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Natural Resource Stewardship and Science

Vegetation Classification and Mapping Project Report, Canyonlands National Park

Natural Resource Technical Report NPS/NCPN/NRTR—2012/577



ON THE COVER
Upper Salt Creek Canyon
Photograph by: Amy Tendick

Vegetation Classification and Mapping Project Report, Canyonlands National Park

Natural Resource Technical Report NPS/NCPN/NRTR—2012/577

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Acronyms and Abbreviations

AA	Accuracy Assessment
APFO	Aerial Photography Field Office (USDA)
ARCH	Arches National Park
BLM	United States Bureau of Land Management
BOR	United States Bureau of Reclamation
BPU	Biophysical Unit
CANY	Canyonlands National Park
CEGL	Community Element Code
CNHP	Colorado Natural Heritage Program
DBH	Diameter at Breast Height (4.5 feet)
DEM	Digital Elevation Model
DOQQ	Digital Orthophotograph Quarter Quadrangle
DRC	Diameter at Root Crown
e^2M	engineering-environmental Management, Inc.
ES	Ecological System
ESRI	Environmental Systems Research Institute
FGDC	Federal Geographic Data Committee
GIS	Geographic Information System
GLCA	Glen Canyon National Recreation Area
GPS	Global Positioning System
I&M	Inventory and Monitoring Program
ISA	Indicator Species Analysis
ISKY	Island in the Sky District of Canyonlands National Park
ITIS	Integrated Taxonomic Information System
MMU	Minimum Mapping Unit
NABR	Natural Bridges National Monument
NAD	North American Datum
NCPN	Northern Colorado Plateau Network
NEED	Needles District of Canyonlands National Park
NM	National Monument
NPS	National Park Service
NRCS	Natural Resource Conservation Service
NVC	National Vegetation Classification
NVCS	National Vegetation Classification Standard
PI	Photointerpreter
QA/QC	Quality Assurance/Quality Control
RSGIG	Remote Sensing and Geographic Information Group (BOR)
SITLA	School and Institutional Trust Lands Administration
SEUG	Southeast Utah Group of the National Park Service
TNC	The Nature Conservancy
TSN	Taxonomic Serial Number
UNESCO	United Nations Education, Science, and Cultural Organization
USDA	United States Department of Agriculture

USDI	United States Department of the Interior
USFS	United States Forest Service
USGS	United States Geological Survey
UTM	Universal Transverse Mercator

Summary

The Northern Colorado Plateau Inventory and Monitoring Network (NCPN) worked with the support of the U.S. Geological Survey - National Park Service (USGS-NPS) Vegetation Mapping Program to describe and map vegetation at Canyonlands National Park (CANY). This collaborative effort involved many project partners, particularly the Rocky Mountain Mapping Center of the USGS, the Western Region office of NatureServe, engineering-environmental Management, Inc. (e^2M), and their cooperators.

The mapping area is approximately 170,618 hectares (421,605 acres), encompassing the entire park as well as an environs of adjacent public and private lands. Ecologists and photointerpreters identified plant associations for CANY and determined how best to map them using 1:12,000-scale, true color aerial photography and digital orthophotography. The team collected vegetation and environmental data from 914 vegetation classification plots and 373 observation points between 2003 and 2004 to prepare the initial classification and vegetation map. Assessment of map accuracy entailed sampling an additional 2,043 data plots from spring of 2007 to late winter of 2009.

Analysis of the classification plot and accuracy assessment plot data revealed 164 National Vegetation Classification Standard (NVC) plant associations, alliances, or park special vegetation types within the park and environs. Twenty-six associations were documented exclusively from accuracy assessment data, the remainder from vegetation plots and observation points.

Vegetation and land use were interpreted to as detailed a level possible from high-resolution, 9” x 9” stereo pairs of 1:12,000-scale true color aerial photography. Polygons representing vegetation or land use map classes were delineated directly on-screen through heads-up digitizing using ArcGIS editing tools and transferred to a spatial database. The project used the program standard minimum mapping unit of 0.5 ha with few exceptions.

Fifty-four map classes represented by 31,497 polygons were developed for CANY. A total of 30,329 polygons represent 41 natural or semi-natural vegetation map classes covering 94.8% of the mapping project area. One map class was documented as point locations only. Twelve additional land use/land cover and geologic map classes describe 1,168 polygons (3.7% of polygons and 5.2% of the area). Average polygon size across all map classes is 9.9 ha (24.4 acres). Lands within CANY make up 135,204 ha (334,096 acres) or 79.2% of the total project area. Blackbrush Shrubland had the highest number of polygons (3600) polygons covering 9.4% of the mapping area. The Potholed and Jointed Sandstone Woodland Complex is the most common map class, delineated on 30,495 ha (75,354 acres) or 17.9% of the project area.

Map accuracy was assessed within the CANY boundary only. Primary analyses of the field data were presented and evaluated at an accuracy assessment (AA) meeting held from August 18-19, 2010. Results from a thematic AA of 41 vegetation map classes remaining following AA analysis indicated an estimate of 86.3% overall map accuracy (Kappa statistic = 85.8%). Fourteen vegetation map classes did not meet the 80% standard for either producer’s or user’s accuracy, but were retained because of their relative rarity and/or value to park managers. These

map classes are described in the Accuracy Assessment section of this report, as is the justification for retention.

Products resulting from the CANY vegetation mapping project include:

Available in this report:

- 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 and observation point data collection

Available elsewhere[1]:

- geodatabase containing map polygon attribute, land use, aerial photography flight lines, plot and point data, and CANY and project boundaries
- ground photography of vegetation classification plots, observation points, and AA points in hard copy and 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

Geospatial products are in Universal Transverse Mercator (UTM) projection, Zone 12, using the North American Datum of 1983.

[1] This document and most of the digital products are available on the internet at: http://biology.usgs.gov/npsveg/. Hard copies of the orthophotos, stereo photos, and original data forms are retained by NCPN and CANY.

Acknowledgments

This project was completed through the effort 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. Angela Evenden (NPS), Mike Story (NPS), Tammy Cook (NPS), Karl Brown (USGS/NPS), and Mike Mulligan (USGS) provided project oversight and coordination. Funding for this project was provided through the USGS-NPS National Vegetation Mapping Program, and the Northern Colorado Plateau Inventory and Monitoring Network.

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, Amy Tendick, and Sarah Topp, and e²M contract field crew members Janet Coles, Peter Williams, Julie Thompson, Travis Belote, Arne Buechling, Jim Von Loh, Joe Schroeder, Brent Eastty, Dusty Janeke, Karin Edwards, Ken McCarron, Matt Smith, and Stephanie Shoemaker.

Karin Decker (CNHP), Janet Coles (NPS), and Travis Belote (e²M) prepared the preliminary vegetation classification and accompanying report. Marion Reid (NatureServe) created the local association description template and Jim Von Loh and Travis Belote (e²M) wrote the draft local association descriptions. Mark Hall (NatureServe) wrote the final local and global association descriptions and assigned final association names.

Gerald Manis (e²M) developed the initial map class concepts. Gerald Manis, Liz Ballenger, David Svendson (NPS), and Janet Coles all participated in photo interpretation and polygon map class attribution. Amy Tendick completed the photo interpretation and developed the final map class concepts and attributes. Gery Wakefield and Aneth Wight (NPS) worked closely with Amy Tendick to produce the final vegetation map coverage.

Database management support and development were skillfully performed by Margaret Beer, Russ DenBleyker, and Helen Thomas (NPS). Their preparation of a project MS Access database for classification plot, observation point, and accuracy assessment data simplified entry and analysis.

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Introduction

Vegetation Classification and Mapping Project, Canyonlands National Park

The Canyonlands National Park (CANY) Vegetation Mapping Project was organized and coordinated by the Northern Colorado Plateau Network (NCPN) Inventory and Monitoring (I&M) Program between 2002 and 2011, with assistance from several project cooperators. The purpose of this project was to describe and map existing plant associations on 170,618 hectares (421,605 acres) within CANY and its environs, and to provide this information in written, tabular, digital, and spatial formats useful to park resource managers, the NCPN I&M Program, and others. The basic project components consist of a classification and description of CANY vegetation and a spatial database of the vegetation and land use interpreted from aerial imagery.

In 2001, the NCPN I&M Program launched a multi-year project to complete vegetation classifications and maps for network park units. Funding was provided by the U.S. Geological Survey (USGS) – National Park Service (NPS) Vegetation Mapping Program and the Northern Colorado Plateau Network. The CANY Vegetation Classification and Mapping Project was initiated by the NCPN, CANY natural resources staff, NatureServe, and private contractors. Project work was coordinated with the USGS-NPS Vegetation Mapping Program. Vegetation classification plot and observation point data collection occurred between 2003 and 2004. Map accuracy assessment was completed in 2009.

Project methods, results, and products are documented in this report. This introductory section describes the NPS I&M Program and the USGS-NPS Vegetation Mapping Program, as well as the CANY mapping project area. Later sections document the methods and results for each of the major steps in the project: scoping, vegetation classification and description, vegetation mapping, and map accuracy assessment.

The USGS-NPS Vegetation Mapping Program

The National Vegetation Mapping Program is a cooperative project between the USGS and the NPS to inventory, classify, describe, and map vegetation in more than 270 national park units within the United States. Consistent vegetation classification, mapping, and accuracy assessment protocols and standards are applied across projects supported by this program. The National Vegetation Mapping Program is administered by the USGS Center for Biological Informatics in cooperation with the NPS I&M Program. Through implementation of the NPS Natural Resource Challenge (NPS 1999), significant funding became available for completing important natural resource baseline inventories in park units, including vegetation classification and mapping. This support provided the NPS with the opportunity to move forward with dozens of new park unit vegetation classification and mapping projects, including CANY. Vegetation classification and mapping products produced by this program are incorporated into the USGS National Biological Information Infrastructure Program, which serves as an information-sharing network (http://biology.usgs.gov/npsveg/).

Northern Colorado Plateau Network Inventory and Monitoring Program

The NPS developed an inventory and long-term monitoring program for park natural resources over the last two decades of the twentieth century. This effort was enhanced by the NPS Natural Resource Challenge (NPS 1999); as a part of this initiative, the NCPN was formed in 2000 to

develop an integrated inventory and monitoring program for 16 park units in Utah, Colorado, Arizona, and Wyoming.

A goal of the NPS I&M Program is 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. Early in the development of its I&M program, the NCPN made completing vegetation maps for each network park unit a priority. In addition to assisting park management, vegetation maps and classification information were seen as contributing significantly to NCPN long-term monitoring efforts. In 2001, the NCPN began implementation of a strategy to complete vegetation mapping in all network park units. The CANY vegetation mapping project is the sixteenth of the network-coordinated projects to be completed.

Vegetation Mapping Program Standards

The NPS I&M Program established guidance and standards for all vegetation mapping projects in a series of documents:

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)

Standards

- National Vegetation Classification Standard (FGDC 1997)
- 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 map attribute accuracy and minimum mapping unit

These documents are available on the USGS-NPS Vegetation Program Web site (http://biology.usgs.gov/npsveg/standards.html).

National Vegetation Classification Standard

The National Vegetation Classification (NVC) is the system used in NCPN vegetation mapping projects (TNC and ESRI 1994a), and is based on the National Vegetation Classification Standard (NVCS) adopted by the Federal Geographic Data Committee (FGDC 1997). The NVCS evolved from work conducted primarily by The Nature Conservancy (TNC), NatureServe, and the Natural Heritage Program network over more than two decades (Grossman et al. 1998). 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. The substantial revisions to the upper levels of the NVCS hierarchy adopted by the Vegetation Subcommittee as Version 2 (FGDC 2008) are not used in this project.

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 seven levels of terrestrial vegetation classification. The five upper levels (class, subclass, group, subgroup, and formation) are based on physiognomic features. The two lower levels (alliance and association) are distinguished by differences in floristic composition. The physiognomic units have a broad geographic perspective and the floristic units have utility in local and site-specific applications (Grossman et al. 1998). The physiognomic levels of the NVCS are based on physical, structural, and environmental characteristics identifiable from satellite imagery, aerial photography, or ground observations (Table 1). Specific criteria defining these physiognomic units are based on ecologic characteristics that vary among major vegetation groups (FGDC 1997).

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. National Vegetation Classification System hierarchy for terrestrial vegetation (FGDC 1997).

Level	Criteria Delineating Level	Example
Class	Structure (height, cover) of dominant vegetation strata	Woodland
Subclass	Growth form characters including leaf type (evergreen, deciduous) for woody plants and persistence (perennial, annual) for herbaceous species	Evergreen woodland
Group	Leaf morphology (broad leaf, microphyllous, xeromorphic), leaf phenology, and climatic conditions	Temperate or subpolar needle-leaved evergreen woodland
Subgroup	Relative degree of human disturbance	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland

Table 1. National Vegetation Classification System hierarchy for terrestrial vegetation (FGDC 1997).

Level	Criteria Delineating Level	Example
Formation	Additional physiognomic characteristics, general environmental conditions, relative landscape position, and hydrologic regimes	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland
Alliance	Dominant or diagnostic species of uppermost or dominant stratum	*Pinus edulis* – (*Juniperus* spp.) Woodland Alliance
Association	Other dominant or diagnostic species from any stratum	*Pinus edulis* – *Juniperus* spp. / *Quercus gambelii* Woodland

Other Standards

In addition to vegetation classification, the FGDC sets standards for map spatial accuracy and for metadata employed in NPS vegetation mapping projects. Standards for map products stipulate map scales of 1:24,000 or finer, and minimum polygon size of 0.5 ha (1.24 acres). Positional accuracy for vegetation maps must meet National Map Accuracy Standards, which specify horizontal errors of less than 10.2 m (33.5 ft.) on the ground for 1:12,000-scale maps.

All digital vegetation products resulting from this project are accompanied by FGDC-compliant metadata. Metadata are "data about the data," and describe the content, quality, condition, and other characteristics of the spatial dataset. Metadata are critical elements that expedite the interpretation and exchange of information among users.

Project Area Description

Location and Setting

The original Canyonlands National Park was created on September 12, 1964 by proclamation of President Lyndon B. Johnson, in order to "… preserve an area in the State of Utah possessing superlative scenic, scientific, and archeological features for the inspiration, benefit, and use of the public" who could experience the "grandeur of a vast, colorful, unspoiled canyon country, the elemental processes that formed it and the excitement of the unexplored" (Public Law 88-590). The original boundary included approximately 104,389 ha (257,952 acres); the park was expanded by 32,220 ha (79,618 acres) on November 12, 1971(Schmieding 2008), giving CANY its present area of 136,610 ha (337,570 acres). The 1971 expansion included the Maze canyon system, Ernie's Country, northern sections of the Island in the Sky plateau, Upper Salt Creek, Lavender and Davis Canyons, and Horseshoe Canyon (Schmieding 2008). Centered around the confluence of the Colorado and Green Rivers, CANY is divided into three geographical districts: the Island in the Sky District (ISKY) is the triangle of land between the two major rivers, the Needles District (NEED) lies east of the Colorado River and the Maze District (which also manages the Detached Unit of Horseshoe Canyon) lies west of the Colorado and Green rivers. Additionally, there is a River District which manages reaches of the Colorado and Green rivers within CANY (Evenden et al. 2002).

CANY is located in southeastern Utah, with portions lying in Grand, Garfield, San Juan and Wayne counties (Figure 1). The nearest municipality is Moab, Utah, located approximately 26.5 km (16.5 miles) northeast of the CANY boundary. The ISKY visitor center, however, is 83.7 km (52 miles) from Moab by road. Parts of CANY are readily accessible by major travel routes including Interstate 70 and Utah Highway 191. ISKY is accessible via UT 313 and the Needles District via UT 211. The Maze District is the least accessible and is reached via UT 24, then by a two-wheel drive unpaved road; most portions are only accessible by four-wheel-drive using two-track roads. Based on 2010 census data, the area is generally sparsely populated (U.S. Census Bureau 2012). Moab (population 5,046) is the county seat of Grand County. The Garfield County seat of Panguitch had a population of 1,502. Monticello (population 1,972) is the San Juan County seat, and Loa (population 514) is the Wayne County seat. These counties have very low population densities, with Grand County the densest at 2.6 people per square mile, and Garfield County the sparsest with a population density of 0.9 people per square mile. Lands adjacent to CANY are administered by the NPS (Glen Canyon National Recreation Area), Bureau of Land Management, Manti LaSal National Forest, State of Utah, and some areas are in private ownership.

The CANY project mapping area (Figure 2). includes the entire 135,204 ha (334,096 acres) of the park as well as 35,414 hectares (87,509 acres) of adjacent public and private lands in the environs for a total project area of 170,618 hectares (421,605 acres).

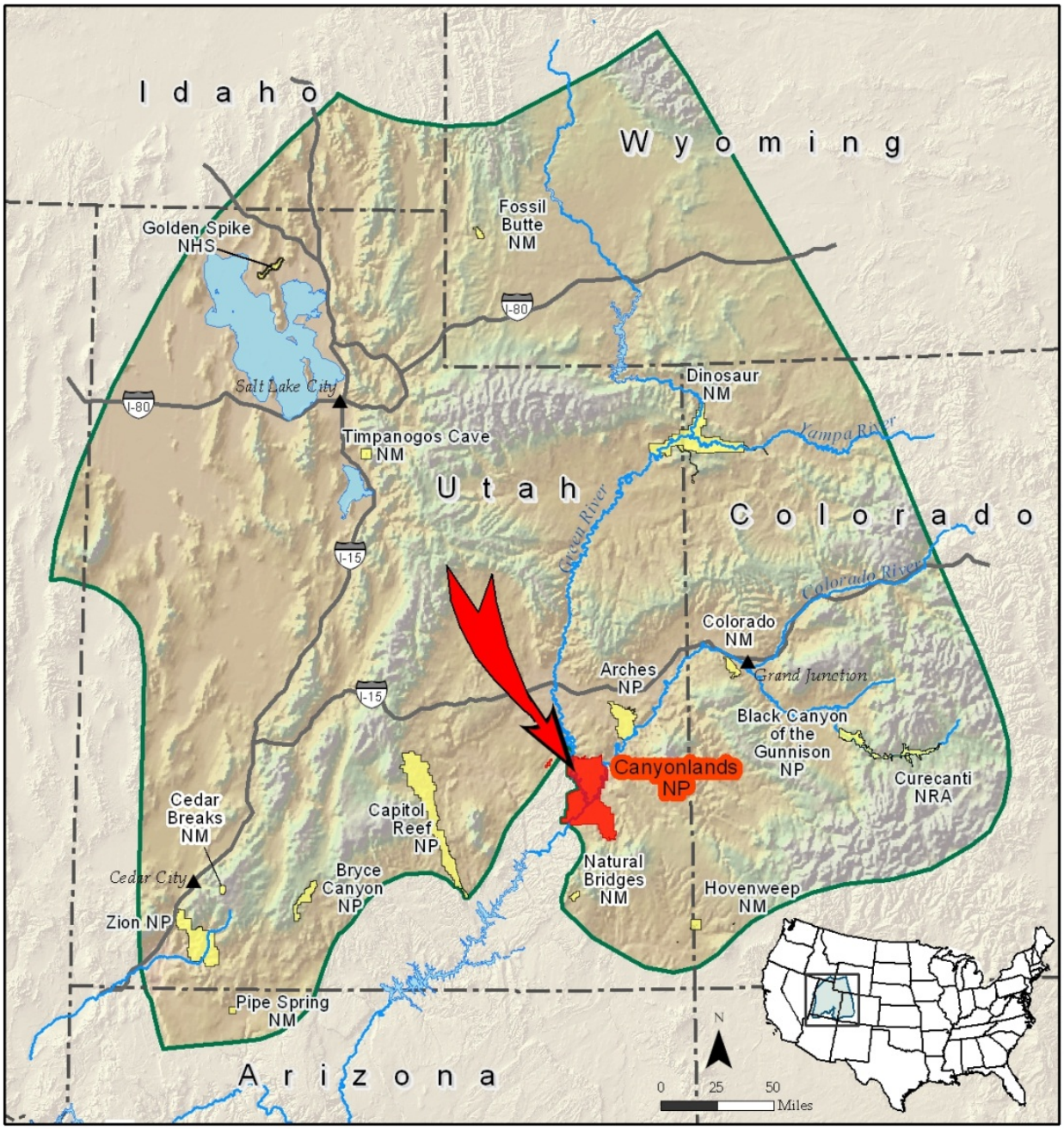


Figure 1. Location of CANY on the Colorado Plateau.

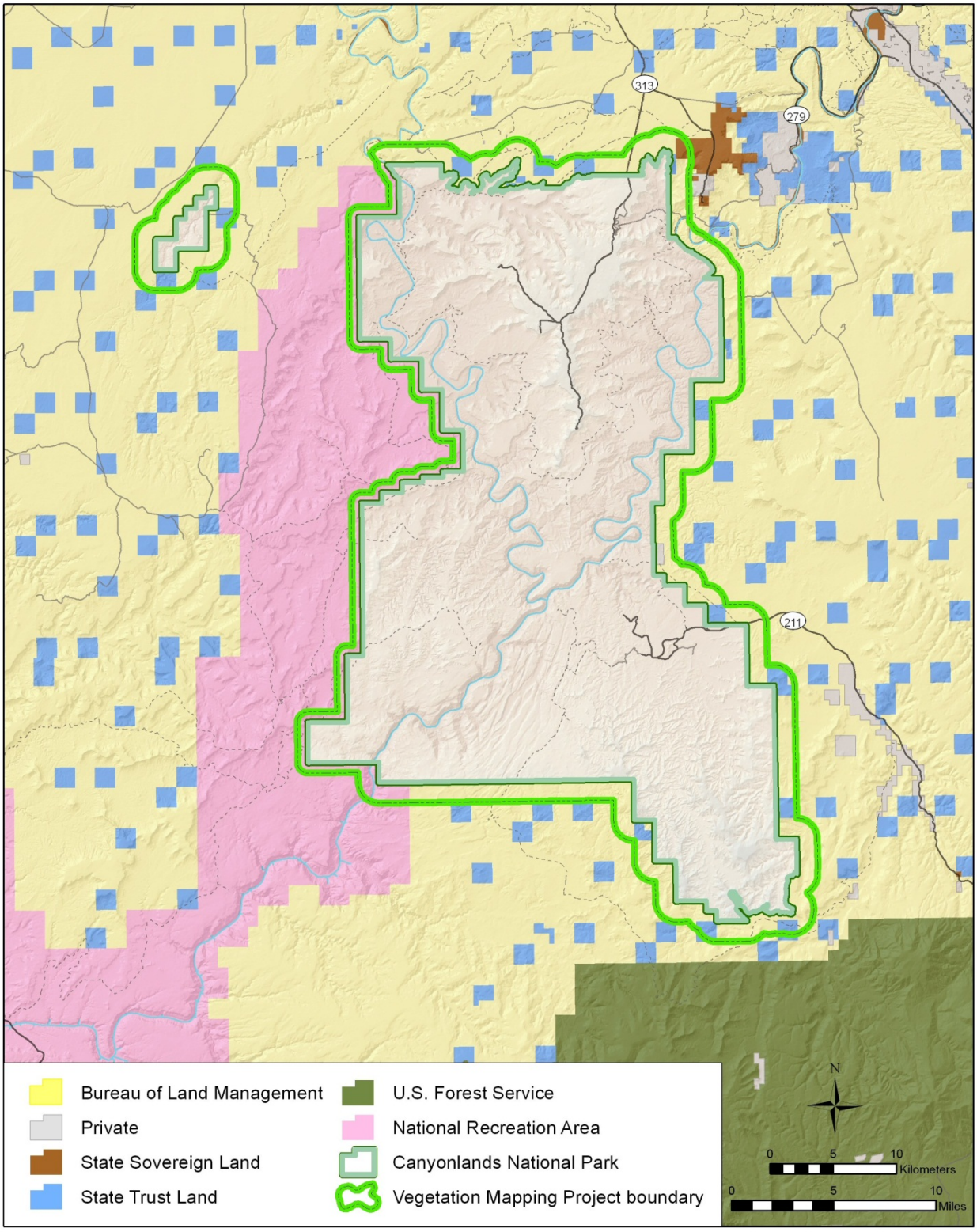


Figure 2. Map of the CANY vegetation mapping project area boundary showing adjacent land ownership.

Topography and Geologic History

Stokes (1986) described the CANY region as the "rugged and remote heart of the Canyon Lands section of the Colorado Plateau physiographic province in southeast Utah". The park is characterized by sedimentary rock, which has been slightly deformed by anticlines, synclines and monoclines. Regional uplift of the Colorado Plateau and concurrent water erosion produced extensive, deep canyon systems which are the defining features of CANY and of the physiognomic sections (Lammers 1991). The Green River flows into the northwest corner of CANY, and the Colorado River flows into the northeast corner; their confluence is in south-central CANY, and the Colorado River exits the park in the southwest corner (USDA-NRCS 2010). Precipitation within CANY drains into one of these two large rivers. CANY is characterized by a highly eroded landscape where rocks have been sculpted into a labyrinth of canyons (Campbell 1987). Elevations within CANY range from 1,140 m (3,740 ft) where the Colorado River exits at the southwestern boundary to 2,180 m (7,152 ft) at the escarpment of Salt Creek Mesa along the southern boundary of the Needles District.

The dramatic scenery of CANY is the result of geologic history and stratigraphy. CANY lies within the Paradox Basin, a shallow ocean basin formed approximately 300 million years ago with a thick accumulation of salt deposits formed by evaporation of seawater. These deep underlying deposits of salt are responsible in part for the current surface topographic and geologic features (Baars 2000). Sandstone and shale exposed within CANY were deposited over the thick layers of salt and represent a variety of ancient environments including beach and shallow marine, tidal flat, coastal dune, barrier islands, sand dune desert, river, lake, floodplain, and lagoon (Baars 2000). Because salt is less dense than most rocks it has a tendency to flow under pressure, flowing laterally along bedding planes and vertically along faults. As it flows, the salt mass displaces and deforms adjacent rocks (Coles et al. 2009). At CANY, evidence of salt tectonics is visible in the prominent jointing in the Needles District. The Grabens are actually a complex system of horsts and grabens, and are partly the result of younger rocks slumping into the gap left behind by an eastward migrating Pennsylvanian salt layer and partly the result of groundwater dissolving that salt layer.

Rocks exposed in CANY are sedimentary, ranging in age from Middle Pennsylvanian (about 320 million years ago) through Jurassic time (about 150 million years ago). From the top of the ISKY mesa in the north to the bottom of Cataract Canyon on the southern boundary, the geologic history can be traced through time. The youngest exposures occur in the Navajo Formation domes atop the ISKY mesa (with the exception of the disjunct Horseshoe Canyon unit which includes thin exposures of the more recent Carmel and Entrada formations). Below the Navajo Formation, Kayenta Formation-capped Wingate Sandstone cliffs with Chinle Shale scarps sit atop rolling benches of the Moenkopi Formation and the deeper White Rim Sandstone mesa. Bordered by the Green River on the west and the Colorado River on the east, the White Rim Sandstone caps a highly-dissected, stair-step wonderland of Organ Rock Shale and undifferentiated Cutler Formation. The Needles District is characterized by fantastically eroded buttes, spires, pinnacles, and pedestals of Cedar Mesa Sandstone (Evenden et al. 2002), and canyons deeply carved in Cedar Mesa Sandstone by Salt Creek and its tributaries, Lavender and Davis canyons, and Big Spring and Elephant canyons. In the Maze District, the deep, intricately carved canyons of Cedar Mesa Sandstone in the South Fork of Horse Canyon and its many tributaries, Jasper, Shot, and Water canyons are the prominent features, as are the mesa tops in

Land of Standing Rocks where spires and buttes of Organ Rock Shale define the landscape. The River District of the Colorado and Green river corridors exposes the oldest formations in CANY (Elephant Canyon, Halgaito Shale, Honaker Trail, and Paradox formations) as near-vertical cliff bands and very steep talus slopes descending to the river banks.

Climate

The climate of CANY is semi-arid, characterized by hot, dry summers and cool to cold winters; temperature varies with altitude and latitude (Brough, Jones and Steven 1987). Potential evapotranspiration exceeds precipitation, making effective soil moisture a critical environmental factor (Evenden et al. 2002). Continuous records of climatic conditions (WRCC 2009) have been maintained since 1965 near the ISKY Visitor Center (Canyonlands – The Neck site), and in NEED (Canyonlands - The Needle station).

Precipitation is distributed roughly evenly between the active growing season and the dormant period. Snow falls between November and March and precipitation in the winter months is usually deposited by frontal storms moving from the west (Evenden et al. 2002, USDA-NRCS 2010). Precipitation is lowest during the winter (December to February) and in the early summer (June), before monsoonal rainfall events occur. Precipitation is highest during the midsummer and early fall months (July through October), with peaks in October. (Figures 3 and 4). Most summer precipitation is produced by convective thunderstorms, as moist air from the Gulf of Mexico is drawn in from the south or southeast (USDA-NRCS 2010). Thunderstorms occur on about 35 days each year, and most occur in July and August. NEED headquarters (elevation 1,523 m [4,998 ft]) have recorded an annual average precipitation of 20.6 cm (8.1 inches). At the slightly higher ISKY headquarters (elevation 1,807 m [5,930 ft]) annual average precipitation is 22 cm (8.67 inches).

Temperature and snowfall exhibit a similar pattern of elevational variation. Generally the warmest month is July and the coldest month is January. Average July maximum temperatures reach 35.4º C (95.8º F) and average minimum January temperatures drop to -11.4º C (11.5º F), as recorded at the NEED station. Average annual snowfall at NEED is 33.9 cm (13.34 inches), although the average snow depth rarely exceeds 6.1 cm (2.4 inches) during any winter month. In contrast, the ISKY district, which is both higher in elevation and further north in latitude, has lower high and higher low temperatures, and significantly higher snowfall (recorded over the same time period). Average July maximum temperatures reach 33.2º C (91.8º F) and average minimum January temperatures drop to -8.3º C (17º F), as recorded at the ISKY station. Average annual snowfall at ISKY is 53.5 cm (21.08 inches), although the average snow depth rarely exceeds 10.2 cm (4 inches) in any winter month.

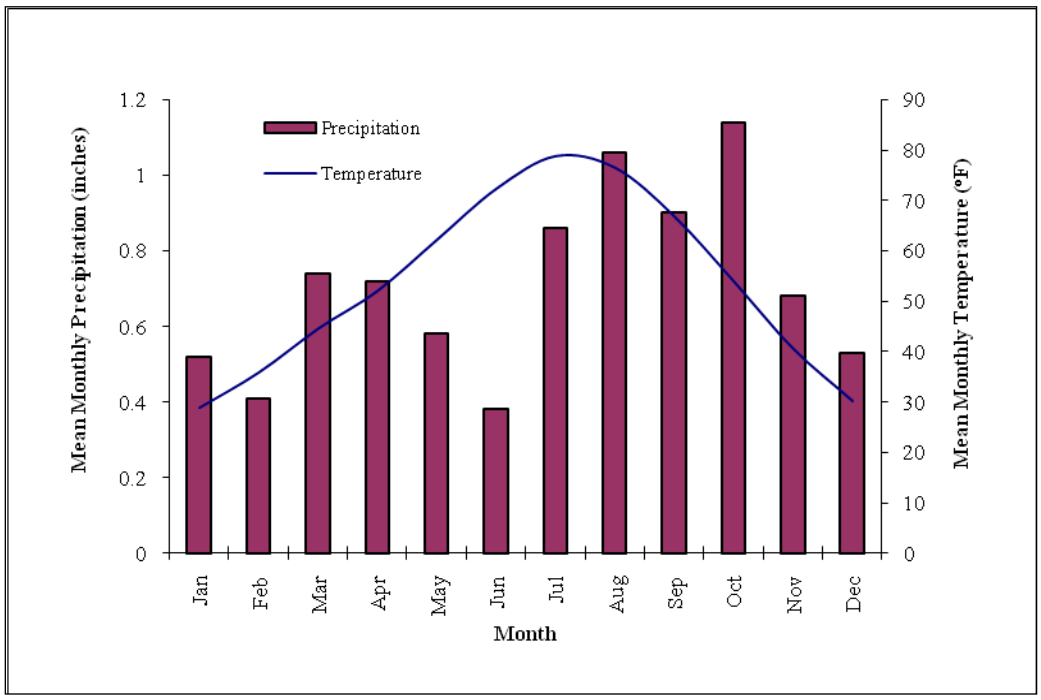


Figure 3. Average precipitation and temperature in NEED.

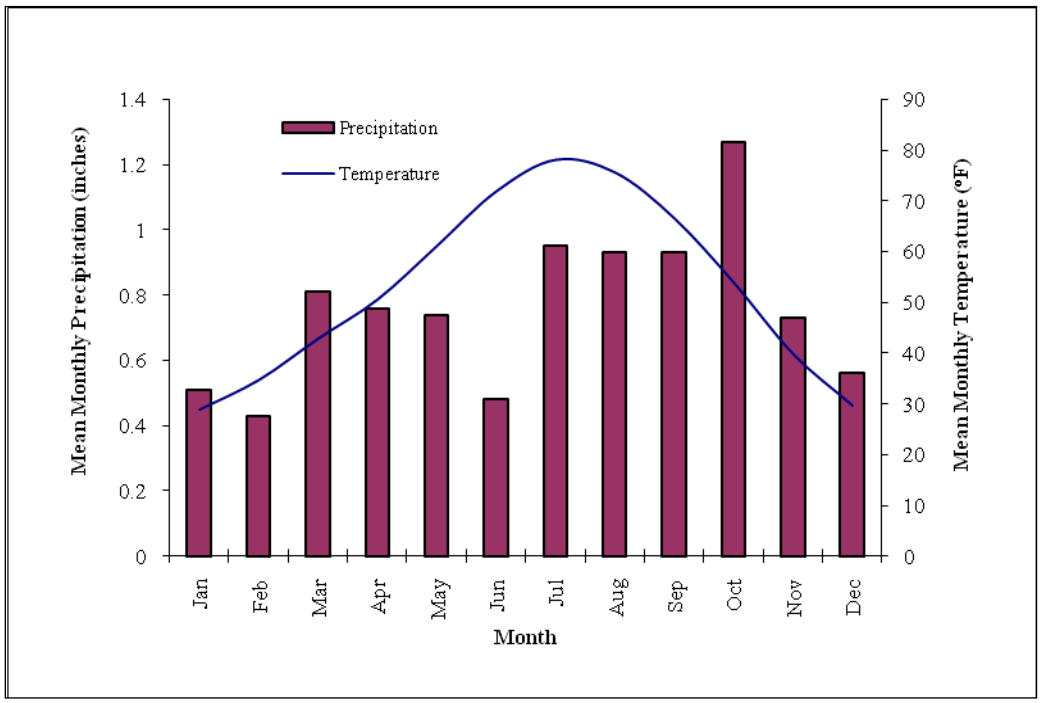


Figure 4. Average precipitation and temperature in ISKY.

Vegetation

While geology is a defining element in the distribution of vegetation in the Colorado Plateau, other factors including elevation, aspect, distance to ground water, soil depth, and soil water-holding capacity tend to drive vegetation distribution patterns. Geology can have an influence on how the factors are combined, but in CANY the prevalence of blackbrush and pinyon-juniper communities across a variety of geologic types demonstrates that the underlying geology is not a reliable predictor of vegetation distribution. 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.

Fertig et al. (2009) include a summary description of vegetation in relationship to soils and geology in CANY, summarized as follows:

1. Exposed sandstone bedrock and cliff rims and other areas with limited soil development typically support short-stature woodlands of two-needle pinyon (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*), with a shrub understory of littleleaf mountain mahogany (*Cercocarpus intricatus*), Utah serviceberry (*Amelanchier utahensis*), cliffrose (*Purshia mexicana* var. *stansburiana*), and/or Bigelow's sagebrush (*Artemisia bigelovii*). Where soils are better developed (up to 30 cm deep) on top of a hardpan or bedrock layer that traps soil moisture, mesa tops and alluvial benches are frequently dominated by blackbrush (*Coleogyne ramosissima*) shrubland communities. Associated species in blackbrush stands include galleta grass (*Pleuraphis jamesii*), shadscale (*Atriplex confertifolia*), and Torrey's ephedra (*Ephedra torreyana*).

2. Open park-like areas with deeper soils (e.g., aeolian deposits over 50 cm thick above bedrock) typically support grass species adapted to use water passing quickly through sandy soil. These grasslands are typically dominated by needle-and-thread (*Hesperostipa comata*), Indian ricegrass (*Achnatherum hymenoides*), blue grama (*Bouteloua gracilis*), galleta grass, winterfat (*Krascheninnikovia lanata*), and green ephedra (*Ephedra viridis*). Grasslands in much of the Needles region were grazed more intensively than those in remote dry portions of the Maze and ISKY areas and, consequently, have less biological soil crust and lower vascular-plant species richness (Kleiner and Harper 1972).

3. Basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) communities are fairly infrequent within CANY, occurring on alluvial benches and toeslopes with moderately deep soils and a high water table (Loope 1977). Stands are found primarily along benches of the Green and Colorado rivers, and in alluvial bottomlands in Salt Creek and Lavender and Davis canyons. Typically associated species include fourwing saltbush (*Atriplex canescens*), greasewood (*Sarcobatus vermiculatus*), rubber rabbitbrush (*Chrysothamnus nauseosus*), and Gambel oak (*Quercus gambelii*). Low benches with clayey soils are more typically vegetated with low growing salt-shrub stands dominated by Gardner's saltbush (*Atriplex gardneri*) and shadscale with budsage (*Artemisia spinescens*), Torrey's ephedra, desert trumpet (*Eriogonum inflatum*), and Hopi blanketflower (*Gaillardia pinnatifida*). The benches are often associated with outcrops of the Chinle, Moenkopi, or Cutler formations (Loope 1977).

4. Riparian shrub communities occur along perennial stretches of rivers and drainages. Coyote willow (*Salix exigua* var. *stenophylla*) and tamarisk (*Tamarix chinensis*) form a border of dense vegetation along much of the Colorado and Green rivers. Stands are interspersed with wetlands supporting cattails (*Typha domingensis* or *T. latifolia*) or common reed (*Phragmites australis*). Mesic terraces above the active river channel support scattered Fremont cottonwood (*Populus fremontii*), desert olive (*Forestiera pubescens*), and Goodding's willow (*Salix gooddingii*). Hanging gardens occur infrequently in shady and permanently wet sandstone seeps, and support water birch (*Betula occidentalis*), golden sedge (*Carex aurea*), alcove columbine (*Aquilegia micrantha*), cave primrose (*Primula specuicola*), alcove death-camas (*Zigadenus vaginatus*), Eastwood's monkey-flower (*Mimulus eastwoodiae*), and southern maidenhair fern (*Adiantum capillus-veneris*).

5. One of the most infrequent vegetation types documented within CANY are small stands of Douglas-fir (*Pseudotsuga menziesii*) and Rocky Mountain maple (*Acer glabrum*) on cool, shaded, north-facing canyon slopes or alcoves (Welsh 1970).

Geology and Vegetation

CANY includes some of the most spectacular exposed geology in the western United States. From atop the cliffs of Wingate Sandstone in ISKY visitors can view millions of years of geologic history exposed in rock formations for many miles in the distance (Figure 5).

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. Sandstones with silica cement (e.g. Wingate) are massive cliff formers and hanging gardens tend to occur where the sandstone has fractured or there is contact between porous sandstone and a water-repellent layer below (shale or claystone) which promotes seepage. Springs emerge where a similar water source is buried under soil. Shale restricts water penetration and tends to capture any water that does penetrate, making it difficult for plant roots to use. Thus shale supports 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 hot/dry surface. Thus sandstone often supports deep-rooted woodlands. 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.

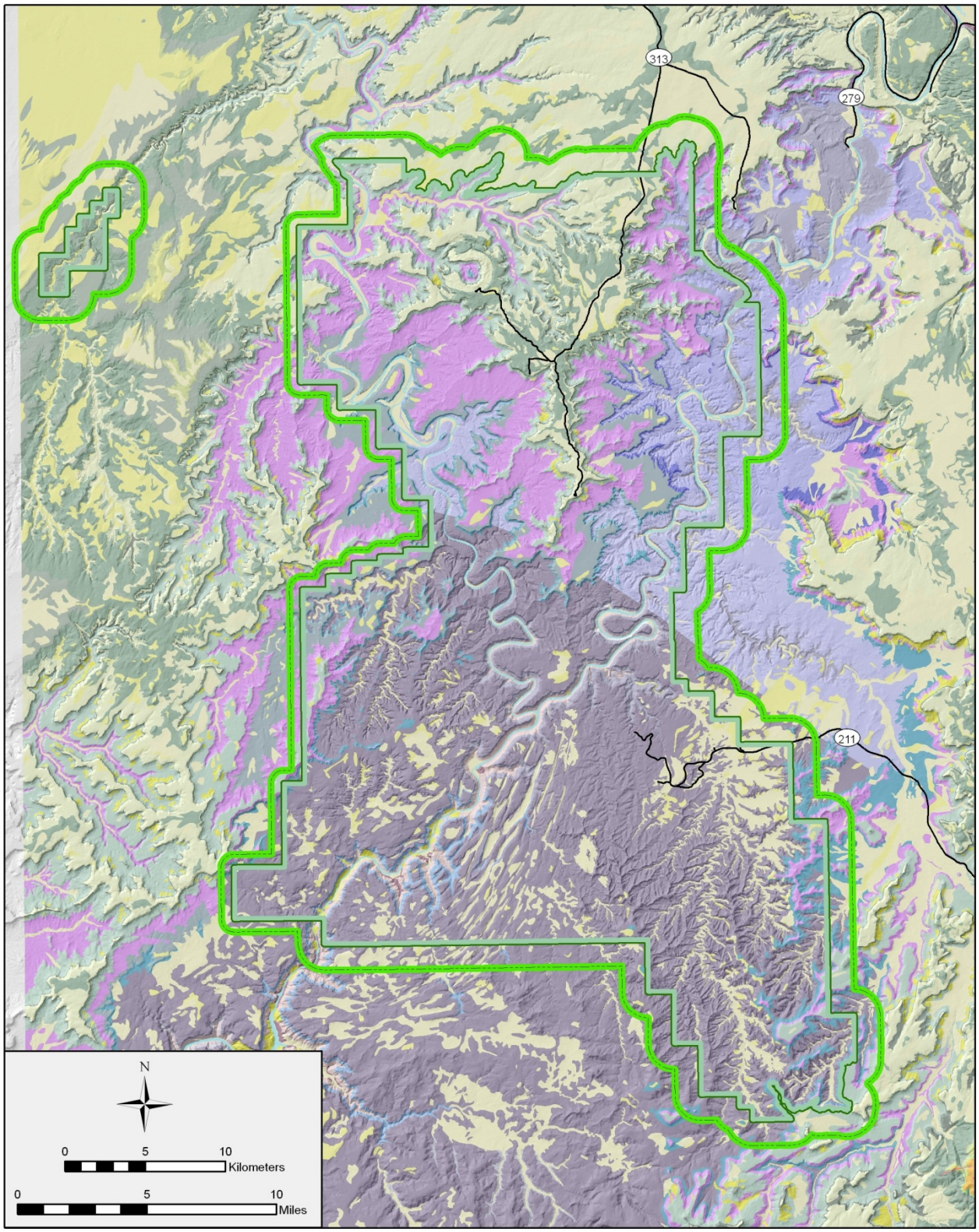


Figure 5a. Generalized geology map of Canyonlands National Park.



Figure 5b. Legend for the Canyonlands National Park geology map.

The remainder of this section is a summary of the geologic history and the general distribution of vegetation in relation to geology across the CANY mapping area. It is organized from oldest to youngest rocks (Figure 6) and illustrated with photographs acquired by field crew members as part of the vegetation classification and accuracy assessment effort. The following description of the geologic history of CANY is derived from Baars (2000), Campbell (1987), and Foos (1999).

Paradox Formation (Pennsylvanian). The oldest rocks exposed within CANY are part of the Paradox Formation in the heart of Cataract Canyon at the mouth of Cross and Y canyons and at the mouth of Lower Red Lake Canyon. During the Pennsylvanian Period, seas covered most of present-day Utah. Approximately 300 million years ago, the Ancestral Rocky Mountains and the Uncompahgre Uplift of eastern Utah and western Colorado were uplifted. Concurrently the Paradox Basin 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 evaporate formed from gypsum salts accumulating on the sea floor (Baars 2000). This formation is unvegetated within CANY.

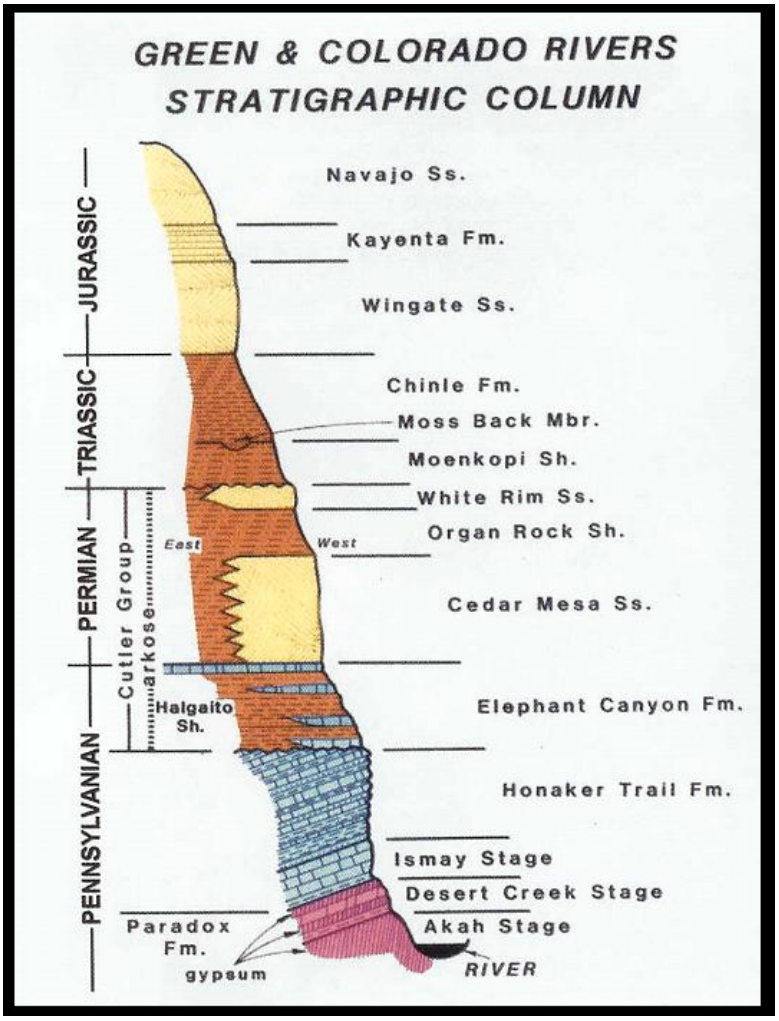


Figure 6. A diagram of the geologic layers (stratigraphy) of Canyonlands National Park.

Honaker Trail Formation (Pennsylvanian). Deposited on the Paradox Formation is the Honaker Trail Formation, which appears as gray, ledgy, massive cliff bands and scree slopes along the river corridors from the southern CANY boundary in Cataract Canyon to just upstream of the confluence of the Green and Colorado rivers (Baars 2010). 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). The dominantly marine section of this formation contains numerous marine fossils. One plant community was documented on the Honaker Trail Formation, a sparse talus slope dwarf-shrubland characterized by Torrey's jointfir, Bigelow sage, snakeweed (*Gutierrezia sarothrae*), and a variety of native grasses and exotic annual plant species (Figure 7).



Figure 7. Characteristic *Artemisia bigelovii - Ephedra* (*viridis, torreyana*) Talus Shrubland growing on shattered gray limestone of the Honaker Trail Formation in Spanish Bottom.

Elephant Canyon Formation (Pennsylvanian). On top of the Honaker Trail Formation is the Elephant Canyon Formation, which grades southward (in CANY, south of Spanish Bottom along the river corridor) into red beds of the Halgaito Shale. 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). It is exposed along the Colorado River corridor from the mouth of Lower Red Lake Canyon upstream to near the CANY boundary at Potash and along the Green River from near the confluence with the Colorado River to several bends upstream of the confluence. The Elephant Canyon Formation supports sparse dwarf-shrubland and woodland communities characterized by shadscale, blackbrush, Torrey's jointfir, Saline lyme grass (*Leymus salinus*), scattered two-needle pinyon pine and Utah juniper with sparse or mixed shrub understories. Occasionally disturbed communities dominated by the non-native invasive annual forb Russian thistle (*Salsola* spp.) have become established. Typical habitats for all plant communities include benches, rims, ridges, ravines, and steep talus slopes (Figure 8).

A small exposure of Halgaito Shale was documented by field crew members along the Colorado River immediately downstream of Surprise Valley in the Maze, where steep talus slopes support sparse Torrey's jointfir with an herbaceous understory.

Cutler Group (Permian). Above the Elephant Canyon Formation is the Cutler Group, which is undifferentiated east of CANY, but is divided into three distinct formations within the park: Cedar Mesa Sandstone, Organ Rock Shale, and White Rim Sandstone.



Figure 8. Rims, benches and slopes in the Elephant Canyon Formation showing characteristic sparse vegetation communities. Bottom photo is of the Halgaito Shale talus slopes near Surprise Valley.

Cedar Mesa Sandstone (Permian). The oldest layer (approximately 260 to 280 million years old) in the Cutler Group is the Cedar Mesa Formation, which forms massive, light-colored, near vertical, fine-grained sandstone cliffs exhibiting numerous horizontally bedded strata (Campbell 1987). 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 CANY as the top of the canyon walls in Cataract Canyon, the steep-walled canyons of The Maze and The Fins of Ernie's Country, and most notably as the dominant rock formation in the Needles District (named for the spectacular "needles" of red and white-banded Cedar Mesa Sandstone spires). Most of the 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 on the surface (mostly stabilized by well-developed biological soil crusts). Characteristic plant communities are patchy dwarfed woodlands and wooded shrublands of two-needle pinyon pine and Utah juniper with a diverse assemblage of shrubs and grasses in the understory, including blackbrush, little-leaf mountain mahogany, Stansbury's cliffrose (*Purshia mexicana*), alder-leaf mountain mahogany (*Cercocarpus montanus),* singleleaf ash *(Fraxinus anomala),* skunkbush sumac (*Rhus trilobata*), yucca (*Yucca* spp.), jointfir (*Ephedra* spp.), and a variety of native grass and forb species (Figure 9).



Figure 9. Dwarfed pinyon – juniper woodlands with blackbrush and little-leaf mountain mahogany dominant in the understory on Cedar Mesa Sandstone.

Organ Rock Shale (Permian). Exposed on top of the Cedar Mesa Sandstone are red beds of Organ Rock Shale. Deposited in coastal lowland and tidal flats environments about 260 million year ago, this layer consists of shales and siltstones, and is a soft-weathering, slope-forming unit (Baars 2000). At CANY, the Organ Rock Shale is exposed below the White Rim Formation on both sides of Grand View Point in the ISKY district, where it extends eastward to rims above the Colorado River and is exposed along the east side of the river in the narrow northernmost section of the Needles District. 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 two-needle pinyon pine and Utah juniper occasionally, but most of the vegetation is a diverse mix of shrubs and grasses, including Utah serviceberry, singleleaf ash, skunkbush sumac, blackbrush, crispleaf buckwheat (*Eriogonum corymbosum*), shadscale, Bigelow sage, yucca, jointfir, snakeweed, needlegrass (*Stipa* spp.), James' galleta, Salina lyme grass, and a diversity of forbs (Figure 10).

White Rim Sandstone (Permian). Above the Organ Rock Shale is a light-colored sandstone cliff band that forms a broad topographic bench. This sandstone takes its name from the White Rim in the ISKY District, which forms a prominent mid-level bench below the Wingate Sandstone cliffs. It is most visible from Grand View Point and other view points along the ISKY park road, is also exposed on the north and south rims of Horse Canyon in the Maze, and caps the cliffs above the Green River from Turk's Head to just upstream of Queen Anne Bottom. The White Rim Sandstone is both eolian and marine in origin, and is a fine-grained sandstone with large-

scale cross-stratification (Campbell 1987). 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 some areas it is saturated with heavy oil and tar; it also contains impressions of sand dollars and starfish fragments may be present (Campbell 1987). Thin red beds deposited over the top of the White Rim were probably deposited as the Toroweap Sea withdrew to the west (Baars 2000).

Most of the White Rim Sandstone surface is unvegetated, but scattered plant communities 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, little-leaf mountain mahogany, yucca, jointfir, and a variety of native grass and forb species, and sparse shrublands characterized by blackbrush, little-leaf mountain mahogany, singleleaf ash, and skunkbush sumac (Figure 11).



Figure 10. Dwarfed pinyon – juniper woodlands and mixed shrubs on Organ Rock Shale.



Figure 11. Little-leaf mountain mahogany and sparse blackbrush shrublands on White Rim Sandstone.

Moenkopi Formation (Triassic). Lying atop the White Rim Sandstone is the Moenkopi Formation; approximately 10 to 20 million years of time is missing in the geologic record due to a regional erosional unconformity (Baars 2000). The Moenkopi Formation was deposited in a near-shore environment of stream channels, tidal flats, muddy lagoons, and beaches that existed

some 215 and 235 million years ago. It is characterized by dark reddish-brown, fine grained mudstones, sandstones, and siltstones that form ledgy slopes and broad rolling benches. The largest exposures occur along the White Rim Road in ISKY, on Pete's Mesa and on the slopes below Elaterite Butte in the Maze, and on the mesa dividing Davis and Horse Canyons in the Needles and the slopes below Cedar Mesa and Salt Creek Mesa. 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, skunkbush sumac, crispleaf buckwheat, rabbitbrush (*Chrysothamnus* spp.), green Mormon-tea, and snakeweed. Native bunchgrasses may contribute low cover, including Indian ricegrass, Salina lyme grass, and James' galleta (Figure 12).

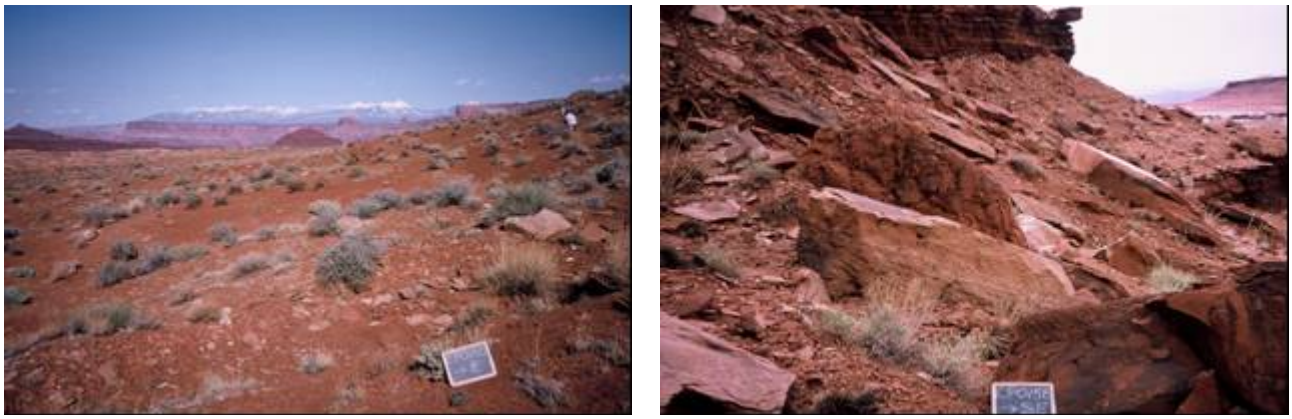


Figure 12. Shrub-dominated communities typical of broad, rolling benches and colluvium-covered slopes of the Moenkopi Formation.

Chinle Formation (Triassic). Another unconformity exists between the Moenkopi Formation and the overlying Chinle Formation. The Chinle Formation represents terrestrial stream and lake environments of approximately 220 to 210 million years ago and forms ledgy slopes and small benches (Foos 1999). The upper portion of the Chinle Formation is exposed in CANY, where the basal layer is the Mossback Member, forming ledges of yellowish-gray to pale orange sandstone. Above the Mossback Member, the Chinle is undifferentiated and forms broad slopes beneath Wingate Sandstone cliffs that are a greenish-gray to reddish-brown color, and consist of bentonitic shales, mudstones, and sandstones (Campbell 1987). Slopes are mostly obscured by talus debris or rockfall. The most extensive exposures of Chinle Formation occur in Taylor Canyon. It is most visible from the White Rim Road in ISKY as talus slopes just below the massive cliffs of Wingate Sandstone that support the entire ISKY mesa. Lesser exposures occur on Elaterite Butte in the Maze and on Cedar Mesa in the Needles. Vegetation of the Chinle Formation is very similar to the Moenkopi Formation, with the addition of singleleaf ash, Bigelow sage, and rarely, siltbush (*Zuckia brandegeei*) (Figure 13).

Wingate Sandstone (Jurassic). The Glen Canyon Group is deposited on the Chinle Formation and in ascending order consists of Wingate Sandstone, the Kayenta Formation, and Navajo Sandstone. The Chinle-Wingate boundary is also 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, orange-to-brown vertically jointed cliffs (Foos 1999). In CANY, these cliffs are 300 to 400 feet thick, unbroken,

and generally coated with a dark red-to-black veneer of desert varnish (Baars 2000). The most representative exposures of Wingate Sandstone are below the ISKY mesa top, above the White Rim Road and in Taylor Canyon. 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).



Figure 13. Shrub-dominated communities typical of benches and colluvium-covered slopes of the Chinle Formation.



Figure 14. Massive Wingate cliffs and sparsely vegetated talus slopes below.

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 represents streambed and floodplain sediments deposited west of the ancestral Rocky Mountains approximately 180 to 200 million years ago (Baars 2000). It forms red to reddish-purple sandstone steps and ledges with shallow to moderately deep pockets of soil and is best exposed topping the Wingate Sandstone cliffs in ISKY (the lowest exposed formation on the ISKY mesa top). This formation is known to preserve numerous dinosaur tracks. Exposures typically support sparse woodlands or wooded shrublands of two-needle pinyon pine, Utah juniper, little-leaf mountain mahogany, Utah serviceberry, Stansbury's cliffrose, blackbrush, green Mormon-tea, snakeweed, James' galleta, and the grass-leaved forb, rock goldenrod (*Petradoria pumila;* Figure 15).



Figure 15. Ledges of Kayenta sandstone support low-cover pinyon-juniper woodlands with mixed shrubs, especially blackbrush and Stansbury's cliffrose.

Navajo Sandstone (Jurassic). Atop the Kayenta Formation are rolling domes of white, buff, and pale orange Navajo Sandstone. This formation originated as sand dunes deposited between approximately 173 and 180 million years ago and exhibits large-scale, sweeping, cross-beds typical of wind-blown sand accumulations (Baars 2000). Navajo Sandstone exposures are common on the ISKY mesa top and above Horseshoe Canyon. 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, blackbrush, little-leaf mountain mahogany, Stansbury's cliffrose, single-leaf ash, green Mormon-tea, snakeweed, yucca, skunkbush sumac, and a variety of native grass and forb species (Figure 16). 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. Typical sparse dwarf woodlands and wooded shrublands on Navajo Sandstone.

Carmel and Entrada Formations (Jurassic). The Carmel and Entrada formations are visible above the rims of Horseshoe Canyon in the disjunct Horseshoe Canyon unit of CANY, exposed as slope-forming units. The Carmel Formation was deposited as tidal flats between about 160 and 172 million years ago, and is composed of greenish-gray to red silty shales, gypsum, and

limestones. The Entrada Formation (Dewey Bridge Member) was deposited in a shallow marine environment some 155 to 160 million years ago, and is composed of reddish-brown siltstones and sandstones. The most representative exposures occur above the western rim of Horseshoe Canyon. Typical plant communities are blackbrush shrublands with scattered Utah juniper, Torrey's joint-fir shrublands with an understory James' galleta, and occasionally dunes of blackbrush and Tucker's sand shinnery oak (*Quercus havardii* var. *tuckeri*; Figure 17).



Figure 17. Typical sparse blackbrush shrublands on slopes of the Carmel Formation (left) and Entrada Sandstone (Dewey Bridge Member) (right).

Quaternary Deposits. Unconsolidated surficial deposits within CANY 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 CANY, 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. These sheets of water-deposited sands and gravels are scattered throughout the lowlands and tributary wash channels within CANY. In the canyons of the Colorado River, Salt Creek and its tributaries, and Horseshoe and Horse canyons (the Maze), alluvial terraces of varied ages and elevations fill the spaces between the active channel and the canyon wall. 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. Valley floors in Salt Creek Pocket, at the mouth of Taylor and Upheaval Dome canyons, in Squaw Flat, and in Ernie's Country, typically support grasslands of James' galleta, needle-and-thread, and Indian ricegrass, although non-native cheatgrass (*Bromus tectorum*) and Russian thistle (*Salsola tragus*) may dominate in areas disturbed by grazing. These areas may also support scattered shrubs or shrublands of fourwing saltbush, rubber rabbitbrush, sand sagebrush (*Artemisia filifolia*), and winterfat (Figure 18).




Figure 18. (L) Winterfat, snakeweed, and mixed grasses on alluvial valley bottom fill in Salt Creek Pocket; (R) big sagebrush, greasewood, and rubber rabbitbrush dominate on alluvial terraces closer to the wash channel.

Closer to the main stream channel are shrublands dominated by greasewood and/or basin big sagebrush, with scattered saltbush and rubber rabbitbrush sometimes present (Figure 20). Canyon terraces directly adjacent to the stream or river with frequent flooding and a high water table may support mesic riparian vegetation (Figure 20) including Fremont cottonwood, Goodding willow, tamarisk, sandbar willow, yellow willow (*Salix lutea),* rushes (*Juncus* spp.), scouring rushes (*Equisetum* spp.), cattails (*Typha* spp.), and a variety of mesic grass species, including saltgrass (*Distichlis spicata*), Kentucky bluegrass (*Poa pratensis*), alkali sacaton (*Sporobolus airoides*) and redtop (*Agrostis stolonifera*). Higher terraces less likely to flood support stands of Gambel oak, skunkbush sumac, or desert olive (Figure 19). Ephemerally flooded wash channels may support mixed shrublands of fourwing saltbush, sand sagebrush, jointfir, and rubber rabbitbrush. Narrow canyon bottoms with high or sloping terraces often support pinyon-juniper woodlands with mixed shrub understories, including Fremont barberry (*Mahonia fremontii*), Gambel oak, and single-leaf ash, among others. These 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.






Figure 19. Terraces of recent alluvium may support a range of communities depending on age, depth to the water table, and vulnerability to flooding. (Top) Lower terraces support communities of cottonwood, willow, and mesic herbaceous species. (Bottom) River terraces support dense stands of tamarisk and/or coyote willow and higher terraces support species such as Gambel oak.

Eolian deposits. Wind-deposited sheets of sand in CANY 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). CANY 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 usually support a sparse shrubland composed of a combination of hoary rosemarymint (*Poliomintha incana*), sand buckwheat (*Eriogonum leptocladon*), and pillar false gumweed (*Vanclevea stylosa*), accompanied by Indian ricegrass and sandhill muhly (*Muhlenbergia pungens*), and occasionally by cheatgrass or Russian thistle (Figure 20a). Sands with a degree of stabilization (usually indicated by the development of rudimentary biological soil crusts) may include sand sagebrush and plains pricklypear (*Opuntia polyacantha;* Figure 20b). 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 joint-fir (Figure 20c). Stable sand sheets may also support an unusual community of green Mormon-tea in a rhizomatous form (referred to as "mots" by field crews) with a sparse to dense understory of Indian ricegrass, needle-and-thread, and/or James' galleta (Figure 20d).



Figure 20. Eolian sands within CANY support a range of shrubland communities depending on the stability of the sand. Loose, blowing sands support a unique shrubland with sand buckwheat, hoary rosemarymint, and sandhill muhly (a). Sand sagebrush, mixed shrubs, and weedy annuals occupy sand sheets that are newly stabilized (b). Blackbrush and Tucker oak indicate a mature, stable sand sheet community (c) The rhizomatous form of green Mormon-tea forms a distinctive community with bunchgrasses as codominants (d).

Colluvial deposits. Colluvial deposits result from the tumbling of rocks and boulders down steep landscapes; the soils accumulate along the sideslopes, 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 the Wingate and Kayenta sandstone cliffs in ISKY, below Organ Rock Shale and Moenkopi Sandstone in the Land of Standing Rocks (the Maze), along the Green and Colorado River corridors from the Halgaito Shale, Honaker Trail, and Paradox Formations, and on small slopes in the Grabens below Cedar Mesa Sandstone. The soil texture depends largely upon the geologic origin of the colluvial material (USDA-NRCS 2010). Sandstone, including the Wingate, usually develops into sandy soil. Soils derived from the Organ Rock and Moenkopi formations have loamy textures (USDA-NRCS 2010). The most unstable slopes support grasses, especially Salina lyme grass. 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 20 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 yellow rabbitbrush (*Chrysothamnus viscidiflorus*). Cooler exposures support scattered Utah juniper and two-needle pinyon pine and

more mesic shrubs such as skunkbush sumac, fendlerbush *(Fendlera rupicola)*, roundleaf buffaloberry (*Shepherdia rotundifolia*), alder-leaf mountain mahogany, single-leaf ash, Utah serviceberry, and Stansbury's cliffrose (Figure 21). Vegetation density is limited by the amount of exposed soil.



Figure 21. Slopes covered by colluvium in CANY show the variability of vegetation communities typical of these slopes, pinyon – juniper with mixed tall shrubs (left) and Torrey's joint-fir sparse vegetation (right).

Soils

The following information describing soils within CANY is summarized from the 2010 Soil Survey of Canyonlands National Park (USDA-NRCS 2010) and from the 1989 Soil Survey of Grand County (Hansen 1989).

CANY soils vary with differences in topography, parent material, climate, and hydrology, among other factors. In general, the more arid the climate, the more influence parent material has on soils (USDA-NRCS 2010). Within CANY, four distinct parent materials are involved in the soil formation process: eolian material, alluvium, colluvium, and residuum. 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). Eolian (wind-deposited) soils are generally composed of recently deposited fine sands but some deposits can be thousands of years old. 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 CANY but are often a minor component of the soil profile in other soil types (USDA-NRCS 2010). Soil textures described within CANY are mostly variations of loams and sands.

Precipitation is the main factor controlling soil productivity at CANY; the regional semi-arid climate generally results in naturally low soil productivity. Low precipitation rates limit vegetative cover and primary productivity, and therefore soil development and soil organic matter (Hansen 1989). Precipitation within CANY is sufficient to facilitate translocation of materials such as salts and clays through the soil profile. These materials, however, collect at the depth in the soil profile to which soil moisture generally penetrates, and create a caliche layer (hardened deposit of calcium carbonate) (USDA-NRCS 2010). Soil susceptibility to water erosion is generally moderate, but can be severe in areas with low permeability, particularly

shale badlands or steep slopes susceptible to sheetwash. Topography (mainly slope and aspect) affects the moisture, temperature, and stability of the soils. Soils on steep areas like talus slopes, usually lack surface zones of structure and organic matter accumulation because erosion and gravity continually remove the top layers of soil. Soils on gentler slopes are often stable enough to develop structure and soil horizons (USDA-NRCS 2010).

Soil chemistry and depth are also important factors that influence vegetation distribution. Deep soils tend to support bunchgrasses; shrublands tend to occupy shallower or more alkaline soils. The most common woodland community in CANY (two-needle pinyon pine – Utah juniper with a mixed shrub understory) occupies rocky soils and fractured bedrock. Shale badlands and sandstone slickrock outcrops cover large areas and have little or no soil development due to their predominant erosive features.

The 2010 soils map for CANY identifies 36 map units, most of which are complexes of individual soil types (series), representing 24 soil series, 20 soil families and one unvegetated unit (Figure 22). For the generalized soil map, the map units were combined into broad associations, each with a distinctive pattern of soils, relief, and drainage: (1) Water-Green River family-Trail, (2) Mido family-Mido-Green River family, (3) Torriorthents-Rock outcrop-Badland, (4) Reef-Rock outcrop-Mathis family, (5) Tsaya family-Moenkopie-Rock outcrop, (6) Rizno-Arches-Rock outcrop, (7) Rock outcrop-Arches-Nalcase, and (8) Mido-Begay.

About 35% of CANY was mapped as bare rock outcrop with no soil development; the remaining two-thirds was mapped to soil type. The two most abundant soil map classes together cover half of CANY. The Torriorthents-Rock outcrop-Badland association is composed of shallow to very deep soils of colluvium and residuum derived from sandstone, shale, and limestone, and occurs on talus slopes, scarp slopes, hills, and structural benches. The next most common map class is the Rock outcrop-Arches-Nalcase association, which is composed of shallow, aeolian soils occurring on mesas, structural benches, and buttes. The next three most abundant map classes cover just under 40% of CANY, as follows: (1) the most abundant is the Rizno-Arches-Rock outcrop association, which is composed of shallow soils of residuum and eolian deposits occurring on mesas and structural benches; (2) the Tsaya family-Moenkopie-Rock outcrop association is composed of shallow soils of residuum, colluvium, and slope alluvium occurring on structural benches, hills, and talus slopes; and (3) the Mido-Begay association includes very deep soils of eolian deposits and slope alluvium occurring on mesas, structural benches, valleys, and grabens. The three remaining map classes occur on about 10% of CANY, and the most abundant of these is the Reef-Rock outcrop-Mathis family, composed of shallow to deep colluvial soils on talus slopes and ledges. The final two map classes consist of alluvial soils occurring along the major rivers and in the major tributary drainages. The Water-Green River family-Trail association is composed of very deep alluvial deposits from mixed sources occurring on floodplains, alluvial plains, and stream terraces of the Green and Colorado rivers (includes 43% water). The Mido family-Mido-Green River family is composed of very deep alluvial and eolian deposits derived from sandstone occurring on floodplain steps and stream terraces in tributary drainages, mainly Salt Creek, Horse, and South Fork Horse canyons (The Maze) (USDA-NRCS 2010).

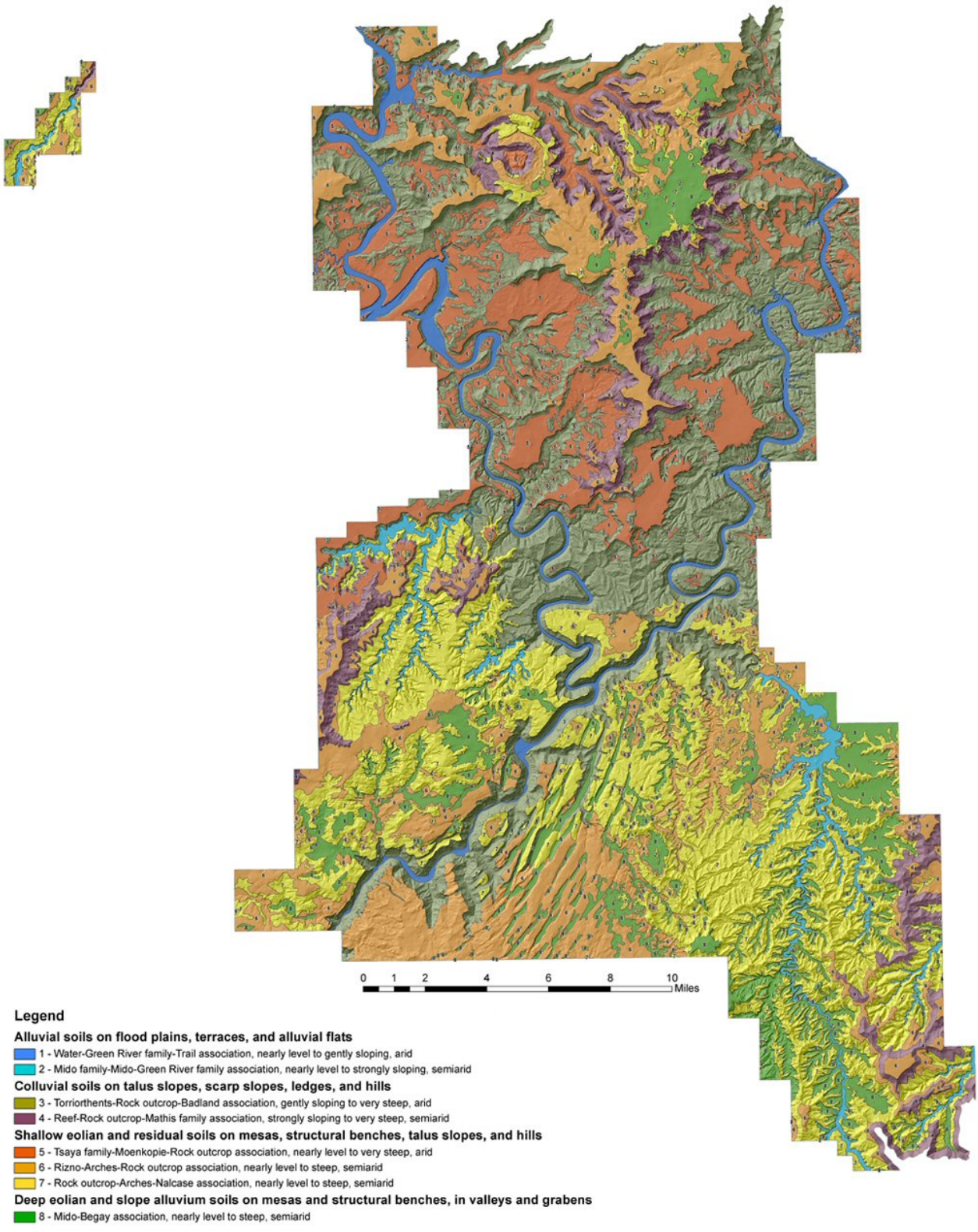


Figure 22. General Soil Map for Canyonlands National Park.

Biological Soil Crusts

Biological soil crusts occur throughout CANY, particularly where thin, sandy soils overlie slickrock (Figure 23). On deeper soils, crusts occupy the nutrient-poor openings between tree canopies and clumps of vascular plants. These crusts are a complex community of cyanobacteria, green algae, lichens, mosses, microfungi, and other true bacteria (Belnap et al. 2001). The cyanobacteria and microfungi have filaments that weave through the top few millimeters of soil, creating a matrix that stabilizes and protects soil surfaces from wind and water erosion. Other attributes of biological soil crusts include fixing atmospheric nitrogen, building soil organic matter (Eldridge and Greene 1994), and retaining soil moisture (Belnap et al. 2001). They are diverse in terms of species composition, often including more species than the associated vascular plant community (Rosentreter 1986, Ponzetti et al. 1998). Where land uses such as livestock grazing have removed the crusts, they may take years to reestablish.



Photo credit: NPS I&M field crews

Figure 23. Examples of well-developed biological soil crusts in Canyonlands.

Extensive field work by Harper and Kleiner in the Chesler and Virginia Park regions of NEED in 1967 and 1968 involved the study of four grasses (*Pleuraphis jamesii*, *Achnatherum hymenoides, Sporobolus cryptandrus,* and *Hesperostipa comata)* and their relationship to soils. Kleiner discovered the importance of "cryptogams" to regional ecology and analyzed the differences between grazed and ungrazed areas in terms of soil integrity, flora distribution and density (Kleiner and Harper 1977). Additional studies at CANY focused on biological soil crusts and their ecological ties to vegetation are numerous and include Belnap (1994, 1997), Johnston (1995), Miller (1997, 2000), Phillips and Belnap (1998), Sperry et al. (1999), Belnap et al. (2000), and Harper and Belnap (2001).

Hydrology and Water Resources

Other than the two large rivers (the Green and Colorado) that divide CANY into its three districts, perennial surface water is relatively rare; there are no other entirely perennial streams. CANY includes more than a dozen streams that are largely intermittent with perennial stretches supporting riparian and wetland woodlands, shrublands, and emergent herbaceous vegetation. Ephemeral washes/drainages are numerous and carry surface flows following thunderstorms and other precipitation events. CANY also contains limited water resources in the form of plunge pools, bedrock potholes (tinajas), seeps, and springs.

CANY has at least 15 intermittent streams with perennial reaches supporting stands of riparian and wetland vegetation, especially where shallow bedrock keeps groundwater at or near the surface. These streams depend mainly on springtime flow from snow melt and precipitation events to drive fluvial processes and support riparian vegetation. Surface flows in many intermittent streams are restricted to short reaches of the drainage immediately downstream from major springs and seeps. There are both spatially and temporally intermittent streams in CANY; sspatially intermittent streams have water above the stream bed in certain areas and below the stream bed in other reaches. The intermittent streams in CANY include Syncline Valley, The Big Draw, and Upper Trail Canyon in ISKY, Horse Canyon and South Fork of Horse Canyon, Water Canyon, and Jasper Canyon in the Maze, Horseshoe Canyon, and Salt Creek Canyon, Horse Canyon, Lost Canyon, Squaw Canyon, Lavender Canyon, Davis Canyon, and Little and Big Spring Canyons in the Needles.

Many smaller, ephemeral tributary washes dissect CANY; 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, but often have larger shrubs and denser and more diverse vegetation than occurs adjacent to the wash channel and floodplain. All drainages within CANY, intermittent or ephemeral, are subject to flash floods, especially following summer thunderstorms (Figure 24). Floods erode and re-deposit bank sediments and in extreme events can eliminate bank vegetation.



NCPN field crews

Figure 24. Flash flood in Taylor Canyon.

Tinajas develop in solution pits formed in level exposures of sandstone; most examples at CANY form in the Navajo and Cedar Mesa sandstones. Seeps and springs provide sufficient water for localized surface flows and moist to saturated soils where they emerge from bedding planes and joints in sandstone cliffs. Most seeps and springs within CANY emerge either from the Navajo, Wingate, White Rim, or Cedar Mesa sandstones, as a result of these more porous formations

contacting an impermeable layer (Figure 25). Seeps often provide hanging garden habitat and also deposit dissolved salts as the water evaporates, staining the cliff surfaces white (Coles et al. 2009). Hanging gardens commonly establish in the Navajo Sandstone, Cedar Mesa Sandstone, and at the top of the Chinle Formation, which support often diverse, although very small, wetland communities often with rare and/or endemic plant species.

Riparian and wetland plant communities occur on the floodplains of the Colorado and Green rivers, in mesic reaches of intermittent tributary canyons, and below perennial seeps and springs. In terms of structure they range from deciduous forests and woodlands to shrublands and herbaceous vegetation types, including hanging gardens and marshes. Riparian and wetland areas provide important wildlife habitat, watering holes, and permanent surface water that is important aquatic habitat for native vertebrates and invertebrates.



Figure 25. Perennial water sources in CANY include the two major rivers (Colorado and Green) as well as areas near seeps or springs, like this site in Lost Canyon.

Land Use and Settlement History

Pre- and proto-historic Occupation

Evidence of Archaic Period Native American occupation is well documented within CANY and throughout the region. The flexibility and adaptability of the hunter-gatherer lifestyle enabled Archaic peoples to occupy this region more or less continually for roughly 7,500 years despite severe droughts which occurred periodically throughout this era (Knox 2002). A period of increased moisture is thought to have begun around the start of the late Archaic (~3100 BCE), and continued until around 800 BCE. A noticeable increase in cultural artifacts can be dated to this period, suggesting that Horseshoe Canyon and the surrounding region experienced an increase in human population numbers (Knox 2002). Rock art studies and site excavations in and around the Horseshoe Canyon area have contributed much to the understanding of Archaic occupation on the Colorado Plateau (Knox 2002). Archaic artifacts have been recorded in CANY as a result of various survey projects, with radiocarbon dates indicating Middle and Late Archaic occupations (500-5000 BCE) (Eininger et al. 2008). The predominance of Barrier Canyon Style rock art in and adjacent to CANY may also be evidence of Archaic occupation (Knox 2002).

Eininger et al. (2008) interpreted corn cobs, numerous storage features, and the predominance of short term habitation sites in river bottomlands providing arable land and water as evidence of

Archaic Period horticulture. Prehistoric resources within CANY are predominantly from the late Pueblo II (900-1150 ACE) and Pueblo III (1150-1300) time periods. The presence of late PII and PIII ceramics throughout CANY suggests fairly widespread use during both periods. Sites in the Canyonlands region, often demonstrate a mixing of Anasazi and Fremont cultural traits (Eininger et al. 2008). Sandals, pottery, cradle boards, clothing, arrow shafts and arrowheads, bows, ax heads, knives, cliff dwellings, kivas, granaries, rockart, and clay figurines from this time period have all been found in CANY.

There is rare and varied evidence of Protohistoric human presence, including a few Desert Side-notched arrow/dart points and two possible Ute petroglyph panels. Paiute potsherds were identified during an ISKY survey (Osborn and Brown 1995) and Sharrock (1966) reported a possible late nineteenth century cribbed hogan in NEED. Rare instances of Hopi ceramics have been recorded at both CANY and Arches National Parks (Eininger et al. 2008).

Post-Columbus

The following late human history of CANY is summarized from Schmieding's complete Administrative History of Canyonlands National Park (Schmieding 2008).

Characterized by extreme aridity, wide temperature variations, difficult terrain, and a lack of arable soils for farming and scant forage for livestock, the CANY region was avoided by Spanish and Mexican trade routes and briefly visited by American explorers. Until more recent times, the central Colorado Plateau was used by Ute and Navajo Indians and Spanish and Anglo-American ranchers, outlaws, and prospectors. The earliest recorded Spanish expeditions to the Colorado Plateau region were the expedition of Tomás Garcés in 1776 to the Grand Canyon and nearby Hopi villages, and the circumnavigation of the Colorado Plateau by Silvestre Escalante and Francisco Domínguez in 1776-77. Escalante's journal is historically important as the first written document describing the Colorado Plateau.

The 1853 Pacific Railroad Survey expedition of the 38th and 39th parallels under Captain John Gunnison performed the first scientific investigations of Utah's canyon country. Gunnison, Lieutenant E. O. Beckwith, and artist R. H. Kern explored the Gunnison River to the Grand (Colorado) River. Traveling between the Book Cliffs and La Sal Mountains, Captain Gunnison described a desert "crossed with great labor and difficulty" that he deemed "utterly valueless for occupation by civilized man." The first written account of the CANY vicinity was prepared by Mormon missionaries. As part of Brigham Young's plan to locate settlements in arable valleys, along transportation routes, and at strategic points of defense, Alfred Billings and Oliver Huntington led forty-one members of the Elk Mountain Mission in May 1855 to colonize Spanish (Moab) Valley. They were driven out by the Utes later that same year (Schmieding 2008).

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 CANY region. The expedition was tasked with following and mapping the course of the San Juan River to its confluence with the Colorado River, locating the confluence of the Green and Colorado Rivers, scouting the Old Spanish Trail, creating a better map of the region, and locating possible routes for a road between New Mexico and southwest Utah, and was successful on all counts except the last. The expedition made strong contributions to knowledge of the geology, paleontology,

geography and archaeology of the greater Canyonlands region. The physician/geologist on the expedition, John S. Newbery, wrote: "Though valueless to the agriculturalist, dreaded and shunned by the emigrant, the miner and even the adventurous trapper, the Colorado Plateau is to the geologist a paradise. Nowhere on the earth's surface, so far as we know, are the secrets of its structure so fully revealed as here." Newberry also understood the Plateau's scenic value and its importance as a forum for interpreting natural history long before tourism was an industry. Newberry was especially impressed by what he described as a "forest of Gothic Spires" in what is now the Needles District of Canyonlands (Schmieding 2008).

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.* Reprinted for popular publication in 1895, Major Powell's narrative remained the number one seller on the region until the 1968 publication of Edward Abbey's *Desert Solitaire* (Schmieding 2008).

Recent History

Towns in the vicinity of present-day CANY (Bluff, Monticello, Blanding, Moab and Hanksville) were settled by Mormon pioneers during the period 1878-1888. Virtually unknown and largely inaccessible, the larger Canyonlands region was used by gold and uranium miners, oil speculators and drillers, outlaws, and ranchers (Schmieding 2008).

The U.S. Geological Survey and Reclamation Service began to focus on Colorado Basin river corridors in 1889 when the USGS installed the first river gauges in canyon country. Hydrology studies focused on the identification of sites for water storage, power production, and flood control dams. Eugene Clyde La Rue surveyed the Green River for USGS in 1912 and the Grand (Colorado) River in 1914; he subsequently recommended a 270-foot dam at the confluence of the two rivers (Junction site). The proposed dam would have stored eight million acre-feet of water and flooded 127 miles of the Green River and 110 miles of the Grand River floodplains, including the Moab Valley. Later surveys and political decisions shifted development focus away from the Junction site to Dark Canyon where a proposed higher dam would have flooded a much larger area, including Cataract Canyon and the Canyonlands basin. Neither of these proposed dams was constructed, and CANY thus avoided the fate of the neighboring Glen Canyon where Lake Powell has inundated significant canyon acreage, resulting in the designation of Glen Canyon National Recreation Area, a reservoir park unit focused on power production and lake recreation (Schmieding 2008).

Because of the relatively late designation of CANY as a national park unit, the region held thousands of claims or leases for uranium, potash, oil and natural gas. There had been no active uranium mining within CANY boundaries since 1957, but much of the land was under oil or natural gas lease (77 leases had five-year extensions when CANY was designated). Although drilling on valid leases occurred within CANY for several years, the NPS ensured that new exploration did not occur; that uranium miners or oil drillers without legal claims did not work within CANY; and that miners/drillers with legal claims followed CANY regulations (Schmieding 2008).

In 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 CANY region were not adapted to the pressures of continuous and heavy grazing by large numbers of livestock. As a result, there was severe 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).

In 1961, there were ten lessees/ranchers grazing livestock on prospective park lands, and these one-year leases were extended to the normal ten-year period following CANY designation in 1964 (allowing ranchers with valid permits to graze in the park until 1975). During the phase-out period, ranchers grazed livestock two to three months annually from November to April. Leased areas were on the Island in the Sky mesa tops, on the White Rim and in the Needles region, with stocking rates dependent on available forage and water. CANY staff monitored livestock numbers, movement patterns, and range conditions, and enforced stocking schedules and the exclusion livestock from sensitive areas. In 1969, livestock grazing was discontinued in Chesler Park due to its biological fragility and in Cataract Canyon to preserve bighorn sheep (*Ovis canadensis nelsoni*) habitat. In accordance with CANY founding legislation, many grazing allotments were terminated on June 30, 1975, and legal livestock grazing within CANY ended November 12, 1982 (Schmieding 2008).

In recent decades, the effects of tourism within CANY have increased, and led to more restrictive management to protect natural resources. CANY visitation was recorded as 19,472 during the 1965 calendar year, and doubled by 1971 to 55,444 annual visitors. Increased visitation and limited staff coverage led NPS to implement restrictions in 1973 that (1) adopted group size limits, permit and reservation systems, fire pan requirements, and rock climbing restrictions, (2) closed Chesler Park to motor vehicles, and (3) limited Virginia Park to authorized researchers. By 1983, visitation numbers had grown to over 100,000, and quadrupled by 1993, to around 400,000 visitors (Schmieding 2008). Since 1993, CANY annual visitation has been documented at around 400,000 visitors, peaking in 1995 at 448,769 recorded visitors (NPS 2012). The majority of visitors are recorded at ISKY, the most accessible of the three CANY districts.

CANY continues to provide educational opportunities for visitors, students, and scholars related to natural and cultural resources research. The good air quality allows visitors panoramic views of many miles and the lack of human development and artificial lights provides exceptional night sky viewing opportunities (Evenden et al. 2002). CANY visitors can participate in a variety of recreational opportunities including hiking, backpacking, horseback riding, canoeing, whitewater rafting, mountain biking the White Rim Road, four-wheel driving on designated trails, wildlife viewing, and camping.

Previous Vegetation Studies

Plant Species

Fertig et al. (2009) and Evenden et al. (2002) include a detailed history of botanists sampling in CANY or its immediate vicinity, summarized below.

The CANY region was visited by western botanists in the late 19th and early 20th centuries, however, no in depth study of the flora of Canyonlands NP existed until the 1960s. The pre-livestock grazing historical vegetation condition has been described anecdotally, but any scientific measurement or quantitative description is lacking from the pre-1880 period. During the 1960's Dr. Stanley Welsh collected plant specimens along the Colorado and Green rivers and throughout CANY. Plant collections were also obtained along the Colorado River in CANY prior to the closure of Glen Canyon Dam filling Lake Powell (Woodbury et al. 1959). Also in the 1960s, Welsh and Moore published floras of NEED (Welsh and Moore 1965) and ISKY. These two published floras identified 212 plant taxa within CANY (Fertig et al. 2009).

Detailed botanical studies of vegetation within CANY progressed when Kleiner and Harper (1972) analyzed and compared the grasslands of the formally grazed Chesler Park and ungrazed Virginia Park in NEED, and identified at least 13 previously unreported vascular-plant species for CANY. Loope (1977) documented at least six previously unreported taxa during vegetation research within CANY and compiled a checklist that included 298 plant species. During the 1980s, floristic, rare-plant, and vegetation monitoring studies added nearly 150 species to the documented flora of CANY. Anderson (1983) conducted a rare plant study in NEED and documented nine additional species; Stanley Welsh, Matthew Chatterley, and Larry Higgins, conducted botanical surveys along the Colorado River and in the ISKY area, contributing 42 previously unrecorded species to the CANY flora; and Jayne Belnap (NPS) and Tim Graham (USGS) recorded an additional 60 plant species while establishing a network of permanent monitoring transects throughout CANY. Other NPS naturalists, rangers, and seasonal employees collected some 35 previously unreported species within CANY during that decade (Fertig et al. 2009).

From 1989 to 1991, Ken Heil and colleagues surveyed national park units of the Colorado Plateau and recorded 27 additional plant species for CANY. Beginning in 1996, Charlie Schelz (SEUG biologist) collected at least 24 previously unrecorded species and cited 46 additional plant species without voucher specimens in annual CANY checklists (Schelz et al. 2006). Since 2003, 50 previously unreported plant species have been confirmed or reported within CANY through vegetation mapping studies and weed inventories (Dewey and Anderson 2005). Walt Fertig added 9 plant species to the park's flora during the process of completing an annotated checklist of vascular flora for CANY. A revised checklist of documented vascular flora for CANY was developed in 2009 by Walt Fertig and Sarah Topp and includes 594 species (of which only 60 remain unvouchered). None of the plant species documented within CANY are federally listed as threatened or endangered; however, 51 species are currently listed as species of concern based on global and statewide rarity (NatureServe 2008) and three species are defined as narrowly endemic (Fertig et al. 2009).

Vegetation Communities

Short- and long-term studies of vegetation communities occurring in CANY are numerous and have been extensively described in the NCPN Phase 1 Report (Evenden et al. 2002), and summarized by Fertig et al. (2009). The following narrative summarizes selected long-term vegetation studies in CANY from these two sources.

Kleiner and Harper (1972) analyzed and compared grasslands at the formerly grazed Chesler Park and the ungrazed Virginia Park sites in NEED. Virginia Park is considered a relict area

because it was inaccessible to grazing livestock. Kleiner (1983) also examined successional trends in Chesler and Virginia parks a decade after his original measurements. This research has been continued and expanded by Jayne Belnap of the USGS Field Office in Moab, Utah (Evenden et al. 2002).

Loope (1977) studied the relationships of vegetation to environment in CANY, and produced a general vegetation map. Loope identified six major vegetation types in Canyonlands. He described the vegetation based on data collected at 157 plots located within CANY, and concluded that vegetation was strongly related to particular combinations of regolith thickness, bedrock composition, and depth to water table. None of the plots were permanently marked (Evenden et al. 2002).

Belnap established the first permanent vegetation transects within CANY in 1987. Earlier vegetation transects had been established in 1983 by Kitchel and Conners, but were abandoned within three years due to faulty design. The Belnap transects were permanent relative to the starting point but the exact location of the 100 quadrats per transect varied. Thus, the data acquired from these transects between 1987 and 1996 exhibit high variability. The sampling protocols were adjusted in 1997 (Schelz and Whitham 1999) so that all the quadrats within each transect were permanently marked with nails that could be relocated easily (Evenden et al. 2002). Permanent vegetation transects were installed in the major plant communities in CANY and have been monitored annually. Currently, there are 28 vegetation plots at CANY that are monitored annually during the spring season, and 23 years of data are available. The monitoring objective is to provide baseline vegetation information and to document vegetation trends and natural vegetation variability. Another goal for several transects is to document vegetation recovery following fire and almost a century of livestock grazing (Evenden et al. 2002).

Schelz (2001) established 17 riparian transects in CANY between 1998 and 2000. The data set represents late summer-early fall monitoring of 13 transects in Salt Creek and four in Horse Canyon, both located in NEED. Data are recorded along a line-intercept oriented perpendicular to the stream channel, and variables include plant cover and height, soil substrate (including ages of biological soil crusts) and the stream channel profile. This data set includes raw measurements for all transects and also raw, summary and comparison data in spreadsheets, tables and graphs (Evenden et al. 2002).

Monitoring of bunchgrass-dominated herbaceous vegetation was initiated in 1994 to compare recovery rates between areas with different grazing histories (Schelz and Moran 2002a). Data were collected from three locations in ISKY (1994) and two locations in NEED (1995). The ISKY sites support needle-and-thread and Indian ricegrass, have similar soils, and receive similar moisture but have different grazing histories. Gray's Pasture was last grazed in 1964, Red Sea Flat in 1976, and Big Flat, located on adjacent BLM-managed land, continues to be grazed. The two NEED sites were grazed until 1975. Annual late spring monitoring is conducted using 30 quadrat sets along each of the nine transects. A spreadsheet containing the bunchgrass data from each year is available and contains data from 61 transects recorded up to 2001 (Schelz and Moran 2002a, 2002b).

In 1990, Schelz and Van Pelt surveyed relict areas, defined as "pristine plant communities located on buttes, mesas, or in canyons and generally remote and or steep-sided enough to

preclude access for livestock and road construction," which included sites in CANY. A cooperative agreement between NPS and The Nature Conservancy resulted in a multi-faceted study to locate, survey, and photograph these relict areas (Van Pelt et al. 1991). This dataset includes descriptions of each relict area, including geologic and physical setting, application of a comprehensive vegetation type classification, a plant species list, location descriptions, and maps (Evenden et al. 2002).

Long-term upland vegetation monitoring by the NCPN was begun in 2006 with specific objectives including: (1) determine annual status and trends in ground cover, vegetation (by life form), soil aggregate stability, hydrologic function, and nutrient cycling; (2) determine annual status and trends in cover of biological soil crusts by morphological group; and 3) determine annual status and trends in cover of exotic plants in upland areas. The response design for integrated upland monitoring is based largely on rangeland assessment procedures (Herrick et al. 2004). Sample site locations are randomly selected, and observations are recorded along three parallel 50-m transects spaced 25 m apart. A point-intercept method is used to record percent cover of understory plant species and ground-cover attributes. The number of shrubs and exotic perennials is recorded in belt transects. Canopy and basal-gap measures are acquired along each transect using line-intercept methods. Surface-soil samples are collected along each transect to assess soil-aggregate stability. Based on the analysis of pilot data, a long-term operational revisit design was created and implemented in 2009. A total of 252 plots in the ISKY and NEED districts of CANY will be sampled long-term over a seven-year revisit schedule (Witwicki 2010).

In 2009, the NCPN completed data collection for a two-year study of 40 impacted springs, including 12 springs within CANY. The primary goal for long-term monitoring of springs, seeps, and hanging gardens is to "assess trends in key indicators of spring and seep ecosystem health in order to enable a more thorough understanding of the impacts of human activities and climate change on these ecosystems" (NCPN 2011a). The SEUG has been monitoring water quality at a small number of spring sites for over 10 years. The NCPN worked closely with SEUG staff to develop a long-term springs monitoring program that augments existing sampling by adding information on site vegetation and disturbance at the monitoring sites, increasing the frequency of flow sampling at some long-term sites, and initiating flow sampling at additional sites, including hanging gardens. SEUG staff has reviewed the NCPN's draft monitoring protocol, and site selection is currently underway (NCPN 2011b).

Exotic Plant Management

Of the 594 vascular plant species documented for CANY, 68 species (11.4%) are non-native, and of these, seven species are on the Utah noxious weed list: musk thistle (*Carduus nutans*), diffuse knapweed (*Centaurea diffusa*), Russian knapweed (*Centaurea repens*), Canada thistle (*Cirsium arvense*), field bindweed (*Convolvulus arvensis*), broad-leaf pepperplant (*Lepidium latifolium*), and Johnsongrass (*Sorghum halepense*) (Fertig et al. 2009). Weed inventories conducted in 2003 and 2004 found that 14 targeted species of concern were absent in 96.9 percent of the areas inventoried. Inventory focused on areas most likely to harbor invasive plants, with priority given to areas of present or projected development and high visitor use (Dewey and Anderson 2005). Areas actually inventoried in CANY in 2003-2004 included lands under the original Implementation Plan plus additional areas added after consultation with Ian Torrence, Vegetation Manager for SEUG. Lands inventoried in CANY primarily consisted of riparian areas, roads and

highways, hiking trails, flats, and canyon bottoms. Of the 14 targeted species, the crews observed seven species in CANY: musk thistle, diffuse knapweed, Canada thistle, bull thistle (*Cirsium vulgare*), Russian olive, tamarisk (*Tamarix chinensis*), and Siberian elm (*Ulmus pumila*). The most abundant target species of concern was tamarisk, comprising 99.6% of the total infested acreage inventoried.

Tamarisk is an exotic tall shrub or tree native to Eurasia, and has been a focus of exotic plant species control and monitoring in CANY (Figure 26). 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 state and local government researchers and private individuals and organizations introduced a biological control for tamarisk. The tamarisk leaf beetle (*Diorhabda elongata*) can control tamarisk spread through repeated defoliations over many years. Initially released on state and private lands, it was introduced in Grand County in 2004 (release sites at Jackson Bottom and Williams Bottom); in 2005 three more releases occurred in and near Grand County (Higgs 2009). Since those releases, the tamarisk leaf beetle has spread throughout the entire CANY river corridor and into several tributary drainages, defoliating tamarisk shrubs during their peak growing season, eventually weakening the plants. A variety of tamarisk leaf beetle monitoring projects have been (or are being) established both inside and outside CANY boundaries by USGS, NPS, Grand County Weed Department, and Tamarisk Coalition, among other groups, to monitor the spread of beetle activity and determine its ecological impacts on native and non-native plant populations and on wildlife habitat (Tamarisk Coalition 2011).

In late 2009, SEUG resource managers completed an Exotic Plant Management Plan and Environmental Assessment/Assessment of Effect (EPMP EA/AEF) for CANY (NPS 2009). The purpose of the EPMP EA/AEF is to "use an integrated approach to eradicate, contain, control, and prevent targeted weeds within the park units of the SEUG. The desired goal is to contain or control the spread of exotic species, and eradicate species that are the most exotic and pose the greatest threat to the biological diversity within SEUG park units, and prevent any new weeds from becoming established. The resulting pro-active management of these plants will promote the ecosystem health of the park's diverse native communities by maintaining and improving native forbs and grass species, increasing the regeneration of native cottonwoods and willows in riparian corridors, and ultimately preventing the loss of wildlife habitat and species diversity." The objectives of the EPMP are to:

1. Restore native plant communities to reduce the need for ongoing exotic plant management.
2. Prevent unacceptable levels of exotic plant damage, using environmentally sound, cost effective management strategies that pose the least possible risk to people, park resources, and the environment.
3. Develop an EPMP/EA/AEF that provides the necessary environmental compliance for exotic plant management treatments at the four SEUG park units.
4. Standardize exotic plant management at parks so their actions can be more effectively implemented by park managers and explained to the public.

During the past decade SEUG resource management staff have worked to eradicate/reduce invasive vegetation within CANY via mechanical and chemical methods on more than 135 acres (as summarized from the annual exotic management reports starting in 1999). Targeted exotic species have included Russian thistle (*Salsola kali*), field bindweed, halogeton (*Halogeton glomeratus*), Russian knapweed, diffuse knapweed, Russian olive, tamarisk, crested wheatgrass (*Agropyron cristatum*), ripgut brome (*Bromus diandrus),* puncturevine (*Tribulus terrestris*), broad-leaf pepperplant, and yellow bluestem (*Bothriochloa ischaemum*).



Photo: NPS NCPN I&M field crews

Figure 26. The invasive, exotic tamarisk chokes perennial waterways of the Green and Colorado rivers and small, ephemeral tributary drainages.

Project Overview

General Approach and Timeline

The goals of this project were to inventory, describe, and map the existing vegetation at Canyonlands National Park and its environs. The CANY project is part of a larger effort undertaken by the NCPN to classify and map vegetation in all network parks. In order to facilitate coordination among network mapping projects, the NCPN developed standardized databases, mapping conventions, reporting standards, and naming conventions.

The NCPN vegetation classification and mapping program was launched in July 2001 at a scoping meeting among network park staff, NCPN staff, and potential project cooperators. Following this meeting, NCPN prepared a multi-year, multi-park project proposal to the USGS/NPS Vegetation Characterization Program to cost-share network I&M funding with the National Vegetation Characterization Program funding to complete vegetation maps for all network parks (Evenden 2001). A meeting to discuss relevant tasks, approaches, needs, timelines, and necessary staffing to complete the project (including determining the CANY project boundary and classification plot sampling needs, discussing base aerial photography and interpretation approaches, and defining additional park special data) was held February 27, 2003. Table 2 is a timeline for the completion of major project components.

NCPN negotiated interagency agreements with the USDA Aerial Photo Field Office and the USDI Bureau of Reclamation Remote Sensing and Geographic Information Group to acquire aerial photography for each park, including CANY. Stereo aerial photography and orthophotography for CANY were flown/acquired on June 18-19, 2002.

Table 2. Timeline for CANY vegetation mapping project tasks.

TASK DESCRIPTION	2002	2003-2004	2005-2006	2007	2008	2009	2010	2011
Planning and Scoping								
Acquire Aerial Imagery								
Field Data Collection								
Photo Interpretation								
Vegetation Classification								
Local & Global Descriptions								
Field Key to Plant Associations								
Accuracy Assessment								
Final Report and Products								

Vegetation classification plot and observation point data were collected by NCPN and e²M ecologists within CANY and a 160,000 acre (64,750 ha) portion of Glen Canyon National Recreation Area (GLCA) during the fall of 2003 and continuing through the 2004 spring to fall field season. A gradsect analysis utilizing spatial representations of the environmental variables

associated with the regional vegetation diversity was developed to help determine classification plot placement. A cost surface analysis was also generated to aid in the efficient sampling of ecological plots. This field sampling strategy guided by a gradsect polygon or biophysical unit coverage was prepared by Gery Wakefield of NPS-SEUG.

Vegetation plot data were entered into a MS Access database developed for the project and were analyzed during the fall of 2004. Data were analyzed by ecologists contracted by e^2M and reviewed by NatureServe ecologists, who prepared the preliminary vegetation classification and report (Decker et al. 2004). The final assignment of plots to associations of the National Vegetation Classification and the local and global plant association descriptions based on the classification were completed by NatureServe ecologists in 2006, with minor revisions through June 2011. An illustrated field key to CANY plant associations was developed, illustrated, and tested prior to map accuracy assessment (AA) in 2007, and revised and finalized in 2011 (Appendix G).

Aerial photointerpretation (PI) for the ISKY district was conducted by the PI consultant with the help of two NCPN ecologists between the fall of 2006 and spring of 2007. Aerial PI for the remainder of CANY was completed by an NCPN ecologist in the summer of 2008. Map units or classes were defined for the project by the primary photointerpreter with input from NCPN ecologists. A variety of photo interpretation methods were performed. Preliminary linework was created by electronic segmentation methods (e-Cognition software) and used as a starting point. The photointerpreters manipulated this linework as necessary using ArcGIS editing tools by onscreen, heads-up digitizing, and were aided by ancillary datasets and by stereo viewing of overlapping stereo aerial photographs. Polygon attribution was completed by the photointerpreters, following standards developed by NCPN (Evenden 2004). An illustrated field key to CANY map classes was drafted in April 2007, with final revisions made in the summer of 2011 (Appendix K).

A draft vegetation map and associated spatial database were completed for CANY in the summer of 2008. Accuracy assessment (AA) data collection was completed by NCPN and e^2M ecologists during the spring and summer of 2007, the summer and fall of 2008, and the late winter and early spring of 2009. AA data were entered into the CANY project database and then analyzed, with results tabulated into a contingency matrix. An AA meeting for CANY was held August 18-19, 2010 at the SEUG office in Moab, Utah with project cooperators from the NCPN, NatureServe, and CANY park staff to determine which map classes should be retained and which should be combined or modified because they failed to meet the 80% accuracy standard. Final revisions were made to the vegetation classification, field keys, vegetation map, and spatial database from winter 2010 to fall 2011. All geospatial products associated with this project are in the UTM projection, Zone 12, NAD83 datum.

Primary Partners and Project Roles

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

engineering-environmental Management, Inc.

- *Jim Von Loh, Senior Biologist* - prepared project work plan, helped prepare agendas and compile minutes for project meetings, coordinated contractor field crews, collected classification plot,

observation point, and AA data, wrote draft local descriptions, wrote draft AA field key to plant associations
- *Travis Belote, Consulting Ecologist* - collected classification plot and observation point data, wrote draft local descriptions, co-authored the Draft Vegetation Classification report
- *Arne Buechling, Consulting Ecologist* - collected classification plot and observation point data
- *Stephanie Shoemaker, Consulting Ecologist* - collected classification plot, observation point, and AA data
- *Peter Williams, Consulting Ecologist* - collected classification plot, observation point, and AA data
- *Julie Thompson, Consulting Ecologist* - collected classification plot and observation point data
- *Buddy Smith, Consulting Ecologist* - collected classification plot and observation point data
- *Brent Eastty, Consulting Ecologist* - collected AA data
- *Dusty Janeke, Consulting Ecologist* - collected AA data
- *Joe Schroeder, Consulting Ecologist* - collected AA data
- *Karin Edwards, Consulting Ecologist* - collected AA data
- *Ken McCarron, Consulting Ecologist* - collected AA data
- *Matt Smith, Consulting Ecologist* - collected AA data
- *Gerald Manis, Photointerpreter* - photointerpreter for the project, developed initial map class concepts

Colorado Natural Heritage Program
- *Karin Decker, Ecologist* - prepared preliminary classification, wrote Draft Vegetation Classification report, editor of the final report

National Park Service, Northern Colorado Plateau Network
- *Angie Evenden, Ph.D., Vegetation Program Manager* - set NCPN project standards, overall project coordination and management, managed field data collection, contributed to the final report, organized project meetings, managed budgets, agreements and contracts
- *Janet Coles, Vegetation Ecologist* - overall project coordination and management, managed field data collection, contributed to the final report, organized project meetings, managed budgets, agreements and contracts, collected plot, observation point, and AA data, assisted with photointerpretation and map class development
- *Amy Tendick, Ecologist* - 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, finalized vegetation map, edited final AA field key, map class guide, and classification local association descriptions, participated in AA analysis meeting, performed data entry and QC
- *Liz Ballenger, Biological Technician* - field crew leader for plot, observation point, and AA data collection, assisted with photo interpretation and map class development, field tested and revised map class guide and AA field key, performed data entry and QC
- *Margaret Beer, Data Manager* - project database development
- *Helen Thomas* - project database support, photo database development
- *Russ Den Bleyker* - project database support and QC
- *Amy Schwarzbach, Biological Technician* - collected plot and observation point data
- *Lisa Hahn, Biological Technician* - collected plot and observation point data
- *Bruce Condie, Sarah Topp, Biological Technicians* - collected plot, observation point, and AA data
- *Aneth Wight, GIS Technician* - provided support to field sampling crews, produced geodatabase, provided plots database support, wrote final project metadata

National Park Service, Canyonlands National Park

- *Mark Miller, Chief of Resources* - participated in scoping meeting and AA analysis meeting, provided input for final report
- *Charlie Schelz, Ecologist* - participated in scoping meeting, provided long-term monitoring data to project lead
- *Mary Moran, Biological Technician* - contributed logistical assistance and plant identification, provided ancillary datasets to primary photointerpreter
- *Gery Wakefield, GIS Team Leader* - provided project boundary coverage, created a gradsect from various ecological datasets to develop target preliminary plots for field sampling, developed target accuracy assessment plots for field sampling using NVMP standards, generated final accuracy assessment contingency table

U.S. Department of Agriculture Aerial Photo Field Office

- *Cindy Sessions, Contracting Officer* - procured aerial photography (9" x 9" stereo coverage)
- *Mark Cox, Photography Specialist* - provided QA/QC of photography, developed photo index

USDI Bureau of Reclamation Remote Sensing and Geographic Information Group

- *Alan Bell, Photography Specialist* - provided aerial photo contract specifications, subcontracted with Horizons, Inc. for aerial photography and production of color DOQQs for project area, provided QA/QC of orthoimagery

USGS Rocky Mountain Geographic Mapping Center

- *Tom Owens, Photography Specialist* - analyzed aerial photography, PI training, reviewed legacy data

NatureServe

- *Marion Reid, Senior Regional Ecologist* - project manager, reviewed classification, final association list and field key to associations
- *Mark Hall, Regional Ecologist* - assigned final NVC names, wrote final AA field key, wrote final global and local descriptions, participated in AA meeting
- *Keith Schulz, Regional Ecologist* – wrote final global descriptions, participated in AA meeting
- *Mary Russo, Ecology Data Manager* - entered CANY local and global descriptions into NatureServe's BIOTICS database, formatted descriptions, completed plant species crosswalk
- *Kristin Snow, Assistant Ecologist/Ecological Information Manager* - developed format for NCPN plant association local and global descriptions

U.S. Geological Survey – National Park Service National Vegetation Mapping Program

- *Mike Story, NPS Program Leader* - provided national level program oversight
- *Karl Brown, Ph.D., USGS Program Leader* - provided national level program oversight
- *Tammy Cook, Vegetation Mapping Program Biologist* - facilitated generation of final products

Aerial Photography

High-quality aerial photography of an appropriate scale is an important part of all USGS-NPS National Vegetation Mapping Program projects. Orthophotography provides a base image for mapping vegetation in a digital format and is the basis for interpreting vegetation patterns. Stereo photographs acquired vertically from the air, with adequate overlap, allow three-dimensional, high-resolution photointerpretation when viewed under a stereoscope (Avery 1978). At the beginning of the NCPN vegetation mapping program, network staff decided to acquire new stereo pair aerial photography, as well as orthorectified imagery at a 1:12,000 scale for eleven of the park units, including CANY.

