Sparse Shrubland [CEGL003834]

Less common:
Artemisia bigelovii Shrubland [CEGL000276]
Cercocarpus intricatus Slickrock Sparse Vegetation [CEGL002977]
Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Shrubland [CEGL002348]
Gutierrezia (microcephala, sarothrae) - (Encelia frutescens, Brickellia microphylla) / Stephanomeria pauciflora Dwarf-shrubland [CEPP005693]
Fraxinus anomala - Rhus trilobata Dry Talus and Slickrock Shrubland [CEGL003963]
Rhus trilobata - Ephedra (viridis, torreyana) Talus and Slickrock Shrubland [CEGL003776]

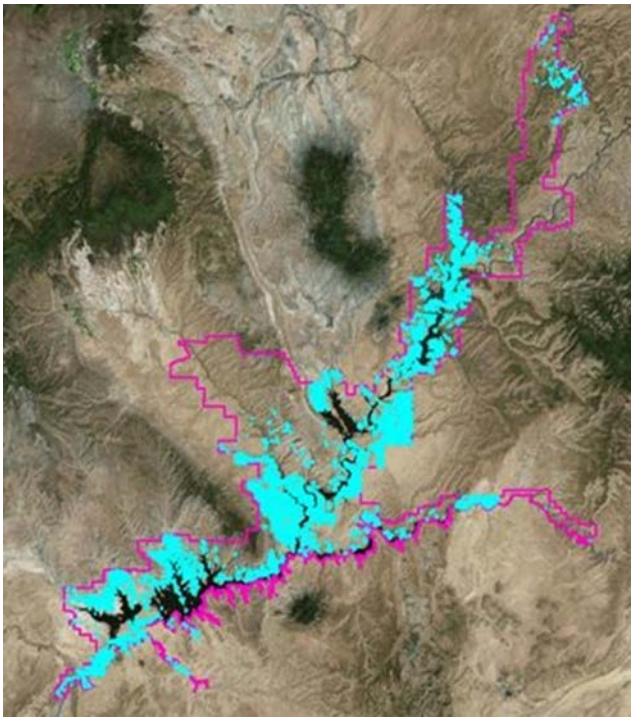
Common species

- *Coleogyne ramosissima*
- *Artemisia bigelovii*
- *Rhus aromatica var. trilobata*
- *Gutierrezia microcephala*
- *Ephedra torreyana*
- *Encelia frutescens*
- *Aristida purpurea*
- *Fraxinus anomala*
- *Cercocarpus intricatus*
- *Gutierrezia sarothrae*
- *Purshia stansburiana*
- *Brickellia microphylla*

- *Yucca angustissima*
- *Stephanomeria pauciflora*

S-SLIC Map Class Statistics

Statistic Name	Statistic Value
Frequency:	1,528 total polygons
Total project area:	48,777 hectares / 120,531 acres
% of vegetated land surface:	13%
Average polygon size:	32 hectares / 79 acres
Producer's accuracy:	82% ± 9%
User's accuracy:	88% ± 8%



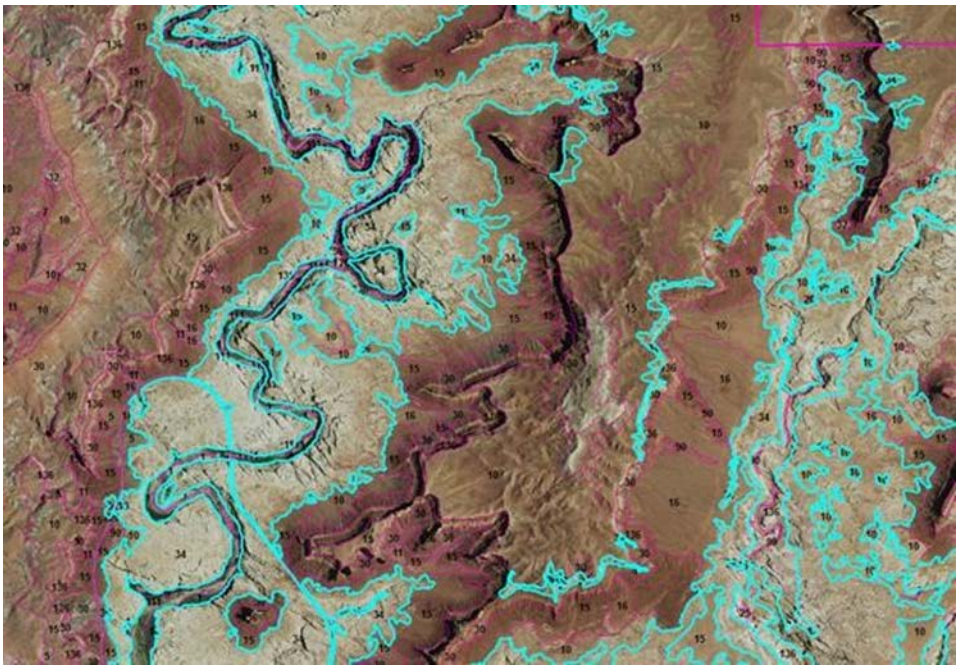
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur on relatively level, sometimes rolling, slickrock areas of hard sandstone typical of the White Rim, Cedar Mesa, Navajo, and Morrison formations. Stands are characterized by sparse cover of *Coleogyne ramosissima, Artemisia bigelovii, Rhus aromatica* var. *trilobata, Gutierrezia* spp., and *Yucca angustissima,* and occasionally *Cercocarpus intricatus,* with scattered, but often diverse grass cover. Bedrock cover generally exceeds 75%. Plants are limited by soil availability, growing most commonly in shallow soil pockets and joints in the bedrock, and trees are exceptionally rare.

Interpretation

This common map class appears as small to very large, regular or irregular polygons on rolling sites and flats throughout the park, where bare sandstone exposures dominate. The color ranges from white to brown, sometimes with joints and cracks visible in the bedrock, some pockets of darker soil (tan to reddish-brown) on top of the bedrock, and a sparsely scattered shrub signature. Common neighbors include polygons of blackbrush shrublands (map class 10), Torrey's joint-fir shale barrens desert scrub (map class 33), sparse talus slope shrublands (map class 30), pinyon - juniper sandstone woodlands (map class 24), and bare sandstone cliffs (map class 136).



Example of photo signature for map class S-SLIC (#34)

Map Class 35
Gardner Saltbush Sparse Vegetation (S-GARD)





Photo credits: NPS

Associations

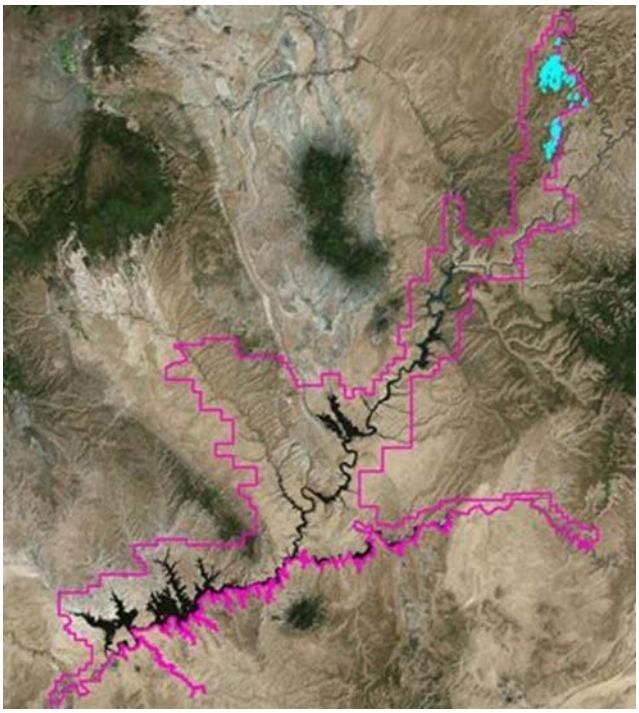
Atriplex gardneri Dwarf-Shrubland [CEGL001438]
Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland [CEGL001431]

Common species

- *Atriplex gardneri*
- *Atriplex confertifolia*
- *Ephedra torreyana*
- *Pleuraphis jamesii*

S-GARD Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	78 total polygons
Total project area:	1,951.7 hectares / 4,822.7 acres
% of vegetated land surface:	0.5%
Average polygon size:	25 hectares / 61.8 acres
Producer's accuracy:	57% ± 20%
User's accuracy:	86% ± 19%



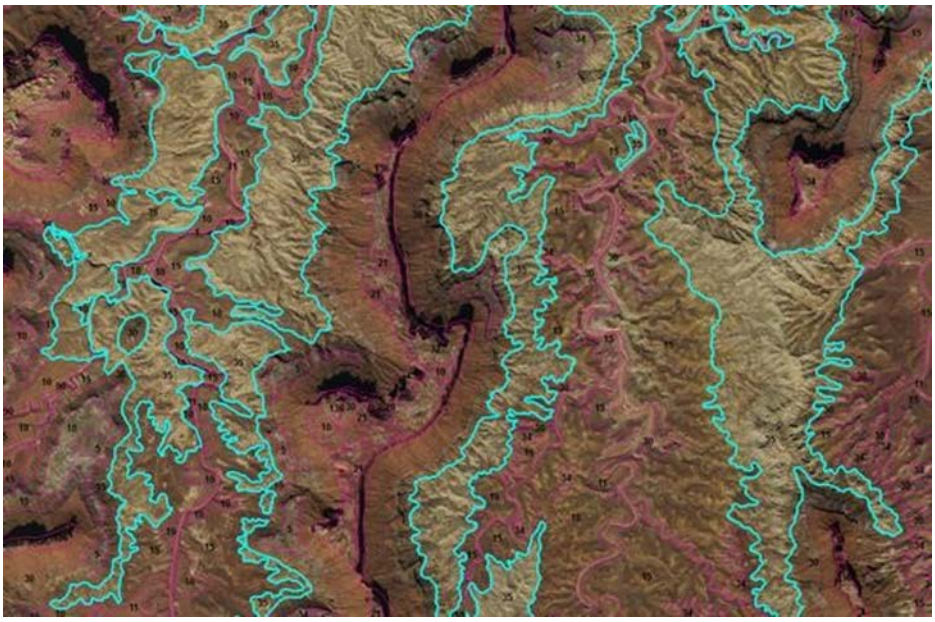
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur on Moenkopi badlands at the base of Chinle formation slopes in canyon bottoms and on benches. Stands are characterized by very sparse *Atriplex gardneri,* sometimes with scattered clumps of *Pleuraphis jamesii,* light gray, often rocky soils, and well-developed, cryptobiotic soil crusts.

Interpretation

This rare map class appears as small to large, regular polygons on gentle slopes and rolling sites on the Moenkopi Formation, concentrated in the northeastern portion of Glen Canyon NRA. The signature is a smooth, tan to dark gray color representing the substrate. The shrubs are too small and their cover too sparse to be visible. Common neighbors include polygons of blackbrush shrublands (map class 10), Torrey's joint-fir shale barrens desert scrub (map class 33), and sparse talus slope shrublands (map class 30).



Example of photo signature for map class S-GARD (#35)

Map Class 36
Chinle Badlands Shadscale Scrub (S-SHAD)




Photo credits: NPS

Associations

Dominant:
Atriplex confertifolia / Pleuraphis jamesii Shrubland [CEGL001304]
Atriplex confertifolia Great Basin Shrubland [CEGL001294]
Atriplex confertifolia Sparse Shrubland [CEGL003830]

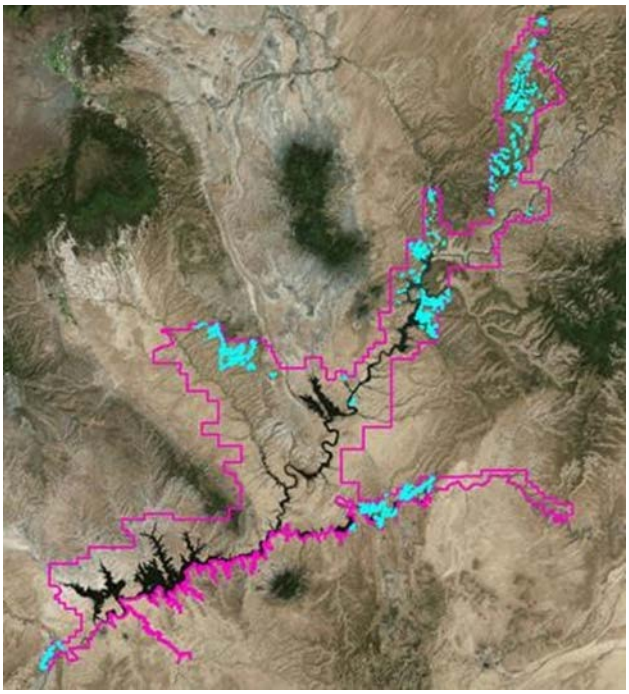
Less common:
Atriplex confertifolia / Achnatherum hymenoides Shrubland [CEGL001311]
Zuckia brandegeei Sparse Vegetation [CEGL002493]

Common species

- *Atriplex confertifolia*
- *Gutierrezia microcephala*
- *Pleuraphis jamesii*
- *Zuckia brandegeei*
- *Gutierrezia sarothrae*
- *Achnatherum hymenoides*

S-SHAD Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	437 total polygons
Total project area:	7,368 hectares / 18,206 acres
% of vegetated land surface:	2%
Average polygon size:	16.9 hectares / 41.7 acres
Producer's accuracy:	91% ± 8%
User's accuracy:	77% ± 11%



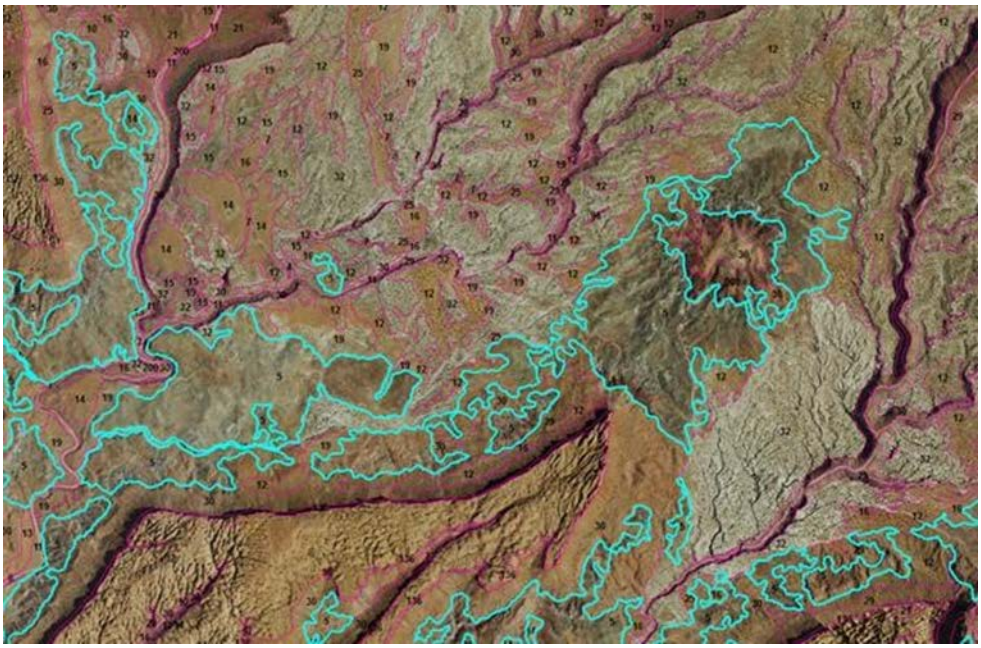
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur on Chinle Formation benches, badlands, and toeslopes, typically at the base of Wingate/Chinle scarps. Soils are fine-textured silts and clays. Blue gray shale is exposed, sometimes with a course-textured layer of rubble deposited on top, and the terrain is generally undulating. Vegetation is sparse and dominated by *Atriplex confertifolia*, less often by *Zuckia brandegeei* or *Gutierrezia* spp., with or without a native grassy understory.

Interpretation

This somewhat common map class appears as small to large, regular polygons on low slopes and toe slopes at the base of Wingate cliffs and talus slopes. Stands are located predominantly in the Orange Cliffs section of Glen Canyon NRA, but are locally common wherever there are outcrops of the Chinle Formation. The signature is generally smooth to mottled, ranging from light yellowish-tan to blue-grey to brownish-purple, and with dark orange to reddish-brown, rougher-textured overlaid deposits of rubble and talus. The shrubs are too small and their cover too sparse to be visible. Common neighbors include polygons of blackbrush shrublands (map class 10), Torrey's joint-fir shale barrens desert scrub (map class 33), pinyon-juniper shale scarps (map class 29), and sparse talus slope shrublands (map class 30).



Example of photo signature for map class S-SHAD (#36)

Map Class 91
Seepweed Sparse Vegetation (S-SEEP)





Photo credits: NPS

Associations

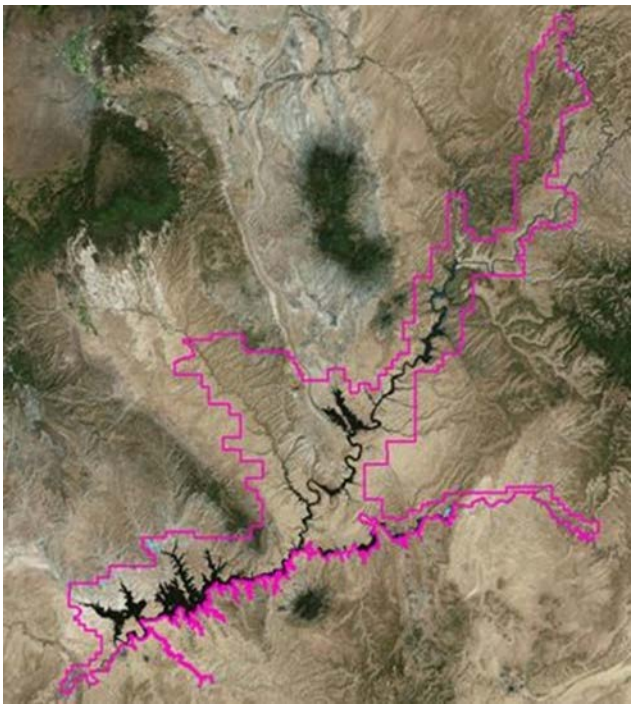
Suaeda moquinii Wet Shrubland [CEGL001991]

Common species

- *Suaeda moquinii*
- *Lycium andersonii*
- *Achnatherum hymenoides*
- *Atriplex confertifolia*
- *Ericameria nauseosa*
- *Erodium cicutarium*

S-SEEP Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	6 total polygons
Total project area:	10.7 hectares / 24.5 acres
% of vegetated land surface:	0.003%
Average polygon size:	1.8 hectares / 4.4 acres
Producer's accuracy:	N/A
User's accuracy:	N/A



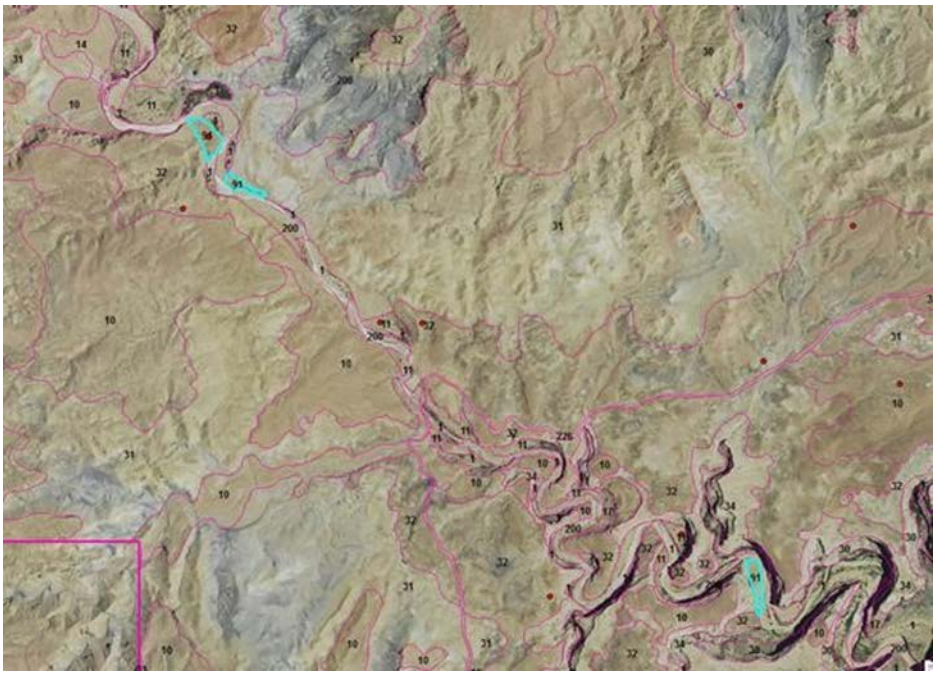
Distribution in Mapping Area

Distribution/Ecology/Composition

Saline overflow areas (salt flats and mud flats) on floodplains and stream terraces, with sparse to low shrub cover dominated by seepweed (*Suaeda moquinii*). *Atriplex* spp. and sparse to low cover of grasses and weedy annual species may be present. Soils are deep, saline, alkaline, clay loams derived from alluvium.