To maximize cost savings, the NCPN planned to acquire aerial photography concurrently for several park units. In order to minimize shadow effects associated with canyon topography and maximize vegetative expression, the goal was to minimize the sun angle by flying as close as possible to noon on the summer solstice (June 21). True color aerial photography was chosen because it minimizes the effects of shadows in deep canyons. It was also determined that true color photography would best illustrate the vegetation patterns of the park units being mapped.

Stereoscopic Aerial Photo Coverage

NCPN contracted with Horizons to acquire new 23 cm x 23 cm (9 in x 9 in) true color aerial photographs for CANY. The imagery was acquired on June 25-July 12, 2002, by Blue Skies Consulting, LLC of Albuquerque, New Mexico. The photography was acquired at a nominal elevation of 6,000 ft (1,829 m) above ground level in a Cessna T210N aircraft. A Wild RC10 camera with 15.2 cm (6 in) lens was used with Kodak Aerocolor negative film. The target scale for this photography was 1:12,000 (1 in = 1,000 ft). The mission was designed with approximately 30% sidelap between flight lines and 60% overlap between individual photographs. The project encompassed 1291.5 linear km (802.5 miles) divided among 35 flight lines and 1230 individual photographs (Figure 27).

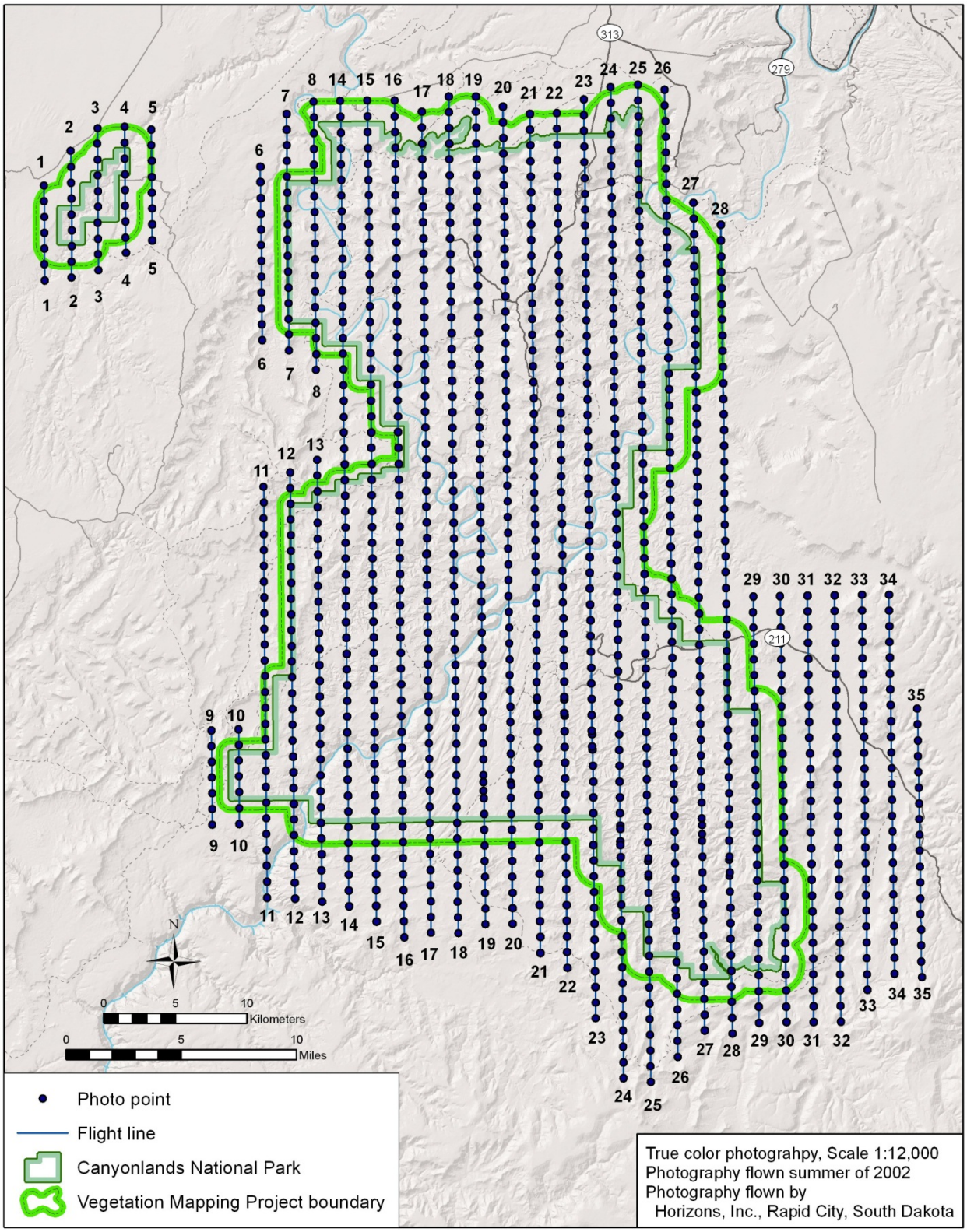


Figure 27. Flight lines for the 2002 stereo aerial photograph coverage of CANY.

Figure 28 is an example of the 23 cm x 23 cm aerial stereo photographs for CANY. These photographs were used for photo interpretation during the mapping phase of the project, as well as by field crews during plot data collection. The film negatives for this aerial photography coverage are permanently stored at the APFO in Salt Lake City, Utah. The APFO made two sets of color prints. One set was distributed to CANY; the other is retained at the NCPN offices in Moab, Utah.

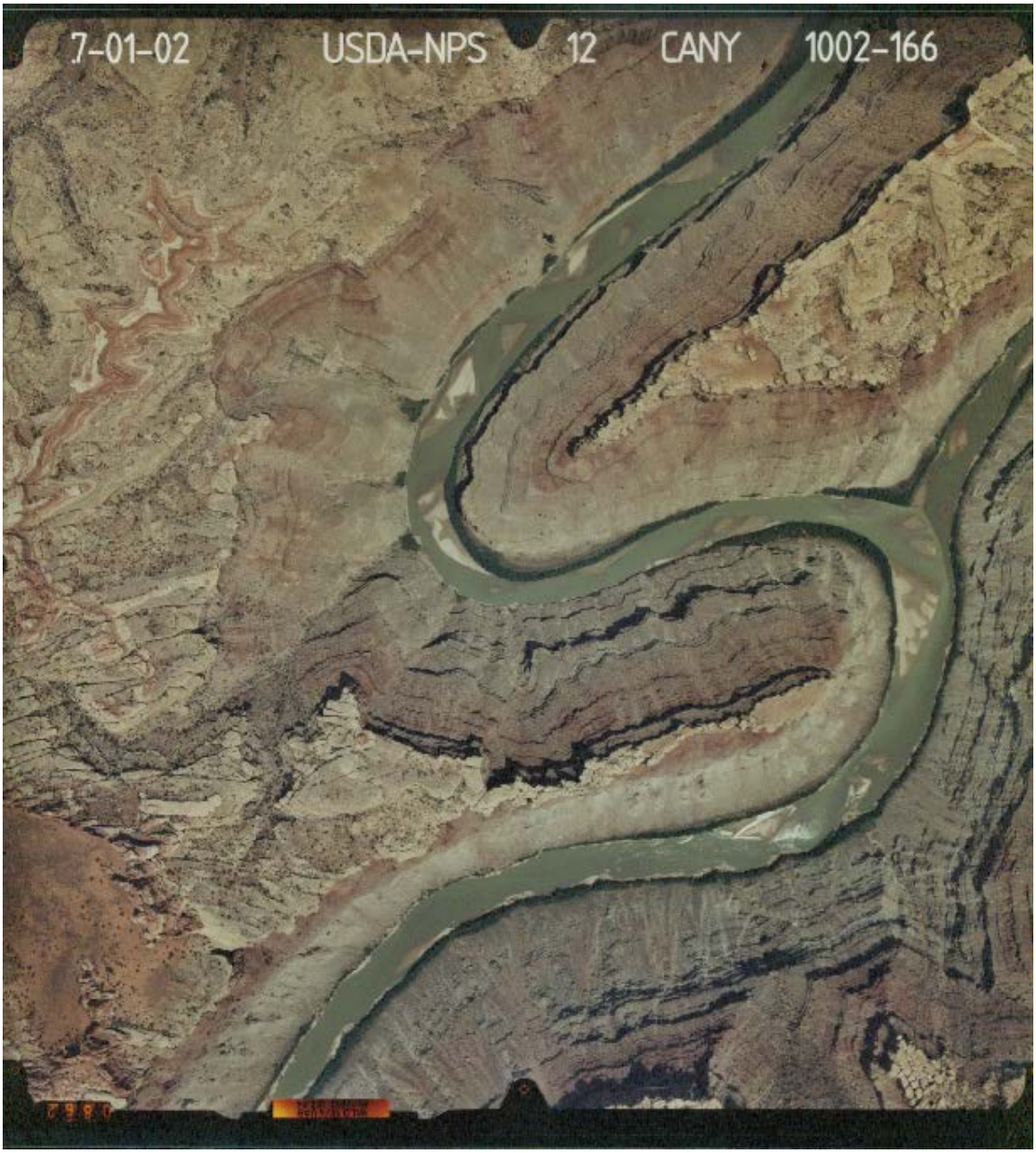


Figure 28. Example of a 9” x 9” stereo aerial photograph taken for the CANY vegetation classification and mapping project.

Digital Orthophotos

The USBOR Remote Sensing and Geographic Information Group in Denver, Colorado, approved 1:12,000 scale digital orthophotography for CANY from the aerial imagery. Developing orthophotography was subcontracted to Horizons Inc. of Rapid City, South Dakota. The photography was flown on June 18-19, 2002, at a mean above ground level elevation of 6,096 m (20,000 ft). Sidelap was approximately 40% and overlap about 60%. Airborne global positioning system (GPS) data were collected for each exposure. A Zeiss RMK 15/23 camera with a 15.2 cm (6 in) lens was used with AGFA100 film. Aerial coverage was similar to the stereo photo imagery (Figure 27).

The original film was scanned at 21 microns to create pixels of approximately 0.84 m. Horizons, Inc. created a photographic mosaic by extracting the high quality image from the center of each photograph and stitching them together digitally. The photographic mosaic was then magnified to the 1:12,000 scale and corrected through a computational process that warps and stretches the image between known control points. The orthorectification process removes distortion caused by tilting of the camera and scale variation of the terrain. Control points for the orthorectification were obtained from USGS digital elevation model (DEM) 10 m data, aero triangulation data, and airborne GPS data. The X, Y, Z, omega, phi, and kappa for each photograph were calculated by Horizons, Inc. Final adjustments to the digital orthophoto database were solved using Erio Technologies ALBANY software. ALBANY is a simultaneous least squares bundle adjustment, which is designed for use with airborne GPS. Color adjustment of the final orthophoto coverage was achieved by visually matching the tone, contrast, and brightness to the original film. Each scanned image was checked for missing data.

The composite image covering the project area was inspected for tone balance and image distortion. In areas of image distortion, imagery from a slightly different angle on an adjacent photo was inserted where possible. The final digital orthophotos were visually inspected for accuracy and consistency. Some areas of the final orthophoto imagery remain blurred due to the extreme terrain and limitations of the USGS DEM data. Film negatives for CANY 2002 color digital orthophotos are permanently archived in airtight containers at the USBOR RSGIG offices in Denver, Colorado.

Project Boundary and Map Extent

A project environs adding a strip approximately 1.6 km (1 mile) wide around the park boundary was chosen by network and CANY staff at the February, 2003 scoping meeting (Figure 2). It was decided that the Orange Cliffs section of Glen Canyon National Recreation Area would be encompassed in the project boundary for plot collection; however only a section of Orange Cliffs, a ½ mile wide strip adjacent to the CANY boundary, was mapped and included in the final project boundary. Wider environs were chosen along the southern boundary of the Park in Beef Basin, Cross Canyon, and Butler Wash areas, because there is a research area within and surrounding this part of the Park and the environs area includes the watershed boundary of this research area. Again, plot collection occurred throughout these wider southern environs, but mapping only occurred in the one mile strip adjacent to the Park boundary. The total project mapping area is 170,618 hectares (421,605 acres). Of this area, 135,204 ha (334,096 acres) are within the CANY boundary and 35,414 hectares (87,509 acres) are in the environs. The environs were delineated to provide data to support management coordination on adjacent private, state, and BLM managed lands.

Minimum Mapping Unit

At the request of park staff, the photointerpreters agreed to map features as polygons to the extent that they could see them, including polygons smaller than the standard 0.5 ha (1.2 acre) minimum mapping unit (MMU) and selected small vegetation stands known as park specials which may be represented by points.

Ecological System Classification

The NCPN elected to use the ecological system (ES) classification structure developed by NatureServe (Comer et al. 2003, NatureServe 2003) as a framework for organizing and presenting plant community data. An ES is defined as a group of plant associations from two or more alliances that tend to co-exist in a given landscape due to similar ecologic processes, substrates, and/or environmental gradients. The ES classification was developed to provide larger scale classification units for application to resource management, mapping, and conservation. Current estimates are that Colorado and Utah support more than 80 ecological systems (NatureServe 2008). This approach complements the NVC; the finer-scale associations provide a basis for interpreting larger-scale ES patterns and concepts. A description of each ecological system identified in CANY appears in Appendix A.

The ecological system classification addresses natural landscapes. Land-use categories used to identify developed areas are described elsewhere in this report. Twenty-six ES units are known to occur within the CANY vegetation mapping project area (in alphabetic order with NatureServe identifying codes):

- Apacherian-Chihuahuan Semi-Desert Grassland (CES302.735)
- Colorado Plateau Blackbrush-Mormon Tea Shrubland (CES304.763)
- Colorado Plateau Hanging Garden (CES304.764)
- Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)
- Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)
- Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
- Inter-Mountain Basins Active and Stabilized Dune (CES304.775)
- Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)
- Inter-Mountain Basins Cliff and Canyon (CES304.779)
- Inter-Mountain Basins Greasewood Flat (CES304.780)
- Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783)
- Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
- Inter-Mountain Basins Playa (CES304.786)
- Inter-Mountain Basins Semi-Desert Grassland (CES304.787)
- Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)
- Inter-Mountain Basins Shale Badland (CES304.789)
- Inter-Mountain Basins Wash (CES304.781)
- North American Arid West Emergent Marsh (CES300.729)
- North American Warm Desert Riparian Woodland and Shrubland (CES302.753)
- Rocky Mountain Cliff, Canyon and Massive Bedrock (CES306.815)
- Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)

- Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)
- Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)
- Rocky Mountain Subalpine-Montane Riparian Shrubland (CES306.832)
- Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)
- Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)

Vegetation Classification and Description

Pre-Field Methods

Preliminary Classification List

A preliminary list of plant associations was completed jointly for CANY, ARCH, and NABR. The process began by accessing NatureServe, and sorting associations by applicable United States Forest Service (USFS) ecoregions as described by Bailey (2001). This list was further focused using the species list updated by park biologist Charlie Schelz in 2000 (Schelz 2001), thus eliminating those associations of species not likely to occur at CANY/ARCH/NABR. List preparation was performed by plant ecologists familiar with the vegetation of the Northern Colorado Plateau and checked by NPS regional and park ecologists (Charlie Schelz and Jayne Belnap) who are familiar with the vegetation types present within CANY/ARCH/NABR. The final preliminary plant association list for CANY/ARCH/NABR contained approximately 110 plant associations for the vegetation mapping project area. 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 CANY were evaluated for adequacy and/or relevance to the National Vegetation Classification and Mapping Program project at CANY. Long-term vegetation monitoring at 27 established, permanent transects has been conducted annually since 1987 (Schelz and Moran 2002a). The series of 25m^2 transects was established by Jayne Belnap to provide baseline vegetation information and document vegetation trends and natural vegetation variability in a variety of vegetation communities. The long-term vegetation monitoring program did not intend to produce a classification for CANY; however, the plots were distributed to represent the primary plant community types, and were subdivided between the NEED, MAZE, and ISKY districts. Twenty-two plant community types are represented by the 27 transects; table 3 provides the transect names and the plant community types they represent.

Table 3. Long-term vegetation monitoring transects monitored annually within CANY.

Park Area	Transect Number	Habitat Type	Location	Representative Plant Community
Canyonlands – Needles District	N1	Planar Pediment Shrub Steppe	Lower Jump	Blackbrush-Galleta Grass-Mormon Tea
	N2	Planar Alluvial Bench Shrub Steppe	Cave Spring Junction	Big Sagebrush
	N3	Planar Plains Grassland	Squaw Flat	Indian Ricegrass-Galleta Grass-Cheatgrass
	N5	Planar Alluvial Bench Shrub Steppe	Salt Pocket	Greasewood-Rabbitbrush
	N7	Slickrock Level Shrub Woodland	Pothole Point	Pinyon Pine-Utah Juniper
	N10	Planar Plains Grassland	Contact Station-Burn	Cheatgrass
	N11	Planar Plains Grassland	Chesler Park	Indian Ricegrass-Galleta Grass-Blue Grama
	N19	Planar Plains Grassland	Contact Station-Control	Cheatgrass-Shadscale

Park Area	Transect Number	Habitat Type	Location	Representative Plant Community
Canyonlands – Island-in-the-Sky District	I1	Planar Mesa Top Grassland	Gray's Pasture	Indian Ricegrass-Needle-and-thread Grass-Blue Grama
	I3	Planar Mesa Top Pygmy Forest	Murphy Point	Pinyon Pine-Utah Juniper
	I4	Planar Mesa Top Pygmy Forest	Grandview Point	Pinyon Pine-Utah Juniper
	I6	Planar Pediment Grass/Shrub Steppe	Musselman Canyon	Galleta Grass-Indian Ricegrass-Blackbrush
	I7	Planar Pediment Shrub Steppe	White Crack	Blackbrush-Mormon Tea
	I8	Riparian Open Valley Shrub Steppe	Upheaval Bottom	Greasewood-Four-wing Saltbush
	I10	Planar Pediment Grass/Shrub Steppe	Taylor Canyon	Four-wing Saltbush-Cheatgrass
	I11	Planar Pediment Shrub Steppe	Musselman Canyon	Snakeweed-Shadscale-Blackbrush
	I12	Shallow Slope Sand Dune Shrub Steppe	White Crack – Sand	Alkali Sacaton-Blackbrush
	I16	Shallow Shale Slope Barrens	Taylor Canyon	Shadscale-Mormon Tea
	I17	Shallow Shale Slope Barrens	Murphy Hogback	Shadscale-Woody Aster
	I18	Planar Mesa Top Grassland	Boundary Grazed	Galleta Grass-Mormon Tea
	I19	Planar Mesa Top Grassland	Boundary Ungrazed	Galleta Grass-Mormon Tea
Canyonlands – Maze District	M1	Slickrock Level Pygmy Forest	Lizard Rock	Pinyon Pine-Utah Juniper
	M2	Planar Plains Grassland	North Flat	Indian Ricegrass-Needle-and-thread Grass-Galleta Grass
	M4	Basin Grass/Shrub Steppe	Spanish Bottom	Four-wing Saltbush-Cheatgrass
	M5	Planar Pediment Shrub Steppe	Chimney Rock	Greasewood
	M10	Planar Plains Grassland	Harvest Scene	Four-wing Saltbush-Alkali Sacaton
	M12	Planar Pediment Shrub Steppe	Jasper Canyon	Prickly Pear-Indian Ricegrass-Needle-and-thread Grass

These legacy data for the long-term vegetation monitoring at CANY at a minimum fall within Category II as defined in program standards for legacy data (TNC 1996), i.e., "*data are adequate to assist in photointerpretation, photographic signature key development, or map accuracy assessment (i.e., the vegetation and site information are of lower quality, but the samples represent existing vegetation and are geo-referenced with reasonable confidence).*" As such these data are considered most useful to assist with: 1) planning a sampling approach; 2) guiding further data collection; 3) providing aerial photo signature guidance and/or validation; 4) writing local plant association descriptions; and 5) preparing the final mapping project report. However, if an ecologist inferred structural composition of each plot based on the available species lists and numerous ground photographs of each site, the data can also be useful for classification plot and observation point data. The data would then be considered Category I: "*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)." Table 4 provides a synopsis and ranking of this data set by e^2M ecologists.

Table 4. Comparison and Ranking of Long-Term Vegetation Monitoring Data Usefulness, Using Key Data Quality Factors

Quality Factors	Long-term Vegetation Monitoring Datasets
Accessibility of data sets	5
Compatibility in sampling approach and methods	2
Utility of data format and condition	5
Recognition of special value of a particular data set	4.5
Inclusion of core vegetation and environmental characteristics	4.5
Currency of the data set	5
Adequacy of geo-referencing	5
Total Ranking Score	**31**
Category of Utility	I/II

Field Methods

The primary purpose of classification plot data was to document the composition and structure of CANY vegetation and associated environmental conditions. These data became the basis for classifying the vegetation within the park and a portion of GLCA. Field methods used in gathering new data for this project followed national program standards (e.g., TNC and ESRI 1994a, 1994b). Data gathered 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 Sampling Approach

The sampling area included the entire park as well as the Orange Cliffs section of Glen Canyon National Recreation Area (GLCA), Utah School and Institutional Trust Lands Administration (SITLA), U.S. Forest Service and BLM lands in the environs. Private lands in the environs were not visited. Because the project area is topographically complex and access can be difficult, the areas to be sampled were selected in advance of the 2003 field season. In order to obtain a thorough sample of the range of plant communities both common/extensive and rare/unique, a method to stratify the park using a gradsect approach was employed (GRADient-directed TranSECTS) (Austin and Heyligers 1989, Gillison and Brewer 1985). A gradsect area survey method that addresses: 1) the need for representative sampling based on environmental stratification, 2) the need for a compromise between statistical sampling, practical logistical problems and costs, and 3) the value of replicated and randomized sampling (Austin and Heyligers 1989, Gillison and Brewer 1985) was used to allow field crews to visit the full spectrum of physical environments and thus most of the vegetation types.

For the CANY modified gradsect, elevation, soils and solar insolation were chosen as the key abiotic factors (Table 5). The selection was based on gradsect biophysical units (BPUs) designed to ensure that all major environmental settings were visited and a good spatial dispersion of sample plots was achieved. The BPUs were constructed by layering soils, elevation, and solar

insolation (an index of sun exposure based on aspect and landscape position) information. The result was a set of polygons representing unique combinations of these environmental factors. The "cost" (distance from road or trail multiplied by a factor accounting for steep slopes) of accessing each polygon was calculated, and the polygons deemed too difficult or dangerous to access were withdrawn. A random sample of polygons representing each combination of factors became the target areas for sampling, although field crews were encouraged to use their judgment and sample areas outside the BPUs if they contained representative or unusual vegetation types.

Table 5. Key abiotic factors and environmental variables used in the modified Gradsect analysis for Canyonlands National Park.

Key Abiotic Factors	Environmental variables
Solar Insolation	Dark (shade)
	Less dark (partial shade)
	Less bright (partial sun)
	Bright (full sun)
Soils	15 classes
Elevation	3,000 – 4,000 feet
	4,000 – 5,000 feet
	5,000 – 6,000 feet
	6,000 – 7,000 feet
	7,000 – 8,000 feet

Field crews were led by ecologists with experience sampling plant communities in national parks and other landscapes. The list of 110 potential plant associations provided a starting point for naming communities sampled in the field. The sampling goal was to collect between three and five classification plots in every vegetation association within the CANY project area. However, some common associations were sampled more often to represent their range of variability, including among geologic substrates, and some rare types were sampled less often, 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 2003 and 2004 field seasons. Six hundred sixty-five classification plots and 322 observation points were sampled in CANY and 249 plots and 51 observation points were sampled in GLCA.

Plot Data Collection

Field crews located classification plots subjectively within the 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 PI. Highly disturbed areas were also avoided for classification plot sampling unless they covered several hectares. 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 size was determined by the physiognomy of the community being sampled (Table 6). Plot shape was adjusted as needed to sample linear bands of vegetation in drainage

bottoms. Plot size and shape were recorded for all classification plots. Plot sizes were consistent for woodlands, shrublands, and herbaceous vegetation stands.

Table 6. Plot sizes and shapes used for vegetation classification sampling at CANY.

Plot Shape	Area (m^2)	Length X Width (m)
Square	400	20 X 20
Rectangular	400	40 X 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 in Appendix B and data definitions in Appendix C. Four categories of data were collected for vegetation plots (Table 6):

- location and plot identifiers
- environmental description
- vegetation description
- other information

Location and Plot Identifiers

CANY staff requested that the vegetation classification plot locations not be permanently marked. 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 are listed in Table 7 and are described in detail in Appendix C. Locations were recorded on topographic maps during each field trip to avoid duplication of effort and ensure that the park was adequately sampled.

Table 7. 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, quad code, GPS unit, GPS file ID, 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 the setting of the plot; describes adjacent communities, note unusual ecological processes, continue descriptions from other narrative fields

Environmental Description

The physical characteristics of each classification plot were documented in both categorical and narrative fields (Table 4; 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 12 physiognomic strata (Appendix B). Within each stratum, the investigator recorded average height and percent canopy cover for all species using the scales in Table 8. Consistent and repeatable 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. All plant material collected for identification was destroyed in analysis. Provisional plant association names were assigned to each plot using the preliminary association list and professional judgment.

Table 8. Vegetation cover and height classes used in the CANY vegetation mapping project.

Species and Strata Canopy Cover Classes				**Strata Height Classes**	
Code	Range	Code	Range	Code	Range
(t)	few	6	>55-65%	01	<0.5 m
T	0-1%	7	>65-75%	02	0.5-1 m
P	>1-5%	8	>75-85%	03	>1-2 m
1-a	>5-10%	9	>85-95%	04	>2-5 m
1-b	>10-15%	10	>95%	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

Other Information

Field crews were encouraged to record general observations on how well the plot represented the stand, the relationship of site conditions to vegetative patterns, characteristics of adjacent vegetation, and site disturbance history. The overall character of the vegetation and features of each plot were recorded in two 35 mm color slide photographs.

Data Processing and Analysis

Nine hundred and fourteen vegetation plots were sampled within the mapping project area during the fall 2003 and 2004 field seasons (Figure 29). Plot data were manually entered into the CANY Vegetation Mapping Project Database, developed by the NCPN data management staff. This database is compatible with the data standards of the PLOTS Database System developed for the USGS-NPS Vegetation Mapping Program by TNC (1997). The NCPN database offers greater flexibility in overall data management than does the NatureServe PLOTS database, and is

designed to accommodate all project field data recorded in plots, observation points, and AA points. Data standards were established by the NCPN for all network vegetation mapping projects, allowing compatibility of data across network park units. Fields associated with the CANY plots database are described in Appendix C.

Each 35 mm color slide associated with the project was scanned into a digital format. The 4,609 digital images of plots, observation points, AA points and scenery were stored in a photograph database. A unique identifier allows each photograph to be linked with the plots and spatial databases.

Observation Points

In addition to classification plots, field crews collected vegetation and environmental data at 373 observation points within the mapping project area. 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 35mm color slide 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:

- they were sampling the environs outside the park boundary
- the vegetation was highly disturbed, ecotonal, or otherwise anomalous and therefore unlikely to be classified under the NVC
- vegetation occupied inaccessible areas where the community could only be viewed from a distance with binoculars
- they were sampling a vegetation type that had already been extensively sampled by field crew members earlier that field season
- they encountered a unique stand of vegetation but didn't have time to sample a full plot
- they wanted to document a vegetation type that consistently occurred in stands smaller than 0.5 ha (1.24 acres).

A thorough quality assessment and quality check (QA/QC) was 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. Additional QA/QC was performed using a set of queries designed to identify inconsistencies across data fields and check for missing data. NCPN technicians standardized the scientific names in the database and noted name changes on the field forms. The primary authority used for plant names for the CANY vegetation mapping project and all other NCPN I&M projects is *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 made available to e^2M and NatureServe ecologists for vegetation classification analysis. Slide labels were printed from the database. A GIS data layer (point data) was developed to document classification plot locations.

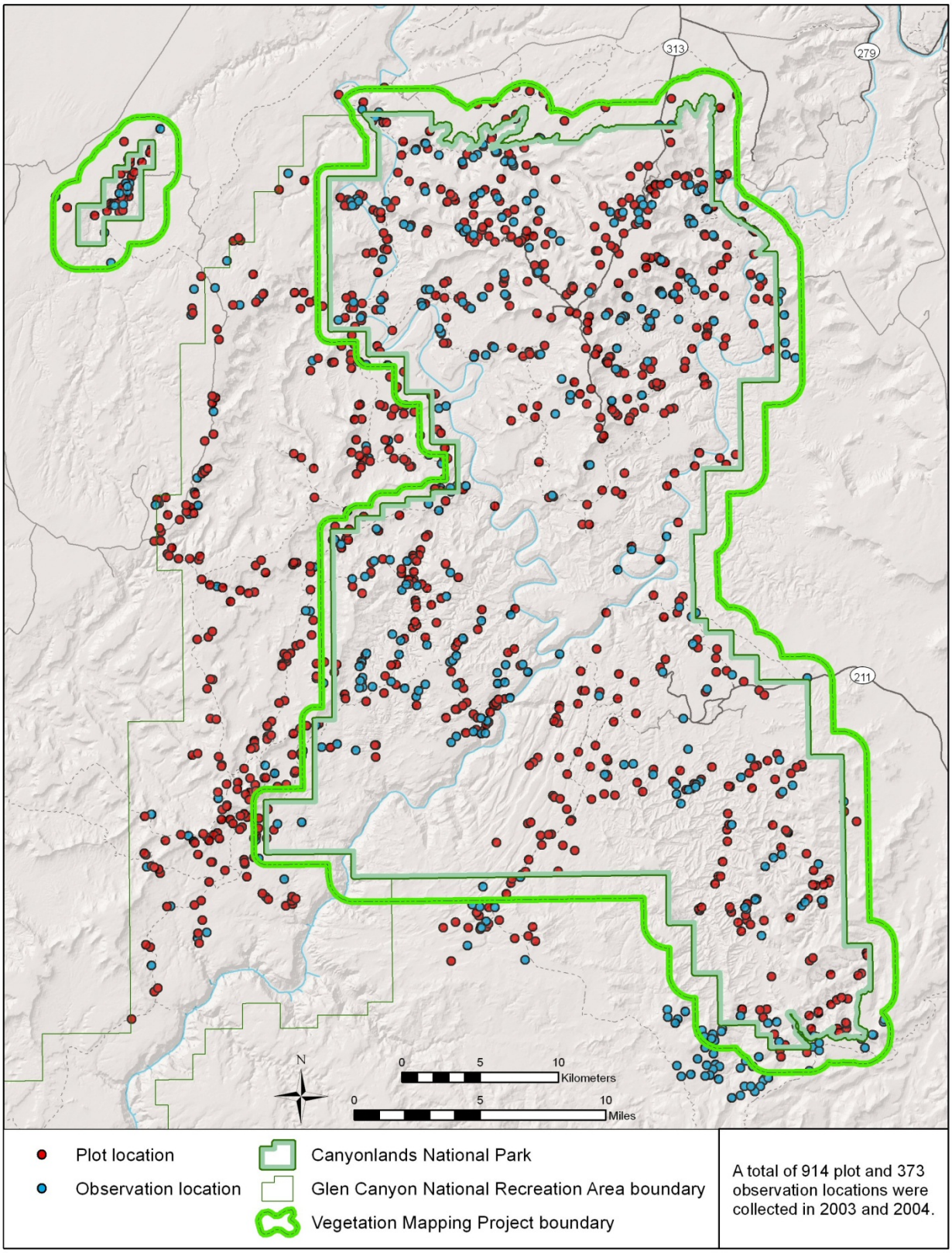


Figure 29. Vegetation plot and observation point locations in the CANY mapping project area.

Classification Data Analysis

A total of 914 plots were available for analysis. An additional 373 observation points were not used in the analysis. The data were exported in list format from the Plots database, and then imported directly into a matrix for analysis using PC-Ord (McCune and Mefford 1999) after species names and cover classes had been formatted to meet PC-Ord requirements. The mid-point of each cover class was 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, all species were retained for the initial analyses. The final data set contained 914 samples and 454 species.

A variety of exploratory analytic techniques were used, including summary statistics, outlier analysis, Bray-Curtis ordination (polar ordination), cluster analysis, indicator species analysis and tabular analysis. Cluster analysis was used to stratify the complete data set initially. When groups identified by the initial cluster analysis could not be parsed further with these methods, individual plots were inspected and assigned to associations or alliances based on species composition, cover and environmental data. There were 39 plots in the dataset with average distance greater than two standard deviations. As is often the case in datasets like this, these outliers for the most part represent valid vegetation types (primarily riparian or weedy types) that are uncommon and hence, undersampled. The outliers were retained in subsequent analyses.

Average total cover for all plots was 30.7%, with a range from 3% to 130%. The average number of species per plot was 15.4 (range 2-35). Gamma, or landscape diversity, as measured by Simpson's index of diversity (1-D, the probability that two randomly selected individuals in a community are of different species) averaged across all plots was reasonably high at 0.74.

The initial ordination of the complete data set (using the Bray-Curtis method with Sorensen distance) was difficult to interpret, and not very useful as a data reduction method. A variety of data transformation and relativization techniques failed to improve the outcome, a common result for a large data set covering many diverse vegetation types. The data were then stratified into smaller sets using cluster analysis (Sorensen Distance, flexible clustering linkage method, $\beta = -0.25$) to search for possible subgroups. The resulting dendrogram (Figure 30) exhibits very low chaining at 0.33%. Indicator species analysis (ISA) (Dufrêne and Legendre 1997) as implemented in PC-Ord (McCune and Mefford 1999) 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).

Indicator values can be used as a mechanism for choosing a stopping point in cluster analysis, as the number of significant indicators is supposed to reach a maximum at some intermediate level (Dufrêne and Legendre 1997). ISA scores and p-values are calculated for each successive level of the cluster analysis, and when plotted against the number of clusters at each level, can give a quick graphic picture of the optimal pruning point. This technique was used to examine the initial dendrogram for an appropriate clustering level. The number of significant indicators continued to increase beyond the point at which the computational time involved in each step reached a point of diminishing returns (>50 groups). The amount of information gained at each level of the dendrogram appears to increase gradually between occasional larger leaps. Larger steps presumably correspond to longer branches of the dendrogram. Because there was no clear criterion for cutting the dendrogram at a particular lower level, we decided that a local maximum of 15 ecologically meaningful groups would be appropriate for stratification. The 15 groups are shown in Table 9. Groups are arranged from largest to smallest and contain summary discussions of the analysis of each of the 15 main groups.

Table 9. 15 groups identified by the initial cluster analysis.

Group	# plots	# spp	Ordination and ISA results
Mixed shrub and pinyon-juniper woodlands	132	211	Six groups of pinyon-juniper with a variety of shrubby or herbaceous understory types
Shrubland and herbaceous dominated by non-vascular	124	212	The influence of non-vascular species confused interpretation of plots. These plots appear to be primarily high non-vascular cover variants of types found in other groups, and not necessarily separate associations. The non-vascular species were removed from the data set, and cluster analysis used to break the group into three initial subgroups: one characterized by *Krascheninnikovia lanata, Ephedra torreyana, Atriplex canescens*, and other sparse shrubs, all with varying cover of *Pleuraphis jamesii,* the second characterized by pinyon-juniper and a variety understory shrubs, and the third consisted of a very mixed group of shrub and herbaceous types.
Atriplex confertifolia – *Ephedra torreyana* shrublands	121	163	Tabular analysis was used to separate plots according to percent cover of the three dominant species, resulting in the following combinations: 1) *Atriplex confertifolia* dominated, 2) *Ephedra torreyana* dominated, 3) *A. confertifolia* and *E. torreyana* in more or less equal proportion, with little to no *Coleogyne ramosissima*, 4) all three species in equal amounts, 5) *Coleogyne ramosissima* dominated, 6) *E. torreyana* and *C. ramosissima* in more or less equal proportion, with little to no *A. confertifolia*, and 7) a couple of plots with equal amounts of *A. confertifolia* and *C. ramosissima* and little *E. torreyana.* Total vegetation cover (exclusive of non-vascular cover) is generally low, with an average of 11.6%.
Pinyon – Juniper and Juniper woodlands	119	185	Although an overlay of these groups on the ordination of the plots again did not show strong patterns, discriminant analysis showed that 76% to 97% of the points were correctly classified based on the species composition, depending on a variable selection option.
Misc. shrublands and herbaceous of sandy, alluvial soils	119	233	The first iteration revealed three shrubland types characterized by *Artemisia filifolia, Sarcobatus vermiculatus*, and *Krascheninnikovia lanata*. Groups identified in the second round were *Artemisia tridentata* ssp. *tridentata* shrublands, and *Ericameria nauseosa* shrublands and a third round identified plots characterized by *Juniperus osteosperma* (not all woodland), or by *Achnatherum hymenoides* (not all herbaceous). A final round separated a new type characterized by *Sphaeralcea coccinea*, and a *Hesperostipa comata* herbaceous association. The remaining plots belong to a variety of shrubland and herbaceous types and include types characterized to some degree by

Group	# plots	# spp	Ordination and ISA results
			Atriplex canescens, Ephedra torreyana, Gutierrezia sarothrae, Opuntia spp., and miscellaneous herbaceous species.
Coleogyne ramosissima shrublands	58	100	In the initial cluster analysis of this group, clusters were almost entirely defined by percent cover of *Coleogyne ramosissima,* in a pattern strikingly similar to that observed at Arches National Monument (Decker and Coles 2003). The group contained four groups separated by having high cover of *Coleogyne ramosissima* (20%+), moderate cover (7.5-12.5%) both with and without pinyon-juniper, and low cover (<7.5%).
Populus fremontii riparian (+hanging gardens/seeps)	54	207	The core of this group is formed by *Populus fremontii* woodlands. *Populus fremontii* is associated with a variety of understory shrubs and herbaceous species, with sparse to dense cover. Willow shrublands (*Salix exigua* and *S. lutea*) also form a recognizable group, as do hanging gardens characterized by *Aquilegia micrantha* and seeps dominated by *Calamagrostis scopulorum.* The remainder of the group includes rarely sampled types characterized by woody riparian species such as *Betula occidentalis, Rhamnus betulifolia, Cornus sericea,* and *Ostrya knowltonii.* Remaining plots are largely wetland herbaceous types characterized by species such as *Juncus balticus, Phragmites australis, Equisetum laevigatum*, and others.
Shrublands - rocky	53	126	This group includes a variety of shrublands of shallow, rocky soils, many of which are characteristic of slickrock areas or rocky soils. Recognizable subgroups include sparse *Cercocarpus intricatus* slickrock vegetation and *Artemisia bigelovii* shrublands. Other shrub or woodland types are characterized by *Fraxinus anomala, Amelanchier utahensis, Coleogyne ramosissima*, *Rhus aromatica* var. *simplicifolia*, and *Juniperus osteosperma.*
Shrublands - grassy	37	114	These are shrublands of areas with sandy or more developed soils. Most plots have a notable graminoid component of species such as *Pleuraphis jamesii, Achnatherum hymenoides, Hesperostipa comata*, and *Bouteloua gracilis*, although total graminoid cover rarely exceeds 15%. The core of this group is formed by a variety of *Ephedra viridis* shrublands and a small cluster of *Artemisia tridentata* ssp. *wyomingensis* shrublands.
Sparse dwarf shrub (*Leymus salinus*)	27	86	Plots are generally characterized by the presence of *Leymus salinus* and/or *Pleuraphis jamesii*. *Leymus salinus* is found as an understory to *Juniperus osteosperma*, as a dominant in a sparse grassland, or as a component of dwarf shrubland or shrub herbaceous types. Other types present in this group include *Eriogonum corymbosum* and *Zuckia brandegeei* associations, as well as a less well defined group characterized by larger shrub species such as *Fendlera rupicola, Chrysothamnus* spp., and *Ephedra* spp.
Weedy and shrubby riparian	24	51	Plots of this group belong primarily to shrubby riparian types, and tended to have a weedy component. Cluster analysis identified subgroups characterized by *Forestiera pubescens, Salix exigua* (alone or with *Populus fremontii* or *Salix gooddingii*), a single *Acer negundo* plot, and a group of *Tamarix chinensis* dominated plots .The *Forestiera pubescens* plots are notable for providing additional documentation for a type that was previously described from a few plots in southwestern Colorado.
Atriplex gardneri – sparse vegetation	17	46	This group is primarily composed of plots belonging to the *Atriplex gardneri* dwarf shrubland type. A few plots on the edge of this cluster are closer in composition to plots of the *Atriplex confertifolia – Ephedra torreyana* cluster discussed above.
Pleuraphis jamesii shrub and herbaceous	16	57	This group included plots characterized by the presence of *Pleuraphis jamesii*, either as a dominant component of herbaceous vegetation, or

Group	# plots	# spp	Ordination and ISA results
			as a codominant with a variety of shrubs including *Atriplex confertifolia, Ephedra torreyana, Krascheninnikovia lanata, Sarcobatus vermiculatus,* or *Opuntia* spp.
Oak woodlands	8	68	This group consisted of plots dominated by *Quercus gambelii*, either as the dominant species, or as an understory to pinyon-juniper.
Sporobolus airoides herbaceous	5	21	This small group formed a clear set of herbaceous plots characterized by *Sporobolus airoides*, and were assigned to associations without additional analysis.

A variety of additional analyses were performed for each group to:

1. Identify groups/plots that appear to belong to existing associations
2. Identify groups/plots that support the description of new associations
3. Characterize groups/plots that don't fit the above criteria

Each of the fifteen groups identified in the initial stratification was analyzed using cluster analysis (Sorensen distance, flexible clustering linkage method, β= -0.25), indicator species analysis, ordination (Bray-Curtis with Sorensen distance), grouping and summary queries from the original data, and tabular analysis as necessary. Techniques for tabular analysis were based on the procedures suggested by Mueller-Dombois and Ellenberg (1974) for classifying vegetation by tabular comparison. For some groups, ordination and cluster analysis were used in an iterative pruning method. With this technique cluster group membership is used to identify interpretable groups in an ordination. These groups are removed from the data set, and the analysis is repeated. Only a few groups proved amenable to analysis by this method. Because CANY/GLCA 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 68 subgroups within the 15 main groups listed above. Of these, eight subgroups were types with only one or two plots that represent undersampled associations or severely degraded examples of known types.

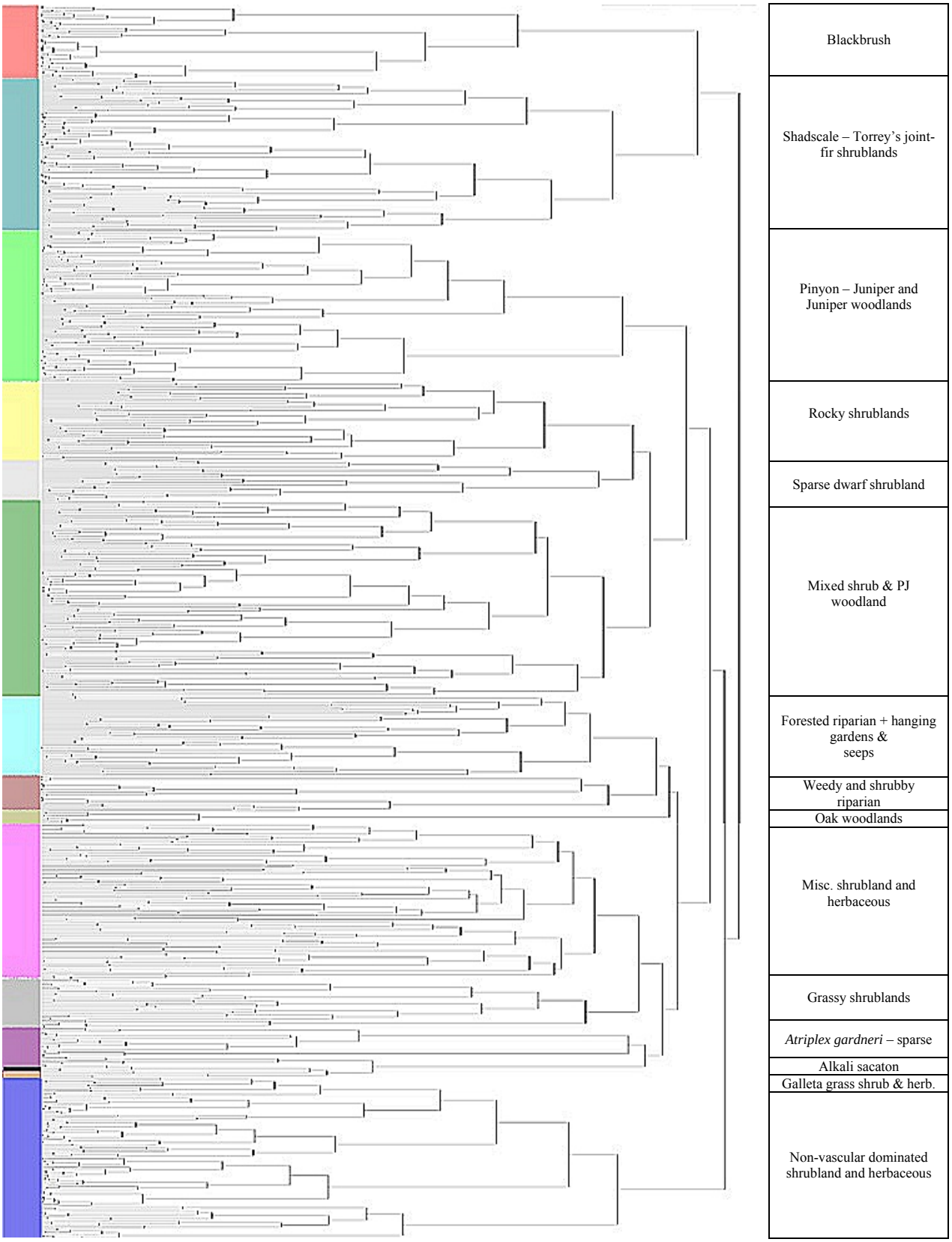


Figure 30. Generalized cluster analysis dendrogram of complete data set, interpreting 15 groups.

Classification Results

The draft classification for CANY was issued by NatureServe at the end of 2004, and underwent several revisions prior to release of the final classification in June 2011. Following the final AA data collection in early 2009, types not previously recognized from the park were analyzed for possible inclusion. Twenty-nine plant associations encountered during AA were added to the CANY final classification. Revisions included amending the classification to include these associations, amending local descriptions based on finding a rare association to be much more common during the AA phase, and updating assignments of associations to ecological systems.

The vegetation of the CANY mapping project area is classified into 164 community types. Of these, 138 are described at the plant association level, four are described at the vegetation alliance level, and twenty-two are described as 'park specials' because they are known from only one or two plots (or only from observation and/or AA points), are known only from CANY, and have no known literature references describing the same or closely related types. Park specials are not assigned to NVC associations or alliances. Four additional NVC associations were described only for the Orange Cliffs section of GLCA, for a total of 168 community types described for the entire CANY/GLCA mapping area (Table 10). Twenty-six associations are documented exclusively from data gathered during AA (Appendix E).

The vegetation of the CANY mapping project area includes 65 NVC alliances and 26 ecological systems. Ninety of the communities are shrubland, wooded shrubland, dwarf-shrubland, or sparse shrubland types (11 riparian), 49 are forest or woodland types (13 riparian), and 29 are herbaceous vegetation types (10 wetland). Juniper and pinyon-juniper woodlands dominate the vegetation, accounting for 11 and 24 associations, respectively. Each association, alliance, or park special is represented by between at least one and as many as 93 plot samples (Appendix E). Types with a single plot may have been rare in CANY, or were simply undersampled as a result of difficult access or the limitations of the biophysical unit 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 10. Classified plant associations for the Canyonlands National Park vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVCS Association	Common Name	Code
UPLAND ASSOCATIONS		
UPLAND FORESTS		
Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)		
Pseudotsuga menziesii / Cercocarpus montanus Woodland	Douglas-fir / Alderleaf Mountain-Mahogany Woodland	CEGL000898
Pseudotsuga menziesii / Quercus gambelii Forest	Douglas-fir / Gambel Oak Forest	CEGL000452
UPLAND WOODLANDS		
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)		
Juniperus osteosperma / Coleogyne ramosissima Woodland	Utah Juniper / Blackbrush Woodland	CEGL002909
Juniperus osteosperma / Hesperostipa comata Woodland	Utah Juniper / Needle-and-Thread Woodland	CEGL001489
Juniperus osteosperma / Leymus salinus Woodland	Utah Juniper / Saline Wildrye Woodland	CEGL003109
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 Woodland	Utah Juniper / James' Galleta Woodland	CEGL002362
Juniperus osteosperma / Quercus gambelii Woodland	Utah Juniper / Gambel Oak Woodland	Park Special
Juniperus osteosperma / Sparse Understory Woodland	Utah Juniper / Sparse Understory Woodland	CEGL000732
Juniperus osteosperma / Sporobolus airoides Woodland	Utah Juniper / Alkali Sacaton Woodland	Park Special
Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata Woodland	Two-needle Pinyon – (One-seed Juniper, Utah Juniper) / Needle-and-Thread Woodland	CEGL000797
Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis Woodland	Two-needle Pinyon – (Utah Juniper) / Blue Grama Woodland	CEGL000778
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

Table 10. Classified plant associations for the Canyonlands National Park vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVCS Association	Common Name	Code
Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland	Two-needle Pinyon - Utah Juniper / Blackbrush Woodland	CEGL000781
Pinus edulis - Juniperus osteosperma / Ephedra viridis Woodland	Two-needle Pinyon – Utah Juniper / Mormon-tea Woodland	CEGL002370
Pinus edulis - Juniperus osteosperma / Fendlera rupicola Woodland	Two-needle Pinyon – Utah Juniper / Fendlerbush Woodland	CEGL004005
Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland	Two-needle Pinyon - Utah Juniper / Mixed Shrubs Talus Woodland	CEGL002328
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
Pinus edulis - Juniperus osteosperma / Quercus havardii var. tuckeri Woodland	Two-needle Pinyon - Utah Juniper / Tucker Sand Shinnery Oak Woodland	CEGL002497
Pinus edulis - Juniperus osteosperma / Rhus trilobata Woodland	Two-needle Pinyon - Utah Juniper / Skunkbush Sumac Woodland	Park Special
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	Park Special
Pinus edulis – Juniperus spp. / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland	Two-needle Pinyon – Juniper Species / Wyoming Big Sagebrush Woodland	CEGL000776
Pinus edulis – Juniperus spp. / Cercocarpus montanus – Mixed Shrub Woodland	Two-needle Pinyon – Juniper Species / Alderleaf Mountain-mahogany Mixed Shrub Woodland	CEGL000780
Pinus edulis - Juniperus spp. / Leymus salinus Woodland	Two-needle Pinyon-juniper species / Saline Wildrye Woodland	CEGL002340
Pinus edulis - Juniperus spp. / Quercus gambelii Woodland	Two-needle Pinyon- Juniper Species / Gambel Oak Woodland	CEGL000791
Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)		
Ostrya knowltonii Woodland	Knowlton's Hophornbeam Woodland	CEGL003971
UPLAND SHRUBLANDS		
Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)		
Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Shrubland	Blackbrush – Stansbury's Cliffrose – Tucker's Sand Shinnery Oak Shrubland	CEGL002348

Table 10. Classified plant associations for the Canyonlands National Park vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVCS Association	Common Name	Code
Coleogyne ramosissima / Pleuraphis jamesii Shrubland	Blackbrush / James' Galleta Shrubland	CEGL001334
Coleogyne ramosissima Shrubland	Blackbrush Shrubland	CEGL001332
Coleogyne ramosissima Sparse Shrubland	Blackbrush Sparse Shrubland	CEGL003834
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 torreyana / Sporobolus cryptandrus Shrub Herbaceous Vegetation	Torrey's Mormon-tea / Sand Dropseed Shrub Herbaceous Vegetation	Park Special
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
Quercus havardii var. tuckeri Shrubland	Tucker's Sand Shinnery Oak Shrubland	CEGL002486
Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)		
Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Wooded Shrubland	Utah Juniper – (Two-needle Pinyon) / Blackbrush – Stansbury's Cliffrose – Tucker Sand Shinnery Oak Woodland	CEGL003774
Juniperus osteosperma / Cercocarpus intricatus Woodland	Utah Juniper / Littleleaf Mountain-mahogany Woodland	CEGL000733
Pinus edulis - Juniperus osteosperma / Muhlenbergia pungens Woodland	Two-needle Pinyon - Utah Juniper / Muhlenbergia pungens Woodland	CEGL002373
Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis) Wooded Shrubland	Two-needle Pinyon - Utah Juniper / (Roundleaf Buffaloberry, Utah Serviceberry) Wooded Shrubland	CEGL002334
Inter-Mountain Basins Active and Stabilized Dune (CES304.775)		
Artemisia filifolia Colorado Plateau Shrubland	Sand Sagebrush Colorado Plateau Shrubland	CEGL002697
Atriplex canescens – Ephedra viridis Shrubland	Fourwing Saltbush – Mormon-tea Shrubland	CEGL003828
Ephedra viridis / Muhlenbergia pungens Shrubland	Mormon-tea / Sandhill Muhly Shrubland	Park Special
Ericameria nauseosa Sand Deposit Sparse Shrubland	Rubber Rabbitbrush Sand Deposit Sparse Shrubland	CEGL002980
Eriogonum leptocladon Sparse Vegetation	Sand Buckwheat Sparse Vegetation	CEGL002822

Table 10. Classified plant associations for the Canyonlands National Park vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVCS Association	Common Name	Code
Poliomintha incana - Artemisia filifolia - Vanclevea stylosa Shrubland	Hoary Rosemarymint – Sand Sagebrush – Pillar False Gumweed Shrubland	CEGL002418
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)		
Artemisia tridentata (ssp. tridentata, ssp. xericensis) Shrubland Alliance	Basin Big Sagebrush Shrubland Alliance	A.830
Artemisia tridentata ssp. tridentata / Hesperostipa comata Shrubland	Basin Big Sagebrush / Needle-and-Thread Shrubland	CEGL002966
Artemisia tridentata – (Ericameria nauseosa) / Bromus tectorum Semi-natural Shrubland	Big Sagebrush – (Rubber Rabbitbrush) / Cheatgrass Semi-natural Shrubland	CEGL002699
Artemisia tridentata ssp. wyomingensis / Bouteloua gracilis Shrubland	Wyoming Big Sagebrush / Blue Grama Shrubland	CEGL001041
Artemisia tridentata ssp. wyomingensis / Disturbed Understory Semi-natural Shrubland	Wyoming Big Sagebrush / Disturbed Understory Semi-natural Shrubland	CEGL002083
Artemisia tridentata ssp. wyomingensis / Hesperostipa comata Colorado Plateau Shrubland	Wyoming Big Sagebrush / Needle-and-Thread Colorado Plateau Shrubland	CEGL002761
Artemisia tridentata ssp. wyomingensis / Sparse Understory Shrubland	Wyoming Big Sagebrush / Sparse Understory Shrubland	CEGL002768
Ericameria nauseosa Shrubland	Rubber Rabbitbrush Shrubland	CEGL002713
Mahonia fremontii Shrubland	Desert Oregon-grape Shrubland	CEGL003967
Inter-Mountain Basins Greasewood Flat (CES304.780)		
Atriplex confertifolia - Sarcobatus vermiculatus Shrubland	Shadscale – Greasewood Shrubland	CEGL001313
Ericameria nauseosa / Sporobolus airoides Shrubland	Rubber Rabbitbrush / Alkali Sacaton Shrubland	CEGL002918
Sarcobatus vermiculatus Disturbed Shrubland	Greasewood Disturbed Shrubland	CEGL001357
Sarcobatus vermiculatus / Pleuraphis jamesii Shrub Herbaceous Vegetation	Greasewood / James' Galleta Shrub Herbaceous Vegetation	Park Special
Sarcobatus vermiculatus / Sporobolus airoides Shrubland	Greasewood / Alkali Sacaton Shrubland	CEGL001368
Sarcobatus vermiculatus / Sporobolus cryptandrus Shrubland	Greasewood / Sand Dropseed Shrubland	Park Special
Sarcobatus vermiculatus / Suaeda moquinii Shrubland	Greasewood / Shrubby Seepweed Shrubland	CEGL001370
Inter-Mountain Basins Wash (CES304.781)		
Artemisia tridentata ssp. tridentata / Sporobolus cryptandrus Shrubland	Basin Big Sagebrush / Sand Dropseed Shrubland	CEGL003826
Atriplex canescens Desert Wash Shrubland	Fourwing Saltbush Desert Wash Shrubland	CEGL003470

Table 10. Classified plant associations for the Canyonlands National Park vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVCS Association	Common Name	Code
Chrysothamnus linifolius Shrubland	Spearleaf Rabbitbrush Shrubland	Park Special
Ericameria nauseosa / Bromus tectorum Semi-natural Shrubland	Rubber Rabbitbrush / Cheatgrass Semi-natural Shrubland	CEGL002937
Ericameria nauseosa Desert Wash Shrubland	Rubber Rabbitbrush Desert Wash Shrubland	CEGL002261
Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783)		
Atriplex gardneri Dwarf-shrubland	Gardner's Saltbush Dwarf-shrubland	CEGL001438
Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland	Gardner's Saltbush / James' Galleta Dwarf-shrubland	CEGL001441
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)		
Atriplex canescens - Artemisia tridentata Shrubland	Fourwing Saltbush – Basin Big Sagebrush Shrubland	CEGL001282
Atriplex canescens / Pleuraphis jamesii Shrubland	Fourwing Saltbush / James' Galleta Shrubland	CEGL001288
Atriplex canescens / Sporobolus airoides Shrubland	Fourwing Saltbush / Alkali Sacaton Shrubland	CEGL001291
Atriplex canescens Shrubland	Fourwing Saltbush Shrubland	CEGL001281
Atriplex confertifolia / Pleuraphis jamesii Shrubland	Shadscale / James' Galleta Shrubland	CEGL001304
Atriplex confertifolia Great Basin Shrubland	Shadscale Great Basin Shrubland	CEGL001294
Atriplex gardneri / Sporobolus airoides Dwarf-shrubland	Gardner's Saltbush / Alkali Sacaton Dwarf-shrubland	Park Special
Krascheninnikovia lanata / Hesperostipa comata Dwarf-shrubland	Winterfat / Needle-and-Thread Dwarf-shrubland	CEGL001327
Krascheninnikovia lanata / Sporobolus cryptandrus Dwarf-shrubland	Winterfat / Sand Dropseed Dwarf-shrubland	Park Special
Krascheninnikovia lanata Dwarf-shrubland	Winterfat Dwarf-shrubland	CEGL001327
Inter-Mountain Basins Playa (CES304.786)		
Atriplex canescens / Suaeda moquinii Shrubland	Fourwing Saltbush / Shrubby Seepweed Shrubland	Park Special
Suaeda moquinii Shrubland	Shrubby Seepweed Shrubland	CEGL001991
Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)		
Chrysothamnus viscidiflorus – Krascheninnikovia lanata Shrubland	Yellow Rabbitbrush – Winterfat Shrubland	Park Special
Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii Dwarf-shrubland	Broom Snakeweed – (Prickly-pear species) / James' Galleta Dwarf-shrubland	CEGL002690
Krascheninnikovia lanata / Bouteloua gracilis Dwarf-shrub Herbaceous	Winterfat / Blue Grama Dwarf-shrub Herbaceous Vegetation	CEGL001321

Table 10. Classified plant associations for the Canyonlands National Park vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVCS Association	Common Name	Code
Vegetation		
Krascheninnikovia lanata / Pleuraphis jamesii Dwarf-shrubland	Winterfat / James' Galleta Dwarf-shrubland	CEGL001322
Opuntia polyacantha / Pleuraphis jamesii Shrubland	Panhandle Prickly-pear / James' Galleta Shrubland	CEGL002299
Opuntia spp. Shrubland Alliance	Prickly-pear species Shrubland Alliance	A.2650
Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)		
Ostrya knowltonii Woodland	Knowlton's Hophornbeam Woodland	CEGL003971
Quercus gambelii - Cercocarpus montanus / (Carex geyeri) Shrubland	Gambel Oak - Alderleaf Mountain-mahogany / (Geyer's Sedge) Shrubland	CEGL001113
Quercus gambelii / Artemisia tridentata Shrubland	Gambel Oak / Big Sagebrush Shrubland	CEGL001111
Quercus gambelii / Rhus trilobata Shrubland	Gambel Oak / Skunkbush Sumac Shrubland	CEGL002338
Quercus gambelii / Sparse Understory Shrubland	Gambel Oak / Sparse Understory Shrubland	CEGL002337
Quercus gambelii / Symphoricarpos longiflorus Shrubland	Gambel Oak / Desert Snowberry Shrubland	Park Special
Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)		
Amelanchier utahensis Shrubland	Utah Serviceberry Shrubland	CEGL001067
Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland	(Utah Serviceberry, Saskatoon Serviceberry) - Alderleaf Mountain-mahogany Shrubland	CEGL001070
UPLAND GRASSLANDS		
Apacherian-Chihuahuan Semi-Desert Grassland and Steppe (CES302.735)		
Pleuraphis jamesii - Sporobolus airoides Herbaceous Vegetation	James' Galleta – Alkali Sacaton Herbaceous Vegetation	CEGL001778
Inter-Mountain Basins Wash (CES304.781)		
Artemisia campestris Stream Terrace Herbaceous Vegetation	Field Sagewort Stream Terrace Herbaceous Vegetation	Park Special
Iva acerosa Herbaceous Vegetation	Copperweed Herbaceous Vegetation	Park Special
Inter-Mountain Basins Active and Stabilized Dune (CES304.775)		
Hymenopappus filifolius Herbaceous Vegetation	Fineleaf Hymenopappus Herbaceous Vegetation	Park Special
Oenothera albicaulis Herbaceous Vegetation	Prairie Evening-primrose Herbaceous Vegetation	Park Special
Rumex hymenosepalus Sparse Vegetation	Canaigre Dock Sparse Vegetation	Park Special

Table 10. Classified plant associations for the Canyonlands National Park vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVCS Association	Common Name	Code
Salsola spp. Semi-natural Herbaceous Vegetation	Russian-thistle species Semi-natural Herbaceous Vegetation	CEGL004004
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)		
Achnatherum hymenoides Colorado Plateau Herbaceous Vegetation	Indian Ricegrass Colorado Plateau Herbaceous Vegetation	CEGL002343
Achnatherum speciosum Herbaceous Vegetation	Desert Needlegrass Herbaceous Vegetation	CEGL003112
Bouteloua gracilis Herbaceous Vegetation	Blue Grama Herbaceous Vegetation	CEGL001760
Bromus tectorum Semi-natural Herbaceous Vegetation	Cheatgrass Semi-natural Herbaceous Vegetation	CEGL003019
Hesperostipa comata Great Basin Herbaceous Vegetation	Needle-and-Thread Great Basin Herbaceous Vegetation	CEGL001705
Oenothera pallida Herbaceous Vegetation	Pale Evening-primrose Herbaceous Vegetation	Park Special
Pleuraphis jamesii Herbaceous Vegetation	James' Galleta Herbaceous Vegetation	CEGL001777
Sphaeralcea (coccinea, parvifolia) Herbaceous Vegetation	(Scarlet Globemallow, Narrowleaf Globemallow) Herbaceous Vegetation	CEGL005366
Sporobolus airoides Southern Plains Herbaceous Vegetation	Alkali Sacaton Southern Plains Herbaceous Vegetation	CEGL001685
Sporobolus cryptandrus Great Basin Herbaceous Vegetation	Sand Dropseed Great Basin Herbaceous Vegetation	CEGL002691
Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)		
Poa fendleriana Herbaceous Vegetation	Muttongrass Herbaceous Vegetation	CEGL001925
UPLAND SPARSE VEGETATION		
Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)		
Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation	Torrey's Joint-fir – (Fourwing Saltbush, Shadscale) Sparse Vegetation	CEGL005801
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)		
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
Cercocarpus intricatus Montane Shrubland	Little-leaf Mountain Mahogany Montane Shrubland	CEGL002587
Chrysothamnus viscidiflorus Talus Shrubland	Yellow Rabbitbrush Talus Shrubland	CEGL002347

Table 10. Classified plant associations for the Canyonlands National Park vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVCS Association	Common Name	Code
Fraxinus anomala - Rhus trilobata Talus Shrubland	Singleleaf Ash – Skunkbush Sumac Talus Shrubland	CEGL003963
Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland	Two-needle Pinyon - Utah Juniper / Littleleaf Mountain-mahogany Woodland	CEGL000779
Rhus trilobata - Ephedra (viridis, torreyana) Talus Shrubland	Skunkbush Sumac – (Mormon-tea, Torrey's Joint-fir) Talus Shrubland	CEGL003776
Inter-Mountain Basins Cliff and Canyon (CES304.779)		
Leymus salinus Shale Sparse Vegetation	Saline Wildrye Shale Sparse Vegetation	CEGL002745
Inter-Mountain Basins Shale Badland (CES304.789)		
Atriplex confertifolia Sparse Shrubland	Shadscale Sparse Shrubland	CEGL003830
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 Sparse Shrubland	Rubber Rabbitbrush Sparse Shrubland	CEGL003961
Eriogonum corymbosum Badlands Sparse Vegetation	Crispleaf Wild Buckwheat Badlands Sparse Vegetation	CEGL002979
Zuckia brandegeei Sparse Vegetation	Siltbush Sparse Vegetation	CEGL002493
Rocky Mountain Cliff, Canyon and Massive Bedrock (CES306.815)		
Pseudotsuga menziesii Scree Woodland	Douglas-fir Scree Woodland	CEGL000911
RIPARIAN, WETLAND AND MESIC ASSOCIATIONS		
RIPARIAN AND WETLAND WOODLANDS AND FORESTS		
North American Warm Desert Riparian Woodland and Shrubland (CES302.753)		
Populus fremontii / Distichlis spicata Woodland	Fremont Cottonwood / Inland Saltgrass Woodland	CEGL003998
Populus fremontii / Sporobolus airoides Woodland	Fremont Cottonwood / Alkali Sacaton Woodland	CEGL004003
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)		
Acer negundo / Disturbed Understory Woodland	Box-elder / Disturbed Understory Woodland	CEGL002693
Fraxinus anomala Woodland	Singleleaf Ash Woodland	CEGL002752

Table 10. Classified plant associations for the Canyonlands National Park vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVCS Association	Common Name	Code
Populus fremontii / Equisetum spp. Woodland	Fremont Cottonwood / Horsetail species Woodland	CEGL003775
Populus fremontii / Ericameria nauseosa Woodland	Fremont Cottonwood / Rubber Rabbitbrush Woodland	CEGL002465
Populus fremontii / Mesic Forbs Woodland	Fremont Cottonwood / Mesic Forbs Woodland	CEGL002470
Populus fremontii / Mesic Graminoids Woodland	Fremont Cottonwood / Mesic Graminoids Woodland	CEGL002473
Populus fremontii / Salix (ligulifolia, lutea) Woodland	Fremont Cottonwood / (Strapleaf Willow, Yellow Willow) Woodland	CEGL004002
Populus fremontii / Salix exigua Forest	Fremont Cottonwood / Coyote Willow Forest	CEGL000666
Populus fremontii / Tamarix sp. Woodland	Fremont Cottonwood / Salt-cedar species Woodland	CEGL005485
Salix gooddingii / Salix exigua Woodland	Gooding's Willow / Coyote Willow Woodland	CEGL003778
RIPARIAN AND WETLAND SHRUBLANDS		
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)		
Forestiera pubescens Shrubland	Stretchberry Shrubland	CEGL001168
Salix (exigua, interior) Temporarily Flooded Shrubland Alliance	(Coyote Willow, Sandbar Willow) Temporarily Flooded Shrubland Alliance	A.947
Salix exigua / Barren Shrubland	Coyote Willow / Barren Shrubland	CEGL001200
Salix exigua / Mesic Graminoids Shrubland	Coyote Willow / Mesic Graminoids Shrubland	CEGL001203
Tamarix spp. Temporarily Flooded Semi-natural Shrubland	Salt-cedar species Temporarily Flooded Semi-natural Shrubland	CEGL003114
Rocky Mountain Subalpine-Montane Riparian Shrubland (CES306.832)		
Betula occidentalis / Cornus sericea Shrubland	Water Birch / Red-osier Dogwood Shrubland	CEGL001161
Cornus sericea Rocky Mountain Shrubland	Red-osier Dogwood Rocky Mountain Shrubland	CEGL001165
Frangula betulifolia Shrubland	Beechleaf Frangula Shrubland	Park Special
Salix lutea / Mesic Graminoids Shrubland	Yellow Willow / Mesic Graminoids Shrubland	CEGL002073
RIPARIAN AND WETLAND HERBACEOUS COMMUNITIES		
North American Arid West Emergent Marsh (CES300.729)		
Typha domingensis Western Herbaceous Vegetation	Southern Cattail Western Herbaceous Vegetation	CEGL001845
Colorado Plateau Hanging Garden (CES304.764)		

Table 10. Classified plant associations for the Canyonlands National Park vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVCS Association	Common Name	Code
Aquilegia micrantha Herbaceous Vegetation	Mancos Columbine Herbaceous Vegetation	CEGL002762
Aquilegia micrantha - Mimulus eastwoodiae Herbaceous Vegetation	Mancos Columbine – Eastwood's Monkey-flower Herbaceous Vegetation	CEGL002729
Calamagrostis scopulorum Hanging Garden Herbaceous Vegetation	Dtich Reedgrass Hanging Garden Herbaceous Vegetation	CEGL002751
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)		
Agrostis stolonifera Seasonally Flooded Herbaceous Alliance	Creeping Bentgrass Seasonally Flooded Herbaceous Alliance	A.1405
Distichlis spicata Herbaceous Vegetation	Inland Saltgrass Herbaceous Vegetation	CEGL001770
Juncus balticus Herbaceous Vegetation	Baltic Rush Herbaceous Vegetation	CEGL001838
Lolium arundinaceum - Agrostis stolonifera Semi-natural Herbaceous Vegetation	Tall Fescue - Creeping Bentgrass Semi-natural Herbaceous Vegetation	Park Special
Phragmites australis Western North America Temperate Semi-natural Herbaceous Vegetation	Common Reed Western North America Temperate Semi-natural Herbaceous Vegetation	CEGL001475
Poa pratensis Semi-natural Seasonally Flooded Herbaceous Vegetation	Kentucky Bluegrass Semi-natural Seasonally Flooded Herbaceous Vegetation	CEGL003081

* Plant associations as determined from the vegetation plot, observation point, and AA point data. Associations are ordered by physiognomy and grouped by ES. Identification codes are provided for plant associations and ecological systems. Because ES 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.

Plant Community Descriptions

This section provides a summary of CANY vegetation by physiognomic group. Appendix F provides detailed local and global descriptions of the 168 plant associations, vegetation alliances and 'park special' vegetation types classified within the mapping project area. Local descriptions are based on classification plot, observation point, and AA point data from CANY and its environs. Global descriptions characterize the association across its range and are based primarily on published and unpublished literature.

Most of the vegetation types at CANY fit into existing NVC association concepts, or 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-two associations were considered unique to CANY; NatureServe designated these as 'Park Specials'. Four vegetation types fit into alliance concepts but lacked sufficient information to justify creating new plant associations.

Upland Forest and Woodland Associations

Canyonlands NP is dominated by upland woodlands, and especially by woodlands of Utah juniper or two-needle pinyon pine – juniper spp. About 20% of classification plots sampled at CANY belong to juniper or pinyon-juniper woodland associations, and juniper is present in many more samples that were characterized as (wooded) shrublands. A few examples of Douglas-fir woodland types were also sampled. One upland forest and thirty-five upland woodland associations occur at Canyonlands, and include (in alphabetical order):

- *Juniperus osteosperma / Cercocarpus intricatus* Woodland
- *Juniperus osteosperma / Coleogyne ramosissima* Woodland
- *Juniperus osteosperma / Hesperostipa comata* Woodland
- *Juniperus osteosperma / Leymus salinus* Woodland
- *Juniperus osteosperma / Mahonia fremontii* Woodland
- *Juniperus osteosperma /* Mixed Shrubs Talus Woodland
- *Juniperus osteosperma / Pleuraphis jamesii* Woodland
- *Juniperus osteosperma / Quercus gambelii* Woodland
- *Juniperus osteosperma /* Sparse Understory Woodland
- *Juniperus osteosperma / Sporobolus airoides* Woodland
- *Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata* Woodland
- *Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis* Woodland
- *Pinus edulis - Juniperus osteosperma / Achnatherum hymenoides* Woodland
- *Pinus edulis - Juniperus osteosperma / Amelanchier utahensis* Woodland
- *Pinus edulis - Juniperus osteosperma / Artemisia bigelovii* Woodland
- *Pinus edulis - Juniperus osteosperma / Artemisia nova* Woodland
- *Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus* Woodland
- *Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima* Woodland
- *Pinus edulis - Juniperus osteosperma / Ephedra viridis* Woodland
- *Pinus edulis - Juniperus osteosperma / Fendlera rupicola* Woodland
- *Pinus edulis - Juniperus osteosperma /* Mixed Shrubs Talus Woodland
- *Pinus edulis - Juniperus osteosperma / Muhlenbergia pungens* Woodland
- *Pinus edulis – Juniperus osteosperma / Pleuraphis jamesii* Woodland
- *Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland
- *Pinus edulis - Juniperus osteosperma / Quercus havardii* var. *tuckeri* Woodland
- *Pinus edulis - Juniperus osteosperma / Rhus trilobata* Woodland

- *Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia* Woodland
- *Pinus edulis - Juniperus osteosperma /* Sparse Understory Woodland
- *Pinus edulis - Juniperus osteosperma / Symphoricarpos longiflorus* Woodland
- *Pinus edulis – Juniperus spp. / Artemisia tridentata (*ssp. *wyomingensis,* ssp. *vaseyana)* Woodland
- *Pinus edulis – Juniperus spp. / Cercocarpus montanus* – Mixed Shrub Woodland
- *Pinus edulis - Juniperus spp. / Leymus salinus* Woodland
- *Pinus edulis - Juniperus spp. / Quercus gambelii* Woodland
- *Pseudotsuga menziesii / Cercocarpus montanus* Woodland
- *Pseudotsuga menziesii / Quercus gambelii* Forest
- *Pseudotsuga menziesii* Scree Woodland

Pinyon-juniper woodlands occur from the northernmost to the southernmost regions of CANY, at mid to high elevations, 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 bottom areas where rain water is concentrated to high elevation slopes 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. Few communities within CANY truly meet the required criterion of 60-100% tree cover indicated for the forest group in the USNVC (Grossman et al. 1998). However, plots with less than 60% cover were assigned to a forest association if the floristics and environmental data indicated they belonged to that group. As with the forest associations, a number of classification plots with woodland associations had tree cover below the 10% cover threshold for woodlands, often because they represented communities growing in slickrock fractures, not in continuous habitat. The most commonly sampled woodland plant association within CANY was the *Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus* Woodland.

Upland Shrubland Associations

Shrublands are the most diverse community type within the CANY mapping area. The majority (50%) of the sampled associations in CANY belong to upland shrubland, wooded shrubland, dwarf-shrubland or sparse shrubland communities. Some communities on badlands are extremely sparse, while others on deep soils with good water holding capacity are relatively densely vegetated. The most commonly sampled plant association within CANY was the *Coleogyne ramosissima* Shrubland. Other common shrublands encountered are dominated by species of *Atriplex* and/or *Ephedra*. Seventy-seven upland shrub associations and two upland shrub alliances occur at CANY, and include:

- *Amelanchier (utahensis, alnifolia) - Cercocarpus montanus* Shrubland
- *Amelanchier utahensis* Shrubland
- *Artemisia bigelovii - Ephedra (viridis, torreyana)* Talus Shrubland
- *Artemisia filifolia* Colorado Plateau Shrubland
- *Artemisia tridentata – (Ericameria nauseosa) / Bromus tectorum* Semi-natural Shrubland
- *Artemisia tridentata* ssp. *tridentata / Sporobolus cryptandrus* Shrubland
- *Artemisia tridentata* ssp. *wyomingensis / Bouteloua gracilis* Shrubland
- *Artemisia tridentata* ssp. *wyomingensis /* Disturbed Understory Semi-natural Shrubland
- *Artemisia tridentata* ssp. *wyomingensis / Hesperostipa comata* Colorado Plateau Shrubland
- *Artemisia tridentata* ssp. *wyomingensis /* Sparse Understory Shrubland
- *Artemisia tridentata (*ssp. *tridentata,* ssp. *xericensis)* Shrubland Alliance
- *Artemisia tridentata* ssp. *tridentata / Hesperostipa comata* Shrubland
- *Atriplex canescens - Artemisia tridentata* Shrubland

- *Atriplex canescens – Ephedra viridis* Shrubland
- *Atriplex canescens – Ephedra viridis* Talus Shrubland
- *Atriplex canescens / Pleuraphis jamesii* Shrubland
- *Atriplex canescens / Sporobolus airoides* Shrubland
- *Atriplex canescens / Suaeda moquinii* Shrubland
- *Atriplex canescens* Shrubland
- *Atriplex confertifolia - Sarcobatus vermiculatus* Shrubland
- *Atriplex confertifolia / Pleuraphis jamesii* Shrubland
- *Atriplex confertifolia* Great Basin Shrubland
- *Atriplex confertifolia* Sparse Shrubland
- *Atriplex gardneri / Pleuraphis jamesii* Dwarf-shrubland
- *Atriplex gardneri / Sporobolus airoides* Dwarf-shrubland
- *Atriplex gardneri* Dwarf-shrubland
- *Cercocarpus intricatus* Montane Shrubland
- *Cercocarpus intricatus* Slickrock Sparse Vegetation
- *Chrysothamnus linifolius* Shrubland
- *Chrysothamnus viscidiflorus – Krascheninnikovia lanata* Shrubland
- *Chrysothamnus viscidiflorus* Talus Shrubland
- *Coleogyne ramosissima - Purshia stansburiana - Quercus havardii* var. *tuckeri* Shrubland
- *Coleogyne ramosissima / Pleuraphis jamesii* Shrubland
- *Coleogyne ramosissima* Shrubland
- *Coleogyne ramosissima* Sparse 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 / Sporobolus cryptandrus* Shrub Herbaceous Vegetation [Park Special]
- *Ephedra torreyana* Sparse Vegetation
- *Ephedra viridis / (Achnatherum hymenoides, Hesperostipa comata)* Shrubland
- *Ephedra viridis / Bouteloua gracilis* Shrubland
- *Ephedra viridis / Muhlenbergia pungens* Shrubland
- *Ephedra viridis / Pleuraphis jamesii* Shrubland
- *Ericameria nauseosa / Bromus tectorum* Semi-natural Shrubland
- *Ericameria nauseosa / Sporobolus airoides* Shrubland
- *Ericameria nauseosa* Sand Deposit Sparse Shrubland
- *Ericameria nauseosa* Shrubland
- *Ericameria nauseosa* Sparse Shrubland
- *Eriogonum corymbosum* Badlands Sparse Vegetation
- *Eriogonum leptocladon* Sparse Vegetation
- *Fraxinus anomala - Rhus trilobata* Talus Shrubland
- *Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii* Dwarf-shrubland
- *Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana - Quercus havardii* var. *tuckeri* Wooded Shrubland
- *Krascheninnikovia lanata / Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation
- *Krascheninnikovia lanata / Hesperostipa comata* Dwarf-shrubland
- *Krascheninnikovia lanata / Pleuraphis jamesii* Dwarf-shrubland
- *Krascheninnikovia lanata / Sporobolus cryptandrus* Dwarf-shrubland
- *Krascheninnikovia lanata* Dwarf-shrubland
- *Mahonia fremontii* Shrubland
- *Opuntia polyacantha / Pleuraphis jamesii* Shrubland
- *Opuntia* spp. Shrubland Alliance

- *Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis)* Wooded Shrubland
- *Poliomintha incana - Artemisia filifolia - Vanclevea stylosa* Shrubland
- *Quercus gambelii - Cercocarpus montanus / (Carex geyeri)* Shrubland
- *Quercus gambelii / Artemisia tridentata* Shrubland
- *Quercus gambelii / Rhus trilobata* Shrubland
- *Quercus gambelii /* Sparse Understory Shrubland
- *Quercus gambelii / Symphoricarpos longiflorus* Shrubland
- *Quercus havardii* var. *tuckeri* Shrubland
- *Rhus trilobata - Ephedra (viridis, torreyana)* Talus Shrubland
- *Sarcobatus vermiculatus / Pleuraphis jamesii* Shrub Herbaceous Vegetation
- *Sarcobatus vermiculatus / Sporobolus airoides* Shrubland
- *Sarcobatus vermiculatus / Sporobolus cryptandrus* Shrubland
- *Sarcobatus vermiculatus / Suaeda moquinii* Shrubland
- *Sarcobatus vermiculatus* Disturbed Shrubland
- *Suaeda moquinii* Shrubland
- *Zuckia brandegeei* Sparse Vegetation

Shrublands in CANY occupy a wide variety of habitats, including terraces along the Green and Colorado 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 CANY, occupying areas of shallow, rocky and/or sandy soils throughout the park. Blackbrush, shadscale, Torrey's joint-fir, and little-leaf mountain-mahogany characterize the sparse canopy, often in a mixed community of several species. Badlands of the Chinle and Moenkopi formations support a characteristic sparse community that may include Gardner's saltbush, siltbush, and/or crispleaf buckwheat. Floodplains with alkaline soils support greasewood or shrubby seepweed where an impermeable layer slows infiltration; basin big sagebrush, Wyoming big sagebrush, winterfat, rabbitbrush, fourwing saltbush, or desert Oregon-grape shrublands occur nearby on sandy, well-drained high terraces or valley floors. Deep, loose sands support unusual communities containing hoary rosemarymint, pillar false gumweed, sand buckwheat, and/or Tucker's sand shinnery oak. More stable sand sheets have sand sagebrush, Torrey's joint-fir or blackbrush communities. Relatively flat sites on plateaus and mesa tops or in broad valley bottoms with deep soils support Mormon-tea, snakeweed, or prickly-pear shrublands. Talus-covered canyon walls have diverse, mixed shrublands that may include Bigelow sage, rabbitbrush species, shadscale, Torrey's joint-fir, skunkbush sumac, serviceberry, alderleaf mountain-mahogany, Mormon-tea, and/or single-leaf ash. Gambel oak shrublands occur in sheltered, cooler sites, areas where the water table is higher, or areas where rain water runoff if concentrated, including wash terraces, coves, alcoves, and heads of ravines.

Upland Herbaceous Associations

Upland herbaceous communities are common but restricted in distribution, occurring mostly in the NEED and more rarely in the other two districts. Herbaceous community diversity is proportionately higher than herbaceous community cover, fewer than 10% of classification plots sampled within CANY belong to herbaceous communities, but 17% of plant associations (19 upland and 10 riparian) are represented in this group. Most grassland types occupy broad valley floors, while forb-dominated types tend to result from intensive disturbance and are generally weed-dominated. "Semi-natural Herbaceous Vegetation" indicates dominance by one or more

species not native to North America. At least 19 upland herbaceous associations occur in CANY, and include:

- *Achnatherum hymenoides* Colorado Plateau Herbaceous Vegetation
- *Achnatherum speciosum* Herbaceous Vegetation
- *Artemisia campestris* Stream Terrace Herbaceous Vegetation
- *Bouteloua gracilis* Herbaceous Vegetation
- *Bromus tectorum* Semi-natural Herbaceous Vegetation
- *Hesperostipa comata* Great Basin Herbaceous Vegetation
- *Hymenopappus filifolius* Herbaceous Vegetation
- *Iva acerosa* Herbaceous Vegetation
- *Leymus salinus* Shale Sparse Vegetation
- *Oenothera albicaulis* Herbaceous Vegetation
- *Oenothera pallida* Herbaceous Vegetation
- *Pleuraphis jamesii - Sporobolus airoides* Herbaceous Vegetation
- *Pleuraphis jamesii* Herbaceous Vegetation
- *Poa fendleriana* Herbaceous Vegetation
- *Rumex hymenosepalus* Sparse Vegetation
- *Salsola* spp. Semi-natural Herbaceous Vegetation
- *Sphaeralcea (coccinea, parvifolia)* Herbaceous Vegetation
- *Sporobolus airoides* Southern Plains Herbaceous Vegetation
- *Sporobolus cryptandrus* Great Basin Herbaceous Vegetation

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 grabens or valley bottoms. Flat sites or swales in degraded areas of previously grazed valley bottoms or plains, typical of the Grabens, Squaw Flat, and Salt Creek Pocket areas in the Needles, 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, globemallow, canaigre dock, and fineleaf hymenopappus. Small stands of alkali sacaton grasslands intermixed with or adjacent to greasewood and/or seepweed shrublands are restricted to alkali floodplains along tributary drainages or along the major river corridors. North-facing, cool-aspect, talus slopes support grasslands of saline lyme grass and in one rare example, muttongrass. Forb-dominated communities characterized by copperweed, field sagewort, pale evening primrose or prairie evening primrose occur on or near wash channels and neighboring terraces or on active sand dunes.

Riparian and Wetland Forest and Woodland Associations

Riparian woodlands are restricted in distribution to the floodplains of the Colorado and Green rivers, near seeps and springs in tributary canyons, and below pour-offs in alcoves and other sheltered locations. These woodlands are characterized by Fremont cottonwood and may have upland or mesic understories depending on the availability of water. Less common are riparian woodlands dominated by Knowlton's hophornbeam, Box-elder, singleleaf ash, or Goodding's willow. One riparian forest and twelve riparian woodland associations occur in CANY, and include:

- *Acer negundo* / Disturbed Understory Woodland
- *Fraxinus anomala* Woodland

- *Ostrya knowltonii* Woodland
- *Populus fremontii / Distichlis spicata* Woodland
- *Populus fremontii / Equisetum* spp. Woodland
- *Populus fremontii / Ericameria nauseosa* Woodland
- *Populus fremontii /* Mesic Forbs Woodland
- *Populus fremontii /* Mesic Graminoids Woodland
- *Populus fremontii / Salix (ligulifolia, lutea)* Woodland
- *Populus fremontii / Salix exigua* Forest
- *Populus fremontii / Sporobolus airoides* Woodland
- *Populus fremontii / Tamarix* sp. Woodland
- *Salix gooddingii / Salix exigua* Woodland

The Fremont cottonwood woodlands within CANY generally have an open canopy and occur on intermittent streams in tributary canyons (predominantly those of the Salt Creek drainage system). Because flood events are frequent, stands of many ages occur. In the older (mostly relict) cottonwood stands established on floodplains of the major rivers, 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). Woodlands characterized by Goodding's willow or box-elder occur on terraces of the Colorado River. Single-leaf ash sparse woodlands occur along dry wash channels throughout CANY. Rare woodlands of Knowlton's hophornbeam occur in cool, sheltered locations, including 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 CANY, and are characterized by dense and homogenous stands of the non-native shrub tamarisk and/or the native shrub coyote willow. Other riparian and wetland shrubland communities occur in tributary drainages, dry wash channels, and near seeps and springs in alcoves. Ten riparian and wetland shrubland associations and one riparian shrubland alliance occur in CANY, and include:

- *Atriplex canescens* Desert Wash Shrubland
- *Betula occidentalis / Cornus sericea* Shrubland
- *Cornus sericea* Rocky Mountain Shrubland
- *Ericameria nauseosa* Desert Wash Shrubland
- *Forestiera pubescens* Shrubland
- *Frangula betulifolia* Shrubland
- *Salix (exigua, interior)* Temporarily Flooded Shrubland Alliance
- *Salix exigua /* Barren Shrubland
- *Salix exigua /* Mesic Graminoids Shrubland
- *Salix lutea /* Mesic Graminoids Shrubland
- *Tamarix* spp. Temporarily Flooded Semi-natural Shrubland

On the drier end of the spectrum, the braided channels of intermittent washes contain generally sparse but distinctive riparian shrub communities characterized by rubber rabbitbrush or saltbush. Coyote willow shrublands are most common on sand bars and seasonally flooded banks or terraces of the Colorado and Green rivers. Tamarisk has become established in many parts of CANY, but is especially common on banks and terraces above the annual floodplain of the major

rivers, where it forms impenetrable thickets. These common riparian shrub species also occur in tributary drainages in sparse, scattered, or small isolated stands, with the exception of lower Salt Creek where they form a continuous band following the drainage. Yellow willow shrublands are less common and occur as dense stands in tributary drainages where there is seasonally or perennially available surface water. Other riparian or wetland shrublands within CANY are rarer, and occur almost exclusively as small, isolated stands near seeps and springs, in alcoves, coves, or at the heads of ravines. Within the Salt Creek drainage system, a major tamarisk removal project has allowed native riparian vegetation to re-establish.

Riparian and Wetland Herbaceous Associations

Riparian and wetland herbaceous associations in CANY are uncommon 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, such as hanging gardens. Nine riparian and wetland herbaceous associations and one wetland herbaceous alliance occur in CANY, and include:

- *Agrostis stolonifera* Seasonally Flooded Herbaceous Alliance
- *Aquilegia micrantha - Mimulus eastwoodiae* Herbaceous Vegetation
- *Aquilegia micrantha* Herbaceous Vegetation
- *Calamagrostis scopulorum* Hanging Garden Herbaceous Vegetation
- *Distichlis spicata* Herbaceous Vegetation
- *Juncus balticus* Herbaceous Vegetation
- *Lolium arundinaceum - Agrostis stolonifera* Semi-natural Herbaceous Vegetation
- *Phragmites australis* Western North America Temperate Semi-natural Herbaceous Vegetation
- *Poa pratensis* Semi-natural Seasonally Flooded Herbaceous Vegetation
- *Typha domingensis* Western Herbaceous Vegetation

Hanging gardens emerging from cracks or alcoves in canyon walls support communities of unusual species that are generally restricted to these habitats, including Mancos columbine, ditch reed grass, and Eastwood's monkey-flower. Seeps along tributary wash channels and the banks of perennial streams support patches of Baltic rush, tall fescue, creeping bentgrass, Kentucky bluegrass, inland saltgrass, southern cattail, and/or common reed grass. Small to large patches of common reed grass also occur growing on high terraces of the Colorado and Green rivers.

Field Key Preparation

An illustrated dichotomous field key to plant associations of the CANY mapping area was developed for this project (Appendix G). The key is designed to assist users in identifying plant associations in the field. 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. To increase the utility of the key, individual plant associations are cross-referenced to map classes.

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 CANY, nor does it explain the full range of variation of all associations.

The field key was tested by NatureServe and NCPN ecologists using CANY vegetation plot data prior to its use by AA field crews. An ecologist selected random plots representing each association, removed the association identifier from the data and attempted to run each plot through the field key using information contained in the plots database. Additional testing of the key occurred in the field before and 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.

Assessment of Global Rarity

CANY lies in the Canyon Lands section the Colorado Plateau physiographic province in southeast Utah. Elevations in CANY span nearly 3,500 feet and encompass the boundary between pinyon-juniper woodlands and shrub-dominated semi-desert vegetation. Divided in thirds by long reaches of two major rivers (the Colorado and the Green), as well as by many small and large tributaries, CANY 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 that occur where porous sandstones contact impervious rock layers and seeps emerge. Few plant associations in CANY are considered globally rare (NatureServe 2006); however, not enough is known about the global distribution of more than half of the plant associations in CANY 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. Two plant associations occurring within CANY are considered critically imperiled (G1): *Achnatherum speciosum* Herbaceous Vegetation and *Forestiera pubescens* Shrubland. Five associations are considered imperiled (G2): *Amelanchier (utahensis, alnifolia) - Cercocarpus montanus* Shrubland, *Aquilegia micrantha - Mimulus eastwoodiae* Herbaceous Vegetation, *Artemisia tridentata* ssp. *wyomingensis / Hesperostipa comata* Colorado Plateau Shrubland, *Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata* Woodland, and *Pleuraphis jamesii - Sporobolus airoides* Herbaceous Vegetation (Figure 31). Eighteen associations are ranked vulnerable (G3) and 37 associations are ranked secure (G4 or G5). Six associations are semi-natural types that are not ranked. Four associations are unrankable due to lack of information or due to substantially conflicting information about status or trends. The remaining 92 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 CANY 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 CANY 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 threaten other vegetation types. Fire is not a significant factor in establishing or maintaining any of the natural plant associations in CANY. Because of recent regional drought and a predicted change over time to a warmer and drier climate, all riparian, hanging garden, and wetland plant communities within CANY 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).

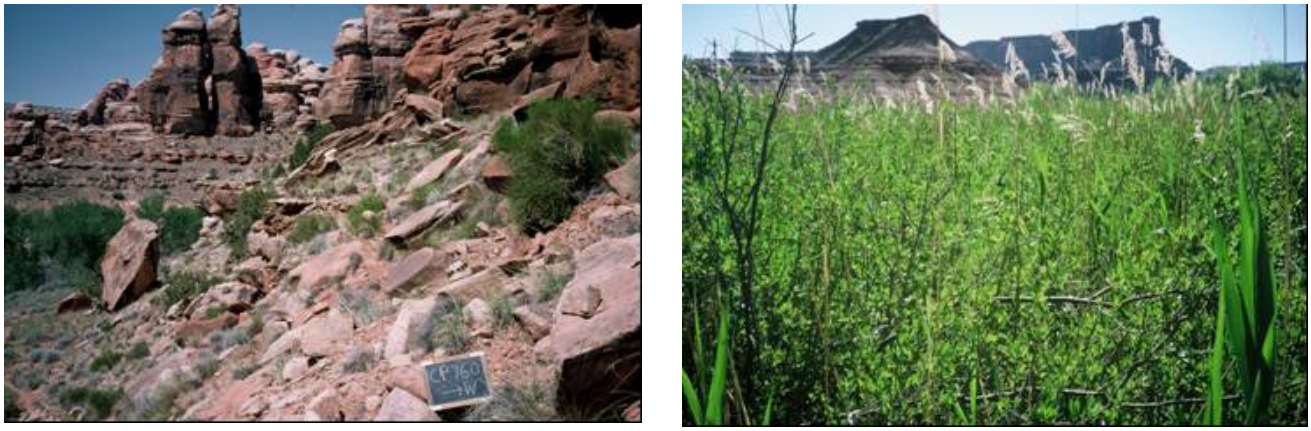


Photo Credit: NPS/NCPN

Figure 31. The globally critically imperiled *Achnatherum speciosum* Herbaceous Vegetation and *Forestiera pubescens* Shrubland associations in CANY.

Vegetation Mapping

Methods

The process of mapping vegetation and land use in the CANY project area followed four steps:

1. Field reconnaissance
2. Map class and polygon attribute development
3. Interpretation and mapping
4. Spatial database development

Each step built upon information created during the previous stage. Field reconnaissance was intended to familiarize the photointerpreters with CANY, patterns of vegetation distribution, and environmental factors useful for developing mapping models. Map class development followed reconnaissance and was based on intensive review of the aerial imagery in concert with data from the vegetation plot sampling. The interpretation and mapping phase applied the map class concepts in order to draw consistent, homogenous polygons on the base orthoimagery. The draft polygon set was digitized and given additional attributes (spatial database development).

Field Reconnaissance

Most field reconnaissance was conducted concurrently with the vegetation plot data collection in the summer of 2004. Additionally, the primary photointerpreters visited CANY on many occasions from the spring of 2007 to the spring of 2008 to assign plant communities or complexes to distinct signatures on the orthophotographs. Understanding the environmental drivers influencing vegetation patterns and identifying information to extract from the project imagery were other important products of the reconnaissance. This was especially important for this project because the aerial photography was acquired in 2002, a drought year at the end of a very dry period during which cover by herbaceous species was probably reduced in comparison to levels found during survey years. Prior to visiting CANY, paper plots of the orthoimagery were created for use in the field. Field notes were written directly on these plots and were used for guidance during the photo interpretation and polygon attribution process.

Observation point data collected by field crew members, as well as a supplemental field trip to the ISKY district to collect verification points to guide mapping, provided additional documentation of the vegetation for the photointerpreter. Three hundred twenty-two observation points and 205 verification points were sampled within the CANY vegetation mapping project area. At each point, a subset of vegetation and environmental data was collected.

Map Class Development

The goal of map class development was to identify meaningful units to represent existing vegetation types and land uses for the CANY vegetation mapping project area. Map classes specific to this project were developed to characterize vegetation types within CANY, a portion of GLCA, and most of the environs. 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 same map classes were used within CANY and in the environs.

The project photointerpreter developed a preliminary set of map class concepts in 2006 based on a review of the ortho- and aerial photography combined with several visits to CANY. Two ecologists responsible for collecting the classification plot data reviewed the preliminary map classes and preliminary vegetation classification with the photointerpreter. Map class concepts were continually refined during the project as the photointerpreters gained more experience with the imagery and made additional field trips to resolve cryptic photosignatures.

The current standard for the USGS-NPS Vegetation Classification and Mapping Program projects is to map to the plant association level of the NVC. However, the level of detail possible in a vegetation map is limited by the quality of available imagery, the skill and experience of the photointerpreter, and the quantity and quality of supporting information. Distinguishing floristic relationships on aerial photography is often difficult and as a result similar plant associations may be grouped into a single map class. At CANY, the relationships between map classes and plant associations are complex. In some cases, distinct plant associations were grouped into a single map class because they occur in similar habitats and could not be distinguished consistently or accurately using remote sensing. In other cases, plant associations that occur on a variety of substrates, e.g., blackbrush shrublands, were assigned to more than one map class.

Polygon Attribute Development

The NCPN adopted a convention for naming map classes to facilitate use of vegetation maps and mapping data across multiple parks. Each map class representing an NVC plant association was assigned the NatureServe common name (e.g. Two-needle Pinyon – Utah Juniper / Wyoming Big Sagebrush Woodland). Map classes representing complexes of associations followed the convention of being named for the unifying botanic and environmental factors, e.g., Potholed and Jointed Sandstone Woodland Complex.

To facilitate tracking and management of vegetation map class information, NCPN developed a map class coding system. Photointerpreters tend to assign a unique number to each map class as a shorthand way of labeling polygons. These numeric codes have been retained within the spatial database and map class guide (Appendix J). NCPN developed a five-letter alphacode system for map classes to be used in all park vegetation mapping projects. Each alphacode begins with the first letter of the corresponding NVC Class (F = Forest, W = Woodland, S = Shrubland, H = Herbaceous, N = nonvascular, and C = Complex). The subsequent four letters generally abbreviate the map class name. For example, the Blackbrush Shrubland map class is represented by the alphacode S-BLAC. For map classes representing coarser levels of the NVC, geologic exposures, and other non-vegetated features, generic names incorporating vegetation and landscape features were used. Geologic exposures were given the prefix G = geology and developed sites the prefix L = land cover/land use.

Photo interpretation and polygon labeling and attribution procedures were standardized for all park vegetation mapping projects (Evenden 2004). After a map class was assigned to each polygon, the polygon was assigned attributes to characterize vegetation structure (density, pattern; Table 11), land use and disturbance. 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.

Table 11. Physiognomic attributes of polygons. In some cases, these attributes were assigned to individual polygons. Otherwise, they were assigned to an entire map class.

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

NCPN photointerpretation standards (Evenden 2004) defined a suite of polygon modifiers to describe altered vegetation, landforms, transportation and utilities, and other situations. Some of these were used in CANY, but the majority of modifiers used were created specifically for CANY by the primary photointerpreter and the NPS project ecologist. Table 12 is a list of the modifiers used in the CANY project.

Table 12. Modifiers used to provide additional information for map polygons in the CANY vegetation mapping project area.

Category	Code	Name	Description
Vegetation Modifiers	a	Altered	Applies when some alteration is evident, but the type is indistinguishable
	b	Burn evidence	Applies to systems disturbed by burns more than one year old (as seen in photography)
	c	Cliff and alcove	Applies to polygons formerly mapped as 97 (Cliff and Alcove Mixed Mesic Shrublands) which are now combined with map class 4 (Gambel Oak Shrublands)
	d	Chained	Applies to systems chained and then seeded with non-native grasses
	e	Eolian	Blackbrush shrublands or wooded shrublands on eolian soils (somewhat active to fairly stabilized)
	f	Gardner Saltbush Badlands	Applies to polygons formerly mapped as 5 (Gardner Saltbush Badlands) which are now combined with map class 15 (Shale Barrens Desert Scrub)

Table 12. Modifiers used to provide additional information for map polygons in the CANY vegetation mapping project area.

Category	Code	Name	Description
	g	Grassy	Shrublands or woodlands with considerable grass cover
	h	Over-grazed	Applies to systems that have been over-grazed by livestock, these are generally in the environs adjacent to CANY
	i	Invasives	Applies to systems where invasive graminoid and/or forb species are a component, sometimes dominant component, of the system
	j	Pinyon-juniper	Pinyon-juniper trees as a subcanopy in cottonwood woodlands
	l	Logged (and burned)	Used only for stands of tamarisk that have been cut and treated
	m	Mesic understory	Woodlands with mixed mesic herbaceous species in the understory
	r	Rocky	Bedrock exposures noted in vegetation types not typical of bedrock habitats (grasslands, dunes, etc.)
	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 & fill slopes associated w/ construction.
	s	Shrubby	Stands of native or non-native herbaceous vegetation that have a noticeable shrub component (shrub-herbaceous types)
	t	Treed	Shrublands with notable tree cover present (wooded shrublands)
	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	Tamarix	Shrublands or woodlands with tamarisk shrubs present in the under- or overstory

Park Specials

In the scoping phase of the project, Park staff identified several natural resource features of interest that might otherwise not have been sampled or recognized for mapping. These features were photographed and noted by field crews as encountered, and other than a point layer for hanging gardens, do not appear in the final map. It was agreed that ancillary GPS data collection

would be collected only for springs, seeps, and invasive species. The park specials discussed for CANY included:

- Hanging gardens, springs, and seeps (record locations at a minimum)
- Grasslands being invaded by juniper (where juniper is less than 2% cover)
- Douglas-fir stands
- Crested wheatgrass stands

Information describing the condition and location of park special features was provided directly to park staff, if so requested, and is searchable in the final plots database but is not otherwise included in the project final report. These features are commonly referred to as "park specials", but should not be confused with the "park special" designation given by NatureServe to plant associations that could not be included in the NVC.

Mapping

The mapping component of the CANY project used a combination of methods to interpret and delineate vegetation polygons. The USGS applied an electronic segmentation method (e-Cognition software) to create preliminary linework on features with high-contrast photo-signatures. Using the preliminary linework as a starting point, photointerpreters performed extensive editing through deleting, merging, cutting, and drawing polygons directly on-screen through heads-up digitizing using ArcGIS editing tools. Photointerpreters were aided by ancillary datasets, including classification plots, geology, and soils layers, among others, and by the use of a stereoscope, which enabled them to view the landscape in stereo in order to pull out finer details. Each polygon was assigned a map class attribute and other descriptive attributes when applicable. CANY environs were interpreted and mapped to the same level of detail.

Spatial Database Development

Each polygon was assigned a map class number and name and Anderson et al. (2002) land use class. Vegetation density and pattern attributes were assigned only when a polygon differed from what was typical for that map class (i.e. stands of big sagebrush with greater than 50% shrub cover were noted). In order to improve the utility of the map and related data, the spatial database was migrated into a geodatabase format, the general structure of which is illustrated in Figure 32. 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.

Map Classes

The final map legend for CANY consists of fifty-four map classes (Table 13). Of these, 42 are vegetation map classes, three are unvegetated geologic map classes, and nine are land-use map classes. Of the 42 vegetation map classes, two represent single NVC plant associations and the remaining 40 vegetation map classes represent polygons delineating multiple plant associations.

Ecological systems (ES) (Comer et al. 2003) are used to organize the vegetation map classes. They were 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. Ecological systems typically occur in patches of tens to thousands of hectares and are expected to persist for 50 or more years. The timeframe allows successional dynamics to be integrated into the concept of each ecological system. In cases

where map classes were more heterogeneous, both in physiognomy and species dominance, the ecological systems for that map class were numerous and failed to create a single mappable classification unit for that map class.

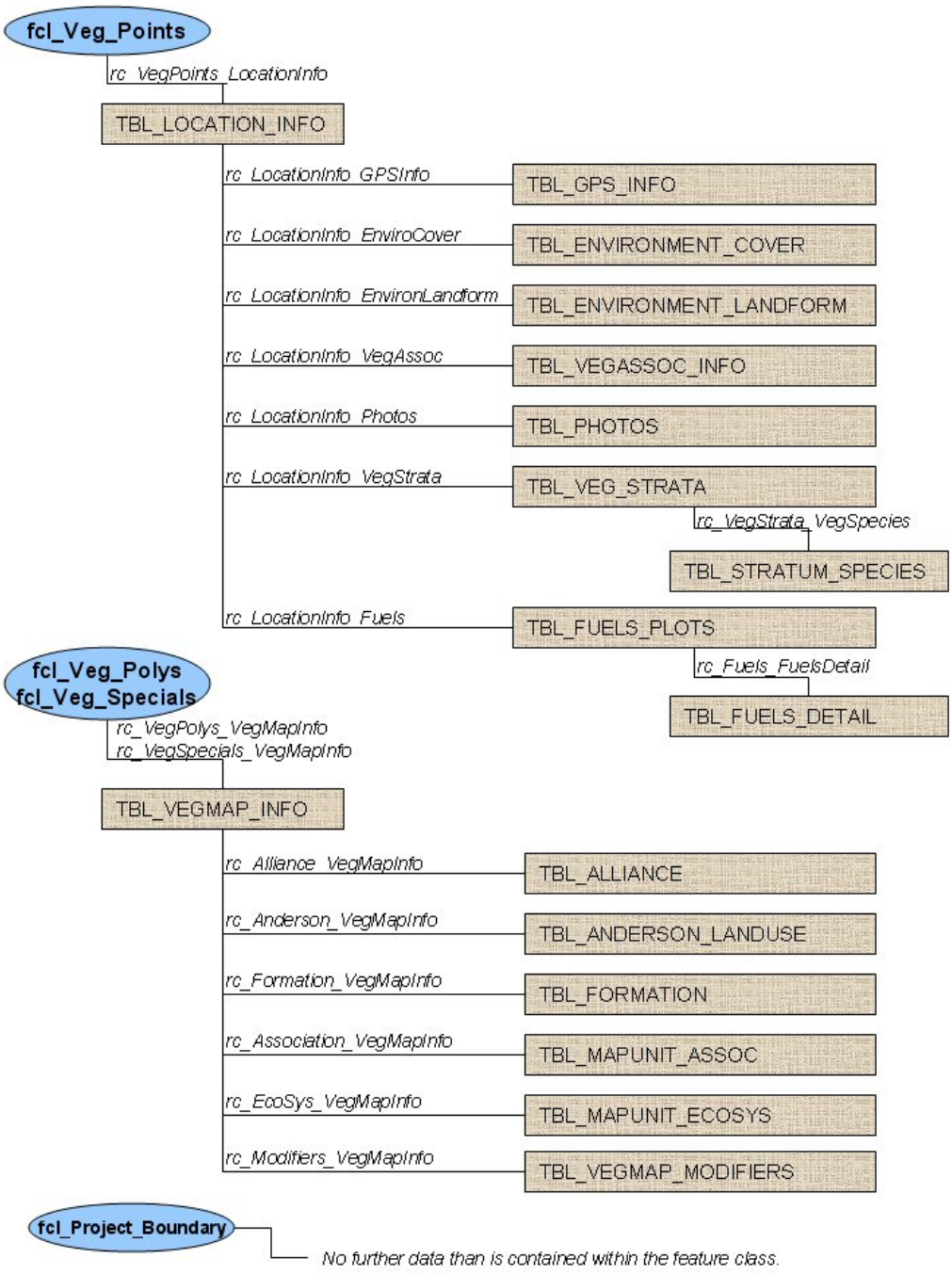


Figure 32. Structure of the CANY geodatabase.