Interpretation

This very rare map class appears as small, narrow, linear or irregular polygons on alluvial flats along the major river corridors and tributary drainages. The color is a light tan representing the substrate with a soft, medium to dark gray-green, speckled shrub signature. Common neighbors include polygons of tamarisk shrublands (map class 1), greasewood shrublands (map class 6), and bare wash channels (map class 200).



Example of photo signature for map class S-SEEP (#91)

Riparian / Wetland Woodlands and Shrublands

Map Class 1
Tamarisk Shrublands (S-TAMX)



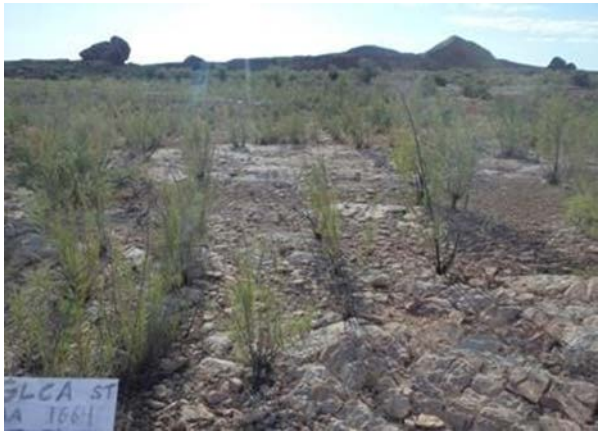


Photo credits: NPS

Associations

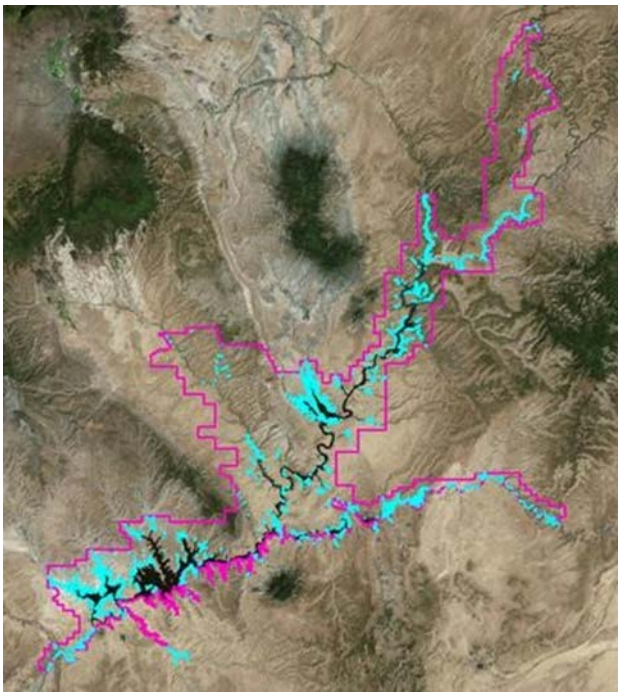
Tamarix spp. Ruderal Riparian Shrubland [CEGL003114]
Tamarix chinensis Ruderal Lakeshore Scrub [CEPP005697]

Common species

- *Tamarix chinensis*
- *Pluchea sericea*
- *Bromus tectorum*
- *Salsola tragus*
- *Isocoma rusbyi*
- *Bromus rubens*
- *Schismus barbatus*
- *Rumex maritimus*

S-TAMX Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	1,397 total polygons
Total project area:	10,658.5 hectares / 26,337.7 acres
% of vegetated land surface:	2.8%
Average polygon size:	7.6 hectares / 18.8 acres
Producer's accuracy:	96% ± 5%
User's accuracy:	88% ± 6%



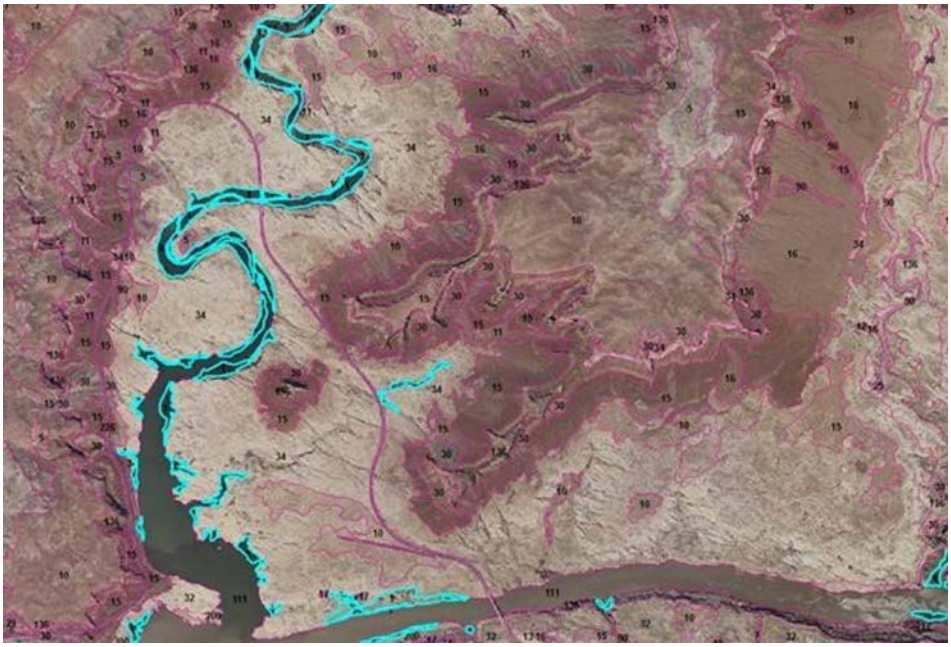
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands of continuous, dense (nearly impenetrable) to widely scattered, young to mature *Tamarix chinensis* shrubs with little to no understory or one dominated by weedy annual species. Stands occur along the banks or on the first terrace of the major rivers (Green, Colorado, and San Juan) and intermittently in a variety of tributary drainages. Stands grow especially well along regulated rivers (dam controlled) where flood-regenerated native species (e.g. cottonwood trees) are declining, and the absence of regular, scouring floods allows *Tamarix* seedlings to become established. Sites are flat and bare soil and litter covers most of the unvegetated surface. Soils are poorly drained to rapidly drained, derived from alluvium, and are subject to frequent flooding.

Interpretation

This common map class occurs as small to large, regular, linear, or sinuous polygons along the edges of the major rivers throughout the entirety of the river corridor in Glen Canyon NRA. The photo signature is a rough-textured, medium to dark green to black color, sometimes continuous other times intermittent and appearing as parallel lines (indicating a fluctuating lake level). Because this map class is widespread throughout the park, it borders a variety of other map classes, with none being particularly common other than the map class for open water (map class 111).



Example of photo signature for map class S-TAMX (#1)

Map Class 2
Coyote Willow Shrublands (S-WILL)





Photo credits: NPS

Associations

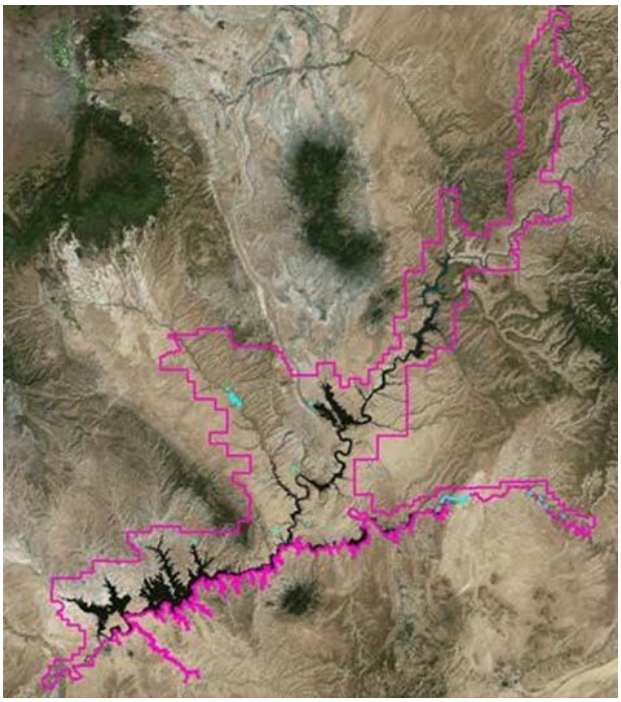
Baccharis (*emoryi*, *salicina*) - *Salix exigua* Wet Shrubland [CEGL005947]
Baccharis salicina Shrubland [CEGL005007]
Baccharis salicifolia Riparian Shrubland [CEGL003549]
Pluchea sericea Wet Shrubland [CEGL003080]
Salix exigua / Gravel Bar Wet Shrubland [CEGL005656]
Salix exigua / Mesic Graminoids Western Wet Shrubland [CEGL001203]

Common species

- *Salix exigua*
- *Pluchea sericea*
- *Phragmites australis*
- *Muhlenbergia asperifolia*
- *Artemisia ludoviciana*
- *Baccharis salicina*
- *Tamarix chinensis*
- *Elymus canadensis*
- *Bromus tectorum*
- *Equisetum laevigatum*

S-WILL Map Class Statistics

Statistic Name	Statistic Value
Frequency:	38 total polygons
Total project area:	103.7 hectares / 256 acres
% of vegetated land surface:	0.03%
Average polygon size:	2.7 hectares / 6.7 acres
Producer's accuracy:	N/A
User's accuracy:	N/A



Distribution in Mapping Area

Distribution/Ecology/Composition

Communities are characterized by fairly dense stands of young/regenerating or older established *Salix exigua, Baccharis salicina,* and/or *Pluchea sericea. Tamarix chinensis* may be mixed in with low numbers, but should not be co-dominant with willow. Stands occur on low, sandy areas connected to the river bank and are part of the active channel. Flooding is too frequent to permit the development of a dense herbaceous layer, but several herbaceous species may be present with low cover. Sites are flat and bare soil and litter covers most of the unvegetated surface. Soils are poorly drained to rapidly drained, derived from alluvium, and are subject to frequent flooding.

Interpretation

This very rare map class occurs as short to long, very narrow, sinuous polygons along the edges of the major rivers (Colorado, San Juan, and Escalante). The photo signature is a smooth, tan color representing the sandbar or active wash channel with scattered gray-green clumps of willows or a continuous, soft-textured, medium green color where the willow canopy is denser. Common

neighbors include polygons of tamarisk shrublands (map class 1), Fremont cottonwood woodlands (map class 3), sparse talus slope shrublands (map class 30), open water (map class 111), and barren sandbars (map class 200).



Example of photo signature for map class S-WILL (#2)

Map Class 3
Fremont Cottonwood Woodlands (W-COTT)





Photo credits: NPS

Associations

Dominant:
Populus fremontii - Salix gooddingii / Salix exigua Riparian Forest [CEGL002684]
Populus fremontii / Salix exigua Riparian Forest [CEGL000666]
Populus fremontii / Ericameria nauseosa Riparian Woodland [CEGL002465]

Less common:
Acer negundo / Disturbed Understory Riparian Woodland [CEGL002693]
Elaeagnus angustifolia Ruderal Riparian Woodland [CEGL005269]
Populus fremontii - Salix gooddingii Riparian Woodland [CEGL000944]
Populus fremontii / Acer negundo Riparian Forest [CEGL000662]
Populus fremontii / Baccharis (emoryi, salicina) Riparian Woodland [CEGL002946]
Populus fremontii / Mesic Forbs Riparian Woodland [CEGL002470]
Populus fremontii / Mesic Graminoids Riparian Woodland [CEGL002473]
Populus fremontii / Scour Riparian Forest [CEGL005978]
Populus fremontii / Sparse Riparian Forest [CEGL005979]
Populus fremontii / Tamarix sp. Ruderal Riparian Woodland [CEGL005485]
Salix gooddingii / Salix exigua Riparian Woodland [CEGL003778]

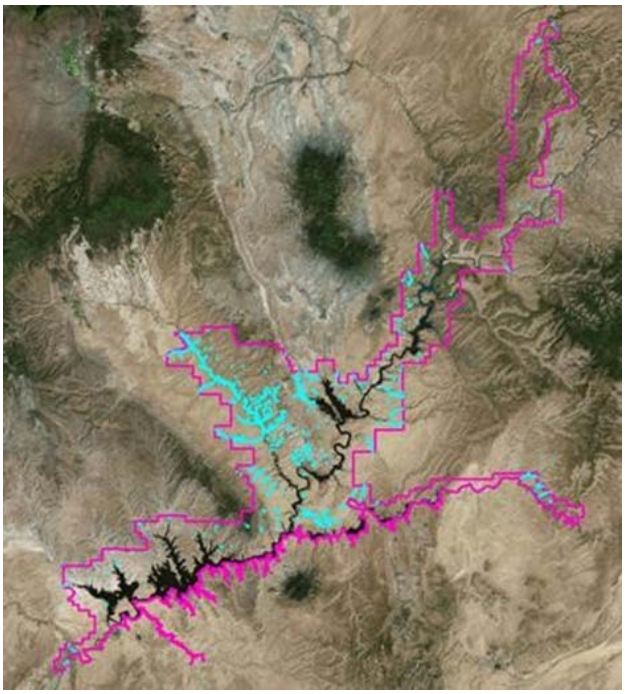
Common species

- *Populus fremontii*
- *Salix gooddingii*
- *Tamarix chinensis*
- *Baccharis salicina*
- *Bromus tectorum*
- *Solidago canadensis*
- *Muhlenbergia asperifolia*

- *Distichlis spicata*
- *Acer negundo*
- *Salix exigua*
- *Elaeagnus angustifolia*
- *Ericameria nauseosa*
- *Artemisia* spp.
- *Heterotheca villosa*
- *Phragmites australis*
- *Juncus* spp.

W-COTT Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	480 total polygons
Total project area:	2,006.5 hectares / 4,958 acres
% of vegetated land surface:	0.5%
Average polygon size:	4 hectares / 10.3 acres
Producer's accuracy:	94% ± 7%
User's accuracy:	92% ± 7%



Distribution in Mapping Area

Distribution/Ecology/Composition

Strands are characterized by open to moderately closed cottonwood woodlands (or more rarely dominated or co-dominated by *Acer negundo* or *Salix gooddingii*), with young to mature to decadent

trees, growing in tributary wash channels. These woodlands may have upland or mesic understories, depending on water availability. Some relict cottonwood stands may have dense *Tamarix chinensis* and/or *Salix exigua* understories. Sites are flat to gently sloping and bare soil and litter cover most of the unvegetated surface. Soils are poorly drained to rapidly drained, derived from alluvium, and are subject to frequent flooding.

Interpretation

This somewhat common map class appears as short to long, narrow, sinuous polygons following drainage channels/washes throughout the park, but especially concentrated in the tributary drainages of the Escalante River. The signature is variable depending on the density of the vegetation, presence or absence of surface water, mesic or upland understories, and shrub or herbaceous understories. The consistent signature includes a tan or light brown meandering line of the scoured wash channel with scattered medium to dark green spots representing cottonwood tree crowns. Because this map class occurs in wash channels throughout the park, a variety of map classes occur adjacent to it, including talus slope communities, terrace and wash communities, grasslands, and shrublands.



Example of photo signature for map class W-COTT (#3)

Map Class 5
Relict Spring-supported Mixed Deciduous Woodlands & Shrublands (W-SPRI)





Photo credits: NPS

Associations

Dominant:
Populus fremontii / Frangula betulifolia - Quercus gambelii Spring & Riparian Woodland [CEPP005699]
Quercus gambelii / Amelanchier utahensis Shrubland [CEGL001110]
Quercus gambelii Shrubland [CEGL002477]

Less common:
Acer grandidentatum / Quercus gambelii Forest [CEGL000559]
Betula occidentalis Desert Spring Shrubland [CEPP009680]
Celtis laevigata var. reticulata - Quercus gambelii - Cercis orbiculata Slickrock Canyon Spring & Riparian Woodland [CEGL002359]
Frangula betulifolia Wet Shrubland [CEPP009630]
Ostrya knowltonii Riparian Woodland [CEGL003971]
Quercus gambelii / Artemisia tridentata Shrubland [CEGL001111]
Quercus gambelii / Poa fendleriana Shrubland [CEGL002949]
Quercus gambelii / Rhus trilobata Shrubland [CEGL002338]
Quercus gambelii / Symphoricarpos oreophilus Shrubland [CEGL001117]

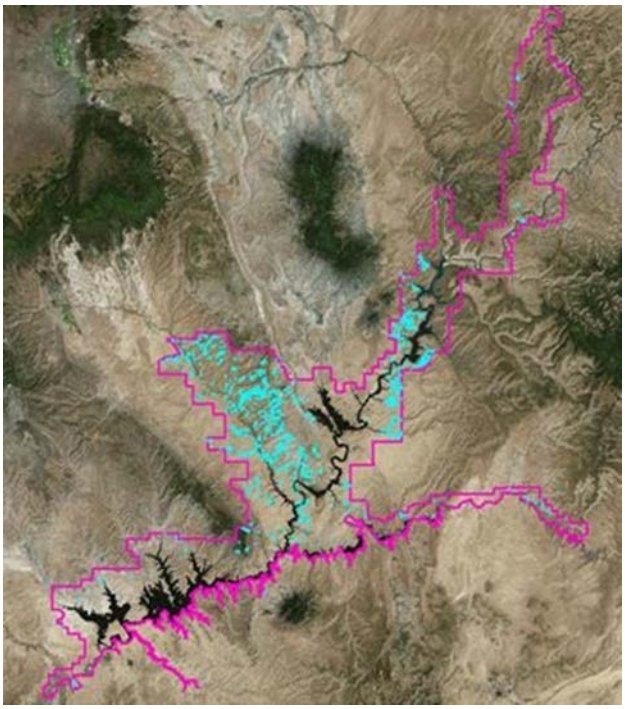
Common species

- *Quercus gambelii*
- *Betula occidentalis*
- *Cercis orbiculata*
- *Populus fremontii*
- *Rhus aromatica var. trilobata*
- *Amelanchier utahensis*

- *Phragmites australis*
- *Parthenocissus vitacea*
- *Acer grandidentatum*
- *Celtis reticulata*
- *Frangula betulifolia*
- *Ostrya knowltonii*
- *Artemisia tridentata*
- *Symphoricarpos* spp.
- *Poa fendleriana*
- *Muhlenbergia asperifoli*a

W-SPRI Map Class Statistics

Statistic Name	**Statistic Value**
Frequency:	1,059 total polygons
Total project area:	1,595.6 hectares / 3,943 acres
% of vegetated land surface:	0.4%
Average polygon size:	1.5 hectares / 3.7 acres
Producer's accuracy:	93% ± 6%
User's accuracy:	87% ± 8%



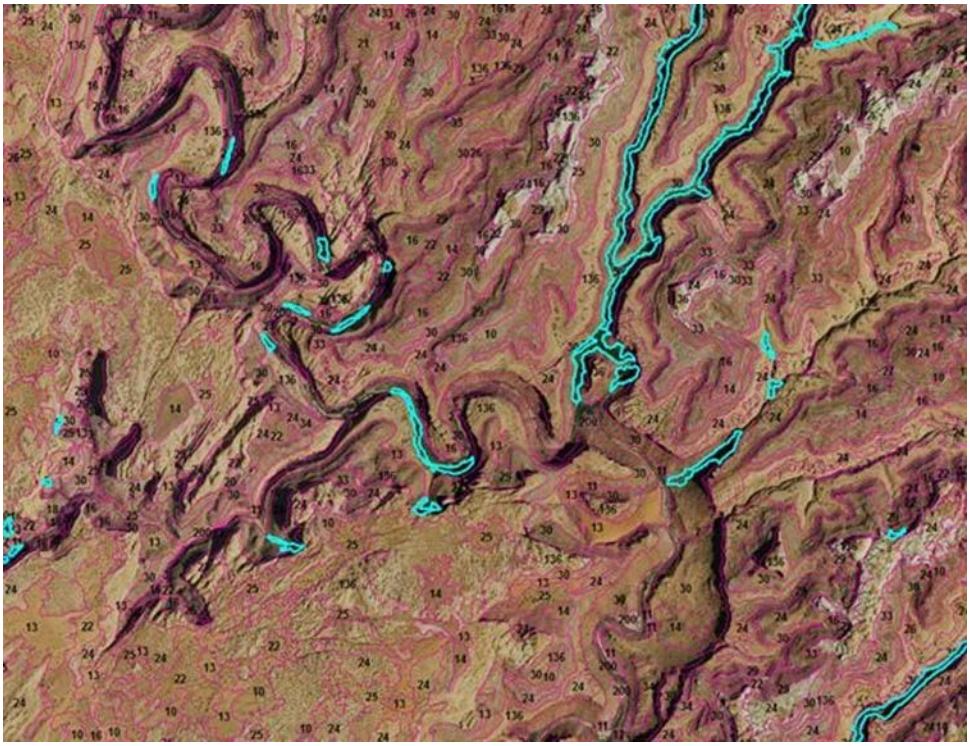
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur in sheltered canyon drainages, on higher wash terraces, steep, sheltered canyon slopes, coves, alcoves, and seep/spring headwater communities throughout the park. Vegetation is dense and dominated by a mix of mesic trees and tall shrubs, including *Acer grandidentatum, Quercus gambelii, Populus fremontii, Celtis reticulata, Betula occidentalis, Cercis orbiculata, Frangula betulifolia,* and *Ostrya knowltonii*. *Pinus edulis* and *Juniperus osteosperma* are absent or present only with trace to very low cover. Stands tend to be small, surrounding seeps or springs where a perennial source of water is present. The herbaceous understory may be dense and diverse, and include *Phragmites australis* and *Equisetum* spp., or may be sparse or dominated by weedy, annual grasses. Sites range from flat to steep, with deep sandy soils, and litter covers most of the unvegetated surface.