Results

Table 13 shows the relationship of vegetation map classes to ecological systems, ordered roughly by physiognomy: upland woodlands, riparian woodlands, upland shrublands, riparian shrublands, upland herbaceous vegetation, wet meadow herbaceous vegetation, and sparse vegetation. Appendix A provides summary descriptions of each ecological system. The geologic and land use map classes could not be placed within the ecological system classification.

Map Class Descriptions

Appendix J provides detailed descriptions of all vegetation map classes used in the final version of the CANY vegetation mapping project. Each map class description includes:

- a summary of the ecological concept of the map class. Reference is made to the abundance and distribution of the map class within CANY as well as the entire project area
- a list of plant associations and common plant species occurring within the map class
- a qualitative description of the photographic signature along with representative samples from the orthophotography
- ground photographs
- statistics and accuracy assessment results

Map Polygons

The CANY vegetation map consists of 31,497 polygons totaling 107,618 hectares (421,605 acres). Average polygon size is 9.9 ha (24.4 acres). Lands within CANY make up 135,204 ha (334,096 acres) or 79% of the total project area. Of the total, 30,329 polygons (95%) represent natural or semi-natural vegetation map classes covering 94.8% of the mapping project area. Map classes representing non-vegetated rock outcrops, and developed or other land use areas account for the remaining 1,168 polygons (5% of polygons and 5.2% of the area).

The polygon count includes adjacent polygons that have the same map code but different density or pattern attributes. Blackbrush Shrubland was represented by the highest number of polygons (3600) covering 9.4% of the mapping area. The Potholed and Jointed Sandstone Woodland Complex covers the most area with 30,495 ha (75,354 acres) or 17.9% of the project area. The largest average polygon size belongs to the Rivers land use map class with 288.8 ha (713.5 acres) per polygon.

Figure 33 is a generalized map of the vegetation of CANY at the ecological system 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 14 provides summary statistics for CANY vegetation map polygons. Included data are map class number and name, number of polygons interpreted within CANY and within the environs area, and the area occupied by interpreted polygons per each mapping unit.

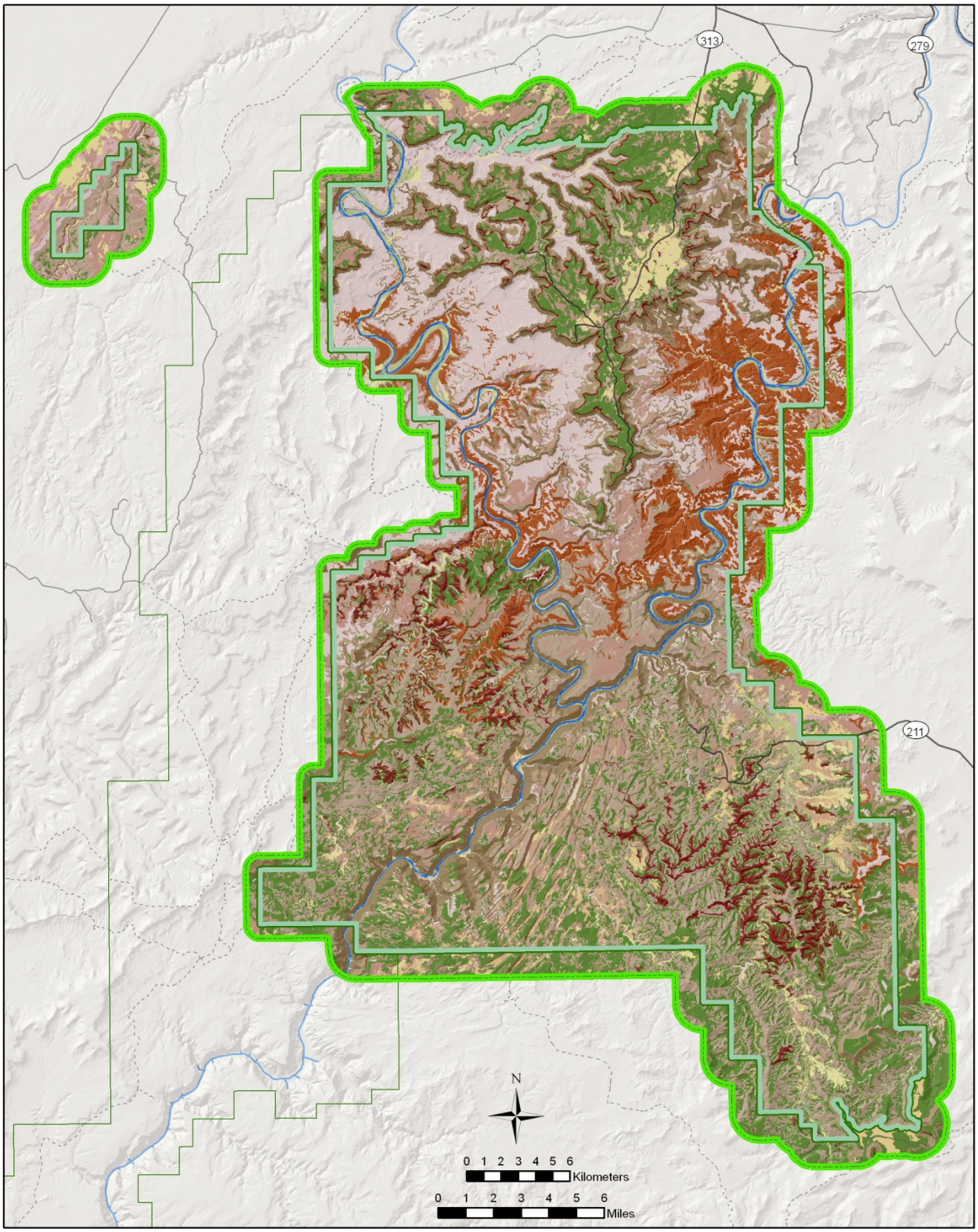


Figure 33a. The CANY ecological system level vegetation map.

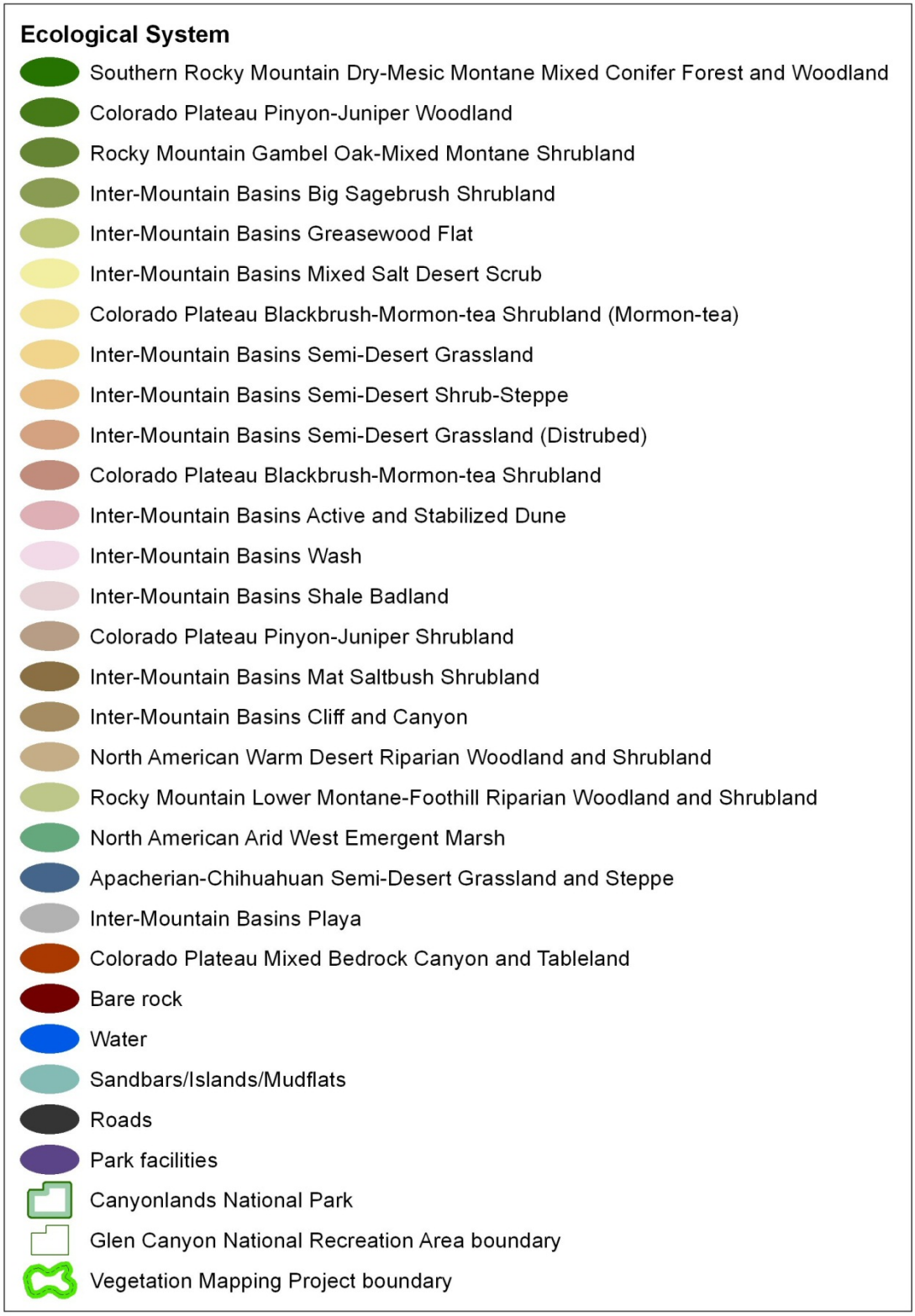


Figure 33b. Legend for CANY ecological system level vegetation map

Table 13. Map classes used in the final (post-AA) CANY vegetation map.

CANY 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 ecological systems classification.

Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)				
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 nova Woodland Pinus edulis - Juniperus osteosperma / Ephedra viridis Woodland Pinus edulis - Juniperus spp. / Cercocarpus montanus - Mixed Shrub Woodland Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	1 : many
22	W-PJSA	Pinyon – Juniper / Wyoming Sagebrush Woodland	Pinus edulis - Juniperus spp. / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland	1 : 1
23	S-SEED	[Chained and Seeded Pinyon – Juniper Woodland] Sagebrush Shrubland	None described for the park	N/A
24	W-PJGR	Juniper – (Pinyon) / Sparse or Grassy Understory Woodland	Juniperus osteosperma / Hesperostipa comata Woodland Juniperus osteosperma / Pleuraphis jamesii Woodland Juniperus osteosperma / Sparse Understory Woodland Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata Woodland Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis Woodland Pinus edulis - Juniperus osteosperma / Achnatherum hymenoides Woodland Pinus edulis - Juniperus osteosperma / Pleuraphis jamesii Woodland Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	1 : many
27	W-PJPO	Pinyon – Juniper “Pour-over” Woodland	Juniperus osteosperma / Mahonia fremontii Woodland Juniperus osteosperma / Quercus gambelii Woodland [Park Special] Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland Pinus edulis - Juniperus spp. / Quercus gambelii Woodland	1 : many
98	W-POND	Ponderosa Pine - Pinyon Pine - Juniper spp. Wash Woodland	Pinus edulis - Juniperus spp. / Quercus gambelii Woodland *No ponderosa pine associations described for the Park	N/A

Table 13. Map classes used in the final (post-AA) CANY vegetation map.

CANY 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 ecological systems classification.

Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
Multiple Ecological Systems: Colorado Plateau Pinyon-Juniper Shrubland (CES304.766) Colorado Plateau Pinyon-Juniper Woodland (CES304.767)				
25	W-PJDU	Pinyon – Juniper Sand Dune 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 / Coleogyne ramosissima Woodland Pinus edulis - Juniperus osteosperma / Ephedra viridis Woodland Pinus edulis - Juniperus osteosperma / Muhlenbergia pungens Woodland Pinus edulis - Juniperus osteosperma / Quercus havardii var. tuckeri Woodland Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	1 : many
26	W-PJWA	Pinyon – Juniper Intermittently Flooded Woodland	Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Wooded Shrubland Juniperus osteosperma / Mixed Shrubs Talus Woodland Juniperus osteosperma / Sparse Understory Woodland Juniperus osteosperma / Quercus gambelii Woodland [Park Special] Juniperus osteosperma / Sporobolus airoides Woodland [Park Special] Pinus edulis - Juniperus osteosperma / Amelanchier utahensis Woodland Pinus edulis - Juniperus osteosperma / Quercus havardii var. tuckeri Woodland Pinus edulis - Juniperus osteosperma / Rhus trilobata Woodland [Park Special] Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland Pinus edulis - Juniperus osteosperma / Symphoricarpos longiflorus Woodland [Park Special] Pinus edulis - Juniperus spp. / Quercus gambelii Woodland	1 : many
33	W-LEDG	Broken Bedrock Ledge and Slope Woodland Complex	Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Wooded Shrubland Pinus edulis - Juniperus spp. / Cercocarpus montanus - Mixed shrub Woodland Pinus edulis - Juniperus osteosperma / Artemisia bigelovii Woodland Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis) Wooded Shrubland	1 : many

Table 13. Map classes used in the final (post-AA) CANY vegetation map.

CANY 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 ecological systems classification.

Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
Multiple Ecological Systems: Colorado Plateau Pinyon-Juniper Shrubland (CES304.766) Colorado Plateau Pinyon-Juniper Woodland (CES304.767) Inter-Mountain Basins Cliff and Canyon (CES304.779) Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822) Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)				
29	C-WOSC	Cool Aspect / Wooded Shale Scarps Complex	Amelanchier utahensis Shrubland Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland Juniperus osteosperma / Leymus salinus Woodland Juniperus osteosperma / Mixed Shrubs Talus Woodland Leymus salinus Shale Sparse Vegetation Pinus edulis - Juniperus osteosperma / Amelanchier utahensis Woodland Pinus edulis - Juniperus osteosperma / Fendlera rupicola Woodland Pinus edulis - Juniperus osteosperma / Leymus salinus Woodland Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia Woodland Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia - Amelanchier utahensis) Woodland Poa fendleriana Herbaceous Vegetation	1 : many
Multiple Ecological Systems: Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765) Colorado Plateau Pinyon-Juniper Shrubland (CES304.766) Colorado Plateau Pinyon-Juniper Woodland (CES304.767)				
32	W-POTH	Potholed and Jointed Sandstone Woodland Complex	Cercocarpus intricatus Montane Shrubland Cercocarpus intricatus Slickrock Sparse Vegetation Fraxinus anomala Woodland Juniperus osteosperma / Cercocarpus intricatus Woodland Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Wooded Shrubland [Cercocarpus intricatus Phase] Juniperus osteosperma / Sparse Understory Woodland Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	1 : many
Multiple Ecological Systems: Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823) Rocky Mountain Cliff, Canyon and Massive Bedrock (CES306.815)				

Table 13. Map classes used in the final (post-AA) CANY vegetation map.

CANY 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 ecological systems classification.

Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
96	W-PSME	Douglas-fir Scree Slope Woodland	Pseudotsuga menziesii Scree Woodland Pseudotsuga menziesii / Quercus gambelii Forest Pseudotsuga menziesii / Cercocarpus montanus Forest	1 : many
Multiple Ecological Systems: North American Warm Desert Riparian Woodland and Shrubland (CES302.753) Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)				
3	W-COTT	Fremont Cottonwood Riverine Woodland	Acer negundo / Disturbed Understory Woodland Populus fremontii / Ericameria nauseosa Woodland Populus fremontii / Salix exigua Forest Populus fremontii / Tamarix chinensis Woodland Populus fremontii / Sporobolus airoides Woodland Salix gooddingii / Salix exigua Woodland	1 : many
Multiple Ecological Systems: North American Warm Desert Riparian Woodland and Shrubland (CES302.753) Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821) Rocky Mountain Subalpine-Montane Riparian Shrubland (CES306.832)				
93	W-COTR	Fremont Cottonwood Intermittently Flooded Tributary Woodland	Populus fremontii / Distichlis spicata Woodland Populus fremontii / Equisetum spp. Woodland Populus fremontii / Ericameria nauseosa Woodland Populus fremontii / Mesic Graminoids Woodland Populus fremontii / Mesic Forbs Woodland Populus fremontii / Salix exigua Forest Populus fremontii / Salix (ligulifolia, lutea) Woodland Populus fremontii / Sporobolus airoides Woodland Salix lutea / Mesic graminoids Shrubland	1 : many
Inter-Mountain Basins Greasewood Flat (CES304.780)				
6	S-SARV	Greasewood Intermittently Flooded Shrubland Complex	Atriplex confertifolia – Sarcobatus vermiculatus Shrubland Sarcobatus vermiculatus Disturbed Shrubland Sarcobatus vermiculatus / Pleuraphis jamesii Shrub Herbaceous Vegetation [Park Special] Sarcobatus vermiculatus / Sporobolus airoides Shrubland Sarcobatus vermiculatus / Sporobolus cryptandrus Shrubland [Park Special] Sarcobatus vermiculatus / Suaeda moquinii Shrubland	1 : many

Table 13. Map classes used in the final (post-AA) CANY vegetation map.

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Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
Multiple Ecological Systems: Inter-Mountain Basins Active and Stabilized Dune (CES304.775) Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777) Inter-Mountain Basins Greasewood Flat (CES304.780) Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784) Inter-Mountain Basins Playa (CES304.786) Inter-Mountain Basins Wash (CES304.781) Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788) Inter-Mountain Basins Semi-Desert Grassland (CES304.787)				
7	S-TERR	High Terrace (Low Valley Bottom) Shrub Herbaceous Complex	Achnatherum hymenoides Colorado Plateau Herbaceous Vegetation Artemisia filifolia Colorado Plateau Shrubland Atriplex canescens Shrubland Atriplex canescens / Pleuraphis jamesii Shrubland Atriplex canescens / Sporobolus airoides Shrubland Atriplex canescens / Suaeda moquinii Shrubland Ericameria nauseosa Shrubland Ericameria nauseosa / Bromus tectorum Semi-natural Shrubland Ericameria nauseosa / Sporobolus airoides Shrubland Oenothera pallida Herbaceous Vegetation [Park Special] Opuntia polyacantha / Pleuraphis jamesii Dwarf-shrubland Opuntia spp. Shrubland Alliance	1 : many
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)				
8	S-SAGE	Basin Big Sagebrush Terrace Shrubland Complex	Artemisia tridentata (ssp. tridentata, ssp. xericensis) Shrubland Alliance Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Semi-natural Shrubland Artemisia tridentata ssp. tridentata / Hesperostipa comata Shrubland Artemisia tridentata ssp. tridentata / Sporobolus cryptandrus Shrubland Atriplex canescens – Artemisia tridentata Shrubland Mahonia fremontii Shrubland	1 : many
9	S-WYSA	Wyoming Big Sagebrush Shrubland	Artemisia tridentata ssp. wyomingensis / Bouteloua gracilis Shrubland Artemisia tridentata ssp. wyomingensis / Disturbed Understory Shrubland Artemisia tridentata ssp. wyomingensis / Hesperostipa comata Shrubland Artemisia tridentata ssp. wyomingensis / Sparse Understory Shrubland	1 : many

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Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)				
10	S-BLAC	Blackbrush Shrubland	Coleogyne ramosissima / Pleuraphis jamesii Shrubland Coleogyne ramosissima Shrubland	1 : many
14	S-EPVI	Green Mormon Tea- Xeric Grasses Shrub Herbaceous Vegetation	Ephedra viridis / (Achnatherum hymenoides - Hesperostipa comata) Shrubland Ephedra viridis / Bouteloua gracilis Shrubland Ephedra viridis / Pleuraphis jamesii Shrubland	1 : many
Multiple Ecological Systems: Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763) Inter-Mountain Basins Active and Stabilized Dune (CES304.775)				
11	S-SAND	Sand Sheet Mixed Shrubland Complex	Artemisia filifolia Colorado Plateau Shrubland Atriplex canescens - Ephedra viridis Shrubland Coleogyne ramosissima Shrubland Coleogyne ramosissima / Pleuraphis jamesii Shrubland Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Shrubland Ephedra torreyana / Achnatherum hymenoides – Pleuraphis jamesii Shrubland Ephedra torreyana / Pleuraphis jamesii Shrubland Ephedra torreyana / Sporobolus cryptandrus Shrub Herbaceous Vegetation [Park Special] Ephedra viridis / (Achnatherum hymenoides - Hesperostipa comata) Shrubland Ephedra viridis / Muhlenbergia pungens Shrubland [Park Special] Quercus havardii var. tuckeri Shrubland	1 : many
Multiple Ecological Systems: Inter-Mountain Basins Active and Stabilized Dune (CES304.775) Inter-Mountain Basins Semi-Desert Grassland (CES304.787)				
13	C-DUNE	Sand Dune Shrub-Herbaceous Complex	Achnatherum hymenoides Colorado Plateau Herbaceous Vegetation Ericameria nauseosa Sand Deposit Sparse Shrubland Eriogonum leptocladon Sparse Vegetation Oenothera albicaulis Herbaceous Vegetation [Park Special] Poliomintha incana - Artemisia filifolia - Vanclevea stylosa Shrubland Rumex hymenosepalus Sparse Vegetation	1 : many

Table 13. Map classes used in the final (post-AA) CANY vegetation map.

CANY 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 ecological systems classification.

Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
Multiple Ecological Systems: Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784) Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)				
18	S-WINT	Winterfat Dwarf-shrubland	Chrysothamnus viscidiflorus - Krascheninnikovia lanata Shrubland [Park Special] Krascheninnikovia lanata Dwarf-shrubland Krascheninnikovia lanata / Bouteloua gracilis Dwarf-shrub Herbaceous Vegetation Krascheninnikovia lanata / Hesperostipa comata Dwarf-shrubland Krascheninnikovia lanata / Pleuraphis jamesii Dwarf-shrubland Krascheninnikovia lanata / Sporobolus cryptandrus Dwarf-shrubland [Park Special]	1 : many
Multiple Ecological Systems: Inter-Mountain Basins Wash (CES304.781) Inter-Mountain Basins Semi-Desert Grassland (CES304.787) Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)				
90	C-WASH	Dry Wash Complex	Atriplex canescens Desert Wash Shrubland Artemisia campestris Stream Terrace Herbaceous Vegetation Chrysothamnus linifolius Shrubland [Park Special] Ericameria nauseosa Desert Wash Shrubland Fraxinus anomala Woodland Iva acerosa Herbaceous Vegetation [Park Special]	1 : many
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)				
1	S-TAMX	Tamarisk River Corridor Shrubland	Tamarisk spp. Temporarily Flooded Shrubland	1 : 1
2	S-WILL	Sandbar Willow Riverine Shrubland	Salix exigua / Barren Shrubland Salix exigua / Mesic Graminoids Shrubland Salix (exigua, interior) Temporarily Flooded Shrubland Alliance	1 : many
5	S-FOPU	High Floodplain Riverine Desert Olive - Reed Grass Complex	Forestiera pubescens Shrubland Phragmites australis Western North America Temperate Semi-natural Herbaceous Vegetation	1 : many
91	S-TRIB	Floodplain and Tributary Tamarisk and Coyote Willow Shrubland Complex	Salix exigua / Barren Shrubland Salix exigua / Mesic Graminoids Shrubland Salix exigua Temporarily Flooded Shrubland Alliance Salix lutea / Mesic graminoids Shrubland Tamarisk spp. Temporarily Flooded Shrubland	1 : many

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Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
Multiple Ecological Systems: Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818) Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821) Rocky Mountain Subalpine-Montane Riparian Shrubland (CES306.832)				
4	S-GOAK	Gambel Oak – Mixed Mesic Shrubs Terrace and Cove Shrubland	Betula occidentalis - Cornus sericea Shrubland Cornus sericea Rocky Mountain Shrubland Forestiera pubescens Shrubland Frangula betulifolia Shrubland [Park Special] Ostrya knowltonii Woodland Quercus gambelii – Cercocarpus montanus / (Carex geyeri) Shrubland Quercus gambelii / Artemisia tridentata Shrubland Quercus gambelii / Rhus trilobata Shrubland Quercus gambelii / Sparse Understory Shrubland Quercus gambelii / Symphoricarpos longiflorus Shrubland	1 : many
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)				
16	H-HERB	Valley Bottom and Benchlands Grasslands	Achnatherum hymenoides Colorado Plateau Herbaceous Vegetation Bouteloua gracilis Herbaceous Vegetation Hesperostipa comata Great Basin Vegetation Pleuraphis jamesii Herbaceous Vegetation	1 : many
Multiple Ecological Systems: Inter-Mountain Basins Active and Stabilized Dune (CES304.775) Inter-Mountain Basins Semi-Desert Grassland (CES304.787) Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)				
17	C-WEED	Weedy Herbaceous Complex	Bromus tectorum Semi-natural Herbaceous Vegetation Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii Dwarf Shrubland Hymenopappus filifolius Herbaceous Vegetation [Park Special] Rumex hymenosepalus Sparse Vegetation Salsola spp. Semi-natural Herbaceous Vegetation Sphaeralcea (coccinea, parvifolia) Herbaceous Vegetation Sporobolus cryptandrus Great Basin Herbaceous Vegetation	1 : many

Table 13. Map classes used in the final (post-AA) CANY vegetation map.

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Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
Multiple Ecological Systems: North American Arid West Emergent Marsh (CES300.729) Colorado Plateau Hanging Garden (CES304.764) Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)				
92	H-HETR	Tributary Mesic Herbaceous Complex	Agrostis stolonifera Seasonally Flooded Herbaceous Alliance Calamagrostis scopulorum Hanging Garden Herbaceous Vegetation Distichlis spicata Herbaceous Vegetation Juncus balticus Herbaceous Vegetation Lolium arundinaceum - Agrostis stolonifera Semi-natural Herbaceous Vegetation [Park Special] Phragmites australis Western North America Temperate Semi-natural Herbaceous Vegetation Poa pratensis Semi-natural Seasonally Flooded Herbaceous Vegetation Typha domingensis Western Herbaceous Vegetation	1 : many
Multiple Ecological Systems: Apacherian-Chihuahuan Semi-Desert Grassland and Steppe (CES302.735) Inter-Mountain Basins Greasewood Flat (CES304.780) Inter-Mountain Basins Semi-Desert Grassland (CES304.787)				
94	H-SPAI	Sporobolus airoides – (Greasewood) Shrub Herbaceous Complex	Atriplex gardneri / Sporobolus airoides Dwarf-shrubland [Park Special] Pleuraphis jamesii - Sporobolus airoides Herbaceous Vegetation Sarcobatus vermiculatus / Sporobolus airoides Shrubland Sporobolus airoides Southern Plains Herbaceous Vegetation	1 : many
Colorado Plateau Hanging Garden (CES304.764)				
100	H-HANG	Hanging Gardens	Aquilegia micrantha - Mimulus eastwoodiae Herbaceous Vegetation Aquilegia micrantha Herbaceous Vegetation Calamagrostis scopulorum Hanging Garden Herbaceous Vegetation	1 : many
Multiple Ecological Systems: Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763) Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783) Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784) Inter-Mountain Basins Shale Badland (CES304.789)				
15	S-SCRU	Shale Barrens Desert Scrub Complex	Atriplex confertifolia Great Basin Shrubland Atriplex confertifolia / Pleuraphis jamesii Shrubland Atriplex gardneri Dwarf-shrubland	1 : many

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Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
			Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland Coleogyne ramosissima Sparse Vegetation Coleogyne ramosissima / Pleuraphis jamesii Shrubland Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation Ephedra torreyana / Pleuraphis jamesii Shrubland Eriogonum corymbosum Badlands Sparse Vegetation Ephedra torreyana Sparse Vegetation Zuckia brandegeei Sparse Vegetation	
Multiple Ecological Systems: **Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)** **Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)** **Colorado Plateau Pinyon-Juniper Woodland (CES304.767)** **Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)** **Inter-Mountain Basins Shale Badland (CES304.789)**				
28	S-MORA	Toeslope/Moraine Sparse Vegetation Complex	Atriplex confertifolia / Pleuraphis jamesii Shrubland Chrysothamnus viscidiflorus Talus Shrubland Ephedra torreyana / Pleuraphis jamesii Shrubland Ericameria nauseosa Sparse Vegetation Juniperus osteosperma / Hesperostipa comata Woodland Juniperus osteosperma / Mixed Shrubs Talus Woodland Zuckia brandegeei Sparse Vegetation	1 : many
Multiple Ecological Systems: **Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)** **Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)** **Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783)** **Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)** **Inter-Mountain Basins Semi-Desert Grassland (CES304.787)** **Inter-Mountain Basins Shale Badland (CES304.789)**				
30	C-TALU	Talus Escarpments Mixed Sparse Vegetation Complex	Achnatherum speciosum Herbaceous Vegetation Artemisia bigelovii - Ephedra (viridis, torreyana) Talus Shrubland Atriplex canescens - Ephedra viridis Talus Shrubland Atriplex confertifolia / Pleuraphis jamesii Shrubland Atriplex confertifolia Sparse Vegetation Atriplex gardneri Dwarf-Shrubland Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland Chrysothamnus viscidiflorus Talus Shrubland	1 : many

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CANY 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 ecological systems classification.

Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
			Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation Ericameria nauseosa Sparse Vegetation Fraxinus anomala - Rhus trilobata Talus Shrubland Rhus trilobata - Ephedra (viridis, torreyana) Talus Shrubland	
Multiple Ecological Systems: Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763) Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765) Colorado Plateau Pinyon-Juniper Woodland (CES304.767) Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)				
31	C-CUTL	Cutler Benches Cliffy Canyonside Mosaic	Atriplex confertifolia / Pleuraphis jamesii Shrubland Chrysothamnus viscidiflorus Talus Shrubland Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation Fraxinus anomala - Rhus trilobata Talus Shrubland Juniperus osteosperma / Mixed Shrubs Talus Woodland Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland	1 : many
Multiple Ecological Systems: Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763) Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)				
34	C-RIMR	Rimrock Sparse Vegetation Complex	Coleogyne ramosissima Sparse Vegetation Fraxinus anomala - Rhus trilobata Talus Shrubland	1 : many
Multiple Ecological Systems: Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783) Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784) Inter-Mountain Basins Shale Badland (CES304.789)				
35	C-CRUS	Cryptobiotic Soil Crust – Ephedra Sparse Vegetation Complex	Atriplex confertifolia / Pleuraphis jamesii Shrubland Atriplex confertifolia Sparse Vegetation Atriplex gardneri Dwarf-Shrubland Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland Ephedra torreyana - (Atriplex spp.) / Nonvascular Gypsum Sparse Vegetation	1 : many
Multiple Ecological Systems: Inter-Mountain Basins Greasewood Flat (CES304.780) Inter-Mountain Basins Playa (CES304.786)				

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Map Class #	Map Class Code	Map Class Name	Description or Associations Assigned to Map Class	Relation
36	S-SALT	Seepweed Salt Flats	Atriplex canescens / Suaeda moquinii Shrubland [Park Special] Suaeda moquinii Shrubland	1 : many
Non-Vegetated and Anderson Land Use Map Classes:				
111	L-RIVR	Rivers	Colorado and Green Rivers	N/A
113	L-POND	Stock Ponds	Small catchments along minor drainages designed to hold runoff for livestock use or groundwater amendment	N/A
132	G-SLRO	Slickrock	Mesas, domes, joints, buttes, and pour-offs of sandstone of any geologic formation. Essentially unvegetated.	N/A
136	G-CLIF	Vertical Sandstone Cliff Bands	Mainly Wingate Formation, very steep escarpment bounding the Island in the Sky and forming canyon walls in several canyons	N/A
200	L-SAND	Sand Bars and Sand Islands	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)	N/A
212	L-HOUS	Park Housing	Housing units built in the park for employee residences	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 t) 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
330	G-MUDF	Mud or Salt Flat	Essentially unvegetated mud or salt flats on the floodplain of the Green or Colorado Rivers	N/A
335	L-BATH	Outhouses	Outhouses mapped where visible in campgrounds	N/A

Table 14. Summary statistics for polygons of each map class developed for the CANY vegetation mapping project.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Park	Environs	Total Area*	Park	Environs	Total Area
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)							
W-PJCO	Pinyon – Juniper / Blackbrush Woodland	1,226	391	1,617	4,762.6	2,431.6	7,194.2
W-MEPJ	Pinyon – Juniper High Elevation Mesa Top Woodland	37	61	98	456.4	853.3	1,309.7
W-PJSA	Pinyon – Juniper / Wyoming Sagebrush Woodland	9	19	28	17.3	125.9	143.2
S-SEED	[Chained and Seeded Pinyon – Juniper Woodland] Sagebrush Shrubland	1	14	15	0.1	63.7	63.8
W-PJGR	Juniper – (Pinyon) / Sparse or Grassy Understory Woodland	694	250	944	1,000.0	444.9	1,444.9
W-PJPO	Pinyon – Juniper “Pour-over” Woodland	1,515	253	1,768	871.2	103.5	974.7
W-POND	Ponderosa Pine - Pinyon Pine - Juniper spp. Wash Woodland	4	6	10	6.6	10.7	17.3
	Subtotal	*3,486*	*994*	*4,480*	*7,114.2*	*4,033.6*	*11,147.8*
Multiple Ecological Systems: Colorado Plateau Pinyon-Juniper Shrubland (CES304.766) Colorado Plateau Pinyon-Juniper Woodland (CES304.767)							
W-PJDU	Pinyon – Juniper Sand Dune Woodland	749	226	975	1,594.5	671.6	2,266.1
W-PJWA	Pinyon – Juniper Intermittently Flooded Woodland	940	212	1,152	1,828.1	412.4	2,240.4
W-LEDG	Broken Bedrock Ledge and Slope Woodland Complex	2,359	445	2,804	13,501.7	4,580.7	18,082.4
	Subtotal	*4,048*	*883*	*4,931*	*16,924.3*	*5,664.7*	*22,588.9*
Multiple Ecological Systems: Colorado Plateau Pinyon-Juniper Shrubland (CES304.766) Colorado Plateau Pinyon-Juniper Woodland (CES304.767) Inter-Mountain Basins Cliff and Canyon (CES304.779) Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822) Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)							
C-WOSC	Cool Aspect / Wooded Shale Scarps Complex	949	213	1,162	5,709.4	1,473.5	7,182.9

Table 14. Summary statistics for polygons of each map class developed for the CANY vegetation mapping project.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Park	Environs	Total Area*	Park	Environs	Total Area
	Subtotal	*949*	*213*	*1,162*	*5,709.4*	*1,473.5*	*7,182.9*
Multiple Ecological Systems: Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765) Colorado Plateau Pinyon-Juniper Shrubland (CES304.766) Colorado Plateau Pinyon-Juniper Woodland (CES304.767)							
W-POTH	Potholed and Jointed Sandstone Woodland Complex	2,139	528	2,667	26,071.8	4,422.8	30,494.7
	Subtotal	*2,139*	*528*	*2,667*	*26,071.8*	*4,422.8*	*30,494.7*
Multiple Ecological Systems: Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823) Rocky Mountain Cliff, Canyon and Massive Bedrock (CES306.815)							
W-PSME	Douglas-fir Scree Slope Woodland	70	60	130	40.3	33.7	74.0
	Subtotal	*70*	*60*	*130*	*40.3*	*33.7*	*74.0*
Multiple Ecological Systems: North American Warm Desert Riparian Woodland and Shrubland (CES302.753) Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)							
W-COTT	Fremont Cottonwood Riverine Woodland	159	7	166	118.3	6.1	124.4
	Subtotal	*159*	*7*	*166*	*118.3*	*6.1*	*124.4*
Multiple Ecological Systems: North American Warm Desert Riparian Woodland and Shrubland (CES302.753) Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821) Rocky Mountain Subalpine-Montane Riparian Shrubland (CES306.832)							
W-COTR	Fremont Cottonwood Intermittently Flooded Tributary Woodland	267	49	316	550.5	68.5	619.0
	Subtotal	*267*	*49*	*316*	*550.5*	*68.5*	*619.0*
Inter-Mountain Basins Greasewood Flat (CES304.780)							
S-SARV	Greasewood Intermittently Flooded Shrubland Complex	282	32	314	545.1	58.6	603.7

Table 14. Summary statistics for polygons of each map class developed for the CANY vegetation mapping project.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Park	Environs	Total Area*	Park	Environs	Total Area
	Subtotal	*282*	*32*	*314*	*545.1*	*58.6*	*603.7*
Multiple Ecological Systems: Inter-Mountain Basins Active and Stabilized Dune (CES304.775) Inter-Mountain Basins Greasewood Flat (CES304.780) Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784) Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788) Inter-Mountain Basins Semi-Desert Grassland (CES304.787)							
S-TERR	High Terrace (Low Valley Bottom) Shrub Herbaceous Complex	282	32	314	545.1	58.6	603.7
	Subtotal	*282*	*32*	*314*	*545.1*	*58.6*	*603.7*
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)							
S-SAGE	Basin Big Sagebrush Terrace Shrubland Complex	685	65	750	759.2	61.8	821.1
S-WYSA	Wyoming Big Sagebrush Shrubland	35	24	59	72.6	32.8	105.4
	Subtotal	*720*	*89*	*809*	*831.8*	*94.6*	*926.5*
Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)							
S-BLAC	Blackbrush Shrubland	2,846	754	3,600	11,149.1	4,943.8	16,092.9
S-EPVI	Green Mormon Tea- Xeric Grasses Shrub Herbaceous Vegetation	100	109	209	1,256.4	1,525.2	2,781.6
	Subtotal	*2,946*	*863*	*3,809*	*12,405.5*	*6,469*	*18,874.5*
Multiple Ecological Systems: Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763) Inter-Mountain Basins Active and Stabilized Dune (CES304.775)							
S-SAND	Sand Sheet Mixed Shrubland Complex	366	121	487	807.8	754.5	1,562.3
	Subtotal	*366*	*121*	*487*	*807.8*	*754.5*	*1,562.3*
Multiple Ecological Systems: Inter-Mountain Basins Active and Stabilized Dune (CES304.775) Inter-Mountain Basins Semi-Desert Grassland (CES304.787)							

Table 14. Summary statistics for polygons of each map class developed for the CANY vegetation mapping project.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Park	Environs	Total Area*	Park	Environs	Total Area
C-DUNE	Sand Dune Shrub-Herbaceous Complex	209	18	227	254.8	31.8	286.6
	Subtotal	*209*	*18*	*227*	*254.8*	*31.8*	*286.6*
Multiple Ecological Systems: Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784) Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)							
S-WINT	Winterfat Dwarf-shrubland	319	58	377	705.5	173.5	879.0
	Subtotal	*319*	*58*	*377*	*705.5*	*173.5*	*879.0*
Multiple Ecological Systems: Inter-Mountain Basins Wash (CES304.781) Inter-Mountain Basins Semi-Desert Grassland (CES304.787) Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)							
C-WASH	Dry Wash Complex	350	88	438	1,083.4	173.5	1,256.9
	Subtotal	*350*	*88*	*438*	*1,083.4*	*173.5*	*1,256.9*
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)							
S-TAMX	Tamarisk River Corridor Shrubland	441	33	474	804.6	73.5	878.1
S-WILL	Sandbar Willow Riverine Shrubland	186	22	208	159.2	23.8	183.0
S-FOPU	High Floodplain Riverine Desert Olive - Reed Grass Complex	320	22	342	261.5	19.2	280.7
S-TRIB	Floodplain and Tributary Tamarisk and Coyote Willow Shrubland Complex	152	53	205	197.7	32.8	230.5
	Subtotal	*1,099*	*130*	*1,229*	*1423.0*	*149.3*	*1572.3*
Multiple Ecological Systems: Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818) Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821) Rocky Mountain Subalpine-Montane Riparian Shrubland (CES306.832)							
S-GOAK	Gambel Oak – Mixed Mesic Shrubs Terrace and Cove Shrubland	703	58	761	350.0	17.1	367.2

Table 14. Summary statistics for polygons of each map class developed for the CANY vegetation mapping project.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Park	Environs	Total Area*	Park	Environs	Total Area
	Subtotal	*703*	*58*	*761*	*350.0*	*17.1*	*367.2*
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)							
H-HERB	Valley Bottom and Benchlands Grasslands	979	242	1,221	1,389.0	952.3	2,341.4
	Subtotal	*979*	*242*	*1,221*	*1,389.0*	*952.3*	*2,341.4*
Multiple Ecological Systems: Inter-Mountain Basins Active and Stabilized Dune (CES304.775) Inter-Mountain Basins Semi-Desert Grassland (CES304.787) Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)							
C-WEED	Weedy Herbaceous Complex	471	67	538	1,756.6	326.7	2,083.3
	Subtotal	*471*	*67*	*538*	*1,756.6*	*326.7*	*2,083.3*
Multiple Ecological Systems: North American Arid West Emergent Marsh (CES300.729) Colorado Plateau Hanging Garden (CES304.764) Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)							
H-HETR	Tributary Mesic Herbaceous Complex	88	6	94	54.1	4.0	58.1
	Subtotal	*88*	*6*	*94*	*54.1*	*4.0*	*58.1*
Multiple Ecological Systems: Apacherian-Chihuahuan Semi-Desert Grassland and Steppe (CES302.735) Inter-Mountain Basins Greasewood Flat (CES304.780) Inter-Mountain Basins Semi-Desert Grassland (CES304.787)							
H-SPAI	Sporobolus airoides – (Greasewood) Shrub Herbaceous Complex	119	20	139	70.0	15.0	85.0
	Subtotal	*119*	*20*	*139*	*70.0*	*15.0*	*85.0*
Colorado Plateau Hanging Garden (CES304.764)							
H-HANG	Hanging Gardens			Documented by point data			
	Subtotal						

Table 14. Summary statistics for polygons of each map class developed for the CANY vegetation mapping project.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Park	Environs	Total Area*	Park	Environs	Total Area
Multiple Ecological Systems: Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763) Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783) Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784) Inter-Mountain Basins Shale Badland (CES304.789)							
S-SCRU	Shale Barrens Desert Scrub Complex	1,684	368	2,052	18,510.6	4,224.4	22,735.0
	Subtotal	*1,684*	*368*	*2,052*	*18,510.6*	*4,224.4*	*22,735.0*
Multiple Ecological Systems: Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763) Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765) Colorado Plateau Pinyon-Juniper Woodland (CES304.767) Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784) Inter-Mountain Basins Shale Badland (CES304.789)							
S-MORA	Toeslope/Moraine Sparse Vegetation Complex	47	11	58	391.1	31.2	422.3
	Subtotal	*47*	*11*	*58*	*391.1*	*31.2*	*422.3*
Multiple Ecological Systems: Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763) Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765) Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783) Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784) Inter-Mountain Basins Semi-Desert Grassland (CES304.787) Inter-Mountain Basins Shale Badland (CES304.789)							
C-TALU	Talus Escarpments Mixed Sparse Vegetation Complex	655	133	788	14,557.1	2,163.4	16,720.6
	Subtotal	*655*	*133*	*788*	*14,557.1*	*2,163.4*	*16,720.6*
Multiple Ecological Systems: Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763) Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765) Colorado Plateau Pinyon-Juniper Woodland (CES304.767) Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)							
C-CUTL	Cutler Benches Cliffy Canyonside Mosaic	185	62	247	8,929.7	2,456.8	11,386.5
	Subtotal	*185*	*62*	*247*	*8,929.7*	*2,456.8*	*11,386.5*

Table 14. Summary statistics for polygons of each map class developed for the CANY vegetation mapping project.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Park	Environs	Total Area*	Park	Environs	Total Area
Multiple Ecological Systems: Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763) Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)							
C-RIMR	Rimrock Sparse Vegetation Complex	*445*	*111*	*556*	*3,217.7*	*539.9*	*3,757.6*
	Subtotal						
Multiple Ecological Systems: Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783) Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784) Inter-Mountain Basins Shale Badland (CES304.789)							
C-CRUS	Cryptobiotic Soil Crust – Ephedra Sparse Vegetation Complex	86	5	91	369.9	18.2	388.1
	Subtotal	*86*	*5*	*91*	*369.9*	*18.2*	*388.1*
Multiple Ecological Systems: Inter-Mountain Basins Greasewood Flat (CES304.780) Inter-Mountain Basins Playa (CES304.786)							
S-SALT	Seepweed Salt Flats	138	10	148	127.0	20.2	147.2
	Subtotal	*138*	*10*	*148*	*127.0*	*20.2*	*147.2*
UNVEGETATED AND ANDERSON LAND USE MAP CLASSES							
L-RIVR	Rivers	4	2	6	1,544.2	188.3	1,732.6
L-POND	Stock Ponds	3	4	7	0.5	1.3	1.8
G-SLRO	Slickrock	476	38	514	4,675.8	73.5	4,749.3
G-CLIF	Vertical Sandstone Cliff Bands	198	83	281	1,628.3	203.1	1,831.4
L-SAND	Sand Bars and Sand Islands	249	25	274	268.1	35.5	303.6
L-HOUS	Park Housing	12	0	12	1.8	0	1.8
L-FACI	Park Facilities	7	0	7	2.3	0	2.3
L-ROAD	Roadways	41	13	54	218.5	47.3	265.8
L-MAIN	Maintenance Yards	6	2	8	4.0	3.9	7.9

Table 14. Summary statistics for polygons of each map class developed for the CANY vegetation mapping project.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Park	Environs	Total Area*	Park	Environs	Total Area
L-HELI	Helicopter Pad	1	0	1	0.1	0	0.1
G-MUDF	Mud or Salt Flat	1	0	1	3.7	0	3.7
L-BATH	Outhouses	3	0	3	0.2	0	0.2
	Subtotal	*1001*	*167*	*1168*	*8,347.5*	*552.9*	*8,900.5*
	Total All Map Classes	**25,746**	**5,751**	**31,497**	**135,204**	**35,414**	**170,618**

* Note: Total polygon area may be less in the full mapping project area because of cumulative rounding error.

Discussion

Mapping the Colorado Plateau national park units, including CANY, is made more challenging by the massive, sheer cliffs and steep, scree slopes that are a common landscape feature. The cliffs and talus/rockfall slopes make field access difficult, confound the generation of slope and aspect data, and create problematic shadows on the aerial photographs and orthoimagery. In addition to requiring the application of special techniques to overcome these challenges, the mapping process revealed opportunities for future improvement.

Things that worked well: Field data and local descriptions of the plant associations provided by project ecologists were extremely important ancillary data sources used by the cartographers to delineate map classes. Other important sources of ancillary data were the long-term vegetation monitoring transects set up by Jayne Belnap and Charlie Schelz. High-quality plot and observation point data, as well as thorough local descriptions helped provide information for direct image interpretation and modeling. Additional data collected by the project photointerpreters on field reconnaissance trips provided a stronger basis and understanding for conducting the interpretation and mapping.

Quality base data is essential to high quality scientific work. For the vegetation mapping in CANY, high quality orthophotography allowed for both confident manual interpretation and a solid source for deriving physiognomic classes and tree coverage densities. The geologic data were detailed and had high horizontal spatial accuracy, both of which are important in GIS applications.

Areas for Improvement: Issues with mapping the vegetation of CANY arose from three key areas: when and how the interpretation/mapping was performed, map class formulation, and cross-walking of plant associations to map classes.

The CANY mapping was done over a two-year time period and up to five individual photointerpreters were working on different sections of the draft map. Some issues arose early in the project due to the differing skill levels of the mappers and differing interpretations of the landscape. When the map was eventually handed over to one photointerpreter, much time was spent trying to bring the map into congruence and to "smooth out the rough edges," both literally and figuratively. Because the interpretation/mapping was done in separate stages, with the ISKY section completed first, the original set of map classes was not sufficient to map all areas of NEED and MAZE. New map classes were formulated and some existing classes were redefined. The defining concepts for some of these new map classes, especially those of the pinyon-juniper woodland communities, were unclear to field crew members. Also, because these map classes were developed later in the mapping process, many of these woodland types were either under or over-mapped during the final phases of mapping and in the map revision process.

Many of the original mapping concepts used for CANY were 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, and they were quite vegetatively heterogeneous. In such cases, a variety of plant associations were cross-walked to each map class, including associations from different physiognomic classes (i.e. shrublands and herbaceous vegetation), and this was reflected in lower map class accuracy numbers. For example, the High Terrace (Low Valley Bottom) Shrub Herbaceous Complex (map

class 7), was developed to represent high terraces and valley bottoms farther from intermittent washes where saltbush shrublands dominate, but it was expanded to include other communities occurring in the same environmental setting and on similar substrates but with different dominant vegetation. In other cases, several map classes with distinct landscape settings and substrates shared very similar diagnostic plant species. For example, plant associations established on rolling shale badlands on the Moenkopi Formation (map class 15), toeslope and moraine communities on the Chinle Formation (map class 28), and talus slopes with warm and/or exposed aspects on a variety of geologic formations (map class 30) were similar.

Some of the common plant associations were assigned to as many as six different map classes, creating a great deal of overlap among those map classes. However, in the case of the *Pinus edulis – Juniperus osteosperma* / Sparse Understory Woodland association, although it is cross-walked to six different map classes, it is a distinct type in most of those different classes. For example, in map class 21, the understory is sparse due to the rockiness (gravel pavement) of the substrate, in map class 25 due to the loose, sandy soils of active dunes, in map classes 24, 26, and 27 due to either high canopy cover or high cover by biological soil crusts, and in map class 32 due to the high bedrock cover. This method of interpretation and mapping employed at CANY can (and did) both over- and undervalue the diversity of the vegetation by either making it appear more diverse than it really is by having many map classes with overlapping associations or making it appear less diverse by having unique associations all lumped into a single map class.

The mapping issues encountered at CANY all reveal opportunities for future improvement of interpretation and mapping. Piecing up large parks such as CANY for the mapping phase of the project can work, but all mappers should have a clear idea of map class concepts and the map class concepts should be developed for the entire park at the start of the mapping process. This may require many field verification trips so that mappers can discuss map class concepts on the ground and resolve issues early on. To deal with the issue of how to formulate map class concepts, mappers should involve Park resource management staff early on so that their input is incorporated. It is inevitable in such a large Park, and one in which the substrate often obscures the vegetation on the aerial imagery, that some map classes will be defined more by landscape setting and substrate than by vegetation. However, the input from Park resource management staff can help make these map classes more distinct and more valuable to future users of the map. Finally, one solution to the issue of cross-walking one association to many different map classes would be to combine those map classes with many overlapping associations, and then use modifiers to clarify differences between polygons in landscape setting or substrate.

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. Ideally, a map has both high user's and producer's accuracy.

Sampling Design

A stratified random sampling approach was used to determine AA sampling locations. The AA included most vegetation map classes and was limited to lands within the CANY boundary; private and federal lands outside of the Park were not included in the accuracy evaluation. Sample sizes for each evaluated map class were selected using scenarios A-E of the USGS-NPS Vegetation Mapping Program guidelines (ESRI et al. 1994):

Scenario A: The class is abundant. It covers more than 50 ha (124 acres) and consists of at least 30 polygons. The recommended sample size is 30.

Scenario B: The class is relatively abundant. It covers more than 50 ha, but consists of fewer than 30 polygons. The recommended sample size is 20. The rationale for reducing the sample size for this type of class is that sample sites are more difficult to find because of the lower frequency of the class.

Scenario C: The class is relatively rare. It covers less than 50 ha but consists of more than 30 polygons. The recommended sample size is 20. The rationale for reducing the sample size is that the class occupies a small area. At the same time, however, the class consists of a considerable number of distinct polygons that are possibly widely distributed. The number of samples therefore remains relatively high because of the high frequency of the class.

Scenario D: The class is rare. It has more than five but fewer than 30 polygons and covers less than 50 ha. The recommended number of samples is five. The rationale for reducing the sample size is that the class consists of small polygons and the frequency of the polygons is low. Specifying more than five sample sites will likely result in multiple samples within the same (small) polygon. Collecting five samples will allow accuracy to be estimated, although the estimate will not be very precise.

Scenario E: The class is very rare. It has fewer than five polygons and occupies less than 50 ha. In this case, it is recommended that the existence of the class be confirmed by a visit to each polygon. The rationale for the recommendation is that with fewer than five sample sites

(assuming one site per polygon), no estimate of level of confidence can be established for the sample and the accuracy of the class can only be confirmed through a field census.

All but two of the vegetated map classes were included in the accuracy assessment. One excluded map class (S-SEED) was only interpreted in the southern environs of CANY, and because AA is done only for lands within the park boundary, this type was omitted from the AA. This type is documented by plot data alone. The other map class (H-HANG) represents hanging gardens and was not interpreted because it occurs on near-vertical cliff faces or beneath cliff overhangs that are invisible on the aerial imagery. Instead, this type is documented by point data derived from the plots database and from field observations marked on copies of the aerial imagery. Nine land-use map classes (L-XXXX) and three geologic classes (G-XXXX) were excluded from AA because they are essentially unvegetated or occur outside the CANY boundary.

Accuracy assessment sampling points were selected for each vegetation map class using guidelines A–E. The primary set of AA evaluation sites included 2,241 points. Secondary and tertiary sets of points were generated in case some of the points in the primary set could not be accessed safely. A 40 m (131 ft) interior buffer from polygon edges was generated for the map coverage to help ensure that 0.5 ha sampling points would fall cleanly within the polygon. The 40 m buffer worked in most situations; however, for small or linear polygons the buffer was reduced or eliminated. Sheer cliffs and steep talus were excluded from the AA point selection pool due to poor or dangerous access. 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 to guide the field crews.

Field Data Collection

Accuracy assessment point data were collected in CANY during the spring and summer of 2007 and the fall of 2008, with the few remaining points collected in the late winter/early spring of 2009. Because the mapping was completed in two stages, and the ISKY district of CANY was completed first, the AA data collection in 2007 was limited to ISKY; new AA points were generated in 2008 for NEED and MAZE. Field crews used GPS receivers, digital orthophotograph plots, and topographic maps to navigate precisely to each pre-selected AA point. The crews evaluated an area approximately 5,000m^2 centered on the AA point coordinates (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, as well as height 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 different from the type recorded for the AA point. A separate illustrated field key was used to identify map classes in CANY. Because of the complex relationships between associations and map classes in CANY, the project leads decided that field crews should key to both association and map class. This improved the precision of accuracy calculations, especially in cases where

one association was cross-walked to many different map classes; it also helped the primary photointerpreter/project lead clarify map class concepts during the revision and final product development process. One or more 35 mm color slides were acquired at each AA point to provide visual documentation of the site.

The field team collected data at 2,043 AA points (Figure 34), the data were manually entered into the plots database and a thorough quality assurance/quality check (QA/QC) was performed on the data prior to analysis. Nomenclature standards and other data management procedures were the same as for the classification plot data (see Vegetation Classification and Description section). Photographic slides were converted to digital format and cataloged in the same database as the classification plot photographs.

Data Analysis

Of the 2,043 AA points collected, 2,034 were used in the final AA data analysis. Nine points were eliminated from the final analysis because they fell in unvegetated areas mapped as either sandbar islands or barren salt or mud flats. However, all 2,043 AA plots were assessed in the initial two analyses, prior to the AA meeting. 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 50m, if recorded) assigned in the field to each AA point were 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 primary photointerpreter/project lead analyzed the map errors revealed in the preliminary contingency table prior to the AA analysis meeting. Each AA point mismatch (disagreement between field call and polygon label) was evaluated for the type of error (true or false). Sources of "false" error include GPS position error, questionable field determinations, edge error, and inclusions (small patches of vegetation within larger map polygons). The majority of false errors identified in the CANY vegetation map were questionable field determinations and in many 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. Mismatches were corrected when a false error was identified, and this raised the overall map accuracy from 65.2% (original accuracy) to 80.3%. All other mismatches were deemed true errors.

On August 18-19, 2010, a meeting was held among CANY staff and project cooperators to complete the AA process. Patterns of error were analyzed and possible solutions for raising individual map class accuracy formulated (Appendix I). Participants discussed alternative solutions and decided on the best solution for the purposes of natural resource management. In

some cases, meeting participants recommended combining certain map classes to achieve higher levels of accuracy and more meaningful vegetation map classes. In other cases, the group recommended retaining map classes with lower accuracy, discussed below. Final edits were made to the vegetation map to reflect the decisions made at the 2010 meeting with CANY staff, and in some cases polygons of "problem" map classes were edited park-wide using newer, higher-resolution aerial imagery. A final contingency table was produced by project cartographers (Table 15). The spatial database was revised to reflect the final combinations of map classes. The original set of 46 vegetated map classes was reduced to 42 by consensus among project participants.

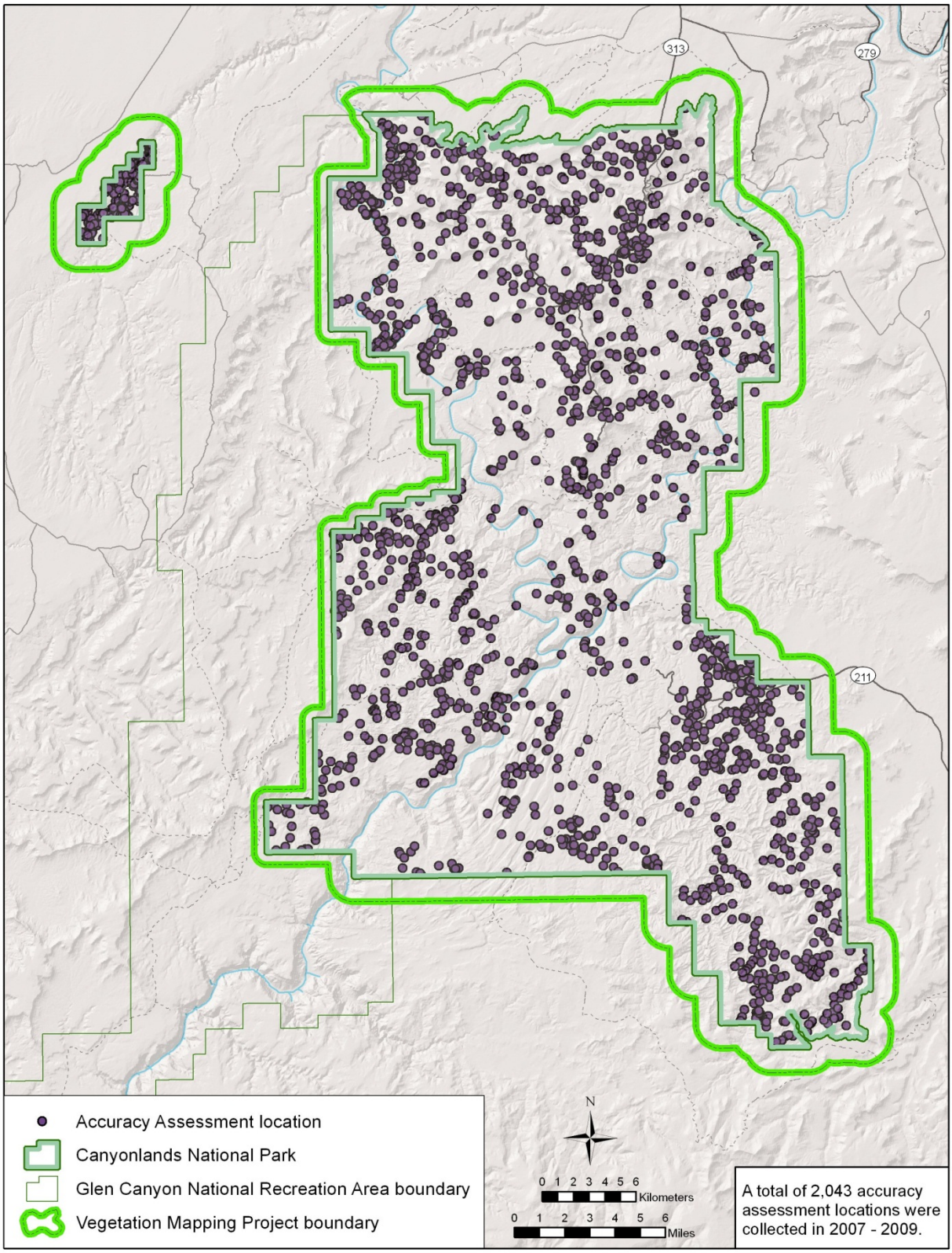


Figure 34. Location of accuracy assessment points sampled within CANY. The accuracy of the map outside of the park boundary was not assessed.

Table 15. Final contingency table for CANY.

This table represent 40 polygon map classes retained following AA and revision whose accuracy was assessed. Map classes 23 and 100 were not accuracy 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 photointerpreter. Overall accuracy is 86.3% (Kappa statistic = 86%). User's and producer's accuracy values with 90% confidence intervals for each map class appear in Tables 16, 17, and 18.

Mapped Data - Omission (Producer's) Error	Accuracy Assessment Field Plot Data - Commission (User's) Error																																								Correct		90% C.I.	
	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	20	21	22	24	25	26	27	28	29	30	31	32	33	34	35	36	90	91	92	93	94	96	98	200	#	%	-	+
1	31	1																																								32	97%	90%	103%
2		5																																								5	100%	90%	110%
3			21		1		1																														1					24	88%	74%	101%
4				36																			5	3		2				1							1					48	75%	64%	86%
5					23																																					23	100%	98%	102%
6	2					47	2																																			51	92%	85%	99%
7							85	1		4	3	3	2		3						1																					102	83%	77%	90%
8							6	52																																		58	90%	82%	97%
9							1	1	19						1																											22	86%	72%	101%
10										185	5	1		3	1			6				1								1												203	91%	88%	95%
11							3			2	37			1			1																									44	84%	74%	94%
13							1				7	26				1					1	2																				38	68%	55%	82%
14													69		2																											71	97%	93%	101%
15							1			6	1			113	1			2								1	2			1		4										132	86%	80%	91%
16							1		1			1	1		40	4	2	1																								51	78%	68%	89%
17							1						1		2	65	1																									70	93%	87%	99%
18							3				1				1	1	43	1																								50	86%	77%	95%
20										3	1							67	3		1					1		1		2												79	85%	78%	92%
21																			22	2								1														25	88%	75%	101%
22																				3																						3	100%	83%	117%
24																		4	2		35		1						1	3												46	76%	65%	88%
25										1								4			1	49	1							1												57	86%	78%	94%
26																							48					1	2						2							53	91%	83%	98%
27				1				1			1							1			1		3	25		3			1	1												38	66%	52%	80%
28										1															29		2															32	91%	81%	101%
29				4						1				1									5		1	62	5	1		3												83	75%	66%	83%
30							1																			1	67	1							1							71	94%	89%	100%
31																											2	28														30	93%	84%	102%
32														1				3			1		2					1	75													83	90%	84%	96%
33																		7								5		1	3	101												117	86%	81%	92%
34																													1		19											20	95%	84%	106%
35														1																		20										21	95%	85%	105%
36	1																																29									30	97%	90%	104%
90							1																											46			3					50	92%	85%	99%
91																																	1		40							41	98%	92%	103%
92								1																											1	21	1					24	88%	74%	101%
93							1	1													2		1											1	5		53					64	83%	74%	91%
94							1																															12				13	92%	76%	108%
96																			1																				5			6	83%	50%	117%
98																																								3		3	100%	83%	117%
200	5	14	2																																						0	21			
correct #	39	20	23	41	24	47	109	57	20	203	56	31	73	120	51	71	47	96	28	5	43	52	66	28	30	75	78	35	83	114	19	24	30	47	49	21	59	12	5	3	0				
correct %	79%	25%	91%	88%	96%	100%	78%	91%	95%	91%	66%	84%	95%	94%	78%	92%	91%	70%	79%	60%	81%	94%	73%	89%	97%	83%	86%	80%	90%	89%	100%	83%	97%	98%	82%	100%	90%	100%	100%	100%		86.3%			
90% C.I -	68%	7%	79%	78%	87%	99%	71%	84%	84%	88%	55%	71%	89%	90%	68%	85%	84%	62%	64%	14%	70%	88%	63%	78%	90%	75%	79%	67%	84%	83%	97%	69%	90%	93%	72%	98%	83%	96%	90%	83%		Kappa = 0.86			
90% C.I +	91%	43%	103%	97%	105%	101%	85%	98%	106%	95%	77%	96%	100%	98%	89%	98%	99%	78%	93%	106%	92%	101%	83%	101%	104%	91%	93%	93%	96%	94%	103%	98%	104%	102%	92%	102%	97%	104%	110%	117%					

Results and Discussion

The map classes shown in tables and figures in this section represent those that remained or were created following adjustment of map classes to improve CANY thematic accuracy. Appendix I provides the complete analysis of all map classes used in the draft map and evaluated during AA. Final overall map accuracy is 86.3% (Kappa correction = 85.8%). Individual map class producer's and user's accuracy values for the 40 map classes that were accuracy-assessed are shown in the tables below with their 90% confidence intervals. 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 25% to 100% (Tables 16, 17, and 18). Twenty-six map classes met or exceeded the 80% program standard for both user's and producer's accuracy (Table 16).

Table 16. Final CANY vegetation map classes that met or exceeded the 80% program standard for both user's and producer's accuracy.

Map Class	Map Class #	Map Class Name	Producer's Accuracy (±90% CI)	User's Accuracy (±90% CI)
W-COTT	3	Fremont Cottonwood Riverine Woodland	88% ± 14%	91% ± 12%
S-FOPU	5	High Floodplain Riverine Desert Olive - Reed Grass Complex	100%	96% ± 9%
S-SARV	6	Greasewood Intermittently Flooded Shrubland Complex	92% ± 7%	100%
S-SAGE	8	Basin Big Sagebrush Terrace Shrubland Complex	90% ± 8%	91% ± 7%
S-WYSA	9	Wyoming Big Sagebrush Shrubland	86% ± 15%	95% ± 11%
S-BLAC	10	Blackbrush Shrubland	91% ± 4%	91% ± 4%
S-EPVI	14	Green Mormon Tea- Xeric Grasses Shrub Herbaceous Vegetation	97% ± 4%	95% ± 6%
S-SCRU	15	Shale Barrens Desert Scrub Complex	86% ± 6%	94% ± 4%
C-WEED	17	Weedy Herbaceous Complex	93% ± 6%	92% ± 6%
S-WINT	18	Winterfat Dwarf-shrubland	86% ± 9%	91% ± 8%
W-PJDU	25	Pinyon – Juniper Sand Dune Woodland	86% ± 8%	94% ± 7%
S-MORA	28	Toeslope/Moraine Sparse Vegetation Complex	91% ± 10%	97% ± 7%
C-TALU	30	Talus Escarpments Mixed Sparse Vegetation Complex	94% ± 6%	86% ± 7%
C-CUTL	31	Cutler Benches Cliffy Canyonside Mosaic	93% ± 9%	80% ± 13%
W-POTH	32	Potholed and Jointed Sandstone Woodland Complex	90% ± 6%	90% ± 6%
W-LEDG	33	Broken Bedrock Ledge and Slope Woodland Complex	86% ± 6%	89% ± 6%
C-RIMR	34	Rimrock Sparse Vegetation Complex	95% ± 11%	100%
C-CRUS	35	Cryptobiotic Soil Crust – Ephedra Sparse Vegetation Complex	95% ± 10%	83% ± 15%
S-SALT	36	Seepweed Salt Flats	97% ± 7%	97% ± 7%
C-WASH	90	Dry Wash Complex	92% ± 7%	98% ± 5%

S-TRIB	91	Floodplain and Tributary Tamarisk and Coyote Willow Shrubland Complex	98% ± 6%	82% ± 10%
H-HETR	92	Tributary Mesic Herbaceous Complex	88% ± 14%	100%
W-COTR	93	Fremont Cottonwood Intermittently Flooded Tributary Woodland	83% ± 9%	90% ± 7%
H-SPAI	94	Sporobolus airoides – (Greasewood) Shrub Herbaceous Complex	92% ± 16%	100%
W-PSME	96	Douglas-fir Scree Slope Woodland	83% ± 27%	100%
W-POND	98	Ponderosa Pine - Pinyon Pine - Juniper spp. Wash Woodland	100%	100%

Thirteen map classes were retained in the final vegetation map for CANY although either user's or producer's accuracy did not meet the 80% program standard (Table 17). A high producer's accuracy but low user's accuracy can mean that a particular map class was undermapped 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 overmapped by the PI and not found to be as common by field crew members. In most cases, the 90% confidence interval includes 80%; CANY staff therefore considered the results to be acceptable.

Table 17. CANY 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-TAMX	1	Tamarisk River Corridor Shrubland	97% ± 7%	79% ± 12%	200
S-WILL	2	Sandbar Willow Riverine Shrubland	100%	25% ± 18%	200
S-GOAK	4	Gambel Oak – Mixed Mesic Shrubs Terrace and Cove Shrubland	75% ± 11%	86% ± 10%	26, 27, 29
S-TERR	7	High Terrace (Low Valley Bottom) Shrub Herbaceous Complex	83% ± 7%	78% ± 7%	8, 10, 11, 13, 16, 18
S-SAND	11	Sand Sheet Mixed Shrubland Complex	84% ± 10%	66% ± 11%	7, 10, 13
C-DUNE	13	Sand Dune Shrub-Herbaceous Complex	68% ± 14%	84% ± 13%	7, 11
W-PJCO	20	Pinyon – Juniper / Blackbrush Woodland	85% ± 7%	70% ± 8%	10, 24, 25, 33
W-MEPJ	21	Pinyon – Juniper High Elevation Mesa Top Woodland	88% ± 13%	79% ± 15%	20, 24
W-PJSA	22	Pinyon – Juniper / Wyoming Sagebrush Woodland	100%	60% ± 46%	21
W-PJGR	24	Juniper – (Pinyon) / Sparse or Grassy Understory Woodland	76% ± 12%	81% ± 11%	20, 21, 33
W-PJWA	26	Pinyon – Juniper Intermittently Flooded Woodland	91% ± 7%	73% ± 10%	4, 27, 29
W-PJPO	27	Pinyon – Juniper "Pour-over" Woodland	66% ± 14%	89% ± 12%	4, 26, 29
C-WOSC	29	Cool Aspect / Wooded Shale Scarps Complex	75% ± 9%	83% ± 8%	4, 30, 33

Eight map classes were undermapped; all were retained because they are ecologically significant types and most errors were with closely related map classes. Map classes 1 and 2 are dynamic vegetation types subject to frequent change related to high and low water events on the major rivers; most of the errors with these map classes were due to mapping sandbars as bare sand based on the 2002 aerial imagery, but finding that five or six years later, during AA field work, many of these sandbars had well-established vegetation. Map classes 7 and 11 are defined more by substrate and/or landscape position than by distinct vegetation characteristics, and so were confused with a variety of other map classes that shared similar vegetation or habitat. Map class 22 is a rare type and occurred as two small inclusions in a large polygon on Cedar Mesa that was mapped as sparse understory pinyon-juniper woodland. The other three map classes that were undermapped were all pinyon-juniper woodlands with different understories and/or habitats and were confused with closely related map classes (mostly other pinyon-juniper woodlands with similar understory species or in similar habitats.

Five map classes were overmapped and in three of them (all pinyon-juniper woodlands with different understories and/or habitats), the errors were with closely related map classes (often a matter of a few percent cover of a diagnostic species or a failure in the map class guide to articulate distinctions between closely related map classes). Map class 4 was overmapped because pure oak communities were often confused by the mapper with pinyon-juniper/oak communities along washes in narrow canyon bottoms (map class 26) and at the base of steep talus slopes (map class 29), as well as below pour-offs and under rims (map class 27). Map class 13 (active sand dunes) was overmapped in areas where the sand signature was less bright (signifying a more stabilized dune situation) and was confused by the mapper with the other two sand sheet map classes (7 and 11). All types were retained because of their value to CANY resource managers.

One map class did not achieve the 80% standard for either user's or producer's accuracy (Table 18). Map class 16 was modeled as a native grassland type but was not consistently differentiated by the mapper from weedy, mostly non-native herbaceous types due to indistinct photo signatures. Some of this could be due to the fact that the aerial photography was acquired during an extremely dry year following a sequence of drought years, where cover by herbaceous species may have appeared as more of a bare ground signature during mapping, but was higher in the survey years when accuracy assessment was conducted, due to more precipitation. The errors attributed to the other three map classes it was confused with all illustrate the difficulty of mapping shrub-herbaceous types. In some cases, the mapper called it a grassland with a shrub modifier, in other cases a shrubland with a grass modifier, but the difference between more grassy than shrubby or more shrubby than grassy was not a fixed concept with a clear cut-off point. Confusion occurred with map classes where characteristic shrubs included saltbush (map class 7), Mormon-tea (map class 14), and winterfat (map class 18) and all included a grassy component (often codominant with the shrub cover), the pure native grasslands were both overmapped (found more shrubby by field crews on the ground) and undermapped (observed as having higher grass cover on the ground). This map class was retained because of its value to CANY resource managers.

Table 18. CANY vegetation map classes where neither the user's or producer's accuracy met 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 #
H-HERB	16	Valley Bottom and Benchlands Grasslands	78% ± 11%	78% ± 11%	7, 14, 17, 18

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Appendix A. Ecological Systems of Canyonlands National Park

Introduction

This appendix contains summary descriptions of 26 terrestrial and riparian/wetland ecological system (ES) units (NatureServe 2003b, Comer et al. 2003) occurring at Canyonlands National Park. Each ecological system represents one or more National Vegetation Classification (NVC) plant associations or alliances (Table 8 within the main report). Map classes were also cross-walked to ES units (Table 11 within the main report).

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

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UPLAND ECOLOGICAL SYSTEMS

CES302.735 APACHERIAN-CHIHUAHUAN SEMI-DESERT GRASSLAND
Division 302 (North-American Warm Desert); Steppe/Savanna

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Foothill]; Lowland [Lowland]; Herbaceous; Temperate [Temperate Xeric]; Short Disturbance Interval; F-Patch/High Intensity [Seasonality/Winter Fire]; Xeromorphic Tree; Thorn Shrub; Graminoid
Concept Summary: This ecological system is a broadly defined desert grassland, mixed shrub-succulent or xeromorphic oak savanna that is typical of the Borderlands of Arizona, New Mexico and northern Mexico (Apacherian region) but extends west to the Sonoran Desert, north into the Mogollon Rim and throughout much of the Chihuahuan Desert. It is found on gently sloping bajadas that support frequent fire throughout the Sky Islands and on mesas and steeper piedmont, foothill and desert mountain slopes up to 1670 m elevation in the Chihuahuan Desert. It is characterized by typically diverse perennial grasses. Common species include grasses *Bouteloua eriopoda, Bouteloua hirsuta, Bouteloua ramosa, Bouteloua rothrockii, Bouteloua curtipendula, Bouteloua gracilis, Eragrostis intermedia, Muhlenbergia emersleyi, Muhlenbergia porteri, Muhlenbergia setifolia*, and *Pleuraphis jamesii*, succulent species of *Agave, Dasylirion*, and *Yucca*, short-shrub species of *Calliandra, Mimosa*, and *Parthenium*, and tall-shrub/short-tree species of *Acacia, Prosopis*, and various oaks (e.g., *Quercus grisea, Quercus emoryi, Quercus arizonica, Quercus oblongifolia*). Many of the historical desert grassland and savanna areas have been converted through intensive grazing and other land uses, some to Apacherian-Chihuahuan Mesquite Upland Scrub (CES302.733) (*Prosopis* spp.-dominated).
Range: This system is found in the Borderlands of Arizona, New Mexico and northern Mexico (Apacherian region), extending to the Sonoran Desert and throughout much of the northern Chihuahuan Desert.
Subnations: AZ, NM, TX

CES304.763 COLORADO PLATEAU BLACKBRUSH-MORMON TEA SHRUBLAND
Division 304 (Inter-Mountain Basins); Shrubland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Foothill]; Shrubland; Temperate Xeric; Aridic
Concept Summary: This ecological system occurs in the Colorado Plateau on benchlands, colluvial slopes, pediments or bajadas. Elevation ranges from 560-1650 m. Substrates are shallow, typically calcareous, non-saline and gravelly or sandy soils over sandstone or limestone bedrock, caliche or limestone alluvium. It also occurs in deeper soils on sandy plains where it may have invaded desert grasslands. The vegetation is characterized by extensive open shrublands dominated by *Coleogyne ramosissima* often with *Ephedra viridis, Ephedra torreyana,* or *Grayia spinosa*. Sandy portions may include *Artemisia filifolia* as codominant. The herbaceous layer is sparse and composed of graminoids such as *Achnatherum hymenoides, Pleuraphis jamesii,* or *Sporobolus cryptandrus*.

Range: Occurs in the Colorado Plateau on benchlands, colluvial slopes, pediments or bajadas. Elevation ranges from 560-1600 m.
Subnations: AZ, CO, NM, UT

CES304.765 COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND

Division 304 (Inter-Mountain Basins); Barren

Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland
Diagnostic Classifiers: Montane, Lower Montane; Lowland, Foothill; Shrubland; Ridge/Summit/Upper Slope; Sedimentary Rock; Temperate Xeric; Alkaline Soil; Aridic
Concept Summary: The distribution of this ecological system is centered on the Colorado Plateau where it is comprised of barren and sparsely vegetated landscapes (generally <10% plant cover) of steep cliff faces, narrow canyons, and open tablelands of predominantly sedimentary rocks, such as sandstone, shale, and limestone. Some eroding shale layers similar to Inter-Mountain Basins Shale Badland (CES304.789) may be interbedded between the harder rocks. The vegetation is characterized by very open tree canopy or scattered trees and shrubs with a sparse herbaceous layer. Common species includes *Pinus edulis, Pinus ponderosa, Juniperus* spp., *Cercocarpus intricatus*, and other short-shrub and herbaceous species, rooted in cracks and pockets where soil accumulates.
Comments: Geographically restricted and distinct from the related Inter-Mountain Basins Cliff and Canyon (CES304.779). Shale areas are not extensive as in shale badlands.
Range: Colorado Plateau.
Subnations: AZ, CO, NM, UT

CES304.766 COLORADO PLATEAU PINYON-JUNIPER SHRUBLAND

Division 304 (Inter-Mountain Basins); Shrubland

Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Foothill]; Mesa; Ridge/Summit/Upper Slope; Sedimentary Rock; Temperate [Temperate Xeric]; Aridic; *Pinus edulis, Juniperus osteosperma*
Concept Summary: This ecological system is characteristic of the rocky mesatops and slopes on the Colorado Plateau and western slope of Colorado, but these stunted tree shrublands may extend further upslope along the low-elevation margins of taller pinyon-juniper woodlands. Sites are drier than Colorado Plateau Pinyon-Juniper Woodland (CES304.767). Substrates are shallow/rocky and shaly soils at lower elevations (1200-2000 m). Sparse examples of the system grade into Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765). The vegetation is dominated by dwarfed (usually <3 m tall) *Pinus edulis* and/or *Juniperus osteosperma* trees forming extensive tall shrublands in the region along low-elevation margins of pinyon-juniper woodlands. Other shrubs, if present, may include *Artemisia nova, Artemisia tridentata* ssp. *wyomingensis, Chrysothamnus viscidiflorus*, or *Coleogyne ramosissima*. Herbaceous layers are sparse to moderately dense and typically composed of xeric graminoids.
Range: Rocky mesa tops and slopes on the Colorado Plateau.

Subnations: AZ, CO, NM, UT

CES304.767 COLORADO PLATEAU PINYON-JUNIPER WOODLAND

Division 304 (Inter-Mountain Basins); Forest and Woodland

Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Lower Montane]; Lowland [Foothill]; Mesa; Ridge/Summit/Upper Slope; Sedimentary Rock; Temperate Xeric; Aridic; *Pinus edulis, Juniperus osteosperma*
Concept Summary: This ecological system occurs in dry mountain slopes, mesas, plateaus, and ridges of the Colorado Plateau region including the Western Slope of Colorado to the Wasatch Range, south to the Mogollon Rim and the northwestern corner of New Mexico. It is typically found at lower elevations (1500-2440 m). 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 system vary in texture ranging from stony, cobbly, gravelly sandy loams to clay loam or clay. *Pinus edulis* and/or *Juniperus osteosperma* dominate the tree canopy. In northern Arizona and northwestern New Mexico, *Juniperus monosperma* and hybrids of *Juniperus* spp. may dominate or codominate the tree canopy. *Juniperus scopulorum* may codominate or replace *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*, or *Poa fendleriana*. This system occurs at higher elevations than Great Basin Pinyon-Juniper Woodland (CES304.773) and Colorado Plateau shrubland systems.
Range: 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. It is typically found at elevations ranging from 1500-2440 m.
Subnations: AZ, CO, NM, UT

CES304.775 INTER-MOUNTAIN BASINS ACTIVE AND STABILIZED DUNE

Division 304 (Inter-Mountain Basins); Barren

Spatial Scale & Pattern: Large Patch
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland
Diagnostic Classifiers: Lowland; Shrub-dominated; Dune; Temperate Continental; Sand Soil Texture; Aridic; W-Landscape/High Intensity
Concept Summary: This ecological system occurs in the Intermountain western U.S. on basins, valleys and plains. Often it is composed of a mosaic of migrating, bare dunes; anchored dunes with sparse to moderately dense vegetation (<10-30% canopy cover); and stabilized dunes. The system is defined by the presence of migrating dunes or, where the dunes are entirely anchored or stabilized, evidence that the substrate is eolian and not residual, that the vegetation is early- or mid-seral, and that the substrate is likely to become actively migrating again with disturbance or increased aridity. In the Colorado Plateau, there are many small active and partially vegetated

dunes along some of the larger washes and playas (where sand is blown out of wash and forms dunes) and some larger dunes such as Coral Pink Dunes in southwestern Utah. Substrates are usually eolian sand, but small dunes composed of silt and clay downwind from playas in the Wyoming Basins (which usually support greasewood vegetation) also are included here. Species occupying these environments are often adapted to shifting, coarse-textured substrates (usually quartz sand) and form patchy or open grasslands, shrublands or steppe, and occasionally woodlands. Vegetation varies and may be composed of *Achnatherum hymenoides, Artemisia filifolia, Artemisia tridentata* ssp. *tridentata, Atriplex canescens, Ephedra* spp., *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ericameria nauseosa, Hesperostipa comata, Leymus flavescens, Muhlenbergia pungens, Psoralidium lanceolatum, Purshia tridentata, Redfieldia flexuosa, Sporobolus airoides, Sarcobatus vermiculatus, Tetradymia tetrameres*, or *Tiquilia* spp. Herbaceous species such as *Achnatherum hymenoides, Redfieldia flexuosa*, and *Psoralidium lanceolatum* are characteristic of early-seral vegetation through much of this system's range. Shrubs are commonly dominant on mid- to late-seral stands, and *Ericameria nauseosa* can be found at any stage.
Comments: Rules should be devised for deciding whether shrub or shrub-steppe vegetation on completely stabilized dunes should be considered part of this active and stabilized dune system, or part of another system. The areas include Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784), Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777), and Inter-Mountain Basins Big Sagebrush Steppe (CES304.778) on sand, and Inter-Mountain Basins Greasewood Flat (CES304.780) on clay and silt.
Range: This system occurs in intermountain basins of the western U.S. including southwestern Montana in the Centennial Valley.
Subnations: AZ, CO, ID, MT, NM, NV, OR, UT, WA, WY

CES304.777 INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND
Division 304 (Inter-Mountain Basins); Shrubland

Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland; Shrubland; Toeslope/Valley Bottom; Deep Soil; Aridic; *Artemisia tridentata* ssp. *tridentata*
Concept Summary: This ecological system occurs throughout much of the western U.S., typically in basins, plains and foothills between 1500 and 2300 m elevation. Soils are typically deep, well-drained and non-saline. These shrublands are dominated by *Artemisia tridentata* ssp. *tridentata* and/or *Artemisia tridentata* ssp. *wyomingensis*. Scattered *Juniperus* spp., *Sarcobatus vermiculatus*, and *Atriplex* spp. may be present in some stands. *Ericameria nauseosa, Chrysothamnus viscidiflorus, Purshia tridentata*, or *Symphoricarpos oreophilus* may codominate disturbed stands. Perennial herbaceous components typically contribute less than 25% vegetative cover. Common graminoid species include *Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus, Festuca idahoensis, Hesperostipa comata, Leymus cinereus, Pleuraphis jamesii, Pascopyrum smithii, Poa secunda*, or *Pseudoroegneria spicata*.
Range: Occurs throughout much of the western U.S., typically in broad basins between mountain ranges, plains and foothills between 1500-2300 m elevation.
Subnations: CA, CO, ID, MT, NV, OR, UT, WA, WY

CES304.779 INTER-MOUNTAIN BASINS CLIFF AND CANYON
Division 304 (Inter-Mountain Basins); Barren

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Cliff (Landform); Rock Outcrops/Barrens/Glades
Concept Summary: This ecological system is found from foothill to subalpine elevations and includes barren and sparsely vegetated landscapes (generally <10% plant cover) of steep cliff faces, narrow canyons, and smaller rock outcrops of various igneous, sedimentary, and metamorphic bedrock types. Also included is vegetation of unstable scree and talus slopes that typically occurs below cliff faces. Widely scattered trees and shrubs may include *Abies concolor, Pinus edulis, Pinus flexilis, Pinus monophylla, Juniperus* spp., *Artemisia tridentata, Purshia tridentata, Cercocarpus ledifolius, Ephedra* spp., *Holodiscus discolor*, and other species often common in adjacent plant communities.
Subnations: CA, ID, NV, OR, UT, WA, WY

CES304.780 INTER-MOUNTAIN BASINS GREASEWOOD FLAT
Division 304 (Inter-Mountain Basins); Mixed Upland and Wetland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland; Wetland
Diagnostic Classifiers: Lowland; Shrubland; Toeslope/Valley Bottom; Alkaline Soil; Deep Soil; Xeromorphic Shrub
Concept Summary: This ecological system occurs throughout the intermountain basins of the western U.S. and extends onto the western Great Plains. It typically occurs on stream terraces and flats associated with drainages or it may form rings around 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 system usually occurs as a mosaic of multiple communities, with open to moderately dense shrublands dominated or codominated by *Sarcobatus vermiculatus*. *Atriplex canescens, Atriplex confertifolia*, or *Krascheninnikovia lanata* may be present to codominant. Occurrences are often surrounded by mixed salt desert scrub. The herbaceous layer, if present, is usually dominated by graminoids. There may be inclusions of *Sporobolus airoides, Distichlis spicata* (where water remains ponded the longest), or *Eleocharis palustris* herbaceous types.
Range: Occurs throughout much of the western U.S. in Intermountain basins and extends onto the western Great Plains.
Subnations: AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

CES304.781 INTER-MOUNTAIN BASINS WASH
Division 304 (Inter-Mountain Basins); Barren

Spatial Scale & Pattern: Linear
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland; Wetland

Diagnostic Classifiers: Lowland; Shrubland; Wash; Toeslope/Valley Bottom; Riverine / Alluvial; Alkaline Soil; Xeromorphic Shrub; *Sarcobatus vermiculatus*
Concept Summary: This barren and sparsely vegetated (generally <10% plant cover) ecological system is restricted to intermittently flooded streambeds and banks that are often lined with shrubs such as *Sarcobatus vermiculatus, Ericameria nauseosa, Fallugia paradoxa*, and/or *Artemisia cana* ssp. *cana* (in more northern and mesic stands). *Grayia spinosa* may dominate in the Great Basin. Shrubs form a continuous or intermittent linear canopy in and along drainages but do not extend out into flats. Typically it includes patches of saltgrass meadow where water remains for the longest periods. Soils are generally less alkaline than those found in the playa system. Desert scrub species (e.g., *Acacia greggii, Prosopis* spp.), that are common in the Mojave, Sonoran and Chihuahuan desert washes, are not present. This type can occur in limited portions of the southwestern Great Plains.
Comments: Compare with Inter-Mountain Basins Greasewood Flat (CES304.780); should it include nonsparse shrublands? Invasive, exotic shrubs shrub as *Tamarix* spp. or *Chamaebatiaria millefolium* may be present to dominant in these washes where disturbed.
Range: This system occurs throughout the Intermountain U.S. into the western Great Plains.
Subnations: AZ, CA, CO, ID, MT, NV, OR, UT, WA, WY

CES304.783 INTER-MOUNTAIN BASINS MAT SALTBUSH SHRUBLAND

Division 304 (Inter-Mountain Basins); Shrubland

Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Lowland]; Shrubland (Shrub-dominated); Alluvial flat; Alluvial Plain; Plain; Alkaline Soil; Saline Substrate Chemistry; Calcareous; Silt Soil Texture; Clay Soil Texture; Dwarf-Shrub; *Atriplex* spp.
Concept Summary: This ecological system occurs on gentle slopes and rolling plains in the northern Colorado Plateau and Uinta Basin on Mancos shale and arid, windswept basins and plains across parts of Wyoming. Substrates are shallow, typically saline, alkaline, fine-textured soils developed from shale or alluvium and may be associated with shale badlands. Infiltration rate is typically low. These landscapes typically support dwarf-shrublands composed of relatively pure stands of *Atriplex* spp., such as *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 *Picrothamnus desertorum*, sometimes with a mix of other low shrubs, such as *Krascheninnikovia lanata* or *Tetradymia spinosa*. *Atriplex confertifolia* or *Atriplex canescens* may be present but do not codominate. *Artemisia tridentata* ssp. *wyomingensis* can occur in patches within this system. 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 system). Annuals are seasonally present

and may include *Eriogonum inflatum, Plantago tweedyi, Monolepis nuttalliana*, and the introduced annual grass *Bromus tectorum*.
Range: This system occurs on gentle slopes and rolling plains in the northern Colorado Plateau and Uinta Basin on Mancos shale and arid, windswept basins and plains across parts of Wyoming, and possibly into Montana and Canada.
Subnations: AZ, CO, MT, NM, UT, WY

CES304.784 INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB
Division 304 (Inter-Mountain Basins); Shrubland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland; Shrubland; Alluvial flat; Alkaline Soil; Saline Substrate Chemistry; Calcareous; Silt Soil Texture; Clay Soil Texture; Xeromorphic Shrub; Dwarf-Shrub; *Atriplex* spp.
Concept Summary: This ecological system includes open-canopied shrublands of typically saline basins, alluvial slopes and plains across the Intermountain U.S. This type also extends in limited distribution into the southern Great Plains. Substrates are often saline and calcareous, medium- to fine-textured, alkaline soils, but include some coarser-textured soils. The vegetation is characterized by a typically open to moderately dense shrubland composed of one or more *Atriplex* species such as *Atriplex confertifolia, Atriplex canescens, Atriplex polycarpa*, or *Atriplex spinifera*. Other shrubs present to codominant may include *Artemisia tridentata* ssp. *wyomingensis, Chrysothamnus viscidiflorus, Ericameria nauseosa, Ephedra nevadensis, Grayia spinosa, Krascheninnikovia lanata, Lycium* spp., *Picrothamnus desertorum*, or *Tetradymia* spp. *Sarcobatus vermiculatus* is generally absent, but if present is not dominant. 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*.
Range: Intermountain western U.S., extending into the southern Great Plains.
Subnations: AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

CES304.786 INTER-MOUNTAIN BASINS PLAYA
Division 304 (Inter-Mountain Basins); Barren

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland; Wetland
Diagnostic Classifiers: Lowland; Playa; Temperate Xeric; Depressional; Alkaline Soil; Saline Substrate Chemistry; Aridic; Alkaline Water; Saline Water Chemistry; Caliche Layer; Impermeable Layer; Intermittent Flooding
Concept Summary: This ecological system is composed of barren and sparsely vegetated playas (generally <10% plant cover) found in the intermountain western U.S. Salt crusts are common throughout, with small saltgrass beds in depressions and sparse shrubs around the margins. These systems are intermittently flooded. The 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. Characteristic species may include *Allenrolfea*

occidentalis, Sarcobatus vermiculatus, Grayia spinosa, Puccinellia lemmonii, Leymus cinereus, Distichlis spicata, and/or *Atriplex* spp.
Range: This system occurs throughout the Intermountain western U.S., extending east into the southwestern Great Plains.
Subnations: CA, CO, ID, NM, NV, OR, UT, WA?, WY

CES304.787 INTER-MOUNTAIN BASINS SEMI-DESERT GRASSLAND
Division 304 (Inter-Mountain Basins); Herbaceous

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland Foothill; Herbaceous; Temperate Xeric; Alkaline Soil; Aridic; Graminoid
Concept Summary: This widespread ecological system occurs throughout the intermountain western U.S. on dry plains and mesas, at approximately 1450 to 2320 m (4750-7610 feet) elevation. These grasslands occur in lowland and upland areas and may occupy swales, playas, mesatops, plateau parks, alluvial flats, and plains, but sites are typically xeric. Substrates are often well-drained sandy or loamy-textured soils derived from sedimentary parent materials but are quite variable and may include fine-textured soils derived from igneous and metamorphic rocks. When they occur near foothill grasslands they will be at lower elevations. The dominant perennial bunch grasses and shrubs within this system are all very drought-resistant plants. These grasslands are typically dominated or by *Achnatherum hymenoides, Aristida* spp., *Bouteloua gracilis, Hesperostipa comata, Muhlenbergia* sp., or *Pleuraphis jamesii* and may include scattered shrubs and dwarf-shrubs of species of *Artemisia, Atriplex, Coleogyne, Ephedra, Gutierrezia*, or *Krascheninnikovia lanata*.
Range: Occurs throughout the Intermountain western U.S. on dry plains and mesas, at approximately 1450 to 2320 m (4750-7610 feet) in elevation.
Subnations: AZ, CA, CO, ID, MT?, NM, NV, OR, UT, WA, WY

CES304.788 INTER-MOUNTAIN BASINS SEMI-DESERT SHRUB-STEPPE
Division 304 (Inter-Mountain Basins); Steppe-Savanna

Spatial Scale & Pattern: Large Patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Foothill]; Woody-Herbaceous; Temperate Xeric; Alkaline Soil; Aridic; Very Short Disturbance Interval; G-Landscape/High Intensity; Graminoid
Concept Summary: This ecological system occurs throughout the arid intermountain western U.S., typically at lower elevations on alluvial fans and flats with moderate to deep soils, and extends into south-central Montana between the Pryor and Beartooth ranges where a distinct rainshadow effect occurs. This semi-arid shrub-steppe is typically dominated by graminoids (>25% cover) with an open shrub to moderately dense woody layer with a typically strong graminoid layer. The most widespread (but not always dominant) species is *Pseudoroegneria spicata*, which occurs from the Columbia Basin to the northern Rockies. Other characteristic grasses include *Achnatherum hymenoides, Bouteloua gracilis, Distichlis spicata, Poa secunda, Poa fendleriana, Sporobolus airoides , Hesperostipa comata, Pleuraphis jamesii*, and *Leymus*

salinus. The woody layer is often a mixture of shrubs and dwarf-shrubs, although it may be dominated by a single species. Characteristic species include *Atriplex canescens, Artemisia tridentata, Chrysothamnus greenei, Chrysothamnus viscidiflorus, Ephedra* spp., *Ericameria nauseosa, Gutierrezia sarothrae*, and *Krascheninnikovia lanata*. *Artemisia tridentata* or *Atriplex canescens* may be present but does not dominate. Annual grasses, especially the exotics *Bromus japonicus* and *Bromus tectorum*, may be present to abundant. Forbs are generally of low importance and are highly variable across the range but may be diverse in some occurrences. The general aspect of occurrences may be either open shrubland with patchy grasses or patchy open herbaceous layers. Disturbance may be important in maintaining the woody component. Microphytic crust is very important in some stands.
Range: This system occurs throughout the intermountain western U.S., typically at lower elevations, and extends into Wyoming and Montana across the Great Divide Basin. It barely gets as far north into north-central Montana (mapzone 20) but is unlikely to be mapped.
Subnations: AZ, CA, CO, ID, MT, NM, NV, OR, UT, WY

CES304.789 INTER-MOUNTAIN BASINS SHALE BADLAND
Division 304 (Inter-Mountain Basins); Barren

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (<10% vasc.); Upland
Diagnostic Classifiers: Lowland; Badlands; Alkaline Soil; Shale and Mudstone; Silt Soil Texture; Clay Soil Texture
Concept Summary: This widespread system of the intermountain western U.S. is composed of barren and sparsely vegetated substrates (<10% plant cover) typically derived from marine shales but also from siltstones and mudstones (clay). Landforms are typically rounded hills and plains that form a rolling topography. The harsh soil properties and high rate of erosion and deposition are driving environmental variables supporting sparse dwarf-shrubs, e.g., *Atriplex corrugata, Atriplex gardneri, Artemisia pedatifida,* and herbaceous vegetation.
Range: This system is found in the intermountain western U.S. It is confirmed by Oregon and Washington review to not occur in either of those states.
Subnations: AZ, CA, CO, ID, MT, NM, NV, UT, WY

CES306.815 ROCKY MOUNTAIN CLIFF, CANYON AND MASSIVE BEDROCK
Division 306 (Rocky Mountain); Barren

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Upland
Diagnostic Classifiers: Canyon; Cliff (Landform); Ridgetop bedrock outcrop; Talus (Substrate); Rock Outcrops/Barrens/Glades; Oligotrophic Soil; Very Shallow Soil; Landslide
Concept Summary: This ecological system of barren and sparsely vegetated landscapes (generally <10% plant cover) is found from foothill to subalpine elevations on steep cliff faces, narrow canyons, and smaller rock outcrops of various igneous (intrusives), sedimentary, and metamorphic bedrock types. It is located throughout the Rocky Mountains and northeastern Cascade Ranges in North America. Also included are unstable scree and talus slopes that typically occur below cliff faces. In general these are the dry sparsely vegetated places on a

landscape. The biota on them reflect what is surrounding them, unless it is an extreme parent material. There may be small patches of dense vegetation, but it typically includes scattered trees and/or shrubs. Characteristic trees include species from the surrounding landscape, such as *Pseudotsuga menziesii, Pinus ponderosa, Pinus flexilis, Populus tremuloides, Abies concolor, Abies lasiocarpa,* or *Pinus edulis* and *Juniperus* spp. at lower elevations. There may be scattered shrubs present, such as species of *Holodiscus, Ribes, Physocarpus, Rosa, Juniperus,* and *Jamesia Americana, Mahonia repens, Rhus trilobata,* or *Amelanchier alnifolia.* Soil development is limited, as is herbaceous cover.
Range: This system is located throughout the Rocky Mountain, including the isolated island ranges of central Montana, and northeastern Cascade Ranges in North America.
Subnations: AZ, CO, ID, MT, NM, OR, TX, UT, WA, WY

CES306.818 ROCKY MOUNTAIN GAMBEL OAK-MIXED MONTANE SHRUBLAND
Division 306 (Rocky Mountain); Shrubland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Shrubland; Shallow Soil; Mineral w/ A-Horizon <10 cm; Loam Soil Texture; Sand Soil Texture; Ustic; Unconsolidated; Intermediate Disturbance Interval [Periodicity/Polycyclic Disturbance]; Broad-Leaved Deciduous Shrub
Concept Summary: This ecological system occurs in the mountains, plateaus, and foothills in the southern Rocky Mountains and Colorado Plateau, including the Uinta and Wasatch ranges and the Mogollon Rim. These shrublands are commonly found on 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 include soil types ranging from calcareous, fine-grained loams to sandy loams, gravelly loams, clay loams, deep alluvial sand, or coarse gravel. The vegetation is typically dominated by *Quercus gambelii* alone or with *Amelanchier alnifolia, Amelanchier utahensis, Artemisia tridentata, Cercocarpus montanus, 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 minor component. This ecological system intergrades with the lower montane-foothills shrubland system and shares many of the same site characteristics. Density and cover of *Quercus gambelii* and *Amelanchier* spp. often increase after fire.
Range: Occurs in the mountains, plateaus and foothills in the southern Rocky Mountains and Colorado Plateau including the Uinta and Wasatch ranges and the Mogollon Rim.
Subnations: AZ, CO, NM, UT, WY

CES306.822 ROCKY MOUNTAIN LOWER MONTANE-FOOTHILL SHRUBLAND
Division 306 (Rocky Mountain); Shrubland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane, Lower Montane; Lowland [Foothill]; Shrubland; Very Shallow Soil; Aridic; Intemediate Disturbance Interval [Periodicity/Polycyclic Disturbance]

Concept Summary: This ecological system is found in the foothills, canyon slopes and lower mountains of the Rocky Mountains and on outcrops and canyon slopes in the western Great Plains. It ranges from southern New Mexico north into Wyoming, and west into the Intermountain basins. These shrublands occur between 1500-2900 m elevation and are usually associated with exposed sites, rocky substrates, and dry conditions that 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 system is generally drier than Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818), but may include mesic montane shrublands where *Quercus gambelii* does not occur. Scattered trees or inclusions of grassland patches or steppe may be present, but the vegetation is typically dominated by a variety of shrubs including *Amelanchier utahensis, Cercocarpus montanus, Purshia tridentata, Rhus trilobata, Ribes cereum, Symphoricarpos oreophilus,* or *Yucca glauca*. In northeastern Wyoming and adjacent Montana, *Cercocarpus ledifolius*, usually with *Artemisia tridentata*, is the common dominant shrub. Grasses include species of *Muhlenbergia, Bouteloua, Hesperostipa,* and *Pseudoroegneria spicata*. Fires play an important role in this system as the dominant shrubs usually have severe die-back, although some species will stump sprout. *Cercocarpus montanus* requires a disturbance such as fire to reproduce, either by seed or root crown sprouting. Fire suppression may allow an invasion of trees into some of these shrublands, but in many cases sites are too xeric for tree growth.
Range: Foothills, canyon slopes and lower mountains of the Rocky Mountains and on outcrops and canyon slopes in the western Great Plains. It ranges from southern New Mexico extending north into Wyoming, and west into the Intermountain region.
Subnations: CO, MT, NE?, NM, SD, UT, WY

CES306.823 SOUTHERN ROCKY MOUNTAIN DRY-MESIC MONTANE MIXED CONIFER FOREST AND WOODLAND
Division 306 (Rocky Mountain); Forest and Woodland

Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Lower Montane]; Forest and Woodland; Aridic; Intermediate Disturbance Interval; F-Patch/Medium Intensity; F-Landscape/Medium Intensity; Needle-Leaved Tree; Montane Mesic Mixed Conifer; Moderate (100-500 yrs) Persistence
Concept Summary: This is a highly variable ecological system of the montane zone of the Rocky Mountains. It occurs throughout the southern Rockies, north and west into Utah, Nevada, western Wyoming and Idaho. These are mixed-conifer forests occurring on all aspects between 1200 and 3300 m elevation. Rainfall averages less than 75 cm per year (40-60 cm) with summer "monsoons" during the growing season contributing substantial moisture. The composition and structure of overstory is 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 most often found in cool, moist locations, often

occurring 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 and graminoid species common, including *Arctostaphylos uva-ursi, Mahonia repens, Paxistima myrsinites, Symphoricarpos oreophilus, Jamesia americana, Quercus gambelii*, and *Festuca arizonica*. This system was undoubtedly characterized by a mixed severity fire regime in its "natural condition," with a high degree of variability in intensity and return interval.
Range: Occurs throughout the southern Rockies into Utah, Nevada, Wyoming and Idaho.
Subnations: AZ, CO, ID, NV, OR, UT, WY

CES306.824 SOUTHERN ROCKY MOUNTAIN MONTANE-SUBALPINE GRASSLAND

Division 306 (Rocky Mountain); Herbaceous

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Herbaceous; Acidic Soil; Mineral: W/ A-Horizon >10 cm; Loam Soil Texture; Silt Soil Texture; Aridic; Short Disturbance Interval; Graminoid; Cool-season bunch grasses
Concept Summary: This Rocky Mountain ecological system typically occurs between 2200 and 3000 m elevation on flat to rolling plains and parks 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. An occurrence usually consists of a mosaic of two or three plant associations with one of the following dominant bunch grasses: *Danthonia intermedia, Danthonia parryi, Festuca idahoensis, Festuca arizonica, Festuca thurberi, Muhlenbergia filiculmis,* or *Pseudoroegneria spicata.* The subdominants include *Muhlenbergia montana, Bouteloua gracilis,* and *Poa secunda.* 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.
Range: This system occurs between 2200 and 3000 m elevation in the Colorado Rockies. Where it transitions in Wyoming to Northern Rocky Mountain Subalpine-Upper Montane Grassland (CES306.806) still needs to be clarified.
Subnations: AZ, CO, NM, UT, WY

RIPARIAN AND WETLAND ECOLOGICAL SYSTEMS

CES300.729 NORTH AMERICAN ARID WEST EMERGENT MARSH

Division 300 (North American); Woody Wetland

Spatial Scale & Pattern: Linear
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Wetland
Diagnostic Classifiers: Herbaceous; Depressional [Lakeshore]; Depressional [Pond]; Mineral: W/ A-Horizon >10 cm; Aquatic Herb; Graminoid; Deep (>15 cm) Water; Saturated Soil
Concept Summary: This widespread ecological system occurs throughout much of the arid and semi-arid regions of western North America, typically surrounded by savanna, shrub steppe,

steppe, or desert vegetation. Natural marshes may occur in depressions in the landscape (ponds, kettle ponds), as fringes around lakes, and along slow-flowing streams and rivers (such riparian marshes are also referred to as sloughs). Marshes are frequently or continually inundated, with water depths up to 2 m. Water levels may be stable, or may fluctuate 1 m or more over the course of the growing season. Water chemistry may include some alkaline or semi-alkaline situations, but the alkalinity is highly variable even within the same complex of wetlands. Marshes have distinctive soils that are typically mineral, but can also accumulate organic material. Soils have characteristics that result from long periods of anaerobic conditions in the soils (e.g., gleyed soils, high organic content, redoximorphic features). The vegetation is characterized by herbaceous plants that are adapted to saturated soil conditions. Common emergent and floating vegetation includes species of *Scirpus* and/or *Schoenoplectus, Typha, Juncus, Potamogeton, Polygonum, Nuphar*, and *Phalaris*. This system may also include areas of relatively deep water with floating-leaved plants (*Lemna, Potamogeton*, and *Brasenia*) and submergent and floating plants (*Myriophyllum, Ceratophyllum*, and *Elodea*).
Range: This system occurs throughout much of the arid and semi-arid regions of western North America, extending east peripherally into the semi-arid portions of the western Great Plains.
Subnations: AZ, CA, CO, ID, MT, NM, NV, OR, TX, UT, WA, WY

CES302.753 NORTH AMERICAN WARM DESERT RIPARIAN WOODLAND AND SHRUBLAND

Division 302 (North American Warm Desert); Woody Wetland

Spatial Scale & Pattern: Linear
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Wetland
Diagnostic Classifiers: Lowland [Lowland]; Forest and Wetland (Treed); Shrubland (Shrub-dominated); Tropical/Subtropical [Tropical Xeric]; Temperate [Temperate Xeric]; Riverine / Alluvial
Concept Summary: This ecological system consists of low-elevation (<1200 m) riparian corridors along medium to large perennial streams throughout canyons and desert valleys of the southwestern United States 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). The vegetation is a mix of riparian woodlands and shrublands. Dominant trees include *Acer negundo, Fraxinus velutina, Populus fremontii, Salix gooddingii, Salix lasiolepis, Celtis laevigata* var. *reticulata, Platanus racemosa*, and *Juglans major*. Shrub dominants include *Salix geyeriana, Shepherdia argentea*, and *Salix exigua*. Vegetation is dependent upon annual or periodic flooding and associated sediment scour and/or annual rise in the water table for growth and reproduction.
Range: This system occurs throughout canyons and desert valleys of the southwestern United States and adjacent Mexico. Major rivers and tributaries include the lower Colorado (up into the lower portions of the Grand Canyon), Gila, Salt, Rio Grande (from Elephant Butte Reservoir to the Gulf Coastal Plain), and the lower Pecos (near its confluence with Rio Hondo in southeastern New Mexico).
Subnations: AZ, CA, NM, NV, TX

CES304.764 COLORADO PLATEAU HANGING GARDEN

Division 304 (Inter-Mountain Basins); Herbaceous Wetland

Spatial Scale & Pattern: Small patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Wetland
Diagnostic Classifiers: Montane, Lower Montane; Cliff; Sedimentary Rock; Temperate Xeric; Seepage-Fed Sloping; Forb; Fern; Graminoid; Saturated Soil
Concept Summary: Hanging gardens in the Colorado Plateau region are surrounded by an arid environment and associated with canyon country. These highly localized environments include canyons with perennial 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 on all exposures, but they are always shaded for much of each day. Temperature and humidity are stable compared to surrounding habitats. Most hanging gardens are dominated by herbaceous plants, a number of which are endemic to this region. Common species include *Adiantum capillus-veneris, Adiantum pedatum, Mimulus eastwoodiae, Mimulus guttatus, Sullivantia hapemanii, Cirsium rydbergii,* and several species of *Aquilegia*.
Range: Colorado Plateau.
Subnations: AZ, CO, NV?, UT

CES306.821 ROCKY MOUNTAIN LOWER MONTANE RIPARIAN WOODLAND AND SHRUBLAND

Division 306 (Rocky Mountain); Woody Wetland

Spatial Scale & Pattern: Linear
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Wetland
Diagnostic Classifiers: Lower Montane; Riverine / Alluvial; Mineral: W/ A-Horizon <10 cm; Unconsolidated; Short (<5 yrs) Flooding Interval; Short (50-100 yrs) Persistence
Concept Summary: This system is found throughout the Rocky Mountain and Colorado Plateau regions within a broad elevation range from approximately 900 to 2800 m. This system often occurs as a mosaic of multiple communities that are tree-dominated with a diverse shrub component. This system is dependent on a natural hydrologic regime, especially annual to episodic flooding. Occurrences are found within the flood zone of rivers, on islands, sand or cobble bars, and immediate streambanks. They can form large, wide occurrences on mid-channel islands in larger rivers or narrow bands on small, rocky canyon tributaries and well-drained benches. It is also typically found in backwater channels and other perennially wet but less scoured sites, such as floodplains swales and irrigation ditches. Dominant trees may include *Acer negundo, Populus angustifolia, Populus balsamifera, Populus deltoides, Populus fremontii, Pseudotsuga menziesii, Picea pungens, Salix amygdaloides*, or *Juniperus scopulorum*. Dominant shrubs include *Acer glabrum, Alnus incana, Betula occidentalis, Cornus sericea, Crataegus rivularis, Forestiera pubescens, Prunus virginiana, Rhus trilobata, Salix monticola, Salix drummondiana, Salix exigua, Salix irrorata, Salix lucida, Shepherdia argentea*, or *Symphoricarpos* spp. Exotic trees of *Elaeagnus angustifolia* and *Tamarix* spp. are common in

some stands. Generally, the upland vegetation surrounding this riparian system is different and ranges from grasslands to forests.
Range: Found throughout the Rocky Mountain and Colorado Plateau regions within a broad elevation range from approximately 900 to 2800 m.
Subnations: AZ, CO, ID, MT, NM, NV, OR, SD, UT, WY

CES306.832 ROCKY MOUNTAIN SUBALPINE-MONTANE RIPARIAN SHRUBLAND

Division 306 (Rocky Mountain); Woody Wetland

Spatial Scale & Pattern: Linear
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Wetland
Diagnostic Classifiers: Montane [Upper Montane]; Montane [Montane]; Shrubland (Shrub-dominated); Riverine / Alluvial; Broad-Leaved Deciduous Shrub; Short (<5 yrs) Flooding Interval; RM Subalpine/Montane Riparian Woodland; Short (50-100 yrs) Persistence
Concept Summary: This system is found throughout the Rocky Mountain cordillera, from New Mexico north into Montana, and also occurs in mountainous areas of the Intermountain region and Colorado Plateau. These are montane to subalpine riparian shrublands 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. Generally it is found at higher elevations, but can be found anywhere from 1700-3475 m. 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 system are associated with beaver activity. This system often occurs as a mosaic of multiple communities that are shrub- and herb-dominated and includes above-treeline, willow-dominated, snowmelt-fed basins that feed into streams. 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 are of either conifer or aspen forests.
Range: This system is found throughout the Rocky Mountain cordillera from New Mexico north into Montana (including the isolated island mountain ranges of central and eastern Montana), and also occurs in mountainous areas of the Intermountain West and Colorado Plateau.
Subnations: AZ, CO, ID, MT, NM, NV, OR, SD, UT, WA, WY

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 Canyonlands National Park. 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 park. 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.