Interpretation

This somewhat common and widely scattered map class appears as short to long, narrow, irregular polygons along drainages and on gentle to steep slopes where a permanent water source is present. Common neighbors include polygons of a variety of bottomland shrublands, pinyon-juniper woodlands, Fremont cottonwood woodlands (map class 3), and sparse talus slope shrublands (map class 30).



Example of photo signature for map class W-SPRI (#5)

Riparian / Wetland Herbaceous Communities

Map Class 15
Spring-supported Herbaceous Vegetation (H-HERB)




Photo credits: NPS

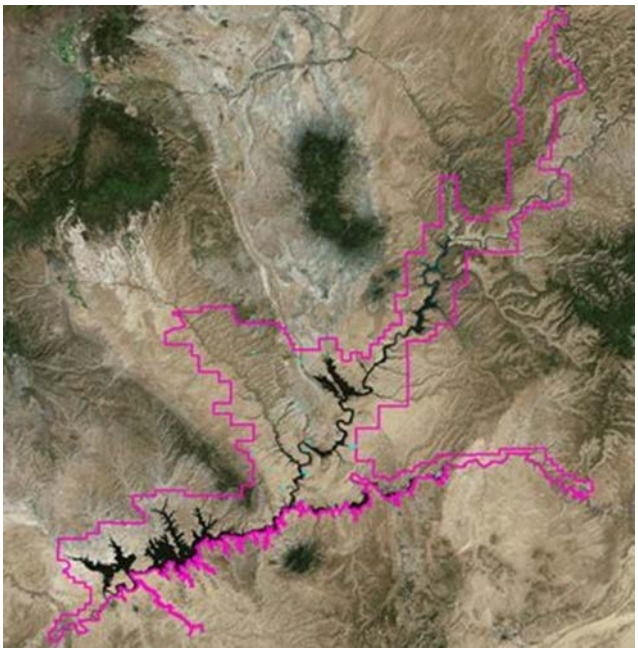
Associations
Distichlis spicata Alkaline Wet Meadow [CEGL001770]
Muhlenbergia asperifolia Wet Meadow [CEGL001779]
Phalaris arundinacea Western Marsh [CEGL001474]
Phragmites australis Western Ruderal Wet Meadow [CEGL001475]
Toxicodendron rydbergii / Mixed Forb Hanging Garden Scrub [CEPP005700]
Typha domingensis Western Marsh [CEGL001845]

Common species

- *Juncus spp.*
- *Distichlis spicata*
- *Equisetum* spp.
- *Carex* spp.
- *Phalaris arundinacea*
- *Phragmites australis*
- *Typha domingensis*
- *Solidago canadensis*
- *Muhlenbergia asperifolia*
- *Toxicodendron rydbergii*

H-HERB Map Class Statistics

Statistic Name	Statistic Value
Frequency:	29 total polygons
Total project area:	23 hectares / 57.7 acres
% of vegetated land surface:	0.01%
Average polygon size:	0.8 hectares / 2 acres
Producer's accuracy:	N/A
User's accuracy:	N/A



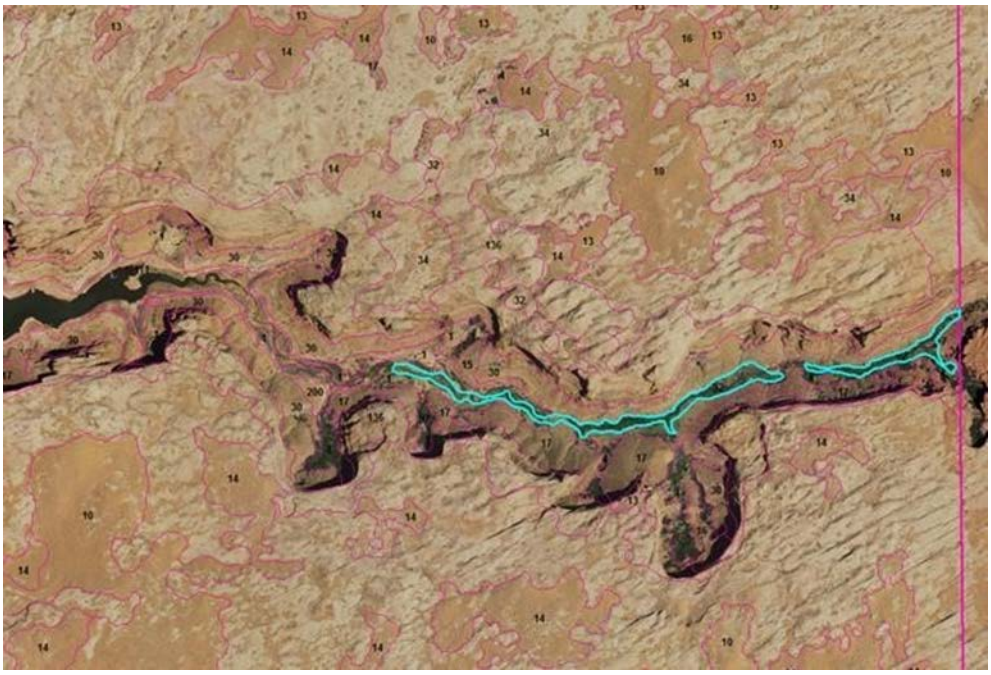
Distribution in Mapping Area

Distribution/Ecology/Composition

Stands occur as very small, spring-supported herbaceous communities along tributary wash channels. A variety of herbaceous species may be present (or it may be a near monoculture of one species) including *Juncus* spp., *Phragmites australis, Distichlis spicata, Typha domingensis, Equisetum* spp., *Carex* spp., *Muhlenbergia asperifolia,* and *Solidago canadensis*.

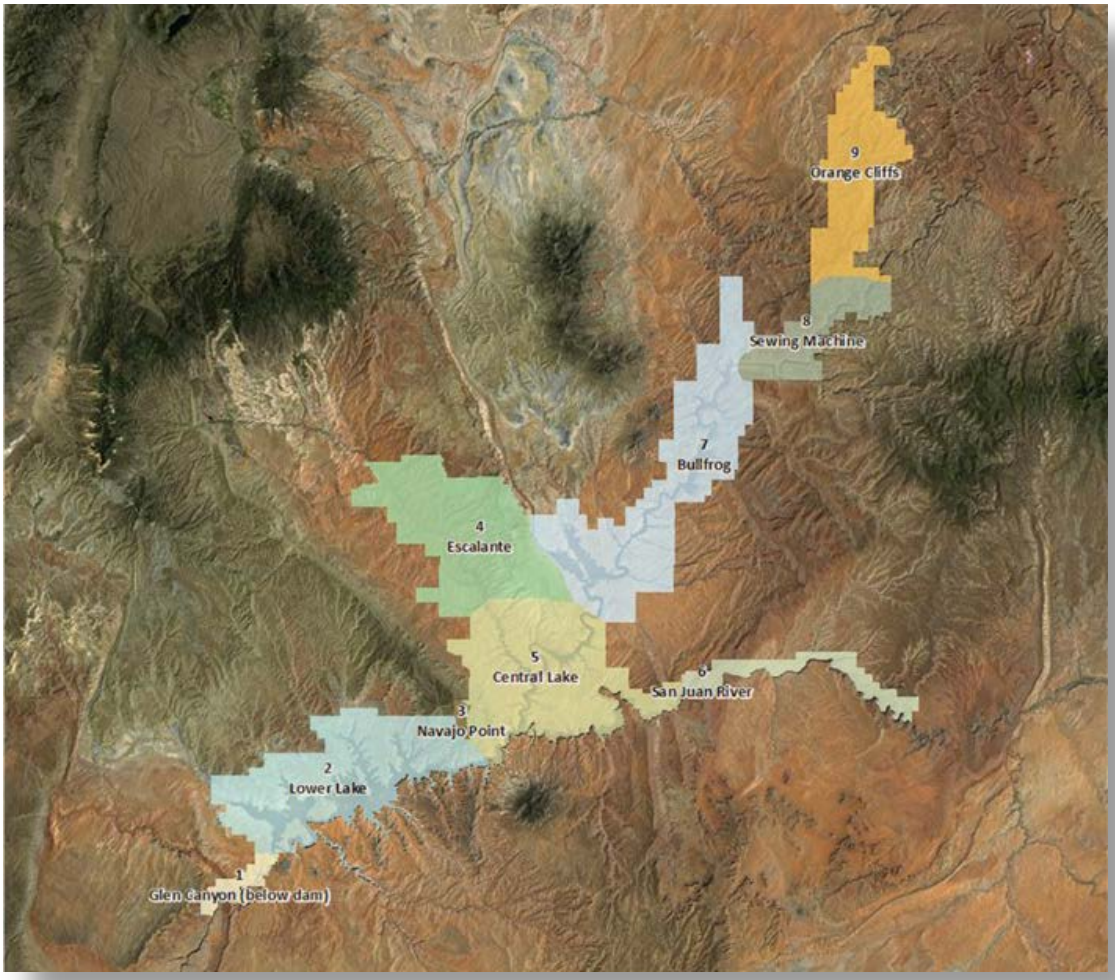
Interpretation

This extremely rare map class appears as very small, irregular, narrow, and sinuous polygons along tributary wash channels. Most examples of this type are too small to pull out with the minimum mapping unit standard (0.5 hectare), but are mosaicked with Fremont cottonwood woodlands (map class 3) and coyote willow shrublands (map class 2). The signature is a smooth-textured, light green to greenish-gray, with tan to light brown exposures of the scoured wash channel often visible. Other than the vegetation types previously mentioned, this map class is found neighboring sparse talus slope shrublands (map class 30) in narrow canyon bottoms or on high slopes where seeps occur at the base of slickrock cliff bands.