B.1. Plot and Observation Point Field Sampling Manual

Vegetation Mapping at Canyonlands NP and Glen Canyon NRA
Northern Colorado Plateau Inventory & Monitoring Network
PROJECT MANUAL - 2004

This document is intended to assist you in conducting vegetation mapping at Canyonlands National Park (CANY) and Glen Canyon National Recreation Area (GLCA) during the 2004 field season. Detailed, field-by-field instructions for data collection are provided. These are abbreviated on a 'cheat sheet' at the end of this document. This project is being directed by the Northern Colorado Plateau Network (NCPN) Inventory and Monitoring Program with assistance from environmental engineering management (e2m) and Nature Serve.

VEGETATION DATA COLLECTION INSTRUCTIONS

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NAVIGATING TO PLOT

You will navigate towards each selected Biophysical Unit (BPU) using BPU maps, park maps, topographic maps, handheld GPS receivers and aerial photos.

- BPU maps will identify the location, size and shape of the polygon.
- Topography (Topo) maps are useful in identifying the landscape through which you will be navigating, and in determining the elevation of a plot. You will find them more legible than the BPU maps in reading the names of features as well.
- GPS receivers indicate the direction and the distance (as the crow flies) to the centroid, the center of the BPU. The centroid is the center of the measured area of a given BPU, but that center does not always land in what appears to be the center of oddly shaped polygons. Regardless of where the centroid is within the polygon, it is an important navigational guide to get you within the vegetative stand you need to sample. ***Note***: *In very homogenous terrain, you may want to GPS the location of your vehicle or track your route, which is also useful in writing the directions to your plot.*
- Aerial photos aid in navigating through the landscape, and are essential in determining where to establish a plot (this will be explained in more detail). **Please** record the vegetation, and its condition, that you walk through and sample on the photo. Feel free to write comments regarding unique features as well.

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 BPU or plot, you see an assemblage of plants that seems unique and that is not included on the list of vegetation types, **please** sample if time allows, or at least complete an observation form. At the beginning of the field season a list of potential plant associations for the parks will be provided. As the season progresses, this list will be updated and you will be better able to recognize new plant alliances and associations more easily.

Park Special Features…in the process of navigating to plots you will encounter unique features or vegetative stands too small to sample, GPS them and note them on aerial photos and maps. These GPS points will be added to the final production map as "Park Special Features" (examples include large potholes, springs, hanging gardens, a small patch of cattails, etc). It is possible that we may be asked to help document Archeological sites for the park. In particular, field crews are requested to document locations (GPS reading) of springs, seeps and hanging gardens and record very general descriptive information on the Park Special Features Form. In addition the park requests that general locations of significant weed occurrences (highly invasive species that pose a big threat) and large areas of infestation also be documented. Finally all NCPN parks are working on documenting with specimen vouchers all vascular plants in each park. 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 requested to collect herbarium quality specimens of park vascular plant species 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. You'll want to 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. The photos will help you identify the different vegetation types available in each BPU to sample – similar color, pattern and texture usually indicate similar vegetation. Take some time and do this carefully, because some of the plots you set up may be re-sampled over time in order to determine responses to management and other useful things. Look at *all* the vegetation layers to determine if the area is structurally and floristically uniform and generally try to place your plots **at least** 30 m (100 feet) from what you see as the 'boundary' between this 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 and usually has sharp boundaries, such as a spring seep. ***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 on the next page indicates what size plot should be for each vegetation type. Circular plots are the standard plot shape employed in this project. In very 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, or communities where the vegetation has a patchy or irregular distribution. Circles are well suited to very large, homogenous vegetative stands. Selecting the shape of the plot to fit it into a given sample area is fine, but please try not to make a plot smaller than the sizes listed below. **Make sure the type you are describing occupies an area of <u>at least</u> ½ hectare** (a circle approximately 80m in diameter!!). This is because 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. Vegetative communities too small for a plot should be sampled as an Observation Point (instructions for points are after plots in this packet).

If you're in a ...	Circular Plot, Homogenous Vegetation	Rectangular Plot, Heterogenous Vegetation
Forest (i.e., trees have their crowns overlapping, usually 60-100% total cover)	400 m^2 22.6 m diameter	400 m^2 10 x 40m 5 x 80 m, etc.
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 m^2 22.6 m diameter	400 m^2 10 x 40m 5 x 80 m, etc.
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 m^2 22.6 m diameter	400 m^2 10 x 40m 5 x 80 m, etc.
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).	100 m^2 11.3 m diameter	100 m^2 5 x 20m 2 x 50m, etc.
Shrub Herbaceous (i.e., forb and/or grass cover roughly equal to shrubs or dwarf shrubs).	100 m^2 11.3 m diameter	100 m^2 5 x 20m 2 x 50m, etc.
Herbaceous (i.e., herbs or grasses dominant, usually forming more than 25 percent cover).	100 m^2 11.3 m diameter	100 m^2 5 x 20m 2 x 50m, etc.

Nonvascular (i.e., lichen or moss cover dominant, usually forming more than 10% cover).	25 m^2 5.65 m diameter	25 m^2 1 x 25 m 2.5 x 10m, etc
Sparsely Vegetated (i.e. less than 10% cover).	1000 m^2	400 or 1000 m^2

VEGETATION PLOT SURVEY FORM INSTRUCTIONS -

IDENTIFIERS/LOCATORS SECTION

Plot Code
This is a unique identifier you give 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.). Circle the appropriate park acronym, and write the plot number on the blank line. The same numbering convention will be used for observation points, except that the number of the observation point is four digits, the first of which is always "9". For example, the group using the numbers 101 through 199 would call their first plot "CANY.0101" and their first observation point "CANY.9101". **Please record the plot code on every side of every form in the provided field.**

BPU Code
The biophysical unit identified is the polygon identifier on the DRG map. If you have encountered a unique or new vegetative community that is not in a designated BPU, enter "None". Find the BPU number on your BPU list and write the number of the plot or observation point in the "Comments" box.

County
Enter name of county. It's usually on the topo map, either under the map name (if the topo is in a single county) or somewhere on the map itself if it includes the county boundaries.

State
This field is already completed as 'UT' on all data sheets.

Site Name
This is best determined from a topo map. Select a nearby feature that an obvious waypoint, such as the name of a canyon, road or arch. (e.g. Upheaval Dome). 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.

Location
This field identifies whether or not the plot is within the park boundary or in the environs. Circle the appropriate location.

Quad Name
Record the **full name** of the 7.5-minute quadrangle, such as "The Knoll". Locate your plot on the map, and mark your location with a dot in a circle and the plot number.

Aerial Photo Number
The photo number is in the upper right hand corner of the photo in the format FLIGHTLINE-FRAME #. Record this number on the form. Locate your plot on the photo, and mark your location with a dot in a circle and the plot number. Again, please draw and comment on the photo regarding the vegetation of the plot and the surroundings.

GPS File Name
This is the name you give to the waypoint when you mark the plot location in your GPS unit. The GPS reading should be taken from the center of the plot. Please give the waypoint the same number as the plot, and the prefix "CP" for a Canyonlands plot (e.g., CP241 for plot #241). If doing an observation point, the file name would be "CO" and the number (e.g., CO9101 for point #101). Mark the plot location on the

BPU map using the same method that you marked the aerial photo with (a dot with a circle around it and the plot number, “CP241”).

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.

Datum
ALWAYS check this on your GPS unit. It should **always** be NAD83. This information is **CRITICAL** for correctly applying your waypoints to the final vegetation map. If it is anything other than NAD83, **please, please, please** record this on the form. This step will keep your work from being wasted.

UTM Zone
This value is already entered on the datasheet as ‘12S’, and will remain the same throughout the project area.

GPS Comments
VERY IMPORTANT: If you resorted to estimating the plot location UTMs on the topo map (see below), 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 plot 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.

Field UTM X, Field UTM Y
Record the UTM easting and northing you saved as a waypoint in your GPS. Please double-check to make sure that the easting is six digits and the northing is seven digits. If recorded incorrectly, your plot will show up in Venezuela or the middle of the Carribean.

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 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.

However, the topo maps you have use the NAD27 datum, while the project standard is (and your GPS units are in) the NAD83 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 the 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 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 wrote down.
5. Update the settings in your GPS unit to the NAD83 datum. This will convert the NAD27 coordinates to NAD83 without screwing up the coordinates you already had in your machine

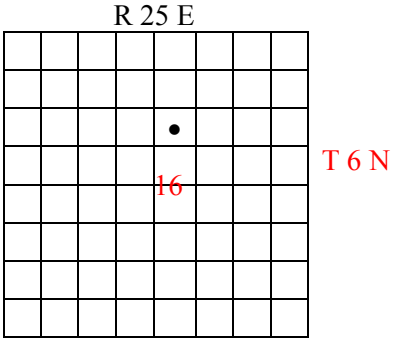
(there may be rounding error). Enter the converted coordinates (now in NAD 83) into the UTM X and UTM Y fields.

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 Error
Note the "Estimated Position Error" (EPE) or PDOP displayed on your GPS unit. The longer you wait to mark the waypoint, the longer the GPS has to gather satellite information and determine your location more accurately, and using the antenna will also help get a more accurate reading. The lower the number, the more accurate your reading. Also, 3D Differential is the most accurate level of reading - you may have to resort to 3D GPS or 2D GPS in canyons or other landforms. If that is the case, please note "3D GPS" or "2D GPS" in the GPS Comments field.

3D Differential?
Circle Y or N accordingly. 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.

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, marked trailhead) 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 distances and use compass directions. Be aware of the ambiguity of words like "above", "near", beyond", "on the back side of", "past". Again, using the GPS unit to give distances can be very helpful. If plot locations lack major landmark features as guides, use township, range and sections from the topo maps. If there are no features within a reasonable distance of your plot and writing directions is taking an inordinately long time, you can use a TRS description to the nearest quarter-quarter-quarter section. TRS directions are extremely error prone, so please have your field partner check it before you leave the plot. The TRS for the plot in the section below is "NW4SW4NE4 Sec. 16, T 6 N, R 25 E".



Note: Although the plots will not be permanently marked, park staff may want to be able to relocate them for long-term vegetation monitoring purposes. Careful documentation of the stand characteristics, access

route, obvious landmarks and vegetation is therefore extremely important. DO NOT use one plot to reference the location of another; TRS is preferable to this.

Survey Date
Date the plot was sampled. Please use this format: Month - Day - Year.

Surveyors
List the last names of the field team members present.

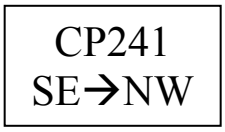
Plot Diameter, Length, Width and Azimuth,
Enter diameter for circular plots (5.65m, 11.3m or 22.6m etc.) OR width and length dimensions for rectangular plots. Record the azimuth for the long side of rectangular plots.

Photos Taken?
Circle Y or N accordingly for plot photos and for biological crust photos.

Camera Name and Model
Record name and model of camera.

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. *Roll number*: record roll number (Roll numbers should be a team member's initials plus a sequential number, which are written on the film before it goes into the camera.). *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 (eg. SE→NW) and any other comments to clarify contents of the photo (especially landscape/scenery photos). Also, representativeness of the biological crust photo can be commented on here. Record the photographer's last name as well.

Taking photographs
Take two color slides of each plot. The purpose is to get a good representation of the vegetation of the plot, not individual species. Try to include a little sky for perspective. For circular plots, please take the two photos from adjacent cardinal points around the plot (e.g., south and east or north and west). 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 the photo is taken. Thus, for rectangular plot 241, the board in the photo taken from the SE edge of the plot, facing NW, will read "CP241, SE→NW". Take the photograph looking across the contour if plot is on a steep slope. In addition, you may want to keep a photograph log for all photos, most importantly for scenic photos not taken at plots.



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 m^2 in area.

Plot Representativeness
Representativeness of plot in stand: Does this sample represent the vegetative community within the surrounding area or polygon? If not, were additional 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, but similar slopes. Multiple plots will be done in this stand. This plot represents a predominantly herbaceous community on a northern aspect."

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
Elevation of the plot. Take this measurement from the topo map, not the GPS unit. The reading you get from a topo map, provided you are certain where you are, is often more accurate than the average reading from the GPS unit. Specify whether 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.

Aspect
Measure the plot aspect in degrees using a compass (set for local magnetic declination, about 12 degrees east for Canyonlands).

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 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 above should relate to the scale of the landform chosen here.*

Surficial 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, aeolian sands or obscured by soils).

Cowardin System

The majority of the plots you'll be conducting will be "Uplands". In Canyonlands, any wetland plots will be in the Palustrine category. This includes riparian, hanging garden and vernal pool wetlands. They are all fed by groundwater and support vascular plant communities.

> **Palustrine:** All nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. This category also includes wetlands lacking such vegetation but with all of the following characteristics: (1) area less than 8 ha; (2) lacking an active wave-formed or bedrock boundary; (3) water depth in the deepest part of the basin less than 2 m (6.6 ft) at low water; and (4) ocean-derived salinities less than .5 parts per thousand.

Hydrology

This field will mostly be completed if you are in a wetland, however, some areas considered uplands may 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 extremely important field for crews to document so please take the time to do a thorough job. Information from this field will be used to prepare local descriptions of the plant community and for photo interpretation.

Ground Cover

Estimate the approximate percentage of the *total* surface area covered by each category. A helpful hint in making ocular estimates is that in a 100 square meter plot, one square meter is equal to 1%. The sum of the cover values should equal 100%. *Notes*: 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 that 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 but the soil test results in a texture other than sand because you are sampling below the surface. If a category is present but covers less than 1% of the ground, enter a "T" on the line next to it.

Soil Texture

Use a trowel to dig a hole a few inches deep (this will vary with soil depth, of course) to expose the soil at root level, from where you will take a small handful of soil to sample. **APPENDIX 2** is a key to use when sampling soil texture.

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 re characterized by strictly upland species, including rabbitbrush.***

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 3 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 2 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 in Canyonlands plots are water gullies, colluvial deposition of rocks on slopes, flash flooding and sometimes old tin cans from cowboys or miners. Other disturbances you may encounter in the buffer include off-road vehicle use, fire, mass-wasting.

Other Comments
Record any other comments. What is the extent of the community you sampled? Describe the landscape context of the community. Describe the adjacent plant communities and their relationship to the plot. Are there any other landscape features or processes influencing this community? Is there an important species that occurs in the BPU but is not within your plot? Is there a large amount of a dead plant material 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 is never without green foliage.

Cold deciduous. Greater than 75% of the total woody cover sheds its foliage in connection with an unfavorable season mainly characterized by winter frost.

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).
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 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 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 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 their 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 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.
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 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 AND STRATA FORM

Plot Code
Circle the correct acronym for the park you are working in. Write the plot number on the blank line. This field is a **must** so that in the event that the two data sheets get separated, they can be paired up again. **Please record the plot code on every side of every form in the provided field.**

Provisional Community Name
You have been provided a list of potential plant associations for Canyonlands, based on what has been found in surrounding parks. Find the name of the association which most closely resembles your plot. It is very likely that some of your plots won't resemble anything on the list – as many types are not yet described and classified. If so, devise a name based on: (1) the dominant species of the dominant strata (including nonvascular) and (2) indicate the physiognomic class (this must match the physiognomic class checked on the backside of the datasheet). For example, if you are in a PJ woodland with only scattered shrubs but a really nice galleta grass layer, you would use a provisional name like "Pinus edulis – Juniperus osteosperma / Pleuraphis jamesii Woodland". The 'provisional community name' will be used in tallying how many of each plant community has been sampled. The provisional name is also a great help to the ecologists who will be using your work to construct a classification. **Note**: This field should be completed only after the entire plot is completed.

Species/Strata Data. A two-page dual purpose form has been developed for recording information on *species* composition and cover and *strata* cover and height. Data on trees and shrubs are to be entered on the front page and herbaceous and non-vascular data on the back of the page. Species lists and cover estimates should be completed first (white portions of form); then cover class and height class estimates for strata should be recorded (shaded portions of form).

The main body of the table is dedicated to recording species names and associated cover estimates (white areas). To begin , the observer needs to make a complete species list for the plot and assign each species to the appropriate stratum. The next section provides a brief discussion on assigning species to the appropriate strata, followed by instructions for completing the species level information.

Stratum: 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 CANY 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. Pinyon and juniper make up the majority of Canyonlands' "canopy", but where they are absent you would begin with the shrubs, or herbaceous species if no shrubs are present either. If the tree crowns in your plot 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, 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".

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 ramosissimum.*
S3 Dwarf Shrub. <0.5 meters tall. For 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.

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, and get measured. 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" 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.

Species / Percent Cover Estimates . Once you have identified your strata, list all plant species in that strata and complete cover estimates per the following instructions. Be thorough in looking for plant species in your plot, but do not spend excessive amounts of time looking for new or different plants. Remember that these plot data are to be used to classify the vegetation of the Park, not to make a complete species list for it. If you had to spend much more than 20 minutes to *find* a species, it probably isn't going to be important in characterizing the vegetation type.

1. **Species Name:** Refer to the plant list you have been provided for plant names used in this area (from *Utah Flora*). Always record the full scientific name for each species – required nomenclature is Welsh et al. – Utah Flora (2004). Please note that columns on both sides of the table may be used to record species within each stratum.
2. '*' – Complete this shaded column in the strata assessment (see below).
3. **Cover Class:** Estimate the aerial / crown cover of **each** plant listed, using the cover class codes listed in the bottom of the page.
4. **% Cover:** Record continuous cover value used to make cover class estimates.
5. **Specimen:** Place a check mark in this column when a specimen has been collected for a given taxon. Keep complete set of notes in a field notebook with required information for processing herbarium specimens. (See handout provided by CANY Curator).

Unknowns. If you can't identify or easily key out the plant at the plot, assign a name to it to be recorded 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 give them. 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 name you assigned the plant. Also, thoroughly label any plant specimens collected as proof of plant occurrence for plants not listed on park plant list.

Strata / Height Class, Cover Class and Diagnostic Species. Once the species list and associated cover data have been completed, the observer should then complete the following fields as specified below. Data for stratum characterization are all shaded in grey on the field form.

1. Indicate the average height class of the stratum in the first column, using the Height Scale at the bottom of the form.
2. Enter the average percent cover class of the whole stratum in the second column, using the Cover Scale at the bottom of the form.
3. '*' – This Column is used to indicate whether a particular species has been identified as a 'diagnostic' species for defining a particular stratum.

ALWAYS fill in the Height Class and Cover Class for "Ht Herbaceous", which represents total cover of species in plot's ground layer (H1, H2, H3 and H4). This field is located at the top of the back page and is labeled as **'Ht Herbaceous'**. It is easy for field crews to overlook this field – so please make an extra effort to complete it for each plot.

TREE STEM AND ROOT CROWN DIAMETERS

This portion of the form is used to record to obtain 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. It is ok to use 6-digit alpha codes for species name in this part of the form. 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 ft.) 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 grown in large multi-stemmed clumps we have decided to measure diameter of the root crown in these situations (see section below). 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. **Please note** on the form that this is what you've 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. **Please note** on the form that this is what you've done. 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.

Juniper branch scratches tend to get infected, so be sure to clean them out thoroughly.

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 these 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 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.

OBSERVATION POINT FORM INSTRUCTIONS – 2004

These instructions correspond to the 2004 version of the Observation Point Forms.
Many fields are identical to fields on the Plot Survey Forms and will not be re-defined here.

Observation Point Forms are to be used when, (1) you find a unique vegetative stand too small to conduct a plot in, (2) you are unable to access a BPU but can view it well enough to collect some data, (3) enough plots have been conducted for a given community type and the project supervisor instructs you to do Observation Points for BPUs encompassing that community, (4) you do not have time to conduct a plot and the area you are in is time consuming to access at a later date, or (5) to record information on park specials (e.g. springs, hanging gardens, etc.). You will notice that these forms are not as extensive as Plot Survey Forms. The primary role of Observation Point forms is to further aid in aerial photo interpretation; a secondary role is to help fill out plant association descriptions.

Please note that the Northern Colorado Plateau Network is in the process of developing a GPS Data Dictionary for recording several fields associated with the Observation Point Survey Form. Please note that all data entered into the GPS unit will also be entered manually on the paper forms.

IDENTIFIERS / LOCATORS SECTION

Most fields in this section are the same as the plot form. Please refer to the Plot Survey Form instructions for this section. As with the procedures for Plots, you must mark the location of the Observation Point on the corresponding topo map, aerial photo and BPU map.

Please indicate the type of observation point you are conducting (e.g. vegetation observation point, spring/seep/hanging garden point, other special feature).

You will not need to measure the area you are surveying for this form, although it is helpful to provide the size of the area described by the point. In terms of photographing this sample area, you are asked to take one photo that accurately captures the vegetative stand. Use the chalkboard as you would at a plot.

Observation Points should be assigned a code similar to Plot Survey codes to be used as a file name and on the chalkboard in the photo. Observation point numbers will be assigned in the 9000 series.

ENVIRONMENTAL DESCRIPTION SECTION

The majority of this section is the same as the Plot Survey Form for which the instructions are stated previously. These fields are as follows: Elevation, Slope, Aspect, Topographic Position, Landform, Geology, Cowardin Wetland Classification System, and Hydrologic Regime.

Environmental Comments
This field is also on the Plot Survey Form. However, it is the only comments field on the Observation Point Form. Please use this space to record comments like you would have at plots, as well as any comments you would have made in the "Animal Use Evidence", "Natural and Anthropogenic Disturbance Comments" and "Other Comments" fields on the Plot Survey Form. Also note why an Observation Point was done instead of a Plot Survey.

Unvegetated Surface

This field is an ocular estimate of ground cover, so plants should be visualized as being cut off at ground level. Because there is no designated sample size for areas surveyed as Observation Points, you will have to estimate percent covers for whatever size the area is. For this estimation, you must use the cover classes listed in the bottom right hand corner of the data sheet. If an unvegetated surface category is not present in your observation point area (e.g., water is very uncommon in the sampling units), leave the corresponding line blank. The cover class "01" represents occurrences greater than 0% but less than 10%.

Note: *These cover classes are very broad, especially for desert species occurrences. If a species is not accurately represented by these cover classes, note this in the comments field.*

VEGETATION DESCRIPTION SECTION

These fields: Leaf Phenology, Leaf Type and Physiognomic Class, are the same as those on the Plot Survey Form. Please refer to the previously listed instructions for these fields.

Provisional Community Name

You have been provided a list of potential plant associations for Canyonlands, based on what has been found in surrounding parks. Find the name of the association which most closely resembles your plot. It is very likely that some of your plots won't resemble anything on the list – as many type are not yet described and classified. If so, devise a name based on : (1) the dominant species of the dominant strata (including nonvascular) and (2) indicate the physiognomic class (this must match the physiognomic class checked on the back side of the datasheet). For example, if you are in a PJ woodland with only scattered shrubs but a really nice galleta grass layer, you would use a provisional name like "Pinus edulis – Juniperus osteosperma / Pleuraphis jamesii Woodland". The 'provisional community name' will be used in tallying how many of each plant community has been sampled. The provisional name is also a great help to the ecologists who will be using your work to construct a classification. Note: this field should be completed only after the entire plot is completed.

DOMINANT PLANT SPECIES LIST

Record information on ***dominant species only***. There are four columns that correspond to the "Stratum" column in this table. The strata have been discussed in the Plot Survey Form instructions, which you should refer to for this form. As for the blank columns:

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.** Estimate the percent aerial cover for each plant species. Again, use the cover class codes listed in the bottom right hand corner of the data sheet.

EXTRA CURRICULAR INSTRUCTIONS - 2004

The Northern Colorado Plateau Network Inventory and Monitoring Program is engaged is a wide suite of inventory activities designed to improve the information basis for developing a long-term natural resource monitoring program. Since field crews will be visiting most areas of each park and especially remote portions – we are requesting assistance with documenting information on the following features as they are encountered and as time allows.

Springs/Seeps/Hanging Gardens (Use Observation Point Form)

These areas are considered significant ecosystems across the Colorado Plateau and have been identified as a high priority vital sign for inclusion in the long-term monitoring program. Unfortunately very little information has been documented on the location and characteristics of these areas within the parks.

Use the 'Observation Point' (blue form) to record basic data on springs, seeps and hanging gardens and circle 'spring/hanging garden' in the Type of Observation field. It is important to take one or more photos to document the site and a GPS (or other) location reading. Please complete basic environmental and vegetation description fields as you are able. Completion of the comments field would be most appreciated.

It the spring community is sizeable enough please consider placing conducting a regular vegetation plot, as we need this information to characterize the full suite of vegetation types. Keep in mind that BPUs will typically overlook springs and seeps.

Invasive Plant Species (Use Invasive Plant Location Log)

Invasions of aggressive non-native species are one of the largest threats to ecosystem integrity of terrestrial and aquatic systems. Field crews are requested to document 'noteworthy' populations of invasive plants on the 'Invasive Plant Log' Form and take photos as feasible and appropriate. We are not requesting a comprehensive inventory of all invasive plants, as that would be another full project. However, the park would appreciate having help documenting populations of invasive plants that are of especially high concern. Early detection of species populations that are small give the park a chance for control or eradication before the problem becomes too big. For example, a small population of diffuse knapweed was found last year near Upheaval Dome. This represented the first occurrence of this species in the park and control efforts were immediately implemented.

In addition to looking for established invasives in the park, field crews should take care to ensure that they are not contributing to the spread of weeds. If you are working in an infested area, please make sure that you are not carrying seeds or other propagules with you to new locations. Also for field workers coming from other areas, please make sure vehicles and clothing are free of weed seed.

General Floristic Inventory – CANY

An important part of the Northern Colorado Plateau Network Program is to assist parks with the documentation of all vascular plants and vertebrate species occurring within each park. As part of the vegetation mapping project, field crews are requested to assist in the collecting of vascular plant vouchers (herbarium specimens) for Canyonlands National Park. The CANY plant list provided to field crews indicates whether or not a voucher has been collected for a given species. If a voucher has not been collected, field crews are to look for opportunities to make collections of these taxa. Field crews will

receive training in how to collect, document and process vouchers. Specimens should contain appropriate flowering and/or fruiting material to assure correct identification. Additionally specimens should contain all appropriate plant parts (roots, leaves, stems, flowers etc.) and as possible show the habit of the plant. Enough material should be collected to fill a herbarium sheet.

OFFICE DATA ENTRY AND TRACKING – 2004

DATA ENTRY

NCPN has developed a park-specific vegetation mapping database application for this project. This database application houses all associated data with the project including vegetation plots, observation points, photographic documentation, and herbarium label information. Data will be entered at regular intervals as the field season progresses. Data will be entered both electronically (from the data dictionary's on the Trimble XM GPS Units) and manually from the field forms. Park Service crews will enter all data (NPS and E2M) collected during the project.

NCPN staff have developed quality assessment and control procedures to help ensure that data collected are consistent, accurate and complete.

SPECIES LIST MANAGEMENT

As mentioned previously NCPN is working with each network park to compile vouchered vascular plant species lists. An important ancillary activity of the vegetation mapping project is to contribute to the collection of voucher specimens for currently undocumented species. To aid in this effort NCPN will provide field crews with a 'working copy' of the vascular plant species list for Canyonlands National Park. This list will include information on taxonomic number, family, genus, species, common name, life form, nativity and whether or not the taxon is documented with a specimen voucher. Field crews are requested to look for opportunities to collect vouchers where none exist. Field crews are requested to work with the NCPN Vegetation Program Manager to regularly update the 'working' species list for CANY.

TRACKING PLANT ASSOCIATIONS

At the beginning of the field season crews will be provided with a working list of 'potential' plant associations for CANY and GLCA. This list will represent the 'best guess' of what is present in the park and is based on recent plant association classification work at nearby parks. As the field season progresses the overall field team leader will revise this list as needed. In addition, the overall field team lead will assign each plot to preliminary plant associations and maintain a 'tracking list' throughout the field season (after each field session). This list will be used to adjust sampling priorities in the field. For example, once an adequate number of plots are collected for a certain type, it may be determined that only observation points are needed for subsequent BPUs. The list will also serve as a guide in knowing when something new is encountered and when to sample additional areas.

HERBARIUM SPECIMENS

Field crews will be instructed on how to collect voucher specimens and associated label data. Specimens will be processed at regular intervals throughout the field season. Processing includes entering all appropriate information into the vegetation mapping database in order to generate herbarium labels, identification, mounting and labeling specimens. Each field crew member is required to record all specimen documentation in a field notebook.

APPENDIX 1: LANDFORM GLOSSARY

(http://soils.usda.gov/technical/handbook/detailedtoc.html#629)

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. (b) (**not preferred**) A general term for a small flood plain bordering a river, on which alluvium is deposited during floods.
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 flood plain.) An general, informal term for a broad flood plain or a low-gradient delta. Compare - alluvial flat.
alluvial plain remnant - An erosional remnant of an alluvial plain which retains the surface form and alluvial deposits of its origin but was not emplaced by, and commonly does not grade to a present-day stream or drainage network. Compare - alluvial plain, erosional remnant, paleoterrace.
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.
artificial levee - An artificial embankment constructed along the bank of a watercourse or an arm of the sea, to protect land from inundation or to confine streamflow to its channel.
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.
backswamp - A flood-plain landform. Extensive, marshy or swampy, depressed areas of flood plains between natural levees and valley sides or terraces. Compare - valley flat.
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. Compare - colluvial apron.
ballena - (colloquial: western US.) A fan remnant having a distinctively-rounded surface of fan alluvium. The ballena's broadly-rounded shoulders meet from either side to form a narrow summit and merge smoothly with concave sideslopes and then concave, short pediments which form smoothly-rounded drainageways between

adjacent ballenas. A partial ballena is a fan remnant large enough to retain some relict fan surface on a remnant summit. Compare - fan remnant.
ballon - (colloquial: western US). A rounded, dome-shaped hill, formed by erosion or uplift.
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.
barchan dune - A crescent-shaped dune with tips extending leeward (downwind), making this side concave and the windward (upwind) side convex. Barchan dunes tend to be arranged in chains extending in the dominant wind direction. Compare - parabolic dune.
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. Compare - head slope, side slope, nose slope, interfluve, free face.
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, flood plains 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. Compare - basin, piedmont slope.
basin-floor remnant - (colloquial: western US) A flat erosional remnant of any former landform of a basin floor that has been dissected following the incision of an axial stream.
bench - (not preferred) refer to structural bench.
beveled base - The lower portion of a canyon wall or escarpment marked by a sharp reduction in slope gradient from the precipitous cliff above, and characteristically composed of thinly mantled colluvium (e.g. < 1 m) and / or carapaced with a thin surficial mantle of large rock fragments from above, which overly residuum of less resistant rock (e.g., shale) whose thin strata intermittently outcrop at the surface; a zone of erosion and transport common in the canyonlands of the semi-arid, southwestern US. Compare - talus slope.
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.
bolson - (colloquial: western US.) A landscape term for an internally drained (closed) intermontane basin into which drainages from surrounding mountains converge inward toward a central depression. Bolsons are often tectonically depressed areas and, according to Peterson, include alluvial flat, alluvial plain, beach plain, barrier beach, lake plain, sand sheets, dunes, and playa. The piedmont slope includes slopes of erosional origin adjoining the mountain front (pediments) and complex construction surfaces (fans). A semi-bolson is an externally drained (open) bolson. Synonym - intermontane basin.
borrow pit - An excavated area from which earthy material has been removed typically for construction purposes offsite; also called barrow pit.
bottomland - (not recommended) use flood plain. An obsolete, informal term loosely applied to varying portions of a flood plain.
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 plan 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.
break - (slopes) An abrupt change or inflection in a slope or profile. Compare - knickpoint, shoulder, escarpment. (geomorphology) A marked variation of topography, or a tract of land distinct from adjacent land, or an irregular or rough piece of ground. Compare - breaks.
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. Compare - mesa, plateau, cuesta.
caldera - A large, more or less circular depression, formed by explosion and/or collapse, which surrounds a volcanic vent or vents, and whose diameter is many times greater than that of the included vent, or vents. Compare - crater.
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.
canyonlands - A deeply and extensively dissected landscape composed predominantly of relatively narrow, steep-walled valleys with small flood plains or valley floors; commonly with considerable outcrops of hard bedrock on steep slopes, ledges, or cliffs, and with broader summits or interfluves than found in badlands. Sideslopes exhibit extensive erosion, active back-wearing, and relatively sparse vegetation.
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 flood plains and young alluvial terraces; a constituent part of *bar and channel* topography.
cinder cone - A conical hill formed by the accumulation of cinders and other pyroclastics, normally basaltic or andesitic composition. Slopes generally exceed 20 percent.
cliff - Any high, very steep to perpendicular or overhanging face of rock or earth; a precipice. Compare - bluff.
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.
closed depression - A generic name for an enclosed area that has no surface drainage outlet and from which water escapes only by evaporation or subsurface drainage; an area of low ground indicated on a topographic map by a hachured contour line forming a closed loop. Compare - open basin.
collapse sinkhole - A type of sinkhole that is formed by collapse of a cave within the underlying soluble bedrock (e.g., limestone, gypsum, salt). Compare - solution sinkhole.
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. Compare - alluvium, slope alluvium, scree, talus, mass movement.
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). Compare - fall, topple, slide, lateral spread, 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*. Compare - summit (*part b*), saddle.

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. Compare - hogback, mesa, dipslope, scarp slope, cuesta valley.
cuesta valley - A low relief, low angle, asymmetrical depression which lies parallel to the strike of underlying strata; a type of strike valley. It's formed by the differential erosion of weaker strata interbedded with more resistant bedrock. It may or may not contain a local drainage network and commonly lies above and is not connected to the regional drainage system. Compare - cuesta, valley, trough, hanging valley.
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. Compare - lahar, mudflow, landslide.
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. Compare - blowout.
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.
dike - A tabular igneous intrusion that cuts across the bedding or foliation of the country rock. Compare – sill.
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.
ditch - An open and usually unpaved (unlined), channel or trench excavated to convey water for drainage (removal) or irrigation (addition) to or from a landscape; smaller than a canal; some ditches are modified natural waterways.
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.
dome - (a) An uplift or anticlinal structure, either circular or elliptical in outline, in which the rocks dip gently away in all directions. A dome may be small (e.g. a salt dome) or many kilometers in diameter. (b) A smoothly rounded landform of rock mass such as a rock-capped mountain summit, that roughly resembles the dome of a building. (e.g. the rounded granite peaks of Yosemite, CA).
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. (See barchan dune, parabolic dune, parna dune, shrub-coppice dune, seif dune, transverse dune).
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.

earthflow - The process, associated sediments (earthflow deposit) or resultant landforms characterized by slow to rapid types of flow dominated by downslope movement of soil, rock, and mud (more than 50% of the particles are < 2 mm), and whether saturated or comparatively dry, behaves as a viscous fluid when moving. Compare - debris flow (coarser, less fluid), mudflow (finer, more fluid).
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.
eolian sands - Sand-sized, clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sand sheet. Compare - 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. Compare - arroyo, intermittent stream, perennial stream.
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.
eroded fan-remnant sideslope - A rough or broken margin of an *eroded fan remnant* highly dissected by ravines and gullies that can be just a fringe or make up a large part of an eroded alluvial fan; its bounding escarpments (risers), originally formed by inset channels, have become highly dissected and irregular such that terrace components (tread and riser) have been consumed or modified and replaced by hillslope positions and components (shoulder, backslope, footslope, etc.); sometimes referred to as *fan remnant sideslopes*. Compare - eroded fan remnant.
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). Compare - alluvial fan, alluvial cone. (b) A fan-shaped mass of congealed lava that formed on a steep slope by the continually changing direction of flow.
fan apron - A sheet-like mantle of relatively young alluvium and soils covering part of an older fan piedmont (and occasionally alluvial fan) surface, commonly thicker and further down slope (e.g., mid-fan or mid-fan piedmont) than a fan collar. It somewhere buries an older soil that can be traced to the edge of the fan apron where the older soil emerges as the land surface, or relict soil. No buried soils should occur within a fan-apron mantle itself. Compare - fan collar.
fan collar - A landform comprised of a thin, short, relatively young mantle of alluvium along the very upper margin (near the proximal end or apex) of a major alluvial fan. The young mantle somewhere buries an older soil that can be traced to the edge of the collar where the older soil emerges at the land surface as a relict soil. Compare - fan apron.
fan remnant - A general term for landforms that are the remaining parts of older fan-landforms, such as alluvial fans, fan aprons, inset fans, and fan skirts, that either have been dissected (erosional fan-remnants) or partially buried (nonburied fan-remnants). 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. Compare - eroded fan remnant, ballena.
fan skirt - The zone of smooth, laterally-coalescing, small alluvial fans that issue from gullies cut into the fan piedmont of a basin or that are coalescing extensions of the inset fans of the fan piedmont, and that merge with the basin floor at their toeslopes. These are generally younger fans which onlap older fan surfaces.
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.
fen - Waterlogged, spongy ground containing alkaline decaying vegetation, characterized by reeds, that develops into peat. It sometimes occurs in sinkholes of karst regions. Compare - bog, marsh, swamp.

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. Compare - mud flat. (c) (not recommended) A nearly level region that visibly displays less relief than its surroundings.
flood plain - 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. SW &
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.
free face - A geomorphic component of hills and mountains consisting of an outcrop of bare rock that sheds rock fragments and other sediments to, and commonly stands more steeply than the angle of repose of, the colluvial slope immediately below; most commonly found on shoulder and backslope positions, and can comprise part or all of a nose slope or side slope. Compare - interfluve, crest, nose slope, side slope, head slope, base slope.
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. Compare - horst.
gravel pit - A depression, ditch or pit excavated to furnish gravel for roads or other construction purposes; a type of borrow pit.
ground soil - Any soil at the present-day land surface and actively undergoing pedogenesis,
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. Compare - arroyo, draw, gully, wash.
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.
hanging valley - A tributary valley whose floor at the lower end is notably higher than the floor of the main valley in the area of junction.
head slope - A geomorphic component of hills consisting of a laterally concave area of a hillside, especially at the head of a drainageway, resulting in converging overland water flow (e.g. sheet wash); head slopes are dominated by colluvium and slope wash sediments (e.g., slope alluvium); contour lines form concave curves. Slope complexity (downslope shape) can range from simple to complex. Headslopes are comparatively moister portions of hillslopes and tend to accumulate sediments (e.g., cummulic profiles) where they are not directly contributing materials to channel flow. Compare - side slope, nose slope, free face, interfluve, crest, base slope.
headwall - A steep slope at the head of a valley; e.g. the rock cliff at the back of a cirque. Compare - cirque headwall.
high hill - A generic name for an elevated, generally rounded land surface with high local relief, rising between 90 meters (approx. 300 ft.) to as much as 300 m (approx. 1000 ft.) above surrounding lowlands. Compare - low hill, hill, hillock.
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. A hill can be further specified based on the magnitude of local relief: *low hill* (30 - 90 m) or *high hill* (90 - 300 m). Informal distinctions between a hill and a mountain are often arbitrary and dependent on local convention. Compare - hillock, plateau, mountain, foothills, hills.

hillock - A generic name for a small, low hill, generally between 3 - 30 m in height and slopes between 5 and 50% (e.g., bigger than a mound but smaller than a hill); commonly considered a microfeature. Compare - mound, hill.
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). Compare - cuesta.
hoodoo - A bizarrely shaped column, pinnacle, or pillar of rock produced by differential weathering or erosion in a region of sporadically heavy rainfall. Formation is facilitated by joints and layers of varying hardness. Compare - earth pillar.
horst - An elongate block that is bounded on both sides by normal faults that dip away from the interior of the horst. It is a structural form and may or may not be expressed geomorphically.
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.
impact crater - a) A generally circular or elliptical depression formed by hypervelocity impact of an experimental projectile or ordinance into earthy or rock material. Compare - caldera, crater, meteorite crater. SW; b) (not recommended - use meteorite crater) A generally circular crater formed by the impact of an interplanetary body (projectile) on a planetary surface.
inset fan - (colloquial; western US) The flood plain of an ephemeral stream that is confined between fan remnants, ballenas, basin-floor remnants, or closely-opposed fan toeslopes of a basin.
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. Compare - stack.
knoll - A small, low, rounded hill rising above adjacent landforms.
lake - An inland body of permanent standing water, fresh or saline, occupying a depression, generally of appreciable size (larger than a pond) and too deep to permit vegetation (excluding subaqueous vegetation) to take not completely across the expanse of water.
lakebed - (a) The flat to gently undulating ground underlain or composed of fine-grained sediments deposited in a former lake. (b) The bottom of a lake; a lake basin.
lakeshore - The narrow strip of land in contact with or bordering a lake; especially a beach.
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*. Compare - solifluction.
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.
levee - An artificial or natural embankment built along the margin of a watercourse or an arm of the sea, to protect land from inundation or to confine streamflow to its channel. Compare artificial levee, natural levee.
longitudinal dune - A long, narrow sand dune, usually symmetrical in cross profile, oriented parallel to the prevailing wind direction ; it is wider and steeper on the windward side but tapers to a point on the lee side. It

commonly forms behind an obstacle in an area where sand is abundant and the wind is strong and constant. Such dunes can be a few meters high and up to 100 km long. Compare - seif dune, transverse dune.
low hill - A generic name for an elevated, generally rounded land surface with low local relief, rising between 30 meters (100 ft.) to as much as 90 m (approx. 300 ft.) above surrounding lowlands. Compare - high hill, hill, hillock.
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. Compare - upland.
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. Flood plains of broad valleys may contain one or more abandoned meander belts in addition to the zone flanking the active stream channel.
meander scar - (a) A crescent-shaped, concave or linear mark on the face of a bluff or valley wall, produced by the lateral erosion of a meandering stream which impinged upon and undercut the bluff; if it's no longer adjacent to the modern stream channel it indicates an abandoned route of the stream; (b) (not recommended - refer to oxbow) An abandoned meander, commonly filled in by deposition and vegetation, but still discernable.
meander scroll - (a) 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. Compare - meander belt, point bar. (b) (not recommended; refer to oxbow lake) - A small, elongate lake on a flood plain in a well-defined part of an abandoned 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. Compare - butte, plateau, cuesta.
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.
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 bare-rock 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. Compare - hill, hillock, plateau, foothills, mountains.
natural levee - A long, broad low ridge or embankment of sand and coarse silt, built by a stream on its flood plain and along both sides of its channel, especially in time of flood when water overflowing the normal banks is forced to deposit the coarsest part of its load. It has a gentle slope away from the river and toward the surrounding floodplain, and its highest elevation is closest to the river bank. Compare - levee, artificial levee, meander belt.
open depression - A generic name for any enclosed or low area that has a surface drainage outlet whereby surface water can leave the enclosure; an area of lower ground indicated on a topographic map by contour lines forming an incomplete loop or basin indicating at least one surface exit. Compare - closed basin.
overbank deposit - Fine-grained sediments (silt and clay) deposited from suspension on a flood plain 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. Compare - meander belt, oxbow lake, bayou.

oxbow lake - The crescent-shaped, often ephemeral body of standing water situated by the side of a stream in the abandoned channel (oxbow) of a meander after the stream formed a neck cutoff and the ends of the original bend were silted up. Compare - meander belt, oxbow.
parabolic dune - A sand dune with a long, scoop-shaped form, convex in the downwind direction so that its horns point upwind, whose ground plan, when perfectly developed, approximates the form of a parabola.
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. Compare - Ephemeral stream, Intermittent stream.
piedmont - (adjective) Lying or formed at the base of a mountain or mountain range; e.g., a piedmont terrace or a piedmont pediment. (noun) An area, plain, slope, glacier, or other feature at the base of a mountain; e.g., a foothill or a bajada. In the United States, the Piedmont is a low plateau extending from New Jersey to Alabama and lying east of the Appalachian Mountains.
piedmont slope - (colloquial - western US) The dominant gentle slope at the foot of a mountain; generally used in terms of intermontane-basin terrain in arid to subhumid regions. Main components include: (a) An erosional surface on bedrock adjacent to the receding mountain front (pediment, rock pediment); (b) A constructional surface comprising individual alluvial fans and interfan valleys, also near the mountain front; and (c) A distal complex of coalescent fans (bajada), and alluvial slopes without fan form. Piedmont slopes grade to basin-floor depressions with alluvial and temporary lake plains or to surfaces associated with through drainage (e.g., axial streams). Compare - bolson, fan piedmont.
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. Compare - meander scroll.
pond - (a) A natural body of standing fresh water occupying a small surface depression, usually smaller than a lake and larger than a pool. (b) A small artificial body of water, used as a source of water. Compare - salt pond.
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.
quarry - Excavation areas, open to the sky, usually for the extraction of stone.
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.
reef - (a) A ridge-like or mound-like structure, layered or massive, built by sedentary calcareous organisms, especially corals, and consisting mostly of their remains; it is wave-resistant and stands above the surrounding contemporaneously deposited sediment. Also, such a structure built in the geologic past and now enclosed in rock, commonly of differing lithology. (b) A mass or ridge of rocks, especially coral and sometimes sand, gravel, or

shells, rising above the surrounding sea or lake bottom to or nearly to the surface, and dangerous to navigation; specifically such a feature at 10 fathoms (18.3 m) or less, formerly 6 fathoms (11 m).
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. Compare - gully.
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.
rise - (refer to lake plain) (a) A general term for a slight increase in slope and elevation of the land surface, usually with a broad summit and gently sloping sides. (b) same as (a) but the term is restricted to microfeatures in areas of very low relief such as lake plains or coastal plains.
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*. Compare - stream.
river valley - an elongate depression of the Earth's surface; carved by a river during the course of it's 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.
rock pediment - An erosion surface of low relief, cut directly into and across bedrock and composed of either bare rock or thinly veneered pedisediment or residuum (e.g. < 1.5 m) over bedrock; it occurs along the flanks of mountain fronts, or at the base of mountains or high hills. Its surface grades to the backwearing mountain slopes or hillslopes above, and generally grades down to and merges with a lower-lying alluvial plain, piedmont slope or valley floor below.
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. The landform may be single, successive (repeated up and down slope), or multiple (as the number of slide components increase). Compare - rotational debris slide, rotational earth slide, rotational rock slide, translational slide, lateral spread, landslide.
rubble - An accumulation of loose angular rock fragments, commonly overlying outcropping rock; the unconsolidated equivalent of a breccia. Compare - scree, talus.
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.
sandhills - A region of semi-stabilized sand dunes or sandy hills, either covered with vegetation or bare, as in north-central Nebraska and the midlands of the Carolinas.
sand plain - (a) A sand-covered plain which may originate by deflation of sand dunes, and who's lower limit of erosion is governed by the ground-water level. Also spelled *sandplain*. (b) (not preferred - refer to *sandy* outwash plain) A small outwash plain composed chiefly of sand deposited by meltwater streams flowing from a glacier.
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. Compare - climbing dune, sand sheet.
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.
scarp slope - The relatively steeper face of a cuesta, facing in a direction opposite to the dip of the strata. Compare - dip slope.
scree - A collective term for an accumulation of coarse rock debris or a sheet of coarse debris mantling a slope. Scree is not a synonym of talus, as scree includes loose, coarse fragment material on slopes without cliffs. Compare - talus, colluvium, mass movement.

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.
slip face - The steeply sloping surface of a dune, standing at or near the angle of repose of loose sand, and advancing downwind by a succession of slides wherever that angle is exceeded.
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.
slope alluvium - Sediment gradually transported down mountain or hill slopes primarily by non-channel alluvial processes (i.e., slope wash processes) and characterized by particle sorting. Lateral particle sorting is evident on long slopes. In a profile sequence, sediments may be distinguished by differences in size and/or specific gravity of coarse fragments and may be separated by stone lines. Sorting of pebbles or cobbles and burnished peds distinguish these materials from unsorted colluvial deposits. Compare - colluvium, slope wash.
slope wash - A collective term for non-fluvial, incipient alluvial *processes* (e.g. overland flow, minor rills) that detach, transport, and deposit sediments down hill and mountain slopes. Related sediments (*slope alluvium*) exhibit nominal sorting or rounding of particles, peds, etc., and lateral sorting downslope on long slopes; stratification is crude and intermittent and readily destroyed by pedoturbation and frost action. Also called *slope wash processes*. Compare - slope alluvium, colluvium, valley-side alluvium.
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.
strath terrace - A type of stream terrace, formed as an erosional surface cut on bedrock and thinly mantled with stream deposits (alluvium).
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 flood plain, 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.
strike valley - A subsequent valley eroded in, and developed parallel to the strike of, underlying weak strata; such as a cuesta; a valley that often, but not necessarily contains a strike valley.
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.
summit - (a) The topographically highest position of a hillslope profile with a nearly level (planar or only slightly convex) surface. Compare - shoulder, backslope, footslope, and toeslope, crest. (b) A general term for the top, or highest area of a landform such as a hill, mountain, or tableland. It usually refers to a high interfluve area of relatively gentle slope that is flanked by steeper slopes, e.g., mountain fronts or tableland escarpments.
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.
syncline - (a) A unit of folded strata that is concave upward whose core contains the stratigraphically younger rocks, and occurs at the earth's surface. In a single syncline, beds forming the opposing limbs of the fold dip toward its axial plane. Compare - monocline, syncline, fold. (b) A fold, at any depth, generally concave upward whose core contains the stratigraphically younger rocks.
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. Compare - talus slope, colluvium, mass movement, scree.
talus cone - A small, steep, cone-shaped landform at the base of a cliff or escarpment, that heads in a relatively small declivity or ravine, and composed of poorly sorted rock and soil debris that has accumulated primarily by episodic rockfall or, to a lesser degree, by slope wash. Not to be confused with an *alluvial cone*; a similar feature but of fluvial origin, composed of better stratified and more sorted material, and that tapers up into a more extensive drainageway. Compare - alluvial cone, beveled base, talus slope.
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.
tank - (colloquial: southwestern US) A natural depression or cavity in impervious rocks in which water collects and remains for the greater part of the year.
terrace - A step-like surface, bordering a valley floor or shoreline, that represents the former position of a flood plain, 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.
terracettes - Small, irregular step-like forms on steep hillslopes, especially in pasture, formed by creep or erosion of surficial materials that may be induced or enhanced by trampling of livestock such as sheep or cattle. Synonyms (not preferred) - catstep, sheep or cattle track.
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.
translational slide - A category of mass movement processes, associated sediments (translational slide deposit) or resultant landforms characterized by the extremely slow to moderately rapid downslope displacement of comparatively dry soil-rock material on a surface (slip face) that is roughly parallel to the general ground surface, in contrast to falls, topples, and rotational slides. The term includes such diverse *slide* types as translational debris slides, translational earth slide, translational rock slide, block glides, and slab or flake slides. Compare - rotational slide, slide, landslide.
transverse dune - A very asymmetric sand dune elongated perpendicular to the prevailing wind direction, having a gentle windward slope and a steep leeward slope standing at or near the angle of repose of sand; it generally forms in areas of sparse vegetation. Compare - longitudinal dune.
valley - An elongate, relatively large, externally drained depression of the Earth's surface that is primarily developed by stream erosion or glacial activity. Compare - basin.

valley floor - A general term for the nearly level to gently sloping, lowest surface of a valley. Landforms include axial stream channels, the flood plain, 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.
zibar - A small, low-relief sand dune that lacks discernible slip faces and commonly occurs on sand sheets, in interdune areas, or in corridors between larger dunes. Zibar spacing can range from 50-400 m with local relief < 10 m. Unlike coppice dunes, zibars are unrelated to deposition around vegetation. Generally dominated by coarser sands. Compare - dune, coppice dune.

APPENDIX 2: SOIL TEXTURE KEY

(Modified from Brewer and McCann 1982)

Soil primarily organic:
0a. Soil is black, is 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 your 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: 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. 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 (more time for forest and woodland plots, less for herbaceous and scrub).
   b. Plan data collection based on priority needs; new types get higher priority.
   c. Communicate with the other team(s) to make sure you aren't duplicating effort.

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 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, plenty of batteries.

Wrapup (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. Re-file the aerial photos and maps.
5. Send exposed rolls of film to be developed.
6. Key unknown plants.
7. Enter edited 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 the 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 2 tape measure(s)
- Trowel or U-dig-it, soil water bottle
- Compass with adjustable declination
- Clinometer
- GPS unit
- Plenty of AA batteries for GPS and walkie talkie
- Radio or walkie talkie and/or cell phone
- 35 mm camera & film (allow at least 3 exposures per plot plus general and scenic photos)
- Baggies for temporary storage of unknown plants, and masking tape for labeling
- Plant press & paper
- Plant Keys / Flora(s)
- Pens / sharpies
- Forms: plot survey (both pages) and observation point
- Clipboard/forms holder
- Pens, pencils, pencil lead, slate board, chalk, and chalkboard eraser or supply of clean rags
- Stapler and extra staples
- Most recent version of provisional classification of the park, with the number of plots still needed per type (updated approx. every 2 weeks)
- 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.)

CODE LIST – CHEATSHEET

LANDFORM

alluvial fan
alluvial flat
alluvial plain remnant
alluvial terrace
alluvium
artificial levee
backslope
badlands
bajada
ballena
ballon
basin
basin floor
bench
blowout
bluff
bolson
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
dike
dip
ditch
divide
dome
drainageway
draw
dune
dune field
earthflow
eolian depositeolian sands
ephemeral stream
escarpment
falling dune
finger ridge
flat
flood plain
foothills
gorge
gravel pit
gulch
gully

LANDFORM

hanging valley
hill
hillslope
hogback
hummock
interdune
interfluve
intermittent stream
island
knob
knoll
lakebed
lakeshore
landslide
ledge
levee
meander belt
mesa
mountain
natural levee
overflow channel
oxbow
pediment
perennial stream
plain
plateau
playa
point bar
pool
quarry
ravine
reef
ridge
rise
rim
rockfall
saddle
sand ramp
sand sheet
scarp
scree slope
shoulder
side slope
slope
slope alluvium
slope wash
slot canyon
stream terrace
summit
swale
talus slope
tank
terrace
terracettes
toeslope
valley
valley floor
valley side
wash (dry wash)
zibar

TOPOGRAPHIC POSITION

SEE THE DIAGRAM ON OTHER SIDE

VEGETATIVE STRATA

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
Upland springs and seeps
Hanging Gardens
Invasive weeds (ignore cheatgrass, dandelions)

PHYSIOGNOMIC CLASS

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

SOIL TEXTURE

Sand: clean, no ball
Loamy sand: ball, no ribbon
Sandy loam: v. gritty weak ribbon
Silt loam: smooth weak ribbon
Loam: slightly gritty weak ribbon
Clay loam: long ribbon, no ring, slightly gritty
Sandy clay loam: long ribbon, no ring, very gritty
Silt: long ribbon, no ring, smooth
Silty clay loam: long ribbon, no ring, slightly gritty and sticky.
Clay: smooth ribbon/ring, edible
Sandy Clay; gritty ribbon & ring
Silty Clay: smooth ribbon/ring
Peat: still has plant parts
Muck: smelly black ooze

ASPECT

Flat
Azimuth (deg.)
Variable

SURFICIAL GEOLOGY

Obscured by soil
Aeolian sands
New Alluvium (Holocene)
Older Alluvium (pre Holocene)
Talus / Colluvium / Landslides
Entrada Sandstone
Dewey Bridge Fm
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

DISTURBANCE

Water gullies
Mass wasting
Mountain pine beetle damage
Flash flooding
Grazing evidence
Development, historic structures
Agriculture
ORV use or Recreation
Wildlife concentration
Fire
Drought

PLOT SIZE

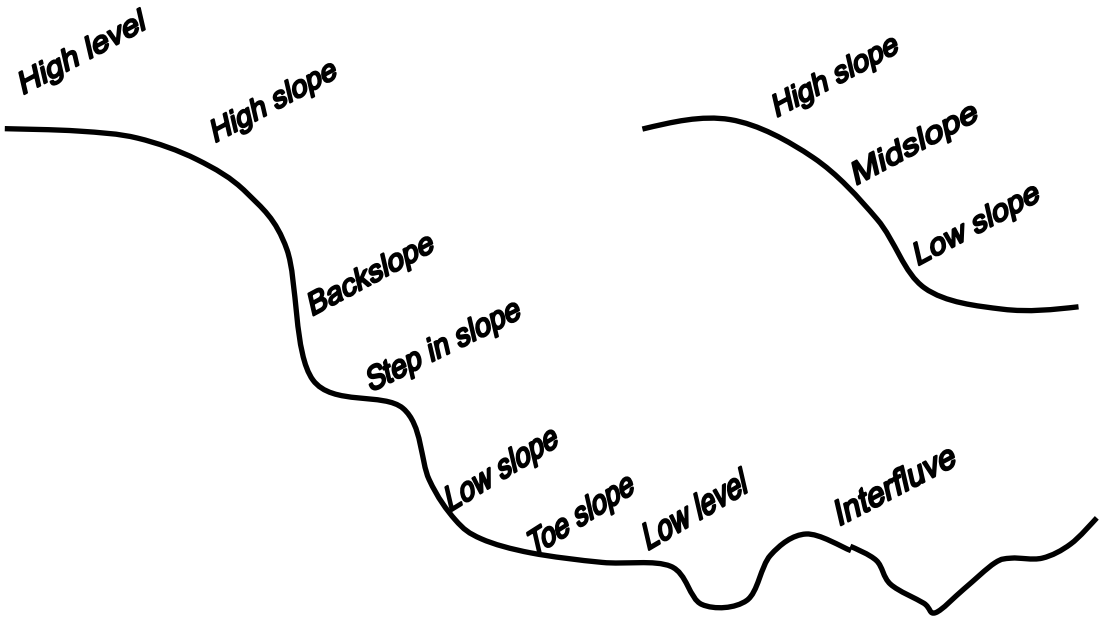
400m^2 (22.6m d):
Forests, Woodlands, Shrublands

100m^2 (11.3m d):
Dwarf Shrublands, Shrub-Herbaceous, Herbaceous

25m^2 (5.65m d):
Non vascular

You may adapt plot size and shape to fit the situation; but never choose a plot size **smaller** than listed here.

TOPOGRAPHIC POSITION - CHEAT SHEET



B.2. Accuracy Assessment Point Field Sampling Manual

Accuracy Assessment at Canyonlands NP
Northern Colorado Plateau Inventory & Monitoring Network
PROJECT MANUAL - 2007

This document is intended to assist you in conducting accuracy assessment data collection at Canyonlands National Park during the 2007 field season. 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 environmental engineering management (e2m) and NatureServe.

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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 data you collect:

- 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 map. You should 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 leading to your confusion in what association to assign to a point.
- Field data error- either by mis-identifying 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

You will 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.

- The DOQQ will identify 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. You will 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 5000m^2 area 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).

You will 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 endzones (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 and document that the point was not actually reached in the comments field. You will be provided with lists of alternate points in case you can't reach one on the primary list, but 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– 2007

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 (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 Canyonlands would be CANY.AA.0101. Be sure to log a new point with your true coordinates in your GPS receiver.

Park:
Enter the four letter park code (CANY).

Quad name:
Leave blank. This will be completed in the office.

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.

Primary, Secondary Map Unit:
You will be provided a key to the map units as well as plant associations. Use this key to determine the map unit of your AA point, and enter this under Primary Map Unit. If borderline, enter one map unit under Primary Map Unit, and the other under Secondary Map Unit. Enter any description of difficulties in your polygon to map unit under Map Unit Comments.

Survey Date:
Date the AA point was sampled. Please use the format Month- Day- Year.

Surveyor:
Full last name(s) of the field team member(s) collecting data.

GPS file:
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:

7. Locate your plot as accurately as possible on the topo map, using triangulation or climbing to a high point.
8. 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.
9. Update the settings in your GPS unit to the NAD27 datum.
10. Create a new waypoint, give it the name of your plot, and enter the UTM coordinates you recorded.
11. Update the settings in your GPS unit to the NAD83 datum. This will convert the NAD27 coordinates to NAD83 without screwing 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.
12. 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 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. In addition, you will need to keep a photograph log for all photos not taken at AA points.



Photos: Type/Roll Number/Frame Number/Photographer/Direction and Comments

For each photo taken at the plot record the following: *Roll number*: record roll number (Roll numbers should be a team member's initials plus a sequential number, which are written on the film before it goes into the camera.) *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 association field. If the situation is borderline between two associations (e.g., some sagebrush, but also some muttongrass), write other association name in the secondary association field. List other associations that are within 50m of the outside border of the half-hectare AA point you are evaluating.

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 comment fields 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). 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.*

Surficial 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. For this estimation, you must use the cover classes listed on the data sheet. 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***.
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 an 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.** Estimate the percent aerial cover (T-100%) for each plant species.

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.

CANYONLANDS 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
flood plain
gulch
gully

LANDFORM

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
wash

TOPOGRAPHIC POSITION

SEE THE DIAGRAM ON OTHER SIDE

VEGETATIVE STRATA

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

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 x 71m square
10m x 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

EXTRACURRICULAR INSTRUCTIONS - 2007

The Northern Colorado Plateau Network Inventory and Monitoring Program is engaged is a wide suite of inventory activities designed to improve the information basis for developing a long-term natural resource monitoring program. Since field crews will be visiting most areas of each park and especially remote portions – we are requesting assistance with documenting information on the following features as they are encountered and as time allows.

INVASIVE PLANT SPECIES

Invasions of aggressive non-native species are one of the largest threats to ecosystem integrity of terrestrial and aquatic systems. Field crews are requested to document 'noteworthy' populations of invasive plants on the 'Invasive Plant Log' Form (or in the data dictionary in the Trimble GeoXM GPS unit- "Weed" feature) and take photos as feasible and appropriate. We are not requesting a comprehensive inventory of all invasive plants, as that would be another full project. However, the park would appreciate having help documenting populations of invasive plants that are of especially high concern. Early detection of species populations that are small give the park a chance for control or eradication before the problem becomes too big. For example, a small population of diffuse knapweed was found in 2003 near Upheaval Dome. This represented the first occurrence of this species in the park and control efforts were immediately implemented.

In addition to looking for established invasives in the park, field crews should take care to ensure that they are not contributing to the spread of weeds. If you are working in an infested area, please make sure that you are not carrying seeds or other propagules with you to new locations. (Wear gaiters to minimize the spread of cheatgrass, for example.) Also for field workers coming from other areas, please make sure vehicles and clothing are free of weed seed.

CONSIDERATIONS FOR PLANNING

Planning for the day:

1. Safety and sustenance: Plenty of food, water, first-aid kit, raingear, sunscreen.
2. Field communications:

c. Develop a plan with other team(s) for radio check-in time.

d. 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:

d. Plan travel based on topography, best access routes, density and complexity of vegetation

e. Communicate with the other team member(s) to make sure you aren't duplicating effort.

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. Develop plan of attack for the week to capture all AA points 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, plenty of batteries.

Wrapup (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. Re-file the aerial photos and maps.
5. Send exposed rolls of film to be developed.
6. Key unknown plants.
7. Enter edited 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 the forms, or with park-related logistics?

MATERIALS CHECKLIST

- Park research permit
- Topo maps
- Park and BLM maps for general navigation
- DOQQ photos of AA point locations
- Geology map
- Compass with adjustable declination
- Clinometer
- GPS unit
- Extra AA batteries for walkie talkie
- Radio or walkie talkie and/or cell phone
- 35 mm camera & slide film (allow 2 exposures per AA point)
- Baggies for temporary storage of unknown plants, and masking tape for labeling
- Plant press & paper
- Plant Keys / Flora(s)
- Pencils / sharpies
- Forms: AA point and observation point
- Clipboard/forms holder
- Pens, pencils, pencil lead, slate board, chalk, and chalkboard eraser or supply of clean rags
- Key to the plant associations of the park
- Notebook of association local descriptions
- Key to the map units of CANY
- 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

EB 7/21

CANY/GLCA NATIONAL PARK VEGETATION MAPPING PROGRAM: PLOT SURVEY FORM 2004

SURVEY AND SITE INFORMATION

Plot Code (Please Circle One): (CANY) GLCA 0620 BPU Code N/A County: SAN JUAN

State UT. Site Name LAVENDER CANYON Location (Please Circle One): (Park) Environs

Quad Name CATHEDRAL BUTTE Aerial Photo # 502-158

GPS file name — Field UTM X 6 1 5 2 5 2 m E Field UTM Y 4 2 0 3 3 1 6 m N

Datum NAD 83 Zone: 12S GPS Unit: (Trimble XM) / Garmin Flat PDOP: 2.5 3D Differential? Y / N

GPS Comments: Need Geology ~~Error +/-: ——— m~~ (Flat Garmin only)

Directions to Plot:
WALK UP SOUTH FORK OF LAVENDER CANYON TO SOUTH FACING COLLUVIAL SLOPE.

Survey Date 6.18.04 Surveyors BUECHLING, BELOTE

Circular Plot Diameter 22.6 Rectangular Plot: length(m) / width(m) / Azimuth /

Plot Photos (Y / N) Biological Crust Photo (Y / N) Camera Name and Model: MINOLTA F2

Photo Type: PLOT	Roll: BW 11	Frame#: 18	Photographer: TB	Comments: N→S
Photo Type: PLOT	Roll: "	Frame#: 19	Photographer: "	Comments: E→W
Photo Type: LANDSCAPE	Roll: "	Frame#: 17	Photographer: TB	Comments:
Photo Type: LANDSCAPE	Roll: "	Frame#: 23	Photographer: TB	Comments:
Photo Type:	Roll:	Frame#:	Photographer:	Comments:

Plot representativeness (discuss plot placement and explain non-representativeness)
PLOT REPRESENTS DRY COLLUVIAL SLOPE WELL — WITH SOUTHERN ASPECTS

ENVIRONMENTAL DESCRIPTION

Elevation: 1,896 ft / (m) From: (GPS) Map (circle one) Slope: 25 deg. Aspect: 135 deg.

Topographic Position (see cheat sheet) MIDSLOPE

Landform (see cheat sheet) CANYON WALL

Surficial Geology (see cheat sheet/map) ORGAN ROCK SHALE

Cowardin System		Hydrology		
X Upland	___ Palustrine	___ Permanently Flooded	___ Unknown	
		___ Semipermanently Flooded	___ Seasonally Flooded	___ Temporarily Flooded
			___ Saturated	___ Intermittently Flooded

Environmental Comments (factors controlling community/plant distribution, seral stage, fire history etc):
THIS AREA IS A MOSTLY SOUTH FACING COLLUVIAL SLOPE ABOVE THE HEAD OF THE SOUTH FORK OF LAVENDER CANYON, SOME AREAS OF THE SLOPE ARE COMPOSED OF LARGE SANDSTONE ROCK, SMALL SANDSTONE FLAKES, AND DEVELOPING SOIL. OTHER AREAS OF THIS SLOPE CONTAIN HUGE BOULDERS (SOME THE SIZE OF LARGE CARS). SOIL AVAILABILITY DETERMINES THE DISTRIBUTION OF VEGETATION AND SOIL MOISTURE AVAILABILITY (LIMITED ON THIS ASPECT) MAY INFLUENCE SPECIES COMPOSITION + DENSITIES.

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CANY/GLCA NATIONAL PARK VEGETATION MAPPING PROGRAM: PLOT SURVEY FORM 2004

ENVIRONMENTAL DESCRIPTION (Continued)

Ground Cover: *(please estimate to the nearest percentage. Sum = 100%)*

36 Bare soil	t Live veg - litter	0 Moss	0 Dark cyanobacteria
0 Bedrock	T Live veg – wood	0 Lichen (on rocks)	0 Water
25 Small rocks (0.2-10cm)	2 Wood (>1cm)	0 Lichen (ground)	
35 Large rocks (>10cm)	T Litter / duff		
0 Sand (0.1-2mm)			

Soil Texture (see cheat sheet):
___ sand ___ loamy sand X sandy loam ___ loam
___ silt loam ___ silt ___ clay loam ___ silty clay
___ sandy clay ___ clay ___ peat ___ muck
___ sandy clay loam ___ silty clay loam

Soil Drainage:
X Rapidly drained ___ Well drained
___ Moderately well drained ___ Somewhat poorly drained
___ Poorly drained ___ Very poorly drained

Animal Use Evidence (including scat, browse, burrows, bedding sites, etc)

NONE OBSERVED.

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)

THIS AREA MAY OCCASSIONALLY EXPERIENCE A ROCKSLIDE WHICH MAY DISTURB VEGETATION.

Other Comments. **Describe surrounding communities and how they relate to the plot.**

THIS PLOT WAS CONDUCTED TO CAPTURE THE DENSITY OF THIS MOSTLY SOUTH FACING SLOPE. ACROSS THIS DRAINAGE A MOSTLY NORTH FACING SLOPE APPEARS TO SUPPORT MUCH DENSER PJ COVER. THE CANYON BOTTOM IS ALSO MORE MESIC + SUPPORTS A MORE DENSE PJ COMMUNITY.

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic Class
Trees and Shrubs	___ Broad-leaved	___ Forest
X Evergreen	X Needle-leaved	X Woodland
___ Cold-deciduous	___ Microphyllous	___ Shrubland
___ Mixed evergreen-cold-deciduous	___ Graminoid	___ Wooded Shrubland
	___ Forb	___ Dwarf Shrubland
Herbs	___ Pteridophyte	___ Shrub Herbaceous
___ Annual	___ Non-vascular	___ Herbaceous
___ Perennial	___ Mixed (describe)	___ Nonvascular
		___ Sparsely Vegetated

Pinyon-juniper age classes (*check one*)

	___ Not PJ	___ Young (100-350 years old)
	___ Old-growth (>500 years old)	___ Invasive (< 80 years old)
	X Mature (350-500 years old; shrub layer absent)	

2004: APR 17; v1.3 2

CANY/GLCA NATIONAL PARK VEGETATION MAPPING PROGRAM: PLOT SURVEY FORM - 2004

VEGETATION DESCRIPTION

Plot Code: [CANY GLCA 0620]

Provisional Community Name: JUNIPERUS OSTEOSPERMA WOODLAND

Supplemental Form (Please Check if Used): ☐

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 at the end of the table and designate with a 0 in Cover Class Column.**

SPECIES/STRATA TABLE / TREES & SHRUBS

Strata / Species Scientific Name	*	Cover Class	% Cover	Spec ✓
T1 EMERGENT Strata Height ____ Strata Cover ____				
T2 CANOPY Strata Height 04 Strata Cover P				
JUNIPERUS OSTEOSPERMA	*	P	4	
T3 SUBCANOPY Strata Height ____ Strata Cover ____				
S1 TALL SHRUB (>2m) Strata Height 04 Strata Cover P				
FRAXINUS ANOMOLA		P	2	
S2 SHORT SHRUB (<2m) Strata Height 03 Strata Cover P				
AMELANCHIER UTAHENSIS	*	P	2	
SYMPHORICARPOS LONGIFLORUS		T	<1	
CHRYSOTHAMNUS VISCIDIFLORUS		T	<1	
CHRYSOTHAMNUS NAUSEOSUS		T	<1	
PURSHIA MEXICANA		T	<1	
EPHEDRA VIRIDIS		T	<1	
CERCOCARPOS MONTANUS		T	<1	
Brickellia microphylla		t		
S3 DWARF SHRUB (<0.5m) Strata Height 01 Strata Cover T				
GUTIERREZIA SAROTHRAE		T	<1	

SPECIES/STRATA TABLE / HERBACEOUS

Strata / Species Scientific Name	*	Cover Class	% Cover	Spec ✓
Ht HERBACEOUS Sum of H1, H2, H3, H4 Strata Height 01 Strata Cover T				
H1 GRAMINOIDS Strata Height 01 Strata Cover T				
HILARIA JAMESII		T	<1	
STIPA SPECIOSA		T	<1	
STIPA HYMENOIDES		t		
ARISTIDA PURPUREA		T	<1	
H2 FORBS Strata Height 01 Strata Cover T				
HAPLOPAPPUS ARMERIOIDES		T	<1	
CRYPTANTHA FLAVA		T	<1	
EUPHORBIA FENDLERI		T	<1	
H3 FERNS & ALLIES Strata Height ____ Strata Cover ____				
H4 TREE SEEDLINGS Strata Height 03 Strata Cover				
PINUS EDULIS		T	<1	
N NON-VASCULAR Strata Height ____ Strata Cover ____				
V VINE/LIANA Strata Height ____ Strata Cover ____				

Cover Scale for Species and Strata

t = 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

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CANY/GLCA NATIONAL PARK VEGETATION MAPPING PROGRAM: PLOT SURVEY FORM - 2004

SUPPLEMENTAL SPECIES AND TREE INFORMATION. Plot Code: [CANY GLCA 0620]

Use this form when there is no room left on the main species/stratum data sheet, and for recording tree DBH/DRC measurements. Please be sure to indicate on the main data sheet that the supplemental sheet was used for a given plot.

SPECIES/STRATA TABLE / TREES & SHRUBS	•	Cover Class	% Cover	Specm ✓
T1 EMERGENT				
T2 CANOPY				
T3 SUBCANOPY				
S1 TALL SHRUB (> 2m)				
S2 SHORT SHRUB (< 2m)				
S3 DWARF SHRUB (< 0.5m)				
N NON-VASCULAR				

H1 GRAMINOIDS	•	Cover Class	% Cover	Specm ✓
H2 FORBS				
H3 FERNS & ALLIES				
H4 TREE SEEDLINGS				

Cover Scale for Species and Strata

t = few	T = 0-1%	1A = 5-10%	2 = 15-25%	4 = 35-45%	5B = 50-55%	7 = 65-75%	9 = 85-95%
	P = 1-5%	1B = 10-15%	3 = 25-35%	5A = 45-50%	6 = 55-65%	8 = 75-85%	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

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.

Plot (circle one): Full Plot / Subplot

SPECIES ✓ ✓	DBH (cm)	DRC	DIAMETERS
JUN OST.			48
"			20
"			22
"			18 / 40
"			63

SPECIES ✓ ✓	DBH (cm)	DRC	DIAMETERS
PIN EDU		5.0	

2004: APR_17; v1.3

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B.4. Example of an Observation Point Data Form

CANY/GLCA NATIONAL PARK VEGETATION MAPPING PROGRAM: OBSERVATION SURVEY FORM 2004

SURVEY AND SITE INFORMATION

Plot Code (Please Circle One): (CANY) GLCA 9115. BPU Code 11967 County: San Juan

Type of Observation (Please Circle One): (VEG/OBS) SPRING/HANGING GARDEN OTHER (Specify) _____

State UT. Site Name S. Fork of Upper Taylor Canyon Location (Please Circle One): (Park) Environs

Quad Name Musselman Arch Aerial Photo # 1102-76

GPS file name _____ Field UTM X 600713 m E Field UTM Y 4255479 m N

Datum NAD 83 Zone: 12S GPS Unit: Trimble XM / (Garmin Flat) PDOP: 5.0 3D Differential? Y / N

GPS Comments: Error: +/- _____ m (Flat Garmin only)

Survey Date 9/13/04 Surveyors Tendick, Ballenger Size of Area: 10 x 50 m

Plot Photos (Y) N) Camera Name and Model: Minolta FZ

Photo Type: Plot Roll: B18 Frame#: 29 Photographer: LB Comments: →SW (from above. no signboard)

Photo Type: _____ Roll: _____ Frame#: _____ Photographer: _____ Comments: _____

Photo Type: _____ Roll: _____ Frame#: _____ Photographer: _____ Comments: _____

ENVIRONMENTAL DESCRIPTION

Elevation: 1,696 ft (m) From: (GPS/Map (circle one) Slope: — deg. Aspect: 358 deg.

Topographic Position (see cheat sheet) low level

Landform (see cheat sheet) Wash, canyon bottom

Surficial Geology (see cheat sheet/map) New Alluvium

Cowardin System	Hydrology		
X Upland	___ Unknown		
___ Palustrine	___ Permanently Flooded	___ Seasonally Flooded	Temporarily Flooded
	___ Semipermanently Flooded	___ Saturated	X Intermittently Flooded

Environmental Comments: We are observing (from above with binoculars) a canyon bottom/wash draining towards the north into upper Taylor Canyon. This upper part of the wash is dominated by QUEGAM and POPFRE and is just downstream from an alcove with a seep and hanging garden community that is shaded for much of the day by the overhangs above it. There is no flowing or standing water in the wash visible from here. The wash is sandy bottomed and ~2m wide. The POPFRE and QUEGAM are mainly growing in a 50 meter long strip at the head of this fork/canyon, but a few POPFRE are scattered another 50 meters downstream. Heavy very thick patch

Unvegetated Surface: *(please use cover scale below)*

01 Bare soil	01 Small rocks (0.2-10cm)	01 Wood (>1cm)	___ Other (describe) _____
___ Bedrock	___ Large rocks (>10cm)	04 Litter / duff	
	01 Sand (0.1-2mm)		

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic Class	Cover scale for strata and unvegetated surfaces:
Trees and Shrubs	X Broad-leaved	___ Forest	01 = 0 – 10%
___ Evergreen	___ Needle-leaved	___ Woodland	02 = 10 – 25%
X Cold-deciduous	___ Microphyllous	___ Shrubland	03 = 25 – 60%
___ Mixed evergreen-cold-deciduous	___ Graminoid	X Wooded Shrubland	04 = 60 – 100%
	___ Forb	___ Dwarf Shrubland	
Herbs	___ Pteridophyte	___ Shrub Herbaceous	
___ Annual	___ Non-vascular	___ Herbaceous	
___ Perennial	___ Mixed (describe)	___ Nonvascular	
		___ Sparsely Vegetated	
		___ Wooded herbaceous	

2004: APR 17; v1.3 (Observation Form) 1

CANY/GLCA NATIONAL PARK VEGETATION MAPPING PROGRAM: OBSERVATION SURVEY FORM 2004

Provisional Community Name: Populus fremontii / Quercus gambelii Wooded Shrubland Plot Code: [CANY] GLCA 9115

	Stratum Height Class	Stratum Cover Class	Dominant Species (mark Diagnostic species with *)	% Cover
T1 Emergent				
T2 Canopy	06	02	* Populus fremontii	20
T3 Sub-canopy				
S1 Tall shrub (> 2 m)	04	04	* Quercus gambelii	60
			Salix exigua	2
			Salix lutea	2
S2 Short Shrub (< 2 m)	03	01	Rosa woodsii	2
S3 Dwarf Shrub (< 0.5 m)				
H Herbaceous	01	02	* Equisetum laevigatum	17
			* Smilacena stellata	8
N Non-vascular				
V Vine/liana				

Height Scale for strata:

01 = < 0.5 m	06 = 10-15m
02 = 0.5-1 m	07 = 15-20m
03 = 1-2 m	08 = 20-35 m
04 = 2-5 m	09 = 35-50 m
05 = 5-10 m	10 = >50 m

Cover scale for strata and unvegetated surfaces:

01	= 0 – 10%
02	= 10 – 25%
03	= 25 – 60%
04	= 60 – 100%

2004: APR 17; v1.3 (Observation Form) 2

B.5. Example of an Accuracy Assessment Data Form

2007 ACCURACY ASSESSMENT POINT FORM - CANYONLANDS NATIONAL PARK
NORTHERN COLORADO PLATEAU NETWORK VEGETATION MAPPING PROJECT

IDENTIFIERS/LOCATORS

AA Point Code: CANY_AA. 1100 Quad name: _____ AA Point Shape: ☒ circle ☐ other

Park Site Name Sheep Bottom

Survey Date 8/23/08 Surveyor(s) J Coles

GPS file name 1100 Field UTM X 607951 m E Field UTM Y 4240349 m N

☐ Coordinates from USGS NAD27 Quad Map (if checked enter coordinates under GPS comments)

GPS Unit: (circle one): (Trimble XM) Garmin Flat / None / Juno / Other: _____ PDOP: 3.10 3D Differential? ☐ yes ☐ no

Datum NAD 83 Zone: 12 Error +/-: _____ m (Flat Garmin only)

GPS Comments:

Camera Name and Model (circle one): (Olympus Stylus) / Canon Sureshot / Minolta FZ/ Other: _____

Roll #	Frame #	Photographer	Direction/Comments
JJC4	13	Coles	"Channel" with ERINAU, Salix W→E
JJC4	14	Coles	"Terrace" with SARVER W→E

MAP UNIT/ PLANT ASSOCIATION INFORMATION

MAP UNIT #	ASSOCIATIONS AT AA POINT	New?	OTHER MAP UNITS /ASSOCIATIONS W/IN 50 M
1 6	1 SARVER/DISTURBED Shrubland	☐	1
2 18	2 ERINAU Shrubland Alliance	☐	2
3	3	☐	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, difficulties with keying)

Polygon is a weird mix of terrace elements - TAMCH1, POPPUS, SALIX SPP., SARVER, ERINAU. Adding to the confusion is the fact that the plot includes an old channel, Thus SARVER Shrubland & ERINAU Shrubland Alliance on the "terrace" and TAMCH1, SALGOO, PHRAUS, DISSP1 in the "channel.

ENVIRONMENTAL DESCRIPTION

Elevation 1,169 (m) / ft From: (GPS) / Map (circle one) | Slope / deg. Aspect / deg.

Topographic Position: Low level

Landform: Terrace, old channel | Geology: Alluvium

Environmental Comments:

Plot contains a broad former channel. TAMCH1 are mostly dwarfed (~1.5m tall) & unhealthy. Vegetation is very dense, and ERINAU are the biggest I have seen

2008: July 24

2007 ACCURACY ASSESSMENT POINT FORM - CANYONLANDS NATIONAL PARK
NORTHERN COLORADO PLATEAU NETWORK VEGETATION MAPPING PROJECT

Unvegetated Surface Cover: *(please use the cover scale below)*

6	Bedrock	1	Large rocks (cobbles, boulders > 10 cm)	1	Sand (0.1-2 mm)
08	Litter, duff	1	Small rocks (gravel, 0.2-10 cm)	P	Bare soil
T	Wood (> 1 cm)			____	Other:____

VEGETATION DESCRIPTION

Leaf phenology (dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic Class	Height Class (m)	Cover Scale
Trees and Shrubs	X Broad-leaved	____ Forest	01 - <0.5	T - <1%
____ Evergreen	____ Needle-leaved	____ Woodland	02 - 0.5-1	P - 1-5%
____ Cold-deciduous	____ Microphyllous	X Shrubland	03 - 1-2	1a - 6-10%
X Mixed evergreen - cold-deciduous	____ Graminoid	____ Dwarf- shrubland	04 - 2-5	1b- 11-15%
Herbs	____ Forb	____ Shrub herbaceous	05 - 5-10	02 - 16-25%
____ Perennial	____ Pteridophyte	____ Wooded herbaceous	06 - 10-15	03 - 26-35%
____ Annual	____ Non Vascular	____ Wooded Shrubland	07 - 15-20	04 - 36-45%
	____ Mixed	____ Herbaceous	08 - 20-35	05 - 46-55%
		____ Nonvascular	09 - 35-50	06 - 56-65%
		____ Sparsely vegetated	10 - >50	07 - 66-75%
				08 - 76-85%
				09 - 86-95%

Strata	Height Class	Cover Class	Dominant species (mark any known diagnostic species with a *)	% Cover
T1 Emergent	04	P	SALGOO	3
T2 Canopy				
T3 Sub-canopy				
S1 Tall shrub	03	P	TAMCHI	2
			FORPUB	T
			SALEXI	T
S2 Short Shrub	02	03	SARVER	20
			ERINAU	12
			ATRCAN	1
S3 Dwarf-shrub	01	P	SWATOR	1
H Herbaceous	01	02	DISSPI	1
			BROTEC	20
			PHRAUS	T
			MALVELLA LEPROSA	T
H4 Tree Seedlings			CHENOPODIUM ALBUM	T
			LEPIDIUM ALYSSOIDES	T
N Non-vascular				

☐ Please check this box if AA point has more than one plant association (e.g. two or more species list at a point recorded on form)

2008: July 24

Appendix C. Database Documentation

C.1. 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 CANY VegMapDB, have been used for all vegetation mapping projects conducted by NCPN. CANY VegMapDB contains plot, observation point, and accuracy assessment data collected during project field work.

Two database files are required to use CANY VegMapDB:

- *CANY_PlotsAA_XP.mdb.* This "frontend" file contains all queries, forms, reports, associated modules and Visual Basic code.
- *CANY_PlotsAA_XP_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 (CANY_PlotsAA_XP_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.

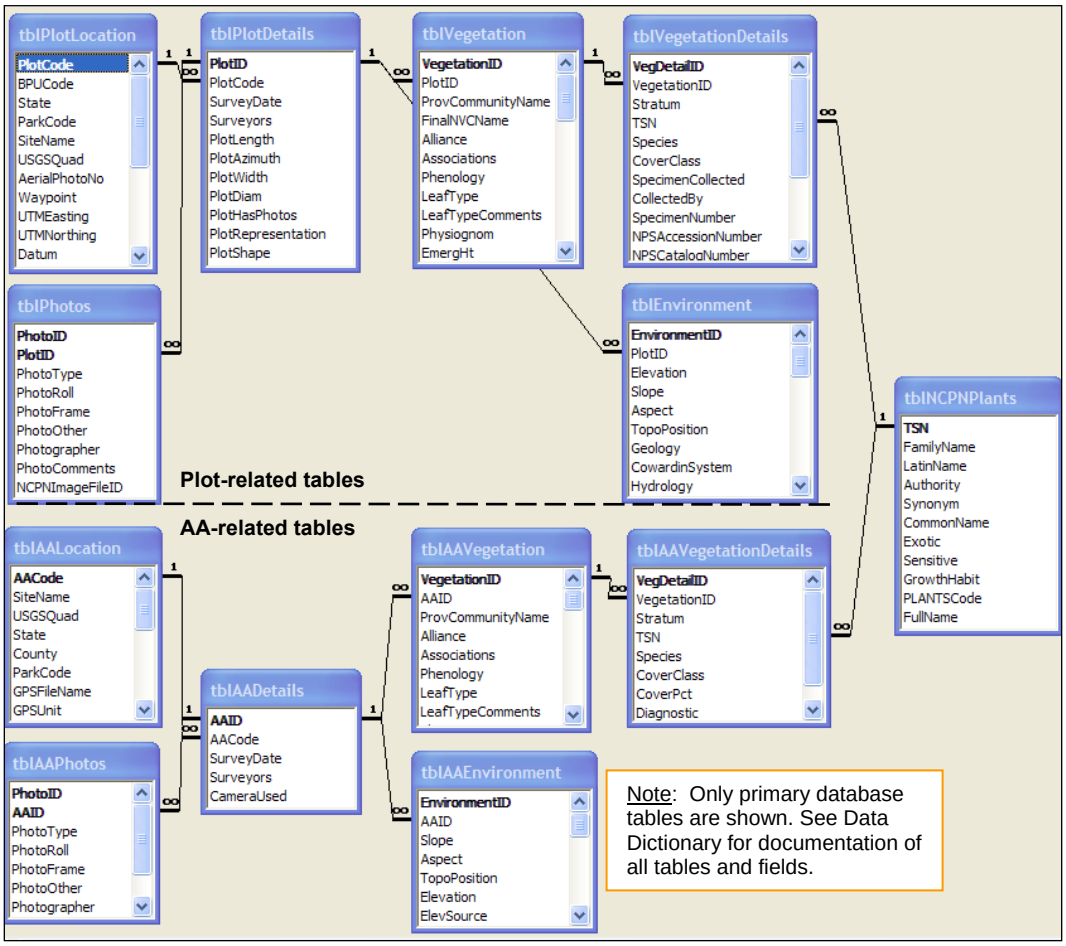


Figure C1. Entity Relationship Diagram for CANY VegMapDB

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/UTM's 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, and decisions that are made on data entry procedures or standards	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
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
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

Field Name	Field Description	Field Type	Field Width
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 CANY and GLCA plots	dbText	3
PJPhotoGuide	n/a for CANY and GLCA plots	dbText	3
SBPhotoGuide	n/a for CANY and 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 CANY and GLCA plots	dbText	3
LitterNorth	n/a for CANY and GLCA plots	dbText	3
LitterEast	n/a for CANY and GLCA plots	dbText	3
LitterSouth	n/a for CANY and GLCA plots	dbText	3
LitterWest	n/a for CANY and GLCA plots	dbText	3
DuffOrigin	n/a for CANY and GLCA plots	dbText	3
DuffNorth	n/a for CANY and GLCA plots	dbText	3
DuffEast	n/a for CANY and GLCA plots	dbText	3
DuffSouth	n/a for CANY and GLCA plots	dbText	3
DuffWest	n/a for CANY and 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
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 CANY and GLCA plots	dbDouble	8
WoodlandCrownHeight	n/a for CANY and GLCA plots	dbDouble	8
ForestCrownBaseHeight	n/a for CANY and GLCA plots	dbDouble	8
ForestCrownHeight	n/a for CANY and GLCA plots	dbDouble	8
CrownRatio	n/a for CANY and GLCA plots	dbText	12
StructureStage	n/a for CANY and GLCA plots	dbText	12
Comments	n/a for CANY and 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
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 field	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 identifier	dbLong	4
PlotID	Foreign key, links to tblPlotDetails	dbLong	4
PhotoType	Type of photo being referenced.	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
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
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	10
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	dbDouble	8
UTMNorthing	UTM northing of plot	dbDouble	8
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	100
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	dbText	2
CanCovTot	Cover class of canopy	dbText	15
CanCovPercent	[not used]	dbText	50
SubHt	Height class of sub-canopy	dbText	2
SubCovTot	Cover class of sub-canopy	dbText	15
SubCovPercent	[not used]	dbText	50
TallShHt	Height class of tall shrub	dbText	2
TallShCovTot	Cover class of tall shrub	dbText	15
TallShCovPercent	[not used]	dbText	50
ShrubHt	Height class of short shrub	dbText	2
ShrubCovTot	Cover class of short shrub	dbText	15
ShrubCovPercent	[not used]	dbText	50
DwarfHt	Height class of dwarf shrub	dbText	2
DwarfCovTot	Cover class of dwarf shrub	dbText	15
DwarfCovPercent	[not used]	dbText	50
HerbHt	Height class of herbaceous	dbText	2
HerbCovTot	Cover class of herbaceous	dbText	15
HerbCovPercent	[not used]	dbText	50
GramHt	Height class of graminoids	dbText	2
GramCovTot	Cover class of graminoids	dbText	15
GramCovPercent	[not used]	dbText	50
ForbHt	Height class of forbs	dbText	2
ForbCovTot	Cover class of forbs	dbText	15
ForbCovPercent	[not used]	dbText	50
FernHt	Height class of ferns	dbText	2
FernCovTot	Cover class of ferns	dbText	15
FernCovPercent	[not used]	dbText	50
SeedlHt	Height class of tree seedlings	dbText	2
SeedlCovTot	Cover class of tree seedlings	dbText	15

Field Name	Field Description	Field Type	Field Width
SeedCovPercent	[not used]	dbText	50
NonvasHt	Height class of non-vascular	dbText	2
NonvasCovTot	Cover class of non-vascular	dbText	15
NonvasCovPercent	[not used]	dbText	50
VineHt	Height class of vines	dbText	2
VineTotCov	Cover class of vines	dbText	15
VineTotPercent	[not used]	dbText	50
EpiHt	Height class of epiphytes	dbText	2
EpiTotCov	Cover class of epiphytes	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): T=0-1%, P=1-5%, 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
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
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	Estimate to the nearest percentage of moss ground cover	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	Estimate to the nearest percentage of lichen ground cover	dbText	3
Gravel	Estimate to the nearest percentage of gravel <10cm wide ground cover	dbText	3
LiveVegLitter	Estimate to the nearest percentage of live veg litter	dbText	3

Field Name	Field Description	Field Type	Field Width
	ground cover		
LiveVegWood	Estimate to the nearest percentage of live veg wood ground cover	dbText	3
Wood	Estimate to the nearest percentage of wood >1cm ground cover	dbText	3
LichenRocks	Estimate to the nearest percentage of lichen covering rocks	dbText	3
LichenGround	Estimate to the nearest percentage of lichen covering ground	dbText	3
DarkCyanobacteria	Estimate to the nearest percentage of dark cyanobacteria ground cover	dbText	3
Water	Estimate to the nearest percentage of water ground cover	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 tblEnvironment	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	dbText	9
UTMNorthing	UTM northing of point	dbText	10
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	8
RepresentATD	Representativeness of association to ***description:***	dbText	4

Field Name	Field Description	Field Type	Field Width
	Good, Fair, or Poor (on association page)		
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	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	20
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	50
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 tlkpStrataAA	dbText	2
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
Species	Latin names of species, from tblNCPNPlants	dbText	100

Field Name	Field Description	Field Type	Field Width
CoverClass	Cover class to describe species and strata (from tlkpCoverAA)	dbText	5
CoverPct	[not used]	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 look-up 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: 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: Look-up of provisional community names

Field Name	Field Description	Field Type	Field Width
Alliance	Alliance name from NatureServe classification	dbText	100

Table Name: tlkpAssociations
Description: Look-up 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: Look-up of cover classes assigned to species and strata in VegetationDetails.

Field Name	Field Description	Field Type	Field Width
CoverClass	Plots: (t)= few, T=0-1%, P =1-5%, 01=5-15%, 1a=5-10%, 1b=10-15%, 02=15-25%, 03=25-35%, 04=35-45%, 05=45-55%, 05a=45-50%, 05b=50-55%, 06=55-65%, 07=65-75%, 08=75 85%, 09=85-95%, 10=>95%. Obs pts: T=0-1%, P=1-5%, 01=0-10%, 02=10-25%, 03=25-60%, 04=60-100%.	dbText	50

Table Name: tlkpCoverAA
Description: Look-up of cover classes assigned to species and strata in AAVegetationDetails.

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%	dbText	50

Table Name: tlkpCowardin
Description: Look-up 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: Look-up 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: Look-up 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: Look-up of height classes assigned to strata in VegetationDetails.

Field Name	Field Description	Field Type	Field Width
HeightClass	01<.5m 02=.5-1m 03=1-2m 04=2-5m 05=5-10m 06=10-15m	dbText	2

Field Name	Field Description	Field Type	Field Width
	07=15-20m 08=20-35m 09=35-50m 10=>50m		

Table Name: tlkpHydrology
Description: Look-up 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: Look-up of landforms in Veg Mapping Manual (from http://soils.usda.gov/technical/handbook/detailedtoc.html#629)

Field Name	Field Description	Field Type	Field Width
Field1	landforms from appendix 1 of field manual	dbText	255

Table Name: tlkpLeafPhen
Description: Look-up 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: Look-up 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: Look-up of parks surveyed in 2004.

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: Look-up 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: Look-up 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: Look-up 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: Look-up 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: Look-up of shapes of plots.

Field Name	Field Description	Field Type	Field Width
PlotShape	shapes of plots	dbText	15

Table Name: tlkpProvisionalCommunities
Description: 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: Look-up 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: tlkpSoilTexture
Description: Look-up of soil textures based on Bowker 2003 field key for CANY, ARCH, and NABR.

Field Name	Field Description	Field Type	Field Width
SoilTexture	Look-up of soil textures based on Bowker 2003 field key for CANY, ARCH, and NABR.	dbText	15

Table Name: tlkpStates
Description: Look-up of all states in the USA

Field Name	Field Description	Field Type	Field Width
StateCode	Two-letter abbreviation for each state	dbText	2

Field Name	Field Description	Field Type	Field Width
StateName	Full name of each state in the USA	dbText	50

Table Name: tlkpStrata
Description: Look-up of strata classes in VegetationDetails (from VegMapping Manual 04/04).

Field Name	Field Description	Field Type	Field Width
Stratum	T1=Emergent T2=Canopy T3=Subcanopy S1=Tall Shrub S2=Short Shrub S3=Dwarf Shrub H1=Graminoid H2=Forb H3=Fern H4=Tree Seedl N=Nonvasc V=Vine E=Epiphyte	dbText	3

Table Name: tlkpStructureStages
Description: Look-up 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: tlkpSurveyors
Description: Look-up of data collection teams for 2003-2004 CANY field seasons.

Field Name	Field Description	Field Type	Field Width
SurveyorName	Last names of crew members on each 2003-2004 CANY data collection team.	dbText	75

Table Name: tlkpTopography
Description: Look-up 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: Look-up 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: Look-up 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

C.2. Geodatabase Documentation

Background

The geodatabase was designed to consolidate all spatial and non-spatial (i.e., tabular) data from the CANY 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.

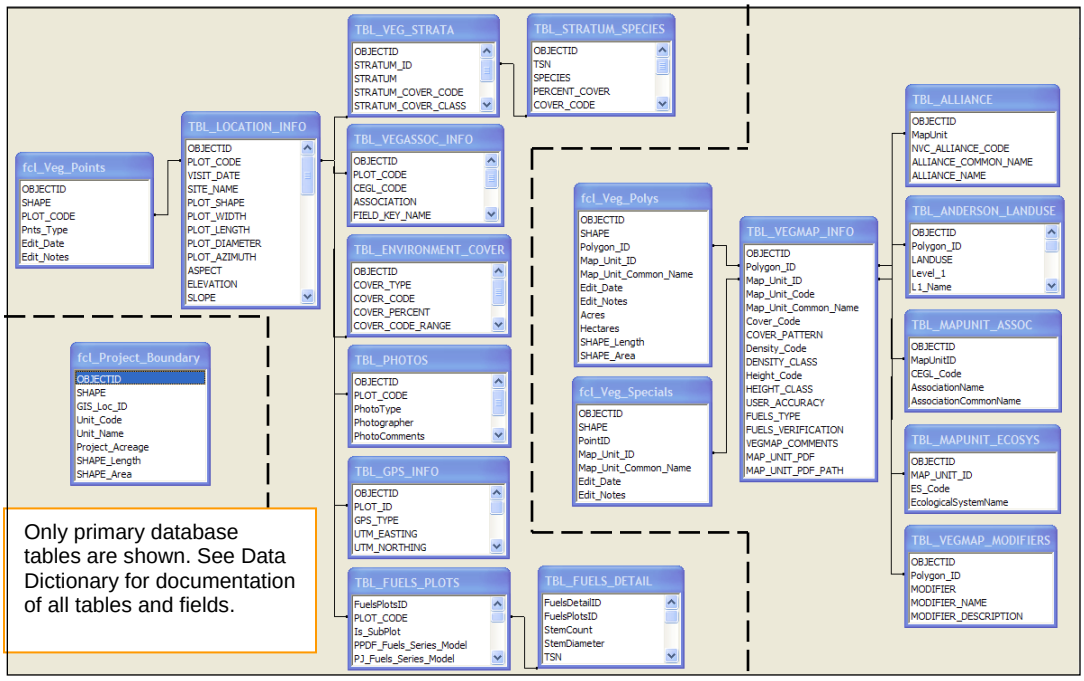


Figure C2. Entity Relationship Diagram for CANY Geodatabase

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 (CANY)	dbText	10
Unit_Name	Full name of national park (Canyonlands National Park)	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
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

Table Name: fcl_Veg_Specials
Description: The feature class containing point data for vegetation types of special interest to the park too small to delineate with a polygon.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
SHAPE	ESRI generated	dbLongBinary	0
PointID	Unique Plot code, used for relating tables (TBL_VEGMAP_INFO)	dbText	15
Map_Unit_ID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	15
Map_Unit_Common_Name	The name of the map unit (or map class)	dbText	250
Edit_Date	Date of any edits to the point or its attributes	dbText	20
Edit_Notes	Notes regarding any edits to the point or its attributes	dbText	150

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	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

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_FORMATION
Description: Contains NVC formation level data for the vegetation polygons.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MAP_UNIT_ID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10
Formation_Code	NVC formation level code	dbText	30
Formation_Name	NVC formation level name	dbText	255

Table Name: TBL_FUELS_DETAIL
Description: Details on stems, height, crown width, and other attributes of trees within plot for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
FuelsDetailID	Unique identifier for record	dbLong	4
FuelsPlotsID	Foreign key to TBL_FUELS_PLOTS	dbLong	4
StemCount	Number of stems measured. Value will be 1 if forest species; >=1 if woodland species.	dbInteger	2
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
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
Species	Species name	dbText	250
WoodlandCrownWidth	In PJ woodlands, the width of the tree crown at its widest point, in meters to the nearest half-meter	dbDouble	8
WoodlandCrownHeight	In PJ woodlands, distance from the ground to the top of the living tree crown, in meters to the nearest half-meter	dbDouble	8
ForestCrownBaseHeight	In Douglas-fir, ponderosa pine, or other tall tree woodlands, the distance from the ground to the base of the living tree crown, exclusive of dead or single branches, in meters to the nearest half-meter	dbDouble	8
ForestCrownHeight	Same as for woodlands, but for real trees	dbDouble	8
CrownRatio	The ratio of crown height to total tree height.	dbText	12
StructureStage	Describes the place of the tree in the canopy - emergent above the canopy, main canopy, sub canopy, sapling, seedling	dbText	12
Comments	General comments regarding the fuels at a specific plot.	dbText	255
PLOT_CODE	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	20

Table Name: TBL_FUELS_PLOTS
Description: Details on stems, height, crown width, and other attributes of trees within plot for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
FuelsPlotsID	Unique identifier for record	dbLong	4
PLOT_CODE	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	20
Is_SubPlot	Indicate if measurements are for subplot (if plot has >25 trees, one quadrant (subplot) of plot can be measured for fuels	dbText	4
PPDF_Fuels_Series_Model	PPDF Fuels series ID	dbText	6
PJ_Fuels_Series_Model	Pinyon/Juniper Fuels series ID	dbText	6
SB_Fuels_Series_Model	Sagebrush Fuels series ID	dbText	6
PJ_Age_Class	If plot contains pinyon and/or juniper, enter value that best describes the age class of the stand	dbText	50
LitterOrigin	Litter measured in cm at origin of plot	dbText	3
LitterNorth	Litter measured in cm at 10 m north of plot center	dbText	3
LitterSouth	Litter measured in cm at 10 m south of plot center	dbText	3
LitterEast	Litter measured in cm at 10 m east of plot center	dbText	3
LitterWest	Litter measured in cm at 10 m west of plot center	dbText	3
DuffOrigin	Duff measured in cm at origin of plot	dbText	3
DuffNorth	Duff measured in cm at 10 m north of plot center	dbText	3
DuffSouth	Duff measured in cm at 10 m south of plot center	dbText	3
DuffEast	Duff measured in cm at 10 m east of plot center	dbText	3
DuffWest	Duff measured in cm at 10 m west of plot center	dbText	3

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
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 and 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
IN_PARK	Indicates if the point was inside or outside the park boundary (only applicable to Plots and Observation points, all AA pts inside park)	dbBoolean	1
UNIT_CODE	4 letter park code (CANY)	dbText	10
AERIAL_PHOTO_NO	9X9 photo name on which the point most directly falls (2002 flight, plots & obs only)	dbText	30
STATE_CODE	State (UT)	dbText	2
USGS_NAME	USGS 1:24k Topo Name	dbText	75
COUNTY_NAME	County where plot is located (Garfield, Grand, 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 and training (plot and obs only).	dbText	220
ALLIANCE	Alliance corresponding to provisional community name (plots and obs only)	dbText	150
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	dbText	40

Field Name	Field Description	Field Type	Field Width
	only		
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

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	The NVC Association Common name	dbText	250

Table Name: TBL_MAPUNIT_ECOSYS
Description: Contains ecological system data for the vegetation polygons by map unit ID.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MAP_UNIT_ID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10
ES_Code	Ecological System code	dbText	30
EcologicalSystemName	Ecological system name (mid-scale classification, larger than associations or alliances, smaller than ecoregions).	dbText	255

Table Name: TBL_PHOTOS
Description: Details on individual photos taken of a point.