Example of photo signature for map class H-HERB (#15)

Appendix J. Sampling Plan Report, Glen Canyon/Rainbow Bridge National Recreation Area



September 18, 2011
Kass Green & Associates
1100 High Court
Berkeley, California 94708
National Park Service Purchase Oder P11PX00094

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Introduction

In 1992 the National Park Service (NPS) embarked on an ambitious project to inventory the vegetation of more than 270 National Parks. Each inventory results in the following products:

1. Vegetation plot data
2. Detailed vegetation report which includes comprehensive descriptions of the vegetation associations of each park
3. Dichotomous vegetation key
4. Digital vegetation map and report on mapping methods
5. Accuracy assessment data & analysis

The inventory is designed and implemented to produce "high quality standardized maps and associated data sets of vegetation and other land-cover occurring within parks…" (NPS 2010). Guided by a 12 step process, the inventory maps and data "…fill and complement a wide variety of resource assessment, park management, and conservation needs." (NPS 2010).

Step 4 of the 12 step guidance calls for Field Plot Data collection to support both development of each park's ecological classification, scheme, descriptions, key and map, and the establishment of a permanent "… record of floristic characteristics of each vegetation type." The field plot sampling will support identification and characterization of the "…full representation of all vegetation types across a park…" (NPS 1994). Because field plots collect detailed and comprehensive data across a myriad of landscapes, field plot collection tends to be labor intensive and costly. The tremendous value of the field plot data to park management coupled with the expense of plot establishment, makes it critical that careful sample planning be implemented to allow for cost effective capture of the vegetation variation of importance[1] to each park. Accordingly, Step 4 calls for a design of a plot sampling plan which considers "…park size, terrain features, heterogeneity of vegetation types, logistical and safety considerations, and the cost of getting to different areas of the park." (NPS 2010).

This report is the Sampling Plan for Glen Canyon National Recreation Area (GLCN) and Rainbow Bridge National Monument (RABR). Straddling Lake Powell and the Colorado River, the vegetation of Glen Canyon National Recreation Area is highly diverse, ranging from hanging gardens to riparian strands of introduced species to pinyon juniper forests to relic stands of Douglas fir to vast areas of sparse desert shrubs and herbs. The vegetation of the Recreation Area is highly influenced by water, elevation, slope and aspect, and includes over 800 species of vascular plants. Encompassing 1.2 million acres of the Colorado Plateau, the park stretches across portions of Utah, Arizona, Colorado, and New Mexico. Rainbow Bridge National Monument (RABR) is a small (160 acre) Monument which is adjacent to GLCN. This report uses the abbreviation GLCN to refer to both Glen Canyon National Recreation Area and Rainbow Bridge National Monument.

[1] Importance can be characterized by numerous attributes including type abundance or rarity, visitor impact, support of wildlife habitat, risk of wildfire, control of invasive/exotic species, protection of relic habitats, etc.

The report is organized as follows:

- Section I – Introduction
- Section II – Methods Used to Create the Field Sampling Layer
- Section III – Data Definitions for the Field Sampling Layer

Methods Used to Create the Field Sampling Layer

Creation of the sampling plan involves:

A. Stratification of the land-cover based on variables believed to be highly correlated with vegetation variation,

B. Creation of a cost access map layer.

C. Sample selection of sample sites which capture the park's vegetation variation at the lowest cost.

D. Review of the sample selection by local experts to ensure that the plan is viable and that all important vegetation types will be captured in the sampling effort.

This section of the report summarizes the methods used to complete the first 3 steps for the creation of a sampling plan for Glen Canyon/Rainbow Bridge National Recreation Area.

Land-Cover Stratification

At 1.2 million acres, Glen Canyon National Recreation Ares is classified as a Very Large Park (greater than 2,500 square kilometers) (NPS 1994) which requires that the park be divided into ecoregions with "representative polygons" of the vegetation of each ecoregion sampled. GLCN ecoregions were delineated by Dr. John Spence of GLCN, and then digitized by KGA personnel (see the cover and Figure 1 below).

Development of representative polygons within ecoregions requires that the park be stratified into areas believed be relatively homogeneous in terms of vegetation type. However, the representative polygons will only be a proxy for vegetation variation as the final park vegetation associations will be determined only after the field plot data is collected and analyzed. Therefore, vegetation delineations may change between the creation of the "representative polygons" for the field sampling plan and the creation of the final vegetation association map.

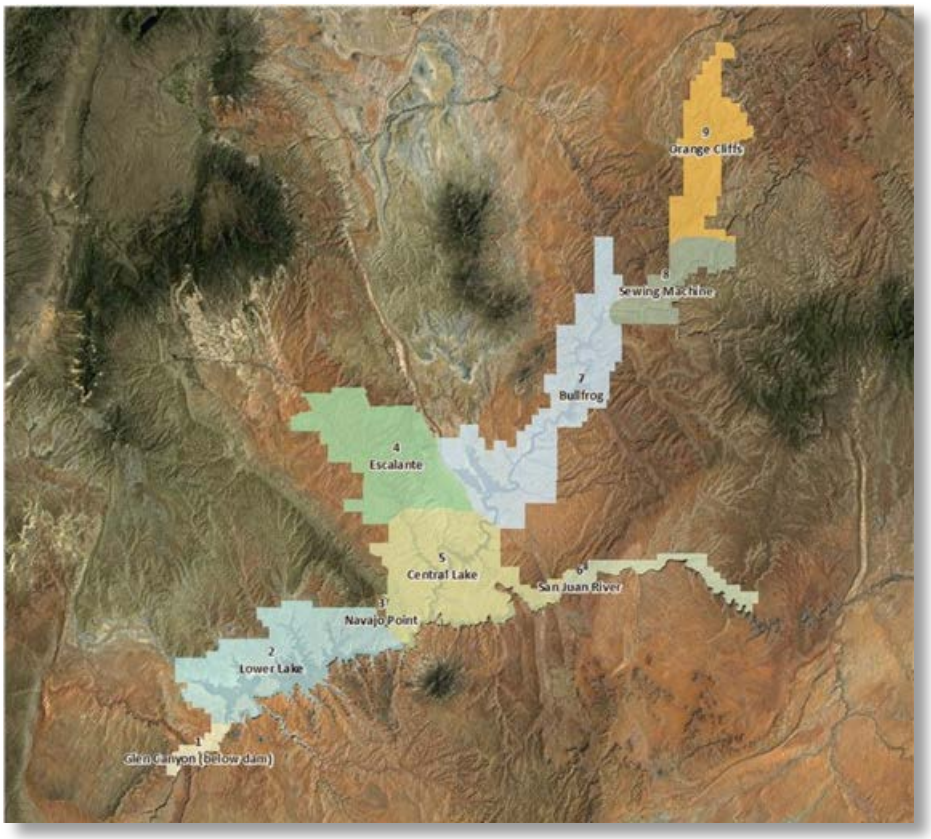


Figure 1. Glen Canyon National Recreation Area Ecoregions.

How a park will be stratified into representative polygons depends on the environmental data available to the park. Source data for stratification can include imagery, legacy vegetation type maps, soils maps, or maps of biophysical units (BPUs) created by combining several ancillary data sets such as geology, elevation, slope, and aspect. Biophysical Units are "discreet, spatial polygons that have a unique suite of biotic and abiotic conditions that influence the vegetation." (Cogan and Von Loh 2011). BPU have been created for many parks (e.g. CARE, CANY, and GRCA) to create sampling strata, but with mixed success.

Two legacy data sets exist which could potentially be used to create representative polygons – the Tuhy MacMahon vegetation maps of 1988 (Tuhy and MacMahon 1988) and the recently created soils maps from the USDA Natural Resources Conservation Service (USDA-NRCS 2010). Unfortunately, the Tuhy and MacMahon maps were never digitized. While the soils map is digital and very good, it is also very coarse in its delineation; with considerable vegetation variation within soil types as evidenced in Figure 2.

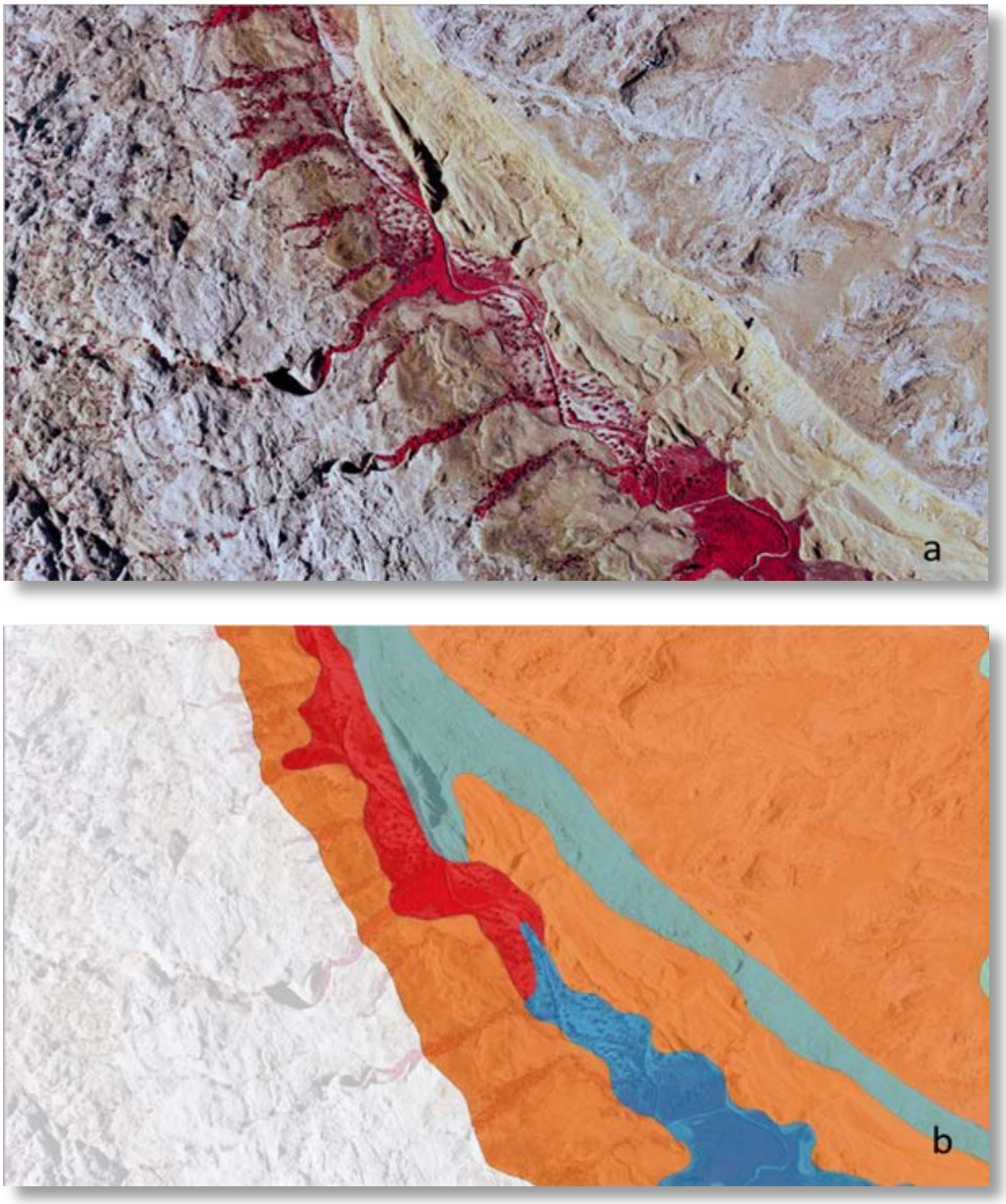


Figure 2. NAIP infrared imagery (a) and NRCS Soils Map (b) for the same area in Ecoregion 5 (along Halls Creek in the Bullfrog Ecoregion). The imagery indicates that there is significant vegetation variation within the NRCS classes.

Because vegetation is highly correlated with spectral reflectance, remotely sensed data has long been used to map vegetation. Accordingly, remotely sensed data can also be used to provide a first approximation of the vegetation types within the park through "the interpretation of patterns that can be recognized from aerial photography) (NPS 1994). For this project, Trimble eCognition (http://www.ecognition.com/suite) automated image segmentation software was used to create "representative polygons" for field sampling within each ecoregion. Figure 3 shows the resulting "representative polygons" (outlined in yellow) for the same area in Bullfrog as shown in Figure 2.

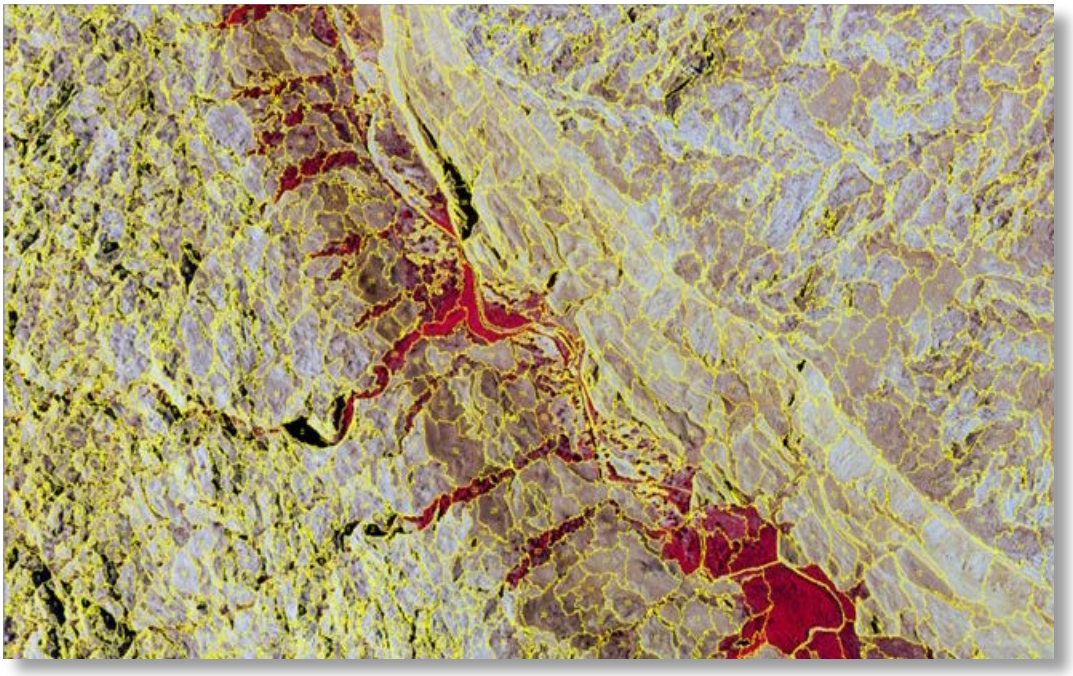


Figure 3. Segments or "Representative Polygons" (in yellow) Over Infrared Imagery for a Portion of the Bullfrog Ecoregion Along Halls Cree

Image Preparation

Four-band 1 meter NAIP imagery was used for all image processing. Each NAIP image is published in a USGS quarter quad area. All processing employed the uncompressed GeoTIFF formats of the NAIP imagery. NAIP imagery is flown every 3 years by state. The segmentation used 2009 1-meter spatial resolution NAIP imagery for the Utah portions of GLCN, and 2007 1-meter spatial resolution NAIP for the Arizona portions of GLCN.

A large park such as GLCN must be processed divided into image processing regions to make the high resolution NAIP imagery manageable. Thirteen image regions were identified with boundaries that roughly correspond to natural geographic divisions such as ridge tops or river centerlines. An image mosaic of the image processing regions was generated by mosaicing the appropriate GeoTIFFs into a single image and then clipping mosaiced image into its specific image region for segmentation processing.

Segmentation

Segmentation divides the landscape up into relatively homogeneous polygons based on the spectral characteristics of imagery. The goal of segmentation is to divide the landscape into segments that have less within than between spectral variation. Segmentation was conducted using the Trimble eCognition Developer software suite. Multi-resolution image segmentation in eCognition uses a "region growing" technique – it starts with samples of single pixel objects distributed across the imagery, and grows the objects into segments by merging like pixels together based on spectral variation and software parameters chosen by the user.

During eCognition segmentation, analysts created a database that characterized each segment in terms of its spectral characteristics, textural characteristics and shape characteristics. The attributes for this database are shown in Table 1. Three of these attributes were used as inputs to the clustering algorithm discussed in the next section. For the Glen Canyon area, the segments were run by processing region. After the processing region runs were complete, the segments were combined into one large park-wide segments layer.

Table 1. Attributes in Segments Database

Field Name	Field Description	Field Name	Field Description
ASYMMETRY	Asymmetry	MN_TX	Mean B4 Texture
BORDERINDX	Border Index	MN_B4	Mean NAIP Band 4
BORDERLGTH	Border Length	MN_B1	Mean NAIP Band 1
BRIGHTNESS	Brightness	RAD_LRG	Radius of the largest enclosing ellipse
COMPACT	Compactness	RAD_SM	Radius of the smallest enclosing ellipse
DENSITY	Density	RECTANGF	Rectangular Fit
ELLIPTICF	Elliptical Fit	ROUNDNESS	Roundness
LGTH_WDTH	Relationship of Length to Width	SHAPEINDEX	Shape Index
MAINDIR	Main Difference	STD_B1	STDEV B1 NAIP
MAXDIFF	Maximum Difference	STD_B2	STDEV B2 NAIP
MN_B2	Mean NAIP Band 2	STD_B3	STDEV B3 NAIP
MN_ B3	Mean NAIP Band 3	STD_B4	STDEV B4 NAIP

There are several user-configurable parameters that control the size and shape of the segments in eCcognition. For Glen Canyon, analysts ran segmentation on a pilot area to determine the optimal parameters and then used the optimal parameters to create segments for the entire park. The final parameters were as follows:

- Scale Factor: 100
- Shape: .3
- Compactness: .7
- Input Bands: Band 1 NAIP, Band 2 NAIP, Band 3 NAIP, Band 4 NAIP

The total number of segments created for all of the Glen Canyon National Recreation area was over 850,000 which included a small buffer outside of the administrative boundary.

Cluster Generation

A clustering algorithm was used to group the segments into similar spectral types within each ecoregion with the assumption being that spectral type is highly correlated with land-cover type. Determining the spectral variables upon which to cluster was a highly iterative process which required

trying different strategies in a pilot area – a portion of the Bullfrog ecoregion. Bullfrog was chosen because of its high variability of elevation, land form, and land-cover type.

Each segment contains detailed information about the spectral characteristics (RGB, NIR, NDVI), shape, and texture of the landcover (see Table 1 above). Any combination of these variables is a candidate for clustering common segments together. After several iterations in the pilot ecoregion, the variables that gave the best clustering results were:

- Mean value of band 2 (green)
- Mean value of band 4 (near infrared)
- Texture

Clustering was accomplished using IBM's SPSS Statistics Desktop v19 for Microsoft Windows XP (http://www-01.ibm.com/software/analytics/spss/). The module used within the software is called the "two-step cluster" which is specifically designed to cluster multiple continuous variables for very large datasets. While the module unfortunately produces few reports on the resulting clusters, it is the only software which allows for clustering datasets as large as each ecoregion's segment dataset.

Quality of the clustering was evaluated through manual inspection of the imagery and the clusters against the NRC soil map. A high correlation of cluster classes with the NRCS map vegetation types was considered an indication that the clusters were correlated with vegetation type.

The water level of Lake Powell was very low at the time of the 2009 imagery collect. Therefore, much of the areas identified as water in the NRCS soils map were actually occupied with vegetation. Because much of the spectral variation in the NAIP imagery occurs in water and riparian areas, it was decided to run clustering separately in areas within ecoregions which were designated by the NRCS soils map as water and sandy wash. One set of 35 clusters was generated for all sandy wash/water areas and another set of 35 clusters was generated for all other NRCS vegetation types. Clusters identified by image analysts as pure water were eliminated from the cluster sampling population.

Thirty-five clusters were requested for each ecoregion. The SPSS software generated a number between 1-35 such that all like cluster numbers shared similar characteristics of green, NIR, and texture values. This cluster number was written back to a cluster output table and then joined back into the master image segments database. Each ecoregion was joined to each of the 800,000 plus image segments and then an individual cluster input table was generated for each ecoregion.

Cluster class numbers for each ecoregion are presented in Table 2, below. The Non Sandy Wash/Water areas all have 35 cluster classes. The Sandy Wash areas have from 0 to 31 cluster classes depending on how much of these areas was occupied with water in the NAIP imagery. For example, of the 35 cluster classes in the Sandy Wash areas of Ecoregion 1, 9 cluster classes were water resulting in only 26 landcover classes. Ecoregions 3, 4 and 9 had no sandy wash areas and therefore no cluster classes for those areas.

Table 2. Cluster Class Numbers for Each Ecoregion.