Field Name	Field Description	Field Type	Field Width

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
PhotoComments	Brief description of photo.	dbText	255
IMAGE_ID	NCPN Photo Database (unique) 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 strata	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

Field Name	Field Description	Field Type	Field Width
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
FUELS_TYPE	Fuels vegetation types (if applicable)	dbText	50
FUELS_VERIFICATION	Fuels verification (if applicable)	dbText	255
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
MAP_UNIT_PDF_PATH	Hard-coded link to Map Unit description PDF document - path name (e.g. C:/CANY/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

Five hundred and fifty four vascular and six non-vascular plant species representing 69 families were noted during plot, observation point and accuracy assessment point data collection at Canyonlands National Park (CANY). The Northern Colorado Plateau Network uses three taxonomic authorities for vascular plants: Welsh et al. 2003 as the nomenclatural authority for Utah parks, Weber and Wittmann 2001 for Colorado parks, and Dorn and Lichvar 1984 for the single park in Wyoming; the CANY vegetation mapping 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 CANY 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. 2003)	Scientific Name (Kartesz 1999)	Common Name (NatureServe)	TSN
Aceraceae	*Acer glabrum* Torr.	*Acer glabrum*	Rocky Mountain maple	28742
	Acer glabrum var. *glabrum* Torr.	*Acer glabrum* var. *glabrum*	Rocky Mountain maple	28743
	Acer negundo L.	*Acer negundo*	box-elder	28749
Agavaceae	*Yucca angustissima* Engelm. ex Trel.	*Yucca angustissima*	fineleaf yucca	43131
	Yucca baccata Torr.	*Yucca baccata*	banana yucca	43134
	Yucca harrimaniae Trel.	*Yucca harrimaniae*	Spanish bayonet	43144
	Yucca L.	*Yucca*	yucca	43116
Aizoaceae	*Sesuvium verrucosum* Raf.	*Sesuvium verrucosum*	winged sea-purslane	19909
Amaranthaceae	*Amaranthus* L.	*Amaranthus*	amaranth	20715
	Amaranthus retroflexus L.	*Amaranthus retroflexus*	red-root amaranth	20745
Amaryllidaceae	*Allium* L.	*Allium*	onion	42634
	Allium nevadense S. Watson	*Allium nevadense*	Nevada onion	42687
Anacardiaceae	*Rhus aromatica* Ait.	*Rhus trilobata*	fragrant sumac	28779
	Rhus aromatica ssp. *trilobata* (Nutt.) Gray ex. S. Wats.	*Rhus trilobata* var. *trilobata*	skunkbush sumac	526551
	Rhus aromatica var. *simplicifolia* (Greene) Cronq.	*Rhus trilobata* var. *simplicifolia*	singleleaf sumac	539585
	Rhus aromatica var. *trilobata* (Nutt.) Gray ex. S. Wats.	*Rhus trilobata* var. *trilobata*	skunkbush sumac	539586
Apiaceae	*Cymopterus acaulis* (Pursh) Raf.	*Cymopterus acaulis*	plains spring-parsley	29628
	Cymopterus newberryi (S. Wats.) M.E. Jones	*Cymopterus newberryi*	sweet-root spring-parsley	29649
	Cymopterus purpureus S. Wats.	*Cymopterus purpureus*	purple spring-parsley	29654
	Cymopterus Raf.	*Cymopterus*	spring-parsley	29625
	Lomatium parryi (S. Wats.) J.F. Macbr.	*Lomatium parryi*	Utah desert-parsley	29735
Apocynaceae	*Apocynum cannabinum* L.	*Apocynum cannabinum*	Indian-hemp	30157
	Amsonia tomentosa Torr. & Frem.	*Amsonia tomentosa*	woolly bluestar	30150
	Amsonia tomentosa var. *stenophylla* Kearney & Peebles	*Amsonia tomentosa* var. *stenophylla*	woolly bluestar	182210
Asclepiadaceae	*Asclepias* L.	*Asclepias*	milkweed	30240
	Asclepias macrosperma Eastw.	*Asclepias involucrata*	dwarf milkweed	30283
	Asclepias speciosa Torr.	*Asclepias speciosa*	showy milkweed	30304
	Asclepias subverticillata (Gray) Vail	*Asclepias subverticillata*	horsetail milkweed	30308
	Asclepias tuberosa L.	*Asclepias tuberosa*	butterfly milkweed	30313
Asteraceae	*Agoseris* Raf.	*Agoseris*	goat-chicory	36485
	Ambrosia L.	*Ambrosia*	ragweed	36495

Family	Scientific Name (Welsh et al. 2003)	Scientific Name (Kartesz 1999)	Common Name (NatureServe)	TSN
Asteraceae	*Ambrosia acanthicarpa* Hook.	*Ambrosia acanthicarpa*	flat-spine bur-ragweed	36497
	Ambrosia tomentosa Nutt.	*Ambrosia tomentosa*	skeletonleaf bur-ragweed	36520
	Antennaria Gaertn.	*Antennaria*	pussytoes	36716
	Antennaria parvifolia Nutt.	*Antennaria parvifolia*	littleleaf pussytoes	36749
	Arctium minus Bernh.	*Arctium minus*	lesser burdock	36546
	Artemisia bigelovii Gray	*Artemisia bigelovii*	Bigelow's sagebrush	35452
	Artemisia campestris L.	*Artemisia campestris*	field sagewort	183748
	Artemisia dracunculus L.	*Artemisia dracunculus*	dragon wormwood	35462
	Artemisia filifolia Torr.	*Artemisia filifolia*	sand sagebrush	35463
	Artemisia frigida Willd.	*Artemisia frigida*	fringed sagebrush	35465
	Artemisia L.	*Artemisia*	sagebrush	35431
	Artemisia ludoviciana Nutt.	*Artemisia ludoviciana*	white sagebrush	35474
	Artemisia ludoviciana ssp. *albula* (Woot.) D.D. Keck	*Artemisia ludoviciana* ssp. *albula*	white sagebrush	35476
	Artemisia nova A. Nels.	*Artemisia nova*	black sagebrush	500971
	Artemisia spinescens D.C. Eaton	*Picrothamnus desertorum*	bud sagebrush	35496
	Artemisia tridentata Nutt.	*Artemisia tridentata*	big sagebrush	35498
	Artemisia tridentata ssp. *tridentata* Nutt.	*Artemisia tridentata* ssp. *tridentata*	basin big sagebrush	35499
	Artemisia tridentata ssp. *wyomingensis* Beetle & Young	*Artemisia tridentata* ssp. *wyomingensis*	Wyoming big sagebrush	183741
	Aster chilensis ssp. *adscendens*	*Symphyotrichum ascendens*	western American-aster	193306
	Aster glaucodes var. *glaucodes* Blake	*Eurybia glauca*	gray wood-aster	193138
	Aster L.	*Aster*	aster	35510
	Asteraceae	*Asteraceae*	sunflowers	35420
	Baccharis salicina Torr. & A. Gray	*Baccharis salicina*	Great Plains false willow	35698
	Brickellia Elliot	*Brickellia*	brickellbush	36859
	Brickellia grandiflora (Hook.) Nutt.	*Brickellia grandiflora*	tassel-flower brickellbush	36878
	Brickellia longifolia S. Watson	*Brickellia longifolia*	longleaf brickellbush	36885
	Brickellia microphylla (Nutt.) A. Gray	*Brickellia microphylla*	littleleaf brickellbush	36886
	Brickellia microphylla var. *scabra* A. Gray	*Brickellia microphylla* var. *scabra*	rough brickellbush	526984
	Brickellia oblongifolia Nutt.	*Brickellia oblongifolia*	narrowleaf brickellbush	36891
	Centaurea repens L.	*Acroptilon repens*	hardheads	510530
	Chaenactis stevioides Hook. & Arn.	*Chaenactis stevioides*	broad-flower pincushion	36998
	Chaetopappa ericoides (Torr.) Nesom	*Chaetopappa ericoides*	rose-heath	501376

Family	Scientific Name (Welsh et al. 2003)	Scientific Name (Kartesz 1999)	Common Name (NatureServe)	TSN
Asteraceae	*Chrysopsis* (Nutt.) Elliot	*Chrysopsis*	goldenaster	202494
	Chrysopsis villosa (Pursh) Nutt. ex DC	*Heterotheca villosa*	hairy false goldenaster	510984
	Chrysothamnus linifolius Greene	*Chrysothamnus linifolius*	spearleaf rabbitbrush	37054
	Chrysothamnus nauseosus (Pallas ex Pursh) Britt.	*Ericameria nauseosa*	rubber rabbitbrush	507594
	Chrysothamnus nauseosus var. *graveolens* (Nutt.) Piper	*Ericameria nauseosa* ssp. *nauseosa* var. *glabrata*	rubber rabbitbrush	533554
	Chrysothamnus nauseosus var. *junceus* (Greene) H.M. Hall	*Ericameria nauseosa* ssp. *consimilis* var. *juncea*	rubber rabbitbrush	533557
	Chrysothamnus Nutt.	*Chrysothamnus*	rabbitbrush	37048
	Chrysothamnus pulchellus var. *bailey* (Woot. & Standl.) S.F. Blake	*Chrysothamnus baileyi*	southwestern rabbitbrush	510990
	Chrysothamnus viscidiflorus (Hook.) Nutt.	*Chrysothamnus viscidiflorus*	yellow rabbitbrush	37090
	Chrysothamnus viscidiflorus ssp. *viscidiflorus* (Hook.) Nutt.	*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*	yellow rabbitbrush	37091
	Chrysothamnus viscidiflorus ssp. *viscidiflorus* var. *stenophyllus* (A. Gray) H.M. Hall	*Chrysothamnus viscidiflorus* ssp. *viscidiflorus* var. *stenophyllus*	yellow rabbitbrush	531602
	Chrysothamnus viscidiflorus var. *lanceolatus* (Nutt.) Greene	*Chrysothamnus viscidiflorus* ssp. *lanceolatus*	yellow rabbitbrush	533581
	Chrysothamnus viscidiflorus var. *stenophyllus* (A. Gray) H.M. Hall	*Chrysothamnus viscidiflorus* var. *stenophyllus*	yellow rabbitbrush	566624
	Chrysothamnus viscidiflorus var. *viscidiflorus* (Hook.) Nutt.	*Chrysothamnus viscidiflorus* ssp. *viscidiflorus* var. *viscidiflorus*	yellow rabbitbrush	566625
	Cirsium arvense (L.) Scop.	*Cirsium arvense*	Canada thistle	36335
	Cirsium calcareum (M.E. Jones) Woot. & Standl.	*Cirsium calcareum*	Cainville thistle	36346
	Cirsium P. Mill.	*Cirsium*	thistle	36334
	Cirsium neomexicanum A. Gray	*Cirsium neomexicanum*	New Mexico thistle	36388
	Cirsium neomexicanum var. *utahense* (Petr.) S.L. Welsh	*Cirsium neomexicanum*	New Mexico thistle	527375
	Cirsium rydbergii Petr.	*Cirsium rydbergii*	Rydberg's thistle	36411
	Cirsium vulgare (Savi) Ten.	*Cirsium vulgare*	bull thistle	36428
	Conyza Less.	*Conyza*	horseweed	37108
	Conyza canadensis (L.) Cronquist	*Conyza canadensis*	Canadian horseweed	37113
	Crepis runcinata (James) Torr. & A. Gray	*Crepis runcinata*	fiddleleaf hawk's-beard	37203
	Dicoria brandegeei A. Gray	*Dicoria canescens* ssp. *brandegeei*	desert twinbugs	37233
	Dyssodia pentachaeta var. *belenidium* (DC.) Strother	*Thymophylla pentachaeta* var. *belenidium*	five-needle pricklyleaf	534695
	Encelia frutescens (A. Gray) A. Gray	*Encelia frutescens*	button brittlebush	37309
	Encelia frutescens var. *frutescens* (A. Gray) A. Gray	*Encelia frutescens*	button brittlebush	527880

Family	Scientific Name (Welsh et al. 2003)	Scientific Name (Kartesz 1999)	Common Name (NatureServe)	TSN
Asteraceae	*Erigeron divergens* Torr. & Gray	*Erigeron divergens*	spreading fleabane	35852
	Erigeron L.	*Erigeron*	fleabane	35803
	Erigeron pumilus Nutt.	*Erigeron pumilus*	shaggy fleabane	35934
	Erigeron pumilus ssp. *concinnoides* Cronquist	*Erigeron concinnus* var. *concinnus*	Navajo fleabane	35936
	Erigeron uintahensis Cronquist	*Erigeron uintahensis*	Uinta fleabane	35959
	Erigeron utahensis A. Gray	*Erigeron utahensis*	Utah fleabane	35967
	Erigeron utahensis var. *sparsifolius* (Eastw.) Cronquist	*Erigeron utahensis* var. *sparsifolius*	Utah fleabane	527970
	Gaillardia pinnatifida Torr.	*Gaillardia pinnatifida*	red-dome blanket-flower	37409
	Gaillardia spathulata A. Gray	*Gaillardia spathulata*	western blanket-flower	502699
	Grindelia Willd.	*Grindelia*	gumweed	37439
	Grindelia fastigiata Greene	*Grindelia fastigiata*	pointed gumweed	37446
	Grindelia squarrosa (Pursh) Dunal	*Grindelia squarrosa*	curly-cup gumweed	37472
	Gutierrezia Lag.	*Gutierrezia*	snakeweed	37478
	Gutierrezia microcephala (DC.) A. Gray	*Gutierrezia microcephala*	threadleaf snakeweed	37482
	Gutierrezia sarothrae (Pursh) Britt. & Rusby	*Gutierrezia sarothrae*	broom snakeweed	37483
	Haplopappus acaulis (Nutt.) Gray	*Stenotus acaulis*	stemless mock goldenweed	505369
	Haplopappus armerioides (Nutt.) Gray	*Stenotus armerioides*	thrift mock goldenweed	505370
	Helianthus annuus L.	*Helianthus annuus*	common sunflower	36616
	Helianthus anomalus S.F. Blake	*Helianthus anomalus*	western sunflower	36617
	Helianthus L.	*Helianthus*	sunflower	36611
	Helianthus petiolaris Nutt.	*Helianthus petiolaris*	prairie sunflower	36671
	Hymenopappus filifolius Hook.	*Hymenopappus filifolius*	fineleaf hymenopappus	37766
	Hymenoxys acaulis (Pursh) K.F. Parker	*Tetraneuris acaulis*	stemless four-nerve-daisy	514991
	Hymenoxys acaulis var. *arizonica* (Greene) K.F. Parker	*Tetraneuris acaulis* var. *arizonica*	Arizona four-nerve-daisy	536275
	Hymenoxys acaulis var. *ivesiana* (Greene) K.F. Parker	*Tetraneuris ivesiana*	Ives' four-nerve-daisy	38512
	Hymenoxys richardsonii var. *floribunda* (A. Gray) K.F. Parker	*Hymenoxys richardsonii* var. *floribunda*	Colorado rubberweed	528536
	Iva axillaris Pursh	*Iva axillaris*	deer-root	36033
	Lactuca L.	*Lactuca*	lettuce	36594
	Lactuca serriola L.	*Lactuca serriola*	prickly lettuce	36608
	Lygodesmia D. Don	*Lygodesmia*	skeletonplant	500397
	Lygodesmia grandiflora (Nutt.) Torr. & Gray	*Lygodesmia grandiflora*	rush-pink	503622

Family	Scientific Name (Welsh et al. 2003)	Scientific Name (Kartesz 1999)	Common Name (NatureServe)	TSN
Asteraceae	*Machaeranthera canescens* (Pursh) Gray	*Machaeranthera canescens*	hoary tansy-aster	37984
	Machaeranthera canescens var. aristata (Eastw.) B.L. Turner	*Machaeranthera canescens* var. *aristata*	hoary tansy-aster	566727
	Machaeranthera canescens var. *glabra* A. Gray	*Machaeranthera canescens* var. *glabra*	hoary tansy-aster	566728
	Machaeranthera grindelioides (Nutt.) Shinners	*Machaeranthera grindelioides*	rayless tansy-aster	37992
	Machaeranthera grindelioides var. *grindelioides* (Nutt.) Shinners	*Machaeranthera grindelioides* var. *grindelioides*	rayless tansy-aster	529072
	Machaeranthera Nees	*Machaeranthera*	tansy-aster	37970
	Machaeranthera tanacetifolia (Kunth) Nees	*Machaeranthera tanacetifolia*	Takhoka-daisy	38013
	Malacothrix sonchoides (Nutt.) Torr. & A. Gray	*Malacothrix sonchoides*	yellow-saucers	38055
	Oxytenia acerosa Nutt.	*Iva acerosa*	copperweed	518080
	Petradoria pumila (Nutt.) Greene	*Petradoria pumila*	grassy rock-goldenrod	38233
	Platyschkuhria integrifolia var. *desertorum* M.E. Jones) W. Ellison	*Platyschkuhria integrifolia* var. *desertorum*	desert basin-daisy	529721
	Senecio L.	*Senecio*	ragwort	36084
	Senecio multilobatus Torr. & Gray ex Gray	*Packera multilobata*	lobeleaf groundsel	36161
	Senecio spartioides Torr. & Gray	*Senecio spartioides*	broom-like ragwort	36184
	Senecio spartioides var. *Multicapitatus* (Greenm. Ex Rydb.) S.L. Welsh	*Senecio spartioides* var. *multicapitatus*	many-head groundsel	531525
	Solidago canadensis L.	*Solidago canadensis*	Canada goldenrod	36224
	Solidago L.	*Solidago*	goldenrod	36223
	Solidago velutina DC.	*Solidago velutina*	three-nerve goldenrod	505290
	Stephanomeria Nutt.	*Stephanomeria*	wire-lettuce	38442
	Stephanomeria exigua Nutt.	*Stephanomeria exigua*	white-plume wire-lettuce	38445
	Stephanomeria pauciflora (Torr.) A. Nelson	*Stephanomeria pauciflora*	brown-plume wire-lettuce	38451
	Stephanomeria tenuifolia var. *tenuifolia* (Raf.) H.M. Hall	*Stephanomeria minor*	lesser wire-lettuce	196293
	Taraxacum officinale G.H. Weber ex Wiggers	*Taraxacum officinale*	common dandelion	36213
	Tetradymia canescens DC.	*Tetradymia canescens*	gray horsebrush	38494
	Thelesperma subnudum A. Gray	*Thelesperma subnudum*	Navajo-tea	38528
	Thelesperma subnudum var. *subnudum* A. Gray	*Thelesperma subnudum* var. *subnudum*	Navajo-tea	530642
	Townsendia annua Beaman	*Townsendia annua*	annual Townsend-daisy	38538
	Townsendia Hook.	*Townsendia*	Townsend-daisy	38536
	Townsendia incana Nutt.	*Townsendia incana*	hoary Townsend-daisy	38549
	Tragopogon dubius Scop.	*Tragopogon dubius*	meadow goat's-beard	38564

Family	Scientific Name (Welsh et al. 2003)	Scientific Name (Kartesz 1999)	Common Name (NatureServe)	TSN
Asteraceae	*Vanclevea stylosa* (Eastw.) Greene	*Vanclevea stylosa*	pillar false gumweed	38587
	Xanthium strumarium L.	*Xanthium strumarium*	rough cocklebur	38692
	Xylorhiza glabriuscula Nutt.	*Xylorhiza glabriuscula*	smooth woody-aster	38698
	Xylorhiza glabriuscula var. *linearifolia* T.J. Watson	*Xylorhiza glabriuscula* var. *linearifolia*	smooth woody-aster	530876
	Xylorhiza tortifolia (Torr. & A. Gray) Greene	*Xylorhiza tortifolia*	Mojave woody-aster	38700
	Xylorhiza Nutt.	*Xylorhiza*	woody-aster	38695
Berberidaceae	*Berberis fendleri* Gray	*Berberis fendleri*	Fendler's barberry	18820
	Mahonia fremontii (Torr.) Fedde	*Mahonia fremontii*	desert oregon-grape	195033
	Mahonia repens (Lindl.) G. Don	*Mahonia repens*	creeping oregon-grape	195045
Betulaceae	*Betula occidentalis* Hook.	*Betula occidentalis*	water birch	19488
	Ostrya knowltonii Coville	*Ostrya knowltonii*	Knowlton's hophornbeam	19510
Boraginaceae	*Cryptantha confertiflora* (Greene) Payson	*Cryptantha confertiflora*	basin yellow cat's-eye	31796
	Cryptanth crassisepala var. *elachantha* I.M. Johnston	*Cryptantha crassisepala* var. *elachantha*	thick-sepal cat's-eye	527560
	Cryptantha flava (A. Nels.) Payson	*Cryptantha flava*	plateau yellow cat's-eye	31770
	Cryptantha flavoculata (A. Nels.) Payson	*Cryptantha flavoculata*	rough-seed cat's-eye	31809
	Cryptantha Lehm. ex G. Don	*Cryptantha*	cat's-eye	31765
	Cryptantha tenuis (Eastw.) Payson	*Cryptantha tenuis*	canyon cat's-eye	31777
	Heliotropium convolvulaceum (Nutt.) Gray	*Heliotropium convolvulaceum*	bindweed heliotrope	31644
	Lappula Moench	*Lappula*	sheepburr	32043
	Lappula occidentalis (S. Wats.) Greene	*Lappula occidentalis*	flat-spine stickseed	528678
	Lappula occidentalis var. *cupulata* (Gray) Higgins	*Lappula occidentalis* var. *cupulata*	flat-spine stickseed	528677
	Lithospermum multiflorum Torr. ex Gray	*Lithospermum multiflorum*	purple gromwell	31951
	Tiquilia hispidissima (Torr. & Gray) A. Richards	*Tiquilia hispidissima*	hairy crinklemat	505518
	Tiquilia latior (I.M. Johnston) A. Richards	*Tiquilia latior*	matted crinklemat	505519
Brassicaceae	*Alyssum* L.	*Alyssum*	madwort	23029
	Alyssum alyssoides (L.) L.	*Alyssum alyssoides*	pale madwort	23030
	Arabis hirsuta (Linnaeus) Scop.	*Arabis hirsuta*	western hairy rockcress	22700
	Arabis holboellii Hornem.	*Arabis holboellii*	Holboell's rockcress	22702
	Arabis L.	*Arabis*	rockcress	22671
	Arabis perennans S. Wats.	*Arabis perennans*	perennial rockcress	22720
	Arabis pulchra M.E. Jones ex S. Wats.	*Arabis pulchra*	beautiful rockcress	22725
	Arabis pulchra var. *pallens* M.E. Jones	*Arabis pulchra* var. *pallens*	beautiful rockcress	184430

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Brassicaceae	*Arabis selbyi* Rydb.	*Arabis selbyi*	Selby's rockcress	22731
	Brassicaceae	*Brassicaceae*	mustards	22669
	Chorispora tenella (Pallas) D.C.	*Chorispora tenella*	crossflower	23099
	Descurainia Webb. & Berth.	*Descurainia*	tansy-mustard	22819
	Descurainia pinnata (Walt.) Britt.	*Descurainia pinnata*	western tansy-mustard	22826
	Dithyrea wislizeni Engelm.	*Dimorphocarpa wislizeni*	touristplant	512398
	Draba L.	*Draba*	whitlow-grass	22844
	Draba cuneifolia Nutt. ex Torr. & Gray	*Draba cuneifolia*	wedgeleaf whitlow-grass	22874
	Lepidium L.	*Lepidium*	pepperwort	22953
	Lepidium alyssoides var. *eastwoodiae* (Woot.) Rollins	*Lepidium alyssoides* var. *eastwoodiae*	mesa pepperwort	531291
	Lepidium densiflorum var. *ramosum* (A. Nelson) Thell.	*Lepidium densiflorum* var. *ramosum*	miner’s pepperweed	528720
	Lepidium latifolium L.	*Lepidium latifolium*	broadleaf pepperwort	503379
	Lepidium montanum Nutt.	*Lepidium montanum*	mountain pepperwort	503381
	Lepidium montanum var. *jonesii* (Rydb.) C.L. Hitchc.	*Lepidium montanum* var. *jonesii*	Jones' pepperwort	528731
	Malcolmia africana (L.) Ait. f.	*Malcolmia africana*	African adder's-mouth	23243
	Physaria (Nutt. ex Torr. & Gray) Gray	*Physaria*	twinpod	23269
	Physaria acutifolia Rydb.	*Physaria acutifolia*	sharpleaf twinpod	23270
	Physaria ludoviciana (Nuttal) O’Kane & Al-Shehbaz	*Lesquerella ludoviciana*	foothill bladderpod	23205
	Physaria newberryi Gray	*Physaria newberryi*	Newberry's twinpod	23281
	Sisymbrium altissimum L.	*Sisymbrium altissimum*	tall hedge-mustard	23312
	Stanleya pinnata (Pursh) Britt.	*Stanleya pinnata*	golden prince's-plume	23329
	Streptanthella longirostris (S. Wats.) Rydb.	*Streptanthella longirostris*	longbeak fiddle-mustard	23333
	Streptanthus cordatus Nutt.	*Streptanthus cordatus*	heartleaf jewelflower	23348
	Thelypodium integrifolium (Nutt.) Endl. ex Walp.	*Thelypodium integrifolium*	entireleaf thelypody	23398
	Thelypodium integrifolium var. *gracilipes* B.L. Robins.	*Thelypodium integrifolium* ssp. *gracilipes*	entireleaf thelypody	541249
Cactaceae	*Echinocereus engelmannii* (Parry ex Engelm.) Lem.	*Echinocereus engelmannii*	Engelmann's hedgehog cactus	19806
	Echinocereus Engelm.	*Echinocereus*	hedgehog cactus	19803
	Echinocereus triglochidiatus Engelm.	*Echinocereus triglochidiatus*	king-cup cactus	19815
	*Echinocereus triglochidiatus*var. *melanacanthus* (Engelm.) L. Benson	*Echinocereus coccineus* var. *coccineus*	scarlet hedgehog cactus	534750
	Opuntia erinacea Engelm. & Bigelow ex Engelm.	*Opuntia erinacea*	oldman cactus	19705

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Cactaceae	*Opuntia fragilis* (Nutt.) Haw.	*Opuntia fragilis*	brittle prickly-pear	19707
	Opuntia P. Mill.	*Opuntia*	prickly-pear	19686
	Opuntia phaecantha Engelm.	*Opuntia phaeacantha*	tulip prickly-pear	19724
	Opuntia phaecantha var. *major* Engelm.	*Opuntia phaeacantha* var. *major*	tulip prickly-pear	195294
	Opuntia polyacantha Haw.	*Opuntia polyacantha*	panhandle prickly-pear	19726
	Opuntia whipplei Engelm. & Bigelow	*Opuntia whipplei*	rattail cholla	19745
	Sclerocactus Britt. & Rose	*Sclerocactus*	fishhook cactus	19758
	Sclerocactus whipplei (Engelm. & Bigelow) Britt. & Rose	*Sclerocactus whipplei*	Whipple's fishhook cactus	19765
	Sclerocactus whipplei var. *roseus* (Clover) L. Benson	*Sclerocactus parviflorus* ssp. *parviflorus*	small-flower fishhook cactus	540500
Capparaceae	*Cleome serrulata* Pursh	*Cleome serrulata*	Rocky Mountain beeplant	22626
	Cleome lutea Hook.	*Cleome lutea*	yellow spiderflower	22620
Caprifoliaceae	*Symphoricarpos* Duham.	*Symphoricarpos*	snowberry	35330
	Symphoricarpos longiflorus Gray	*Symphoricarpos longiflorus*	desert snowberry	35334
	Symphoricarpos oreophilus Gray	*Symphoricarpos oreophilus*	mountain snowberry	35338
Caryophyllaceae	*Arenaria fendleri* Gray	*Arenaria fendleri*	Fendler's sandwort	20245
	Arenaria fendleri var. *eastwoodiae* (Rydb.) Harrington	*Arenaria eastwoodiae* var. *eastwoodiae*	Eastwood's sandwort	532222
	Arenaria fendleri var. *fendleri* Gray	*Arenaria fendleri* var. *fendleri*	Fendler's sandwort	184229
	Silene antirrhina L.	*Silene antirrhina*	sleepy catchfly	20045
Celastraceae	*Paxistima myrsinites* (Pursh) Raf.	*Paxistima myrsinites*	Oregon boxleaf	504149
Chenopodiaceae	*Atriplex canescens* (Pursh) Nutt.	*Atriplex canescens*	fourwing saltbush	20518
	Atriplex confertifolia (Torr. & Frém.) S. Wats.	*Atriplex confertifolia*	shadscale	20519
	Atriplex gardneri (Moq.) D. Dietr.	*Atriplex gardneri*	Gardner's saltbush	20531
	Atriplex garrettii Rydb.	*Atriplex garrettii*	Garrett's saltbush	20532
	Atriplex L.	*Atriplex*	saltbush	20505
	Bassia All.	*Bassia*	smotherweed	20586
	Bassia americana	*Kochia americana*	greenmolly	20694
	Bassia hyssopifolia (Pallas) Kuntz	*Bassia hyssopifolia*	five-horn smotherweed	20588
	Bassia scoparia (L.) A.J. Scott	*Bassia scoparia*	burningbush	565741
	Chenopodium album L.	*Chenopodium album*	lamb's-quarters	20592
	Chenopodium atrovirens Rydb.	*Chenopodium atrovirens*	pinyon goosefoot	20593
	Chenopodium desiccatum A. Nels.	*Chenopodium desiccatum*	arid-land goosefoot	20604
	Chenopodium fremontii S. Wats.	Chenopodium fremontii	Fremont's goosefoot	20607

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Chenopodiaceae	*Chenopodium* L.	Chenopodium	goosefoot	20589
	Chenopodium leptophyllum (Moq.) Nutt. ex S. Wats.	Chenopodium leptophyllum	narrowleaf goosefoot	20616
	Corispermum villosum Rydb.	Corispermum villosum	hairy bugseed	511432
	Cycloloma atriplicifolium (Spreng.) Coult.	Cycloloma atriplicifolium	winged pigweed	20685
	Grayia spinosa (Hook.) Moq.	*Grayia spinosa*	spiny hopsage	20690
	Halogeton glomeratus (Bieb.) C.A. May	*Halogeton glomeratus*	salt-lover	20692
	Krascheninnikovia lanata (Pursh) A.D.J. Meeuse & Smit	*Krascheninnikovia lanata*	winterfat	503290
	Salsola L.	*Salsola*	Russian-thistle	20654
	Salsola paulsenii Litv.	*Salsola paulsenii*	barbwire Russian-thistle	20657
	Salsola tragus L.	*Salsola tragus*	prickly Russian-thistle	520950
	Sarcobatus vermiculatus (Hook.) Torr.	*Sarcobatus vermiculatus*	greasewood	20707
	Suaeda calceoliformis (Hook.) Moq.	*Suaeda calceoliformis*	Pursh seepweed	505402
	Suaeda Forsk. ex J.F. Gmell.	*Suaeda*	sea-blite	20659
	Suaeda torreyana S. Wats.	*Suaeda moquinii*	shrubby seepweed	20675
	Zuckia brandegeei (Gray) Welsh & Stutz ex Welsh	*Zuckia brandegeei*	siltbush	505810
Cornaceae	*Cornus sericea* L.	*Cornus sericea*	red-osier dogwood	501637
	Cornus sericea ssp. *sericea* L.	*Cornus sericea* ssp. *sericea*	red-osier dogwood	523904
Crossosomataceae	*Glossopetalon* Gray	*Glossopetalon*	greasebush	500300
	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
	Carex curatorum Stacey	*Carex curatorum*	Kaibab sedge	39565
	Carex L.	*Carex*	sedge	39369
	Carex nebrascensis Dewey	*Carex nebrascensis*	Nebraska sedge	39711
	Carex rossii Boott	*Carex rossii*	Ross' sedge	39786
	Cyperus L.	*Cyperus*	flatsedge	39882
	Cyperus erythrorhizos Muhl.	*Cyperus erythrorhizos*	red-root flatsedge	39887
	Eleocharis palustris (L.) Roemer & J.A. Schultes	*Eleocharis palustris*	common spikerush	40019
	Eleocharis rostellata (Torr.) Torr.	*Eleocharis rostellata*	beaked spikerush	40022
	Scirpus acutus Muhl. ex Bigelow	*Schoenoplectus acutus*	hardstem bulrush	40240
	Scirpus pungens Vahl	*Schoenoplectus pungens*	common threesquare	40275
	Scirpus validus Vahl	*Schoenoplectus tabernaemontani*	softstem bulrush	40239

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Elaeagnaceae	*Elaeagnus angustifolia* L.	*Elaeagnus angustifolia*	Russian-olive	27770
	Shepherdia rotundifolia Parry	*Shepherdia rotundifolia*	roundleaf buffaloberry	27780
Ephedraceae	*Ephedra* L.	*Ephedra*	joint-fir	183496
	Ephedra torreyana S. Wats.	*Ephedra torreyana*	Torrey's joint-fir	502318
Ephedraceae	*Ephedra viridis* Coville	*Ephedra viridis*	Mormon-tea	502319
Equisetaceae	*Equisetum arvense* L.	*Equisetum arvense*	field horsetail	17152
	Equisetum hyemale L.	*Equisetum hyemale*	common scouring-rush	17154
	Equisetum hyemale var. *affine* (Engelm.) A.A. Eat.	*Equisetum hyemale* var. *affine*	common scouring-rush	527892
	Equisetum L.	*Equisetum*	horsetail	17148
	Equisetum laevigatum A. Braun	*Equisetum laevigatum*	smooth horsetail	17156
Euphorbiaceae	*Chamaesyce albomarginata* (Torr. & Gray) Small	*Chamaesyce albomarginata*	white-margin sandmat	501400
	Chamaesyce fendleri (Torr. & Gray) Small	*Chamaesyce fendleri*	Fendler's sandmat	501419
	Chamaesyce glyptosperma (Engelm.) Small	*Chamaesyce glyptosperma*	rib-seed sandmat	501422
	Chamaesyce parryi (Engelm.) Rydb.	*Chamaesyce parryi*	Parry's sandmat	501448
	Chamaesyce S.F. Gray	*Chamaesyce*	sandmat	28244
	Euphorbia L.	*Euphorbia*	spurge	28032
Fabaceae	*Astragalus ceramicus* Sheldon	*Astragalus ceramicus*	painted milkvetch	25457
	Astragalus convallarius Greene	*Astragalus convallarius*	lesser rushy milkvetch	25477
	Astragalus convallarius var. *convallarius Greene*	*Astragalus convallarius* var. *convallarius*	lesser rushy milkvetch	192422
	Astragalus desperatus M.E. Jones	*Astragalus desperatus*	rimrock milkvetch	25491
	Astragalus desperatus var. *desperatus* M.E. Jones	*Astragalus desperatus* var. *desperatus*	rimrock milkvetch	192450
	Astragalus lentiginosus var. *palans* (M.E. Jones) M.E. Jones	*Astragalus lentiginosus* var. *palans*	freckled milkvetch	192580
	Astragalus L.	*Astragalus*	milkvetch	25392
	Astragalus moencoppensis M.E. Jones	*Astragalus moencoppensis*	Moenkopi milkvetch	25586
	Astragalus mollissimus Torr.	*Astragalus mollissimus*	woolly milkvetch	25589
	Astragalus monumentalis Barneby	*Astragalus monumentalis*	Monument Valley milkvetch	25593
	Astragalus preussii Gray	*Astragalus preussii*	Preuss' milkvetch	25640
	Astragalus preussii var. *preussii* Gray	*Astragalus preussii* var. *preussii*	Preuss' milkvetch	192703
	Astragalus sabulonum Gray	*Astragalus sabulonum*	gravel milkvetch	25663
	Caesalpinia repens Eastw.	*Caesalpinia repens*	creeping nicker	184653
	Dalea L.	*Dalea*	prairie-clover	26597

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Fabaceae	*Dalea flavescens* (S. Wats.) Welsh	*Dalea flavescens*	yellow prairie-clover	26614
	Dalea oligophylla (Torr.) Shinners	*Dalea candida* var. *oligophylla*	white prairie-clover	512059
	Glycyrrhiza lepidota Pursh	*Glycyrrhiza lepidota*	American licorice	26719
	Hedysarum boreale Nutt.	*Hedysarum boreale*	northern sweet-vetch	26724
	Lupinus argenteus Pursh	*Lupinus argenteus*	silver-stem lupine	503575
	Lupinus L.	*Lupinus*	lupine	25916
	Lupinus pusillus Pursh	*Lupinus pusillus*	rusty lupine	26099
	Lupinus pusillus ssp. *pusillus* Pursh	*Lupinus pusillus* ssp. *pusillus*	rusty lupine	26100
	Melilotus alba Medikus	*Melilotus officinalis*	sweetclover	26149
	Melilotus officinalis (L.) Lam.	*Melilotus officinalis*	sweetclover	26150
	Melilotus P. Mill.	*Melilotus*	sweetclover	26148
	Pediomelum megalanthum (Woot. & Standl.) Rydb.	*Pediomelum megalanthum*	Intermountain Indian-breadroot	504181
	Peteria thompsoniae S. Wats.	*Peteria thompsoniae*	Thompson's peteria	26838
	Psoralidium lanceolatum (Pursh) Rydb.	*Psoralidium lanceolatum*	lemon scurfpea	504645
	Psoralidium tenuiflorum (Pursh) Rydb.	*Psoralidium tenuiflorum*	slender-flower lemonweed	504646
	Psorothamnus thompsoniae (Vail) Welsh & Atwood	*Psorothamnus thompsoniae*	Thompson's smokebush	26934
	Sophora stenophylla Gray	*Sophora stenophylla*	fringeleaf necklace	26964
Fagaceae	*Quercus welshii X gambelii*	*n/a*	oak hybrid	
	Quercus gambelii Nutt.	*Quercus gambelii*	Gambel oak	19337
	Quercus welshii	*Quercus havardii* var. *tuckeri*	sand shinnery oak	
Gentianaceae	*Swertia* L.	*Frasera*	swertia	30107
	Swertia albomarginata (S. Wats.) Kuntze	*Frasera albomarginata*	desert elkweed	30109
	Swertia radiata (Kellogg) Kuntze	*Frasera speciosa*	monument plant	30120
	Swertia utahensis (M.E. Jones) St. John	*Frasera paniculata*	tufted elkweed	30123
Grossulariaceae	*Ribes aureum* Pursh	*Ribes aureum*	golden currant	24452
Hydrangeaceae	*Fendlera rupicola* Gray	*Fendlera rupicola*	fendlerbush	24331
	Philadelphus microphyllus Gray	*Philadelphus microphyllus*	littleleaf mock orange	24437
Hydrophyllaceae	*Phacelia crenulata* var. *corrugata* (A. Nels.) Brand	*Phacelia crenulata* var. *corrugata*	notchleaf scorpionweed	529549
	Phacelia ivesiana Torr.	*Phacelia ivesiana*	Ives' scorpionweed	504273
	Phacelia Juss.	*Phacelia*	scorpionweed	31433
Juncaceae	*Juncus arcticus* ssp. *ater* (Rydb.) Hultén	*Juncus balticus* var. *montanus*	mountain rush	525993

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Juncaceae	*Juncus arcticus* Willd.	*Juncus arcticus*	arctic rush	39222
	Juncus balticus var. *mexicanus*(Wild. Ex J.A. & J.H. Schultes) Kuntze	*Juncus mexicanus*	Mexican rush	536414
	Juncus L.	*Juncus*	rush	39220
Lamiaceae	*Dracocephalum parviflorum* Nutt.	*Dracocephalum parviflorum*	American dragonhead	32490
Lamiaceae	*Hedeoma drummondii* Benth.	*Hedeoma drummondii*	Drummond's false pennyroyal	32512
	Lycopus americanus Muhl. Ex W. Bart.	*Lycopus americanus*	American water-horehound	32254
	Poliomintha incana (Torr.) Gray	*Poliomintha incana*	hoary rosemarymint	504488
Liliaceae	*Calochortus nuttallii* Torr. & Gray	*Calochortus nuttallii*	sego-lily	42863
	Calochortus Pursh	*Calochortus*	mariposa-lily	42823
	Eremocrinum albomarginatum (M.E. Jones) M.E. Jones	*Eremocrinum albomarginatum*	lonely lily	42925
	Smilacina stellata (L.) Desf.	*Maianthemum stellatum*	starflower false solomon's-seal	43038
	Zigadenus elegans Pursh	*Zigadenus elegans*	mountain deathcamas	43158
	Zigadenus Michx.	*Zigadenus*	deathcamas	43155
	Zigadenus paniculatus (Nutt.) S. Watson	*Zigadenus paniculatus*	sand-corn	43167
Linaceae	*Linum aristatum* Engelm.	*Linum aristatum*	bristle flax	29231
Loasaceae	*Mentzelia albicaulis* (Dougl. ex Hook.) Dougl. ex Torr. & Gray	*Mentzelia albicaulis*	white-stem blazingstar	503757
	Mentzelia L.	*Mentzelia*	blazingstar	202469
	Mentzelia multiflora (Nutt.) Gray	*Mentzelia laciniata*	cutleaf blazingstar	503778
Malvaceae	*Malvella leprosa* (Ortega) Krapov.	*Malvella leprosa*	alkali mallow	21846
	Sphaeralcea coccinea (Nutt.) Rydb.	*Sphaeralcea coccinea*	scarlet globemallow	21920
	Sphaeralcea grossulariifolia (Hook. & Arn.) Rydb.	*Sphaeralcea grossulariifolia*	currantleaf globemallow	21939
	Sphaeralcea janeae (Welsh) Welsh	*Sphaeralcea janeae*	Jane’s globemallow	505320
	Sphaeralcea leptophylla (Gray) Rydb.	*Sphaeralcea leptophylla*	scaly globemallow	21947
	Sphaeralcea parvifolia A. Nels.	*Sphaeralcea parvifolia*	narrowleaf globemallow	21953
	Sphaeralcea St.-Hill	*Sphaeralcea*	globemallow	21909
Nyctaginaceae	*Abronia fragrans* Nutt. ex Hook.	*Abronia fragrans*	heart's-delight	19557
	Allionia incarnata L.	*Allionia incarnata*	trailing windmills	19581
	Mirabilis L.	*Mirabilis*	four o'clock	19624
	Mirabilis linearis (Pursh) Heimerl	*Mirabilis linearis*	narrowleaf four-o'clock	19651
	Mirabilis multiflora (Torr.) Gray	*Mirabilis multiflora*	Colorado four-o'clock	19654

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Nyctaginaceae	*Tripterocalyx micranthus* (Torr.) Hook.	*Tripterocalyx micranthus*	small-flower sand-verbena	19621
Oleaceae	*Forestiera pubescens* Nutt.	*Forestiera pubescens*	stretchberry	32957
	Fraxinus anomala Torr. Ex S. Wats.	*Fraxinus anomala*	singleleaf ash	32937
Onagraceae	*Calylophus lavandulifolius* (Torr. & Gray) Raven	*Calylophus lavandulifolius*	lavender-leaf sundrops	501160
	Camissonia walkeri (A. Nels.) Raven	*Camissonia walkeri*	Walker's suncup	27559
Onagraceae	*Gaura parviflora* Dougl. Ex Lehm.	*Gaura mollis*	velvetweed	27660
	Oenothera albicaulis Pursh	*Oenothera albicaulis*	prairie evening-primrose	27373
	Oenothera caespitosa Nutt.	*Oenothera caespitosa*	tufted evening-primrose	565328
	Oenothera L.	*Oenothera*	evening-primrose	27367
	Oenothera longissima Rydb.	*Oenothera longissima*	long-stem evening-primrose	27428
	Oenothera pallida ssp. *pallida* Lindl.	*Oenothera pallida*	pale evening-primrose	27437
Orchidaceae	*Epipactus gigantea* Dougl. ex Hook.	*Epipactis gigantea*	giant helleborine	43481
	Habenaria zothecina Higgins & Welsh	*Platanthera zothecina*	alcove bog orchid	514389
Orobanchaceae	*Orobanche fasciculata* Nutt.	*Orobanche fasciculata*	clustered broomrape	34290
Pinaceae	*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.	*Abies concolor*	white fir	181826
	Pinus edulis Engelm.	*Pinus edulis*	two-needle pinyon	183336
	Pinus ponderosa P. & C. Lawson	*Pinus ponderosa*	ponderosa pine	183365
	Pseudotsuga menziesii (Mirbel) Franco	*Pseudotsuga menziesii*	Douglas-fir	183424
Plantaginaceae	*Plantago patagonica* Jacq.	*Plantago patagonica*	woolly plantain	32907
Poaceae	*Agropyron cristatum* (L.) Gaertn.	*Agropyron cristatum*	crested wheatgrass	182478
	Agrostis stolonifera L.	*Agrostis stolonifera*	creeping bentgrass	40400
	Andropogon glomeratus (Walter) Britton, Sterns & Poggenb.	*Andropogon glomeratus*	bushy bluestem	40454
	Aristida arizonica Vasey	*Aristida arizonica*	Arizona three-awn	41410
	Aristida purpurea Nutt.	*Aristida purpurea*	purple three-awn	41429
	Avena L.	*Avena*	oat	41455
	Bouteloua barbata Lag.	*Bouteloua barbata*	six-weeks grama	41498
	Bouteloua curtipendula (Michx.) Torr.	*Bouteloua curtipendula*	sideoats grama	41500
	Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths	*Bouteloua gracilis*	blue grama	41493
	Bromus inermis Leyss.	*Bromus inermis*	smooth brome	40502
	Bromus rubens L.	*Bromus rubens*	foxtail brome	40518
	Bromus tectorum L.	*Bromus tectorum*	cheatgrass	40524

Family	Scientific Name (Welsh et al. 2003)	Scientific Name (Kartesz 1999)	Common Name (NatureServe)	TSN
Poaceae	*Calamagrostis canadensis* (Michx) P. Beauv.	*Calamagrostis canadensis*	bluejoint	40544
	Calamagrostis scopulorum M.E. Jones	*Calamagrostis scopulorum*	ditch reedgrass	40566
	Distichlis spicata (L.) Greene	*Distichlis spicata*	inland saltgrass	40662
	Elymus canadensis L.	*Elymus canadensis*	Canada wildrye	40683
	Elymus cinereus Scribn. & Merr.	*Leymus cinereus*	Great Basin wildrye	40689
	Elymus elymoides (Raf.) Swezey	*Elymus elymoides*	squirreltail	502264
	Elymus L.	*Elymus*	wildrye	40677
	Elymus lanceolatus (Scribn. & J.G. Sm.) Gould	*Elymus lanceolatus*	streambank wheatgrass	502267
	Elymus repens (L.) Gould	*Elymus repens*	quackgrass	512839
	Elymus salinus M.E. Jones	*Leymus salinus* ssp. *salinus*	saline wildrye	512841
	Eymus smithii (Rydb.) Gould	*Pascopyrum smithii*	western wheatgrass	512844
	Elymus spicatus (Pursh) Gould	*Pseudoroegneria spicata* ssp. *spicata*	bluebunch wheatgrass	512845
	Elymus trachycaulus (Link) Gould ex Shinners	*Elymus trachycaulus*	slender wheatgrass	502282
	Erioneuron pilosum (Buckley) Nash	*Erioneuron pilosum*	hairy woolly grass	41731
	Erioneuron pulchellum (Kunth) Tateoka	*Dasyochloa pulchella*	low woolly grass	41732
	Eremopyrum triticeum (Gaertn.) Nevski	*Eremopyrum triticeum*	annual false wheatgrass	41717
	Festuca arundinacea Schreb.	*Lolium arundinaceum*	tall fescue	40810
	Festuca octoflora Walt.	*Vulpia octoflora*	eight-flower six-weeks grass	513551
	Festuca ovina L.	*Festuca ovina*	sheep fescue	40804
	Hilaria jamesii (Torr.) Benth.	*Pleuraphis jamesii*	James' galleta	41768
	Hordeum jubatum L.	*Hordeum jubatum*	foxtail barley	40871
	Hordeum pusillum Nutt.	*Hordeum pusillum*	little barley	40866
	Muhlenbergia andina (Nutt.) Hitchc.	*Muhlenbergia andina*	foxtail muhly	41884
	Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi	*Muhlenbergia asperifolia*	alkali muhly	41899
	Muhlenbergia porteri Scribn. ex Beal	*Muhlenbergia porteri*	bush muhly	41933
	Muhlenbergia pungens Thurb. ex A. Gray	*Muhlenbergia pungens*	sandhill muhly	41934
	Munroa squarrosa (Nutt.) Torr.	*Monroa squarrosa*	false buffalo grass	41882
	Oryzopsis micrantha (Trin. & Rupr.) Thurb.	*Piptatherum micranthum*	little-seed mountain ricegrass	41989
	Panicum L.	*Panicum*	panicgrass	40901
	Panicum virgatum L.	*Panicum virgatum*	switchgrass	40913
	Phragmites Adans.	*Phragmites*	reed	41071

Family	Scientific Name (Welsh et al. 2003)	Scientific Name (Kartesz 1999)	Common Name (NatureServe)	TSN
Poaceae	*Phragmites australis* (Cav.) Trin. ex Steud.	*Phragmites australis*	common reed	41072
	Poa annua L.	*Poa annua*	annual bluegrass	41107
	Poa bigelovii Vasey & Scribn.	*Poa bigelovii*	Bigelow's bluegrass	41112
	Poa fendleriana (Steud.) Vasey	Poa fendleriana	muttongrass	504467
	Poa L.	*Poa*	bluegrass	41074
	Poa pratensis L.	*Poa pratensis*	Kentucky bluegrass	41088
	Poa secunda J. Presl	*Poa secunda*	Sandberg bluegrass	41103
	Poaceae	*Poaceae*	grasses	40351
	Schizachyrium scoparium (Michx.) Nash	*Schizachyrium scoparium*	little bluestem	42076
	Spartina pectinata Link	*Spartina pectinata*	prairie cordgrass	41272
	Sporobolus R. Br.	*Sporobolus*	dropseed	42115
	Sporobolus airoides (Torr.) Torr.	*Sporobolus airoides*	alkali sacaton	42128
	Sporobolus contractus Hitchc.	*Sporobolus contractus*	narrow-spike dropseed	42131
	Sporobolus cryptandrus (Torr.) Gray	*Sporobolus cryptandrus*	sand dropseed	42132
	Sporobolus flexuosus (Thurb. ex Vasey) Rydb.	*Sporobolus flexuosus*	mesa dropseed	42137
	Sporobolus giganteus Nash	*Sporobolus giganteus*	giant dropseed	42138
	Stipa arida M.E. Jones	*Achnatherum aridum*	Mormon needlegrass	42159
	Stipa comata Trin. & Rupr.	*Hesperostipa comata*	needle-and-thread	42172
	Stipa coronata Thurb.	*Achnatherum coronatum*	giant needlegrass	42173
	Stipa hymenoides Roemer & J.A. Schultes	*Achnatherum hymenoides*	Indian ricegrass	522063
	Stipa L.	*n/a*		42158
	Stipa lettermanii Vasey	*Achnatherum lettermanii*	Letterman's needlegrass	522065
	Stipa neomexicana (Thurb. ex Coult.) Scribn.	*Hesperostipa neomexicana*	New Mexico needlegrass	42165
	Stipa speciosa Trin. & Rupr.	*Achnatherum speciosum*	desert needlegrass	42194
	Tridens Roem. & Schult.	*Tridens*	fluffgrass	42220
	Tridens muticus (Torr.) Nash	*Tridens muticus*	slim tridens	42228
Polemoniaceae	*Gilia* Ruiz & Pavón	*Gilia*	gilia	31075
	Gilia inconspicua (Sm.) Sweet	*Gilia inconspicua*	shy gilia	31127
	Gilia leptomeria Gray	*Gilia leptomeria*	sand gilia	31150
	Ipomopsis aggregata (Pursh) V. Grant	*Ipomopsis aggregata*	scarlet skyrocket	31192
	Ipomopsis congesta (Hook.) V. Grant	*Ipomopsis congesta*	ball-head skyrocket	31202
	Ipomopsis gunnisonii (Torr. & Gray) V. Grant	*Ipomopsis gunnisonii*	sand-dune skyrocket	31210

Family	Scientific Name (Welsh et al. 2003)	Scientific Name (Kartesz 1999)	Common Name (NatureServe)	TSN
Polemoniaceae	*Ipomopsis longiflora* (Torr.) V. Grant	*Ipomopsis longiflora*	white-flower skyrocket	31198
	Ipomopsis roseata (Rydb.) V. Grant	*Ipomopsis roseata*	rosy skyrocket	31218
	Leptodactylon watsonii (Gray) Rydb.	*Leptodactylon watsonii*	Watson's prickly-phlox	503390
	Phlox austromontana Coville	*Phlox austromontana*	desert mountain phlox	30913
	Phlox hoodii Richards.	*Phlox hoodii*	Hood's phlox	30948
	Phlox L.	*Phlox*	phlox	30897
Polygonaceae	*Eriogonum* Michx.	*Eriogonum*	buckwheat	21054
	Eriogonum alatum Torr.	*Eriogonum alatum*	winged buckwheat	21057
Polygonaceae	*Eriogonum bicolor* M.E. Jones	*Eriogonum bicolor*	pretty buckwheat	21078
	Eriogonum cernuum Nutt.	*Eriogonum cernuum*	nodding buckwheat	21090
	Eriogonum corymbosum Benth.	*Eriogonum corymbosum*	crispleaf buckwheat	21103
	Eriogonum corymbosum var. *corymbosum* Benth.	*Eriogonum corymbosum* var. *corymbosum*	crispleaf buckwheat	195443
	Eriogonum corymbosum var. *orbiculatum* (S. Stokes) Reveal & Brotherson	*Eriogonum corymbosum* var. *orbiculatum*	crispleaf buckwheat	195447
	Eriogonum deflexum Torr.	*Eriogonum deflexum*	flat-crown buckwheat	21111
	Eriogonum gordonii Benth.	*Eriogonum gordonii*	Gordon's buckwheat	21138
	Eriogonum inflatum Torr. & Frem.	*Eriogonum inflatum*	desert trumpet	21163
	Eriogonum leptocladon Torr. & Gray	*Eriogonum leptocladon*	sand buckwheat	21179
	Eriogonum microthecum Nutt.	*Eriogonum microthecum*	slender buckwheat	21192
	Eriogonum microthecum var. *foliosum* (Torr. & Gray) Reveal	*Eriogonum microthecum* var. *simpsonii*	Simpson's buckwheat	535156
	Eriogonum ovalifolium Nutt.	*Eriogonum ovalifolium*	cushion buckwheat	21212
	Eriogonum palmerianum Reveal	*Eriogonum palmerianum*	Palmer's buckwheat	502413
	Eriogonum shockleyi S. Wats.	*Eriogonum shockleyi*	Shockley's buckwheat	21245
	Eriogonum umbellatum ssp. *subaridum* (S. Stokes) Munz	*Eriogonum umbellatum* var. *subaridum*	sulphur-flower buckwheat	195621
	Eriogonum umbellatum Torr.	*Eriogonum umbellatum*	sulphur-flower buckwheat	21266
	Eriogonum wetherillii Eastw.	*Eriogonum wetherillii*	Wetherill's buckwheat	21278
	Rumex L.	*Rumex*	dock	20933
	Rumex hymenosepalus Torr.	*Rumex hymenosepalus*	canaigre dock	20962
	Rumex venosus Pursh	*Rumex venosus*	veined dock	20980
Primulaceae	*Primula specuicola* Rydb.	*Primula specuicola*	cave primrose	24032
Pteridaceae	*Adiantum capillus-veneris* L.	*Adiantum capillus-veneris*	southern maidenhair	17308
Ranunculaceae	*Aquilegia micrantha* Eastw.	*Aquilegia micrantha*	Mancos columbine	18743

Family	Scientific Name (Welsh et al. 2003)	Scientific Name (Kartesz 1999)	Common Name (NatureServe)	TSN
Ranunculaceae	*Clematis ligusticifolia* Nutt.	*Clematis ligusticifolia*	deciduous traveler's-joy	18702
	Delphinium andersonii Gray	*Delphinium*	larkspur	18457
	Delphinium nuttallianum Pritz. Ex Walp.	*Delphinium nuttallianum*	two-lobe larkspur	18483
Rhamnaceae	*Ceanothus greggii* Gray	*Ceanothus greggii*	Mojave Desert whitethorn	28473
	Ceanothus greggii var. *franklinii* Welsh	*Ceanothus greggii* var. *franklinii*	Mojave Desert whitethorn	531448
	Rhamnus betulifolia Greene	*Frangula betulifolia*	beechleaf frangula	28563
Rosaceae	*Amelanchier alnifolia* (Nutt.) Nutt. ex M. Roemer	*Amelanchier alnifolia*	Saskatoon serviceberry	25109
	Amelanchier utahensis Koehne	*Amelanchier utahensis*	Utah serviceberry	25121
	Cercocarpus Kunth	*Cercocarpus*	mountain-mahogany	25131
Rosaceae	*Cercocarpus intricatus* S. Wats.	*Cercocarpus intricatus*	littleleaf mountain-mahogany	25133
	Cercocarpus montanus Raf.	*Cercocarpus montanus*	alderleaf mountain-mahogany	25136
	Coleogyne ramosissima Torr.	*Coleogyne ramosissima*	blackbrush	25150
	Fallugia paradoxa (D. Don) Endl. ex Torr.	*Fallugia paradoxa*	Apache plume	25167
	Holodiscus dumosus (Nutt. ex Hook.) Heller	*Holodiscus dumosus*	rockspirea	25178
	Peraphyllum ramosissimum Nutt.	*Peraphyllum ramosissimum*	wild crabapple	25270
	Petrophyton caespitosum (Nutt.) Rydb.	*Petrophyton caespitosum*	tufted rockmat	25272
	Potentilla biennis Greene	*Potentilla biennis*	biennial cinquefoil	24695
	Prunus L.	*Prunus*	plum	24762
	Prunus virginiana L.	*Prunus virginiana*	chokecherry	24806
	Purshia mexicana (D. Don) Henrickson	*Purshia mexicana*	Mexican cliffrose	195899
	Purshia mexicana var. *stansburiana* (Torr.) Welsh	*Purshia stansburiana*	Stansbury's cliffrose	195902
	Purshia tridentata (Pursh) DC.	*Purshia tridentata*	antelope bitterbrush	25290
	Rosa woodsii Lindl.	*Rosa woodsii*	Woods' rose	24847
Rubiaceae	*Galium* L.	*Galium*	bedstraw	34796
	Galium multiflorum var. *coloradoense* (W. Wight) Cronq.	*Galium coloradoense*	Colorado bedstraw	535620
Salicaceae	*Populus angustifolia* James	*Populus angustifolia*	narrowleaf cottonwood	22452
	Populus fremontii S. Wats.	*Populus fremontii*	Fremont cottonwood	22459
	Populus L.	*Populus*	cottonwood	22444
	Populus X *intercurrens*	*n/a*	lanceleaf cottonwood	
	Salix eriocephala (Michx.)	*Salix eriocephala*	Missouri River willow	22528
	Salix eriocephala var. *watsonii* (Bebb) Dorn	*Salix lutea*	yellow willow	540021

Family	Scientific Name (Welsh et al. 2003)	Scientific Name (Kartesz 1999)	Common Name (NatureServe)	TSN
Salicaceae	*Salix exigua* Nutt.	*Salix exigua*	coyote willow	22529
	Salix goodingii Ball	*Salix gooddingii*	Goodding's willow	22539
	Salix L.	*Salix*	willow	22476
Santalaceae	*Comandra umbellata* (L.) Nutt.	*Comandra umbellata*	bastard toadflax	501614
	Comandra umbellata var. *pallida* (A. DC.) M.E. Jones	*Comandra umbellata* ssp. *pallida*	bastard toadflax	533741
Scrophulariaceae	*Castilleja* Mutis ex L. f.	*Castilleja*	Indian-paintbrush	33049
	Castilleja chromosa A. Nels.	*Castilleja applegatei* ssp. *martinii*	wavyleaf Indian-paintbrush	525154
	Castilleja linariifolia Benth.	*Castilleja linariifolia*	wyoming Indian-paintbrush	33138
	Castilleja scabrida Eastw.	*Castilleja scabrida*	rough Indian-paintbrush	33165
	Castilleja scabrida var. *scabrida* Eastw.	*Castilleja scabrida* var. *scabrida*	Zion Indian-paintbrush	527216
Scrophulariaceae	*Cordylanthus* Nutt. ex Benth.	*Cordylanthus*	bird's-beak	33537
	Cordylanthus wrightii Gray	*Cordylanthus wrightii*	Wright's bird's-beak	33577
	Mimulus eastwoodiae Rydb.	*Mimulus eastwoodiae*	Eastwood's monkeyflower	33309
	Penstemon barbatus (Cav.) Roth	*Penstemon barbatus*	beard-lip beardtongue	33825
	Penstemon comarrhenus Gray	*Penstemon comarrhenus*	dusty beardtongue	33854
	Penstemon cyanocaulis Payson	*Penstemon cyanocaulis*	bluestem beardtongue	33868
	Penstemon eatonii Gray	*Penstemon eatonii*	firecracker penstemon	33686
	Penstemon utahensis Eastw.	*Penstemon utahensis*	Utah firecracker	33785
	Penstemon Schmidel	*Penstemon*	beardtongue	33665
Solanaceae	*Lycium torreyi* Gray	*Lycium torreyi*	Torrey's wolfberry	30549
	Physalis hederifolia var. *fendleri* (Gray) Cronq.	*Physalis hederifolia* var. *fendleri*	Fendler's ground-cherry	529625
	Solanum L.	*Solanum*	nightshade	30412
Tamaricaceae	*Tamarix chinensis* Lour.	*Tamarix chinensis*	Chinese tamarisk	22308
	Tamarix L.	*Tamarix*	tamarisk	22303
Typhaceae	*Typha domingensis* Pers.	*Typha domingensis*	southern cattail	42327
	Typha latifolia L.	*Typha latifolia*	broadleaf cattail	42326
Ulmaceae	*Celtis laevigata* var. *reticulata* (Torr.) L. Benson	*Celtis laevigata* var. *reticulata*	netleaf hackberry	527226
	Celtis reticulata Torr.	*Celtis laevigata* var. *reticulata*	netleaf hackberry	19045

NON-VASCULAR PLANTS

Family	Scientific Name (Welsh et al. 2003)	Scientific Name (Kartesz 1999)	Common Name (NatureServe)	TSN
Bacidaceae	*Squamarina* Poelt.	*Squamarina*	rim lichen	190068
Catillariaceae	*Toninia* A. Massal.	*Toninia*	bruised lichen	190205
Collemataceae	*Collema* Wigg.	*Collema*	jelly lichen	191331
Hymeneliaceae	*Aspicilia* Massal.	*Aspicilia*	rimmed lichen	189695
Psoraceae	*Psora* Hoffm.	*Psora*	scale lichen	190026
Teloschistaceae	*Fulgensia* Massal. and De Not.	*Fulgensia*	sulphur lichen	191759

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 138 NVC associations, four NVC alliances, and twenty-two "Park Specials" were described for Canyonlands. Four additional NVC associations were described only for the Orange Cliffs section of Glen Canyon NRA. Twenty six 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. 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 Point, and AA Point Assignments
Acer negundo / Disturbed Understory Woodland	CEGL002693	3	CANY.0610, CANY.9550, CANY.9551
Achnatherum hymenoides Colorado Plateau Herbaceous Vegetation	CEGL002343	19	CANY.0165, CANY.0251, CANY.0272, CANY.0381, CANY.0424, CANY.0432, CANY.0439. CANY.0449, CANY.0539, CANY.0549, CANY.0629, CANY.0637, CANY.0666. CANY.0721, CANY.0773, CANY.0776, CANY.0791, CANY.9063, CANY.9337
Achnatherum speciosum Herbaceous Vegetation	CEGL003112	1	CANY.0760
Agrostis stolonifera Seasonally Flooded Herbaceous Alliance	A.1405	1	CANY.9058
Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland	CEGL001070	1	CANY.0801
Amelanchier utahensis Shrubland	CEGL001067	9	CANY.0148, CANY.0375, CANY.0377, CANY.0527, CANY.0531, CANY.0545, CANY.0726, CANY.9020, CANY.9317
Aquilegia micrantha Herbaceous Vegetation	CEGL002762	4	CANY.9078, CANY.9080, CANY.9377, CANY.9420
Aquilegia micrantha - Mimulus eastwoodiae Herbaceous Vegetation	CEGL002729	4	CANY.0250, CANY.0283, CANY.0521, CANY.9301
Artemisia bigelovii - Ephedra (viridis, torreyana) Talus Shrubland	CEGL003755	7	CANY.0142, CANY.0169, CANY.0192, CANY.0445, CANY.0657, CANY.0771, CANY.9705
Artemisia campestris Stream Terrace Herbaceous Vegetation	Park Special	1	CANY.0396
Artemisia filifolia Colorado Plateau Shrubland	CEGL002697	10	CANY.0259, CANY.0263, CANY.0421, CANY.0454, CANY.0550, CANY.0562, CANY.0563. CANY.0667, CANY.0789, CANY.0836

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Artemisia tridentata – (Ericameria nauseosa) / Bromus tectorum Semi-natural Shrubland	CEGL002699	16	CANY.0613, CANY_AA.2029, CANY_AA.2053, CANY_AA.2228, CANY_AA.2726, CANY_AA.2943, CANY_AA.3107, CANY_AA.3154, CANY_AA.3172, CANY_AA.3237, CANY_AA.3245, CANY_AA.3248, CANY_AA.3256, CANY_AA.3267, CANY_AA.3301, CANY_AA.3303
Artemisia tridentata (ssp. tridentata, ssp. xericensis) Shrubland Alliance	A.830	7	CANY.0214, CANY.0383, CANY.0627, CANY.0744, CANY.0756, CANY.0765, CANY.9344
Artemisia tridentata ssp. tridentata / Hesperostipa comata Shrubland	CEGL002966	4	CANY.9733, CANY.9742, CANY_AA.2052, CANY_AA.2423, CANY_AA.2548
Artemisia tridentata ssp. tridentata / Sporobolus cryptandrus Shrubland	CEGL003826	5	CANY.0394, CANY_AA.2597, CANY_AA.2930, CANY_AA.2941, CANY_AA.3308
Artemisia tridentata ssp. wyomingensis / Bouteloua gracilis Shrubland	CEGL001041	6	CANY.0387, CANY.0806, CANY.9105, CANY.9395, CANY.9399, CANY.9407
Artemisia tridentata ssp. wyomingensis / Disturbed Understory Semi-natural Shrubland	CEGL002083		GLCA only
Artemisia tridentata ssp. wyomingensis / Hesperostipa comata Colorado Plateau Shrubland	CEGL002761	5	CANY.0413, CANY.0568, CANY.9088, CANY.9360, CANY.9406
Artemisia tridentata ssp. wyomingensis / Sparse Understory Shrubland	CEGL002768	8	CANY_AA.0310, CANY_AA.0341, CANY_AA.0348, CANY_AA.2027, CANY_AA.2145, CANY_AA.2448, CANY_AA.2528, CANY_AA.2844
Atriplex canescens - Artemisia tridentata Shrubland	CEGL001282	3	CANY.0224, CANY.0748, CANY.0797
Atriplex canescens – Ephedra viridis Shrubland	CEGL003828	2	CANY.0234, CANY.0318
Atriplex canescens – Ephedra viridis Talus Shrubland	CEGL001287		GLCA only

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Atriplex canescens / Pleuraphis jamesii Shrubland	CEGL001288	7	CANY_AA.0692, CANY_AA.2073, CANY_AA.2116, CANY_AA.2128, CANY_AA.2350, CANY_AA.2351, CANY_AA.2374
Atriplex canescens / Sporobolus airoides Shrubland	CEGL001291	1	CANY.0209
Atriplex canescens / Suaeda moquinii Shrubland	Park Special	8	CANY.0211, CANY_AA.1104, CANY_AA.1105, CANY_AA.1106, CANY_AA.1113, CANY_AA.1194, CANY_AA.1252, CANY_AA.2024
Atriplex canescens Desert Wash Shrubland	CEGL003470	5	CANY.0355, CANY.9359, CANY.9556, CANY_AA.0604, CANY_AA.0774
Atriplex canescens Shrubland	CEGL001281	15	CANY.0140, CANY.0191, CANY.0223, CANY.0260, CANY.0261, CANY.0280, CANY.0390, CANY.0444, CANY.0581, CANY.0583, CANY.0594, CANY.0611, CANY.0635, CANY.9345, CANY.9713
Atriplex confertifolia - Sarcobatus vermiculatus Shrubland	CEGL001313	4	CANY.0778, CANY_AA.1193, CANY_AA.1232, CANY_AA.2011
Atriplex confertifolia / Pleuraphis jamesii Shrubland	CEGL001304	23	CANY.0128, CANY.0135, CANY.0143, CANY.0159, CANY.0161, CANY.0347, CANY.0348, CANY.0356, CANY.0359, CANY.0522, CANY.0533, CANY.0580, CANY.0584, CANY.0654, CANY.0655, CANY.0720, CANY.0737, CANY.0790, CANY.0792, CANY.9003, CANY.9321, CANY.9326, CANY.9348
Atriplex confertifolia Great Basin Shrubland	CEGL001294	2	CANY_AA.0453, CANY_AA.0598
Atriplex confertifolia Sparse Shrubland	CEGL003830	10	CANY.0180, CANY.0382, CANY.0592, CANY.0827, CANY.9007, CANY.9016, CANY.9039, CANY.9045, CANY.9349, CANY.9508
Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland	CEGL001441	3	CANY.0136, CANY.0178, CANY.9005
Atriplex gardneri / Sporobolus airoides Dwarf-shrubland	Park Special	1	CANY.0361

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Atriplex gardneri Dwarf-shrubland	CEGL001438	20	CANY.0139, CANY.0158, CANY.0174, CANY.0175, CANY.0176, CANY.0177, CANY.0501, CANY.0503, CANY.0510, CANY.0518, CANY.0519, CANY.0653, CANY.0705, CANY.9010, CANY.9011, CANY.9028, CANY.9309, CANY.9310, CANY.9502, CANY.9702
Betula occidentalis / Cornus sericea Shrubland	CEGL001161	1	CANY.0311
Bouteloua gracilis Herbaceous Vegetation	CEGL001760	1	CANY_AA.3292
Bromus tectorum Semi-natural Herbaceous Vegetation	CEGL003019	15	CANY_AA.0464, CANY_AA.0513, CANY_AA.0884, CANY_AA.2037, CANY_AA.2101, CANY_AA.2415, CANY_AA.2447, CANY_AA.2694, CANY_AA.2803, CANY_AA.2810, CANY_AA.2819, CANY_AA.2963, CANY_AA.4029, CANY_AA.4163, CANY_AA.4350
Calamagrostis scopulorum Hanging Garden Herbaceous Vegetation	CEGL002751	10	CANY.0103, CANY.0264, CANY.0433, CANY.9081, CANY.9113, CANY.9300, CANY.9379, CANY.9408, CANY.9409, CANY.9410
Cercocarpus intricatus Montane Shrubland	CEGL002587	1	CANY.0325
Cerocarpus intricatus Slickrock Sparse Vegetation	CEGL002977	18	CANY.0245, CANY.0268, CANY.0350, CANY.0418, CANY.0538, CANY.0540, CANY.0649, CANY.0658, CANY.0662, CANY.0664, CANY.0713, CANY.0730, CANY.0735, CANY.0750, CANY.0825, CANY.9070, CANY.9366, CANY.9743
Chrysothamnus linifolius Shrubland	Park Special	1	CANY.0138
Chrysothamnus viscidiflorus – Krascheninnikovia lanata Shrubland	Park Special	5	CANY_AA.2040, CANY_AA.2064, CANY_AA.2143, CANY_AA.2845, CANY_AA.2852
Chrysothamnus viscidiflorus Talus Shrubland	CEGL002347	3	CANY.0182, CANY.9001, CANY.9009

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Shrubland	CEGL002348	8	CANY.0186, CANY.0230, CANY.0231, CANY.0247, CANY.0337, CANY.0552, CANY.0644, CANY.0716
Coleogyne ramosissima / Pleuraphis jamesii Shrubland	CEGL001334	11	CANY.0116, CANY.0130, CANY.0149, CANY.0150, CANY.0156, CANY.0157, CANY.0353, CANY.0515, CANY.9312, CANY.9512, CANY.9727
Coleogyne ramosissima Shrubland	CEGL001332	93	CANY.0100, CANY.0126, CANY.0154, CANY.0155, CANY.0167, CANY.0187, CANY.0194, CANY.0229, CANY.0243, CANY.0246, CANY.0255, CANY.0276, CANY.0285, CANY.0301, CANY.0305, CANY.0306, CANY.0313, CANY.0320, CANY.0330, CANY.0332, CANY.0338, CANY.0339, CANY.0340, CANY.0352, CANY.0357, CANY.0363, CANY.0364, CANY.0365, CANY.0366, CANY.0368, CANY.0376, CANY.0409, CANY.0426, CANY.0430, CANY.0456, CANY.0506, CANY.0508, CANY.0511, CANY.0512, CANY.0513, CANY.0514, CANY.0526, CANY.0532, CANY.0537, CANY.0541, CANY.0542, CANY.0572, CANY.0645, CANY.0646, CANY.0647, CANY.0648, CANY.0651, CANY.0663, CANY.0702, CANY.0714, CANY.0715, CANY.0718, CANY.0738, CANY.0770, CANY.0775, CANY.0780, CANY.0781, CANY.0824, CANY.9013, CANY.9015, CANY.9021, CANY.9023, CANY.9029, CANY.9030, CANY.9031, CANY.9032, CANY.9043, CANY.9066, CANY.9067, CANY.9071, CANY.9072, CANY.9075, CANY.9119, CANY.9331, CANY.9333, CANY.9357, CANY.9367, CANY.9372, CANY.9504, CANY.9505, CANY.9513, CANY.9707, CANY.9709, CANY.9719, CANY.9720, CANY.9722, CANY.9723, CANY.9724
Coleogyne ramosissima Sparse Shrubland	CEGL003834	6	CANY.0185, CANY.0536, CANY.9044, CANY.9316, CANY.9320, CANY.9323, CANY.9503
Cornus sericea Rocky Mountain Shrubland	CEGL001165	1	CANY.0111
Distichlis spicata Herbaceous Vegetation	CEGL001770	3	CANY_AA.3002, CANY_AA.3114, CANY_AA.3286

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation	CEGL005801	50	CANY.0134, CANY.0137, CANY.0151, CANY.0152, CANY.0160, CANY.0162, CANY.0256, CANY.0346, CANY.0354, CANY.0367, CANY.0399, CANY.0400, CANY.0402, CANY.0403, CANY.0405, CANY.0406, CANY.0507, CANY.0509, CANY.0525, CANY.0551, CANY.0595, CANY.0599, CANY.0602, CANY.0605, CANY.0606, CANY.0607, CANY.0652, CANY.0659, CANY.0660, CANY.0661, CANY.0674, CANY.0709, CANY.0710, CANY.0722, CANY.0794, CANY.0833, CANY.9022, CANY.9308, CANY.9318, CANY.9322, CANY.9325, CANY.9347, CANY.9353, CANY.9506, CANY.9553, CANY.9703, CANY.9704, CANY.9706, CANY.9738, CANY.9739
Ephedra torreyana - (Atriplex spp.) / Nonvascular Gypsum Sparse Vegetation	CEGL002349	6	CANY.0360, CANY.9327, CANY_AA.0299, CANY_AA.0386, CANY_AA.0851, CANY_AA.0854
Ephedra torreyana / Achnatherum hymenoides - Pleuraphis jamesii Shrubland	CEGL002352	4	CANY.0369, CANY.0523, CANY.0731, CANY.0736
Ephedra torreyana / Pleuraphis jamesii Shrubland	CEGL003772	6	CANY.0343, CANY.0351, CANY.0517, CANY.0733, CANY.0829, CANY.9125
Ephedra torreyana / Sporobolus cryptandrus Shrubland	Park Special	3	CANY_AA.4020, CANY_AA.4039, CANY_AA.4043
Ephedra torreyana Sparse Vegetation	CEGL002353	10	CANY.0184, CANY.0254, CANY.0277, CANY.0278, CANY.0315, CANY.0401, CANY.0419, CANY.0832, CANY.9124, CANY.9351
Ephedra viridis / (Achnatherum hymenoides, Hesperostipa comata) Shrubland	CEGL002354	11	CANY.0112, CANY.0118, CANY.0235, CANY.0310, CANY.0317, CANY.0319, CANY.0327, CANY.0358, CANY.0700, CANY.0823, CANY.9025
Ephedra viridis / Bouteloua gracilis Shrubland	CEGL003934	8	CANY_AA.0321, CANY_AA.0349, CANY_AA.0352, CANY_AA.0362, CANY_AA.0368, CANY_AA.0674, CANY_AA.2386, CANY_AA.2789

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Ephedra viridis / Muhlenbergia pungens Shrubland	Park Special	2	CANY.0826, CANY_AA.0779
Ephedra viridis / Pleuraphis jamesii Shrubland	CEGL002356	6	CANY.0341, CANY_AA.0185, CANY_AA.0342, CANY_AA.0783, CANY_AA.4341, CANY_AA.4443
Ericameria nauseosa / Bromus tectorum Semi-natural Shrubland	CEGL002937	5	CANY.0441, CANY_AA.0286, CANY_AA.0907, CANY_AA.0934, CANY_AA.0963, CANY_AA.3298
Ericameria nauseosa / Sporobolus airoides Shrubland	CEGL002918	2	CANY.0287, CANY.0712
Ericameria nauseosa Desert Wash Shrubland	CEGL002261	15	CANY.0344, CANY.0448, CANY.0587, CANY.0600, CANY.0641, CANY.0668, CANY.0671, CANY.0711, CANY.0723, CANY.0796, CANY.9004, CANY.9018, CANY.9052, CANY.9555, CANY.9557
Ericameria nauseosa Sand Deposit Sparse Shrubland	CEGL002980	2	CANY.0326, CANY.0817
Ericameria nauseosa Shrubland	CEGL002713	3	CANY.9053, CANY_AA.2573, CANY_AA.2718
Ericameria nauseosa Sparse Shrubland	CEGL003961	4	CANY.0104, CANY.0124, CANY.0431, CANY.9411
Eriogonum corymbosum Badlands Sparse Vegetation	CEGL002979	3	CANY.0181, CANY.0435, CANY.9350
Eriogonum leptocladon Sparse Vegetation	CEGL001343	7	CANY.0345, CANY_AA.0048, CANY_AA.0305, CANY_AA.0611, CANY_AA.0722, CANY_AA.0724, CANY_AA.4460
Forestiera pubescens Shrubland	CEGL001168	9	CANY.0145, CANY.0202, CANY.0213, CANY.0505, CANY.0585, CANY.0609, CANY.9305, CANY.9701, CANY.9708
Frangula betulifolia Shrubland	Park Special	2	CANY.0284, CANY.9314

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Fraxinus anomala - Rhus trilobata Talus Shrubland	CEGL003963	17	CANY.0153, CANY.0183, CANY.0188, CANY.0349, CANY.0404, CANY.0516, CANY.0534, CANY.0547, CANY.0591, CANY.0598, CANY.0708, CANY.0830, CANY.9002, CANY.9012, CANY.9017, CANY.9352, CANY.9710
Fraxinus anomala Woodland	CEGL002752	3	CANY.0831, CANY.9046, CANY.9329
Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii Dwarf-shrubland	CEGL002690	17	CANY.0805, CANY.9307, CANY.9380, CANY_AA.2076, CANY_AA.2085, CANY_AA.2170, CANY_AA.2394, CANY_AA.2418, CANY_AA.2650, CANY_AA.2786, CANY_AA.2799, CANY_AA.3041, CANY_AA.3109, CANY_AA.3191, CANY_AA.3325, CANY_AA.4600, CANY_AA.4604
Hesperostipa comata Great Basin Herbaceous Vegetation	CEGL001705	8	CANY.0389, CANY.0392, CANY.0717, CANY.0758, CANY.0795, CANY.0810, CANY.9341, CANY.9712
Hymenopappus filifolius Herbaceous Vegetation	Park Special	2	CANY.0393, CANY.0561
Iva acerosa Herbaceous Vegetation	Park Special	3	CANY.0262, CANY_AA.4240, CANY_AA.4317
Juncus balticus Herbaceous Vegetation	CEGL001838	2	CANY.0108, CANY_AA.3111
Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri Wooded Shrubland	CEGL003774	35	CANY.0106, CANY.0131, CANY.0133, CANY.0197, CANY.0236, CANY.0252, CANY.0267, CANY.0269, CANY.0286, CANY.0302, CANY.0307, CANY.0324, CANY.0334, CANY.0336, CANY.0371, CANY.0380, CANY.0425, CANY.0440, CANY.0453, CANY.0524, CANY.0565, CANY.0571, CANY.0576, CANY.0578, CANY.0701, CANY.0703, CANY.0729, CANY.0732, CANY.0766, CANY.0769, CANY.0782, CANY.0783, CANY.0784, CANY.0814, CANY.0844
Juniperus osteosperma / Cercocarpus intricatus Woodland	CEGL000733	5	CANY.0384, CANY.9068, CANY.9087, CANY.9334, CANY.9336

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Juniperus osteosperma / Coleogyne ramosissima Woodland	CEGL002909	4	CANY.0342, CANY.0734, CANY.9042, CANY.9721
Juniperus osteosperma / Hesperostipa comata Woodland	CEGL001489	10	CANY.0123, CANY.0763, CANY_AA.0090, CANY_AA.2048, CANY_AA.2446, CANY_AA.3011, CANY_AA.4247, CANY_AA.4280, CANY_AA.4290, CANY_AA.4476
Juniperus osteosperma / Leymus salinus Woodland	CEGL003109	3	CANY.0398, CANY.0839, CANY.9416
Juniperus osteosperma / Mahonia fremontii Woodland	CEGL003965	2	CANY.0265, CANY.0423
Juniperus osteosperma / Mixed Shrubs Talus Woodland	CEGL002266	14	CANY.0129, CANY.0170, CANY.0242, CANY.0281, CANY.0420, CANY.0422, CANY.0620, CANY.0834, CANY.9128, CANY.9330, CANY.9342, CANY.9371, CANY.9511, CANY.9552
Juniperus osteosperma / Pleuraphis jamesii Woodland	CEGL002362	3	CANY_AA.2066, CANY_AA.4225, CANY_AA.4283
Juniperus osteosperma / Quercus gambelii Woodland	Park Special	3	CANY_AA.2012, CANY_AA.2774, CANY_AA.3281
Juniperus osteosperma / Sparse Understory Woodland	CEGL000732	4	CANY.0615, CANY.0724, CANY.9014, CANY.9369
Juniperus osteosperma / Sporobolus airoides Woodland	Park Special	6	CANY.0837, CANY.9741, CANY_AA.4147, CANY_AA.4269, CANY_AA.4310, CANY_AA.4348
Krascheninnikovia lanata Dwarf-shrubland	CEGL001327	7	CANY.0199, CANY.0407, CANY.0631, CANY.0798, CANY.0803, CANY.9356, CANY.9735
Krascheninnikovia lanata / Bouteloua gracilis Dwarf-shrub Herbaceous Vegetation	CEGL001321	2	CANY.0408, CANY_AA.2825

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Krascheninnikovia lanata / Hesperostipa comata Dwarf-shrubland	CEGL001327	8	CANY.0575, CANY_AA.0112, CANY_AA.2828, CANY_AA.2905, CANY_AA.4047, CANY_AA.4412, CANY_AA.4425, CANY_AA.4437
Krascheninnikovia lanata / Pleuraphis jamesii Dwarf-shrubland	CEGL001322	12	CANY.0257, CANY.0450, CANY.0546, CANY.0555, CANY.0566, CANY.0570, CANY.0643, CANY.0665, CANY.0772, CANY.0802, CANY.9355, CANY.9418
Krascheninnikovia lanata / Sporobolus cryptandrus Dwarf-shrubland	Park Special	3	CANY.0743, CANY_AA.2312, CANY_AA.2427
Leymus salinus Shale Sparse Vegetation	CEGL002745	14	CANY.0179, CANY.0316, CANY.0373, CANY.0374, CANY.0379, CANY.0502, CANY.0529, CANY.0608, CANY.0725, CANY.0788, CANY.9006, CANY.9041, CANY.9346, CANY.9507
Lolium arundinaceum - Agrostis stolonifera Semi-natural Herbaceous Vegetation	Park Special	1	CANY.0417
Mahonia fremontii Shrubland	CEGL003967	1	CANY.9065
Oenothera albicaulis Herbaceous Vegetation	Park Special	1	CANY.0650
Oenothera pallida Herbaceous Vegetation	Park Special	2	CANY.0577, CANY_AA.0740
Opuntia polyacantha / Pleuraphis jamesii Shrubland	CEGL002299	3	CANY.0543, CANY.9130, CANY_AA.4036, CANY_AA.4377
Opuntia spp. Shrubland Alliance	A.2650	4	CANY.0168, CANY.0446, CANY.0628, CANY.9050
Ostrya knowltonii Woodland	CEGL003971	5	CANY.9034, CANY_AA.0176, CANY_AA.0199, CANY_AA.0238, CANY_AA.0463
Phragmites australis Western North America Temperate Semi-natural Herbaceous Vegetation	CEGL001475	6	CANY.0216, CANY.0673, CANY.9026, CANY.9051, CANY.9364, CANY.9375
Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis Woodland	CEGL000778	3	CANY_AA.2203, CANY_AA.2508, CANY_AA.2782

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata Woodland	CEGL000797	5	CANY_AA.2183, CANY_AA.2232, CANY_AA.2529, CANY_AA.4169, CANY_AA.4503
Pinus edulis - Juniperus osteosperma / Achnatherum hymenoides Woodland	CEGL002364	1	CANY_AA.2550
Pinus edulis - Juniperus osteosperma / Amelanchier utahensis Woodland	CEGL002329	5	CANY.0727, CANY.9402, CANY.9403, CANY.9421, CANY.9501
Pinus edulis - Juniperus osteosperma / Artemisia bigelovii Woodland	CEGL002118	5	CANY.0764, CANY_AA.0017, CANY_AA.2623, CANY_AA.2886, CANY_AA.4404
Pinus edulis - Juniperus osteosperma / Artemisia nova Woodland	CEGL002331		GLCA only
Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland	CEGL000779	44	CANY.0113, CANY.0115, CANY.0119, CANY.0166, CANY.0219, CANY.0232, CANY.0237, CANY.0249, CANY.0258, CANY.0270, CANY.0271, CANY.0303, CANY.0304, CANY.0309, CANY.0314, CANY.0321, CANY.0322, CANY.0414, CANY.0428, CANY.0554, CANY.0569, CANY.0754, CANY.0774, CANY.0787, CANY.0812, CANY.0815, CANY.9061, CANY.9084, CANY.9086, CANY.9093, CANY.9097, CANY.9098, CANY.9103, CANY.9120, CANY.9132, CANY.9373, CANY.9374, CANY.9381, CANY.9392, CANY.9393, CANY.9394, CANY.9396, CANY.9397, CANY.9413
Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland	CEGL000781	22	CANY.0114, CANY.0239, CANY.0240, CANY.0244, CANY.0274, CANY.0437, CANY.0704, CANY.9033, CANY.9116, CANY.9121, CANY.9127, CANY.9361, CANY.9382, CANY.9412, CANY.9417, CANY.9422, CANY.9500, CANY.9725, CANY.9731, CANY.9734, CANY.9736, CANY.9744
Pinus edulis - Juniperus osteosperma / Ephedra viridis Woodland	CEGL002370	2	CANY_AA.0709, CANY_AA.2776
Pinus edulis - Juniperus osteosperma / Fendlera rupicola Woodland	CEGL004005	1	CANY_AA.0759

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland	CEGL002328	8	CANY.0127, CANY.0189, CANY.0196, CANY.0412, CANY.0520, CANY.0530, CANY.9057, CANY.9302
Pinus edulis - Juniperus osteosperma / Muhlenbergia pungens Woodland	CEGL002373	3	CANY_AA.0456, CANY_AA.2100, CANY_AA.4346
Pinus edulis – Juniperus osteosperma / Pleuraphis jamesii Woodland	CEGL002379	1	CANY_AA.3076
Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland	CEGL000782	14	CANY.0101, CANY.0132, CANY.0173, CANY.0233, CANY.0300, CANY.0331, CANY.0333, CANY.0335, CANY.0436, CANY.0443, CANY.0559, CANY.9090, CANY.9100, CANY.9315
Pinus edulis - Juniperus osteosperma / Quercus havardii var. tuckeri Woodland	CEGL002497	6	CANY.0452, CANY.9515, CANY_AA.2224, CANY_AA.2290, CANY_AA.3216, CANY_AA.3293
Pinus edulis - Juniperus osteosperma / Rhus trilobata Woodland	Park Special	7	CANY.0195, CANY_AA.0213, CANY_AA.0219, CANY_AA.3034, CANY_AA.3123, CANY_AA.3336, CANY_AA.4312
Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia Woodland	CEGL002335	3	CANY.0253, CANY.0275, CANY.0427
Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis) WoodedShrubland	CEGL002334	9	CANY.0248, CANY.0266, CANY.0415, CANY.0429, CANY.0434, CANY.0675, CANY.0841, CANY.0842, CANY.9383
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	CEGL002148	29	CANY.0107, CANY.0171, CANY.0308, CANY.0323, CANY.0395, CANY.0438, CANY.0500, CANY.0528, CANY.0567, CANY.0619, CANY.0622, CANY.0630, CANY.0757, CANY.0767, CANY.0807, CANY.0816, CANY.0843, CANY.0845, CANY.9089, CANY.9091, CANY.9092, CANY.9099, CANY.9109, CANY.9118, CANY.9129, CANY.9384, CANY.9387, CANY.9401, CANY.9415
Pinus edulis - Juniperus osteosperma / Symphoricarpos longiflorus Woodland	Park Special	2	CANY_AA.0712, CANY_AA.4078

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Pinus edulis – Juniperus spp. / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland	CEGL000776	3	CANY_AA.2159, CANY_AA.2700, CANY_AA.2894
Pinus edulis – Juniperus spp. / Cercocarpus montanus – Mixed Shrubs Woodland	CEGL000780	28	CANY.0238, CANY.0386, CANY.0388, CANY.0391, CANY.0411, CANY.0442, CANY.0617, CANY.0621, CANY.0626, CANY.0742, CANY.0755, CANY.9094, CANY.9095, CANY.9096, CANY.9101, CANY.9102, CANY.9104, CANY.9107, CANY.9110, CANY.9112, CANY.9340, CANY.9388, CANY.9389, CANY.9390, CANY.9391, CANY.9400, CANY.9714, CANY.9718
Pinus edulis - Juniperus spp. / Leymus salinus Woodland	CEGL002340	12	CANY.0102, CANY.0117, CANY.0120, CANY.0121, CANY.0122, CANY.0125, CANY.0328, CANY.0329, CANY.0410, CANY.0451, CANY.0811, CANY.9516
Pinus edulis - Juniperus spp. / Quercus gambelii Woodland	CEGL000791	10	CANY.0221, CANY.0747, CANY.0779, CANY.0786, CANY.0799, CANY.0800, CANY.0809, CANY.9085, CANY.9395, CANY.9711
Pleuraphis jamesii - Sporobolus airoides Herbaceous Vegetation	CEGL001778		GLCA only
Pleuraphis jamesii Herbaceous Vegetation	CEGL001777	19	CANY.0105, CANY.0163, CANY.0164, CANY.0190, CANY.0193, CANY.0457, CANY.0535, CANY.0553, CANY.0557, CANY.0632, CANY.0719, CANY.0728, CANY.0746, CANY.0768, CANY.0804, CANY.0813, CANY.9037, CANY.9332, CANY.9717
Poa fendleriana Herbaceous Vegetation	CEGL001925	1	CANY.0110
Poa pratensis Semi-natural Seasonally Flooded Herbaceous Vegetation	CEGL003081	1	CANY.0749
Poliomintha incana - Artemisia filifolia - Vanclevea stylosa Shrubland	CEGL002418	9	CANY.0227, CANY.0642, CANY_AA.0333, CANY_AA.0896, CANY_AA.0899, CANY_AA.0903, CANY_AA.0926, CANY_AA.0948, CANY_AA.0949
Populus fremontii / Distichlis spicata Woodland	CEGL003998	2	CANY.0141, CANY.0226

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Populus fremontii / Equisetum spp. Woodland	CEGL003775	3	CANY.0741, CANY.9056, CANY.9363
Populus fremontii / Ericameria nauseosa Woodland	CEGL002465	13	CANY.0207, CANY.0215, CANY.0228, CANY.0589, CANY.0593, CANY.0596, CANY.0597, CANY.0624, CANY.0670, CANY.0672, CANY.0762, CANY.0822, CANY.0838
Populus fremontii / Mesic Forbs Woodland	CEGL002470	3	CANY.0172, CANY_AA.0865, CANY_AA.3203
Populus fremontii / Mesic Graminoids Woodland	CEGL002473	8	CANY.0385, CANY.0638, CANY.0759, CANY.9059, CANY.9060, CANY.9338, CANY.9510, CANY.9737
Populus fremontii / Salix (ligulifolia, lutea) Woodland	CEGL004002	3	CANY.0217, CANY.0634, CANY.9083
Populus fremontii / Salix exigua Forest	CEGL000666	5	CANY.0416, CANY.0639, CANY.0640, CANY.0753, CANY.9064
Populus fremontii / Sporobolus airoides Woodland	CEGL004003	3	CANY.0835, CANY_AA.0587, CANY_AA.1071
Populus fremontii / Tamarix sp. Woodland	CEGL005485	14	CANY_AA.0760, CANY_AA.0762, CANY_AA.1004, CANY_AA.1070, CANY_AA.1076, CANY_AA.1084, CANY_AA.1088, CANY_AA.1089, CANY_AA.1095, CANY_AA.1096, CANY_AA.1097, CANY_AA.1099, CANY_AA.2260, CANY_AA.3113
Pseudotsuga menziesii / Cercocarpus montanus Woodland	CEGL000898	1	CANY.0614
Pseudotsuga menziesii / Quercus gambelii Forest	CEGL000452	4	CANY.0616, CANY.9339, CANY_AA.2937, CANY_AA.3265
Pseudotsuga menziesii Scree Woodland	CEGL000911	1	CANY_AA.3236
Quercus gambelii - Cercocarpus montanus / (Carex geyeri) Shrubland	CEGL001113	3	CANY.0218, CANY.0740, CANY.0818
Quercus gambelii / Artemisia tridentata Shrubland	CEGL001111	3	CANY_AA.2079, CANY_AA.2709, CANY_AA.3299

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Quercus gambelii / Rhus trilobata Shrubland	CEGL002338	9	CANY.0625, CANY.9335, CANY_AA.0820, CANY_AA.0917, CANY_AA.2711, CANY_AA.2769, CANY_AA.3021, CANY_AA.3186, CANY_AA.3232
Quercus gambelii / Sparse Understory Shrubland	CEGL002337	5	CANY.0109, CANY.0312, CANY.0745, CANY.0751, CANY.9114
Quercus gambelii / Symphoricarpos longiflorus Shrubland	Park Special	1	CANY.0612
Quercus havardii var. tuckeri Shrubland	CEGL002486	4	CANY.0455, CANY_AA.0859, CANY_AA.0872, CANY_AA.0900
Rhus trilobata - Ephedra (viridis, torreyana) Talus Shrubland	CEGL003776	12	CANY.0739, CANY.0828, CANY.9008, CANY.9038, CANY.9073, CANY.9074, CANY.9304, CANY.9313, CANY.9319, CANY.9324, CANY.9509, CANY.9514
Rumex hymenosepalus Sparse Vegetation	Park Special	3	CANY.0548, CANY_AA.0407, CANY_AA.0704
Salix exigua / Barren Shrubland	CEGL001200	8	CANY.0200, CANY.0205, CANY.0212, CANY.0588, CANY.0604, CANY.0820, CANY.9035, CANY.9079
Salix exigua / Mesic Graminoids Shrubland	CEGL001203	2	CANY.0397, CANY.0761
Salix (exigua, interior) Temporarily Flooded Shrubland Alliance	A.947	7	CANY.0821, CANY_AA.0803, CANY_AA.0947, CANY_AA.0971, CANY_AA.1037, CANY_AA.3091, CANY_AA.3285
Salix gooddingii / Salix exigua Woodland	CEGL003778	3	CANY.0601, CANY_AA.1057, CANY_AA.1241
Salix lutea / Mesic Graminoids Shrubland	CEGL002073	7	CANY.0220, CANY.0618, CANY.0623, CANY.0785, CANY.0840, CANY.9378, CANY.9726
Salsola spp. Semi-natural Herbaceous Vegetation	CEGL004004	12	CANY.0206, CANY.0210, CANY.0279, CANY.0282, CANY.0544, CANY.0574, CANY.0586, CANY.0636, CANY.0819, CANY.9049, CANY.9419, CANY.9729

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Sarcobatus vermiculatus Disturbed Shrubland	CEGL001357	3	CANY.0144, CANY.0633, CANY.0707
Sarcobatus vermiculatus / Pleuraphis jamesii Shrub Herbaceous Vegetation	Park Special	5	CANY.0777, CANY.9728, CANY_AA.2002, CANY_AA.2010, CANY_AA.2087
Sarcobatus vermiculatus / Sporobolus airoides Shrubland	CEGL001368	3	CANY.0204, CANY.0370, CANY.0656
Sarcobatus vermiculatus / Sporobolus cryptandrus Shrubland	Park Special	2	CANY.0793, CANY_AA.2349
Sarcobatus vermiculatus / Suaeda moquinii Shrubland	CEGL001370	4	CANY_AA.1085, CANY_AA.1086, CANY_AA.1111, CANY_AA.1128
Sphaeralcea (coccinea, parvifolia) Herbaceous Vegetation	CEGL005366	8	CANY.0198, CANY.0222, CANY.0372, CANY.0556, CANY.0558, CANY.0560, CANY.0564, CANY.0573
Sporobolus airoides Southern Plains Herbaceous Vegetation	CEGL001685	4	CANY.0362, CANY.0504, CANY.0669, CANY.0706
Sporobolus cryptandrus Great Basin Herbaceous Vegetation	CEGL002691	9	CANY.0447, CANY.0808, CANY_AA.0490, CANY_AA.2093, CANY_AA.2176, CANY_AA.2412, CANY_AA.2734, CANY_AA.2800, CANY_AA.3241
Suaeda moquinii Shrubland	CEGL001991	21	CANY_AA.1108, CANY_AA.1175, CANY_AA.1180, CANY_AA.1181, CANY_AA.1182, CANY_AA.1183, CANY_AA.1185, CANY_AA.1186, CANY_AA.1187, CANY_AA.1189, CANY_AA.1190, CANY_AA.1228, CANY_AA.1248, CANY_AA.1249, CANY_AA.1253, CANY_AA.1254, CANY_AA.1255, CANY_AA.1256, CANY_AA.1261, CANY_AA.1262, CANY_AA.2033
Tamarix spp. Temporarily Flooded Semi-natural Shrubland	CEGL003114	12	CANY.0146, CANY.0147, CANY.0201, CANY.0203, CANY.0582, CANY.0590, CANY.0603, CANY.0752, CANY.9027, CANY.9048, CANY.9055, CANY.9740
Typha domingensis Western Herbaceous Vegetation	CEGL001845	2	CANY.0225, CANY.9054

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Zuckia brandegeei Sparse Vegetation	CEGL002493	3	CANY.0241, CANY.0378, CANY.9040

Appendix F. Plant Association Descriptions for Canyonlands National Park

NATIONAL VEGETATION CLASSIFICATION

Vegetation Associations of Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

21 March 2011

by

NatureServe

1101 Wilson Blvd., 15th floor
Arlington, VA 22209

4001 Discovery, Suite 270
Boulder, CO 80303

This subset of the International Ecological Classification Standard covers vegetation associations of Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section). 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, mary_russo@natureserve.org, and/or Mark Hall, Vegetation Ecologist, Boulder, CO mark_hall@natureserve.org.

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Arlington, VA 22209

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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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Alberta Natural Heritage Information Centre, Edmonton, AB, Canada; Atlantic Canada Conservation Data Centre, Sackville, New Brunswick, Canada; British Columbia Conservation Data Centre, Victoria, BC, Canada; Manitoba Conservation Data Centre. Winnipeg, MB, Canada; Ontario Natural Heritage Information Centre, Peterborough, ON, Canada; Quebec Conservation Data Centre, Quebec, QC, Canada; Saskatchewan Conservation Data Centre, Regina, SK, Canada; Yukon Conservation Data Centre, Yukon, Canada

Latin American and Caribbean
Centro de Datos para la Conservacion de Bolivia, La Paz , Bolivia; Centro de Datos para la Conservacion de Colombia, Cali,Valle, Columbia; Centro de Datos para la Conservacion de Ecuador, Quito, Ecuador; Centro de Datos para la Conservacion de Guatemala, Ciudad de Guatemala , Guatemala; Centro de Datos para la Conservacion de Panama, Querry Heights , Panama; Centro de Datos para la Conservacion de Paraguay, San Lorenzo , Paraguay; Centro de Datos para la Conservacion de Peru, Lima, Peru; Centro de Datos para la Conservacion de Sonora, Hermosillo, Sonora , Mexico; Netherlands Antilles Natural Heritage Program, Curacao , Netherlands Antilles; Puerto Rico-Departmento De Recursos Naturales Y Ambientales, Puerto Rico; Virgin Islands Conservation Data Center, St. Thomas, Virgin Islands.

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Pseudotsuga menziesii / Quercus gambelii Forest

Douglas-fir / Gambel Oak Forest

CODE	CEGL000452
PHYSIOGNOMIC CLASS	Forest (I)
PHYSIOGNOMIC SUBCLASS	Evergreen forest (I.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen forest (I.A.8.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen forest (I.A.8.N.)
FORMATION	Conical-crowned temperate or subpolar needle-leaved evergreen forest (I.A.8.N.c.)
ALLIANCE	*PSEUDOTSUGA MENZIESII* FOREST ALLIANCE (A.157) Douglas-fir Forest Alliance

ECOLOGICAL SYSTEM(S): Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)
Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland (CES306.825)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This forest association occurs on mountains and plateaus from Colorado to Trans-Pecos Texas, west into New Mexico, Arizona and Utah. Elevation ranges from 1229 to 2870 m (4030-9400 feet). Stands are found along drainages, lower and middle slopes, steep upper slopes and gentle to rolling tops of mesas and ridges. Aspects are variable. This forest occurs as both a non-obligate riparian community on the outer margins of riparian areas in desert canyons and steep draws, and as an upland forest forming extensive stands on typically north-facing hillslopes (southern aspects at higher elevations). Soils vary but are often shallow and rocky, ranging from sand to clay, often derived from sandstone. The vegetation is characterized by a relatively sparse to dense evergreen tree canopy dominated by *Pseudotsuga menziesii*, sometimes with *Quercus gambelii* well-represented in the understory. Scattered large *Pinus ponderosa, Pinus strobiformis, Pinus flexilis, Pinus edulis*, or *Juniperus* spp. (especially on drier sites) may be present in the tree canopy or subcanopy. *Abies concolor* is typically not present. *Quercus gambelii* dominates both the subcanopy (tree form, if present) and the moderately dense tall-shrub layer that consists of dense clumps of oak. *Quercus gambelii* must have at least 5% cover, but there is frequently well over 25%. At higher elevations, *Quercus gambelii* are more treelike and *Symphoricarpos oreophilus* will be present with significant cover in the short-shrub layer. At lower elevations, scattered *Pinus edulis, Juniperus osteosperma*, or *Juniperus deppeana* are often present. The presence of *Chrysothamnus depressus* in some stands reflects the presence of fairly well-developed soils. The herbaceous layer is generally sparse and composed of mostly graminoids with scattered forbs, but it can be moderately dense and diverse. Many other species are associated, such as *Amelanchier* spp., *Holodiscus dumosus, Fendlera rupicola, Fraxinus anomala, Mahonia repens, Paxistima myrsinites, Quercus X pauciloba, Robinia neomexicana, Rosa woodsii, Carex* spp., *Festuca arizonica, Koeleria macrantha, Muhlenbergia virescens, Poa fendleriana, Lathyrus lanszwertii* var. *leucanthus, Thalictrum fendleri*, and *Vicia americana*. The shrub layer has equal or greater cover than graminoids.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This forest community is rare within the park and was sampled at the head of Lavender Canyon, near Fisheye Arch, and in Salt Creek.

Globally

This *Pseudotsuga menziesii* forest association occurs in the southern Rocky Mountains and southwestern U.S. and is found on foothills, mountains and plateaus from Colorado to Trans-Pecos Texas, west to Arizona and Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This forest association was sampled next to a talus-filled, intermittently flooded drainage at the head of a canyon, in a pour-off area, and on a colluvial slope. Sites are moderately to steeply sloping (11 to 31 degrees), oriented to the north and north-northeast, and lie between 1229 and 1810 m elevation. Most of the unvegetated surface is covered

by litter and large rocks, with lesser cover of gravel, bedrock, and bare soil. The soil is a rapidly drained loamy sand derived from alluvium.

Globally
This forest association occurs on mountains and plateaus at elevations ranging from 1229 to 2870 m (4030-9400 feet). Stands are found along drainages, gentle to moderate lower and middle slopes, steep upper slopes and gentle to rolling tops of mesas and ridges. Aspects are variable. This forest occurs as both a non-obligate riparian community on the outer margins of riparian areas in desert canyons and steep draws, and as an upland forest forming extensive stands on typically north-facing hillslopes, canyon sideslopes and mesa escarpments (southern aspects at higher elevations). Soils vary but are often shallow and rocky, ranging from sand to clay, often derived from sandstone. The surface is generally largely covered with a thin layer of litter. Parent materials are variable and include recent alluvium, fractured limestone, sandstone, metamorphic/granitic rocks, basalt, andesite, volcanic tuff, eroded Claron Formation (Pink Member), and even slickrock. Occasionally, talus to large blocks of rock and bedrock dominate the surface of sites on colluvial slopes / landslide deposits.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This montane forest association is rare within the park. Total vegetation cover is ranges from 22 to 40%; *Pseudotsuga menziesii* trees between 20 and 35 m tall create an open canopy with 6-9% cover. Scattered seedlings of *Pseudotsuga menziesii* and *Pinus edulis* provide sparse cover. A subcanopy of *Pinus edulis* and *Juniperus osteosperma* may be present with low to moderate cover. The shrub layer is sparse, consisting of scattered clumps of *Quercus gambelii* (with 6 to 12% cover) and lesser cover by *Amelanchier utahensis*, with rare *Cercocarpus montanus, Fraxinus anomala, Forestiera pubescens, Ephedra viridis, Symphoricarpos longiflorus, Rhus trilobata, Mahonia fremontii, Brickellia longifolia*, and *Yucca angustissima*. The herbaceous layer is sparse and depauperate; *Achnatherum hymenoides, Pleuraphis jamesii, Poa fendleriana, Lepidium montanum, Machaeranthera grindelioides*, and *Packera multilobata (= Senecio multilobatus)* are rooted between large rocks. Biological soil crusts contribute less than 1% cover.

Globally
This forest is characterized by a relatively sparse to moderately dense evergreen tree canopy dominated by *Pseudotsuga menziesii*, with *Quercus gambelii* well-represented in the understory. Scattered large *Pinus ponderosa, Pinus strobiformis, Pinus flexilis, Pinus edulis*, or *Juniperus* spp. (especially on drier sites) may be present in the tree canopy or subcanopy. *Abies concolor* is typically not present. *Quercus gambelii* typically dominates both the subcanopy (tree form, if present) and the open to moderately dense tall-shrub layer that often consists of dense clumps of oak. *Quercus gambelii* must have at least 5% cover, but there is frequently well over 25%. At higher elevations, *Quercus gambelii* are more treelike, and *Symphoricarpos oreophilus* will be present with significant cover in the short-shrub layer. At lower elevations, scattered *Pinus edulis, Juniperus osteosperma*, or *Juniperus deppeana* are often present. The presence of *Chrysothamnus depressus* in some stands reflects the presence of fairly well-developed soils. Other common shrub species, depending on geographic location, may include *Acer glabrum, Arctostaphylos patula, Amelanchier* spp., *Brickellia longifolia, Cercocarpus montanus, Fendlera rupicola, Fraxinus anomala, Holodiscus dumosus, Mahonia repens, Paxistima myrsinites, Prunus virginiana, Purshia tridentata, Quercus X pauciloba, Rhus trilobata, Ribes cereum, Robinia neomexicana, Rosa woodsii, Shepherdia rotundifolia*, and *Yucca* spp. The generally sparse herbaceous layer is composed of mostly graminoids with scattered forbs but ranges to moderately dense and diverse. Species vary greatly by site characteristics and location. Associated graminoids may include *Achnatherum hymenoides, Bromus* spp., *Carex geyeri, Carex rossii, Elymus elymoides, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Muhlenbergia virescens, Piptatherum micranthum*, and *Poa fendleriana*. Common forbs include *Achillea millefolium* var. *occidentalis, Cryptantha* sp., *Galium coloradoense, Gilia stenothyrsa, Lathyrus lanszwertii* var. *leucanthus, Lepidium montanum, Machaeranthera grindelioides, Maianthemum stellatum, Packera multilobata, Packera neomexicana, Physaria acutifolia, Thalictrum fendleri, Solidago* spp., and *Vicia americana*. The shrub layer generally has equal or greater cover than graminoids. Post-burn stands may have relatively low cover of *Quercus gambelii* temporarily, as these shrubs resprout and grow. This open conifer forest transitions to *Quercus gambelii* woodlands in drier sites and at lower elevations.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*
Tall shrub/sapling	*Amelanchier utahensis*, *Quercus gambelii*

Globally

Stratum	Species
Tree canopy	*Pinus ponderosa*, *Pseudotsuga menziesii*
Tall shrub/sapling	*Quercus gambelii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Vulnerable: *Gilia stenothyrsa* (globally imperiled, G3)

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This is a broadly defined association characterized by dominance or codominance of two widespread species, *Pseudotsuga menziesii* and *Quercus gambelii*. Within the literature on habitat type, there are four phases mentioned: *Festuca arizonica* phase, *Holodiscus dumosus* phase, *Muhlenbergia virescens* phase (all defined by having at least 5% cover of both *Quercus gambelii* and the nominal species), and *Quercus gambelii* (typic) phase by a undeveloped herbaceous layer (Alexander et al. 1984b, DeVelice et al. 1986, Alexander et al. 1987, Fitzhugh et al. 1987, Johnston 1987, Larson and Moir 1987, Muldavin et al. 1996, Stuever and Hayden 1997b). There are three similar *Pseudotsuga menziesii* associations in the USNVC that use these phase species as nominal species. These phases represent "intermediate" vegetation. Review of these associations is needed to clarify relationships among associations and possibly subdivide this broadly defined association into types based on herbaceous layer and habitat.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This *Pseudotsuga menziesii* stand grows on the steep slope of a drainage at the head of Lavender Canyon. Soils are developed in between large colluvium and support mixed deciduous shrubs. This area may flood during heavy rains.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY.0616, CANY.9339), and 2008 Accuracy Assessment (2 points: CANY_AA.2937, CANY_AA.3265).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: K.A. Schulz, mod. J. Drake

REFERENCES: Alexander et al. 1984b, Alexander et al. 1987, Bader 1932, Blackhawk Coal Company 1981, Bourgeron and Engelking 1994, Bourgeron et al. 1993b, Bourgeron et al. 1995, CONHP unpubl. data 2003, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008c, Coles et al. 2010, DeVelice et al. 1986, Diamond 1993, Fitzhugh et al. 1987, Freeman and Dick-Peddie 1970, Hansen et al. 2003, Hansen et al. 2004d, Hess and Wasser 1982, Johnston 1987, Keammerer 1974b, Kittel et al. 1994, Kittel et al. 1999b, Komarkova et al. 1988a, Komarkova et al. 1988b, Larson and Moir 1987, Muldavin et al. 1996, Romme et al. 1993, Salas et al. 2010, Stuever and Hayden 1997b, Thomas et al. 2009b, Thomas et al. 2010, Tiedemann and Terwilliger 1978, Von Loh et al. 2007, Western Ecology Working Group n.d., Youngblood and Mauk 1985

Populus fremontii / Salix exigua Forest

Fremont Cottonwood / Coyote Willow Forest

CODE	CEGL000666
PHYSIOGNOMIC CLASS	Forest (I)
PHYSIOGNOMIC SUBCLASS	Deciduous forest (I.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous forest (I.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
ALLIANCE	*POPULUS FREMONTII* TEMPORARILY FLOODED FOREST ALLIANCE (A.313) Fremont Cottonwood Temporarily Flooded Forest Alliance

ECOLOGICAL SYSTEM(S): Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland (CES304.045)
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This association is documented from along large rivers in Utah, southwestern New Mexico, and Arizona. Stands are found on stable bars at mid elevations of the floodplain. Substrates are typically relatively recently deposited alluvium. Periodic flooding is required for the growth, maintenance and reproduction of this forest. 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. *Salix gooddingii* or *Baccharis salicifolia* are not abundant or are absent. Other associated species include *Castilleja linariifolia, Distichlis spicata, Leymus cinereus, Muhlenbergia asperifolia, 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland is distributed along low-lying areas along drainages within the park and was sampled in Water, Horseshoe, and Salt Creek canyons.