Cluster Class	Ecoregions								
	1	2	3	4	5	6	7	8	9
Non Sandy Wash/Water NRC Vegetation	101-135	201-235	301-335	401-440	501-535	601-635	701-735	801-835	901-940
Sandy Wash/Water NRC Vegetation	145-175 (26 classes)	241-275 (18 classes)	n/a	n/a	541-575 (24 classes)	641-675 (31 classes)	741-775 (20 classes)	841-875 (26 classes)	n/a
Water (identified from the cluster classes)	90	90	n/a	n/a	90	90	90	90	n/a

Because the classes are based on spectral information alone, the process produces three types of classes:

- Those with a one-to-one relationship between vegetation type and class. This type is rare as it represents a vegetation class which is spectrally unique.
- Classes which have a one-to-many relationship between vegetation type and class. There definitely are cluster classes within ecoregions which represent the same type of vegetation. Thus, there probably will be more cluster classes than there are vegetation classes.
- Classes which have a many-to-one relationship between vegetation type and class. For example, one class might represent two desert shrub associations which the park wants to distinguish from one another. Such confusion will be an indicator that the two vegetation types may not be able to be mapped separately. However, because mapping incorporates many more variables predictive of vegetation type than spectral reflectance (e.g. slope, soil type, aspect, etc.), the mapping classes will be less confused than the sampling cluster classes.

Cost Access Map Layer

A cost access map layer represents the relative cost of accessing areas of the park for field work. A park such as Glen Canyon covers large distances and has significantly sloped areas which make portions of the park very difficult to access.

The following strategy was applied to the cost analysis:

1. Roads and the main lake and river water bodies are considered easily accessible and not assigned any 'cost' of access.
2. Relative cost is determined by the distance an area of the park is from the roads and water body layers.

3. Slope increases cost and the a 'slope multiplier' is calculated which increases the access cost for areas that are highly sloped.

4. A rule was implemented which determined that no access is permitted for any portion of the park where the slope exceeds 60%. Any portion of the park that cannot be accessed via a path that contains no slope greater than 30% was also be considered inaccessible.

An access layer was generated using the NHD water bodies which enable boat access within the park. A road layer was merged with the boat access layer which provides the basis of access cost. It was assumed that any area of the park just off a road or the river are ‘zero’ cost. That is, driving distance and boat ride distance are not cost inhibitors.

A slope layer was generated from the USGS 10m DEM database. A cost surface multiplier was assigned to each cell based on the slope. It is assumed that travel time decreases with increased slope. Slopes of over 60% are considered inaccessible and given a high value in the cost surface.

The cost distance spatial analysis tool within ArcMap calculates a cost value by cumulatively adding the access cost (as determined by the slope multiplier) of each cell within the raster from each access point. The output cell is given the value of the ‘least cost’ value to access the point. (A longer hike from a road may be preferred versus a very steep climb from a water body). These values are re-classed to relative access cost numbers that can be used as guidelines for selecting plots. The cost access map values are listed in Table 3. Figure 4 displays the final cost access map layer.

Table 3. Cost Access Values.

Re-classed Cost Value	Description
4	Easy Access (close to access point; < 1 hour hike)
3	Moderate (further from access point and/or some moderate slope; 1 – 2.5 hr hike
2	Long hike (2.5-5 hours)
1	Very long hike(remote parts of park requiring long hikes and likely going over slope; > 5 hrs)
0	Not preferred (areas that require crossing steep grades (>45%); not preferred, case by case
-1	Inaccessible (cannot be accessed without crossing a slope grade of over 60%)

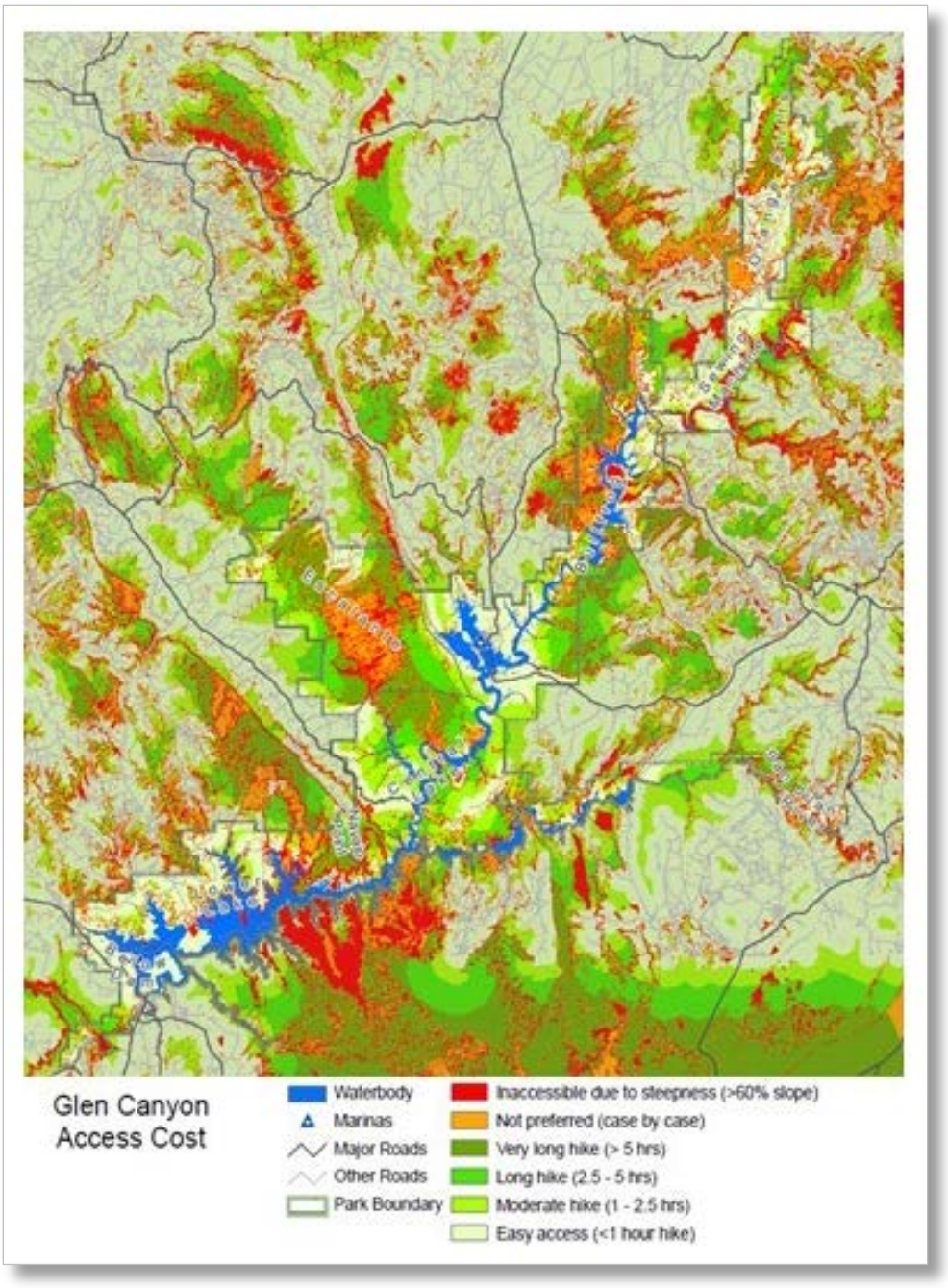


Figure 4. Cost Access Map Layer for GLCN and RABR.

Sample Selection

Glen Canyon sample sites were selected to ensure that all potentially unique vegetation types are represented in the sample segments. Several steps are performed to identify a sample selection site:

1. Each ecoregion was sampled individually.

2. Each work region unique cluster a number which represent potentially unique types of vegetation. Four samples of each of the cluster classes within each region were sampled. A representation of each cluster number was identified for sampling.

3. To minimize the cost to access each cluster, the access cost value was used as a guide to select a sample cluster. The easiest access samples are selected per cluster (plus, there are 1 or 2 samples selected from the 'moderate' access cost to enable more geographic diversity.

4. Among the cluster samples, individual sites are spaced out enough to avoid spatial autocorrelation and to ensure geographic dispersion.

Using the above 4 steps, the final section of samples was a combination of automatic and manual processes. An automated process identified potential sample sites using the above steps. The final selection of samples was then performed by an image analyst to ensure good geographic dispersion. The sample set is large enough that the final field samples can be a much smaller subset of the identified samples.

Review of the Sample Selection

It is anticipated that approximately 100 plan associations will be defined for GLCN and RABR (Spence 2011). This estimate does not include the hanging gardens and springs of the park – each of which may be its own association. At 5 samples per association, a minimum of 500 field samples will need to be captured. The final step in the sampling plan process will be review of the sample selection by local experts to ensure that the plan is viable and that all important vegetation types will be captured in the field sampling effort. To provide as much flexibility as possible, the sample set is large enough (1500 samples) that the final field samples can be a much smaller subset of the identified samples. However, there inevitably will be rare vegetation types which were not identified in the sampling layer but which need to be sampled. Only a local expert, with in-depth knowledge of GLCN vegetation can make the final decisions on what segments will be sampled in the field. Known rare or relic types need to be identified and included in the sampling, logistics need to be specified, and excess samples need to be eliminated.

Data Definitions for the Field Sampling Layer

Fields in the resulting sampling layer, named GLCA_Segments, are defined as follows:

SoilsVeg: the vegetation type as identified by the SSURGO soils feature class for the region. This value is determined by which vegetation class is covers the majority of the segment.

Proc_Rgn: The image processing region used to generate the segments. NAIP imagery from Utah (2010) and Arizona (2007) was mosaiced together and then clipped to smaller image region areas along natural geographic features.

Work_Rgn: A unique identifier representing a specific ecoregion within the park. The ecoregion is determined by a drawn representation of 9 unique ecoregions. This drawing was digitized into a feature class and each eco-region given a unique identifier number:

Eco_Name: The name which corresponds to the above described Work_Rgn. The following regions are identified in the park:

1: Glen Canyon (below dam)

2: Lower Lake

3: Navajo Point

4: Escalante

5: Central Lake

6: San Juan River

7: Bullfrog

8: Sewing Machine

9: Orange Cliffs

Access_Cost: this is a reclassified number of the relative cost to access any given area in the park. The exact methods are described in the methods documentation. The value is based on ease of access based on segment location for water based access, road based access, and steepness of terrain to reach plot from nearest water or road access point. The key to the value is:

-1: inaccessible due to steepness (>60 percent slope must be crossed to reach segment)

0: not preferred as access requires crossing >45% slope

1: very long hike required (probably >5 hours)

2: long hike (2.5 - 5 hours)

3: moderate access (1 - 2.5 hour hike)

4: easy access (< 1 hour hike)

Plot_Flag: an indicator whether the segment has been selected as a sample plot.

0: segment is NOT selected as a sample

1: segment is selected as a sample plot

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