Globally

This riparian forest is known from southwestern New Mexico along the Gila River, the East Fork of the Virgin River in southwestern Utah, the Fremont River in southeastern Utah, and in canyons in north-central Arizona. It likely occurs elsewhere in Utah and Arizona.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This forest association occurs on intermittently flooded low-lying areas, including washes, floodplains, and sand bars. Sites are flat or slope gently and lie between 1247 and 1724 m elevation. Litter and bare soil cover most of the unvegetated surface, with sparse cover by downed wood. Soils are moderately well-drained to rapidly drained sandy loams, sands, or loamy sands derived from alluvium.

Globally

This riparian forest association is documented from along large rivers in southwestern Utah, southwestern New Mexico, and Arizona. Elevation ranges from 1220-1950 m (4000-6400 feet). Stands are found on stable bars in floodplains and along streambanks in canyons, where the water table is still high but flooding occurs only occasionally. Substrates are typically relatively recently deposited alluvium. Stream gradient is typically gentle, and soils are rapidly drained, sandy or silty clays derived from alluvium (Szaro 1989, Muldavin et al. 2000a).

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

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 10 m tall of *Populus fremontii* with 13 to 60% cover.

The understory is dominated by low to dense cover of *Salix exigua*. Seedlings of *Populus fremontii* are rarely present. Associated shrubs include *Salix lutea, Ericameria nauseosa, Poliomintha incana*, and *Gutierrezia sarothrae*. The herbaceous layer is variable and includes a diversity of both graminoids and forbs; *Juncus balticus, Elymus canadensis, Distichlis spicata, Ambrosia acanthicarpa, Machaeranthera* sp., and *Iva acerosa* are common species.

Globally
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, Artemisia tridentata*, or *Quercus gambelii*. The herbaceous layer is generally sparse, depending on the density of the shrub and tree layers. *Castilleja linariifolia, Distichlis spicata, Leymus cinereus, Muhlenbergia asperifolia, 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, Melilotus officinalis, Bromus* spp., and *Poa pratensis* are often present in disturbed stands.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Populus fremontii*
Tall shrub/sapling	*Salix exigua*, *Salix lutea*
Herb (field)	*Elymus canadensis*, *Juncus balticus*

Globally

Stratum	Species
Tree canopy	*Populus fremontii*
Tall shrub/sapling	*Salix exigua*
Herb (field)	*Phragmites australis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Elaeagnus angustifolia* (exotic, High)

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 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.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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* 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* 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.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This community is controlled by surface runoff and the availability of groundwater.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (4 plots: CANY.0416, CANY.0639, CANY.0640, CANY.0753).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: E. Milford, E. Muldavin, mod. K. Schulz and J. Coles

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, NMNHP unpubl. data, Romme et al. 1993, Salas et al. 2009, Szaro 1989, Western Ecology Working Group n.d.

Juniperus osteosperma / Cercocarpus intricatus Woodland

Utah Juniper / Littleleaf Mountain-mahogany Woodland

CODE	CEGL000733
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*JUNIPERUS OSTEOSPERMA* WOODLAND ALLIANCE (A.536) Utah Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S):
Great Basin Pinyon-Juniper Woodland (CES304.773)
Inter-Mountain Basins Cliff and Canyon (CES304.779)
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)
Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
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 1500 and 1980 m (4920-6500 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. Total vegetation cover rarely exceeds 35% because the high exposure of rock limits where plants can grow. The canopy is open, with *Juniperus osteosperma* trees providing between 5 and 25% cover; the trees are 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%. Associated shrubs include *Amelanchier utahensis, Fraxinus anomala, Artemisia bigelovii, Glossopetalon spinescens* var. *meionandrum, Atriplex confertifolia, Cercocarpus montanus, Chrysothamnus*

greenei, Philadelphus microphyllus, Symphoricarpos longiflorus, and *Ephedra viridis*. The herbaceous layer is diverse in terms of species composition and provides sparse to low cover. Graminoids commonly include *Aristida purpurea, Achnatherum hymenoides, Hesperostipa* and/or *Achnatherum* spp. (= *Stipa* spp.), and *Muhlenbergia pungens*. Forbs are diverse but provide sparse cover; *Stenotus acaulis (= Haplopappus acaulis)* occurs throughout the range.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association is rare within the park and was sampled 800 m southeast of Peekaboo Campground, in the West Fork of Salt Creek, east of Horseshoe Canyon, near Castle Arch, and on Horsethief Point.

Globally
This association is known from southeastern Utah, western Colorado and northern Nevada. It may also occur in eastern California and is likely to occur in scattered stands throughout the Great Basin and Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association was found on flat to steep sites (up to 34 degree slopes) that lie between 1441 and 2113 m elevation, are oriented from the northwest to southeast, and occur on a series of sloping rock ledges, mesa tops, rims and in slot canyons. Most of the unvegetated surface is exposed bedrock, with lesser cover large and small rocks, bare soil and litter. A diverse, lichen-rich biological soil crust community provides up to 11% cover. The soil is a rapidly drained sandy loam derived from Cedar Mesa sandstone.

Globally
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 1500 and 1980 m (4920-6500 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This Utah juniper woodland is rare within the park. Total vegetation cover is is sparse (4-10% cover, though up to 21% in one sampled stand). The dwarfed tree canopy of *Juniperus osteosperma* has between 1 and 7% cover, and *Cercocarpus intricatus* dominates a sparse shrub understory with 2 to 6% cover. *Pinus edulis* seedlings may be present. Associated species with very low cover include *Fraxinus anomala, Philadelphus microphyllus, Artemisia bigelovii, Ephedra* spp., *Glossopetalon spinescens* var. *meionandrum, Cercocarpus montanus, Quercus havardii* var. *tuckeri, Rhus trilobata, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Yucca angustissima, Opuntia erinacea*, and *Echinocereus triglochidiatus*. Herbaceous species are diverse but contribute only a trace of cover; *Achnatherum hymenoides, Achnatherum coronatum, Aristida purpurea, Tetraneuris acaulis (= Hymenoxys acaulis), Lepidium montanum, Stenotus armerioides (= Haplopappus armerioides)*, and *Cryptantha flavoculata* were reported from the sampled plot. The cover of biological soil crusts is low because there is little soil in these stands, but the small patches that do occur are well-developed and diverse.

Globally
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, Echinocereus triglochidiatus, Ephedra viridis, Fraxinus anomala, Glossopetalon spinescens* var. *meionandrum, 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* and/or *Achnatherum* spp. (= *Stipa* spp.), and *Muhlenbergia pungens*. Forbs are diverse but provide sparse cover; *Stenotus acaulis (= Haplopappus acaulis)* occurs throughout the range.

Tetraneuris acaulis (= Hymenoxys acaulis), Lepidium montanum, and *Cryptantha flavoculata* are also reported from plots.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Glossopetalon spinescens* var. *meionandrum*
Short shrub/sapling	*Cercocarpus intricatus*, *Cercocarpus montanus*, *Ephedra viridis*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Cercocarpus intricatus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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*.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Lots of exposed bedrock benefits the plants that can find a toehold by concentrating runoff to the small pockets of soil. Lichen-rich biocrust stabilizes the soil between plants. This sheltered aspect nurtures a great variety of plants. The thin soil with extensive exposed rock seems to be the defining factor here. Wherever the soil gets deeper, the juniper and oak increase and this mixed shrub community disappears.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (5 plots: CANY.0384, CANY.9068, CANY.9087, CANY.9334, CANY.9336).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Blackburn et al. 1968c, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Clark et al. 2009, Driscoll et al. 1984, Romme et al. 1993, Western Ecology Working Group n.d.

Juniperus osteosperma / Coleogyne ramosissima Woodland [Provisional]

Utah Juniper / Blackbrush Woodland

CODE	CEGL002909
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*JUNIPERUS OSTEOSPERMA* WOODLAND ALLIANCE (A.536) Utah Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association is known only from Canyonlands National Park but likely occurs elsewhere on the Colorado Plateau in Utah. Stands are restricted to mesatops between 1503 and 1625 m elevation on gentle to moderate slopes. Most of the unvegetated surface is bedrock with low to moderate exposure of soil, litter and biological soil crusts. Soils are rapidly drained loamy sands derived from the Kayenta Formation or White Rim sandstone. 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%. Associated shrubs include *Artemisia bigelovii, Ephedra viridis, Ephedra torreyana, Yucca angustissima, Eriogonum microthecum, Gutierrezia microcephala, Opuntia erinacea*, and *Sclerocactus whipplei*. Herbaceous species provide sparse cover and may include *Achnatherum hymenoides, Sporobolus cryptandrus, Bouteloua gracilis, Vulpia octoflora, Packera multilobata (= Senecio multilobatus), Machaeranthera canescens, Plantago patagonica, Eriogonum alatum, Lepidium montanum, Cryptantha flava, Hymenopappus filifolius*, and *Comandra umbellata*. Biological soil crusts provide up to 22% cover and are generally well-developed.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association is rare within the park and was sampled in the northern third of Big Draw Canyon, along the White Rim Road, near Junction Butte, and in Squaw Flat.

Globally

This woodland is only known from Canyonlands National Park but likely occurs elsewhere in the Colorado Plateau in Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association is restricted to mesatops, rims, and broad plateaus within the park. Sites are on gentle to moderate slopes between 1500 and 1625 m elevation. Bedrock, rocks, and bare soil cover most of the unvegetated surface with low to moderate exposure of litter and biological soil crusts. Soils are rapidly drained loamy sands derived from the Kayenta Formation or White Rim sandstone.

Globally

This woodland association has only been described from Canyonlands National Park. Until further inventory is completed, there is no global information

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This juniper woodland is rare within the park. Total vegetation cover does not exceed 30%. Stands are characterized by scattered *Juniperus osteosperma* with between 1 and 16% cover, and a shrub understory dominated by *Coleogyne ramosissima* with between 1 and 8% cover. Associated shrubs include *Fraxinus anomala, Fendlera rupicola, Artemisia bigelovii, Atriplex canescens, Ephedra viridis, Ephedra torreyana, Purshia mexicana, Symphoricarpos longiflorus, Yucca angustissima, Eriogonum microthecum, Gutierrezia microcephala or sarothrae, Opuntia*

erinacea, and *Sclerocactus whipplei*. Herbaceous species provide sparse cover and may include *Achnatherum hymenoides, Pleuraphis jamesii, Sporobolus cryptandrus, Bouteloua gracilis, Vulpia octoflora, Aristida purpurea, Bromus rubens, Packera multilobata (= Senecio multilobatus), Machaeranthera canescens, Cryptantha confertiflora, Plantago patagonica, Eriogonum alatum, Lepidium montanum, Cryptantha flava, Hymenopappus filifolius*, and *Comandra umbellata*. Biological soil crusts provide up to 22% cover and are generally well-developed.

Globally
This woodland association has only been described from Canyonlands National Park. Until further inventory is completed, there is no global information

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Coleogyne ramosissima*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Coleogyne ramosissima*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GU (28-Oct-2002).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Juniper trees are stunted on the slickrock. Blackbrush shows some drought stress. Vegetation is isolated in widely spaced gardens and cracks of shallow soil.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (4 plots: CANY.0342, CANY.0734, CANY.9042, CANY.9721).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: K.A. Schulz

REFERENCES: CONHP Ecology Team 2001, Western Ecology Working Group n.d.

Juniperus osteosperma / Hesperostipa comata Woodland

Utah Juniper / Needle-and-Thread Woodland

CODE	CEGL002815
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*JUNIPERUS OSTEOSPERMA* WOODLAND ALLIANCE (A.536) Utah Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Inter-Mountain Basins Juniper Savanna (CES304.782)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association occurs on slopes, hills, 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 at Capitol Reef National Park, some stands occur on barren shale slopes of the Carmel Formation. Soils are generally sandy loams, with a few stands on clay loams. Gravel, bare ground or cryptobiotic crusts cover much of the unvegetated surface. 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 25%. Shrubs are generally present but too sparse to form a layer. Common species include *Coleogyne ramosissima, Ephedra torreyana, Ephedra viridis, Eriogonum microthecum, Gutierrezia sarothrae*, and *Opuntia polyacantha*. The herbaceous layer is diverse and has up to 30% cover, including *Hesperostipa*. Other characteristic graminoids include *Poa fendleriana, Bouteloua eriopoda, Bouteloua gracilis, Pleuraphis jamesii*, and *Achnatherum hymenoides*. Forbs may be diverse but contribute little cover; *Hymenoxys richardsonii* and *Mirabilis multiflora* are among the few species recorded in sampled plots.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association was sampled 300 m southwest of the confluence of Salt Creek and Angel Arch canyons, near Junction Butte, in Lavender Canyon, in upper and middle sections of Salt Creek Canyon, in Jasper Canyon, west of the Dollhouse, and near Maze Overlook.

Globally

This association has been described from the Colorado Plateau, specifically from western Colorado and eastern Utah. It is likely to occur on sandy soils at low to moderate elevations throughout the plateau.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association occurs on canyon sides and bottoms, along drainages, on terraces, benches, and in coves. Sites are on flat to moderately steep (up to 17 degrees) slope, oriented to all aspects, and occurring between 1336 and 1723 m elevation. Bare soil and biological soil crusts cover most of the unvegetated surface, with low to moderate cover by gravel and litter. Soils are rapidly drained clay loams or sandy loams derived from Chinle Formation shale or Cedar Mesa sandstone.

Globally

This woodland association occurs on slopes, hills, 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This Utah juniper woodland has a total vegetation cover between 11 and 32%. Stands are characterized by a dwarfed canopy of *Juniperus osteosperma* with 3 to 15% cover and an herbaceous understory dominated by *Hesperostipa comata*, with 1 to 15% cover. *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. If *Pinus edulis* trees are present, they have only sparse cover. Shrubs are generally present but do not provide enough cover to constitute a stratum; *Ericameria nauseosa, Fraxinus anomala, Ephedra torreyana, Coleogyne ramosissima, Eriogonum microthecum, Atriplex canescens, Ephedra viridis, Gutierrezia sarothrae, Krascheninnikovia lanata*, and *Opuntia* spp. (up to 5% cover) were reported from the sampled plots. Associated grasses include *Stipa speciosa* (dominant graminoid in one stand), *Achnatherum hymenoides, Sporobolus cryptandrus, Pleuraphis jamesii, Poa fendleriana*, and *Bouteloua gracilis*. Forbs include *Machaeranthera grindelioides, Tetraneuris acaulis (= Hymenoxys acaulis), Artemisia frigida, Amsonia tomentosa, Townsendia incana, Lepidium montanum, Streptanthella longirostris*, and *Chaetopappa ericoides*.

Globally

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 *Atriplex canescens, Coleogyne ramosissima, Quercus gambelii, Ephedra torreyana, Ephedra viridis, Eriogonum microthecum, Ericameria nauseosa, Krascheninnikovia lanata, Gutierrezia sarothrae, Opuntia erinacea*, and *Opuntia polyacantha*. 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*, and *Achnatherum hymenoides*. Forbs may be diverse but contribute little cover; *Chaetopappa ericoides, Hymenoxys richardsonii, Machaeranthera grindelioides, Mirabilis multiflora, Streptanthella longirostris, Tetraneuris acaulis (= Hymenoxys acaulis)*, and *Townsendia incana*are among the species recorded in sampled plots. *Bromus tectorum* may be abundant in plots that have experienced chronic or severe disturbance.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Herb (field)	*Achnatherum hymenoides*, *Hesperostipa comata*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Herb (field)	*Hesperostipa comata*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally

Exotic/Invasive: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (6-Jul-2005).

CLASSIFICATION COMMENTS

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Lower-angle slopes with a north-facing aspect and rocky soils favor the *Juniperus osteosperma*, in contrast to the deeper soils downslope (north) where they are absent.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY.0123, CANY.0763) and 2007 and 2008 Accuracy Assessment (8 points: CANY_AA.0090, CANY_AA.2048, CANY_AA.2446, CANY_AA.3011, CANY_AA.4247, CANY_AA.4280, CANY_AA.4290, CANY_AA.4476).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Clark et al. 2009, Coles et al. 2008a, Romme et al. 1993, Von Loh et al. 2007, Western Ecology Working Group n.d.

Juniperus osteosperma / Leymus salinus Woodland

Utah Juniper / Saline Wildrye Woodland

CODE	CEGL003109
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*JUNIPERUS OSTEOSPERMA* WOODLAND ALLIANCE (A.536) Utah Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
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. 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 (2 to 25 degree slope) and are generally underlain by Mesozoic marine shales of the Morrison Formation or Mancos shale. Colluvium from sandstone cliffs or outcrops upslope from the stand may cover the ground surface. Soils are rapidly drained and may be sandy loams or silty clays. The vegetation is characterized by a sparse to open canopy of *Juniperus osteosperma* with between 1 and 25% cover. *Pinus edulis* is either absent or present in very low amounts in the canopy, although *Juniperus osteosperma* and *Pinus edulis* seedlings may be present. There is no shrub layer, but scattered short and dwarf-shrubs may total up to 10% cover in more heavily vegetated stands. Common species include *Atriplex confertifolia, Artemisia bigelovii, Artemisia nova, Artemisia tridentata* ssp. *wyomingensis, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Glossopetalon spinescens* var. *meionandrum, Ephedra viridis, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia erinacea, Opuntia polyacantha, Shepherdia rotundifolia*, and *Yucca harrimaniae*. The herbaceous layer is dominated by *Leymus salinus* with between 1 and 25% cover. The remainder of the herbaceous cover is sparse but diverse. Additional graminoids present include *Achnatherum hymenoides, Pleuraphis jamesii, Poa fendleriana*, and *Poa secunda*. Forbs 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*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland is frequent within the park and recreation area and was sampled in Canyonlands National Park near Grand View, adjacent to the Syncline Loop Trail, 3 km south-southeast of Peekaboo Springs, in Cross Canyon, and near the Harvest Scene pictographs. In Glen Canyon National Recreation Area, it was sampled near Red Cove, 4.5 km northeast of Hans Flat Ranger Station, near Sunset Pass, 500 m west of Observation Rock, and adjacent to North Trail Canyon Trail.

Globally

The plant association occurs on low-elevation marine shales in western Colorado and eastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland is common on canyon rims, ledges, colluvial slopes, and toeslopes. Sites are on moderate to steep slopes between 1568 and 1884 m elevation. Most of the unvegetated surface is covered by rocks or bare soil, with low cover by bedrock, litter, biological soil crusts and dead wood. Soils include rapidly drained loams and sands derived from colluvium, Kayenta Formation, Cedar Mesa sandstone, or Chinle Formation.

Globally

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 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 (2 to 25 degree 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This Utah juniper woodland is common within the park and recreation area. Total vegetation cover ranges from 11 to 22%. Stands are characterized by an open canopy, typically 2 to 5 m tall, of *Juniperus osteosperma* with 2 to 9% cover, and an understory dominated by *Leymus salinus* with 2 to 10% cover. Scattered *Pinus edulis* occur in the canopy of most stands, and *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. Shrubs are generally present but do not provide enough cover to constitute a layer; common species include *Ephedra viridis, Shepherdia rotundifolia, Ericameria nauseosa, Chrysothamnus viscidiflorus* var. *stenophyllus, Gutierrezia sarothrae, Artemisia bigelovii, Eriogonum microthecum*, and *Xylorhiza tortifolia*. Associated herbaceous species include *Achnatherum hymenoides, Pleuraphis jamesii, Bromus tectorum, Machaeranthera grindelioides, Stanleya pinnata*, and *Streptanthella longirostris*. Although the cover of biological soil crusts is sparse, the small patches are well-developed.

Globally

This association has a sparse to open canopy of *Juniperus osteosperma* with between 1 and 25% cover. *Pinus edulis* is either absent or present in very low amounts in the canopy, although *Juniperus osteosperma* and *Pinus edulis* seedlings may be present. There is no shrub layer, but scattered short and dwarf-shrubs may total up to 10% cover in more heavily vegetated stands. Common species include *Atriplex confertifolia, Artemisia bigelovii, Artemisia nova, Artemisia tridentata* ssp. *wyomingensis, Chrysothamnus viscidiflorus, Ephedra viridis, Gutierrezia sarothrae, Glossopetalon spinescens* var. *meionandrum, Ephedra viridis, Eriogonum microthecum, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia erinacea, Opuntia polyacantha, 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, 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*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Shepherdia rotundifolia*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Achnatherum hymenoides*, *Leymus salinus*, *Pleuraphis jamesii*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Herb (field)	*Leymus salinus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Exotic/Invasive: *Ovis canadensis* (reintroduced bighorn sheep may utilize this type.)

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.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Steep slopes and active colluvial soils indicate an unstable habitat. North-facing slopes favor a significant bunchgrass understory.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (6 plots: CANY 0398, CANY 0839, GLCA 0584, GLCA 0703, GLCA 0710, GLCA 0712).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Baker 1982b, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, 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.

Juniperus osteosperma / Mahonia fremontii Woodland

Utah Juniper / Desert Oregon-grape Woodland

CODE	CEGL003965
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*JUNIPERUS OSTEOSPERMA* WOODLAND ALLIANCE (A.536) Utah Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association is know only from Canyonlands National Park and Glen Canyon National Recreation Area but likely occurs elsewhere on the Colorado Plateau in Utah. Stands occur on the deep soils of plateaus, stream terraces, benches, and wash banks. Sites are on flat to gentle 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. 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 *Rhus trilobata, Ephedra viridis, Atriplex canescens, Symphoricarpos longiflorus, Yucca angustissima*, and *Gutierrezia sarothrae*. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland is rare within the park and recreation area and is represented by sample plots located east of Lizard Rock and adjacent to the trail that descends from the Maze Overlook in Canyonlands National Park and near Flint Cove in Glen Canyon National Recreation Area.

Globally

This woodland association has only been described from Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section). Until further inventory is completed, there is no global information.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland occurs on the deep soils of plateaus, stream terraces, benches, and wash banks. Sites are on flat 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.

Globally

This woodland association has only been described from Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section). Until further inventory is completed, there is no global information.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This Utah juniper woodland is uncommon within the park and recreation area. Total vegetation cover ranges from 23 to 61%. Stands are 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. Associated shrubs include *Rhus trilobata, Ephedra viridis, Atriplex canescens, Symphoricarpos longiflorus, Yucca angustissima*, and *Gutierrezia*

sarothrae. 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.

Globally
This woodland association has only been described from Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section). Until further inventory is completed, there is no global information.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Ephedra viridis*, *Mahonia fremontii*
Herb (field)	*Gutierrezia sarothrae*, *Yucca angustissima*
Herb (field)	*Achnatherum hymenoides*, *Aristida purpurea*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Mahonia fremontii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (10-Jul-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Active sand dunes clearly separate this community from the pinyon-juniper / sparse understory woodland that prevails nearby.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (4 plots: CANY 0265, CANY 0423, GLCA 0717, GLCA 0768).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Juniperus osteosperma / Mixed Shrubs Talus Woodland

Utah Juniper / Mixed Shrubs Talus Woodland

CODE	CEGL002266
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*JUNIPERUS OSTEOSPERMA* WOODLAND ALLIANCE (A.536) Utah Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is known from Arches National Park and Colorado National Monument but likely is widespread in the canyons of the Colorado Plateau. Stands occur on midslopes, ledges, benches, bottoms and especially talus or rockfall slopes of canyons and midslopes of ridges. Elevations range between 1376 and 1585 m. Sites are moderately steep to very steep (9-40 degree 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 and large and small rocks. Parent materials are sandstones, shale, and Precambrian gneiss. 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 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, Brickellia microphylla, Cercocarpus montanus, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Fendlera rupicola, Fraxinus anomala, Gutierrezia sarothrae, Rhus trilobata*, and 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, 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* and *Chamaesyce fendleri*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is known from Shafer Trail, Syncline Trail, Aztec Butte, Surprise Valley, The Maze, Lavender Canyon, and the Maze Overlook.

Globally

This association is known from Arches National Park and Colorado National Monument but likely is widespread in the canyonlands of the Colorado Plateau in western Colorado and eastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This talus slope association is known from canyon walls, ledges, colluvial slopes, rockfalls, and ridges at elevations ranging from 1376-1780 m. Sites are extremely rocky, often unstable and steep. Aspects are variable and appear to not be as influential as the colluvial substrate in dictating vegetation and physiognomy. Soils are derived from sandstone and shale and composed of rapidly drained clay loam, sandy loam and loamy sand.

Globally

This association is known from Arches National Park and Colorado National Monument but likely is widespread in the canyons of the Colorado Plateau. Stands occur on midslopes, ledges, benches, bottoms and especially talus or

rockfall slopes of canyons and midslopes of ridges. Elevations range between 1376 and 1585 m on the Colorado Plateau and extend up to 2121 m on the Western Slope of Colorado. Sites are moderately steep to very steep (9 to 40 degree 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 and 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is characterized by a sparse, widely spaced canopy of *Juniperus osteosperma*. No other canopy species were observed to occur in sample areas. As a result of the unstable substrate, the understory consists of a highly variable array of shrub species including *Artemisia bigelovii, Brickellia microphylla, Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Encelia frutescens, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa* ssp. *consimilis* var. *juncea, Eriogonum bicolor, Eriogonum corymbosum, Gutierrezia sarothrae, Opuntia erinacea, Rhus trilobata* var. *simplicifolia, Shepherdia rotundifolia, Symphoricarpos longiflorus, Xylorhiza tortifolia*, and *Yucca angustissima*. As a result of poor rooting substrate, herbaceous cover is extremely sparse with low species constancy.

Globally

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 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, Brickellia microphylla, Cercocarpus montanus, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Fendlera rupicola, Fraxinus anomala, Gutierrezia sarothrae, Rhus trilobata*, and 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, 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* and *Chamaesyce fendleri*.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Ephedra viridis*, *Ericameria nauseosa*
Herb (field)	*Gutierrezia sarothrae*, *Xylorhiza tortifolia*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Ericameria nauseosa*
Herb (field)	*Gutierrezia sarothrae*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (10-Jan-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (8 plots: CANY 0129, CANY 0170, CANY 0242, CANY 0281, CANY 0420, CANY 0422, CANY 0620, CANY 0834).
Local Description Authors: M.E. Hall
Global Description Authors: M.S. Reid and J. Coles, mod. K.A. Schulz

REFERENCES: Coles et al. 2009a, Von Loh et al. 2007, Western Ecology Working Group n.d.

Juniperus osteosperma / Pleuraphis jamesii Woodland

Utah Juniper / James' Galleta Woodland

CODE	CEGL002362
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*JUNIPERUS OSTEOSPERMA* WOODLAND ALLIANCE (A.536) Utah Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This woodland association occurs on valley floors, ridges, and benches in northwestern Colorado and eastern Utah. Sites have gentle to moderate slopes (1-9 degrees) occur between 1341 and 1860 m elevation, and may be oriented to any aspect. The unvegetated surface has high cover of litter and low exposure of bare soil. Soils are well-drained sands, sandy clays, or clay loams derived from shales, sandstones, talus, eolian sands or alluvium. Stands occur in relatively small patches, often in a mosaic with other pinyon-juniper / grass understory woodland types. Total vegetation cover rarely exceeds 60%. The tree canopy consists of *Juniperus osteosperma* with between 5 and 40% cover. *Pinus edulis* is generally absent. Scattered shrubs, such as *Artemisia tridentata* ssp. *wyomingensis, Atriplex canescens, Ephedra viridis, Chrysothamnus viscidiflorus, Gutierrezia sarothrae*, and *Opuntia polyacantha*, 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. Biological soil crusts may be well-developed in areas that are protected from grazing.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is known from three sites at the Maze Overlook, Elaterite Butte, and Lavender Canyon.

Globally
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.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is known from five observation points from 1341-1801 m elevation on toeslopes, colluvial slopes, and erosion fans on all aspects. Slopes range from 3 to 9 degrees Substrates include talus, sandstone and alluvium.

Globally
This woodland association occurs on valley floors, ridges, and benches in northwestern Colorado and eastern Utah. Sites have gentle slopes (2-3 degrees) occur between 1579 and 1860 m elevation, and may be oriented to any aspect. The unvegetated surface has high cover of litter and low exposure of bare soil. Soils are well-drained sands, sandy clays, or clay loams derived from shales, sandstones, or a mix of the two.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is uncommon in the park and known from five observation points. Occurrences are characterized by a sparse canopy of *Juniperus osteosperma* ranging from 4-9% cover and a sparse herbaceous layer dominated by the bunchgrass *Pleuraphis jamesii* ranging from 5-8% cover with *Achnatherum hymenoides* codominant in one stand. Shrubs are common, although none clearly dominate. Species include *Ephedra torreyana, Ephedra viridis, Coleogyne ramosissima, Artemisia bigelovii, Artemisia filifolia, Gutierrezia sarothrae, Krascheninnikovia lanata*, and *Opuntia polyacantha*. Graminoid associates include *Poa fendleriana* and *Achnatherum speciosum (= Stipa speciosa)*.

Globally
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 tridentata* ssp*. wyomingensis, Atriplex canescens, Ephedra viridis, Chrysothamnus viscidiflorus, Gutierrezia sarothrae*, and *Opuntia polyacantha*, 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.

MOST ABUNDANT SPECIES
*Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)*Data are not available.

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (22-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2008 Accuracy Assessment (3 points: CANY_AA.2066, CANY_AA.4225, CANY_AA.4283).
Local Description Authors: M.E. Hall
Global Description Authors: J. Coles

REFERENCES: Clark et al. 2009, Coles et al. 2008a, Romme et al. 1993, Western Ecology Working Group n.d.

Juniperus osteosperma / Sparse Understory Woodland

Utah Juniper / Sparse Understory Woodland

CODE	CEGL000732
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*JUNIPERUS OSTEOSPERMA* WOODLAND ALLIANCE (A.536) Utah Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S): Great Basin Pinyon-Juniper Woodland (CES304.773)
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
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. Lack of soil moisture-holding capacity, southern or western aspects, old-growth conditions, 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 many types of soils, geology, slope, aspect and landform. Total vegetation cover ranges from 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 throughout the range of this association. Common species include *Ephedra viridis, Gutierrezia sarothrae*, and *Elymus elymoides*. Cryptobiotic crust cover may be high.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association is infrequent within the park and recreation area. It was sampled near Shafer Trail, in Musselman Canyon, in the Maze (Horse Canyon), and in Lavender Canyon in Canyonlands National Park and near Waterhole Road in Glen Canyon National Recreation Area.

Globally
This association occurs widely in the Great Basin of Nevada and western Utah, as well as the Colorado Plateau and western Rocky Mountains of eastern Utah and western Colorado, and extends north to the Uinta Mountains.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association occurs on sand dunes, canyon bottoms, drainages/wash bottoms, and ridges. Sites are on flat to moderate slopes oriented generally to the east between 1338 and 1738 m elevation. Exposed soil and rocks cover most of the unvegetated surface, with low to moderate cover of bedrock and litter. The canyon bottom site has sparse cover by biological soil crusts. Soils are rapidly drained sandy loams or loamy sands derived from Moenkopi Formation or alluvium.

Globally
This widespread woodland association occurs on slopes, ridges, benches and mesas at elevations ranging between 1400 and 2200 m (4600-7220 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 (hydrothermically 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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This juniper woodland type tends to have sparse total vegetation cover ranging from 7 to 20%. Stands are characterized by a dwarfed canopy of *Juniperus osteosperma* with 10 to 12% cover. *Juniperus osteosperma* seedlings may be present. Neither shrubs nor herbaceous species provide sufficient cover (>5%) to constitute a layer. Shrubs present include *Fraxinus anomala, Coleogyne ramosissima, Ephedra viridis, Artemisia tridentata* ssp. *wyomingensis, Rhus trilobata, Ericameria nauseosa, Amelanchier utahensis, Ephedra torreyana, Eriogonum microthecum, Eriogonum leptocladon, Gutierrezia sarothrae, Yucca angustissima, Opuntia phaeacantha, Opuntia polyacantha*, and *Sclerocactus whipplei*. Herbaceous species include *Pleuraphis jamesii, Aristida purpurea, Achnatherum hymenoides, Bouteloua gracilis, Amsonia tomentosa, Poa fendleriana, Hesperostipa comata, Bromus tectorum, Cryptantha flava, Hymenopappus filifolius, Tetraneuris acaulis, Machaeranthera grindelioides, Erigeron utahensis*, and *Lepidium montanum*. Most stands have little in the way of biological soil crusts.

Globally
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. Common species include *Ephedra viridis, Cercocarpus montanus, Artemisia tridentata* ssp. *wyomingensis, Gutierrezia sarothrae*, and *Opuntia* spp. Forbs and grasses also total less than 5% (usually 1% or less) and may include *Pleuraphis jamesii, Achnatherum hymenoides, Petradoria pumila*, or *Elymus elymoides*. Cryptobiotic crusts may cover as much as 25% of the unvegetated area in stands with sandy substrates.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Ericameria nauseosa*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNRQ (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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 hydrothermically 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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Clumps of vegetation and some crusting stabilize the sand and make the dunes less active.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY.0615, CANY.0724, CANY.9014, CANY.9369, GLCA.0590).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles

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, Romme et al. 1993, Von Loh et al. 2008, Western Ecology Working Group n.d.

Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata Woodland

Two-needle Pinyon - (One-seed Juniper, Utah Juniper) / Needle-and-Thread Woodland

CODE	CEGL000797
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Southern Rocky Mountain Pinyon-Juniper Woodland (CES306.835)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association is known from western and south-central Colorado and eastern Utah. Stands occur on a variety of sites from flat or gentle lower slopes, benches, wash terraces, mesatops to steep colluvial slopes to montane alluvial fans. Parent materials are frequently sandstone or shale. This woodland is characterized by the dominance or codominance of *Pinus edulis* in an open evergreen tree canopy. *Juniperus osteosperma* or *Juniperus monosperma* may codominate some stands, and *Juniperus scopulorum* may also be present. The sparse to moderately dense herbaceous layer is dominated by the perennial bunchgrass *Hesperostipa comata (= Stipa comata)*, with *Achnatherum hymenoides (= Oryzopsis hymenoides), Koeleria macrantha, Bouteloua gracilis, Pleuraphis jamesii (= Hilaria jamesii)*, and *Pascopyrum smithii* often present to common. Forb cover is generally sparse but may include *Heterotheca villosa, Hymenoxys* spp., *Artemisia dracunculus (= Artemisia dracunculoides), Oxytropis lambertii, Castilleja* sp., *Eriogonum jamesii*, and *Sphaeralcea coccinea*. Scattered shrubs and dwarf-shrubs may also be present, such as *Cercocarpus montanus, Quercus gambelii, Atriplex canescens, Artemisia frigida, Ephedra viridis*, or *Gutierrezia sarothrae*. *Opuntia polyacantha* and *Yucca glauca* are often present. Diagnostic of this woodland association is the dominance or codominance of *Pinus edulis* in the tree canopy and a *Hesperostipa comata*-dominated herbaceous layer.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association is rare within Canyonlands National Park. It was sampled on Cathedral Butte, Salt Creek Mesa, and in The Fins of Ernie's Country.

Globally

This association is known from four counties (Montrose, San Miguel, Mesa, and Saguache) in western portion of Colorado (Isaacson 1967, P. Lyon pers. comm.). It also occurs in southeastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association was sampled on a wash terrace, in a canyon bottom, and on benches, on flat to moderately steep slopes (up to 9 degrees) oriented to the north or south that lie between 1506 and 2739 m elevation. The substrate is derived of alluvial deposits.

Globally

This woodland association occurs on slopes, benches and ridges and wash terraces with coarse-sandy, sometimes rocky soils. Elevations range between 1490 and 2739 m (4900-7070 feet); slopes are level to steep and may be oriented to any aspect. The unvegetated soil surface may be rocky, gravelly, or mostly bare ground, or biological soil crusts can have high cover in areas that have been protected from grazing. The sandy or silty soils are generally derived from sandstone, less often from shale, alluvial or eolian deposits.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is characterized by a sparse to moderate (2 to 13% cover) canopy of *Pinus edulis* and *Juniperus ostesosperma* and a sparse to moderate graminoid layer dominated by *Hesperostipa comata* (with 2 to 8% cover). Shrub cover includes trace to low cover of *Fraxinus anomala, Cercocarpus montanus, Atriplex canescens, Ephedra viridis, Mahonia fremontii, Artemisia tridentata* ssp. *wyomingensis, Ericameria nauseosa,* and *Gutierrezia sarothrae*. Other graminoids present with sparse to low cover include *Sporobolus airoides, Achnatherum hymenoides, Sporobolus contractus, Muhlenbergia pungens, Bouteloua gracilis,* and *Pleuraphis jamesii* with scattered forbs *Haplopappus armerioides, Machaeranthera canescens, Heterotheca villosa,* and *Petradoria pumila* sometimes present.

Globally

This woodland association occurs on sandy, sometimes rocky soils in the northern Colorado Plateau. Total vegetation cover ranges between 10% to at least 70%. This woodland association is characterized by an open to somewhat closed canopy, typically 2-5 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees, and an understory dominated by the bunchgrass *Hesperostipa comata*. Scattered shrubs such as *Ephedra viridis* and *Chrysothamnus viscidiflorus* are present but do not form a layer. The herbaceous layer is diverse and provides up to 15% cover. *Achnatherum hymenoides* may be codominant with *Hesperostipa comata*, and *Pleuraphis jamesii* or *Bouteloua*

gracilis may be present with low cover. Forbs are more diverse but contribute little cover and may include *Hymenoxys richardsonii, Sphaeralcea coccinea*, and *Mirabilis multiflora*. Biological crusts are present in some stands.

MOST ABUNDANT SPECIES
*Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)*Data are not available.

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Herb (field)	*Hesperostipa comata*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G2? (14-Nov-1997). This is a rare, regionally endemic association. It is poorly known, with only five documented locations from four counties (Montrose, San Miguel, Mesa, and Saguache) in the western portion of Colorado (CONHP 1997). None of these stands are protected. There is some uncertainty about the accuracy of this rank (the actual rank may be lower) because both Isaacson (1967) and Colorado Natural Heritage Program field investigators (P. Lyons pers. comm.) suggest it may be more widespread on the western slope of Colorado and may extend into Utah. This association occurs in a relatively common environmental setting, being found on flat or gently inclining slopes or benches of sandstone origin (CONHP 1997). Existing stands have been degraded by overgrazing, non-native species invasion, and possibly fire suppression. As of 2006, this association has been found regularly in national park units in southern and eastern Utah, as well as western Colorado. However, stands tend to be small, isolated, and affected by grazing.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Juniperus monosperma-codominated stands are restricted to south-central Colorado.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2008 Accuracy Assessment (5 points: CANY_AA.2183, CANY_AA.2232, CANY_AA.2529, CANY_AA.4169, and CANY_AA.4503).
Local Description Authors: M.E. Hall and A. Tendick
Global Description Authors: D. Clark, mod. J. Coles and K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data, CONHP unpubl. data 2003, Clark et al. 2009, Coles et al. 2008c, Coles et al. 2010, Driscoll et al. 1984, Isaacson 1967, Romme et al. 1993, Thomas et al. 2009b, Von Loh et al. 2007, Western Ecology Working Group n.d.

Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis Woodland

Two-needle Pinyon - (Utah Juniper) / Blue Grama Woodland

CODE	CEGL000778
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association is known from mountains and mesas in the southern Colorado Plateau, Mogollon Rim and extending north into southern Utah and probably western Colorado. Elevations normally range from 1700-2400 m (5575-7875 feet). Sites are variable but generally are relatively dry and rocky. Stands occur on flat to moderate slopes along drainages and on mesatops, on gentle to moderate (10-40%) rocky slopes of foothills, and at the base of cinder cones. The substrates are variable and range from deep, fine- or coarse-textured soils derived from cinder to finer-textured soils derived from sandstone, shale and limestone. The vegetation is characterized by an open to moderately dense tree canopy (10-65% cover) codominated by *Pinus edulis* and *Juniperus osteosperma* trees that are between 1 and 5 m tall. *Pinus edulis* may be present with relatively small cover in some stands. *Juniperus deppeana* may replace *Juniperus osteosperma* in southern stands. Other species of *Juniperus*, such as *Juniperus scopulorum*, may be present in higher elevation stands. Shrub cover is sparse (<10% cover). If *Quercus gambelii* is present, it has less than 5% cover. Other associated shrubs may be present in low cover, such as *Cercocarpus montanus, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum microthecum, Rhus trilobata*, or *Yucca* spp. The herbaceous layer is typically moderately dense and is dominated by the warm-season, perennial short grass *Bouteloua gracilis*. Associated graminoids include *Aristida* spp., *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua curtipendula, Elymus elymoides, Koeleria macrantha, Hesperostipa comata (= Stipa comata), Hesperostipa neomexicana (= Stipa neomexicana)*, and *Pleuraphis jamesii (= Hilaria jamesii)*. *Muhlenbergia montana* is absent or scarce (<1% cover). Forb cover is typically low but may be moderately diverse.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare association was sampled on Ant Hill Mesa and in Big Pocket in upper Salt Creek Canyon in Canyonlands National Park.

Globally

This woodland association is known from mountains and mesas in the southern Colorado Plateau and Mogollon Rim of northern Arizona and extends into southern Utah and probably into western Colorado and possibly into western New Mexico.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is known from two sites on a mesatop and one on a valley side. Sampled sites have gentle to moderately steep slopes (up to 12-degrees), are oriented to the northeast, and lie between 1794 and 1918 m elevations. The soil surface is mostly exposed soil and litter, with lesser cover by wood and biological soil crust. Soils are deep, fine, and sandy and are alluvial or aeolian in origin.

Globally

This woodland association is known from mountains and mesas in the southern Colorado Plateau, Mogollon Rim and extending north into southern Utah and probably western Colorado. Elevations normally range from 1700-2400 m (5575-7875 feet). Sites are variable but generally are relatively dry and rocky. Stands occur on flat to moderate slopes along drainages and on mesatops, on gentle to moderate (10-40%) rocky slopes of foothills, and at the base of

cinder cones. The substrates are variable and range from to deep, coarse-textured soils derived from cinder, to sandy loams derived from sandstone or fine-textured soils derived from limestone or shale.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Total vegetation cover in this rare woodland type is 19 to 24% and is characterized by a sparse canopy (5% cover) codominated by *Pinus edulis* and *Juniperus osteosperma* that are between 1 and 5 m tall. The understory is dominated by *Bouteloua gracilis* (with 2-6% cover), and often co-dominated by *Chrysothamnus viscidiflorus* (with trace to 7% cover). Scattered shrubs occur (with trace to 3% cover) and include *Krascheninnikovia lanata, Ephedra viridis, Atriplex canescens*, *Artemisia tridentata* ssp. *wyomingensis*, *Gutierrezia sarothrae*, and *Opuntia polyacantha*. Other graminoids present with trace to 2% cover include *Bromus tectorum, Hesperostipa comata, Aristida purpurea, Pleruaphis jamesii* (up to 5% cover recorded in one plot), and *Achnatherum hymenoides;* scattered forbs of *Phlox* sp. and *Hymenopappus filifolius* may be present. Biological soil crusts have up to 27% cover and may be well-developed.

Globally
This plant association is characterized by a sparse to moderately dense tree canopy (5-65% cover) codominated by *Pinus edulis* and *Juniperus osteosperma* trees that are between 1 and 5 m tall. *Juniperus deppeana* may replace *Juniperus osteosperma* in southern stands. Other species of *Juniperus*, such as *Juniperus scopulorum*, may be present in higher elevation stands. Shrub cover is sparse (<10% cover). If *Quercus gambelii* is present, it has less than 5% cover. Other associated shrubs may be present, such as scattered *Artemisia tridentata, Brickellia californica, Cercocarpus montanus, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Fallugia paradoxa, Gutierrezia sarothrae, Opuntia* spp., *Purshia stansburiana, Rhus trilobata, Ribes cereum*, or *Yucca* spp. The herbaceous layer is typically moderately dense and is dominated by the warm-season, perennial short grass *Bouteloua gracilis*. Associated graminoids include *Aristida* spp., *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua curtipendula, Elymus elymoides, Koeleria macrantha, Hesperostipa comata (= Stipa comata), Hesperostipa neomexicana (= Stipa neomexicana)*, and *Pleuraphis jamesii (= Hilaria jamesii)*. *Muhlenbergia montana* is absent or scarce (<1% cover). Forb cover is typically low but may be moderately diverse. Species such as *Artemisia dracunculus, Eriogonum* spp., *Hymenoxys richardsonii*, and *Oxytropis lambertii* are common.

MOST ABUNDANT SPECIES
*Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)*Data are not available.

Globally

Stratum	Species
Tree canopy	*Juniperus deppeana*, *Juniperus osteosperma*, *Juniperus scopulorum*, *Pinus edulis*
Herb (field)	*Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
The two *Pinus edulis / Bouteloua gracilis* plant associations are treated as phases in Stuever and Hayden (1997a). In the USNVC we are including stands with southern Great Plains, Chihuahua Desert floristic affinities in *Pinus edulis*

- *(Juniperus monosperma) / Bouteloua gracilis* Woodland (CEGL002151), and stands with the Colorado Plateau and Great Basin floristic affinities in *Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis* Woodland (CEGL000778). Both of these associations may include stands codominated by *Juniperus deppeana* in their southern extent. Stuever and Hayden (1997a) also described a *Juniperus deppeana* phase (recognized by its dominance in the stand) and hillslope phase, which occurs on slopes >8 degrees and may have low cover of grasses (<5% cover). More survey is needed to fully understand the distribution and ecological relationships between these 3 species of *Juniperus* and *Pinus edulis*.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2008 Accuracy Assessment (3 points: CANY_AA.2203, CANY_AA.2508, CANY_AA.2782).
Local Description Authors: M.E. Hall and A. Tendick
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, Clark et al. 2009, Dick-Peddie 1986, Driscoll et al. 1984, Dwyer and Pieper 1967, Hansen et al. 2003, Hansen et al. 2004c, Hansen et al. 2004d, Jameson 1962, Kennedy 1983a, Ladyman and Muldavin 1996, Larson and Moir 1987, Little 1987, Moir and Carleton 1987, Muldavin et al. 1998a, Powell 1988a, Romme et al. 1993, Stuever and Hayden 1997a, Thomas et al. 2009a, Thomas et al. 2010, USFS 1982, Western Ecology Working Group n.d., Wright et al. 1973, Wright et al. 1979

Pinus edulis - Juniperus osteosperma / Achnatherum hymenoides Woodland

Two-needle Pinyon - Utah Juniper / Indian Ricegrass Woodland

CODE	CEGL002364
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This woodland association currently is documented from Canyonlands and Capitol Reef national parks in southeastern Utah. It occurs on basin floors, canyon bottoms, channels, and hillslopes. Sites are gentle (up to 3 degrees) occur between 1506 and 1860 m (4946-6100 feet) elevation, and are oriented to southwestern and northwestern aspects. Parent materials include Moenkopi Formation (shale), Cedar Mesa sandstone, new alluvium, outcrops and basalt boulders. Soils are rapidly drained and fine-textured. 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 *Cercocarpus montanus, 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. The most conspicuous associated graminoid is *Andropogon gerardii*.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is uncommon and documented only in Davis Canyon.

Globally
This association has been documented only from Moenkopi Formation outcrops in the central part of Capitol Reef National Park and The Fins of Ernies Country and Davis Canyon in Canyonlands National Park in southeastern Utah.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association was observed on a gently sloping (3 degree) hillslope at 1646 m in elevation on a northwestern aspect. Soils are finely textured and derived from Cedar Mesa sandstone.

Globally
This association has been described from Capitol Reef and Canyonlands national parks. It occurs on basin floors, canyon bottoms, and hillslopes. Sites are gentle (up to 3 degrees), occur between 1506 and 1860 m (4946-6100 feet) elevation, and are oriented to southwestern and northwestern aspects. Parent materials include Moenkopi Formation (shale), Cedar Mesa sandstone, new alluvium, outcrops and basalt boulders. Soils are rapidly drained and fine-textured.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is characterized by an open canopy (<10% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. Shrub cover is sparse with no clear dominants and may include *Cercocarpus montanus, Ericameria nauseosa, Gutierrezia sarothrae,* and *Amelanchier utahensis*. The herbaceous layer is composed of *Achnatherum hymenoides* with 6% cover. No other graminoid species were present.

Globally
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 *Cercocarpus montanus, 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. The most conspicuous associated graminoid is *Andropogon gerardii*.

MOST ABUNDANT SPECIES
*Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)*Data are not available.

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (22-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2008 Accuracy Assessment (1 point: CANY_AA.2550).
Local Description Authors: M.E. Hall
Global Description Authors: J. Coles, mod. M.E. Hall

REFERENCES: Clark et al. 2009, Romme et al. 1993, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Amelanchier utahensis Woodland

Two-needle Pinyon - Utah Juniper / Utah Serviceberry Woodland

CODE	CEGL002329
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Foothill Limber Pine-Juniper Woodland (CES306.955)
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
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 (4 to 58 degrees). 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 surface is composed primarily of exposed bedrock, rocks, gravel and bare ground. This woodland association has an open to relatively closed tree canopy and sparse to dense total vegetation cover. *Juniperus osteosperma* and *Pinus edulis* comprise the tree canopy, but individually do not exceed 25% cover. There is a tall-shrub stratum with up to 25% cover dominated by *Amelanchier utahensis*. Other shrubs that may be present with low cover include *Artemisia tridentata, Cercocarpus montanus, Fraxinus anomala, Ephedra viridis, Fendlera rupicola, Quercus gambelii, Rhus trilobata*, and *Symphoricarpos oreophilus*. Dwarf-shrubs may include *Yucca harrimaniae, Gutierrezia sarothrae*, and *Chrysothamnus viscidiflorus*. The herbaceous layer has sparse to low cover and contains graminoids, such as *Achnatherum hymenoides, Carex geyeri, Leymus salinus*, and *Poa fendleriana*, and forbs, such as *Antennaria parvifolia, Erigeron peregrinus, Eriogonum ovalifolium, Heterotheca villosa, Lathyrus lanszwertii, Lepidium montanum, Phlox austromontana*, and *Streptanthella longirostris*. Disturbed stands may contain *Bromus tectorum*.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association was sampled adjacent to Shafer Trail Road, below Salt Creek Mesa, in Water Canyon, and near Aztec Butte in Canyonlands National Park and in the Elaterite Basin of Glen Canyon National Recreation Area.

Globally
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.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association was sampled on a mesa side, colluvial slope, ledge and in a drainage bottom. Sites are on moderate to steep slopes (up to 30 degrees) oriented to the north and lie between 1406 and 2110 m elevation. Rock, bedrock, litter and sand covers most of the unvegetated surface, with lesser cover by bare soil, gravel, wood and biological soil crusts. Soils are rapidly drained sandy clay loams or loamy sands derived from the Moenkopi Formation.

Globally
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 (4 to 58 degrees). 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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Stands of this rare pinyon-juniper woodland are characterized by a sparse to moderately dense canopy of *Juniperus osteosperma* with or without *Pinus edulis*, which are typically between 2 and 10 m tall and individually do not exceed 20% cover. The understory is likewise sparse and tends to be a mixed shrub community dominated by *Amelanchier utahensis* (with 3 to 15% cover). Total vegetation cover ranges from 15 to 49%. Associated shrub cover is diverse but generally sparse and includes scattered individuals of *Fendlera rupicola, Fraxinus anomala, Shepherdia rotundifolia, Coleogyne ramosissima, Cercocarpus intricatus, Ericameria nauseosa, Rhus trilobata, Chrysothamnus viscidiflorus, Ephedra torreyana, Eriogonum corymbosum, Purshia mexicana, Artemisia bigelovii, Eriogonum microthecum*, and *Gutierrezia microcephala*. The herbaceous layer provides sparse cover. Graminoids include *Leymus salinus, Achnatherum hymenoides, Pleuraphis jamesii, Poa fendleriana*, and *Aristida purpurea*. Forbs include *Hymenopappus filifolius, Cryptantha flava, Astragalus moencoppensis*, and *Erigeron utahensis*.

Globally
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 shrubs that may be present with low cover (<5% cover) include *Artemisia tridentata, Coleogyne ramosissima, Cercocarpus montanus, Eriogonum microthecum, Fraxinus anomala, Ephedra viridis, Fendlera rupicola, Quercus gambelii, Purshia mexicana, Rhus trilobata*, and *Symphoricarpos oreophilus*. Dwarf-shrubs may include *Yucca harrimaniae, Gutierrezia sarothrae*, and *Chrysothamnus viscidiflorus*. 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, 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*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Fendlera rupicola*

Short shrub/sapling	*Chrysothamnus viscidiflorus*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Chorispora tenella* (exotic, Insignificant)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (11-Jan-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Moenkopi Formation with large boulders from White Rim above strewn about in drainage bottom. Drainage is wide and stable, not prone to inundation by flash floods. This area is a mix of open desert pavement soils, gully sides and colluvial slopes with a large boulder cover from Moenkopi ledges and cliffs.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (6 plots: CANY.0727, CANY.9402, CANY.9403, CANY.9421, CANY.9501, GLCA.0750).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Drake and J. Coles, mod. K.A. Schulz

REFERENCES: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2010, Romme et al. 1993, Salas et al. 2010, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Artemisia bigelovii Woodland

Two-needle Pinyon - Utah Juniper / Bigelow Sagebrush Woodland

CODE	CEGL002118
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is found in western Colorado and eastern Utah, usually on mesa tops and canyon rims. 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. 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* with 2-20% cover each. The shrub layer is also open and, besides the abundance of *Artemisia bigelovii*, is usually mixed in composition. *Artemisia bigelovii* is the most abundant shrub with 2-10% cover. Other typical shrubs are *Echinocereus triglochidiatus, Ephedra torreyana, Ephedra viridis, Eriogonum corymbosum, Fraxinus anomala* (which can be present in the tree canopy, as well), 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*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association is rare within the park and was sampled in Salt Creek Canyon 2.5 km north of the junction with Angel Arch Canyon, on Cedar Mesa, Confluence Mesa, in upper Lavender Canyon, and in The Fins of Ernie's Country.

Globally

This Colorado Plateau woodland association is found in western Colorado and southeastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association occurs on gentle to steep slopes with exposed bedrock slabs and ledges, as well as on mesa tops and in drainages. Sampled sites are oriented to the west, northwest, and east and lie between 1396 and 1973 m elevation. Small rocks, biological soil crusts, bedrock and exposed soil cover most of the unvegetated surface, with lesser cover by large rocks, wood, and litter. The soil is a rapidly drained loamy sand derived from Cedar Mesa sandstone.

Globally

This association is most commonly found on mesa tops and canyon rims but has been found on valley midslopes with rocky or ledgy substrates. Slopes can vary in steepness (sampled plots are between 1 and 35 degrees) and local aspect 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 elevation and mostly on sandstone substrates. 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. 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This pinyon-juniper woodland is rare within the park. Total vegetation cover ranges from 11 to 30%. Stands are characterized by an open canopy, between 5 and 10 m tall, of *Pinus edulis* and *Juniperus osteosperma* with 3-17% combined cover. The understory is mixed but dominated by *Artemisia bigelovii* with 2-6% cover. *Pinus edulis* seedlings contribute sparse cover. Associated shrubs include *Fraxinus anomala, Cercocarpus intricatus, Rhus trilobata, Ephedra viridis, Fendlera rupicola, Ericameria nauseosa, Chrysothamnus viscidiflorus, Gutierrezia sarothrae*, and *Yucca baccata*. The herbaceous layer is sparse but may include *Achnatherum hymenoides, Achnatherum coronatum, Stipa lettermanii, Aristida purpurea, Pleuraphis jamesii, Tetraneuris acaulis (= Hymenoxys acaulis), Lepidium montanum, Petradoria pumila, Streptanthus cordatus*, and *Machaeranthera grindelioides*. Biological soil crust cover is sparse but well-developed in small patches.

Globally
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*. These tree species can vary in abundance from 2-20% cover each. The shrub layer has sparse to low cover and, besides the abundance of *Artemisia bigelovii*, is variable in composition. *Artemisia bigelovii* is the most abundant shrub with 2-10% cover. Other typical components of the shrub stratum include *Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Ephedra torreyana, Ephedra viridis, Eriogonum corymbosum, Fendlera rupicola, Fraxinus anomala* (which can be present in the tree canopy, as well), *Gutierrezia sarothrae*, and *Yucca baccata*. Occasional *Artemisia tridentata* ssp. *wyomingensis, Atriplex canescens, Cercocarpus intricatus, Grayia spinosa, Purshia stansburiana, Rhus trilobata*, and *Tetradymia spinosa* may be present in some stands. 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, Erodium cicutarium, Heterotheca villosa, Machaeranthera grindelioides, Streptanthus cordatus*, and *Tetraneuris acaulis*. Stands of this community sampled at higher elevation have northern aspects and more dense vegetation cover.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Fraxinus anomala*
Short shrub/sapling	*Artemisia bigelovii*
Herb (field)	*Achnatherum coronatum*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Herb (field)	*Artemisia bigelovii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Exotic/Invasive: *Erodium cicutarium* (invasive, Medium/Low)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (15-Dec-2004).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Trees root into bedrock fractures, as does *Fraxinus anomala*. Downslope where soils accumulate on lower-angle slopes and benches, both the trees and *Fraxinus anomala* disappear, and *Artemisia bigelovii* and forbs increase. Soils here are well-stabilized, either with biocrust or (more typically) with a small rock pavement surface.

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0764) and 2007 and 2008 Accuracy Assessment (4 points: CANY_AA.0017, CANY_AA.2623, CANY_AA.2886, CANY_AA.4404).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Drake, mod. J. Coles and K.A. Schulz

REFERENCES: Clark et al. 2009, Romme et al. 1993, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Artemisia nova Woodland

Two-needle Pinyon - Utah Juniper / Black Sagebrush Woodland

CODE	CEGL002331
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This Colorado Plateau association occurs in western and northern Colorado, eastern Utah and northeastern Arizona 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 other directions are possible. Elevation ranges from 1772 to 2518 m (5800-8260 feet). The soils are variable and range from sandy loam to silt clay loam and sandy clay soil textures. Soils are typically shallow and rapidly drained. Parent materials are often sandstones or limestones but can also be eolian deposits or shale. The unvegetated surface is composed of litter, bare soil, bedrock, and large and small rocks. Cryptogams often have moderate to high cover. 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 3 and 35% canopy cover, although in some sparsely vegetated stands, they may have less. 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 (rarely up to 50%). Other shrubs include *Amelanchier utahensis, Artemisia tridentata, Cercocarpus montanus, Ephedra viridis, Gutierrezia microcephala, Purshia stansburiana, Purshia tridentata*, and *Opuntia* spp. A number of herbaceous species can be found across the range of this association, but any one stand usually has low to moderate diversity and less than 10% cover in aggregate. Common herbaceous species include the graminoids *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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association is uncommon within the recreation area and is represented by one plot located 25.7 km (16 miles) south of Hans Flat Ranger Station.

Globally
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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare woodland association was sampled once on a mesatop. The site is gentle (1-degree slope), is oriented to the southeast (120 degrees) and lies at 2109 m elevation. Gravel covers most of the unvegetated surface, with lesser cover by large rocks, bare soil, and bedrock. Downed wood and litter provide sparse cover. The soil is a rapidly drained loamy sand derived from eolian deposits.

Globally

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 other directions are possible. 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This pinyon-juniper woodland is uncommon within the mapping area and was only sampled within the Glen Canyon National Recreation Area. Total vegetation cover is 23% in the one sampled stand. The stand is characterized by an open tree canopy of *Pinus edulis* and *Juniperus osteosperma* totaling 20% cover. *Artemisia nova* contributes a sparse shrub understory. Associated shrubs include *Chrysothamnus viscidiflorus, Ephedra viridis, Purshia stansburiana*, and *Eriogonum microthecum*. The herbaceous layer provides sparse cover and tends to be dominated by forbs. The non-native annual *Bromus tectorum* was the only grass recorded. Forbs include *Cryptantha flava, Penstemon palmeri*, and *Stanleya pinnata*.

Globally

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 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, Ephedra viridis, Gutierrezia microcephala, Purshia stansburiana, Purshia tridentata*, and *Opuntia* spp. 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.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Artemisia nova*, *Purshia mexicana*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Herb (field)	*Artemisia nova*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (11-Jan-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) 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). *Artemisia nova* grows in thin soils in bedrock cracks, while pinyon and juniper trees have mounds of soil deposited around them.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: GLCA 0520).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Drake, mod. J. Coles and K.A. Schulz

REFERENCES: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2010, Romme et al. 1993, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland

Two-needle Pinyon - Utah Juniper / Littleleaf Mountain-mahogany Woodland

CODE	CEGL000779
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S):
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)
Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This woodland association occurs 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 the Colorado Plateau and in extreme northwestern Colorado, adjacent Utah, and possibly Wyoming. South and southwest aspects are common, and slopes can be variable in 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. Bare soil is common. 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). *Pinus edulis* and *Juniperus osteosperma* vary in cover between 1 and 15%, though higher covers are possible. The shrubs *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*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland is common within both the park and recreation area. It was sampled in Canyonlands National Park adjacent to Upheaval Dome Loop Trail, along Neck Spring Loop Trail, south of Squaw Canyon Campground, in Horse Canyon, west-southwest of Willow Flat Campground, on the north side of Aztec Butte, along Lathrop Trail, on the rim of Buck Canyon, along Devil's Loop Trail, on Butler Wash, west of the Big Spring Trail, and on the south side of Pappy's Pasture. In Glen Canyon National Recreation Area, it was sampled near Hans Flat Ranger Station, in Calf Canyon, and east of Teapot Rock Campsite.

Globally
This plant association is found on the Colorado Plateau and in extreme northwestern Colorado, adjacent Utah, and possibly Wyoming.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
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 walls, cliffs, canyon rims, ledges, ridges, plateaus, shelves, benches, mesas, and colluvial slopes. Sites are on flat to steep slopes (up to 35 degrees), include all aspects, and lie between 1484 and 2139 m elevation. Bedrock, exposed soil or rocks cover most of the unvegetated surface, with low cover by litter, biological soil crusts and dead wood. Soils are rapidly drained sandy loams, sands, or silt loams derived from colluvium, Wingate sandstone, Navajo sandstone, Cedar Mesa sandstone, or Kayenta Formation.

Globally
This woodland association occurs on dry, sandstone ridgetops, mesa edges, outcrops, colluvial slopes, slickrock hills, benches and knolls at moderate elevations (1484 -2470 m) on the Colorado Plateau and in extreme northwestern Colorado, adjacent Utah, and possibly Wyoming. 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 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This pinyon-juniper woodland is common within the park and recreation area. Total vegetation cover ranges from 5 to 31%. Stands are characterized by an open canopy, typically 5 to 10 m tall, of *Pinus edulis* and *Juniperus osteosperma* with between 1 and 15% cover. *Cercocarpus intricatus* dominates a patchy understory that ranges in cover from 1 to 8%. 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, Ericameria nauseosa, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Yucca angustissima*, and *Opuntia polyacantha*. The herbaceous layer is very diverse but provides only sparse cover. Graminoids include *Achnatherum hymenoides, Aristida purpurea, Vulpia octoflora (= Festuca octoflora), Leymus salinus*, and *Pleuraphis jamesii*. Forbs include *Arenaria fendleri, Cryptantha* sp., *Stenotus armerioides (= Haplopappus armerioides), Tetraneuris acaulis (= Hymenoxys acaulis), Chamaesyce fendleri, Machaeranthera grindelioides, Petradoria pumila*, and *Cryptantha flava*. Biological soil crusts can cover as much as 33% of the soil and are generally well-developed.

Globally
The association is characterized by an 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). 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 as a best fit. The shrub layer represents the mesic end of the pinyon-juniper / mixed shrub understory communities found on slickrock exposures. *Amelanchier utahensis, Arctostaphylos patula, Gutierrezia sarothrae, Mahonia fremontii, Quercus gambelii* (low cover), or *Yucca* spp. are often present in many stands. A variety of other shrubs and dwarf-shrubs may be present depending on location, including *Artemisia bigelovii, Brickellia microphylla, Cercocarpus montanus, Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Ephedra viridis, Eriogonum corymbosum, Fendlerella utahensis, Fraxinus anomala, Glossopetalon spinescens* var. *meionandrum, Holodiscus dumosus, Philadelphus microphyllus, Purshia stansburiana, Quercus turbinella*, or *Shepherdia rotundifolia*. *Coleogyne ramosissima* is typically absent. 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*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*, *Fraxinus anomala*
Short shrub/sapling	*Cercocarpus intricatus*, *Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*, *Yucca angustissima*
Herb (field)	*Achnatherum hymenoides*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Cercocarpus intricatus*
Herb (field)	*Achnatherum hymenoides*, *Elymus elymoides*, *Poa fendleriana*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High)

Globally
Vulnerable: *Hymenoxys lapidicola* (critically imperiled, G1), *Yucca elata* var. *utahensis* (vulnerable, G5T3?)

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.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: These sites lie mostly on bedrock; any precipitation is channeled into cracks in the bedrock where most of the plants are rooted. Shrubs have some dead branches from drought stress.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (35 plots: CANY 0113, CANY 0115, CANY 0119, CANY 0166, CANY 0219, CANY 0232, CANY 0237, CANY 0249, CANY 0258, CANY 0270, CANY 0271, CANY 0303, CANY 0304, CANY 0309, CANY 0314, CANY 0321, CANY 0322, CANY 0414, CANY 0428, CANY 0554, CANY 0569, CANY 0754, CANY 0774, CANY 0787, CANY 0812, CANY 0815, GLCA 0302, GLCA 0307, GLCA 0504, GLCA 0505, GLCA 0527, GLCA 0581, GLCA 0700, GLCA 0714, GLCA 0764).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: A.E. Black, mod. K.A. Schulz, J. Drake, J. Coles

REFERENCES: Baker 1983b, Baker 1983c, Baker 1984a, Baker and Kennedy 1985, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2009a, Driscoll et al. 1984, Romme et al. 1993, Salas et al. 2010, Thomas et al. 2010, Von Loh et al. 2007, Western Ecology Working Group n.d., Zimmerman 1978

Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland

Two-needle Pinyon - Utah Juniper / Blackbrush Woodland

CODE	CEGL000781
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This woodland association has been described from valley bottoms, terraces, benches, slopes, mesa rims, elevated plains and rolling terrain sometimes interrupted by bedrock. It occurs extensively across the Colorado Plateau from southwestern Colorado through southern Utah into Arizona and probably also Nevada. Sites are on flat to moderate slopes (0-11 degrees) 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. 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 Arizona, *Mortonia sempervirens* may be codominant. Other common shrub species may include *Agave utahensis, Cercocarpus montanus, Ephedra viridis, Glossopetalon spinescens* var. *aridum (= Glossopetalon nevadense), Glossopetalon spinescens , Gutierrezia sarothrae, Opuntia polyacantha, Purshia stansburiana, Quercus turbinella, Yucca baccata, Yucca harrimaniae*, and *Yucca elata* var. *utahensis (= Yucca utahensis)*. The sparse herbaceous layer is composed of graminoids such as *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Elymus elymoides, Poa fendleriana, Bouteloua curtipendula*, and *Aristida* species. *Bromus rubens, Bromus tectorum*, and *Vulpia octoflora* may be present to abundant in disturbed sites. Forbs are typically variable and scattered, contributing little cover. *Lappula occidentalis,*

Lepidium montanum, Chaenactis stevioides, Psilostrophe sparsiflora, and *Streptanthella longirostris* are among the many species that have been recorded. Scattered cacti are often present, including *Opuntia erinacea, Opuntia phaeacantha, Opuntia polyacantha, Echinocereus triglochidiatus*, and *Echinocereus engelmannii*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland occurs within the park and recreation area and was sampled at the head of Taylor Canyon, along Grand View Point Road, near the Aztec Butte Trail pullout, near the Colorado River Overlook and Green River Overlook, and 2 km east of the pullout for Wilhite Trailhead in Canyonlands National Park and south of Hans Flat Ranger Station and in Calf Canyon in Glen Canyon National Recreation Area.

Globally
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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland type is widespread throughout the park and recreation area and occurs on a variety of substrates. It is documented on canyon rims, benches, sand dunes, plateaus, ledges, and valley floors. Sites are on flat to moderate slopes oriented to any aspect and lying between 1539 and 1885 m elevation. Most of the unvegetated surface consists of exposed soil, rocks or litter. Bedrock and biological soil crusts have sparse cover in most stands. Soils are rapidly drained sandy loams, sandy clay loams, or loamy sands derived from Kayenta Formation, Navajo sandstone, Cedar Mesa sandstone, the Moenkopi Formation, or eolian deposits.

Globally
This woodland association has been described from valley bottoms, terraces, benches, 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 (0-11 degrees) 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 Cedar Mesa, Dakota or Navajo sandstones and the Morrison Formation (Salt Wash Member), Kayenta Formation, and Moenkopi Formation.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This pinyon-juniper woodland is common within the park and recreation area. Total vegetation cover ranges from 8 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 11% cover. *Coleogyne ramosissima* dominates the shrub understory with between 4 and 16% cover. Scattered *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. Associated shrubs include *Mahonia fremontii, Purshia mexicana, Ephedra viridis, Artemisia bigelovii, Ericameria nauseosa, Gutierrezia sarothrae, Yucca angustissima, Opuntia polyacantha, Opuntia erinacea, Eriogonum microthecum, Sclerocactus whipplei*, and *Opuntia phaeacantha*. Herbaceous species provide sparse cover and may include *Achnatherum hymenoides, Pleuraphis jamesii, Vulpia octoflora, Streptanthella longirostris, 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; cover was as high as 65% in a few stands.

Globally
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, Cercocarpus montanus, Ephedra viridis, Glossopetalon spinescens* var. *aridum (= Glossopetalon nevadense), Glossopetalon spinescens, Gutierrezia sarothrae, Opuntia polyacantha, Purshia stansburiana, Quercus turbinella, Yucca baccata, Yucca harrimaniae*, and *Yucca elata* var. *utahensis (=*

Yucca utahensis). The sparse herbaceous layer is composed of graminoids such as *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Elymus elymoides, Poa fendleriana, Bouteloua curtipendula*, and *Aristida* species. *Bromus rubens, Bromus tectorum*, and *Vulpia octoflora* may be present to abundant in disturbed sites. Forbs are typically variable and scattered, contributing little cover. *Lappula occidentalis, Lepidium montanum, Chaenactis stevioides, Psilostrophe sparsiflora*, and *Streptanthella longirostris* are among the many species that have been recorded. Scattered cacti are often present, including *Opuntia erinacea, Opuntia phaeacantha, Opuntia polyacantha, Echinocereus triglochidiatus*, and *Echinocereus engelmannii*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Coleogyne ramosissima*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Coleogyne ramosissima*
Short shrub/sapling	*Mortonia sempervirens*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Exotic/Invasive: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, 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.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This community is controlled by exposure. The hot, dry slopes favor xeric shrubs and trees. The *Coleogyne ramosissima* shrubs have many dead branches due to drought stress.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (12 plots: CANY 0114, CANY 0239, CANY 0240, CANY 0244, CANY 0274, CANY 0437, CANY 0704, GLCA 0308, GLCA 0335, GLCA 0528, GLCA 0563, GLCA 0578).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Clark et al. 2009, Coles et al. 2009a, Driscoll et al. 1984, FEIS 1996, Larson and Moir 1987, Romme et al. 1993, Stuever and Hayden 1997a, Warren et al. 1982, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Ephedra viridis Woodland

Two-needle Pinyon - Utah Juniper / Mormon-tea Woodland

CODE	CEGL002370
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Southern Rocky Mountain Pinyon-Juniper Woodland (CES306.835)
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association occurs on dry middle and upper slopes of ridges and canyons, as well as on colluvial slopes and benches in eastern Utah and northwestern Colorado. Sites are flat to steep (0-18 degree slope), mostly on south- or west-facing slopes between 1558 and 2204 m elevation. Soils are coarse, rocky and generally are derived from sedimentary rocks. 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 10% cover. Few other shrubs are present, and because of the low diagnostic value of *Ephedra viridis*, these 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This type was observed from Chesler Park and above the south fork of Rough Canyon.

Globally

This association has been documented only from scattered sites in the southern part of Capitol Reef National Park in southeastern Utah and the canyons of the Yampa and Green rivers in Dinosaur National Monument in northeastern Utah and northwestern Colorado. It is likely to occur in xeric, rocky sites throughout the pinyon-juniper zone of the Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is rare in the park. Sites include a drainage with a nearly flat slope and a stabilized dune at 1659 to 1703 m elevation with soils derived of eolian sands. Sites have western or northwestern aspects.

Globally

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. Slopes are flat to steep (0-32 degrees), are generally oriented to the south or west, and lie between 1558 and 2204 m (5100-7230 feet) elevation. Soils are rocky and are derived mainly from sedimentary rocks.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This pinyon-juniper woodland is characterized by a sparse to open canopy codominated by *Pinus edulis* and *Juniperus osteosperma* with cover varying from 7-16%. *Ephedra viridis* is the most constant shrub and occurs with sparse to moderate cover ranging from 3 to 17%. Other species of shrubs that are present may include *Amelanchier utahensis, Cercocarpus* spp., *Opuntia polyacantha, Coleogyne ramosissima, Gutierrezia sarothrae*, and *Atriplex*

canescens. Herbaceous species are sparse, although *Pleuraphis jamesii* and *Achnatherum hymenoides* may be present with low cover.

Globally
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 clearly dominated by *Ephedra viridis* (3-15% cover); 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*.

MOST ABUNDANT SPECIES
*Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)*Data are not available.

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Poa secunda*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

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.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based 2007 and 2008 Accuracy Assessment (2 points: CANY_AA.0709, CANY_AA.2776).
Local Description Authors: M.E. Hall
Global Description Authors: J. Coles, mod. M.E. Hall

REFERENCES: Clark et al. 2009, Coles et al. 2008a, Romme et al. 1993, Thomas et al. 2010, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Fendlera rupicola Woodland

Two-needle Pinyon - Utah Juniper / Fendlerbush Woodland

CODE	CEGL004005
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S):

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association is known from the Northern Colorado Plateau at Canyon de Chelly National Monument in northeastern Arizona and Canyonlands National Park in southwestern Utah. It occurs in canyons, ridges and talus slopes from 1637-2146 m (5369-7041 feet) elevation. Stands occur on gentle to moderately steep slopes (4-14 degrees) on all aspects. The soils are generally shallow and rocky, and loamy sand to sandy loam in texture. The vegetation is characterized by an open to moderately dense tree canopy (10-50% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. *Juniperus monosperma* may be present in some stands. *Fendlera rupicola* dominates or codominates the open to moderately dense tall-shrub layer. Other shrubs may be present, including *Artemisia ludoviciana, Artemisia tridentata, Gutierrezia microcephala, Gutierrezia sarothrae, Opuntia phaeacantha, Opuntia polyacantha* var. *polyacantha, Opuntia whipplei*, and *Purshia stansburiana*. *Quercus gambelii* may be present with <5% cover. Herbaceous cover is variable, ranging from sparse to moderately dense, but is generally dominated the perennial graminoid *Bouteloua gracilis* (<5% cover) with scattered perennial forbs.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

A single occurrence of this association is known from Gooseberry Canyon headwaters.

Globally

This woodland association is known only from Canyon de Chelly National Monument in northeastern Arizona in the southern Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is known from a single location. It occurs on a talus slope at 1637 m elevation on a 25% slope with a northeastern aspect. Substrate is characterized as Wingate-derived soils on large boulders.

Globally

This woodland association is known from the Northern Colorado Plateau at Canyon de Chelly National Monument in northeastern Arizona and Canyonlands National Park in southwestern Utah. It occurs in canyons, ridges and talus slopes from 1637-2146 m (5369-7041 feet) elevation. Stands occur on gentle to moderately steep slopes (4-14 degrees) on all aspects. The soils are generally shallow and rocky, and loamy sand to sandy loam in texture.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is known from a single occurrence characterized by an open (10% cover) canopy of *Pinus edulis* and *Juniperus osteosperma*, the latter of which predominates. The understory consists of a sparse (5% cover) shrub layer of mostly *Fendlera rupicola* with *Artemisia bigelovii, Atriplex confertifolia, Chrysothamnus viscidiflorus*, and *Ephedra torreyana* at lower covers. Within the observation area is 10% cover of the bunchgrass *Leymus salinus (= Elymus salinus)* with *Pleuraphis jamesii* and *Achnatherum hymenoides* occurring at trace covers.

Globally
This woodland association is characterized by an open to moderately dense tree canopy (10-50% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. *Juniperus monosperma* may be present in some stands. *Fendlera rupicola* dominates or codominates the open to moderately dense tall-shrub layer. Other shrubs may be present, including *Artemisia bigelovii, Artemisia ludoviciana, Artemisia tridentata, Atriplex confertifolia, Chrysothamnus viscidiflorus, Gutierrezia microcephala, Gutierrezia sarothrae, Opuntia phaeacantha, Opuntia polyacantha* var. *polyacantha, Opuntia whipplei*, and *Purshia stansburiana*. *Quercus gambelii* may be present with <5% cover. Herbaceous cover is variable, ranging from sparse to moderately dense, but is generally dominated the perennial graminoid *Bouteloua gracilis* (<5% cover) with scattered perennial forbs. Other species that are frequently found in the herbaceous layer include *Achnatherum hymenoides, Arabis fendleri, Artemisia ludoviciana, Cryptantha cinerea, Elymus elymoides, Leymus salinus (= Elymus salinus), Hesperostipa comata* ssp. *comata, Heterotheca villosa, Lappula occidentalis, Penstemon barbatus, Poa fendleriana, Packera neomexicana (= Senecio neomexicanus)*, and *Streptanthus cordatus*. The exotic annual grass *Bromus tectorum* is often present with low to moderate cover (1-25%).

MOST ABUNDANT SPECIES
*Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)*Data are not available.

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Fendlera rupicola*
Short shrub/sapling	*Opuntia phaeacantha*
Herb (field)	*Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (19-Jul-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2007 Accuracy Assessment (1 point: CANY_AA.0759).
Local Description Authors: M.E. Hall
Global Description Authors: K.A. Schulz, mod. M.E. Hall

REFERENCES: Thomas et al. 2010, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland

Two-needle Pinyon - Utah Juniper / Mixed Shrubs Talus Woodland

CODE	CEGL002328
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This Colorado Plateau open woodland association is found in western Colorado and eastern Utah generally on lower slopes where talus and rockfalls accumulate. Sites can be between 1330 and 2290 m (4365-7500 feet) elevation. Slopes can be gentle to steep and of any aspect. The unvegetated ground surface is mostly bedrock and large and small rocks. Soils are rapidly drained. The parent material is talus rockfall. This woodland association can have sparse to moderate vegetation cover (4-61%) but is most often relatively sparse (<15% cover). The sparse to open tree canopy is 2-10 m tall. *Pinus edulis* and *Juniperus osteosperma* are the dominant canopy trees; either species can range from extremely low to moderate cover. The composition of the shrub stratum can be diverse, but cover is sparse to low. 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. Common graminoid species are *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Elymus elymoides, 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparsely vegetated association is widely distributed within the park and recreation area. In Canyonlands National Park, it was sampled along the Murphy Trail, near Teapot Rock, Grand View Point, the Golden Stairs, Red Cove, Burro Seep and Upheaval Dome, on a mesa east of Cow Canyon, and in Cross, North Trail and Water canyons.

Globally

This association is found on the eastern edge of the Colorado Plateau and western slope of the southern Rocky Mountains in western Colorado.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This mixed community type occurs on colluvial slopes and talus-covered ledges, canyon walls, ridges, and mesa sides. Sites are moderate to steep (12- to 31-degree slopes), and lie between 1330 and 1939 m elevation. Boulders, rocks, bedrock and bare ground cover most of the unvegetated surface. Litter and biological soil crusts have sparse cover. Soils are rapidly drained and vary in texture from clay loam to sand; parent materials include Chinle, Kayenta, Moenkopi formations and Cutler Group (including Cedar Mesa sandstone).

Globally

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 38-degrees) 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 and Cutler Group (including Cedar Mesa sandstone).

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This open woodland grows on colluvial slopes and canyon walls throughout the park and recreation area. Total vegetation cover ranges from 3 to 19%. The vegetation is characterized by an open canopy of *Pinus edulis* and *Juniperus osteosperma* with between 1 and 5% cover. The shrub layer has as much or more cover than the tree canopy. Shrubs present vary greatly from site to site; the most common species are *Rhus trilobata* var. *simplicifolia (= Rhus aromatica* var. *simplicifolia), Ephedra torreyana, Gutierrezia sarothrae, Ephedra viridis, Ericameria nauseosa*, and *Chrysothamnus viscidiflorus*. The herbaceous layer is typically sparse in cover. Common graminoids include *Pleuraphis jamesii* and *Achnatherum hymenoides*. Forbs vary among sites.

Globally

This woodland association can have very sparse to moderate total vegetation cover (4-61%) but is most often relatively sparse (<15%). The sparse to open tree canopy is 2-10 m tall. *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. A few *Fraxinus anomala* may be found in some stands. The composition of the shrub stratum can be diverse, but cover is sparse to low. Common species are *Amelanchier utahensis, Artemisia bigelovii, Artemisia tridentata* ssp*. vaseyana, Brickellia microphylla, Cercocarpus montanus, Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Ephedra viridis, Ephedra torreyana, Eriogonum corymbosum, Fendlera rupicola, Gutierrezia sarothrae, Opuntia* spp., and *Rhus trilobata*. 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, 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.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Amelanchier utahensis*, *Ericameria nauseosa*, *Rhus trilobata*
Short shrub/sapling	*Artemisia bigelovii*, *Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Artemisia bigelovii*, *Ephedra viridis*
Herb (field)	*Opuntia fragilis*
Herb (field)	*Achnatherum hymenoides*, *Elymus elymoides*, *Poa fendleriana*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally

Exotic/Invasive: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (11-Jan-2005).

CLASSIFICATION COMMENTS

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This mixed sparse woodland association is widespread throughout the park and recreation area occupying canyon walls and steep colluvial slopes. The vegetation is variable depending on the microclimate and topography of individual sites, but consistently has low cover by *Juniperus osteosperma* and *Pinus edulis* trees.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (14 plots: CANY.0127, CANY.0189, CANY.0196, CANY.0412, CANY.0520, CANY.0530, GLCA.0131, GLCA.0132, GLCA.0304, GLCA.0556, GLCA.0572, GLCA.0705, GLCA.0708, GLCA.0748).
Local Description Authors: J. Coles
Global Description Authors: J. Drake, mod. K.A. Schulz

REFERENCES: Coles et al. 2009a, Coles et al. 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Muhlenbergia pungens Woodland

Two-needle Pinyon - Utah Juniper / Sandhill Muhly Woodland

CODE	CEGL002373
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This rare, open woodland association is currently documented from Canyonlands and Capitol Reef national parks in southeastern Utah. It occurs on the lower and middle slopes of ridges, on benches, terraces and dunes. Sites are gentle (<3-degree slopes), occur between 1640 and 2134 m (5379-7000 feet) elevation, and tend to be oriented to northeastern, eastern and southeastern aspects. Parent materials include eolian deposits. Soils are rapidly drained sands. The total vegetation cover generally does not exceed 50%. The vegetation is characterized by an open canopy of *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), but scattered individuals of *Artemisia frigida, Gutierrezia sarothrae*, and *Opuntia polyacantha* may be present. Associated herbaceous species commonly include *Achnatherum hymenoides, Abronia elliptica, Arenaria eastwoodiae, Streptanthella longirostris*, and *Townsendia incana*. One stand above Deep Creek Canyon has moderate cover of cryptogamic soil.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is rare and was documented east of Standing Rock, near Upheaval Dome, and in between Horse and Davis canyons.

Globally
This association has been documented from scattered sites throughout Capitol Reef and Canyonlands national parks in southeastern Utah.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is known from high and low level areas on dune deposits. Sites are 1640-1734 m in elevation on gentle slopes (<3-degrees) on northeastern and southeastern aspects. Parent materials include wind-deposited eolian sands.

Globally
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 gently sloping (<3-degrees), 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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association is characterized by a sparse canopy of *Pinus edulis* and *Juniperus osteosperma* which does not exceed 10% total cover. Shrub cover is patchy and inconsistent. Species may include *Coleogyne ramosissima, Opuntia polyacantha, Ephedra viridis*, and *Atriplex canescens*. The most consistent understory species is the graminoid *Muhlenbergia pungens* which averages 6% cover and may be present with *Achnatherum hymenoides, Bouteloua gracilis*, and *Pleuraphis jamesii* at lower covers. Forb cover is sparse or absent.

Globally
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 comprised of short and dwarf-shrubs and succulents that provide sparse to low cover. Common dwarf-shrubs include *Atriplex canescens, Artemisia frigida, Coleogyne ramosissima, Ephedra viridis, Gutierrezia sarothrae*, and *Opuntia polyacantha*. The remaining herbaceous layer is diverse in terms of species composition and provides sparse to low cover. The tall bunchgrass *Achnatherum hymenoides* is commonly present. Forbs are moderately diverse in terms of species composition and include *Abronia elliptica, Arenaria eastwoodiae, Streptanthella longirostris*, and *Townsendia incana*. One stand above Deep Creek Canyon has moderate cover of cryptogamic soil.

MOST ABUNDANT SPECIES
*Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)*Data are not available.

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (23-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This association has only been described from Capitol Reef and Canyonlands national parks and appears inherently rare. Further inventory is needed to develop a more comprehensive description.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2007 and 2008 Accuracy Assessment (3 points: CANY_AA.0456, CANY_AA.2100, and CANY_AA.4346).
Local Description Authors: M.E. Hall
Global Description Authors: J. Coles, mod. M.E. Hall

REFERENCES: Clark et al. 2009, Romme et al. 1993, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Pleuraphis jamesii Woodland

Two-needle Pinyon - Utah Juniper / James' Galleta Woodland

CODE	CEGL002379
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S):

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This rare woodland association is currently documented only from Capitol Reef National Park in southeastern Utah; this summary is derived from plots sampled in the park in 1986 and 2005. It occurs on pediment surfaces cut into ridges and hills between 1950 and 2020 m (6400-6625 feet) elevation. Parent materials include basalt alluvium or colluvium overlying Moenkopi siltstone that is occasionally exposed. Soils are rapidly drained and fine-textured. Total vegetation cover is around 30%. 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 *Gutierrezia sarothrae, Atriplex confertifolia, Shepherdia rotundifolia, Chrysothamnus viscidiflorus*, and *Ephedra torreyana* are commonly present. Associated herbaceous species include *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata*, and a variety of forbs with sparse cover.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is found at Davis Canyon, Lavender Canyon and Big Pocket.

Globally
This association has been documented from southeastern Utah, the high plateaus of southern Utah, and in southwestern Colorado.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is known in the park from three locations on a bench, erosion fan, and a valley side on variable aspects. Elevations range from 2569-3033 m (8323-9826 feet) with positions at low levels and midslopes. Soils are derived of eolian sands and new alluvium.

Globally
This association has only been described from Capitol Reef National Park. Until further inventory is completed, there is no global information.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This pinyon - juniper woodland is characterized by a sparse to open canopy not exceeding 20% cover mostly dominated by *Juniperus osteosperma* with lesser amounts of *Pinus edulis*. Other canopy associates are absent. The understory is composed of sparse shrub cover and mostly graminoid-dominated. Shrubs may include *Ericameria nauseosa* var. *juncea (= Chrysothamnus nauseosus* var. *junceus), Artemisia tridentata* ssp. *wyomingensis, Atriplex canescens, Ephedra viridis, Gutierrezia sarothrae, Krascheninnikovia lanata*, and *Opuntia polyacantha*. The dominant graminoid is *Pleuraphis jamesii* with lesser amounts of *Bouteloua gracilis, Aristida purpurea, Muhlenbergia pungens, Poa fendleriana*, and *Achnatherum hymenoides*.

Globally
This association has only been described from Capitol Reef National Park. Until further inventory is completed, there is no global information.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Herb (field)	*Ericameria nauseosa* var. *juncea*
Herb (field)	*Bouteloua gracilis*, *Pleuraphis jamesii*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (23-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This association has only been described from Capitol Reef National Park. Until further inventory is completed, there is no global information.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2008 Accuracy Assessment (3 points: CANY_AA.2066, CANY_AA.2782, CANY_AA.3076).
Local Description Authors: M.E. Hall
Global Description Authors: J. Coles

REFERENCES: Clark et al. 2009, Romme et al. 1993, Thomas et al. 2009b, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland

Two-needle Pinyon - Utah Juniper / Stansbury's Cliffrose Woodland

CODE	CEGL000782
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association is known from the Colorado Plateau of southern Utah and Colorado south to central Arizona. 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. The vegetation 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. *Cercocarpus montanus* and *Purshia tridentata* are scarce or absent. 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*. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (<5% cover) with scattered perennial forbs.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland occurs within the park and recreation area and was sampled near the Upheaval Dome second overlook, adjacent to the North Fork of the Syncline Trail, 350 m northeast of the Aztec Butte parking area, on the rim of Shafer Canyon, and on the rim of the Big Draw in Canyonlands National Park and south of Hans Flat Ranger Station in Glen Canyon National Recreation Area.

Globally

This woodland association occurs in the Colorado Plateau region of central Arizona, western New Mexico, southwestern Colorado, and southern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland occurs on ridges, canyon rims, mesas, buttes, plains, and plateaus. Stands are on flat to steep slopes (0-25 degrees), include all aspects, and lie between 1461 and 2090 m elevation. Bare soil, bedrock, gravel and large rocks cover most of the unvegetated surface in most stands; litter, dead wood and biological soil crusts provide sparse cover. Soils are rapidly drained sandy loams, sandy clays, sandy clay loams, and sands derived from mostly sandstone parent materials.

Globally

This woodland occurs on the Colorado Plateau of southern Utah and Colorado south to central Arizona, on dry canyon rims, ridges, hills, benches, mesas and occasionally in intermittent drainages. Elevations range from 1400 to 2165 m (4600-7100 feet). Stands typically occur on gentle to moderately steep slopes on all aspects, but range from flat to steep slopes (0-17 degrees). 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, Moenkopi Formation, Morrison Formation, Cedar Mesa sandstone and eolian silt deposits.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This pinyon-juniper woodland type is relatively common within the park and recreation area. Total vegetation cover ranges from 10 to 30%. Stands are characterized by an open canopy, typically 2 to 5 m tall, of *Pinus edulis* and *Juniperus osteosperma* with between 8 and 25% cover. The mixed shrub understory may be relatively sparse but is dominated by *Purshia stansburiana* with between 2 and 8% cover. Scattered *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. Associated shrubs may include *Fraxinus anomala, Amelanchier utahensis, Ephedra viridis, Symphoricarpos longiflorus, Artemisia nova, Rhus trilobata, Chrysothamnus viscidiflorus, Shepherdia rotundifolia, Gutierrezia sarothrae, Yucca angustissima, Artemisia bigelovii, Brickellia microphylla, Eriogonum microthecum*, and *Opuntia erinacea*. The herbaceous layer is generally sparse cover but may include a diversity of species, including *Achnatherum hymenoides, Pleuraphis jamesii, Aristida purpurea, Vulpia octoflora (= Festuca octoflora), Poa fendleriana, Chamaesyce fendleri, Streptanthella longirostris*, and *Packera multilobata (= Senecio multilobatus)*.

Globally

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. Total vegetation cover can vary from 12% to more than 65%, with tree canopy sometimes falling below 10% cover in very open stands. *Cercocarpus montanus* and *Purshia tridentata* are scarce or absent. Other shrubs may be present, including *Amelanchier utahensis, Arctostaphylos patula, Artemisia bigelovii, Artemisia nova, Artemisia tridentata, Chamaebatiaria millefolium, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Fraxinus anomala, Gutierrezia sarothrae, Quercus gambelii* (<5% cover), *Rhus trilobata, Shepherdia rotundifolia, Symphoricarpos longiflorus*, or species of *Yucca* and *Opuntia*. 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, Descurainia pinnata, Eriogonum ovalifolium, Lappula occidentalis, Oenothera pallida*, and *Penstemon linarioides*.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Purshia stansburiana*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Chamaesyce fendleri*, *Streptanthella longirostris*
Herb (field)	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Purshia stansburiana*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Exotic/Invasive: *Bromus tectorum* (invasive, High), *Descurainia pinnata* (invasive), *Erodium cicutarium* (invasive, Medium/Low)

CONSERVATION STATUS RANK
Global Rank & Reasons: G4? (1-Feb-1996).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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 Zacateca, 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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Sites have large amounts of exposed slickrock with small surface rocks and varying soil depths. There are variable slopes and aspects due to cliffs and ledges with shallow soils. Plants are mainly rooted in shallow pockets of soil in depressions and in cracks between rocks.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (16 plots: CANY 0101, CANY 0132, CANY 0173, CANY 0233, CANY 0300, CANY 0331, CANY 0333, CANY 0335, CANY 0436, CANY 0443, CANY 0559, GLCA 0514, GLCA 0521, GLCA 0522, GLCA 0524, GLCA 0704).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: BIA 1979, Baker 1980a, Baker 1984a, Bourgeron and Engelking 1994, Britton and Wright 1983, CONHP unpubl. data 2003, 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. 2003, Hansen et al. 2004d, Isaacson 1967, Kartesz 1999, Larson and Moir 1987, Moir and Carleton 1987, Northcutt 1978, Romme et al. 1993, Stuever and Hayden 1997a, Thomas et al. 2010, USFS 1982, USFS 1985c, Von Loh et al. 2008, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Quercus havardii var. *tuckeri Woodland*

Two-needle Pinyon - Utah Juniper / Tucker Sand Shinnery Oak Woodland

CODE	CEGL002497
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association occurs on deep accumulations of eolian and alluvial sands on canyon and valley floors, in intermittent washes, and on dunes and sandsheets on plateaus and benches in southeastern Utah. It is located on level to gently sloping (0-11%) sites between 1445 and 1868 m (4740-6130 feet) elevation. Aspect apparently does not influence the distribution of this association, although it does influence the vegetative composition somewhat. 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. Geologic substrates include various sandstones, which for the most part have eroded and been redeposited as eolian sands. Soils are rapidly drained, moderately deep loamy sands, sandy loams, and sands. 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 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; cooler, more mesic stands include *Amelanchier utahensis, Cercocarpus intricatus, Cercocarpus montanus, Mahonia fremontii*, and *Shepherdia rotundifolia*. In more exposed, drier stands these shrubs are mostly replaced by *Artemisia bigelovii, Ephedra viridis, Eriogonum microthecum, 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, Bouteloua gracilis, Muhlenbergia pungens*, and *Pleuraphis jamesii*. Forbs often present include species typical of sandy sites: *Cryptantha flava, Tetraneuris acaulis (= Hymenoxys acaulis), Lepidium montanum*, and *Streptanthella longirostris*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association is uncommon within the park and the recreation area and was sampled near the intersection of the roads to the various Dollhouse formations, along the Chesler Park trail and in upper Chesler Canyon, in Big Spring Canyon, Squaw Flat, and Salt Creek Pocket in Canyonlands National Park and 350 m southeast of the High Spur area of Glen Canyon National Recreation Area.

Globally

This association is apparently restricted to southeastern Utah. It may also occur in some parts of southern Colorado.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association occurs on a series of dunes along a valley side, canyon bottom and canyon edge, as well as along a wash and wash bank/terrace. Sites are on flat to gentle slopes (up to 5 degrees), oriented to the north and south, lying between 1507 and 1868 m elevation. Bedrock, biological soil crusts, exposed sand or litter covers most of the unvegetated surface, with lesser cover by small rocks and bare soil. Soils are rapidly drained sands derived from Cedar Mesa sandstone and eolian deposits.

Globally

This woodland association occurs on canyon and valley floors, in intermittent washes, on dunes and sandsheets on plateaus and benches in southeastern Utah. It is located on level to gently sloping (0-11%) sites between 1445 and 1868 m (4740-6130 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. Geologic substrates include 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 and Carmel Formation. Soils are rapidly drained, moderately deep loamy sands, sandy loams, and sands.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This pinyon-juniper woodland association is rare within the park and recreation area. It is restricted to areas with deep, sandy soils. Total vegetation cover ranges from 9 to 49%. Stands are characterized by an open tree canopy,

typically 2 to 5 m tall, of *Pinus edulis* and *Juniperus osteosperma* (either one may be dominant) with between 8-17% combined tree cover. *Quercus havardii* var. *tuckeri* clones occupy sand mounds between tree canopies and provide between 2 and 32% cover. Associated tall shrubs include *Quercus gambelii, Cercocarpus montanus, Mahonia fremontii,* and *Fraxinus anomala;* with associated short and dwarf shrubs *Coleogyne ramosissima, Ephedra viridis, Ericameria nauseosa, Eriogonum leptocladon, Chrysothamnus viscidiflorus, Yucca harrimaniae, Gutierrezia sarothrae,* and the succulent *Opuntia* spp. Herbaceous species are diverse but provide only sparse cover; *Poa fendleriana, Achnatherum hymenoides, Hesperostipa comata, Muhlenbergia pungens, Bouteloua gracilis, Pleuraphis jamesii, Cryptantha flava, Packera multilobata (= Senecio multilobatus), Heterotheca villosa, Oenothera pallida, Eriogonum cernuum, Lepidium montanum*, and *Streptanthella longirostris* were reported from sampled stands.

Globally
This woodland association is limited to sites with deep, loose sands. 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, drier stands these shrubs are mostly replaced by *Artemisia bigelovii, Ephedra viridis, Eriogonum microthecum, 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, Bouteloua gracilis, Muhlenbergia pungens*, and *Pleuraphis jamesii*. Forbs often present include species typical of sandy sites: *Cryptantha crassisepala, Cryptantha flava, Lappula occidentalis, Lepidium montanum, Streptanthella longirostris*, and *Tetraneuris acaulis (= Hymenoxys acaulis).*

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Quercus havardii* var. *tuckeri*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Fraxinus anomala*
Short shrub/sapling	*Quercus havardii* var. *tuckeri*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Chenopodium album* (exotic)

Globally
Vulnerable: *Quercus havardii* var. *tuckeri* (vulnerable, G4T3?Q); **Exotic/Invasive**: *Bromus tectorum* (invasive/exotic, 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 and Capitol Reef, the three national parks in which this association has been documented, there are nine 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.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The slope and aspect of these sites follow the banks of the wash. The slope ranges from about 20 degrees to almost flat, and the aspect varies greatly with both sides of the wash having the same community. This area is a series of stabilized humps of sand interspersed with blowouts. The roots of the *Ephedra viridis* and oak clones help to stabilize the sand mounds. The blowouts contain small perennial forbs and many annuals.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY.0452, CANY.9515, GLCA.0312) and 2008 Accuracy Assessment (4 points: CANY_AA.2224, CANY_AA.2290, CANY_AA.3216, CANY_AA.3293).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia Woodland

Two-needle Pinyon - Utah Juniper / Roundleaf Buffaloberry Woodland

CODE	CEGL002335
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
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* spp. / *Artemisia tridentata* (ssp. *wyomingensis*, ssp. *vaseyana*) Woodland (CEGL000776) 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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland is common within the park and recreation area and was sampled in Shot Canyon and north of the Land of Standing Rocks in Canyonlands National Park and in Millard Canyon, above Horseshoe Canyon, adjacent to Flint Trail, at the head of Happy Canyon, near Sunset Pass, and near Elaterite Basin in Glen Canyon National Recreation Area.

Globally
This association has been documented from southern Utah. It may also occur in northern New Mexico within the range of *Shepherdia rotundifolia*.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland occurs on shallow soils of canyon bottoms, canyon sides, rims, toeslopes, mesas, and colluvial slopes. Sites are on gentle to steep slopes (up to 35 degrees) oriented to all aspects and lying between 1445 and 2004 m elevation. Bedrock, bare soil and rocks cover most of the unvegetated surface, with low cover by litter, dead wood and biological soil crusts. Soils are variable and include loams and sands derived from a range of shale, conglomerate and sandstone parent materials.

Globally
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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This pinyon-juniper woodland is common within the park and 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 11% 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, Ericameria nauseosa, Chrysothamnus viscidiflorus*, and *Gutierrezia sarothrae*. Herbaceous species are diverse but provide sparse cover. Graminoids include *Leymus salinus, Pleuraphis jamesii*, and *Achnatherum hymenoides*. Forbs include *Machaeranthera grindelioides, Chamaesyce fendleri, Cryptantha flava*, and *Stanleya pinnata*.

Globally
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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Chrysothamnus viscidiflorus*, *Ericameria nauseosa*, *Shepherdia rotundifolia*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Achnatherum hymenoides*, *Leymus salinus*, *Pleuraphis jamesii*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Shepherdia rotundifolia*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jan-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Vegetation is growing in soil pockets behind fallen rocks and is controlled by slope, aspect, and rockfall disturbances.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (13 plots: CANY 0253, CANY 0275, CANY 0427, GLCA 0102, GLCA 0104, GLCA 0111, GLCA 0506, GLCA 0523, GLCA 0585, GLCA 0586, GLCA 0588, GLCA 0589, GLCA 0752).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Clark et al. 2009, Coles et al. 2008c, Romme et al. 1993, Salas et al. 2010, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland

Two-needle Pinyon - Utah Juniper / Sparse Understory Woodland

CODE	CEGL002148
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Great Basin Pinyon-Juniper Woodland (CES304.773)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This variable woodland association is widespread in parts of western Colorado and eastern Utah. It is found most commonly on mid- to upper slopes, though other topographic positions are possible. It has been sampled at elevations between 1354 and 2389 m and on all aspects. At higher elevations, it tends toward southwestern 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. The lack of an understory may be due to high rock cover, low

soil moisture, or a closed evergreen canopy of pinyon and juniper. This widespread 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 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 tridentata* ssp*. wyomingensis, Cercocarpus montanus, Ephedra viridis, Eriogonum microthecum, Shepherdia rotundifolia*, and *Opuntia* spp. 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* spp., and *Tetraneuris acaulis*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland is common and widely distributed within the park and recreation area. It is represented by plots sampled in Canyonlands National Park northwest of Whale Rock, adjacent to the Syncline Loop Trail, in Musselman Canyon, up the West Fork of Salt Creek, adjacent to Alcove Spring Trail, adjacent to Lathrop Canyon Trail, along White Rim Road, up the South Fork of Lavender Canyon, northeast of Tower Ruin, in Elephant Canyon, on top of Cedar Mesa, and north of Teapot Rock Campsite. In Glen Canyon National Recreation Area, it was sampled near Hans Flat Ranger Station, in Ranger Canyon, in Water Canyon, on Big Water Basin, on Waterhole Flat, west of Panorama Point Campsite, at the head of Horse Canyon, northwest of Teapot Rock, and near Sunset Pass.

Globally
This association is known to occur in western Colorado and eastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland occurs on sandstone soils on valley floors, plateaus, colluvial slopes, hills, canyon rims, canyon sides, mesas, plains, and benches. Stands occupy flat to steep slopes oriented to any aspects and lying between 1354 and 2108 m elevation. Depending on the site, most of the unvegetated surface may consist of exposed bare soil, bedrock, or rock. Litter and dead wood are always sparse, but biological soil crusts may have up to 50% cover in stands with a sandy substrate. Soils include rapidly drained sandy loams, sandy clays, silt loams, sandy clay loams, and loamy sands derived from a variety of sandstone and shale parent materials.

Globally
This woodland association is found most commonly on mid- to upper slopes, though other topographic positions are possible, such as 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. At higher elevations, such as in Black Canyon of the Gunnison National Park it tends toward southwestern aspects. Sites range from flat to moderately steep (0-25 degrees). 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
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 large rock or gravel limiting germination sites, or (3) because the stand is old-growth and the dense mature canopy excludes most understory species. Total vegetation cover in Canyonlands National Park stands is variable, ranging from 5 to 41%. The woodland canopy may be 2 to 10 m tall and consists of *Pinus edulis* and *Juniperus osteosperma* with between 2 and 30% cover. Total understory cover does not exceed 5% and is usually much less. Common shrubs include scattered

individuals of *Fraxinus anomala, Ephedra viridis, Chrysothamnus viscidiflorus, Shepherdia rotundifolia, Purshia mexicana, Artemisia bigelovii, Coleogyne ramosissima, Symphoricarpos longiflorus, Gutierrezia sarothrae, Yucca angustissima, Opuntia erinacea, Eriogonum microthecum*, and *Opuntia polyacantha*. Herbaceous species are likewise diverse, including *Achnatherum hymenoides, Pleuraphis jamesii, Aristida purpurea, Elymus elymoides, Leymus salinus, Cryptantha flava, Packera multilobata (= Senecio multilobatus), Tetraneuris acaulis (= Hymenoxys acaulis), Chamaesyce fendleri, Machaeranthera grindelioides, Cordylanthus wrightii, Petradoria pumila, Arenaria fendleri*, and *Lepidium montanum*. The sparsest sites have little vascular understory, only biological soil crusts.

Globally
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 tridentata* ssp. *wyomingensis, Cercocarpus montanus, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra viridis, Eriogonum microthecum, Gutierrezia sarothrae, Shepherdia rotundifolia, Symphoricarpos longiflorus*, and *Opuntia* spp., usually *Opuntia fragilis* or *Opuntia polyacantha*. 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* spp., and *Tetraneuris acaulis*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Descurainia pinnata* (exotic)

Globally
Exotic/Invasive: *Bromus tectorum* (invasive, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (15-Dec-2004).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Stands are characterized by classic slickrock rim environments, with thin soils accumulating in joints, fractures, and occasional low spots on exposed bedrock rims. Trees and shrubs are rooted into fractures and herbaceous vegetation grows on the thin soils.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (47 plots: CANY 0107, CANY 0171, CANY 0308, CANY 0323, CANY 0395, CANY 0438, CANY 0500, CANY 0528, CANY 0567, CANY 0619, CANY 0622, CANY 0630, CANY 0757, CANY 0767, CANY 0807, CANY 0816, CANY 0843, CANY 0845, GLCA 0100, GLCA 0110, GLCA 0301, GLCA 0334, GLCA 0500, GLCA 0503, GLCA 0507, GLCA 0512, GLCA 0513, GLCA 0515, GLCA 0516, GLCA 0517, GLCA 0519, GLCA 0532, GLCA 0533, GLCA 0534, GLCA 0553, GLCA 0560, GLCA 0592, GLCA 0594, GLCA 0701, GLCA 0713, GLCA 0716, GLCA 0718, GLCA 0745, GLCA 0754, GLCA 0758, GLCA 0771, GLCA 0772).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Drake, mod. J. Coles and K.A. Schulz

REFERENCES: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2010, Romme et al. 1993, Salas and Bolen 2010b, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.

*Pinus edulis - Juniperus spp. / Artemisia tridentata (***ssp.** *wyomingensis,* **ssp.** *vaseyana) Woodland*

Two-needle Pinyon - Juniper species / (Wyoming Big Sagebrush, Mountain Big Sagebrush) Woodland

CODE	CEGL000776
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Southern Rocky Mountain Pinyon-Juniper Woodland (CES306.835)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This broadly defined woodland association is common in the Colorado Plateau but also occurs on dry foothills and mesas from north-central New Mexico and southern Colorado west to the eastern Mojave Desert, in extreme northwestern Colorado and adjacent Utah. 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. The vegetation is characterized by a typically open tree canopy (10-30% cover but ranges up to 50% cover) that is codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus osteosperma* is

common from northwestern New Mexico west and north into Arizona and Utah. *Juniperus scopulorum* is more common in higher elevation stands. *Artemisia tridentata* (either ssp. *vaseyana* or ssp. *wyomingensis* depending on location) strongly dominates the sparse to moderately dense short-shrub layer (10-35% cover). *Purshia stansburiana* is typically absent or scarce. Other shrubs present may include *Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus, Ephedra viridis, Gutierrezia sarothrae, Quercus gambelii* (typically <5% cover), or species of *Yucca* and *Opuntia*. Herbaceous cover is variable but generally sparse and dominated by graminoids (<5% cover) with scattered forbs.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland is uncommon within the park and recreation area and was sampled south of Butler Wash and on Cedar Mesa in Canyonlands National Park and near Horseshoe Canyon, near Hans Flat Ranger Station, and in Big Water Canyon in the recreation area.

Globally
This woodland association is common on the Colorado Plateau, occurring from north-central New Mexico and southern Colorado west to the Mogollon Rim of Arizona and the eastern Mojave Desert, and in extreme northwestern Colorado and adjacent Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland occurs on deep soils of mesatops, plains, plateaus, and canyon bottoms. Sites are flat to gently sloping (less than 3 degrees), oriented to all aspects, and lie between 1685 and 2106 m elevation. Exposed soil and biological soil crust covers most of the unvegetated surface, with lesser cover by litter, and sparse to low cover by dead wood. Soils are rapidly drained sandy loams or loamy sands derived from alluvial and eolian deposits.

Globally
This broadly defined 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 can also be abundant on some sites. Parent material includes sandstone and shale.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This pinyon-juniper woodland type is uncommon within the mapping area. Total vegetation cover ranges from 12 to 40% and is characterized by an open canopy of *Pinus edulis* and *Juniperus osteosperma* that are less than 10 m tall and have variable cover that totals between 3 and 26%. *Artemisia tridentata* ssp. *wyomingensis* dominates the shrub understory with between 4 and 20% cover. Scattered *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. Associated shrubs include *Amelanchier utahensis, Atriplex canescens, Ephedra viridis, Gutierrezia sarothrae* (up to 20% cover in one sampled site), *Opuntia erinacea, Opuntia polyacantha*, and *Sclerocactus whipplei*. The herbaceous layer provides sparse cover and may include *Achnatherum hymenoides, Pleuraphis jamesii, Bouteloua gracilis, Bromus tectorum, Elymus elymoides, Vulpia octoflora (= Festuca octoflora), Hesperostipa comata, Packera multilobata (= Senecio multilobatus), Cordylanthus wrightii, Gilia inconspicua*, and *Lepidium montanum*.

Globally
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 codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *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, Ephedra viridis, Gutierrezia*

sarothrae, Quercus gambelii (typically <5% cover), or species of *Yucca* and *Opuntia*. 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 species of *Cryptantha, Eriogonum, Penstemon*, and *Phlox*. Cryptogram cover tends to be low, but some stands may have moderate cover.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*, *Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Chenopodium album*, *Cordylanthus wrightii*, *Packera multilobata*
Herb (field)	*Achnatherum hymenoides*, *Bouteloua gracilis*, *Bromus tectorum*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma*, *Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: These sites were grazed historically and currently are subject to wind erosion and drought stress.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (4 plots: GLCA.0101, GLCA.0502, GLCA.0568, GLCA.0724) and 2008 Accuracy Assessment (3 points: CANY_AA.2159, CANY_AA.2700, CANY_AA.2894).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles

REFERENCES: Bourgeron and Engelking 1994, Bunting 1987, CONHP unpubl. data 2003, 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, Romme et al. 1993, Salas et al. 2009, Salas et al. 2010, Stuever and Hayden 1997a, 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, Warren et al. 1982, Western Ecology Working Group n.d., Wright et al. 1979

Pinus edulis - Juniperus spp. / Cercocarpus montanus - Mixed Shrubs Woodland

Two-needle Pinyon - Juniper species / Alderleaf Mountain-mahogany - Mixed Shrubs Woodland

CODE	CEGL000780
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Southern Rocky Mountain Pinyon-Juniper Woodland (CES306.835)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This broadly defined woodland association is common on the Colorado Plateau, occurring on sheltered colluvial slopes, sandstone hogbacks, dry foothills and mesas from north-central New Mexico and southern Colorado west to the Mogollon Rim of Arizona, and in western Colorado and adjacent Utah. It can be found on any slope position, though lower slopes are less common. 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. The unvegetated surface is characterized by bedrock, large and small rocks, and/or bare soil with little litter. Sandstone or shale are the most common parent materials. This association is characterized by an open to moderately dense tree canopy (10-60% cover) dominated by a combination of *Pinus edulis* and *Juniperus* spp. 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* spp. codominate in most stands, but sometimes one may be more prevalent than the other. The species of *Juniperus* varies with geography and elevation and includes *Juniperus deppeana, Juniperus monosperma, Juniperus osteosperma*, and *Juniperus scopulorum*. 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. Other shrubs may be present, including *Amelanchier* spp., *Artemisia bigelovii, Artemisia tridentata, Ephedra viridis, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Fendlera rupicola, Garrya ovata, Mahonia* spp., *Nolina microcarpa, Quercus gambelii, Quercus grisea, Rhus trilobata*, 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. Extremely open stands of this association, usually occurring on fractured slickrock exposures, may have as little as 5% total vegetation cover and an upper canopy only 2 m tall.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This common woodland commonly occurs within both the park and recreation area and was sampled 750 m north of Grandview Point, 1 km north-northwest of Salt Creek Canyon Trailhead, in the East Fork of Salt Creek Canyon, adjacent to the Salt Creek Trail, in Lavender Canyon, and adjacent to Horse Canyon Road in Canyonlands National Park, and south of Hans Flat Ranger Station in Glen Canyon National Recreation Area.

Globally

This widespread woodland association is found from southern Colorado and north-central New Mexico to the Mogollon Rim of Arizona, north across the Colorado Plateau into western Colorado and adjacent Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland occurs mostly on the steep slopes of plateaus, ridges, and colluvial slopes, or gentle to moderate slopes on canyon rims and ledges. Stands are on slopes that may be as steep as 36 degrees, are generally oriented to the north, and lie between 1597 and 2008 m elevation. Bedrock, rocks and gravel cover most of the unvegetated surface, with lesser cover by litter and biological soil crusts. Soils are rapidly drained sandy loams, clay loams, sandy clay loams, or loamy sands derived from a range of sandstone, shale and derived parent materials.

Globally

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- to 36-degree) 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This pinyon-juniper / mixed shrubs woodland is common within the park and recreation area. Total vegetation cover ranges from 5 to 76%. Stands are characterized by an open canopy, typically 2 to 5 m tall, of *Pinus edulis* and *Juniperus osteosperma* with 1 to 15% cover each. The tall shrub *Cercocarpus montanus* dominates a mixed shrub understory that provides between 1 and 20% cover. Scattered *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. The remainder of the shrub stratum may include scattered individuals of *Fraxinus anomala, Amelanchier utahensis, Quercus gambelii, Purshia stansburiana, Ephedra viridis, Artemisia bigelovii, Symphoricarpos longiflorus, Eriogonum microthecum, Symphoricarpos oreophilus, Yucca angustissima*, and *Opuntia erinacea*. The herbaceous layer provides sparse cover. Graminoids present may include *Achnatherum hymenoides, Pleuraphis jamesii, Poa fendleriana, Leymus salinus, Aristida purpurea*, and *Bouteloua gracilis*. Forbs present may include *Machaeranthera grindelioides, Chamaesyce fendleri, Hymenopappus filifolius, Stenotus armerioides (= Haplopappus armerioides), Cryptantha flava, Tetraneuris acaulis (= Hymenoxys acaulis)*, and *Packera multilobata (= Senecio multilobatus)*. Biological soil crusts are patchy but may contribute up to 27% cover and are generally well-developed.

Globally

This association is characterized by an open to moderately dense tree canopy (10-60% cover) dominated by a combination of *Pinus edulis* and *Juniperus* spp. The canopy averages 2-5 m tall, but some stands may be as tall as 10 m. *Pinus edulis* and *Juniperus* spp. 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 monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus deppeana* is common in southern New Mexico, and *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., *Nolina microcarpa, Purshia stansburiana, Quercus gambelii* (<5% cover), *Quercus grisea, Rhus trilobata, Symphoricarpos oreophilus*, 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, 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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*, *Fraxinus anomala*
Tall shrub/sapling	*Cercocarpus montanus*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma*, *Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Cercocarpus montanus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This is a widely distributed and variable association, found throughout much of the Colorado Plateau, edges of the Colorado Rockies and south into 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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The community is controlled by the northern exposure and sandstone bedrock that provides favorable microhabitats.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (13 plots: CANY 0238, CANY 0386, CANY 0388, CANY 0391, CANY 0411, CANY 0442, CANY 0617, CANY 0621, CANY 0626, CANY 0742, CANY 0755, GLCA 0511, GLCA 0531).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles

REFERENCES: Baker 1983b, Baker 1984a, Baker and Kennedy 1985, Bourgeron and Engelking 1994, Bradley et al. 1992, CONHP unpubl. data 2003, 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. 2003, Hansen et al. 2004d, Hess and Wasser 1982, Isaacson 1967, Johnston 1987, Kennedy 1983a, Larson and Moir 1987, Marr et al. 1979, Medina 1986, Moir 1963, Moir and Carleton 1987, Moir and Ludwig 1979, Pase and Lindenmuth 1971, Romme et al. 1993, Stuever and Hayden 1997a, Thomas et al. 2010, USFS 1981a, USFS 1981b, USFS 1983a, USFS

1985d, USFS 1985e, USFS 1985g, Von Loh et al. 2007, Von Loh et al. 2008, Vories 1974, Western Ecology Working Group n.d., Wright et al. 1979

Pinus edulis - Juniperus spp. / Leymus salinus Woodland

Two-needle Pinyon - Juniper species / Saline Wildrye Woodland

CODE	CEGL002340
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association is widespread throughout the Colorado Plateau, but limited to small stands on specific substrates. Stands tend to occupy the tops, shoulders, upper and middle slopes of ridges, as well as canyon sides. These sites range from moderately to steeply sloping (25-45+ degree slopes), although a minority of stands occur on gentle slopes with gradients not exceeding 6 degrees. Elevations range between 1483 and 2301 m (4865-7550 feet). 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 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. 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. Shrubs are generally present but do not provide enough cover to constitute a stratum. Common species include *Ephedra viridis, Shepherdia rotundifolia, Opuntia* spp., and *Chrysothamnus viscidiflorus*. 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*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland occurs within the park and recreation area and was sampled along the Syncline Loop Trail, on the rim of Upheaval Dome, 500 m northwest of the heliport parking area, adjacent to the main park road, North Flats, near the Dollhouse formations, and in Cross Canyon in Canyonlands National Park, and 500 m east of Cleopatra's Chair in Glen Canyon National Recreation Area.

Globally

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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland occurs on valley sides, canyon slopes, gullies, ledges, ridges, and colluvial slopes. Sites are steep (20- to 32-degree slopes), oriented to the north, and lie between 1601 and 1860 m elevation. Bare soil and rocks cover most of the unvegetated surface, with lesser cover by bedrock, gravel, litter, dead wood and biological soil crusts. Soils are rapidly drained sandy loams, clay loams, or loamy sands derived from a variety of parent materials, including sandstones, shales, and colluvium.

Globally
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, gullies, ledges, and colluvial slopes. These sites range from moderately to steeply sloping (25-45+ degree slopes), although a minority of stands occur on gentle slopes with gradients not exceeding 6 degrees. 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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This pinyon-juniper woodland is moderately common within the park and recreation area. Total vegetation cover ranges from 20 to 35%. Stands are characterized by an open canopy, typically 2 to 10 m tall, of *Pinus edulis* and *Juniperus osteosperma* with 5 to 8% cover, and an herbaceous layer dominated by *Leymus salinus* with between 6 and 18% cover. Scattered *Pinus edulis* and *Juniperus osteosperma* may be present. There is no developed shrub layer, but scattered individuals of *Fraxinus anomala, Purshia stansburiana, Ephedra viridis, Gutierrezia sarothrae, Artemisia bigelovii, Eriogonum microthecum, Chrysothamnus viscidiflorus* var. *stenophyllus*, and *Opuntia erinacea* are commonly present. The remaining herbaceous layer provides little cover but may include many species: *Pleuraphis jamesii, Achnatherum hymenoides, Bromus tectorum, Vulpia octoflora, Poa fendleriana, Stenotus armerioides (= Haplopappus armerioides), Machaeranthera grindelioides, Arenaria fendleri, Erigeron utahensis* var. *sparsifolius, Tetraneuris acaulis (= Hymenoxys acaulis)*, and *Streptanthella longirostris*.

Globally
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. Shrubs are generally present but do not provide enough cover to constitute a stratum. Common species include scattered *Ephedra viridis, Shepherdia rotundifolia, Opuntia* spp., and *Chrysothamnus viscidiflorus*. 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 armerioides), Streptanthella longirostris*, and *Tetraneuris acaulis (= Hymenoxys acaulis)*. *Bromus tectorum* is common in stands that have experienced disturbance from roads or grazing.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Machaeranthera grindelioides*, *Stenotus armerioides*
Herb (field)	*Achnatherum hymenoides*, *Leymus salinus*, *Pleuraphis jamesii*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Herb (field)	*Leymus salinus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High), *Descurainia pinnata* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G3G4 (26-Jan-2006). This association is likely to be somewhat more common than *Juniperus osteosperma / Leymus salinus* 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*.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Slopes are steep and large boulders and small rocks are abundant. There is active colluvial movement downslope. Plants often have accumulations of soil and rock on their uphill sides.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (19 plots: CANY 0102, CANY 0117, CANY 0120, CANY 0121, CANY 0122, CANY 0125, CANY 0328, CANY 0329, CANY 0410, CANY 0451, CANY 0811, GLCA 0134, GLCA 0309, GLCA 0332, GLCA 0583, GLCA 0707, GLCA 0715, GLCA 0756, GLCA 0774).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Baker 1982b, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2010, Romme et al. 1993, Shute and West 1978, Von Loh et al. 2007, Western Ecology Working Group n.d.

Pinus edulis - Juniperus spp. / Quercus gambelii Woodland

Two-needle Pinyon - Juniper species / Gambel Oak Woodland

CODE	CEGL000791
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS - (JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Southern Rocky Mountain Pinyon-Juniper Woodland (CES306.835)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This widespread woodland association is known from the Colorado Plateau and southern Rocky Mountains, occurring from south-central Colorado to south-central New Mexico, west along the Mogollon Rim of Arizona, and north into Utah and western Colorado. 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, 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). The vegetation is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus deppeana* is common in southern New Mexico, and *Juniperus osteosperma* is common in northwestern New Mexico, northern Arizona and in Utah. *Juniperus scopulorum* is more common in higher elevation stands. An occasional *Pinus ponderosa* tree may be present in some 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*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland is moderately common within the park and recreation area and was sampled 200 m west of Squaw Flat Campground, in Salt Creek Canyon, 200 m east of Needles Outpost, in Sugar Canyon, in Davis Canyon, and south of Salt Creek Pocket in Canyonlands National Park, and 300 m northeast of Burro Seep in Glen Canyon National Recreation Area.

Globally

This woodland association occurs in foothills and mesas from southern Colorado to south-central New Mexico, west along the Mogollon Rim of Arizona, and north into Utah and western Colorado.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland occurs on the deep soils of benches, stream terraces, ridges, canyon sides, and valley floors. Sites are gentle to steeply sloping (up to 27 degrees), include all aspects, and lie between 1509 and 1837 m elevation. Litter and exposed soil cover most of the unvegetated surface, with lesser cover by biological soil crusts. Soils are rapidly drained sandy loams, silt loams, or loamy sands derived from alluvial, colluvial or eolian deposits.

Globally

This widespread woodland association is known from the Colorado Plateau and southern Rocky Mountains, occurring from south-central Colorado to south-central New Mexico, west along the Mogollon Rim of Arizona, and north into Utah and western Colorado. 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This bottomland woodland is common within the park and recreation area. Total vegetation cover ranges from 18 to 67%. Stands are characterized by an open canopy, typically 2 to 10 m tall, of *Pinus edulis* and *Juniperus osteosperma* with between 8 and 40% cover. The shrub layer is dominated by scattered, dense clones of *Quercus*

gambelii with between 4 and 40% cover. Scattered *Pinus edulis* and *Juniperus osteosperma* seedlings may be present. Associated shrubs may include *Amelanchier utahensis, Ericameria nauseosa, Ephedra viridis, Mahonia fremontii, Gutierrezia sarothrae, Yucca angustissima*, and *Eriogonum microthecum*. The herbaceous layer provides sparse cover; common species include *Achnatherum hymenoides, Poa fendleriana, Lepidium montanum, Tetraneuris acaulis (= Hymenoxys acaulis)*, and *Machaeranthera grindelioides*.

Globally
This widespread association is characterized by an open to moderately dense tree canopy (10-70% cover) codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus deppeana* is common in southern New Mexico, and *Juniperus osteosperma* is common in northwestern New Mexico, northern Arizona and in 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, Cercocarpus montanus, Symphoricarpos oreophilus*, or species of *Yucca* and *Opuntia* are common shrub associates. Other shrubs, depending on geography, may include *Artemisia tridentata, Artemisia nova, Arctostaphylos patula, Cercocarpus ledifolius, Ephedra viridis, Fendlera rupicola, Gutierrezia sarothrae, Garrya* spp., *Mahonia fremontii, Ptelea trifoliata, Prunus* spp., *Quercus X pauciloba, Robinia neomexicana*, or *Rosa* spp. 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*. Common forbs may include *Artemisia frigida, Balsamorhiza sagittata, Geranium caespitosum, Lepidium montanum, Machaeranthera grindelioides, Packera neomexicana, Thalictrum fendleri, Tetraneuris acaulis*, or *Vicia americana*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Shrub/sapling (tall & short)	*Quercus gambelii*
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Ericameria nauseosa*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Poa fendleriana*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma*, *Juniperus osteosperma*, *Juniperus scopulorum*, *Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*, *Quercus gambelii*
Tall shrub/sapling	*Cercocarpus montanus*
Short shrub/sapling	*Symphoricarpos oreophilus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Chenopodium album* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Community is located on fine, deep soils with a north-facing aspect in a narrower section of canyon, probably providing cooler and moister conditions.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (8 plots: CANY 0221, CANY 0747, CANY 0779, CANY 0786, CANY 0799, CANY 0800, CANY 0809, GLCA 0303).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Bassett 1987, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, 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, Muldavin et al. 1994a, Muldavin et al. 2000b, Romme et al. 1993, Steinhoff 1978, Stuever and Hayden 1997a, 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

Pseudotsuga menziesii / Cercocarpus montanus Woodland

Douglas-fir / Alderleaf Mountain-mahogany Woodland

CODE	CEGL000898
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Conical-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.b.)
ALLIANCE	*PSEUDOTSUGA MENZIESII* WOODLAND ALLIANCE (A.552) Douglas-fir Woodland Alliance

ECOLOGICAL SYSTEM(S): Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This Colorado Plateau woodland association occupies dry, sometimes rocky sites on the slopes of ravines, canyons and mountains in central and southern Utah and northwestern Colorado, where it occurs in isolated stands at the lower end of the *Pseudotsuga menziesii* zone. Sites are gentle to steep (4-30 degree slopes), occur between 1738 and 2575 m (5700-8450 feet) elevation, and are oriented to all aspects, although warm west and south aspects are rare. Rocks, gravel and litter cover most of the unvegetated surface. Parent materials include sandstones and shale, weathering into rapidly drained sandy loams, silt loams or clay loams. Total vegetation cover ranges from 25 to 90%. The 10- to 20-m tall canopy is open and dominated by *Pseudotsuga menziesii* with 10-35% cover. Other trees are generally present in the canopy and subcanopy, including *Juniperus scopulorum, Pinus edulis, Juniperus osteosperma*, and occasionally *Abies concolor*. There is an open shrub layer dominated by *Cercocarpus montanus* with between 5 and 15% cover. Associated shrubs include *Amelanchier utahensis, Cercocarpus intricatus, Ephedra viridis, Fraxinus anomala, Fendlera rupicola, Rhus trilobata, Shepherdia rotundifolia*, and *Symphoricarpos oreophilus*. If *Quercus gambelii* is present, it has less than 5% cover. The herbaceous layer is moderately diverse, provides sparse cover, and includes the graminoids *Carex rossii, Achnatherum hymenoides, Hesperostipa comata, Poa fendleriana*, and *Poa secunda*.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is rare within the park and is represented by one plot located in Lavender Canyon, approximately 1.5 km beyond Cleft Arch.

Globally
This association has been documented from central and southern Utah and northwestern Colorado. It is likely to occur in cool canyons throughout the Colorado Plateau and also in the foothills of southwestern Colorado.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparse forest association was sampled once in an alcove at the head of a deep gully. The site is steep (31 degrees), oriented to the north (24 degrees), and lies at 1773 m elevation. Litter covers most of the unvegetated surface; there is low exposure of bare soil. The soil is a rapidly drained sandy loam derived from alluvium and colluvium.

Globally
This Colorado Plateau woodland association occurs on dry, sometimes rocky sites on the slopes of ravines, canyons and mountains in central and southern Utah and northwestern Colorado. Sites are gentle to steep (4-30 degree slopes), occur between 1738 and 2575 m (5700-8450 feet) elevation, and are oriented to a variety of aspects, although warm west and south aspects are rare. Rocks, gravel and litter cover most of the unvegetated surface. Parent materials include sandstones and shale, weathering into coarse-textured, rapidly drained sandy loams, silt loams or clay loams.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This montane forest association is rare within the park. Total vegetation cover is 24% and is characterized by an open canopy of *Pseudotsuga menziesii* (up to 7% cover) that is as much as 20 m tall. *Juniperus osteosperma* trees contribute sparse cover in the subcanopy; *Pinus edulis* and *Juniperus osteosperma* are the only trees reproducing. The shrub layer is sparse and consists of scattered *Cercocarpus montanus, Amelanchier utahensis, Fraxinus anomala, Fendlera rupicola, Quercus gambelii, Rhus trilobata, Symphoricarpos longiflorus, Ephedra viridis, Yucca harrimaniae*, and *Yucca angustissima*. The herbaceous layer is sparse and depauperate. Bunch grasses include *Hesperostipa comata* and *Poa fendleriana*, while forbs common to this habitat include *Packera multilobata (= Senecio multilobatus)* and *Lepidium montanum*.

Globally
This woodland association occurs in isolated stands at the lower end of the *Pseudotsuga menziesii* zone in Utah (Youngblood and Mauk 1985) and northwestern Colorado. Total vegetation cover ranges from 25 to 90%. The 10- to 20-m tall canopy is open and dominated by *Pseudotsuga menziesii* with 10-35% cover. Other trees are generally present in the canopy and subcanopy, including *Juniperus scopulorum, Pinus edulis, Juniperus osteosperma*, and occasionally *Abies concolor*. There is an open shrub layer dominated by *Cercocarpus montanus* with between 5 and 15% cover. Associated shrubs include *Amelanchier utahensis, Cercocarpus intricatus, Ephedra viridis, Fraxinus anomala, Fendlera rupicola, Rhus trilobata, Shepherdia rotundifolia, Symphoricarpos oreophilus, Yucca harrimaniae*, and *Yucca angustissima*. If *Quercus gambelii* is present, it has less than 5% cover. The herbaceous layer is moderately diverse, provides sparse cover, and includes the graminoids *Carex rossii, Achnatherum hymenoides, Achnatherum nelsonii, Hesperostipa comata, Poa fendleriana*, and *Poa secunda*. Common forbs include *Eriogonum umbellatum, Lepidium montanum*, and *Packera multilobata (= Senecio multilobatus)*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Cercocarpus montanus*
Short shrub/sapling	*Rhus trilobata*, *Symphoricarpos longiflorus*

Globally

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*

Tall shrub/sapling *Cercocarpus montanus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G4? (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Because the shrub layer is somewhat mixed, it may sometimes be difficult in the field to distinguish this association from the broadly defined but somewhat more mesic *Pseudotsuga menziesii / Symphoricarpos oreophilus* Forest (CEGL000462).

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This mostly north-facing area below an alcove of Lavender Canyon receives runoff from adjacent cliffs, which provide enough soil moisture to support *Pseudotsuga menziesii*.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0614).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Clark et al. 2009, Coles et al. 2008a, Driscoll et al. 1984, Romme et al. 1993, Western Ecology Working Group n.d., Youngblood and Mauk 1985

Pseudotsuga menziesii Scree Woodland

Douglas-fir Scree Woodland

Douglas-fir Scree Slope

CODE	CEGL000911
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Conical-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.b.)
ALLIANCE	*PSEUDOTSUGA MENZIESII* WOODLAND ALLIANCE (A.552) Douglas-fir Woodland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Cliff, Canyon and Massive Bedrock (CES306.815)
Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
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. It has the appearance of a stand of scattered trees with a sparse

understory; the vegetation is limited by the lack of soil development. Slopes generally exceed 30 degrees 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 2180 m (3100-7150 feet), and sites are usually limited to warm, south- to west-facing slopes in canyons. In northern Arizona, stands occur on various aspects around 2930 m (9600 feet) elevation, and in southern Colorado stands have been documented at around 2560 m (8400 feet). Most of the unvegetated ground surface is covered by rocks and boulders, with small amounts of litter and dead wood. Soils are poorly developed and often too rocky to sample. 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, Juniperus communis, Dasiphora fruticosa* ssp. *floribunda, Holodiscus dumosus, Prunus virginiana, Ribes inerme, Ribes montigenum, Salix scouleriana, Shepherdia canadensis, Shepherdia rotundifolia*, and *Symphoricarpos oreophilus*. Herbaceous species are sparse and inconsistent among sites.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association is rare within the park and recreation area and was represented by one plot located in upper Salt Creek in Canyonlands and one located in the head of a canyon 750 m southwest of Observation Rock summit in the recreation area.

Globally
This association has been documented from sites scattered throughout the interior western U.S., including Montana, Utah, New Mexico, Arizona and Colorado.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland was sampled on a colluvial slope at the head of a canyon. Sites are moderately steep to steep (7-22 degrees), oriented to the west or north, and lie between 1768 and 1879 m elevation. Most of the unvegetated surface is covered by litter, with moderate cover of dead wood, bare soil, and scattered moss-covered boulders. Soils are rapidly drained loamy sands derived from colluvium.

Globally
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 30 degrees 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 2180 m (3100-7150 feet), and sites are usually limited to warm, south- to west-facing slopes in canyons. In northern Arizona, stands occur on various aspects around 2930 m (9600 feet) elevation, and in southern Colorado stands have been documented at around 2560 m (8400 feet). Most of the unvegetated ground surface is covered by rocks and boulders, with small amounts of litter and dead wood. Soils are poorly developed and often too rocky to sample.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This Douglas-fir scree woodland is rare within the park and recreation area. Total vegetation cover is 21-54% and is characterized by a tree layer of *Pseudotsuga menziesii* with 10-40% 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 *Amelanchier utahensis, Quercus gambelii, Fraxinus anomala, Mahonia fremontii, Shepherdia rotundifolia*, *Cercocarpus intricatus,* and *Rosa woodsii*. The herbaceous layer is sparse and depauperate; only unknown species of *Achnatherum* and *Penstemon* were recorded.

Globally
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, Juniperus communis, Dasiphora fruticosa* ssp. *floribunda, Holodiscus dumosus, Prunus virginiana, Ribes inerme, Ribes montigenum, Salix scouleriana, Shepherdia canadensis, Shepherdia rotundifolia*, and *Symphoricarpos oreophilus*. Herbaceous species are sparse and inconsistent among sites.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Shepherdia rotundifolia*
Short shrub/sapling	*Mahonia fremontii*

Globally

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) 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.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: GLCA.0702) and 2008 Accuracy Assessment (1 point: CANY_AA.3236).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles

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, Thomas et al. 2010, Western Ecology Working Group n.d.

Acer negundo / Disturbed Understory Woodland

Box-elder / Disturbed Understory Woodland

CODE	CEGL002693
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*ACER NEGUNDO* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.642) Box-elder Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This riparian association is found in the Colorado Plateau and other areas of the southwestern U.S. 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. The tree canopy of this association is open to moderately closed and 5-15 m tall. The dominant tree species is *Acer negundo* with scattered *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 chinensis*, 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*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This community was sampled on the east bank of the Colorado River north of The Loop, at the mouth of Elephant Canyon, and near the confluence with the Green River.

Globally

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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association occurs on intermittently flooded river terraces. Sites are flat to steep (36-degree slope), oriented to the west (288 degrees), and lie between 1156 and 1603 m elevation. The unvegetated surface has high cover of litter, downed wood and sparse to moderate exposure of bare soil. Parent materials are sandstones and shale that have eroded and redeposited as alluvium. The soil is a well-drained silt.

Globally

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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This riparian woodland is rare within the park. Total vegetation cover ranges from 63% to nearly 100% and is characterized by an open to closed canopy of 2- to 10-m tall *Acer negundo* trees with between 15% and 80% cover. The shrub layer contributes 5-48% cover and includes *Forestiera pubescens, Salix exigua* and the invasive species *Tamarix chinensis*. The herbaceous layer contributes 3-70% cover and includes *Phragmites australis,* the non-native annual grass *Bromus tectorum,* and the forbs *Lepidium alyssoides* var. e*astwoodiae* and *Stanleya pinnata*.

Globally
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 chinensis*, 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* is common. Other typical components of the herbaceous stratum are *Heterotheca villosa, Poa pratensis, Lepidium latifolium, Sisymbrium altissimum, Taraxacum officinale*, and *Verbascum thapsus*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Acer negundo*
Tall shrub/sapling	*Forestiera pubescens*, *Tamarix chinensis*
Herb (field)	*Stanleya pinnata*

Globally

Stratum	Species
Tree canopy	*Acer negundo*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Tamarix chinensis* (exotic)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Poa pratensis* (exotic, Medium)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (14-Aug-2001).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This steep terrace near the confluence of the Green and Colorado rivers supports *Acer negundo* with only young *Tamarix chinensis* present near the bank. Cracks from dried soil exist in some areas. There are several dead and downed *Acer negundo* trees, although the live ones appear healthy.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY.0610, CANY.9550, CANY.9551), and 2008 Accuracy Assessment (2 points: CANY_AA.1031, CANY_AA.1064).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Drake, mod. J. Coles and K.A. Schulz

REFERENCES: Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2010, Salas et al. 2010, Thomas et al. 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.

Fraxinus anomala Woodland

Singleleaf Ash Woodland

CODE	CEGL002752
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*FRAXINUS ANOMALA* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.2511) Singleleaf Ash Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)
Rocky Mountain Subalpine-Montane Riparian Shrubland (CES306.832)
Inter-Mountain Basins Wash (CES304.781)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This locally occurring association is found in deep canyons and mountains on the Colorado Plateau in Utah and western Colorado between 1430 and 2043 m (4700-6700 feet) elevation. This vegetation is 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. The vegetation is characterized by a moderately dense (30-50%) cold-deciduous tall-shrub (2-5 m) canopy that is dominated by *Fraxinus anomala* with *Amelanchier alnifolia* and *Quercus gambelii* frequent associates. There may be a sparse short-shrub stratum composed of species such as *Ephedra viridis, Ericameria nauseosa, Holodiscus dumosus, Rhus trilobata, Symphoricarpos rotundifolius*, and the vine *Vitis arizonica*. Herbaceous species are variable and contribute minimal cover.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association is rare within the park and was sampled on the White Rim 150 m southeast of the Millard Canyon Campground, in a side canyon of Anderson Bottom, and in Trail Canyon.

Globally

This woodland association occurs in canyons and mountains on the Colorado Plateau in southwestern Utah and western Colorado, and may occur in similar habitats in Arizona and New Mexico.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association occurs on the thin soils of slickrock canyon rims, in drainages on steep, colluvial slopes, or along intermittently flooded wash channels. Sampled sites are flat to steeply sloping (0-24 degrees), oriented to the east and northeast, and lie between 1197 m and 1410 m elevation. Bedrock, large rocks, and/or sand cover most of the unvegetated ground cover. The soil is a rapidly drained loamy sand derived from White Rim sandstone.

Globally

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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This unusual woodland type is rare within the park. Total vegetation is limited by the degree of bedrock fracturing or exposed niches for plant rooting in general and rarely exceeds 8%. The canopy consists of *Fraxinus anomala* (with up to 6% cover and between 1 and 2 m tall), growing with scattered individuals of *Rhus trilobata, Ericameria nauseosa, Ephedra torreyana, Coleogyne ramosissima, Shepherdia rotundifolia, Gutierrezia microcephala* or *sarothrae*, and *Brickellia microphylla* or *longifolia*. Herbaceous species are moderately diverse but contribute only sparse cover. Common bunch grasses include *Aristida purpurea, Achnatherum hymenoides*, *Sporobolus* sp. and *Pleuraphis jamesii*. Forbs include *Hymenopappus filifolius, Machaeranthera grindelioides, Lepidium montanum, Amsonia tomentosa, Grindelia* sp., *Eriogonum inflatum*, and *Tetraneuris acaulis (= Hymenoxys acaulis)*.

Globally

This association is characterized by a moderately dense (30-50%) cold-deciduous tall-shrub canopy that is typically 2-5 m tall and dominated by *Fraxinus anomala*. Associated tall shrubs include *Amelanchier alnifolia* and *Quercus gambelii*, (which is codominant in at least one stand). Taller trees are sometimes present and include *Juniperus osteosperma, Pinus edulis*, or *Pseudotsuga menziesii*. Short shrubs contribute low cover and include *Ephedra viridis, Ericameria nauseosa, Holodiscus dumosus, Rhus trilobata, Symphoricarpos rotundifolius*, and the vine *Vitis arizonica*. Herbaceous species are variable and contribute minimal cover. Common species include *Achnatherum hymenoides, Artemisia ludoviciana*, Asteraceae spp., *Bromus tectorum, Elymus elymoides, Eriogonum* spp., and *Poa fendleriana*.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Fraxinus anomala*
Herb (field)	*Brickellia microphylla*
Herb (field)	*Hymenopappus filifolius*

Globally

Stratum	Species
Tall shrub/sapling	*Amelanchier alnifolia*, *Fraxinus anomala*, *Quercus gambelii*
Short shrub/sapling	*Ericameria nauseosa*, *Rhus trilobata*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GUQ (26-Jun-2001).

CLASSIFICATION COMMENTS

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally

This association is known from only a few scattered locations: the Roan Plateau and Colorado National Monument in western Colorado, Zion National Park, and Capitol Reef National Park. 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.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The sampled plot is located in typical slickrock rim environment: lots of bare exposed slickrock with pockets of sandy soil in fractures, low spots, and bedding troughs. Large shrubs are no doubt rooted in fractures, smaller vegetation in the thin soils.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY.0831, CANY.9046, CANY.9329).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: G. Kittel, mod. J. Drake and J. Coles

REFERENCES: CONHP 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.

Populus fremontii / Distichlis spicata Woodland [Provisional]

Fremont Cottonwood / Inland Saltgrass Woodland

CODE	CEGL003998
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*POPULUS FREMONTII* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.644) Fremont Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): North American Warm Desert Riparian Woodland and Shrubland (CES302.753)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This rare woodland association is known from intermittently flooded washes and stream terraces on flat to gently sloping sites in Canyonlands National Park. More information may be added in the future after additional inventory and classification work are done. In Canyonlands, it occurs at elevations from 1293 to 1432 m over moderately well-drained to rapidly drained sandy loams or loamy sands derived from alluvium. *Populus fremontii* is the dominant species and forms open canopies 10-15 m tall. Shrubs are present but sparse and include *Tamarix chinensis, Ericameria nauseosa, Chrysothamnus viscidiflorus, Atriplex canescens, Sarcobatus vermiculatus*, and *Gutierrezia sarothrae*. The herbaceous layer is dominated by *Distichlis spicata*. Other herbaceous associates include *Sporobolus airoides, Achnatherum hymenoides, Bromus tectorum*, and *Juncus balticus*. Forbs include *Lepidium montanum, Ambrosia acanthicarpa, Salsola tragus, Chenopodium album, Iva acerosa, Conyza canadensis, Oenothera pallida*, and *Stanleya pinnata*.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association is rare within the park and was sampled only 500 m from the Taylor Canyon road in Big Draw and in Horseshoe Canyon upstream of the Great Gallery.

Globally
This association is known only from Canyonlands National Park in Utah.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association occurs in intermittently flooded washes and stream terraces. Sites are flat to gently sloped and lie between 1293 and 1432 m elevation. Litter covers most of the unvegetated surface. Soils are moderately well-drained to rapidly drained sandy loams or loamy sands derived from alluvium.

Globally
This association is documented from a single occurrence and will require further documentation to develop a thorough global description.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This cottonwood woodland type is rare within the park. Total vegetation cover ranges from 39 to 50%. The 10- to 15-m tall canopy is open; *Populus fremontii* contributes between 20 and 35% cover. Shrubs are generally present but do not constitute a layer; common species present include *Tamarix chinensis, Ericameria nauseosa, Chrysothamnus viscidiflorus, Atriplex canescens, Sarcobatus vermiculatus*, and *Gutierrezia sarothrae*. The herbaceous layer is dominated by *Distichlis spicata* with between 5 and 9% cover. Additional graminoids include *Sporobolus airoides, Achnatherum hymenoides, Bromus tectorum*, and *Juncus balticus*. Forbs include *Lepidium montanum, Ambrosia acanthicarpa, Salsola tragus, Chenopodium album, Iva acerosa, Conyza canadensis, Oenothera pallida*, and *Stanleya pinnata*.

Globally
This association is documented from a single occurrence and will require further documentation to develop a thorough global description.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Populus fremontii*
Herb (field)	*Distichlis spicata*, *Juncus balticus*, *Sporobolus airoides*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Conyza canadensis* (exotic), *Salsola tragus* (exotic), *Tamarix chinensis* (exotic), *Xanthium strumarium* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jul-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The main wash channel holds stagnant water and probably has puddles most of the year. Flooding would impact the lower end of this site closest to the wash. Occasional major floods would affect the area where trees occur.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY.0141, CANY.0226).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: M.S. Reid

REFERENCES: Western Ecology Working Group n.d.

Populus fremontii / Equisetum spp. Woodland [Provisional]

Fremont Cottonwood / Horsetail species Woodland

CODE	CEGL003775
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*POPULUS FREMONTII* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.644) Fremont Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This deciduous riparian woodland is found in the Colorado Plateau in southeastern Utah, where it occurs along narrow streams, on low alluvial terraces in canyon bottoms and intermittently flooded wash bottoms with a high water table. These sites flood periodically and generally have a high water table or flowing water during the growing season. Sampled sites slope gently (not exceeding 3%) at 1421-1536 m elevation. The unvegetated surface has high cover of litter. Soils are rapidly drained sandy loams derived from alluvium. The vegetation is characterized by an open tree canopy, typically 15-20 m tall, of *Populus fremontii* trees with up to 45% cover, with the understory dominated by the fern ally *Equisetum hyemale* (up to 35% cover). Flood scouring removes most vegetation except for *Equisetum* sp. Scattered shrubs and other trees species may be present, including *Juniperus osteosperma, Forestiera pubescens, Rhus trilobata, Salix exigua*, and *Salix lutea*, but do make a distinct shrub layer. The sparse to moderately dense herbaceous layer is moderately diverse in species composition. Other herbaceous species include relatively mesic species such as *Juncus balticus, Maianthemum stellatum, Artemisia ludoviciana* and exotic forage species *Medicago sativa, Melilotus officinalis*, and *Poa pratensis*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland is rare within the park and was sampled in Salt Creek approximately 500 m upstream of Peekaboo Camp, in Lost Canyon, and in Horseshoe Canyon.

Globally

This association is known only from Arches and Canyonlands national parks in southeastern Utah but likely occurs elsewhere in the southwestern U.S. along rivers and streams with periodic flooding.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association was sampled in an intermittently flooded wash bottom with a high water table, on a stream terrace, and on a canyon floor. The sites are flat to gently sloping and lie between 1442 and 1544 m elevation. Litter covers most of the unvegetated surface, with lesser cover by exposed bare soil and sand. Soils are rapidly drained loamy sands derived from alluvium.

Globally

This deciduous riparian woodland is known from drainages in the Colorado Plateau in southeastern Utah. Stands occur in intermittently flooded wash bottoms with a high water table, along narrow streams and on low alluvial terraces in canyon bottoms. These sites flood periodically and generally have a high water table or flowing water during the growing season. Sampled sites are gently sloping (not exceeding 3%) and range from 1421-1536 m elevation. The unvegetated surface has high cover of litter. Soils are rapidly drained sandy loams derived from alluvium.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This Fremont cottonwood woodland type is rare within the park. Total vegetation cover ranges from 21% to nearly 100%. The canopy is well-developed, consisting of *Populus fremontii* trees with 7 to 30% cover and 10-15 m tall. *Salix goodingii* can sometimes be codominant in the canopy, with up to 15% cover. *Equisetum laevigatum* dominates the understory with 5 to 20% cover. Shrubs are present but do not provide enough cover to constitute a stratum; *Salix lutea, Forestiera pubescens*, and *Salix exigua* may be present. *Clematis ligusticifolia* provides up to 10% cover. Other herbaceous species include *Juncus balticus, Elymus canadensis* (up to 20% cover), *Sporobolus airoides, Phragmites australis, Solidago canadensis, Maianthemum stellatum, Comandra umbellata, Cirsium calcareum*, and *Artemisia ludoviciana*.

Globally
This riparian woodland is characterized by an open to moderate tree canopy (30-45% cover), typically 10-20 m tall, of *Populus fremontii* trees. The understory is dominated by the fern ally *Equisetum hyemale* (20-35% cover). Flood scouring removes most vegetation except for *Equisetum* sp. Scattered shrubs and other trees species may be present, including *Juniperus osteosperma, Forestiera pubescens, Rhus trilobata* var. *trilobata, Salix exigua*, and *Salix lutea*, but do make a distinct shrub layer. The vine *Clematis ligusticifolia* is usually present and may provide up to 10% cover. The sparse to moderately dense herbaceous layer is moderately diverse in species composition. Other herbaceous species include *Juncus balticus, Maianthemum stellatum, Artemisia ludoviciana, Comandra umbellata, Cirsium calcareum, Glycyrrhiza lepidota*, and exotic forage species *Medicago sativa, Melilotus officinalis*, and *Poa pratensis*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Populus fremontii*
Tall shrub/sapling	*Salix lutea*
Herb (field)	*Clematis ligusticifolia*
Herb (field)	*Maianthemum stellatum*
Herb (field)	*Equisetum laevigatum*

Globally

Stratum	Species
Tree canopy	*Populus fremontii*
Herb (field)	*Equisetum hyemale*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (16-Mar-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Populus fremontii / Scour Forest (CEGL005978) is very similar to this type. More sampling is needed to clarify differences.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Plot is located in a wide, flat wash bottom. Although the water table here is undoubtedly high, surface moisture

clearly arrives in the form of rain runoff. Canyon walls and rims surrounding the area must shed most of the rain collected in this canyon wash.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY.0741, CANY.9056, CANY.9363).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: K.A. Schulz

REFERENCES: Coles et al. 2009a, Western Ecology Working Group n.d.

Populus fremontii / Ericameria nauseosa Woodland

Fremont Cottonwood / Rubber Rabbitbrush Woodland

CODE	CEGL002465
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*POPULUS FREMONTII* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.644) Fremont Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)
North American Warm Desert Riparian Woodland and Shrubland (CES302.753)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This common woodland association occurs on the high terraces of perennial streams and on the banks of intermittent washes throughout the Colorado Plateau on sites that are rarely subject to flooding. Sites are level to gently sloping and are located between 1165 and 2165 m (3825-7100 feet) elevation. Soils are poorly developed, well-drained sands and loamy sands derived from alluvium. 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, Salix gooddingii*, 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 is low to moderate in terms of species composition and cover. *Ericameria nauseosa* dominates or codominates the stratum, often with *Artemisia tridentata* ssp. *tridentata*. Other shrubs may be scattered through the stand, including *Rhus trilobata, Sarcobatus vermiculatus, Opuntia* spp., *Forestiera pubescens, Atriplex canescens*, and *Fraxinus anomala*. The exotic *Tamarix chinensis* 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, Agrostis stolonifera, Bromus tectorum, Bromus japonicus, Elymus canadensis, Sporobolus* spp., and *Juncus balticus*. Forbs commonly present include *Ambrosia acanthicarpa, Artemisia campestris, Castilleja linariifolia, Equisetum hyemale, Lepidium montanum, Sphaeralcea* spp., and *Heterotheca villosa*.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland is distributed on low-lying sites within the park and was observed along the Green River, adjacent to Lost Canyon Trail, in Lockhart, Lathrop, Lavender, Horse, and Horseshoe canyons, along the Colorado River, and along the Salt Creek drainage.

Globally
This association has been described from eastern Utah and Arizona. It is likely to be widespread throughout the Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association occurs on intermittently flooded low-lying areas including valley floors, stream terraces, and canyon bottoms. Sites are flat or slope gently between 1165 and 1688 m elevation. The unvegetated surface is mostly either litter or bare ground; one site had high cover of woody debris. Soils are rapidly drained loams, sands, or loamy sands derived from alluvium or eolian deposits.

Globally

This common woodland association occurs on the high terraces of perennial streams and on the banks of intermittent washes throughout the Colorado Plateau. These habitats are rarely subject to flooding. Sites are level to gently sloping and are located between 1165 and 2165 m (3825-7100 feet) elevation. Aspect is not important in determining the distribution of this association. Bare soil and litter cover most of the unvegetated surface. Soils are poorly developed, well-drained sands and loamy sands derived from alluvium.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This Fremont cottonwood woodland type grows in many drainages and low-lying areas within the park. Total vegetation cover ranges from 11 to 82% depending on the length of time stands have been isolated from the water table. Stands are characterized by a canopy between 5 and 20 m tall of *Populus fremontii* trees with between 6 and 60% cover. *Populus fremontii* seedlings are rare and provide sparse cover. The understory is dominated by *Ericameria nauseosa* with between 1 and 13% cover. Other shrubs present include scattered individuals of *Forestiera pubescens*, as well as *Atriplex canescens, Artemisia tridentata* ssp*. tridentata, Artemisia filifolia, Rhus trilobata, Sarcobatus vermiculatus, Gutierrezia sarothrae, Atriplex gardneri, Opuntia polyacantha*, and *Yucca angustissima*. The herbaceous layer is diverse but provides only sparse cover. Common herbs include *Achnatherum hymenoides, Bromus tectorum, Sporobolus cryptandrus, Pleuraphis jamesii, Poa fendleriana, Artemisia campestris, Heterotheca villosa, Artemisia ludoviciana, Dalea candida* var. *oligophylla (= Dalea oligophylla), Hymenopappus filifolius, Ipomopsis aggregata, Lepidium montanum, Machaeranthera grindelioides, Iva acerosa*, and *Sphaeralcea parvifolia*.

Globally

This woodland association is common throughout the Colorado Plateau, where it occupies dry terraces along intermittent and perennial stream courses. Total vegetation cover ranges from 27 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, Salix gooddingii*, 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 is low to moderate in terms of species composition and cover. *Ericameria nauseosa* dominates or codominates the stratum, often with *Artemisia tridentata* ssp*. tridentata*. Other shrubs may be scattered through the stand, including *Rhus trilobata, Sarcobatus vermiculatus, Opuntia* spp., *Forestiera pubescens, Atriplex canescens, Fraxinus anomala*, and in the southern extent *Parryella filifolia* and *Isocoma drummondii*. The exotic *Tamarix chinensis* 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, Agrostis stolonifera, Bromus tectorum, Bromus japonicus, Elymus canadensis, Sporobolus airoides*, and *Juncus balticus*. Forbs commonly present include *Ambrosia acanthicarpa, Artemisia campestris, Castilleja linariifolia, Equisetum hyemale, Lepidium montanum, Sphaeralcea* spp., and *Heterotheca villosa*.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Populus fremontii*
Short shrub/sapling	*Ericameria nauseosa*
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Artemisia campestris*, *Salsola tragus*
Herb (field)	*Achnatherum hymenoides*, *Bromus tectorum*, *Sporobolus cryptandrus*

Globally

Stratum	Species
Tree canopy	*Populus fremontii*
Short shrub/sapling	*Atriplex canescens*, *Ericameria nauseosa*
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Artemisia campestris*
Herb (field)	*Achnatherum hymenoides*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Hordeum jubatum* (exotic), *Salsola tragus* (exotic)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Tamarix chinensis* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (24-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The water table is very close to the surface, but the area is subject to flooding only in very high water events. The area is highly disturbed by cattle and humans.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (13 plots: CANY 0207, CANY 0215, CANY 0228, CANY 0589, CANY 0593, CANY 0596, CANY 0597, CANY 0624, CANY 0670, CANY 0672, CANY 0762, CANY 0822, CANY 0838).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Thomas et al. 2009a, Western Ecology Working Group n.d.

Populus fremontii / Mesic Forbs Woodland

Fremont Cottonwood / Mesic Forbs Woodland

CODE	CEGL002470
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE (A.644)	*POPULUS FREMONTII* TEMPORARILY FLOODED WOODLAND ALLIANCE Fremont Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)
North American Warm Desert Lower Montane Riparian Woodland and Shrubland (CES302.748)
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland (CES304.045)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This woodland association is documented along low-gradient perennial and intermittent streams, in mesic valley bottoms and below springs in southeastern Utah. 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. Sites slope gently (less than 5%) and are located between 1530 and 1890 m (5020-6200 feet) elevation. Soils are typically somewhat poorly drained fine sands in these temporarily flooded sites and are derived from alluvium and colluvium. 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* and the exotic 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 height of the water table. Documented species with significant cover include *Iva acerosa, Maianthemum stellatum, Equisetum arvense*, and *Equisetum laevigatum*. Graminoids are low in cover and include *Juncus balticus, Phragmites australis*, and *Schoenoplectus americanus*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland is rare within the park and was sampled approximately 3.2 km (2 miles) below the North Fork of Syncline Trail, in the upper part of Horseshoe Canyon, and in Lost Canyon.

Globally

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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association was sampled on an intermittently flooded drainage bottom near a perennial spring, on a bench of a wash, and in a canyon bottom. Sites are flat and lie between 1428 m and 1530 m elevation. Litter, bare soil, or sand covers most of the unvegetated surface with sparse exposure of small rocks. The soil is a moderately well-drained loamy sand derived from alluvium.

Globally

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 1530 and 1890 m (5020-6200 feet) elevation. Soils are typically somewhat poorly drained fine sands in these temporarily flooded sites and are derived from alluvium and colluvium.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This Fremont cottonwood woodland type is rare within the park. Total vegetation cover is 35-95% and is characterized by a canopy between 5 and 20 m tall of *Populus fremontii* trees with up to 22-30% cover. The understory is dominated by a carpet of *Maianthemum stellatum* or *Iva acerosa,* or by a variety of forbs with low cover, including *Xanthium strumarium, Senecio* sp., *Conyza canadensis, Equisetum laevigatum, Taraxacum officinale, Artemisia dracunculus, Cirsium* sp., *Solidago* sp., and *Lactuca serriola*. Shrubs are present but do not have enough cover to constitute a layer; common species include *Ericameria nauseosa, Chrysothamnus linifolius, Salix* sp., *Tamarix chinensis, Rosa woodsii*, and *Forestiera pubescens*. The riparian vine *Clematis ligusticifolia* contributes sparse cover. Associated graminoid species include *Phragmites australis, Poa bigelovii, Elymus canadensis, Achnatherum speciosum, Distichlis spicata,* and *Juncus balticus.*

Globally
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. Documented species with significant cover include *Iva acerosa, Maianthemum stellatum, Equisetum arvense*, and *Equisetum laevigatum*. Graminoids are low in cover and include *Juncus balticus, Phragmites australis*, and *Schoenoplectus americanus*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Populus fremontii*
Herb (field)	*Maianthemum stellatum*
Herb (field)	*Juncus balticus*
Herb (field)	*Equisetum laevigatum*

Globally

Stratum	Species
Tree canopy	*Populus fremontii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Taraxacum officinale* (exotic)

Globally
Exotic/Invasive: *Tamarix chinensis* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (24-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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 non-graminoid herbaceous species, where there is no consistent dominant or diagnostic element.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The plant community is dependent on the mesic drainage bottom and possibly the alluvial soils. Drainage has a little standing water but is not flowing.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0172) and 2007 and 2008 Accuracy Assessment (2 points: CANY_AA.0865, CANY_AA.3203).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles

REFERENCES: Clark et al. 2009, Romme et al. 1993, Western Ecology Working Group n.d.

Populus fremontii / Mesic Graminoids Woodland

Fremont Cottonwood / Mesic Graminoids Woodland

CODE	CEGL002473
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*POPULUS FREMONTII* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.644) Fremont Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)
North American Warm Desert Lower Montane Riparian Woodland and Shrubland (CES302.748)
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland (CES304.045)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This woodland association occurs on the banks of intermittent and perennial streams, in seepy areas on valley bottoms and in active floodplains in southeastern Utah. 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 1438 and 1768 m (4715-5800 feet) elevation. Soils are typically somewhat poorly drained fine sands derived from alluvium. Total vegetation cover generally exceeds 50%. The vegetation is characterized by an open canopy of *Populus fremontii* trees that range in cover from 25 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, and 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 species is characteristic of this type, but significant species recorded from sampled sites include *Equisetum* spp., *Juncus balticus, Juncus ensifolius, Muhlenbergia asperifolia*, and *Polypogon viridis*. Forbs are present but are inconsistent and provide low cover.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association is uncommon within the park and was sampled in Horse, Lost and Horseshoe canyons, near Peekaboo Spring, on the Syncline Tail, and 300 m southeast of the Upper Jump area.

Globally

This association has been described from a few locations in southeastern Utah. It is likely more widespread, although not common, throughout the Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association occurs in intermittently flooded low-lying areas of canyon bottoms, wash banks, and floodplains. Sites are either flat or slope gently and lie between 1321 and 1700 m elevation. Litter and sand cover most of the unvegetated surface, with moderate exposure of bare soil and sparse cover of downed wood, rocks, and gravel. Soils are moderately well-drained to rapidly drained clay loams or sandy loams derived from alluvium.

Globally

This woodland association occurs on the banks of intermittent and perennial streams, in seepy areas on valley bottoms and in active floodplains in southeastern Utah. 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 1438 and 1768 m (4715-5800 feet) elevation. Soils are typically somewhat poorly drained fine sands derived from alluvium.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This Fremont cottonwood woodland type is uncommon within the park. Total vegetation cover ranges from 17 to 100%. The canopy, typically 10-20 m tall, is of *Populus fremontii* trees with 20 to 80% cover, and an understory of mesic perennial graminoids ranging in cover from 8 to 30%. Characteristic species include *Phragmites australis, Typha domingensis, Elymus canadensis, Juncus balticus*, and the scouring-rush *Equisetum arvense*. Scattered *Juniperus osteosperma* trees may occasionally contribute to a subcanopy layer. Shrubs contribute only sparse to low cover and may include scattered *Salix exigua, Salix lutea, Tamarix chinensis, Rhus trilobata, Ericameria nauseosa, Artemisia tridentata* ssp. *tridentata*, and *Atriplex confertifolia*. Associated herbaceous species contributing low cover include *Achnatherum hymenoides, Panicum virgatum, Poa pratensis, Sporobolus airoides, Bromus tectorum, Poa fendleriana, Solidago* sp., *Cirsium arvense, Ambrosia acanthicarpa, Artemisia campestris, Artemisia ludoviciana*, and *Heterotheca villosa*. *Clematis ligusticifolia* provides sparse cover.

Globally
This woodland association is documented only from southeastern Utah but is likely to occur in small patches throughout the Colorado Plateau. Total vegetation cover generally exceeds 50%. This woodland association is characterized by an open canopy of *Populus fremontii* trees that range in cover from 25 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, and 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 species is characteristic of this type, but significant species recorded from sampled sites include *Equisetum* spp., *Juncus balticus, Juncus ensifolius, Muhlenbergia asperifolia*, and *Polypogon viridis*. Forbs are present but are inconsistent and provide low cover.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Populus fremontii*
Tall shrub/sapling	*Salix exigua*
Short shrub/sapling	*Ericameria nauseosa*
Herb (field)	*Clematis ligusticifolia*
Herb (field)	*Juncus balticus*, *Phragmites australis*
Herb (field)	*Equisetum arvense*

Globally

Stratum	Species
Tree canopy	*Populus fremontii*
Herb (field)	*Juncus balticus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Elymus trachycaulus* (exotic), *Phragmites australis* (exotic, High), *Poa pratensis* (exotic, Medium), *Tamarix chinensis* (exotic), *Xanthium strumarium* (exotic)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Dactylis glomerata* (exotic, Medium/Insignificant), *Melilotus officinalis* (exotic, Medium/Low), *Tamarix chinensis* (exotic), *Trifolium repens* (exotic, Medium/Low)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (24-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: These Fremont cottonwood groves appear to be in the main drainageways of the canyons, and water apparently flows through here in a wide stream. Sites are subject to overbank flooding that may cause erosion and channel movement over time.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (8 plots: CANY.0385, CANY.0638, CANY.0759, CANY.9059, CANY.9060, CANY.9338, CANY.9510, CANY.9737).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles

REFERENCES: Clark et al. 2009, Romme et al. 1993, Western Ecology Working Group n.d.

Populus fremontii / Salix (ligulifolia, lutea) Woodland

Fremont Cottonwood / (Strapleaf Willow, Yellow Willow) Woodland

CODE	CEGL004002
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*POPULUS FREMONTII* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.644) Fremont Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): North American Warm Desert Riparian Woodland and Shrubland (CES302.753)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This woodland association is known from narrow stream terraces and intermittently flooded drainage bottoms in Canyonlands National Park and Natural Bridges National Monument. Occurrences range from 1555 to 1910 m of elevation on flat, moderately well- to rapidly drained substrates of sands or loamy sands derived of alluvium. Bare ground, litter, and bare sand occupy most of the unvegetated surface. The vegetation of these stands is characterized by open canopies of *Populus fremontii* with a moderately dense to dense shrub layer dominated by *Salix lutea*. Other shrub associates include *Salix exigua, Mahonia fremontii, Tamarix chinensis*, and *Rhus trilobata*. The herbaceous layer may be patchy to dense depending on shrub cover. Herbaceous associates include *Equisetum laevigatum, Phragmites australis, Juncus arcticus, Solidago canadensis, Heterotheca villosa, Comandra umbellata*, and *Penstemon cyanocaulis*, and *Juncus balticus*.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association is rare and was sampled in a canyon near Gothic Arch, in the Maze (Horse Canyon) north of Lizard Rock, and along Lost Canyon Trail 400 m east-southeast of Lost Canyon Campground.

Globally
This riparian woodland has only been reported from three locations in two National Park Service units on the Colorado Plateau (Utah).

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association occurs in intermittently flooded drainage bottoms. Sites are flat and lie between 1438 and 1563 m elevation. Patches of litter and bare sand cover most of the unvegetated surface, with lesser cover by gravel, rocks, bedrock, and wood. Soils are moderately well-drained to rapidly drained sands or loamy sands derived from alluvium.

Globally
This woodland association is known from narrow stream terraces and intermittently flooded drainage bottoms. Occurrences range from 1555 to 1910 m of elevation on flat, moderately well- to rapidly drained substrates of sands or loamy sands derived from alluvium. Bare ground, litter, and bare sand occupy most of the unvegetated surface.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This Fremont cottonwood woodland type is rare within the park. Total vegetation cover ranges from 61 to 89%. Stands are characterized by an open canopy between 10 and 20 m tall of *Populus fremontii* with 4 to 18% cover and an understory dominated by *Salix lutea* with 10 to 55% cover. Associated shrubs include *Salix exigua, Forestiera pubescens, Frangula betulifolia, Mahonia fremontii, Tamarix chinensis*, and *Rhus trilobata*. The herbaceous layer can be diverse and well-developed or sparse and patchy, depending on the degree of willow cover. *Equisetum laevigatum, Phragmites australis, Juncus arcticus, Solidago canadensis, Iva acerosa, Heterotheca villosa, Comandra umbellata*, and *Penstemon cyanocaulis* are the most consistent species. The riparian vine *Clematis ligusticifolia* may contribute sparse cover.

Globally
The vegetation of these stands ranges from 60 to nearly 100% total cover. The dominant vegetation is characterized by open canopies of *Populus fremontii* ranging from 10-18% with a moderately dense to dense shrub layer dominated by *Salix lutea*. Other shrub associates include *Salix exigua, Mahonia fremontii, Tamarix chinensis, Ericameria nauseosa*, and *Rhus trilobata*. The herbaceous layer may be patchy to dense depending on shrub cover. Herbaceous associates include *Equisetum laevigatum, Phragmites australis, Juncus arcticus, Solidago canadensis, Heterotheca villosa, Comandra umbellata, Penstemon cyanocaulis*, and *Juncus balticus*. The riparian vine *Clematis ligusticifolia* may contribute sparse cover.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Populus fremontii*
Tall shrub/sapling	*Salix lutea*
Herb (field)	*Solidago canadensis*
Herb (field)	*Juncus balticus*, *Phragmites australis*
Herb (field)	*Equisetum laevigatum*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Phragmites australis* (exotic, High), *Tamarix chinensis* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (13-Jul-2006). There is insufficient information at this time to rank this association. It is currently known only from three occurrences. Because of the generally degraded condition of riparian systems in the Western United States and the requirement of this association for frequent flooding (suggests intact hydrologic system), it is unlikely to be common anywhere in the Colorado Plateau. This association is therefore is unlikely to receive a global rank lower than G3.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This association has been reported from two NPS units within the northern Colorado Plateau: Canyonlands National Park and Natural Bridges National Monument. It is likely to occur elsewhere where the ranges of the diagnostic species overlap (primarily the northern Colorado Plateau).

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The soil is saturated in some places just a few centimeters below the surface (spotty damp places in depressions). Area is subject to flash flooding; debris was piled up 8-10 cm on the upstream side of plants.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY.0217, CANY.0634, CANY.9083).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: M.E. Hall

REFERENCES: Coles et al. 2008c, Western Ecology Working Group n.d.

Populus fremontii / Sporobolus airoides Woodland [Provisional]

Fremont Cottonwood / Alkali Sacaton Woodland

CODE	CEGL004003
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*POPULUS FREMONTII* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.644) Fremont Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): North American Warm Desert Riparian Woodland and Shrubland (CES302.753)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This apparently rare association is known from a single occurrence in Canyonlands National Park. Additional information about its distribution and composition will be added following further inventory. It occurs on flat stream terraces at 1382 m elevation. The soil is rapidly drained loamy sand derived from alluvium. This occurrence is characterized by an open canopy of *Populus fremontii*. Scattered shrubs have less than 10% cover and include *Mahonia fremontii, Atriplex canescens, Artemisia filifolia, Gutierrezia sarothrae*, and *Opuntia erinacea*. *Sporobolus airoides* is the herbaceous dominant. Other herbaceous species found in the sampled plot include *Phragmites australis, Distichlis spicata, Achnatherum hymenoides, Vulpia octoflora (= Festuca octoflora), Sphaeralcea parvifolia, Lepidium montanum*, and *Iva acerosa*.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland is rare within the park and was sampled 150 m south of the Harvest Scene pictographs within the Maze, near Upheaval Dome, and at Anderson Bottom.

Globally
This association is documented only from Canyonlands National Park in Utah.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association was sampled on a stream and river terrace. Sites are flat and lies between 1194 and 1382 m elevation. Litter, sand, bare soil, and dead wood cover most of the unvegetated surface with lesser cover by rocks and gravel. The soil is a rapidly drained loamy sand derived from alluvium.

Globally
This association is documented from a single occurrence and will require further documentation to develop a thorough global description.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This Fremont cottonwood woodland type is rare within the park. Total vegetation cover ranges from 29 to 37%. Stands are characterized by an open canopy between 5 and 10 m tall of *Populus fremontii* with 10 to 16% cover. The understory is dominated by *Sporobolus airoides* with between 7 and 15% cover. Shrubs cover less than 10% of the plot and include scattered *Mahonia fremontii, Atriplex canescens, Artemisia filifolia, Sarcobatus vermiculatus, Gutierrezia sarothrae*, and *Opuntia* spp. Associated herbaceous species include *Phragmites australis, Distichlis spicata, Achnatherum hymenoides, Vulpia octoflora (= Festuca octoflora), Bromus tectorum, Salsola tragus, Artemisia dracunculus, Sphaeralcea parvifolia, Lepidium montanum*, and *Iva acerosa*.

Globally
This association is documented from a single occurrence and will require further documentation to develop a thorough global description.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Populus fremontii*
Short shrub/sapling	*Artemisia filifolia*
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Distichlis spicata*, *Phragmites australis*, *Sporobolus airoides*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (14-Jul-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The canyon bottom in this area is relatively broad and allows for the wash channel to be braided with low (0.5 to 1 m high), flat stream terraces in between. This community is located on such a terrace, high enough so that flash flooding will be a very rare event, but low enough to have proximity to the water table and fine alluvial soils.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0835) and 2007 and 2008 Accuracy Assessment (2 points: CANY_AA.0587, CANY_AA.1071).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: M.E. Hall

REFERENCES: Western Ecology Working Group n.d.

Populus fremontii / Tamarix sp. Woodland [Provisional]

Fremont Cottonwood / Salt-cedar species Woodland

CODE	CEGL005485
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*POPULUS FREMONTII* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.644) Fremont Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland (CES304.045)
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This community is likely to be widespread throughout the range of *Populus fremontii*, but has only been documented from Canyonlands National Park and Ouray National Wildlife Refuge and reported from the lower Colorado River. It occurs 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 2 degree grade), and substrates are composed of new alluvium. 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* (which in some instances may be codominant with *Tamarix chinensis*), *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*.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is known from The Big Draw, Tuxedo Bottom, West of Turk's Head, Hardscrabble, Upheaval Bottom, Horse Canyon and the Maze.

Globally
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.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Stands occurs in linear patches on streambanks and terraces, channel beds and river islands at elevations ranging from 1169-1536 m in elevation. Slopes are flat to gentle (not exceeding 2 degree grade), and substrates are composed of new alluvium.

Globally
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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
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* (which in some instances may be codominant with *Tamarix chinensis*), *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*.

Globally
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
*Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)*Data are not available.

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNA (ruderal) (19-Feb-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This association has only been documented from Canyonlands National Park. Due to low conservation priority and stand density, this community is under sampled, but is likely to be widespread within the range of *Populus fremontii*.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2007 and 2008 Accuracy Assessment (8 points: CANY_AA.0760, CANY_AA.0762, CANY_AA.1004, CANY_AA.1070, CANY_AA.1084, CANY_AA.1096, CANY_AA.1097, CANY_AA.4136).
Local Description Authors: M.E. Hall and A. Tendick
Global Description Authors: 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.

Salix gooddingii / Salix exigua Woodland

Goodding's Willow / Coyote Willow Woodland

CODE	CEGL003778
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*SALIX GOODDINGII* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.640) Goodding's Willow Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This riparian woodland is known from the Colorado Plateau in southeastern Utah and occurs on sandy wash bottoms in narrow slickrock canyons and intermittently flooded terraces of the Colorado River. Water tables remain at or near the surface throughout the growing season. Sampled sites are gently sloping and occur at 1293-1835 m elevation. The unvegetated surface has high cover of litter and generally sparse cover of bare soil and large rocks. Soils are intermittently moist to saturated loamy sands to poorly drained sandy clay derived from alluvium. The vegetation 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, but *Forestiera pubescens* and exotic *Tamarix chinensis* can contribute significant cover. Native herbaceous 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 weedy or exotic forbs such as *Ambrosia acanthicarpa, Salsola tragus*, and *Xanthium strumarium*, or the introduced pasture grass *Lolium arundinaceum (= Festuca arundinacea)*.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland is rare within the park and was sampled on the Colorado River just downstream of Sheep Bottom, on a sand bar and on an island just downstream of Little Bridge Canyon.

Globally
This association is known only from Arches and Canyonlands national parks in southeastern Utah, and isolated locations in eastern New Mexico. It is likely to occur elsewhere in the southwestern U.S. along rivers and streams with periodic flooding.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association occurs on flat to gently sloping, intermittently flooded terraces and islands of the Colorado River between 1175 and 1738 m elevation. Litter or bare soil covers most of the unvegetated surface, with sparse cover by wood and large rocks. The soil is a poorly drained sandy clay derived from alluvium.

Globally
This riparian woodland occurs on sandy wash bottoms in narrow slickrock canyons and intermittently flooded terraces of the Colorado River in the Colorado Plateau. Water tables remain at or near the surface throughout the growing season. Sampled sites are gently sloping and occur at 1293-1835 m elevation. The unvegetated surface has high cover of litter, sparse to moderate cover of sand or bare soil, and sparse cover of large rocks. Soils are intermittently moist to saturated loamy sands to poorly drained sandy clay derived from alluvium.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare riparian woodland has a total vegetation cover ranging from 20% to nearly 100%. The 10- to 35-m tall canopy is dominated by *Salix gooddingii* trees with 2-35% cover, sometimes with scattered *Celtis laevigata* var. *reticulata (= Celtis reticulata)*. Scattered clumps of shrubs occur throughout the understory; *Salix exigua* is generally dominant (with up to 35% cover), but *Tamarix chinensis, Sarcobatus vermiculatus,* and *Forestiera pubescens* can contribute significant cover. Herbaceous species were not recorded or have sparse to low cover and include *Echinochloa crus-galli, Cyperus erythrorhizos, Suaeda torreyana,* and *Bromus tectorum*.

Globally
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, but *Forestiera pubescens* and exotic *Tamarix chinensis* can contribute significant cover. Native herbaceous 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 weedy or exotic forbs such as *Ambrosia acanthicarpa, Salsola tragus*, and *Xanthium strumarium*, or the introduced pasture grass *Lolium arundinaceum (= Festuca arundinacea)*. Seedling *Populus fremontii* may also be present in the ground layer.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Salix gooddingii*
Tall shrub/sapling	*Salix exigua*, *Tamarix chinensis*

Globally

Stratum	Species
Tree canopy	*Salix gooddingii*
Tall shrub/sapling	*Salix exigua*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Tamarix chinensis* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (20-Mar-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This very dense vegetation is adjacent to the Colorado River and grows on alluvial soil with several distinct layers of clay and sand. Plant roots are probably saturated throughout most of the year. This area may be submerged during very high waterflow.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot): (Plot: CANY.0601) and 2008 field data (2 AA points): (CANY_AA.1057, CANY_AA.1241).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. K.S. King

REFERENCES: Coles et al. 2009a, Western Ecology Working Group n.d.

Cercocarpus intricatus Montane Shrubland

Littleleaf Mountain-mahogany Montane Shrubland

CODE	CEGL002587
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Temperate broad-leaved evergreen shrubland (III.A.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate broad-leaved evergreen shrubland (III.A.2.N.)
FORMATION	Sclerophyllous temperate broad-leaved evergreen shrubland (III.A.2.N.c.)
ALLIANCE	*CERCOCARPUS INTRICATUS* SHRUBLAND ALLIANCE (A.2659) Littleleaf Mountain-mahogany Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Cliff and Canyon (CES304.779)
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This montane association occurs on exposed peaks, ridges and plateaus in the Colorado Plateau of western Colorado and eastern Utah and the Wasatch Range in northern Utah. Elevations range from 1850 to 2650 m (6070-8700 feet). Sites are on level to gentle slopes that may be oriented to any aspect. Plants are rooted in cracks and potholes in the limestone or sandstone bedrock. Exposed bedrock, gravel and large rock cover much of the surface area. Soil collects only in depressions and crevices of the rocky surface and is generally a poorly developed sandy loam. The vegetation is dominated by low-statured *Cercocarpus intricatus* with more than 10% cover. Other shrubs with lesser cover commonly associated include *Amelanchier utahensis, Cercocarpus montanus, Ephedra viridis, Eriogonum corymbosum*, and *Symphoricarpos oreophilus*. The herbaceous layer is diverse but sparse in cover and may include the graminoids *Leymus salinus, Poa fendleriana, Pseudoroegneria spicata, Poa fendleriana, Achnatherum hymenoides, Koeleria macrantha*, and the cushion forbs *Arenaria fendleri, Petrophyton caespitosum*, and *Phlox* spp. Scattered individuals of *Pinus edulis* or *Juniperus osteosperma* may occur in stunted, shrublike form rarely exceeding 2 m in height and not exceeding 5% cover.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association is rare within the park and is represented by one plot located along the Lathrop Trail approximately 2.25 km from the trailhead.

Globally
This association is documented from Blue Mountain within Dinosaur National Monument in northwestern Colorado as well as from slickrock sites in Canyonlands National Park in eastern Utah and the Wasatch Range in northern

Utah. It probably also occurs on other high limestone ridges in northwestern Colorado, such as Douglas Mountain and Cold Springs Mountain. It may also occur in analogous habitats in southwestern Wyoming and elsewhere in the Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland occurs on a slickrock plateau with large potholes. The site is on a moderate slope (9 degrees) to the south-southwest at 1848 m elevation. Sandstone bedrock covers most of the unvegetated surface, with shallow bare soil in pothole depressions. The soil is a rapidly drained loamy sand derived from Navajo sandstone.

Globally
This montane association occurs on exposed peaks, ridges and plateaus in the Colorado Plateau of western Colorado and eastern Utah. Elevations range from 1850 to 2650 m (6070-8700 feet). Slopes are gentle, and sites may be oriented to any aspect. Plants are rooted in cracks and potholes in the limestone or sandstone bedrock. Exposed bedrock, gravel and large rock cover much of the surface area. Soil collects only in depressions and crevices of the rocky surface and is generally a poorly developed sandy loam.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare shrubland has a total vegetation cover limited to between 5 and 15% because woody plants are only able to root in the potholes. *Cercocarpus intricatus* is overwhelmingly dominant, although scattered *Pinus edulis* and *Juniperus osteosperma* trees occur in the potholes and provide sparse cover. Additional shrubs present (rarely with more than 1% cover) include *Ephedra viridis, Eriogonum corymbosum*, and *Chrysothamnus viscidiflorus*. Herbaceous species present include *Achnatherum hymenoides, Bromus tectorum, Poa fendleriana, Plantago patagonica, Lepidium montanum*, and *Artemisia ludoviciana*.

Globally
This montane shrubland is dominated by *Cercocarpus intricatus*, usually with more than 10% cover, growing in bedrock cracks. Other shrubs with less cover commonly associated include *Amelanchier utahensis, Cercocarpus montanus, Ephedra viridis, Eriogonum corymbosum, Holodiscus dumosus, Quercus gambelii* (<5% cover), and *Symphoricarpos oreophilus*. Although *Cercocarpus intricatus* is overwhelmingly dominant, scattered individuals of *Pinus edulis, Juniperus osteosperma*, or *Pseudotsuga menziesii* may occur in stunted, shrub-like form, rarely exceeding 2 m in height and not exceeding 5% cover. The herbaceous layer is diverse but sparse in cover and may include the graminoids *Leymus salinus, Poa fendleriana, Pseudoroegneria spicata, Poa fendleriana, Achnatherum hymenoides*, and *Koeleria macrantha*, and the cushion forbs *Arenaria fendleri, Galium multiflorum, Petrophyton caespitosum*, and *Phlox* spp.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Pinus edulis*
Short shrub/sapling	*Cercocarpus intricatus*

Globally

Stratum	Species
Short shrub/sapling	*Cercocarpus intricatus*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (7-Apr-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This type represents *Cercocarpus intricatus* shrublands at a much higher density than usually occurs on slickrock. The only difference between this association and *Cercocarpus intricatus* Slickrock Sparse Vegetation (CEGL002977) is the density of *Cercocarpus intricatus* (>10%). Otherwise the setting is similar and the associated species are very similar.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Lucky plants in potholes flourish, probably because of runoff from extensive slickrock surfaces. A few dead standing pinyon and juniper skeletons occur in the area near plot.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: **Plots and Observation Points**: The description is based on 2004 field data (1 plot): (Plot: CANY 0325).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Coles et al. 2008a, Coles et al. 2009b, Western Ecology Working Group n.d.

Artemisia filifolia Colorado Plateau Shrubland

Sand Sagebrush Colorado Plateau Shrubland

CODE	CEGL002697
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA FILIFOLIA* SHRUBLAND ALLIANCE (A.816) Sand Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)
Inter-Mountain Basins Active and Stabilized Dune (CES304.775)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This sand sagebrush shrubland association is widespread in the Colorado Plateau of Utah, Arizona and probably New Mexico. It occurs 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 12 degrees), and may be oriented to any aspect, although there is a slight tendency toward warmer southerly aspects. Elevations range from 1122 to 1769 m (3680-5803 feet). Sand or bare soil covers most of the unvegetated ground surface, although biological soil crusts may have up to 40% cover. Soils are sandy and derived from local sandstones, alluvium, or eolian deposits. 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. Regardless of cover, the vegetation is characterized by an open shrub canopy dominated by *Artemisia filifolia* that is usually mixed with other shrubs, especially *Atriplex canescens, Ericameria nauseosa*, and *Opuntia* spp. Less commonly, the shrub layer will include *Vanclevea stylosa, Eriogonum leptocladon*, or *Sarcobatus vermiculatus*. *Coleogyne ramosissima, Ephedra viridis*, and *Ephedra torreyana* are generally absent or have only trace cover. The herbaceous layer is moderate in terms of species composition and provides sparse to moderate cover. Graminoids that are consistently present include *Achnatherum hymenoides* and *Bromus tectorum*; some sites may also have *Hesperostipa comata, Pleuraphis jamesii, Sporobolus cryptandrus*, and *Vulpia octoflora*. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association occurs throughout the mapping area. Sites sampled included the western portion of Ernie's Country, near Chimney Rock, near the Maze Overlook, in Red Lake and Horse canyons, and 200 m south of the Harvest Scene Pictographs in Canyonlands National Park, and in Calf and Millard canyons in Glen Canyon National Recreation Area.

Globally
This sand sagebrush shrubland association is widespread on sandy sites in the Colorado Plateau of Utah, Colorado, Arizona and New Mexico.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrub association occurs on deep, well-drained sandy soils of benches, stream terraces, sand bars and valley bottoms. Sites tend to be flat or slope gently and within the mapping area occur between 1222 and 1556 m elevation. Bare sand is exposed over most of the unvegetated surface; litter tends to be sparse. Biological soil crust communities provide sparse to moderate cover (up to 58%) depending on the degree of site disturbance. Soils are derived from alluvium or eolian deposits.

Globally
This sand sagebrush shrubland is widespread on sandy sites in the Colorado Plateau of Utah, Colorado, Arizona and New Mexico. This common association occurs on sandy sites on valley floors, valley sides, stream terraces, stabilized dunes and sandsheets, benches, floodplains, terraces and alluvial fans. Most sites are level to gently sloping, with a few on moderate slopes (up to 12 degrees), and may be oriented to any aspect, although there is a slight tendency to occur on warmer southerly aspects. Elevations range from 1122 to 1769 m (3680-5803 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sandy shrubland is relatively sparsely vegetated; total vegetation cover does not exceed 17% and can be as low as 2%. The canopy consists of scattered or clumped *Artemisia filifolia* shrubs. Other shrubs provide little cover but may include *Atriplex canescens, Ericameria nauseosa, Ephedra torreyana, Opuntia erinacea*, and *Opuntia polyacantha*. The herbaceous layer is diverse but contributes little cover in the understory; *Achnatherum hymenoides, Achnatherum coronatum, Sporobolus airoides, Sporobolus cryptandrus, Salsola tragus, Sphaeralcea coccinea, Abronia fragrans, Chenopodium album, Dalea candida* var. *oligophylla (= Dalea oligophylla), Hymenopappus filifolius, Plantago patagonica, Amsonia tomentosa*, and *Machaeranthera canescens* have been recorded in park plots. The presence of the non-native annual grass *Bromus tectorum* indicates past disturbance such as grazing.

Globally
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, especially *Atriplex canescens, Ericameria nauseosa*, and *Opuntia* spp. Less commonly, the shrub layer will include *Vanclevea stylosa, Eriogonum leptocladon*, or *Sarcobatus vermiculatus*. *Coleogyne ramosissima, Ephedra viridis*, and *Ephedra torreyana* are generally absent or have relatively low cover (usually <1%). The herbaceous layer is moderate in terms of species composition and provides sparse to moderate cover. Graminoids that are consistently present include *Achnatherum hymenoides* and *Bromus tectorum*; some sites may also have *Hesperostipa comata, Pleuraphis jamesii, Sporobolus cryptandrus*, and *Vulpia octoflora*. 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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Artemisia filifolia*, *Ericameria nauseosa*
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Opuntia erinacea*, *Opuntia polyacantha*
Herb (field)	*Abronia fragrans*, *Salsola tragus*, *Sphaeralcea coccinea*
Herb (field)	*Achnatherum hymenoides*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia filifolia*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Salsola paulsenii* (exotic, Low), *Salsola tragus* (exotic)

Globally
Exotic/Invasive: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Halogeton glomeratus* (exotic, High/Medium), *Malcolmia africana* (exotic), *Salsola tragus* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (14-Aug-2001).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Biological soil crust cover is continuous and well-developed throughout this bench.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (12 plots: CANY 0259, CANY 0263, CANY 0421, CANY 0454, CANY 0550, CANY 0562, CANY 0563, CANY 0667, CANY 0789, CANY 0836, GLCA 0577, GLCA 0726).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

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.

Artemisia tridentata ssp. *tridentata / Hesperostipa comata Shrubland*

Basin Big Sagebrush / Needle-and-Thread Shrubland

CODE	CEGL002966
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA TRIDENTATA (SSP. TRIDENTATA, SSP. XERICENSIS)* SHRUBLAND ALLIANCE (A.830) (Basin Big Sagebrush, Foothill Big Sagebrush) Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)
Inter-Mountain Basins Big Sagebrush Steppe (CES304.778)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This shrubland association occurs in small to large patches on point bars, stream terraces, valley floors and alluvial fans in the interior western U.S. and possibly British Columbia, Canada. Slopes are generally gentle but can range up to 10 degrees in steeper tributary drainages. Elevations range from 1220 to 2000 m at any aspect. Soils are sandy loams or loamy sands derived from alluvium. Although associated with drainages and floodplains, this community occurs in sites that rarely flood. Total vegetation cover tends to be somewhat sparse, as many examples have had their herbaceous cover reduced by grazing; undisturbed examples have total vegetation cover up to 90%. The dominant shrub is *Artemisia tridentata* ssp. *tridentata*. Others occurring as scattered individuals include *Ericameria nauseosa, Chrysothamnus viscidiflorus, Ephedra viridis, Krascheninnikovia lanata, Opuntia polyacantha*, and *Atriplex canescens*. The understory is dominated or codominated by the native bunchgrass *Hesperostipa comata*. Common herbaceous associates include *Achnatherum hymenoides, Bouteloua gracilis, Poa secunda, Sporobolus cryptandrus*, and *Sphaeralcea coccinea*. Moss and cryptogamic crusts may have significant cover in sites that have not experienced recent grazing.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association was sampled in Davis Canyon and Lavender Canyon in Canyonlands National Park.

Globally

This shrubland association occurs in the interior western U.S. from Washington to Montana south to Utah and Nevada. It may also occur in Oregon, California, and British Columbia, Canada.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association occurs on stream terraces and on the toeslopes of canyon bottoms. Sites are flat to moderately sloping (up to 10 degrees), oriented to the east and northeast, and lie between 1628 and 1646 m elevation. The unvegetated surface has low to high exposure of bare soil, low to moderate cover of litter, and low to high cover of soil crusts (ranging from dark cyanobacteria to mosses and lichens). Soils are rapidly drained silts or loamy sands derived from alluvium.

Globally

This shrubland association occurs in small to large patches on point bars, stream terraces, valley floors and alluvial fans in the interior western U.S. and British Columbia, Canada. Slopes are generally gentle but can range up to 10 degrees in steeper tributary drainages. Elevations range from 1220 to 2000 m (4000-6580 feet), and stands may be oriented to any aspect. Soils are sandy loams or loamy sands derived from alluvium. Although associated with drainages and floodplains, this community occurs in sites that rarely flood.

Dynamics: This association occupies similar habitats as *Artemisia tridentata* ssp. *tridentata / Sporobolus airoides* Shrubland (CEGL002200), but the sandy soils tend to favor the salt-intolerant *Hesperostipa comata*. Higher cover

by *Hesperostipa comata* indicates less grazing pressure; grazed sites have relatively low *Hesperostipa* cover. According to Tueller and Blackburn (1974), in the Great Basin of Nevada, this association indicates sites that have been less impacted by grazing, as opposed to sagebrush sites with an understory dominated by grazing-tolerant *Pascopyrum smithii, Elymus elymoides*, and *Poa secunda*. Daubenmire (1970) reports that stands of *Artemisia tridentata / Hesperostipa comata* differ from adjacent stands of *Artemisia tridentata / Pseudoroegneria spicata* shrublands in that soils under the former prefer drier and/or less fertile soils than the latter.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This basin big sagebrush shrubland is rare within the park and recreation area. Total vegetation cover ranges from 23 to 49%, and the shrub canopy is dominated by *Artemisia tridentata* ssp. *tridentata* with 9-16% cover, usually accompanied by *Atriplex canescens, Mahonia fremontii, Ericameria nauseosa, Ephedra viridis,* the succulent *Opuntia polyacantha* or *erinacea*, and the dwarf-shrub *Gutierrezia sarothrae*. Scattered trees of *Juniperus osteosperma* with sparse cover occur in some stands. The native perennial bunchgrass *Hesperostipa comata* dominates the herbaceous layer with 3-20% cover, and the non-native annual grass *Bromus tectorum* is common in some stands. Other native herbaceous species include *Sporobolus airoides, Sporobolus cryptandrus, Achnatherum hymenoides, Gaillardia pinnatifida, Bouteloua gracilis, Pleuraphis jamesii, Senecio multilobatus, Hymenopappus filifolius,* and *Sphaeralcea parvifolia.*

Globally

Total vegetation cover tends to be somewhat sparse in this association (10-40%), as many examples have had their herbaceous cover reduced by grazing; undisturbed examples have total vegetation cover up to 90%. Cover of the dominant shrub *Artemisia tridentata* ssp. *tridentata* ranges from 5 to 55% in this association. *Ericameria nauseosa, Chrysothamnus viscidiflorus, Ephedra viridis, Krascheninnikovia lanata, Opuntia polyacantha*, and *Atriplex canescens* also frequently occur as scattered individuals in the shrub layer. The understory cover totals between 5 and 40% and is dominated or codominated by the native bunchgrass *Hesperostipa comata*. Common herbaceous associates include *Achnatherum hymenoides, Bouteloua gracilis, Poa secunda, Sporobolus cryptandrus*, and *Sphaeralcea coccinea*. Moss and cryptogamic crusts may have significant cover in sites that have not experienced recent grazing.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Hesperostipa comata*
Herb (field)	*Bromus tectorum*

Globally

Stratum	Species
Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Achnatherum hymenoides*
Herb (field)	*Hesperostipa comata*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic)

Globally

Data not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (14-Aug-2001).

CLASSIFICATION COMMENTS

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally
Of the references for this association, Daubenmire (1970), Hironaka et al. (1983), and Caicco and Wellner (1983f, 1983k) clearly reference *Artemisia tridentata* ssp*. tridentata / Stipa comata* vegetation type. All the others (Poulton 1955, Tueller et al. 1966, Blackburn 1967, Blackburn et al. 1968c, 1971, McLean 1970, Tueller and Blackburn 1974, DeVelice and Lesica 1993) do not provide information as to the subspecies of *Artemisia tridentata*. However, it is likely, based on habitat data, photos, and descriptions, that these studies were working with *Artemisia tridentata* ssp*. tridentata / Stipa comata* vegetation types.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Low terrace dominated by *Artemisia tridentata* ssp*. tridentata* with a fairly dense grass understory (mostly *Hesperostipa comata*). Many large *Mahonia fremontii* and some scattered *Juniperus osteosperma* on this terrace as well.

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY.9733, CANY.9742) and 2008 Accuracy Assessment (3 points: CANY_AA.2052, CANY_AA.2423, CANY_AA.2548)
Local Description Authors: A. Tendick
Global Description Authors: J. Coles

REFERENCES: Blackburn 1967, Blackburn et al. 1968c, Blackburn et al. 1971, CONHP 2003, Caicco and Wellner 1983f, Caicco and Wellner 1983k, Daubenmire 1970, DeVelice and Lesica 1993, Hironaka et al. 1983, Kagan et al. 2004, MTNHP 2002b, McLean 1970, Poulton 1955, Tueller et al. 1966, Tueller and Blackburn 1974, and Western Ecology Working Group n.d.

Artemisia tridentata ssp*. tridentata / Sporobolus cryptandrus Shrubland*

Basin Big Sagebrush / Sand Dropseed Shrubland

CODE	CEGL003826
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA TRIDENTATA (SSP. TRIDENTATA, SSP. XERICENSIS)* SHRUBLAND ALLIANCE (A.830) (Basin Big Sagebrush, Foothill Big Sagebrush) Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Wash (CES304.781)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This shrubland association was sampled once in Canyonlands National Park in eastern Utah and occurs in an intermittent wash on a stream terrace at 1680 m elevation. The site is flat and has high cover of litter and moderate exposure of bare soil. Biological soil crusts have up to 25% cover, although they are usually not highly developed, and soils are rapidly drained silt loams derived from alluvium. Total vegetation cover sampled was 56%. Vegetation is characterized by an open shrub layer (<25% cover) of *Artemisia tridentata* ssp*. tridentata* with scattered *Atriplex canescens* and *Ephedra viridis*. The succulent *Opuntia erinacea* contributes more than a third of the total cover. Herbaceous species have up to 15% cover; the most conspicuous species is *Sporobolus cryptandrus* (10% cover). Other herbaceous species include plants typical of sandy, somewhat alkaline areas: *Achnatherum hymenoides, Hesperostipa comata, Abronia fragrans, Oenothera pallida*, and *Sphaeralcea parvifolia*.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association is rare within the park and was sampled on a stream terrace of the West Fork of Salt Creek and on several stream terraces in Lavender Canyon in Canyonlands National Park.

Globally
This basin big sagebrush shrubland is only known from one plot in Canyonlands National Park in eastern Utah. It is likely more widespread in eastern Utah on undisturbed stream terraces.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland occurs on stream terraces. Sites are flat to gently sloping (up to 3 degrees), oriented to the southeast and northwest, and occur between 1637 and 1716 m elevation. The unvegetated surface has moderate to high cover of litter and moderate to high exposure of bare soil. Biological soil crusts have up to 35% cover, although they are usually not highly developed, and soils are rapidly drained silt loams derived from alluvium.

Globally
This shrubland association was sampled once in Canyonlands National Park in eastern Utah and occurs in an intermittent wash on a stream terrace at 1680 m elevation. The site is flat and has high cover of litter and moderate exposure of bare soil. Biological soil crusts have up to 25% cover, although they are usually not highly developed, and soils are rapidly drained silt loams derived from alluvium.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This alluvial basin big sagebrush shrubland association is rare. Total vegetation cover ranges from 24% to 56% cover and is characterized by an open canopy of *Artemisia tridentata* ssp. *tridentata* accompanied by scattered *Atriplex canescens, Ericameria nauseosa, Mahonia fremontii, Krascheninnikovia lanata,* and *Ephedra viridis*. The succulents *Opuntia erinacea, Opuntia whipplei,* or *Opuntia polyacantha* contribute low to moderate cover. Herbaceous species have up to 15% total cover; the most conspicuous species is *Sporobolus cryptandrus* with 3-10% cover. Other herbaceous species include plants typical of sandy, somewhat alkaline areas: *Achnatherum hymenoides, Hesperostipa comata, Sporobolus airoides, Bouteloua gracilis, Abronia fragrans, Artemisia campestris, Gaillardia aristata, Hymenopappus filifolius, Oenothera pallida*, and *Sphaeralcea parvifolia*. The non-native, annual grass, *Bromus tectorum* (with 3-8% cover) and forb, *Salsola tragus* are typical associates in the understory.

Globally
Total vegetation cover sampled was 56%. Vegetation is characterized by an open shrub layer (<25% cover) of *Artemisia tridentata* ssp. *tridentata* with scattered *Atriplex canescens* and *Ephedra viridis*. The succulent *Opuntia erinacea* contributes more than a third of the total cover. Herbaceous species have up to 15% cover; the most conspicuous species is *Sporobolus cryptandrus* (10% cover). Other herbaceous species include plants typical of sandy, somewhat alkaline areas: *Achnatherum hymenoides, Hesperostipa comata, Abronia fragrans, Oenothera pallida*, and *Sphaeralcea parvifolia*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Opuntia* spp.
Herb (field)	*Sporobolus cryptandrus*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Opuntia erinacea*
Herb (field)	*Sporobolus cryptandrus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jun-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Broad, low terrace dominated by ARTTRI with a mixed herbaceous, somewhat weedy understory. Crypto cover is extensive and well-developed.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0394) and 2008 Accuracy Assessment (4 points: CANY_AA.2597, CANY_AA.2930, CANY_AA.2941, CANY_AA.3308).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: K.A. Schulz

REFERENCES: Francis 1986, Western Ecology Working Group n.d.

Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Semi-natural Shrubland

Big Sagebrush - (Rubber Rabbitbrush) / Cheatgrass Semi-natural Shrubland

CODE	CEGL002699
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA TRIDENTATA* SHRUBLAND ALLIANCE (A.829) Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)
Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This association is common throughout the Colorado Plateau and likely occurs on disturbed sites throughout the range of basin big sagebrush in the western U.S. Stands occur in small to moderate-sized patches on alluvial terraces, floodplains, and point bars, mostly below 2000 m (6560 feet) elevation. *Artemisia tridentata* ssp*. tridentata* shrubs are always present, often with a lesser component of *Ericameria nauseosa, Atriplex canescens*, or *Chrysothamnus viscidiflorus*. *Bromus tectorum* dominates the occasionally sparse herbaceous layer, frequently accompanied by other weedy exotic or annual grasses and forbs. Individuals or small patches of native grasses and forbs may occur, including *Leymus cinereus, Achnatherum hymenoides*, and *Sporobolus cryptandrus*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association was sampled in Lavender Canyon near Cleft Arch, in Chesler Canyon, Davis Canyon, Horse Canyon, and in upper and lower Salt Creek, including near Angel Arch in Canyonlands National Park and in Waterhole Canyon 750 m downstream of the waterhole in Glen Canyon National Recreation Area.

Globally

This association is widespread in southern Utah and western Colorado and likely occurs on disturbed sites throughout the range of basin big sagebrush in the western U.S.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association occurs on stream terraces and in canyon bottoms and valley bottoms. Sites are flat to gently sloping (up to 3 degrees) and occur between 1512 and 1750 m elevation. The unvegetated surface has sparse to high exposure of bare soil, low to high cover of litter, and sparse to high cover of soil crusts (ranging from dark cyanobacteria to mosses and lichens). Soils are rapidly drained silts or loamy sands derived from alluvium.

Globally

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, but elevations range from 1130-2045 m. Soils are variable and 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, eolian deposits and Precambrian gneiss. The unvegetated surface often has high cover of litter and bare soil with low cover of rocks. Cryptobiotic soil crusts are often extensive (up to 15% in some stands).

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This disturbed basin big sagebrush shrubland is rare within the park and recreation area. Total vegetation cover ranges from 22 to 100%, and the shrub canopy is dominated by *Artemisia tridentata* ssp. *tridentata* with 3-54% cover, usually accompanied by *Atriplex canescens, Ericameria nauseosa, Ephedra viridis, Krascheninnikovia lanata*, and the succulent *Opuntia polyacantha*. Scattered trees of *Juniperus osteosperma* with low total cover occur in some stands. The non-native annual grass *Bromus tectorum* dominates the relatively dense herbaceous layer with 2-82% cover, and the non-native forb *Salsola tragus* is common in some stands. Relict native herbaceous species include *Sporobolus cryptandrus, Achnatherum hymenoides, Sporobolus contractus, Hesperostipa comata, Pleuraphis jamesii, Artemisia dracunculus, Lepidium montanum, Lepidium alyssoides* var. *eastwoodiae, Hymenopappus filifolius, Lappula occidentalis, Conyza canadensis, Sphaeralcea parvifolia, Sphaeralcea ambigua, Streptanthella longirostris, Machaeranthera canescens, Oenothera pallida*, and *Cordylanthus wrightii*.

Globally

This big sagebrush association is widespread on floodplains and terraces within the Colorado Plateau that have been subject to grazing. *Artemisia tridentata* ssp. *tridentata* is always present in the sparse to dense shrub canopy (10-70% cover) with cover of sagebrush between 5 and 70% and up to 2 m in height. *Ericameria nauseosa* is not always present but is likely to be 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*, and *Sarcobatus vermiculatus*. 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, Lappula occidentalis, Lactuca serriola*, and *Sisymbrium altissimum*. Because it is dominated by annual species, the total herbaceous cover varies depending on seasonal precipitation. Remnant native herbaceous vegetation may include scattered individuals or patches of *Achnatherum hymenoides, Descurainia pinnata, Elymus elymoides, Hesperostipa comata, Heterotheca villosa, Leptodactylon watsonii, Oenothera caespitosa, Senecio spartioides, Stenotus acaulis*, and others. Exotic perennial species such as *Acroptilon*

repens, Agropyron cristatum, Bromus inermis, Cardaria draba, and *Carduus nutans* ssp. *macrolepis* may also be present because of the disturbed nature of this community.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Opuntia phaeacantha*
Herb (field)	*Bromus tectorum*

Globally

Stratum	Species
Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Bromus tectorum*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)

Globally
Exotic/Invasive: *Acroptilon repens* (exotic, High/Medium), *Agropyron cristatum* (exotic, Medium/Low), *Bromus inermis* (exotic, High/Medium), *Bromus rigidus* (exotic), *Bromus tectorum* (exotic, High), *Cardaria draba* (exotic), *Carduus nutans* ssp. *macrolepis* (exotic), *Ceratocephala testiculata* (exotic), *Erodium cicutarium* (exotic, Medium/Low), *Lactuca serriola* (exotic, Low/Insignificant), *Salsola tragus* (exotic), *Sisymbrium altissimum* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNA (ruderal) (14-Aug-2001).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This semi-natural association is likely much more widespread across the western U.S. but is not often sampled.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This patch of *Artemisia tridentata* ssp. *tridentata* was grazed recently as noted by the abundant *Bromus tectorum* and old cow manure.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY 0613, GLCA 0775), and 2008 Accuracy Assessment (15 points: CANY_AA.2029, CANY_AA.2053, CANY_AA.2228, CANY_AA.2726, CANY_AA.2943, CANY_AA.3107, CANY_AA.3154, CANY_AA.3172, CANY_AA.3237, CANY_AA.3245, CANY_AA.3248, CANY_AA.3256, CANY_AA.3267, CANY_AA.3301, and CANY_AA.3303).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2009a, Romme et al. 1993, Thomas et al. 2009b, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.

Artemisia tridentata ssp. *wyomingensis / Bouteloua gracilis Shrubland*

Wyoming Big Sagebrush / Blue Grama Shrubland

CODE	CEGL001041
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA TRIDENTATA SSP. WYOMINGENSIS* SHRUBLAND ALLIANCE (A.832) Wyoming Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Great Basin Xeric Mixed Sagebrush Shrubland (CES304.774)
Colorado Plateau Mixed Low Sagebrush Shrubland (CES304.762)
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This common sagebrush association occurs on ridges, plateaus and benches, and valleys in Wyoming, western Colorado and southeastern Utah. Elevations range from 1840to 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. *Artemisia tridentata* ssp. *wyomingensis* dominates the shrub layer, which may also include lesser amounts of *Artemisia cana, Chrysothamnus viscidiflorus, Sarcobatus vermiculatus, Rhus trilobata, Opuntia polyacantha*, and *Atriplex canescens*. 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*. The introduced grasses *Bromus tectorum* and *Bromus japonicus* are often present. A mix of herbs, including *Artemisia frigida, Gutierrezia sarothrae, Vulpia octoflora (= Festuca octoflora), 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 sagebrush / native grass associations.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association is limited to deep soils in the park and recreation area. Areas sampled include sites adjacent to the East Fork of Salt Creek and on Cedar Mesa in Canyonlands National Park and on Hans Flat, 150 m west of Millard Canyon Overlook, and south of Hans Flat Ranger Station in Glen Canyon National Recreation Area.

Globally

This Wyoming big sagebrush type is found in the Great Basin region of the western United States and possibly into the Great Plains. Documented sites include the Bighorn, Powder River and Wind River basins in Wyoming, Curecanti National Recreation Area in western Colorado, and Capitol Reef and Canyonlands national parks in southeastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland occurs on deep soils of mesas, plains and a valley floor. Sites are flat to gently sloped and are located between 1840 and 2071 m elevation. Bare soil covers most of the unvegetated surface. Dead wood, litter and biological soil crusts provide sparse cover. Soils are rapidly drained and loamy and are derived from alluvium or eolian deposits.

Globally

This common sagebrush shrubland occurs on the slopes of ridges and valleys and on plateaus, plains and benches 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 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This Wyoming big sagebrush shrubland occurs on deep soils within the park and recreation area. Total vegetation cover ranges from 13 to 55% and is dominated by an open canopy of *Artemisia tridentata* ssp*. wyomingensis* with 10 to 27% cover. The understory may be sparse to moderately dense but is always dominated by the perennial grass *Bouteloua gracilis*. Associated shrubs include *Ephedra viridis, Krascheninnikovia lanata, Opuntia erinacea, Gutierrezia sarothrae*, and *Opuntia polyacantha*. Additional grasses may include low cover by *Hesperostipa comata, Achnatherum hymenoides, Elymus elymoides, Bromus tectorum, Pleuraphis jamesii*, and *Vulpia octoflora (= Festuca octoflora)*. Forbs vary among stands; *Packera multilobata (= Senecio multilobatus), Lappula occidentalis, Cordylanthus wrightii, Eriogonum cernuum, Descurainia pinnata, Machaeranthera canescens*, and *Townsendia incana* are common species. Scattered seedlings of *Juniperus osteosperma* occur in some stands.

Globally

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, Chrysothamnus viscidiflorus, Sarcobatus vermiculatus, Rhus trilobata, Opuntia polyacantha*, and *Atriplex canescens*. The understory usually is dominated by *Bouteloua gracilis* together with a combination of *Pascopyrum smithii, Pseudoroegneria spicata, Hesperostipa comata, Carex filifolia, Koeleria macrantha, Poa secunda, Pleuraphis jamesii, Achnatherum hymenoides, Sporobolus cryptandrus*, and *Elymus elymoides*. The introduced grasses *Bromus tectorum* and *Bromus japonicus* are often present but generally contribute less cover. A mix of herbs, including *Artemisia frigida, Gutierrezia sarothrae, Vulpia octoflora (= Festuca octoflora), Phlox hoodii*, and *Sphaeralcea coccinea*, often are present but generally contribute little cover.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Gutierrezia sarothrae*, *Opuntia erinacea*
Herb (field)	*Packera multilobata*
Herb (field)	*Achnatherum hymenoides*, *Bouteloua gracilis*, *Elymus elymoides*, *Hesperostipa comata*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High), *Descurainia pinnata* (exotic)

Globally

Exotic/Invasive: *Bromus japonicus* (exotic), *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION COMMENTS

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally

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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The soil is fine-grained and deep. The community is controlled by the deposition of sand and a history of grazing.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (5 plots: CANY 0387, CANY 0806, GLCA 0300, GLCA 0501, GLCA 0518).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

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 unpubl. data b, Stoecker-Keammerer Consultants n.d.a, Thomas et al. 2010, Van Pelt 1978, Warren et al. 1992, Western Ecology Working Group n.d.

Artemisia tridentata ssp. *wyomingensis / Disturbed Understory Semi-natural Shrubland*

Wyoming Big Sagebrush / Disturbed Understory Semi-natural Shrubland

CODE	CEGL002083
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA TRIDENTATA SSP. WYOMINGENSIS* SHRUBLAND ALLIANCE (A.832) Wyoming Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This Wyoming big sagebrush shrubland has been found in northern Arizona, western Colorado, eastern Utah and southwestern Wyoming and is likely widespread in other parts of the interior western U.S. It can occur on a variety of landscape positions on sites that are flat to moderately steep. This association has been sampled at elevations between 1455 and 2372 m (4770-7777 feet) but is probably found elsewhere. The unvegetated surface is mostly composed of litter, bare soil, and rocks. Soils are typically eolian, alluvial, or colluvial loamy sands to clay loams. This shrubland association has moderately open to dense vegetation cover with an open to closed short-shrub layer. The dominant shrub is *Artemisia tridentata* ssp. *wyomingensis* with low to moderate cover. Scattered *Pinus edulis, Juniperus osteosperma*, and *Juniperus scopulorum* trees (2-5 m tall) may be present with sparse cover. Other tall, short, and dwarf-shrubs that may be found are *Ericameria nauseosa, Ephedra viridis, Gutierrezia sarothrae, Sarcobatus vermiculatus*, and succulents. The herbaceous stratum has low to high cover and diversity, but weedy, exotic and invasive species, such as *Aristida purpurea, Astragalus nuttallianus, Bromus tectorum, Chenopodium album, Descurainia pinnata, Elymus elymoides, Erodium cicutarium, Lappula occidentalis, Lepidium* sp., *Phacelia crenulata*, or *Vulpia octoflora*, tend to dominate.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland is rare within the recreation area and is represented by one plot located approximately 4 miles south of Hans Flat Ranger Station.

Globally
This association has been observed in northern Arizona, western Colorado, eastern Utah and southwestern Wyoming. It is very likely to occur in other parts of the western U.S.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland was sampled on a mesatop. The south-facing site slopes gently at 2050 m elevation. Bare soil or litter cover most of the unvegetated surface. The soil is a rapidly drained silt loam derived from alluvium.

Globally
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 degrees) and have any aspect. Sampled sites have elevations between 1455 and 2372 m (4770-7777 feet). The unvegetated 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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This degraded Wyoming big sagebrush community is rare within the recreation area. Total vegetation does not exceed 15% and consists almost solely of *Artemisia tridentata* ssp*. wyomingensis*. Scattered individual shrubs of *Chrysothamnus viscidiflorus, Krascheninnikovia lanata, Atriplex canescens*, and *Opuntia erinacea* may be present. The herbaceous layer is dominated by *Bromus tectorum*, but *Bouteloua gracilis, Achnatherum hymenoides*, and *Elymus elymoides* have sparse cover. Forbs include *Sphaeralcea coccinea* and *Plantago patagonica*. Biological soil crust cover is sparse.

Globally
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 has low to high cover and diversity and tends to be dominated by weedy and exotic species, especially *Bromus tectorum*. Common graminoids include *Achnatherum hymenoides, Alyssum desertorum, Aristida purpurea, Bouteloua gracilis, Bromus tectorum, Vulpia octoflora, Elymus elymoides, Elymus lanceolatus, Hesperostipa comata, Pascopyrum smithii, Poa fendleriana*, and *Pleuraphis jamesii*. Forbs provide sparse to high cover and include *Astragalus nuttallianus, Ceratocephala testiculata (= Ranunculus testiculatus), Chenopodium album, Descurainia pinnata, Erigeron concinnus, Erodium cicutarium, Lappula occidentalis, Lepidium* sp., *Phacelia crenulata, Plantago patagonica, Sphaeralcea coccinea, Taraxacum officinale*, and *Trifolium gymnocarpon*. Biological soil crust cover is sparse.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNA (invasive) (14-Dec-2004).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This association is closely related to *Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Semi-natural Shrubland (CEGL002699), and there may be overlap between the two. Clear criteria need to be developed to distinguish these associations from one another.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The 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 the site is subject to wind erosion and desiccation.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: GLCA 0508).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Drake, mod. J. Coles 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, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.

Artemisia tridentata ssp. *wyomingensis / Hesperostipa comata Colorado Plateau Shrubland*

Wyoming Big Sagebrush / Needle-and-Thread Colorado Plateau Shrubland

CODE	CEGL002761
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA TRIDENTATA SSP. WYOMINGENSIS* SHRUBLAND ALLIANCE (A.832) Wyoming Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This 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 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 (0-26 degrees). Substrates include eolian sands, loess and landslide deposits; most often soils are not residual but develop from these secondary sources. Total vegetation cover ranges from 25 to 75%, dominated by *Artemisia tridentata* ssp. *wyomingensis*. Other shrubs provide little additional cover but may include *Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Leptodactylon pungens, Opuntia polyacantha*, and *Yucca harrimaniae*. *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, Lepidium*

montanum, Linum lewisii, 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association is rare within the park and was sampled in upper Butler Wash and adjacent to the road near Pappy's Pasture.

Globally
This 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 western Colorado, and may extend into Wyoming.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association occurs on terraces and plains. Sites slope gently, are oriented to the west and lie between 1692 and 1859 m elevation. Bare soil covers most of the unvegetated surface, with sparse cover of litter and downed wood. Biological soil crusts contribute sparse to moderate cover. Soils are rapidly drained silts or loamy sands.

Globally
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 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 (0-26 degrees). 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare Wyoming big sagebrush shrubland has total vegetation cover of between 14 and 24% cover. The shrub canopy is dominated by *Artemisia tridentata* ssp. *wyomingensis* with between 10 and 12% cover and an understory dominated by *Hesperostipa comata* with 1 to 5% cover. Associated shrubs include *Ephedra viridis, Atriplex canescens, Chrysothamnus viscidiflorus, Gutierrezia sarothrae*, and the succulent *Opuntia polyacantha*. The herbaceous layer may be relatively diverse and includes the grasses *Achnatherum hymenoides, Bromus tectorum, Elymus elymoides*, and *Pleuraphis jamesii*, as well as forbs such as *Sphaeralcea coccinea, Oenothera albicaulis, Lepidium montanum* var. *jonesii, Eriogonum cernuum*, and *Machaeranthera canescens*. Scattered *Juniperus osteosperma* trees and seedlings may be present.

Globally
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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Achnatherum hymenoides*, *Hesperostipa comata*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Hesperostipa comata*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Vulnerable: *Penstemon teucrioides* (vulnerable, G2G3Q)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Apr-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The live shrubs here have quite a few dead branches, possibly from recent drought. There are a few yellow needles on the *Juniperus osteosperma* trees.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY 0413, CANY 0568).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Baker 1984a, Coles et al. 2008a, Coles et al. 2010, Salas et al. 2010, Thomas et al. 2009b, Von Loh et al. 2007, Western Ecology Working Group n.d.

Artemisia tridentata ssp. *wyomingensis / Sparse Understory Shrubland*

Wyoming Big Sagebrush / Sparse Understory Shrubland

CODE	CEGL002768
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA TRIDENTATA SSP. WYOMINGENSIS* SHRUBLAND ALLIANCE (A.832) Wyoming Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is intended to represent sagebrush shrublands where the sparse understory is the result of edaphic conditions, not grazing or other disturbance. 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. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association is rare within the recreation area and was represented by one plot located 4 miles south of Hans Flat Ranger Station. In Canyonlands National Park, this shrubland association was sampled near the Aztec Butte trailhead, southwest of Butler Wash, on Cedar Mesa, and in upper Salt Creek.

Globally

This association is scattered widely over the Colorado Plateau of Utah and Colorado and extends west into the southern Rocky Mountains.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association occurs on xeric, well-drained sites with deep soils, occurring from plains and benches on mesa tops to terraces and low hills in valley bottoms. Sites are flat to gently sloping (up to 4 degrees), occur at all aspects, and occur between 1669 and 2084 m elevation. Bare soil covers most of the unvegetated surface, with sparse to low cover by litter, and sparse to moderate cover by biological soil crusts. The soil is a rapidly drained silt loam.

Globally

This association occurs in scattered patches throughout the sagebrush zone of the Colorado Plateau and western Rocky Mountains. 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This Wyoming big sagebrush association has a total vegetation cover of 10-41%. The shrub layer is dominated by *Artemisia tridentata* ssp. *wyomingensis* with between 7% and 35% cover, with additional sparse to low cover

provided by *Ephedra viridis, Ephedra torreyana, Coleogyne ramosissima, Chrysothamnus viscidiflorus, Atriplex canescens, Gutierrezia sarothrae, Eriogonum bicolor*, and *Opuntia erinacea* or *polyacantha*. 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 5% cover and includes *Bouteloua gracilis, Pleuraphis jamesii, Achnatherum hymenoides*, *Hesperostipa comata,* and *Aristida purpurea*. Forbs present include *Chenopodium leptophyllum, Descurainia pinnata, Lepidium montanum,* and *Packera multilobata (= Senecio multilobatus)*. The non-native annual grass, *Bromus tectorum,* and forb*, Salsola tragus* are present with sparse cover in some stands.

Globally
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 *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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*, *Ephedra viridis*
Herb (field)	*Bouteloua gracilis*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (13-Apr-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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 Semi-natural Shrubland (CEGL002083).

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: No signs of prior fires were evident in this stand. This community has established on gently sloping alluvium and was heavily grazed by livestock historically. It is apparently recovering but is subject to wind erosion and desiccation. It occupies a hot exposure.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: **Plots and Observation Points**: The description is based on 2004 field data (1 plot): (Plot: GLCA.0509) and 2008 field data (8 AA points): (CANY_AA.0310, CANY_AA.0341, CANY_AA.0348, CANY_AA.2027, CANY_AA.2145, CANY_AA.2448, CANY_AA.2528, and CANY_AA.2844).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick

Global Description Authors: J. Coles

REFERENCES: Coles et al. 2008a, Coles et al. 2010, Peterson 2008, Von Loh et al. 2008, Western Ecology Working Group n.d.

Chrysothamnus viscidiflorus Talus Shrubland

Yellow Rabbitbrush Talus Shrubland

CODE	CEGL002347
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*CHRYSOTHAMNUS VISCIDIFLORUS* SHRUBLAND ALLIANCE (A.2651) Yellow Rabbitbrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Cliff and Canyon (CES304.779)
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare shrubland was sampled on a colluvial slope below the rim of Airport Tower and in Taylor Canyon.

Globally

This association is documented from sites in southeastern Utah and western Colorado. It is likely to be locally distributed throughout the Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland occurs on colluvial slopes. The sampled sites are on north to north-east facing, moderate to steep slopes (29- to 45-degrees), and occur between 1341 m and 1489 m elevation. Boulders, bedrock, and loose rocks cover most of the unvegetated surface; bare soil covers the rest. The soil is a rapidly drained loam derived from Chinle Formation.

Globally

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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This unusual colluvial shrubland has a total vegetation cover not exceeding 5-12%. *Chrysothamnus viscidiflorus* is the dominant shrub, contributing up to 2% cover. Other shrubs present include *Atriplex confertifolia, Atriplex gardneri, Ericameria nauseosa, Ephedra torreyana, Zuckia brandegeei, Xylorhiza glabriuscula*, and *Gutierrezia sarothrae*. The herbaceous layer is also sparse; *Leymus salinus, Achnatherum hymenoides, Bromus tectorum* and *Pleuraphis jamesii* may all be present.

Globally
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, 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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus*

Globally

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (21-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Rocky surface over compact soils must shed water quickly. Boulders here are relatively small, so vegetation is more evenly distributed and less driven by microclimates. Soils are very shallow, with hardpan (bedrock) 5-12 cm below the surface.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: **Plots and Observation Points**: The description is based on 2004 field data (3 plot): (Plots: CANY.0182, CANY.9001, CANY.9009).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Clark et al. 2009, Coles et al. 2008a, Romme et al. 1993, Western Ecology Working Group n.d.

Ericameria nauseosa / Bromus tectorum Semi-natural Shrubland

Rubber Rabbitbrush / Cheatgrass Semi-natural Shrubland

CODE	CEGL002937
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ERICAMERIA NAUSEOSA* SHRUBLAND ALLIANCE (A.835) Rubber Rabbitbrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)
Inter-Mountain Basins Wash (CES304.781)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This shrubland occurs in disturbed situations at moderate altitudes in the Colorado Plateau; it extends into the Great Basin and is likely widespread in disturbed areas across the western U.S. Most stands are the result of fire burning sagebrush or other types of shrublands, but some derive from other forms of disturbance, including overgrazing. Elevations range from 1220 to 2085 m (4000-6840 feet), and sites occur on gentle to steep slopes. 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. 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 *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 *Descurainia pinnata, Lappula occidentalis*, and *Salsola tragus*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare shrubland was sampled adjacent to the Syncline Loop Trail in a canyon floor riparian area, in Butler Wash, and in Lathrop Canyon and Horseshoe Canyon.

Globally

This association has currently only been described from northeastern Arizona, northwestern Colorado and southern, eastern and northern Utah but is likely more widespread throughout the western U.S. in disturbed areas.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This short shrubland occurs on disturbed canyon bottoms and wash channels and terraces. Sampled sites are flat (less than 3 degrees slope), oriented to the east and west, and occur between at 1181 and 1691 m elevation. Bare soil and litter cover most of the unvegetated surface with lesser cover by biological soils crusts. The soil is a rapidly drained loamy sand.

Globally

This shrubland occurs in disturbed situations at moderate altitudes in the Colorado Plateau; it extends into the Great Basin and is likely widespread in disturbed areas across the western U.S. It has been documented from sites in northeastern Arizona, northwestern Colorado and southern, eastern and northern Utah. Sites include intermittently flooded drainages, stream terraces and broad floodplains, basins and moderate to steep upland slopes. Elevations range from 1220 to 2085 m (4000-6840 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.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This disturbed shrubland is rare within the park and has total vegetation cover of between 21 and 56%. The vegetation is characterized by an open canopy of *Ericameria nauseosa* (2 to 36% cover), occasionally co-dominated by *Atriplex canescens*, and an understory dominated by the non-native annual grass *Bromus tectorum* (3 to 25% cover). *Mahonia fremontii, Amelanchier utahensis, Ephedra viridis*, *Chrysothamnus linifolius, Gutierrezia sarothrae,* and *Opuntia erinacea* contribute diversity but little cover. Relict bunch grasses in the understory include *Achnatherum hymenoides* (which can be nearly codominant with *Bromus tectorum*), *Hesperostipa comata*, and *Sporobolus cryptandrus*. Forbs reflect the disturbed nature of the community; *Artemisia dracunculus, Artemisia ludoviciana, Artemisia campestris, Bassia hyssopifolia, Machaeranthera canescens, Salsola tragus, Plantago patagonica* (with up to 20% cover), and *Sphaeralcea parvifolia* were recorded.

Globally

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 *Elaeagnus angustifolia* or *Juniperus* spp. trees are present in some stands. The herbaceous layer contains many species but is overwhelmingly dominated by *Bromus tectorum* providing up to 90% cover. 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 *Descurainia pinnata, Lappula occidentalis*, and exotics *Salsola tragus, Rumex crispus, Sonchus asper, Tamarix chinensis*, and *Tragopogon dubius*.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Mahonia fremontii*
Short shrub/sapling	*Ericameria nauseosa*
Herb (field)	*Achnatherum hymenoides*, *Bromus tectorum*, *Sporobolus contractus*, *Sporobolus cryptandrus*

Globally

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*
Herb (field)	*Bromus tectorum*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally

Vulnerable: *Yucca elata* var. *utahensis* (globally vulnerable; endemic variety, G5T3?); **Exotic/Invasive**: *Bromus tectorum* (exotic, High), *Descurainia pinnata* (weedy native), *Elaeagnus angustifolia* (exotic, High), *Lepidium latifolium* (exotic, High), *Rumex crispus* (exotic, Low/Insignificant), *Salsola tragus* (exotic), *Sonchus asper* (exotic), *Tamarix chinensis* (exotic), *Tragopogon dubius* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (14-Aug-2001).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The lush growth in the canyon bottom suggests a high water table and a narrow stream trickles through intermittently. High canyon walls provide shade since the canyon runs east to west. The shrubs are large, old and seem to be in robust health.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0441) and 2007 Accuracy Assessment (5 points: CANY_AA.0286, CANY_AA.0907, CANY_AA.0934, CANY_AA.0963, and CANY_AA.3298).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Romme et al. 1993, Salas et al. 2010, Thomas et al. 2010, Western Ecology Working Group n.d.

Ericameria nauseosa / Sporobolus airoides Shrubland

Rubber Rabbitbrush / Alkali Sacaton Shrubland

CODE	CEGL002918
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ERICAMERIA NAUSEOSA* SHRUBLAND ALLIANCE (A.835) Rubber Rabbitbrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Greasewood Flat (CES304.780)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This short-shrub association occurs on stream terraces in southeastern Utah and western Colorado. It is uncommon within its range, 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%) 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. Total vegetation cover ranges from 15 to 65% and 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, Dicoria canescens, 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 *Wyethia scabra* and *Astragalus moencoppensis*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association is rare within the park and recreation area and was sampled near Muffin Arch and in Holeman Spring Basin in Canyonlands National Park, and Big Water Canyon of Glen Canyon National Recreation Area.

Globally

This association has been documented from southeastern Utah and reported from Colorado. It is likely to occur in small, isolated patches throughout the Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland occurs on stream terraces and wash bottoms. Sites are flat to gently sloping and lie between 1263 and 1538 m elevation. Most of the unvegetated surface is bare soil with low to moderate cover of litter and biological soil crusts. Soils are rapidly drained sandy loams or loamy sands derived from alluvium.

Globally

This short-shrub association occurs on stream terraces in southeastern Utah and western Colorado. Sites slope gently (1-2%) 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.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This unusual shrubland is rare within the park and recreation area. Total vegetation cover ranges from 13 to 64% depending on the degree of disturbance from flooding or livestock use. The shrub canopy is dominated by *Ericameria nauseosa* with between 3 and 60% cover; the understory is well-developed and is dominated or codominated by *Sporobolus airoides* with between 2 and 10% cover. Associated shrubs include species typical of Colorado Plateau floodplains: *Atriplex canescens, Atriplex confertifolia, Gutierrezia sarothrae, Yucca harrimaniae, Sclerocactus whipplei*, and *Opuntia polyacantha*. Other grasses present may include *Achnatherum hymenoides*; forbs are more diverse and include *Machaeranthera canescens, Astragalus moencoppensis, Chenopodium desiccatum*, and *Eriogonum cernuum*. Biological soil crust cover ranges from sparse to 35% but is often in an early stage of development because of occasional disturbance.

Globally

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, Dicoria canescens, 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 *Wyethia scabra* and *Astragalus moencoppensis*.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Sporobolus airoides*

Globally

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*

Herb (field) *Sporobolus airoides*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G3Q (28-Oct-2002).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Soils are sandy and lack crusting or any rock cover. Lack of flood debris indicates that this terrace rarely floods, although *Ericameria nauseosa* roots may be deep enough to tap into the water table.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY 0287, CANY 0712, GLCA 0130).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Clark et al. 2009, Romme et al. 1993, Western Ecology Working Group n.d.

Ericameria nauseosa Desert Wash Shrubland

Rubber Rabbitbrush Desert Wash Shrubland

CODE	CEGL002261
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ERICAMERIA NAUSEOSA* SHRUBLAND ALLIANCE (A.835) Rubber Rabbitbrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Wash (CES304.781)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
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 degrees) 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 or sandy loams. This shrubland association has sparse to moderate total vegetation cover (1-65%). This association 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*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland is distributed along low-lying areas within the park and recreation area and was sampled south of the Zeus and Moses formations, along the Colorado River, in Dog Leg Canyon, near Horseshoe Canyon Trailhead, in Horse Canyon, on Valentine's Bottom, along White Rim Road, and in Davis Canyon in Canyonlands National Park and in Big Water Canyon, near Bagpipe Butte, and in Millard Canyon in Glen Canyon National Recreation Area.

Globally
This association has been found in western Colorado and eastern Utah. It is likely found in other places of the arid western U.S.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland occurs on intermittently flooded canyon bottoms, washes, floodplains and terraces. Sites are flat or slope gently and lie between 1182 and 1599 m elevation. Most of the unvegetated surface is bare soil or sand with sparse cover by gravel, large rocks, litter and downed wood. Soils are well-drained to rapidly drained sandy loams, sands or loamy sands derived from alluvium.

Globally
This association is found in or adjacent to temporary watercourses on point bars, basin floors, and low stream terraces. Stands have been found between 1189 and 2104 m (3900-6900 feet) elevation. Sites are flat to gently sloping (<3 degrees) 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This desert wash shrubland occupies wash banks, washes, and other dynamic, low-lying areas within the park and recreation area. Total vegetation cover ranges from 7 to 18% depending on the frequency of disturbance. The shrub canopy is dominated by clumps of *Ericameria nauseosa* on point bars, islands and banks with between 7 and 15% cover. Associated shrubs are typical of desert washes, but have much less cover than the *Ericameria*, and include *Atriplex canescens, Artemisia filifolia, Encelia frutescens, Ephedra torreyana, Gutierrezia sarothrae, Fraxinus anomala*, and *Tamarix chinensis*. The herbaceous layer is diverse but contributes only sparse cover. Common graminoids include *Achnatherum hymenoides, Bromus tectorum, Pleuraphis jamesii*, and *Sporobolus cryptandrus*. Forbs vary among sites; *Salsola tragus, Dalea candida* var. *oligophylla (= Dalea oligophylla), Artemisia ludoviciana, Stanleya pinnata, Chamaesyce fendleri, Abronia fragrans, Ambrosia acanthicarpa, Lepidium montanum*, and *Astragalus* sp. were recorded in the sample plots.

Globally
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, 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*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Salsola tragus*
Herb (field)	*Achnatherum hymenoides*, *Bromus tectorum*

Globally

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Descurainia pinnata* (exotic), *Halogeton glomeratus* (exotic, High/Medium), *Salsola tragus* (exotic), *Tamarix chinensis* (exotic), *Xanthium strumarium* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (10-Jan-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
In sparse or patchy stands, *Ericameria nauseosa* acts as an indicator species.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The relatively mesic and intermittently flooded environment facilitates this community.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (13 plots: CANY 0344, CANY 0448, CANY 0587, CANY 0600, CANY 0641, CANY 0668, CANY 0671, CANY 0711, CANY 0723, CANY 0796, GLCA 0127, GLCA 0559, GLCA 0728).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Drake, mod. 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. 2009a, Von Loh et al. 2007, Western Ecology Working Group n.d.

Ericameria nauseosa Sand Deposit Sparse Shrubland

Rubber Rabbitbrush Sand Deposit Sparse Shrubland

CODE	CEGL002980
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ERICAMERIA NAUSEOSA* SHRUBLAND ALLIANCE (A.835) Rubber Rabbitbrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Active and Stabilized Dune (CES304.775)
Southern Colorado Plateau Sand Shrubland (CES304.793)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

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*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association is rare within the park and recreation area and was sampled 300 m west of Lathrop Trail and on a ridge on the eastern extent of Pappy's Pasture in Canyonlands National Park and 3 km north-northeast of Hans Flat Ranger Station in Glen Canyon National Recreation Area.

Globally

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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparse shrubland occurs on active sand dunes and unstable sandsheets. Sites are moderate to steeply sloping (5-27 degrees) and lie between 1793 and 1988 m elevation. Most of the unvegetated surface consists of sand or bare soil with low cover by litter and biological soil crusts. Soils are rapidly drained sandy loams or sands derived from eolian deposits.

Globally

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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparse shrubland is rare within the park and recreation area. Total vegetation cover does not exceed 11% and is characterized by an open canopy of scattered *Ericameria nauseosa* shrubs with between 3 and 7% cover. Associated shrubs are typical of sandy environments; *Ephedra viridis, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Eriogonum microthecum, Yucca angustissima*, and *Opuntia polyacantha* are common in the sampled stands. The herbaceous layer likewise consists primarily of sandy species such as *Achnatherum hymenoides, Aristida purpurea, Muhlenbergia pungens, Hesperostipa comata, Sporobolus cryptandrus, Bouteloua gracilis, Poa fendleriana, Abronia fragrans, Hymenopappus filifolius, Arenaria fendleri, Artemisia campestris, Cryptantha flava, Oenothera pallida, Townsendia incana, Comandra umbellata, Phlox austromontana*, and *Rumex hymenosepalus*. Biological soil crust cover does not exceed 11% and is generally in a very early stage of development, dominated by *Collema* sp., mosses and dark cyanobacteria. In some stands, *Juniperus osteosperma* trees and *Pinus edulis* and *Juniperus osteosperma* seedlings provide sparse cover.

Globally

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*.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Abronia fragrans*, *Hymenopappus filifolius*
Herb (field)	*Achnatherum hymenoides*

Globally

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Gutierrezia sarothrae*, *Opuntia polyacantha*
Herb (field)	*Heterotheca villosa*
Herb (field)	*Achnatherum hymenoides*, *Aristida purpurea*, *Hesperostipa comata*, *Sporobolus cryptandrus*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally

Exotic/Invasive: *Bromus tectorum* (exotic, High); **Other**: *Yucca elata* var. *utahensis* (endemic variety, G5T3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (22-Jan-2002).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This association is distinguished as much by its setting as its floristics, and as such is floristically fairly diverse.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Sand is blowing both in and out of this area, leaving plants on mounds and exposing some roots. Loose sand seems to be burying some plants and exposing others.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY 0326, CANY 0817, GLCA 0306).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Romme et al. 1993, Salas et al. 2010, Von Loh et al. 2002, Western Ecology Working Group n.d.

Ericameria nauseosa Shrubland

Rubber Rabbitbrush Shrubland

CODE	CEGL002713
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ERICAMERIA NAUSEOSA* SHRUBLAND ALLIANCE (A.835) Rubber Rabbitbrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This is a broadly defined, semi-arid upland shrubland currently described from western Colorado, Nevada, and Utah and is likely more widespread. Elevations range from 1169 to 2420 m (3834-8000 feet). Stands occur on flat to gently sloping (<8%), dry alluvial terraces above ephemeral washes or perennial stream and river channels or may form a band in the alluvial flats above playas. Substrates are deep, moderately well- to well-drained silty clay loam to sandy loam soils derived from stratified alluvium. The ground surface has moderate to high cover of bare soil. The vegetation is characterized by a moderately dense to dense (40-70% cover) shrub canopy dominated by *Ericameria nauseosa* shrubs 0.5-3 m tall, with a relatively sparse herbaceous layer. Some stands have low diversity, others have additional associated short and dwarf-shrubs such as *Artemisia frigida, Artemisia tridentata* ssp. *wyomingensis, Atriplex canescens, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Psorothamnus polydenius, Rosa woodsii, Sarcobatus vermiculatus*, and *Tetradymia tetrameres*. The sparse herbaceous layer is a mixture of grasses and forbs. Grass cover is generally low and may include native species such as *Achnatherum lettermanii, Achnatherum hymenoides, Distichlis spicata, Pseudoroegneria spicata, Sporobolus airoides*, and *Elymus elymoides*. Non-native grasses include *Bromus tectorum* and *Poa pratensis*. Common forbs may include the native species *Erigeron flagellaris, Tragopogon dubius, Achillea millefolium, Agoseris glauca, Potentilla crinita, Artemisia ludoviciana, Eriogonum hookeri, Rumex salicifolius*, and *Verbesina encelioides*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland was observed and sampled in upper Salt Creek, lower Salt Creek, and near the mouth of Deadhorse Canyon on the Green River.

Globally
This is a broadly defined upland shrubland association currently described from western Colorado, Utah and Nevada, but it likely occurs more widely in the western U.S.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association occurs on washes, wash and creek terraces, and overflow channels. Elevations range from 1178-1798 m on flat sites with deep silty or sandy soils derived from alluvium.

Globally
This is a broadly defined, semi-arid upland shrubland association currently described from western Colorado , Nevada, and Utah and is likely more widespread. Elevations range from 1191-2420 m (3900-8000 feet). Stands occur on flat to gently sloping (<8%), dry alluvial terraces above ephemeral washes or perennial stream and river channels or may form a band in the alluvial flats above playas. Substrates are deep, moderately well- to well-drained silty clay loam to sandy loam soils derived from stratified alluvium. Sand or other coarse-textured material may underlay finer-textured layers (Bundy et al. 1996). The ground surface has moderate to high cover of bare soil.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is characterized by a moderately dense to dense (15-70% cover) shrub layer of *Ericameria nauseosa*. Shrub associates include *Sarcobatus vermiculatus* (up to 8% cover), *Atriplex canescens* (up to 10% cover), *Artemisia tridentata* ssp. *tridentata,* and *Forestiera pubescens*. The invasive species *Bromus tectorum* and *Salsola tragus* may be present with sparse cover. Other herbaceous species observed at low covers include *Machaeranthera canescens* and *Sporobolus airoides.*

Globally
The vegetation is characterized by a moderate to dense (35-70% cover) shrub canopy dominated by *Ericameria nauseosa* shrubs 0.5-3 m tall, with a relatively sparse herbaceous layer. In Colorado, stands have low diversity. Additional associated short and dwarf-shrubs are *Artemisia frigida, Artemisia tridentata* ssp. *wyomingensis*, and *Rosa woodsii*. In Nevada, stands are more diverse, and several other shrubs, such as *Atriplex canescens, Psorothamnus polydenius, Sarcobatus vermiculatus*, and *Tetradymia tetrameres*, may be important. The sparse herbaceous layer is a mixture of grasses and forbs. Native grasses include *Achnatherum hymenoides, Distichlis spicata*, and *Elymus elymoides*. Common forbs may include the non-natives *Cirsium arvense, Descurainia incana* ssp. *incisa, Erodium cicutarium, Lepidium campestre, Iva axillaris, Salsola tragus*, and *Sisymbrium altissimum*, and the natives *Eriogonum hookeri, Rumex salicifolius*, and *Verbesina encelioides*. The introduced annual grass *Bromus tectorum* was observed to be prominent in one stand in Utah, although native grasses *Pseudoroegneria spicata* and *Sporobolus airoides* are typically absent or have low cover.

MOST ABUNDANT SPECIES

*Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)*Data are not available.

Globally

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Exotic/Invasive: *Bromus tectorum* (invasive/exotic, High), *Cirsium arvense* (invasive/exotic, High/Medium), *Descurainia pinnata* (invasive/exotic), *Erodium cicutarium* (invasive/exotic, Medium/Low), *Iva axillaris* (invasive/exotic), *Lepidium campestre* (invasive/exotic), *Poa pratensis* (invasive/exotic, Medium), *Salsola tragus* (invasive/exotic), *Sisymbrium altissimum* (invasive/exotic), *Taraxacum officinale* (invasive/exotic), *Tragopogon dubius* (invasive/exotic, Medium/Low)

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (26-Jun-2001).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This broadly defined upland *Ericameria nauseosa* association is not limited to washes or dune/sandsheet shrubland. Diagnostic of this type is a sparse herbaceous layer that is not dominated by the widespread introduced annual grass *Bromus tectorum* or the native grasses *Pseudoroegneria spicata* or *Sporobolus airoides*. One of the stands classified by Bundy et al. (1996) is codominated by *Tetradymia tetrameres*. These transitional types are difficult to classify, and further survey and classification work are needed to fully characterize this association.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 observation point: CANY.9053) and 2008 Accuracy Assessment (2 points: CANY_AA.2573 and CANY_AA.2718).
Local Description Authors: M.E. Hall and A. Tendick
Global Description Authors: K.A. Schulz, mod. G. Kittel

REFERENCES: Bundy et al. 1996, Coles et al. 2010, FEIS 2006, McArthur et al. 1997, Salas and Bolen 2010b, USFS 1937, Western Ecology Working Group n.d.

Ericameria nauseosa Sparse Shrubland

Rubber Rabbitbrush Sparse Shrubland

CODE	CEGL003961
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ERICAMERIA NAUSEOSA* SHRUBLAND ALLIANCE (A.835) Rubber Rabbitbrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This sparse shrubland is only known from Canyonlands National Park in eastern Utah. Stands occur on colluvial deposits in canyons on steep slopes (22-34 degrees) between 1471 and 1549 m elevation. Rocks and gravel cover most of the unvegetated surface, with low cover by bare soil. Soils are rapidly drained sandy clay loams derived from colluvium of the Moenkopi and Organ Rock formations. 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, 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparse shrubland association is rare within the park and was sampled in Horse Canyon, in Trail Canyon, adjacent to the Gooseberry Trail, and 100 m from the Alcove Spring seep.

Globally
This sparse shrubland association is only know from one plot in Canyonlands National Park in eastern Utah. It is likely more widespread in eastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare shrubland occurs on colluvial deposits in canyons. Stands are located on steep slopes (22-37 degrees) between 1419 and 1549 m elevation. Rocks and gravel cover most of the unvegetated surface, with low cover by bare soil. Soils are rapidly drained sandy clay loams derived from colluvium of the Moenkopi and Organ Rock formations.

Globally
This sparse shrubland is only know from Canyonlands National Park in eastern Utah. Stands occur on colluvial deposits in canyons on steep slopes (22-34 degrees) between 1471 and 1549 m elevation. Rocks and gravel cover most of the unvegetated surface, with low cover by bare soil. Soils are rapidly drained sandy clay loams derived from colluvium of the Moenkopi and Organ Rock formations.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparse shrubland is rare within the park. Total vegetation cover ranges from 2 to 14%. The open shrub canopy is dominated by *Ericameria nauseosa* var. *juncea* with up to 8% cover, usually accompanied by a diversity of other shrubs, including *Ephedra viridis, Ephedra torreyana, Chrysothamnus viscidiflorus* var. *stenophyllus, Gutierrezia sarothrae, Yucca angustissima*, and *Opuntia erinacea*. The herbaceous layer is sparse and inconsistent among stands, depending on the substrate; *Pleuraphis jamesii, Achnatherum hymenoides, Bromus tectorum, Tiquilia latior, Cryptantha* sp., *Stanleya pinnata, Lepidium montanum* var. *jonesii*, and *Eriogonum inflatum* were recorded in the sample plots. 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. *Juniperus osteosperma* trees and seedlings are occasionally present with less than 1% cover.

Globally
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, 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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa* var. *juncea*
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa* var. *juncea*
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Gutierrezia sarothrae*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jun-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Rock cover is greater than 90% of the ground surface, and slopes are very loose. The soil is very shallow, very hard, and full of small rocks.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: **Plots and Observation Points**: The description is based on 2004 field data (3 plots): (Plots: CANY 0104, CANY 0124, CANY 0431, CANY 9411).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Tamarix spp. Temporarily Flooded Semi-natural Shrubland

Salt-cedar species Temporarily Flooded Semi-natural Shrubland

CODE	CEGL003114
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Temporarily flooded microphyllous shrubland (III.A.4.N.c.)
ALLIANCE	*TAMARIX* SPP. SEMI-NATURAL TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.842) Salt-cedar species Semi-natural Temporarily Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): North American Warm Desert Lower Montane Riparian Woodland and Shrubland (CES302.748)
North American Warm Desert Riparian Woodland and Shrubland (CES302.753)
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This broadly defined association is composed of shrublands which form moderately dense to dense thickets on banks of larger streams across the western Great Plains, interior and southwestern U.S. and northern Mexico. Stands are dominated by introduced species of *Tamarix*, including *Tamarix chinensis, Tamarix chinensis, Tamarix gallica*, and *Tamarix parviflora*. *Tamarix* spp. were introduced from the Mediterranean and have become naturalized in various sites, including salt flats and other 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. A remnant herbaceous layer may be present, depending on the age and density of the shrub layer, although in many cases this layer also consists of aggressive exotic species such as *Lepidium latifolium*. *Tamarix* species have become a critical nuisance along most large rivers in the semi-arid West and, because of permanent changes in flood regimes and the difficulty of removing trees, reflect irreversibly changed vegetation on many sites.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This riparian shrubland occurs on floodplains and banks of rivers, streams, and washes within the park. It was sampled along the Green River, near Fort Bottom Trail, in Lockhart Canyon, along the Colorado River, and near Salt Creek Campground.

Globally

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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This invasive riparian shrubland occurs in intermittently or seasonally flooded low-lying areas including river terraces, canyon bottoms, stream channels and river islands. Sites are flat to steep (0- to 23-degree slopes) and are located between 1176 and 1791 m elevation. Bare soil and litter cover most of the unvegetated surface, sometime with sparse cover of downed wood. Soils are poorly drained to rapidly drained sandy loams, silt loams, silty clay loams, or silts derived from alluvium.

Globally

These widespread shrublands are common along larger streams, rivers, and around playas in the western U.S. and Mexico. Elevation ranges from 75 m below sea level to 1860 m. *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 flood-regenerated native species such as *Populus* are

declining, and the absence of regular scouring floods allows *Tamarix* seedlings to become established. Substrates are commonly thin sandy loam soil over alluvial deposits of sand, gravel or cobbles.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Salt-cedar shrublands have become established on the floodplains and banks of rivers and streams throughout the park. Total vegetation cover in these stands ranges from 25 to 100% and is dominated by a dense canopy, typically 2 to 10 m tall, of *Tamarix chinensis* usually providing up to 90% of the total vegetation cover. Other shrubs may be present but with low cover, including *Salix exigua, Forestiera pubescens*, and *Ribes aureum*. The herbaceous layer tends to be limited, as it is inhibited by the dense canopy and litter cover. It consists largely of weedy or exotic salt-tolerant species, including *Bromus tectorum, Elymus trachycaulus, Juncus balticus, Poa pratensis, Chenopodium album, Bassia scoparia, Descurainia pinnata*, and *Salsola tragus*. The riparian vine *Clematis ligusticifolia* is occasionally present with sparse cover.

Globally

This semi-natural shrubland occurs along streams, rivers and playas where it forms a moderate to dense tall-shrub layer that is solely or strongly dominated by species of *Tamarix*, including *Tamarix chinensis, Tamarix chinensis, Tamarix gallica*, and *Tamarix parviflora*. Other shrubs may include species of *Salix* (especially *Salix exigua*) and *Prosopis, Rhus trilobata*, and *Sarcobatus vermiculatus* but with low cover (if shrub species are codominant, then the stand is classified as a natural shrubland). Scattered *Acer negundo, Salix amygdaloides, Populus* spp., or *Elaeagnus angustifolia* trees 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 others have been reported from shrublands in this association.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Salix exigua*, *Tamarix chinensis*
Herb (field)	*Chenopodium album*
Herb (field)	*Bromus tectorum*

Globally

Stratum	Species
Tall shrub/sapling	*Tamarix chinensis*, *Tamarix gallica*, *Tamarix parviflora*, *Tamarix chinensis*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bassia scoparia* (exotic, Low), *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Descurainia pinnata* (exotic), *Halogeton glomeratus* (exotic, High/Medium), *Phragmites australis* (exotic, High), *Poa pratensis* (exotic, Medium), *Salsola tragus* (exotic), *Tamarix chinensis* (exotic), *Taraxacum officinale* (exotic)

Globally

Exotic/Invasive: *Bromus tectorum* (exotic, High), *Lepidium latifolium* (exotic, High), *Poa pratensis* (exotic, Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (24-Jul-2001).

CLASSIFICATION COMMENTS

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This *Tamarix chinensis* riparian shrubland is typical of mesic areas along the river.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (8 plots: CANY 0146, CANY 0147, CANY 0201, CANY 0203, CANY 0582, CANY 0590, CANY 0603, CANY 0752).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Baalman 1965, 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, 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, Romme et al. 1993, Sawyer and Keeler-Wolf 1995, Smith and Douglas 1989, Stevens and Shannon 1917, Szaro 1989, Thomas et al. 2009a, Ungar 1968, Von Loh et al. 2002, Ware and Penfound 1949, Western Ecology Working Group n.d.

Artemisia bigelovii - Ephedra (viridis, torreyana) Talus Shrubland

Bigelow Sagebrush - (Mormon-tea, Torrey's Joint-fir) Talus Shrubland

CODE	CEGL003755
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland (III.A.5.N.a.)
ALLIANCE	*ARTEMISIA BIGELOVII* SHRUBLAND ALLIANCE (A.1103) Bigelow Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)
Colorado Plateau Mixed Low Sagebrush Shrubland (CES304.762)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This mixed colluvial slope shrubland is known from Arches and Canyonlands national parks and Glen Canyon National Recreation Area in eastern Utah and likely is more widespread throughout the canyonlands of the Colorado Plateau. This sparse mixed shrubland occurs on the colluvial deposits that form the lower slopes of canyons and valleys and on mesatops, steep canyonsides, benches, hills and escarpments. Most stands are on steep slopes (1-39 degrees) 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. 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 but may not be dominant. As many as 15 species of shrubs 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association is widespread in the park and recreation area. Sites sampled include Big Draw Canyon, 150 m west of Fort Bottom Trail parking area, in Cyclone Canyon, on Spanish Bottom, 1 km northwest of Millard Camp, and in Elephant Canyon in Canyonlands National Park and near Buttes of the Cross and at the head of Horse Canyon in Glen Canyon National Recreation Area.

Globally
This association is known from Arches and Canyonlands national parks and Glen Canyon National Recreation Area and likely is widespread throughout the canyonlands of the Colorado Plateau in eastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association occurs on steep, rocky colluvial slopes associated with mesas, canyon sides, benches, hills and escarpments. Sites are located on gentle to steep (1- to 39-degree) slopes between 1193 and 1673 m elevation. The unvegetated surface has variable cover of bare soil, low to moderate cover of small and large rocks, and sparse cover of litter and downed wood. Cryptogamic soil communities provide sparse cover. Soils vary in texture and parent materials; most are sandy or loamy in texture and are derived from Cedar Mesa sandstone, Chinle shale, Moenkopi shale and Honaker Trail Formation.

Globally
This sparse mixed shrubland occurs on the colluvial deposits that form the lower slopes of canyons and valleys and on mesatops, steep canyonsides, benches, hills and escarpments. Stands are on gentle to more typically steep slopes (1- to 39-degree) 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 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 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This mixed shrubland occurs on steep colluvial slopes. Total vegetation cover ranges from 4 to 17%. 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 sarothrae*, and *Echinocereus triglochidiatus*. *Rhus trilobata* and *Fraxinus anomala* are absent or have no more than trace cover. The herbaceous layer may include many species but never provides more than a few percent cover; *Pleuraphis jamesii, Achnatherum hymenoides, Aristida purpurea, Stanleya pinnata, Chamaesyce fendleri*, and *Eriogonum inflatum* are the most consistent species. Biological soil crust formation is rare on these active slopes.

Globally
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, Ericameria nauseosa, Eriogonum corymbosum*, and *Gutierrezia sarothrae*. *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. *Pleuraphis jamesii, Achnatherum hymenoides, Aristida purpurea, Chamaesyce fendleri, Eriogonum inflatum, Lepidium montanum*, and *Stanleya pinnata* are the most consistent species. Biological soil crust formation is rare on

active slopes, but may be 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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*
Short shrub/sapling	*Artemisia bigelovii*, *Ephedra torreyana*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia bigelovii*, *Ephedra torreyana*, *Ephedra viridis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (13-Mar-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Steep colluvial slopes with small microenvironments on the downslope sides of the large boulders create this community.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (8 plots: CANY 0142, CANY 0169, CANY 0192, CANY 0445, CANY 0657, CANY 0771, GLCA 0318, GLCA 0746).
Local Description Authors: J. Coles
Global Description Authors: K.A. Schulz

REFERENCES: Coles et al. 2009a, Western Ecology Working Group n.d.

Ephedra torreyana / Achnatherum hymenoides - Pleuraphis jamesii Shrubland

Torrey's Joint-fir / Indian Ricegrass - James' Galleta Shrubland

CODE	CEGL002352
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland (III.A.5.N.a.)
ALLIANCE	*EPHEDRA TORREYANA* SHRUBLAND ALLIANCE (A.2572) Torrey's Joint-fir Shrubland Alliance

ECOLOGICAL SYSTEM(S):

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

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-degree slopes), occur between 1220 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. 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 codominated by *Achnatherum hymenoides* and *Pleuraphis jamesii* with between 2 and 15% cover. Associated shrubs include *Atriplex canescens, Opuntia polyacantha*, and *Gutierrezia sarothrae*. *Coleogyne ramosissima* is absent or has 1% or less cover. The remaining herbaceous layer often includes *Astragalus amphioxys, Malacothrix sonchoides, Sporobolus airoides, Sporobolus flexuosus*, and *Sphaeralcea parvifolia*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is found in Taylor Canyon, Horse Canyon, Lathrop Trailhead, Horseshoe Canyon, Lost Canyon, Upheaval Canyon, north of Gooseberry Canyon, in Holeman Springs Basin, near Junction Butte and the Maze Overlook.

Globally

This association is known from scattered sites in southeastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association typically occurs on dunes and sandsheets, and more rarely on stream terraces, at elevations ranging from 1200-1544 m (3888-5002 feet) on variable aspects. Positions include low levels, high levels, toeslopes, low slopes and midslopes with soils derived from aeolian sands, which dominate the unvegetated soil surface.

Globally

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-degree slopes), occur between 1220 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 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This Mormon-tea association is characterized by a shrub layer dominated by *Ephedra torreyana*, with between 2 and 8% cover. Total vegetation cover ranges from 6 to 31%. *Coleogyne ramosissima* may sometimes be codominant in the shrub layer. *Artemisia filifolia, Ericameria nauseosa, Atriplex canescens, Atriplex confertifolia, Opuntia polyacantha*, *Gutierrezia sarothrae,* and *Yucca angustissima* are frequent associates in the shrub and dwarf-shrub layers, but are never codominant. The understory is graminoid-dominated, the most abundant species being *Achnatherum hymenoides*, with between 1 and 10% cover. *Pleuraphis jamesii* is almost always present but at low covers (trace to 2%). In a couple examples of this type, *Hesperostipa comata* is codominant with *Achnatherum hymenoides.* Other associated grasses with low cover may include *Aristida purpurea, Sporobolus airoides,* and *Sporobolus flexuous*. *Amsonia tomentosa, Abronia fragrans, Sphaeralcea parvifolia, Sphaeralcea janeae, Salsola tragus, Dalea oligophylla, Dalea flavescens, Cryptantha flava,* and *Rumex hymenosepalus* are commonly associated forbs.

Globally

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 codominated by *Achnatherum hymenoides* and *Pleuraphis jamesii* with between 2% and 15% cover. Associated shrubs include *Atriplex canescens, Opuntia polyacantha*, and *Gutierrezia sarothrae*. *Coleogyne ramosissima* is absent or has 1% or less cover. The remaining herbaceous layer often includes *Astragalus amphioxys, Malacothrix sonchoides, Sporobolus airoides, Sporobolus flexuosus*, and *Sphaeralcea parvifolia*.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Coleogyne ramosissima*, *Ephedra torreyana*
Herb (field)	*Opuntia polyacantha*
Herb (field)	*Achnatherum hymenoides*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex canescens*
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Gutierrezia sarothrae*, *Opuntia polyacantha*
Herb (field)	*Achnatherum hymenoides*, *Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally

Exotic/Invasive: *Salsola tragus* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (21-Mar-2005).

CLASSIFICATION COMMENTS

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (4 observation points: CANY.0369, CANY.0523, CANY.0731, CANY.0736) and 2007 and 2008 Accuracy Assessment (9 points: CANY_AA.0183, CANY_AA.0337, CANY_AA.4023, CANY_AA.4144, CANY_AA.4148, CANY_AA.4153, CANY_AA.4154, CANY_AA.4161, CANY_AA.4183).
Local Description Authors: M.E. Hall and A. Tendick
Global Description Authors: J. Coles

REFERENCES: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.

Ephedra torreyana / Pleuraphis jamesii Shrubland

Torrey's Joint-fir / James' Galleta Shrubland

CODE	CEGL003772
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland (III.A.5.N.a.)
ALLIANCE	*EPHEDRA TORREYANA* SHRUBLAND ALLIANCE (A.2572) Torrey's Joint-fir Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This short-shrub association occurs on typically deep alkaline soils on plateaus, mesas, benches, lower slopes and stream terraces in the canyonlands of the Colorado Plateau. Sites are flat to moderately steep (up to 18-degree 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. 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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association occurs on deep soils in the park and recreation area. Sampled sites include along the White Rim Road, inTaylor Canyon, on Gooseberry Mesa, on Syncline Trail, near Buttes of the Cross, and in Surprise Valley in Canyonlands National Park.

Globally
This association is known from Arches and Canyonlands national parks and Glen Canyon National Recreation Area in eastern Utah and likely is widespread throughout the canyonlands of the Colorado Plateau in eastern Utah and possibly southern Arizona.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This desert shrubland occurs on deep soils of mesas, benches, canyon sides, alluvial flats, and valley bottoms. Sites are flat to steeply sloped (0-21 degrees), oriented to the north, south, and east, and lie between 1266 and 1433 m elevation. Bare soil and gravel cover most of the unvegetated surface, with sparse to moderate cover of large rocks, and sparse cover of litter. Soils are rapidly drained loamy sands, clays, sandy clay loams, or sandy loams derived from alluvium, Moenkopi Formation or White Rim sandstone.

Globally

This desert short-shrub association occurs on deep alkaline soils on plateaus, mesas, benches, lower slopes and stream terraces in canyonlands of the Colorado Plateau. Sites are flat to moderately steep (up to 18-degree 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 or sandy loams derived from Halgaito Shale, Moenkopi Formation or White Rim sandstone.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This desert shrubland is restricted to deep, alkaline soils within the park. Total vegetation cover ranges from 6 to 11%. The shrub canopy is dominated by scattered *Ephedra torreyana* with 2-5% cover. Associated shrubs include *Ericameria nauseosa, Coleogyne ramosissima, Atriplex confertifolia, Opuntia polyacantha, Sclerocactus whipplei, Yucca angustissima, Eriogonum leptocladon,* and *Eriogonum microthecum*. The understory is dominated by the perennial grass *Pleuraphis jamesii* with between 2 and 5% cover. Other herbaceous species with trace to 1% cover include occasional clumps of *Achnatherum hymenoides, Sporobolus cryptandrus,* and *Vulpia octoflora (= Festuca octoflora)*. Forbs commonly present with trace cover include *Chenopodium album, Amsonia tomentosa, Sphaeralcea leptophylla, Sphaeralcea parvifolia, Sphaeralcea coccinea,* and *Xylorhiza glabriuscula.*

Globally

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 *Atriplex gardneri* and *Coleogyne ramosissima* may be present to codominant. Other shrubs include *Atriplex confertifolia, Ericameria nauseosa, Eriogonum microthecum, Opuntia erinacea, Opuntia phaeacantha, Opuntia polyacantha*, and *Sclerocactus whipplei*. 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.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*, *Coleogyne ramosissima*
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Opuntia polyacantha*
Herb (field)	*Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Coleogyne ramosissima*
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Salsola tragus* (exotic)

Globally
Vulnerable: *Sclerocactus whipplei* (globally imperiled, G1G3)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (30-Mar-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Area of deeper soil supports relatively dense vegetation. This gently rolling terrain is not affected by erosion.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (6 plots: CANY.0343, CANY.0351, CANY.0517, CANY.0733, CANY.0829, CANY.9125).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: K.A. Schulz

REFERENCES: Coles et al. 2009a, Western Ecology Working Group n.d.

Ephedra viridis / (Achnatherum hymenoides, Hesperostipa comata) Shrubland

Mormon-tea / (Indian Ricegrass, Needle-and-Thread) Shrubland

CODE	CEGL002354
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland (III.A.5.N.a.)
ALLIANCE	*EPHEDRA VIRIDIS* SHRUBLAND ALLIANCE (A.858) Mormon-tea Shrubland Alliance

ECOLOGICAL SYSTEM(S):
North American Warm Desert Active and Stabilized Dune (CES302.744)
Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)
Inter-Mountain Basins Active and Stabilized Dune (CES304.775)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This short-shrub association occurs on sand dunes and sandsheets deposited on plateaus, benches and valley floors in southeastern Utah. 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*. Sites occupy gentle to moderately steep slopes (0-24 degrees) between 1378 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. Soils are rapidly drained loamy sands and sandy loams derived from eolian sands or alluvial deposits. Total vegetation cover ranges from 1 to 55% but generally is around 35%. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association occurs on deep, sandy soils in the park and recreation area. Areas sampled include along Neck Spring Trail, 200 m southeast of the Whale Rock Trail parking lot, along Upheaval Dome Road, 2 km northwest of Airport Tower, on Gray's Pasture, near the Island in the Sky Visitor Center, and near Horseshoe Canyon in Canyonlands National Park, and near Hans Flat Ranger Station in Glen Canyon National Recreation Area.

Globally
This association is locally common on sandy sites in the Colorado Plateau in southeastern Utah and likely occurs in adjacent states.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland occurs on the fine-sandy, deep soils of dunes, plateaus, valley floors, saddles and mesas. Sites are flat to steep (0- to 24-degree slopes), include all aspects, and occur between 1551 and 2018 m elevation. The unvegetated surface has moderate to high exposure of bare soil or sand and sparse to low cover of litter. Cryptogamic soil communities provide sparse to low cover. Soils are rapidly drained loamy sands, sands or sandy loams derived from alluvium or eolian deposits.

Globally
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 (0- to 24-degrees) between 1378 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland occurs on deep, sandy soils within the park and recreation area. Total vegetation cover ranges from 12 to 20%. The shrub canopy is dominated by *Ephedra viridis* with between 2 and 20% cover and an understory dominated by *Achnatherum hymenoides* and *Hesperostipa comata* with at least 1% and up to 20% cover. Other shrubs present include *Atriplex canescens, Coleogyne ramosissima, Eriogonum leptocladon, Opuntia polyacantha, Gutierrezia sarothrae, Opuntia erinacea*, and *Sclerocactus whipplei*. Associated graminoids include *Bouteloua gracilis, Pleuraphis jamesii, Muhlenbergia pungens, Sporobolus cryptandrus, Vulpia octoflora (= Festuca octoflora), Aristida purpurea*, and *Sporobolus airoides*. Forbs are highly variable in composition; *Machaeranthera canescens, Plantago patagonica, Artemisia campestris, Sphaeralcea parvifolia, Cryptantha* sp., *Hymenopappus filifolius, Lappula occidentalis, Packera multilobata (= Senecio multilobatus), Abronia fragrans, Chaenactis stevioides, Eriogonum deflexum, Oenothera pallida*, and *Salsola tragus* were recorded in the sample plots. Cryptogam cover is variable, ranging from none to 25%.

Globally
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 *Coleogyne ramosissima, Atriplex canescens, Eriogonum leptocladon, Gutierrezia sarothrae*, and the succulents *Opuntia erinacea, Opuntia polyacantha*, and *Sclerocactus whipplei*. Other grasses include *Aristida purpurea, Bouteloua gracilis, Muhlenbergia pungens, Sporobolus airoides, 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, Cymopterus newberryi, Cryptantha* sp., *Descurainia pinnata, Eriogonum deflexum, Hymenopappus filifolius, Lappula occidentalis, Machaeranthera canescens, Mentzelia multiflora, Oenothera pallida, Packera multilobata (= Senecio multilobatus), Plantago patagonica*, 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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex canescens*, *Ephedra viridis*
Herb (field)	*Opuntia polyacantha*
Herb (field)	*Machaeranthera canescens*, *Plantago patagonica*
Herb (field)	*Achnatherum hymenoides*, *Bouteloua gracilis*, *Hesperostipa comata*

Globally

Stratum	Species
Shrub/sapling (tall & short)	*Ephedra viridis*
Herb (field)	*Achnatherum hymenoides*, *Hesperostipa comata*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Descurainia pinnata* (exotic), *Salsola tragus* (exotic)

Globally
Vulnerable: *Sclerocactus whipplei* (globally imperiled, G1G3); **Exotic/Invasive**: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Salsola tragus* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (21-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Dunes are active and the soil surface is unconsolidated and unstable.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (11 plots: CANY 0112, CANY 0118, CANY 0235, CANY 0310, CANY 0317, CANY 0319, CANY 0327, CANY 0358, CANY 0700, CANY 0823, GLCA 0529).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Anderson 2001b, Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.

Ephedra viridis / Bouteloua gracilis Shrubland

Mormon-tea / Blue Grama Shrubland

CODE	CEGL003934
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland (III.A.5.N.a.)
ALLIANCE	*EPHEDRA VIRIDIS* SHRUBLAND ALLIANCE (A.858) Mormon-tea Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

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. It is found on plateaus at elevations between 1825 and 1982 m. Soils are rapidly drained loamy sands or sandy loams derived from eolian deposits. Vegetation is characterized by relatively open shrublands dominated by *Ephedra viridis* with *Gutierrezia sarothrae* and *Opuntia erinacea* as the only consistently associated shrubs. The understory is dominated by *Bouteloua gracilis*. Other graminoids include *Achnatherum hymenoides, Vulpia octoflora (= Festuca octoflora), Bromus tectorum*, and *Sporobolus cryptandrus*. Forbs commonly present with sparse cover include *Eriogonum cernuum, Lupinus pusillus*, and *Sphaeralcea parvifolia*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association was sampled in Willow Flat, near Aztec Butte, in Chesler Park, Red Sea Flat, and north of Butler Wash in the Park and near Hans Flat Ranger Station and in Millard Canyon in the Recreation Area.

Globally

This shrubland association is currently known only from Glen Canyon National Recreation Area in southeastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association occurs on level sites of plateaus, mesatops and plains, including on microdunes, sandy interfluves and low slopes. Sites are oriented to all aspects and lie between 1696 and 1982 m elevation. Bare soil covers most of the unvegetated surface, with low to moderate cover of biological soils crusts (mostly moss), and sparse to low cover of litter. Soils are rapidly drained loamy sands or sandy loams derived from eolian deposits.

Globally

This association is documented from Glen Canyon National Recreation Area and will require further documentation to develop a thorough global description.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This Mormon-tea / blue grama shrubland has total vegetation cover that ranges from 14 to 53%. The shrub canopy is dominated by *Ephedra viridis* with 6 to 40% cover; the understory is dominated by *Bouteloua gracilis* with between 1 and 17% cover. Associated shrubs include *Chrysothamnus viscidiflorus, Atriplex canescens, Krascheninnikovia lanata, Coleogyne ramosissima (*codominant in a couple plots), *Gutierrezia sarothrae* and *Opuntia erinacea* or *polyacantha*. Associated graminoids with sparse to low cover include *Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii, Vulpia octoflora (= Festuca octoflora), Bromus tectorum*, *Sporobolus contractus,* and *Sporobolus cryptandrus*. Forbs commonly present with sparse cover include *Eriogonum cernuum, Machaeranthera canescens, Lupinus pusillus*, *Salsola tragus,* and *Sphaeralcea parvifolia*. Some plots contain scattered *Juniperus osteosperma* with less than 1% cover.

Globally
This association is documented from Glen Canyon National Recreation Area and will require further documentation to develop a thorough global description.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*, *Opuntia erinacea*
Herb (field)	*Eriogonum cernuum*, *Plantago patagonica*
Herb (field)	*Achnatherum hymenoides*, *Bouteloua gracilis*, *Vulpia octoflora*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jun-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This community is found on deep soils. Grazing history likely contributes to the present mix of species.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (4 plots: GLCA 0311, GLCA 0525, GLCA 0706, GLCA 0723) and 2007 and 2008 Accuracy Assessment (8 points: CANY_AA.0321, CANY_AA.0349, CANY_AA.0352, CANY_AA.0362, CANY_AA.0368, CANY_AA.0674, CANY_AA.2386, CANY_AA.2789).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: M.S. Reid and M.E. Hall

REFERENCES: Anderson 2001b, Western Ecology Working Group n.d.

Ephedra viridis / Pleuraphis jamesii Shrubland

Mormon-tea / James' Galleta Shrubland

CODE	CEGL002356
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland (III.A.5.N.a.)
ALLIANCE	*EPHEDRA VIRIDIS* SHRUBLAND ALLIANCE (A.858) Mormon-tea Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)
North American Warm Desert Active and Stabilized Dune (CES302.744)
Inter-Mountain Basins Active and Stabilized Dune (CES304.775)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This shrubland association is found in southeastern Utah on the Colorado Plateau. It occurs on partly stabilized dunefields and sandsheets on valley floors, plateau slopes, benches and mesatops. Stands of this 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*. Sites are located on gentle slopes (2-6 degrees) between 1396 and 1850 m (4577-6070 feet) elevation. Aspect is not important in determining the distribution of this association. The unvegetated surface has high exposure of bare soil and low to moderate cover of litter; biological soil crusts provide up to 30% cover. The rapidly drained, fine sandy loam, loamy sand, and sandy clay soils are derived from sandstones and shales, eolian deposits and alluvium. Total vegetation cover ranges from 6 to 85%. 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 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, Plantago patagonica*, and *Sphaeralcea parvifolia*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland is distributed on deep, fine soils within the park and recreation area. It was sampled in a side canyon of Taylor Canyon, in Willow Flats, on Horsethief Point, south of Chimney Rock, and in the north fork of Range Canyon in Canyonlands National Park, and near High Spur, in Horseshoe Canyon, near Flint Cove, and in Waterhole Canyon in Glen Canyon National Recreation Area.

Globally

This association is known from sandy sites in the Colorado Plateau in southeastern Utah and likely occurs in adjacent states.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association occurs on deep, fine-textured soils of valleys, mesas, plains, benches and plateaus, as well as on dunes and wash terraces. Sites are flat to gently sloping (less than 5 degrees), are oriented to any aspect, and lie between 1500 and 1851 m elevation. Bare soil covers most of the unvegetated surface; litter and biological soil crusts have sparse to moderate cover. Soils are rapidly drained fine sandy loams, loams or loamy sands derived from alluvium.

Globally
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 (<6 degrees) between 1396 and 1850 m (4577-6070 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 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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparse shrubland occupies deep, fine soils within the park and recreation area. Total vegetation cover ranges from 6 to 58%; the shrub canopy is dominated by *Ephedra viridis* with 1 to 42% cover. Associated shrubs, all with sparse to low cover, include *Krascheninnikovia lanata, Atriplex canescens, Coleogyne ramosissima, Chrysothamnus viscidiflorus, Gutierrezia sarothrae*, and *Opuntia* sp. The understory is dominated by the perennial bunchgrass *Pleuraphis jamesii* with between 1 and 12% cover. The remaining herbaceous layer is variable in composition and may include scattered individuals of *Achnatherum hymenoides, Aristida purpurea, Hesperostipa comata, Bouteloua gracilis, Bromus tectorum, Sporobolus cryptandrus, Lupinus pusillus, Salsola* spp., *Eriogonum cernuum, Plantago patagonica, Gilia inconspicua, Sphaeralcea* spp., *Helianthus petiolaris, Packera multilobata (= Senecio multilobatus)*, and *Mentzelia albicaulis*. Some plots contain scattered *Juniperus osteosperma* with less than 1% cover.

Globally
Stands of this 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 5 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, Gutierrezia sarothrae*, and *Opuntia polyacantha*. The herbaceous layer is diverse in terms of species composition and provides sparse to low cover (<20%). Associated graminoids include *Aristida purpurea, Bouteloua gracilis, Sporobolus airoides, Sporobolus cryptandrus*, and the annual exotic grass *Bromus tectorum* (up to 15% cover). Forb cover is low but may be diverse. Associated forbs include *Cryptantha crassisepala, Eriogonum cernuum, Gilia inconspicua, Helianthus petiolaris, Lappula occidentalis, Lupinus pusillus, Mentzelia albicaulis, Packera multilobata (= Senecio multilobatus), Plantago patagonica*, and *Sphaeralcea parvifolia*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Achnatherum hymenoides*, *Aristida purpurea*, *Hesperostipa comata*, *Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Descurainia pinnata* (exotic)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (22-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Sampled areas definitely were grazed heavily in the recent past, although there is only a small amount of browsing evident in 2004.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (6 plots: CANY.0341, GLCA.0106, GLCA.0107, GLCA.0109, GLCA.0767, GLCA.0777) and 2007 and 2008 Accuracy Assessment (5 points: CANY_AA.0185, CANY_AA.0342, CANY_AA.0783, CANY_AA.4341, CANY_AA.4443).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Anderson 2001b, Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.

Poliomintha incana - Artemisia filifolia - Vanclevea stylosa Shrubland

Hoary Rosemarymint - Sand Sagebrush - Pillar False Gumweed Shrubland

CODE	CEGL002418
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland (III.A.5.N.a.)
ALLIANCE	*POLIOMINTHA INCANA* SHRUBLAND ALLIANCE (A.862) Hoary Rosemarymint Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)
Inter-Mountain Basins Active and Stabilized Dune (CES304.775)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This Colorado Plateau shrubland association occurs where there is loose, blowing sand on dunes, benches, sandsheets, stabilized climbing dunes on steep canyonsides and in intermittent channels on valley floors in southeastern Utah. It usually occurs in small patches within a matrix of shrublands on more stable sands and dominated by *Coleogyne ramosissima* or *Artemisia filifolia*. Stands are located on flat to moderate slopes (up to 17 degrees) between 1271 and 1663 m (4170-5455 feet) elevation and tend to be oriented to southern or eastern aspects. The unvegetated surface has low cover of litter and moderate to high exposure of sand and bare soil. Biological soil crusts may absent or provide sparse to moderate cover, up to 25% cover. Soils are poorly developed, rapidly drained sands and sandy loams derived from eolian sands and sandy alluvium. Total vegetation cover ranges from 5 to 55% and 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 *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*, and *Muhlenbergia pungens* 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, Cryptantha crassisepala, Chamaesyce parryi (= Euphorbia parryi), Hymenopappus filifolius, Iva acerosa, Oenothera pallida, Stephanomeria exigua*, and *Streptanthella longirostris*. Isolated *Juniperus osteosperma* occur in some stands where the sand is shallow over bedrock.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association is rare within the park and recreation area and was sampled in Horseshoe Canyon, southwest above Water Canyon, and on Hardscrabble Hill in Canyonlands National Park and in Big Spring Canyon in the Glen Canyon National Recreation Area.

Globally
This association has been documented from the Colorado Plateau in southeastern Utah, where it is locally common on sandy sites.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland occurs on active and stabilized sand dunes, on climbing and falling dunes lying against a steep canyon side or in canyon bottom. Sites may be flat to steeply sloped (up to 33 degrees), have a northeast to southeast aspect and lie between 1248 and 1568 m elevation. Sand and bare soil cover most of the unvegetated surface, with lesser cover by biological soil crusts and sparse to low cover of litter. Soils are rapidly drained sandy loams or loamy sands derived from eolian deposits.

Globally
This short-shrub association occurs where there is loose, blowing sand on dunes, benches, sandsheets, stabilized climbing dunes on steep canyonsides and in intermittent channels in southeastern Utah. Stands are generally located on flat to moderate slopes (up to 17 degrees) between 1271 and 1663 m (4170-5455 feet) elevation and tend to be oriented to southern or eastern aspects. The unvegetated surface has low cover of litter and moderate to high exposure of sand and bare soil. Biological soil crusts may be absent or provide sparse to moderate cover, up to 25% cover. Soils are poorly developed, rapidly drained sands and sandy loams derived from eolian sands and sandy alluvium. Parent materials include Navajo and Entrada sandstone formations that have eroded and distributed as alluvium and eolian deposits.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This unusual mixed sand shrubland is uncommon within the park and recreation area. Total vegetation does not exceed 26% and may be as low as 5% 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* (with trace to 5% cover), *Artemisia filifolia* (absent to 7% cover), and *Vanclevea stylosa* (with 2 to 5% cover). Associated shrubs include *Ephedra viridis, Atriplex canescens, Tetradymia canescens, Eriogonum leptocladon, Ericameria nauseosa, Gutierrezia sarothrae*, and *Brickellia microphylla*. *Achnatherum hymenoides* is almost always present in the understory, with up to 7% cover. Herbaceous species are generally sparse, except in cases where *Salsola tragus* or *Bromus tectorum* have up to 15% cover. Associated graminoids include *Muhlenbergia pungens, Aristida purpurea,* and *Sporobolus cryptandrus*. Forbs include species typical of sandy soils: *Abronia fragrans, Ambrosia acanthicarpa, Cryptantha flava, Ipomopsis gunnisonii, Mentzelia albicaulis, Astragalus mollissimus, Lepidium montanum, Helianthus petiolaris, Sphaeralcea parvifolia, Machaeranthera canescens, Plantago patagonica*, and *Iva acerosa*.

Globally
This association often occurs as small patches in a matrix of other sand dune communities typical of the Colorado Plateau and generally dominated by *Coleogyne ramosissima* or *Artemisia filifolia*. Total vegetation cover ranges from 5 to 55%. 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 viridis, Eriogonum leptocladon, Gutierrezia sarothrae, 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, Muhlenbergia pungens, Sporobolus cryptandrus*, 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, Plantago patagonica, 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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Artemisia filifolia*, *Vanclevea stylosa*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Salsola tragus*
Herb (field)	*Achnatherum hymenoides*, *Aristida purpurea*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia filifolia*, *Poliomintha incana*, *Vanclevea stylosa*
Short shrub/sapling	*Eriogonum leptocladon*
Herb (field)	*Achnatherum hymenoides*, *Muhlenbergia pungens*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)

Globally
Vulnerable: *Vanclevea stylosa* (vulnerable, G3); **Exotic/Invasive**: *Bromus tectorum* (invasive/exotic, High), *Salsola tragus* (invasive/exotic), *Tamarix chinensis* (invasive/exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (24-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Plant distribution may be controlled by shifting/blowing sand, although this dune field appears stable with

continuous cover of well-developed cryptogamic soils and a lack of plant pedestals. This stand is controlled by slope, aspect, exposure to sun, and wind desiccation.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY.0227, CANY.0642, GLCA.0721) and 2007 Accuracy Assessment (7 points: CANY_AA.0333, CANY_AA.0896, CANY_AA.0899, CANY_AA.0903, CANY_AA.0926, CANY_AA.0948, CANY_AA.0949).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.

Atriplex canescens - Artemisia tridentata Shrubland

Fourwing Saltbush - Big Sagebrush Shrubland

CODE	CEGL001282
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*ATRIPLEX CANESCENS* SHRUBLAND ALLIANCE (A.869) Fourwing Saltbush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
Sonora-Mojave Mixed Salt Desert Scrub (CES302.749)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This shrubland is found on the western slope of the Colorado Rocky Mountains, Colorado Plateau, Great Basin, and Mojave Desert. 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 14-degrees, 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). 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. Associated shrubs include *Chrysothamnus viscidiflorus, Ephedra nevadensis, Ericameria nauseosa, Gutierrezia sarothrae, Gutierrezia microcephala, Krascheninnikovia lanata, Lycium* spp., and *Opuntia* spp. *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*, and *Pascopyrum smithii* are common grasses. Forbs may include *Cirsium neomexicanum, Eriogonum inflatum, Eriogonum racemosum, Penstemon* spp., or *Sphaeralcea coccinea*. Introduced species are common in disturbed stands.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association is rare within the park and was sampled only in Davis, Horseshoe, and Salt Creek canyons.

Globally
This shrubland is found on the western slope of the Colorado Rocky Mountains, Colorado Plateau, Great Basin, and Mojave Desert.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association occurs on benches, canyon floors, and stream terraces. Sites are generally flat and lie between 1508 and 1818 m elevation. Bare soil covers most of the unvegetated surface, although litter has high cover in some stands. Soils are rapidly drained and texturally are silt loams or loamy sands derived from alluvium.

Globally

This shrubland is found on the western slope of the Colorado Rocky Mountains, Colorado Plateau, Great Basin, and Mojave Desert. 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 14 degrees, 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This bottomland shrubland is rare within the park. Total vegetation cover ranges between 19 and 56%. The shrub canopy is typically 1-2 m tall in which *Atriplex canescens* and *Artemisia tridentata* ssp. *tridentata* are codominant. Associated shrubs with lesser cover include *Ericameria nauseosa, Sarcobatus vermiculatus, Opuntia polyacantha, Opuntia erinacea*, and *Suaeda moquinii (= Suaeda torreyana)*. The herbaceous layer is moderately diverse in terms of species composition but generally contributes little cover. Common species include the non-native annual *Bromus tectorum*, the native bunch grasses *Sporobolus cryptandrus* and *Achnatherum hymenoides*, as well as forbs such as *Abronia fragrans, Mentzelia multiflora, Sphaeralcea parvifolia*, and *Rumex hymenosepalus*. Weedy annual forbs are often present to dominant, depending on spring moisture; *Erodium cicutarium, Lappula occidentalis, Salsola tragus, Descurainia sophia*, and *Chenopodium album* were recorded in most plots. Cryptogams are generally sparse but one plot had 25% cover.

Globally

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., and *Opuntia* spp. (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, 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.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*, *Atriplex canescens*
Herb (field)	*Descurainia sophia*, *Erodium cicutarium*
Herb (field)	*Bromus tectorum*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata*, *Atriplex canescens*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Descurainia sophia* (exotic, Medium/Low), *Erodium cicutarium* (exotic, Medium/Low), *Salsola tragus* (exotic)

Globally
Exotic/Invasive: *Agropyron cristatum* (invasive/exotic, Medium/Low), *Arctium minus* (invasive/exotic, Medium/Insignificant), *Bromus rubens* (invasive/exotic), *Bromus tectorum* (invasive/exotic, High), *Carduus nutans* (invasive/exotic, High/Low), *Chenopodium album* (invasive/exotic), *Cirsium arvense* (invasive/exotic, High/Medium), *Convolvulus arvensis* (invasive/exotic, Medium/Low), *Descurainia sophia* (invasive/exotic, Medium/Low), *Erodium cicutarium* (invasive/exotic, Medium/Low), *Lactuca serriola* (invasive/exotic, Low/Insignificant), *Lappula occidentalis* (invasive/exotic), *Medicago sativa* (invasive/exotic, Insignificant), *Salsola tragus* (invasive/exotic), *Tragopogon dubius* (invasive/exotic, Medium/Low)

CONSERVATION STATUS RANK
Global Rank & Reasons: G4 (20-Sep-2000).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: There are signs of drought-stress on *Atriplex canescens* and *Artemisia tridentata* ssp. *tridentata* with dead shrubs and dead branches on live plants. This valley has a grazing history and the weedy nature of this community reflects this.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY 0224, CANY 0748, CANY 0797).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. 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, Tirmenstein 1999c, Warren et al. 1982, Western Ecology Working Group n.d., Wright 1980, Wright et al. 1979

Atriplex canescens - Ephedra viridis Shrubland

Fourwing Saltbush - Mormon-tea Shrubland

CODE	CEGL003828
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*ATRIPLEX CANESCENS* SHRUBLAND ALLIANCE (A.869) Fourwing Saltbush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Active and Stabilized Dune (CES304.775)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This open shrubland association is only know from two plots in Canyonlands National Park in eastern Utah. It is likely more widespread in eastern Utah on undisturbed stream terraces. Stands occur on sand dunes and sandsheets. Sites are flat to moderately sloping (up to 11 degrees), oriented to the southwest, and are located between 1722 and 1860 m elevation. Bare ground covers most of the unvegetated surface, with little litter. Soils are rapidly drained sandy loams or loamy sands derived from eolian deposits. Total vegetation cover is only around 10-15% and is characterized by *Atriplex canescens* and *Ephedra viridis*, each with up to 5% cover. Other shrubs present with lesser cover may include *Coleogyne ramosissima, Ericameria nauseosa, Gutierrezia sarothrae*, and *Opuntia polyacantha*. The herbaceous layer is moderately diverse but contributes only sparse cover. Grasses include *Hesperostipa comata, Muhlenbergia pungens, Aristida purpurea, Sporobolus cryptandrus, Bouteloua gracilis*, and *Sporobolus contractus*. Forbs include the sand-loving and weedy species *Rumex hymenosepalus, Sphaeralcea parvifolia, Salsola tragus, Chenopodium album, Artemisia campestris*, and *Plantago patagonica*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association is rare within the park and was sampled 230 m east of the parking area for Whale Rock and in Gray's Pasture.

Globally

This open shrubland association is currently only know from two plots in Canyonlands National Park in eastern Utah. It is likely more widespread in eastern Utah on undisturbed stream terraces.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association occurs on sand dunes and sandsheets. Sites are flat to moderately sloping (up to 11 degrees), oriented to the southwest, and are located between 1722 and 1860 m elevation. Bare ground covers most of the unvegetated surface, with little litter. Soils are rapidly drained sandy loams or loamy sands derived from eolian deposits.

Globally

This open shrubland association is only know from two plots in Canyonlands National Park in eastern Utah. It is likely more widespread in eastern Utah on undisturbed stream terraces. Stands occur on sand dunes and sandsheets. Sites are flat to moderately sloping (up to 11 degrees), oriented to the southwest, and are located between 1722 and 1860 m elevation. Bare ground covers most of the unvegetated surface, with little litter. Soils are rapidly drained sandy loams or loamy sands derived from eolian deposits.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparse shrubland is rare within the park. Total vegetation cover is only around 10-15% and is characterized by *Atriplex canescens* and *Ephedra viridis*, each with up to 5% cover. Other shrubs present with lesser cover may include *Coleogyne ramosissima, Ericameria nauseosa, Gutierrezia sarothrae*, and *Opuntia polyacantha*. The herbaceous layer is moderately diverse but contributes only sparse cover. Grasses include *Hesperostipa comata, Muhlenbergia pungens, Aristida purpurea, Sporobolus cryptandrus, Bouteloua gracilis*, and *Sporobolus contractus*. Forbs include the sand-loving and weedy species *Rumex hymenosepalus, Sphaeralcea parvifolia, Salsola tragus, Chenopodium album, Artemisia campestris*, and *Plantago patagonica*.

Globally

Total vegetation cover is only around 10-15% and is characterized by *Atriplex canescens* and *Ephedra viridis*, each with up to 5% cover. Other shrubs present with lesser cover may include *Coleogyne ramosissima, Ericameria nauseosa, Gutierrezia sarothrae*, and *Opuntia polyacantha*. The herbaceous layer is moderately diverse but contributes only sparse cover. Grasses include *Hesperostipa comata, Muhlenbergia pungens, Aristida purpurea, Sporobolus cryptandrus, Bouteloua gracilis*, and *Sporobolus contractus*. Forbs include the sand-loving and weedy species *Rumex hymenosepalus, Sphaeralcea parvifolia, Salsola tragus, Chenopodium album, Artemisia campestris*, and *Plantago patagonica*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex canescens*, *Ephedra viridis*
Herb (field)	*Opuntia polyacantha*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex canescens*, *Ephedra viridis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Chenopodium album* (exotic), *Salsola tragus* (exotic)

Globally
Exotic/Invasive: *Chenopodium album* (exotic), *Salsola tragus* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jun-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Plots are in a stabilized dune area dominated by *Ephedra viridis, Opuntia polyacantha*, and mixed herbaceous species with scattered *Atriplex canescens*. Microtopography is rolling and rocks are absent. Soils seem fairly well-developed, and crust cover is mostly mosses. Sandy soil is mostly well-stabilized by young (light-colored) cryptograms. Many weedy species are found in the area.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY 0234, CANY 0318).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Anderson 2001b, Howard 2003, NatureServe n.d.

Atriplex canescens - Ephedra viridis Talus Shrubland

Fourwing Saltbush - Mormon-tea Talus Shrubland

CODE	CEGL001287
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*ATRIPLEX CANESCENS* SHRUBLAND ALLIANCE (A.869) Fourwing Saltbush Shrubland Alliance
ECOLOGICAL SYSTEM(S):	Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784) Sonora-Mojave Mixed Salt Desert Scrub (CES302.749) Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This sparse shrubland association occurs on talus slopes throughout the northern Colorado Plateau. It has been reported from western Colorado and southeastern Utah. Sites are on moderately steep to steep slopes (12- to 41-degrees), occur between 1500 and 1865 m (4920-6140 feet) elevation, and tend to occur on southeast aspects. The underlying substrate is usually shale, covered by a layer of sandstone talus. 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 are the exotic grass *Bromus tectorum* and the natives *Achnatherum hymenoides, Aristida purpurea*, and *Hesperostipa comata*. Forbs are sparse. Scattered *Juniperus osteosperma* trees occur throughout many stands, but with cover not exceeding 5%.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association is rare within the park and recreation area. The sampled plot is halfway to Sunset Pass along a closed 4x4 road.

Globally

This sparse shrubland occurs on talus slopes throughout the northern Colorado Plateau. It has been reported from western Colorado in Colorado National Monument and southeastern Utah in Canyonlands National Park.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparse mixed shrubland occurs on slopes covered by colluvium fallen from sandstone cliffs upslope. The one sampled site occupies a steep (30-degree) slope at 1865 m elevation. Most of the unvegetated surface is covered by large boulders, with lesser amounts of bare soil and small rocks visible. The soil is a rapidly drained loamy sands derived from the Chinle Formation.

Globally

This sparse shrubland association occurs on warm talus slopes throughout the northern Colorado Plateau. Sites are on moderately steep to steep slopes (12- to 41-degrees), occur between 1500 and 1865 m (4920-6140 feet) elevation, and tend to 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 sandy.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparsely vegetated colluvial slope shrubland is rare within the recreation area. Total vegetation cover is 5%, and the vegetation is characterized by a diverse mix of shrubs, among which *Atriplex canescens* and *Ephedra viridis* are codominant. The dwarf-shrub *Gutierrezia sarothrae* is also present. The herbaceous layer contributes sparse cover and may include *Bromus tectorum, Leymus salinus, Sporobolus cryptandrus*, and the forb *Stanleya pinnata*.

Globally

This uncommon 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 are the exotic grass *Bromus tectorum* and the natives *Achnatherum hymenoides, Aristida purpurea*, and *Hesperostipa comata*. Forbs are sparse. Scattered *Juniperus osteosperma* trees occur throughout many stands, but with cover not exceeding 5%.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex canescens*, *Ephedra viridis*
Herb (field)	*Gutierrezia microcephala*
Herb (field)	*Leymus salinus*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex canescens*, *Ephedra viridis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G4 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The plot is on a talus slope of huge boulders that have calved from Wingate sandstone above. No pinyon pine or juniper trees occur here because of the lack of soil and the frequency of disturbance.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: GLCA 0587).
Local Description Authors: J. Coles
Global Description Authors: J. Coles, mod. K.A. Schulz

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.

Atriplex canescens / Pleuraphis jamesii Shrubland

Fourwing Saltbush / James' Galleta Shrubland

CODE	CEGL001288
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*ATRIPLEX CANESCENS* SHRUBLAND ALLIANCE (A.869) Fourwing Saltbush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
Sonora-Mojave Mixed Salt Desert Scrub (CES302.749)
Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This broadly defined shrubland association has been reported from the Colorado Plateau and Uinta Basin and may occur in the Chihuahuan Desert and eastern California. As defined, this association occurs on two distinct types of landforms: alluvial flats and stream terraces with fine-textured, alkaline or saline silty clay loam soils, or on upland flats covered by eolian sand deposits. 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, Krascheninnikovia lanata, Gutierrezia sarothrae, Artemisia bigelovii*, or *Opuntia polyacantha*, depending on topographic position and substrate. Other graminoids 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This uncommon association is known from the Needles entrance, Big Pocket, Lower Upheaval Dome Trailhead, Salt Creek Pocket, in Horse Canyon, and on the Colorado River at Spanish Bottom.

Globally

This association has been documented from the Colorado Plateau (Four Corners region) of southeastern Utah and southwestern Colorado. It is to be expected in adjacent northern Arizona and New Mexico, and probably occurs in the Chihuahuan Desert and eastern California. 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 sites used in this description have also been grazed heavily and show high cover by disturbance-tolerant herbaceous species.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is known from valley and canyon floors, toeslopes, hills, plains and terraces. Sites are at elevations ranging from 1192 to 1795 m with gentle to moderately steep slopes (0-9 degrees) on west, north, northwest, and southwest aspects. Soils are derived from alluvial or colluvial deposits and eolian sands of stabilized dunes.

Globally

This shrubland association occurs in the Colorado Plateau and Uinta Basin of eastern Utah and western Colorado and may occur in the Chihuahuan Desert and eastern California. Elevation ranges from 300-1900 m. It occurs on two distinct types of landforms: upland sites such as sandsheets with coarse-textured soils, or lowland sites such as alluvial flats and stream terraces with fine-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. 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 than *Atriplex canescens / Sporobolus airoides*- or *Atriplex confertifolia*-dominated shrublands that prefer saline bottomland sites.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association is uncommon in the park and characterized by a sparse shrub layer (2-9% cover) of *Atriplex canescens*. Other shrubs contribute to cover, but are not codominant, and include *Atriplex confertifolia, Ericmaeria nauseosa, Coleogyne ramosissima, Artemisia tridentata,Krascheninnikovia lanata, Ephedra torreyana* (up to 5% cover in one stand), *Gutierrezia sarothrae* (up to 9% cover in one stand), and *Opuntia* spp. The most abundant herbaceous species is *Pleuraphis jamesii* which is present at sparse covers ranging from 3-10%. Although this species is most consistent, *Hesperostipa comata* codominates on two sites and *Sporobolus cryptandrus* codominates on one site. Other native herbaceous species present include *Bouteloua gracilis, Sporobolus contractus,* and *Achnatherum hymenoides*. The invasive species *Salsola tragus* (up to 6% cover), *Bromus tectorum* (up to 10% cover), and *Plantago patagonica* (up to 10% cover) were present at a few sites. Scattered *Juniperus osteosperma* trees may be present with low cover.

Globally

This broadly defined shrubland association is characterized by a sparse to moderately dense canopy (10-40% cover) of shrubs dominated by *Atriplex canescens*, with a sparse to moderate graminoid layer that is dominated by *Pleuraphis jamesii*. Many stands have the appearance of a shrubby grassland and may form a mosaic with *Ericameria nauseosa, Sarcobatus vermiculatus* or *Atriplex confertifolia* shrublands. Associated shrubs may include *Ephedra torreyana, Grayia spinosa*, several species of *Opuntia, Chrysothamnus viscidiflorus, Krascheninnikovia lanata, Gutierrezia sarothrae*, and *Artemisia bigelovii*. Other graminoids 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, Cryptantha crassisepala, Descurainia pinnata, Mentzelia albicaulis, Phacelia crenulata, Sphaeralcea grossulariifolia*, and *Chenopodium* spp. 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.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus*, *Ericameria nauseosa*
Short shrub/sapling	*Atriplex canescens*
Short shrub/sapling	*Gutierrezia sarothrae*, *Krascheninnikovia lanata*
Herb (field)	*Achnatherum hymenoides*, *Bouteloua gracilis*, *Pleuraphis jamesii*, *Sporobolus airoides*, *Sporobolus cryptandrus*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally

Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola kali* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G4 (1-Feb-1996).

CLASSIFICATION COMMENTS

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally
As this association is currently defined, it is characterized only by the codominance of *Atriplex canescens* and *Pleuraphis jamesii*. 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.

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 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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2007 and 2008 Accuracy Assessment (7 points: CANY_AA.0692, CANY_AA.2073, CANY_AA.2116, CANY_AA.2128, CANY_AA.2350, CANY_AA.2351, and CANY_AA.2374).
Local Description Authors: M.E. Hall and A. Tendick
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: BLM 1979a, BLM 1979b, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Clark et al. 2009, Diamond 1993, Driscoll et al. 1984, Francis 1986, Miller et al. 1977, Romme et al. 1993, Shute and West 1978, Soil Conservation Service 1978, Thomas et al. 2009a, U.S. Bureau of Reclamation 1976, Von Loh 2000, Von Loh et al. 2008, Western Ecology Working Group n.d.

Atriplex canescens / Sporobolus airoides Shrubland

Fourwing Saltbush / Alkali Sacaton Shrubland

CODE	CEGL001291
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*ATRIPLEX CANESCENS* SHRUBLAND ALLIANCE (A.869) Fourwing Saltbush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
Chihuahuan Mixed Salt Desert Scrub (CES302.017)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This shrubland occurs in the northern Chihuahua Desert extending into the Trans-Pecos of Texas, southwestern Great Plains, and Colorado Plateau. Stands are found in washes, floodplains and on alluvial flats, extending up lower slopes of alluvial fans or bajadas. Elevation ranges from 915-2170 m (3000-7100 feet). Sites are level to gently sloping. Substrates are typically moderately deep, alkaline, calcareous, fine-textured soils or calcareous sands. Some areas are subject to periodic inundation from direct precipitation onto the clayey, somewhat impermeable soils, and runoff from surrounding higher elevations and overtopping drainages. Sediment deposition may occur during these events. Cover of bare soil can be high (>50%). The vegetation is characterized by an open to moderately dense (10-50% cover) short-shrub layer dominated by *Atriplex canescens* with a perennial graminoid layer dominated by *Sporobolus airoides*. The shrub layer has greater cover than the herbaceous layer, which may include other scattered shrubs and dwarf-shrubs, such as *Artemisia filifolia, Atriplex confertifolia, Atriplex obovata, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae, Isocoma pluriflora, Krascheninnikovia lanata, Lycium* spp., *Opuntia* spp., *Prosopis glandulosa*, and *Sarcobatus vermiculatus*. Associated herbaceous species, such as *Achnatherum hymenoides, Ambrosia psilostachya, Artemisia campestris, Elymus elymoides, Pascopyrum smithii, Pleuraphis jamesii, Sphaeralcea coccinea, Sporobolus cryptandrus, Sporobolus nealleyi*, and *Suaeda* spp., may be present. *Bouteloua gracilis* cover is typically minor and inconsistent. Forbs are limited and scattered and trees are accidental or absent. Diagnostic of this *Atriplex canescens*-dominated shrubland is a *Sporobolus airoides*-dominated herbaceous layer.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland is rare within the park and is represented by one plot located on the banks of the Green River just upstream of Valentine Bottom.

Globally

This shrubland occurs in the northern Chihuahua Desert extending into Trans-Pecos Texas, the southwestern Great Plains and Colorado Plateau in Colorado, New Mexico, Arizona, and Utah. It is reported from California and likely also occurs in Nevada and Mexico.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland occurs on the first terrace of the Green River floodplain. The one sampled site is flat and lies at 1179 m elevation. Litter covers most of the unvegetated surface. The soil is a rapidly drained silt loam derived from alluvium.

Globally

This shrubland occurs on alkaline sites in the northern Chihuahua Desert extending into the Trans-Pecos of Texas, southwestern Great Plains, and Colorado Plateau. Sites are in washes, floodplains and on alluvial flats, extending up lower slopes of alluvial fans or bajadas. Elevation ranges from 915-2170 m (3000-7100 feet). Sites are level to gently sloping (1-5%), and soils are typically moderately deep, alkaline, calcareous, fine-textured soils such as silt loam, loamy clay or clay (Francis 1986, Shaw et al. 1989, Muldavin et al. 2000b), although some sites in active floodplains may be rapidly drained sandy soils. Some areas are subject to periodic inundation from direct precipitation onto the clayey, somewhat impermeable soils, and runoff from surrounding higher elevations and overtopping drainages. Sediment deposition may occur during these events. The ground surface is characterized by large patches of tussock grasses intermixed with exposed soil and litter. Cover of bare soil may be high (>50%) (Francis 1986). Evidence of overland flow and erosion, e.g., gullies, rills, plant pedestalling, is common (Soil Conservation Service n.d.).

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This alkaline shrubland is rare within the park; it may have been more common in the past, but most examples have been degraded by flood control and grazing. Total vegetation cover does not exceed 20% and is dominated by *Atriplex canescens,* and the medium-tall bunchgrass *Sporobolus airoides*. Other shrubs contributing sparse cover include *Atriplex gardneri, Suaeda moquinii (= Suaeda torreyana)*, and *Opuntia phaeacantha*. Additional herbaceous species include the non-native annuals *Bromus tectorum* and *Bromus rubens*. Forbs include *Iva axillaris, Stanleya pinnata*, and *Sphaeralcea parvifolia*.

Globally
The association is characterized by an open to moderately dense (10-50% cover) short-shrub layer dominated by *Atriplex canescens* with a perennial graminoid layer dominated by *Sporobolus airoides* but includes sparse *Atriplex canescens - Sporobolus airoides*-dominated stands (<10% total vegetation cover). The shrub layer generally has greater cover than the herbaceous layer and may include other scattered shrubs and dwarf-shrubs, such as *Artemisia filifolia, Atriplex confertifolia, Atriplex obovata, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae, Isocoma pluriflora, Krascheninnikovia lanata, Lycium berlandieri, Lycium pallidum, Opuntia imbricata, Opuntia leptocaulis, Opuntia phaeacantha, Prosopis glandulosa*, and *Sarcobatus vermiculatus*. Associated herbaceous species, such as *Achnatherum hymenoides, Ambrosia psilostachya, Artemisia campestris, Elymus elymoides, Pascopyrum smithii, Pleuraphis jamesii, Sphaeralcea* spp., *Sporobolus cryptandrus, Sporobolus nealleyi*, and *Suaeda* spp., may be present. *Bouteloua gracilis* cover is typically minor and inconsistent (Francis 1986, Shaw et al. 1989, Muldavin et al. 2000b). However, *Bouteloua gracilis* with *Sporobolus cryptandrus* is well-represented within Salinas Pueblo Missions National Monument in New Mexico. Introduced species such as *Salsola kali, Bromus tectorum*, or *Marrubium vulgare* may be common. Forbs are limited and scattered and trees are accidental or absent.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Opuntia phaeacantha*, *Suaeda moquinii*
Herb (field)	*Iva axillaris*
Herb (field)	*Sporobolus airoides*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Sporobolus airoides*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Marrubium vulgare* (exotic, Medium/Low), *Salsola kali* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: G5? (9-Nov-2005). Although this type is widespread, it usually occurs in relatively small patches. Both of the diagnostic species are resistant to moderate grazing, but this association has likely been converted to semi-natural shrublands in heavily grazed areas.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Stands with relatively low cover of *Atriplex canescens* (10-25%) are included in this association because the shrub density is often variable within stands, but species composition and ecological processes do not change significantly. There are several similar associations that vary according to the abundance of different codominants, especially graminoids. Rangewide review of these types is needed to clarify their extent.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The sampled site is not subject to frequent flooding as it occupies the first terrace with a steep cut bank and is

currently approximately 4 m above river level. Vegetation is controlled mainly by water table/river level fluctuations, also, rainwater from White Rim cliffs to the west probably collects in pockets on this flat plain.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY 0209).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles, K.S. King, M.E. Hall

REFERENCES: Baker 1984a, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Clark et al. 2009, Coles et al. 2003, Coles et al. 2009a, Diamond 1993, Dick-Peddie 1986, Donart et al. 1978a, Driscoll et al. 1984, Francis 1986, Hansen et al. 2004b, Muldavin et al. 2000b, Romme et al. 1993, Salas et al. 2010, Shaw et al. 1989, Soil Conservation Service n.d., USFS 1937, Vest 1962a, Western Ecology Working Group n.d.

Atriplex canescens Desert Wash Shrubland

Fourwing Saltbush Desert Wash Shrubland

CODE	CEGL003470
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*ATRIPLEX CANESCENS* SHRUBLAND ALLIANCE (A.869) Fourwing Saltbush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Wash (CES304.781)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This desert wash shrubland is known from two plots in Utah (Canyonlands and Capitol Reef national parks) and four plots in northern Arizona (Wupatki National Monument) but is likely more widespread. Stands occur on sandy terraces and wash bottoms at 1178 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. Total vegetation cover is 6-25% 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 tectorum* and *Salsola tragus* are sometimes present.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association was sampled north of the mouth of Lathrop Canyon, in Cross Canyon, Horseshoe Canyon, Trail Canyon, and north of Upheaval Bottom.

Globally
This desert wash shrubland is known from two plots in Utah (Canyonlands and Capitol Reef national parks) and four plots in northern Arizona (Wupatki National Monument). It is likely more widespread in eastern Utah and southern Arizona along drainages.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This open shrubland occurs on sandy terraces and wash banks and bottoms. Sites are flat to gently sloping (up to 5 degrees) and occur between 1178 and 1737 m elevation. The unvegetated surface has low to high exposure of bare

ground or sand, sparse to moderate cover of small rocks, and low to moderate cover of litter. Biological soil crusts provide sparse to high cover. Soils are rapidly drained sands and derived from alluvium.

Globally
This desert wash shrubland is know from two plots in Utah (Canyonlands and Capitol Reef national parks) and four plots in northern Arizona (Wupatki National Monument) but is likely more widespread. Stands occur on sandy terraces and wash bottoms at 1178 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.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Total vegetation cover in this shrubland is between 7% and 36% and is dominated by scattered shrubs of *Atriplex canescens* with 2-5% cover. Associated shrubs include *Ericameria nauseosa, Brickellia longifolia, Ephedra torreyana, Ephedra viridis, Mahonia fremontii, Atriplex gardneri*, and the dwarf-shrubs *Opuntia polyacantha* and *Gutierrezia sarothrae*. *Sarcobatus vermiculatus* was codominant in one sparse stand. The herbaceous layer contributes sparse to moderate cover. Grasses include the non-native annual *Bromus tectorum* and the native bunch grasses *Sporobolus cryptandrus* (with up to 8% cover), *Sporobolus airoides, Sporobolus flexuosus, Sporobolus contractus, Pleuraphis jamesii,* and *Achnatherum hymenoides*. Forbs include *Salsola tragus, Stanleya pinnata, Sphaeralcea parvifolia, Descurainia pinnata*, *Gaillardia spathulata, Artemisia ludoviciana, Artemisia dracunculus*, and *Plantago patagonica,* among other species.

Globally
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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*
Short shrub/sapling	*Atriplex canescens*

Globally

Stratum	Species
Tall shrub/sapling	*Fraxinus anomala*
Short shrub/sapling	*Ericameria nauseosa*
Short shrub/sapling	*Atriplex canescens*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (14-Apr-2003).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The plot is only a couple of feet above the wash channel and could be flooded by a large storm. Plants are doing well here, showing considerable new growth. This is a large, homogenous community that repeats whenever the wash bottom gets wide and flat with a deep sand floor.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY.0355, CANY.9359, CANY.9556), and 2007 and 2008 Accuracy Assessment (2 points: CANY_AA.0604, CANY_AA.0774).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: K.A. Schulz

REFERENCES: Clark et al. 2009, Coles et al. 2003, Hansen et al. 2004b, Howard 2003, Romme et al. 1993, USFS 1937, Western Ecology Working Group n.d.

Atriplex canescens Shrubland

Fourwing Saltbush Shrubland

CODE	CEGL001281
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*ATRIPLEX CANESCENS* SHRUBLAND ALLIANCE (A.869) Fourwing Saltbush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
Sonora-Mojave Mixed Salt Desert Scrub (CES302.749)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This shrubland association is known from the Great Basin north into the southern Columbia Basin and east into Wyoming and the Colorado Plateau. It is common at middle elevations on 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. The vegetation is characterized by a sparse to moderately dense 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 *Psorothamnus* spp. *Artemisia bigelovii, Artemisia tridentata*, and *Ephedra viridis, Krascheninnikovia lanata*, or *Purshia stansburiana* may be present but are not codominants. 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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association occurs in scattered locations throughout the park and recreation area. Areas sampled included Taylor, Horse, Lathrop, and Cyclone canyons, along the Green River, in Ernie's Country, in Surprise Valley, 1.5 km east of Salt Creek, in Spanish Bottom, and along the Colorado River in Canyonlands National Park, and in Calf Canyon in Glen Canyon National Recreation Area.

Globally
This shrubland association may occur throughout much of the interior western U.S. It is known from the southern Columbia Basin and Great Basin east into Wyoming and the Colorado Plateau.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association occurs on deep, fine-textured alkaline soils of plains, stream terraces, and valley bottoms. Sites are flat to gently sloping and lie between 1167 and 1764 m elevation. Bare ground covers most of the unvegetated surface, with lesser cover by litter and downed wood. Biological soil crusts provide sparse to moderate cover. Soils are moderately well-drained to rapidly drained, loamy, silty or sandy in texture and derived from alluvium or eolian deposits.

Globally
This widespread shrubland association occurs throughout much of the western U.S. and is found 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 middle elevations (1235-2256 m [4050-7400 feet]) on the Colorado Plateau, but will occur at lower elevations (down to 610 m [2000 feet]) along alluvial benches where soils are often finer-textured and possibly saline/alkaline (Beatley 1976) in the Great Basin region. 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. At lower elevations, it may occur as a mosaic with *Lycium pallidum - Grayia spinosa-* or *Atriplex confertifolia*-dominated shrublands.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This fourwing saltbush shrubland occurs in a number of valley bottoms and dry washes throughout the park. Total vegetation cover ranges between 6 and 48% and is dominated by an open canopy of *Atriplex canescens* with up to 35% cover. The remaining shrub layer may include *Ephedra torreyana, Ericameria nauseosa, Krascheninnikovia lanata, Opuntia polyacantha*, and *Gutierrezia sarothrae*. The herbaceous layer is diverse in terms of species composition and provides sparse to low cover. The non-native annuals *Bromus tectorum* and *Salsola tragus* occur in most stands with sparse cover. Native graminoids present include *Achnatherum hymenoides, Sporobolus cryptandrus*, and *Pleuraphis jamesii*. Forbs are highly variable in composition and include *Abronia fragrans, Chenopodium album, Sphaeralcea coccinea, Cryptantha* sp., and *Plantago patagonica*. Biological soil crust has up to 54% cover.

Globally
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 tridentata, Ephedra viridis, Krascheninnikovia lanata*, or *Purshia stansburiana* may be present but are not codominants. *Artemisia filifolia* may be present to subdominant in a few stands. 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, Salsola kali*, and *Tribulus terrestris* can be common on disturbed sites and may form a moderately dense herbaceous stratum.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Opuntia polyacantha*

Herb (field)	*Salsola tragus*
Herb (field)	*Achnatherum hymenoides*, *Bromus tectorum*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex canescens*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bassia scoparia* (exotic, Low), *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Descurainia pinnata* (exotic), *Salsola tragus* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This type is controlled by very rare overbank flooding and wind action. Most areas have been historically grazed.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (15 plots: CANY 0140, CANY 0191, CANY 0223, CANY 0260, CANY 0261, CANY 0280, CANY 0390, CANY 0444, CANY 0581, CANY 0583, CANY 0594, CANY 0611, CANY 0635, GLCA 0580).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Drake, J. Coles, 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, Howard 2003, Ostler et al. 2000, Peterson 2008, Romme et al. 1993, Salas and Bolen 2010b, Von Loh et al. 2007, Western Ecology Working Group n.d.

Atriplex confertifolia - Sarcobatus vermiculatus Shrubland

Shadscale - Greasewood Shrubland

CODE	CEGL001313
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*ATRIPLEX CONFERTIFOLIA* SHRUBLAND ALLIANCE (A.870) Shadscale Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
Sonora-Mojave Mixed Salt Desert Scrub (CES302.749)
Inter-Mountain Basins Greasewood Flat (CES304.780)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This shrub association is found scattered in saline soils on valley floors, alluvial terraces and alluvial fans across the Colorado Plateau and western Wyoming. Elevations range from 1350 to 2257 m, slopes range from level to moderately steep (0-33 degree slopes), and sites can be oriented to any aspect. Substrates are typically fine-textured and poorly drained soils such as clays, clay loams and silt loams. Total vegetation cover ranges from less than 20% to more than 50%, with the higher values tending to occur in shrublands located on valley floors and alluvial terraces. The open shrub stratum generally consists primarily of *Sarcobatus vermiculatus* shrubs with between 1 and 20% cover. *Atriplex confertifolia* shrubs are scattered throughout the canopy, with between 1 and 5% cover. Other shrubs present with minor cover include *Gutierrezia sarothrae* and *Suaeda moquinii (= Suaeda torreyana)*. The often sparse herbaceous layer is variable and can have as much as 35% cover. This layer tends to reflect a degree of disturbance; common species include *Achnatherum hymenoides, Astragalus nuttallianus, Bromus tectorum, Lappula occidentalis, Lepidium densiflorum, Plantago patagonica*, and *Sphaeralcea parvifolia*. Sparse nonvascular species are generally present on the soil surface and may have as much as 95% cover in undisturbed sites.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland is rare within the park and was sampled on a stream terrace south of the park entrance road near the turnoff for Needles Outpost, on the Green River across from Upheaval Bottom, and on the Colorado River at the mouth of Musselman Canyon.

Globally

This shrub association is found scattered in saline soils on valley floors, alluvial terraces and alluvial fans across the Colorado Plateau, in Arizona and Colorado and extends west into California and Nevada.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland occurs on a stream terrace exhibiting ponding and on a riverine terrace. Sites are flat to gently sloping and occur between 1188 and 1474 m elevation. The unvegetated surface has a high cover of bare soil, low to moderate cover of litter and small rocks, and sparse to moderate cover by biological soil crusts (mostly mosses and dark cyanobacteria). The soil is a well-drained silt loam derived from alluvium.

Globally

This mixed shrub association is found in habitats across the Colorado Plateau and in western Wyoming. It occurs in habitats that are significantly saline, either because of poor drainage or high levels of salts in the soil. Miller et al. (1977) report this association as occurring in low-lying, internally drained areas such as abandoned stream channels. Recent plot data from eastern Utah, western Colorado and western Wyoming indicate that habitat for this association includes badland toeslopes, alluvial fans and stream terraces, especially those that exhibit ponding as well as low-lying areas on valley floors. Elevations range from 1350 to 2257 m. Sites range from level to moderate and occasionally steep (to 33 degrees) and can be oriented to any aspect. Substrates are well-drained to poorly drained soils with clay, clay loam, silt loam and sandy loam texture that are typically derived from alluvium, but they may include eolian sand. Soil surface typically has high cover of bare ground with low cover of litter and biological crust.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This alkaline shrubland is rare within the park and recreation area. Total vegetation cover is between 16% and 24% and is characterized by *Sarcobatus vermiculatus* (1-18% cover) accompanied by *Atriplex confertifolia* with 2-5% cover. Additional shrubs present include *Atriplex canescens, Ericameria nauseosa, Ephedra torreyana, Suaeda moquinii (= Suaeda torreyana), Opuntia polyacantha, Gutierrezia sarothrae,* and *Sclerocactus whipplei*. The herbaceous layer is absent or has low cover. Native perennial grass species present include *Sporobolus airoides, Pleuraphis jamesii, Distichlis spicata,* and *Achnatherum hymenoides* and non-native annual species include the grass, *Bromus tectorum*, and the forb, *Salsola tragus.* The biological soil crust is in an early state of development and consists of mosses and dark cyanobacteria.

Globally

This open shrubland occurs in saline habitats and usually has relatively low cover of vegetation. However, total vegetation cover ranges from less than 15% to more than 100%, with the higher values tending to occur in

shrublands located on valley floors and alluvial terraces. Upland sites tend to have sparser vegetation. The shrub stratum is less than 1 m tall and is composed of *Sarcobatus vermiculatus* (1-20% cover) with *Atriplex confertifolia* shrubs scattered throughout the canopy (1-5% cover). Other shrubs present with minor cover include *Artemisia tridentata, Atriplex gardneri, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae, Opuntia* spp., *Sclerocactus parviflorus, Symphoricarpos oreophilus*, and *Suaeda moquinii (= Suaeda torreyana)*. The herbaceous layer is variable but can have as much as 35% cover. This layer tends to reflect a degree of disturbance; common species include grasses *Achnatherum hymenoides, Leymus cinereus, Pleuraphis jamesii, Poa fendleriana, Sporobolus airoides*, and forbs such as *Astragalus jejunus, Astragalus nuttallianus, Eriogonum brevicaule, Lappula occidentalis, Lepidium densiflorum, Physaria condensata, Plantago patagonica*, and *Sphaeralcea parvifolia*. Exotic species such as *Bromus tectorum* and *Iva axillaris* are often present in disturbed stands. Mosses and ground lichens are generally present and may have as much as 95% cover in undisturbed sites.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Sarcobatus vermiculatus*
Short shrub/sapling	*Atriplex confertifolia*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*, *Sarcobatus vermiculatus*
Herb (field)	*Bromus tectorum*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Iva axillaris* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Deep, fine soils. This appears to be a flat, low area that doesn't drain quickly after a heavy rain. There is evidence of puddles. Soil surfaces are both biologically and physically crusted, but physically crusted surfaces are flaky or hexagonally cross-hatched.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0778) and 2008 Accuracy Assessment (3 points: CANY_AA.1193, CANY_AA.1232, and CANY_AA.2011).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Clark et al. 2009, Driscoll et al. 1984, Fenemore 1970, Kagan et al. 2004, Miller et al. 1977, Peterson 2008, Romme et al. 1993, Von Loh et al. 2007, Western Ecology Working Group n.d.

Atriplex confertifolia / Pleuraphis jamesii Shrubland

Shadscale / James' Galleta Shrubland

CODE	CEGL001304
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*ATRIPLEX CONFERTIFOLIA* SHRUBLAND ALLIANCE (A.870) Shadscale Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This widespread western shrubland association is reported from the southwestern Great Plains, Colorado Plateau, Great Basin, Columbia Plateau and Mojave Desert mountains. 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. 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% in sampled stands). Associated shrubs include *Artemisia bigelovii, Artemisia tridentata* ssp. *wyomingensis, Atriplex canescens, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra torreyana, Ericameria nauseosa, 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. If other *Atriplex* species are present, they do not dominate the canopy. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association occurs throughout the park and recreation area. Sites sampled include along the Murphy Trail, 1 km north of Taylor Camp, in the Big Draw, in Lathrop Canyon, in Taylor Canyon, along the Green River, in Little Bridge Canyon, along the Upheaval Canyon Trail, in Buck Canyon, along the Colorado River, and near the Needles Visitor Center in Canyonlands National Park, and in Millard Canyon, in Anderson Bottom, and 2 km northwest of Teapot Rock in Glen Canyon National Recreation Area.

Globally

This widespread shrubland association occurs throughout much of the intermountain western U.S. and is reported from the Columbia Plateau south to the Great Basin, Colorado Plateau, and Mojave Desert mountains and east into the southwestern Great Plains.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This common shrubland association occurs on plateaus, alluvial fans, talus slopes, basins, benches, rims, canyon sides, canyon bottoms, toeslopes, and plains. Sites are flat to steep (0- to 30-degree slopes), include all aspects, and lie between 1184 1736 m elevation. Bare ground or rocks cover most of the unvegetated surface. Litter and downed

wood have sparse cover, as do biological soil crusts. The soils may be sandy loamy or clay, are rapidly drained and are derived from alluvium, the Chinle, Moenkopi, or Elephant Canyon formations.

Globally
This widespread association occurs in a variety of habitats throughout much of the intermountain western U.S. and extends south to Mojave Desert mountains and east into the southwestern Great Plains. Elevation ranges from 1184 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.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This common shrubland is widespread within the park and recreation area. Total vegetation cover ranges from 4 to 20% and is characterized by a sparse shrub layer dominated by *Atriplex confertifolia* and an herbaceous understory dominated by *Pleuraphis jamesii* with at least 1% cover. Stands with less than 1% grass cover and less than 5% total cover were placed in *Atriplex confertifolia* Sparse Shrubland (CEGL003830). Other shrubs may be present, including *Ephedra torreyana, Coleogyne ramosissima, Kochia americana (= Bassia americana), Opuntia polyacantha, Gutierrezia sarothrae, Xylorhiza tortifolia*, and *Sclerocactus whipplei*. The herbaceous layer is often diverse, but few species have more than a trace amount of cover. Common species include *Bromus tectorum, Achnatherum hymenoides, Eriogonum inflatum, Salsola tragus, Sphaeralcea leptophylla, Phacelia crenulata*, and *Stanleya pinnata*.

Globally
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 sarothrae, Krascheninnikovia lanata, Lycium pallidum, 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. 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*, 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 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%.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Bromus tectorum*, *Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*
Short shrub/sapling	*Gutierrezia sarothrae*
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Halogeton glomeratus* (exotic, High/Medium), *Salsola tragus* (exotic)

Globally
Vulnerable: *Sclerocactus whipplei* (globally imperiled, G1G3); **Exotic/Invasive**: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: G3G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This widespread shrubland association is only defined by the codominance of *Atriplex confertifolia* and *Pleuraphis jamesii*. Stands are found in different regions (from southwestern Great Plains to Great Basin), 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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: These sites are exposed to sun, wind, and sheet erosion. *Atriplex confertifolia* shrubs appear drought-stressed and stunted.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (28 plots: CANY 0128, CANY 0135, CANY 0143, CANY 0159, CANY 0161, CANY 0347, CANY 0348, CANY 0356, CANY 0359, CANY 0522, CANY 0533, CANY 0580, CANY 0584, CANY 0654, CANY 0655, CANY 0720, CANY 0737, CANY 0790, CANY 0792, CANY 9003, CANY 9321, CANY 9326, CANY 9348, GLCA 0120, GLCA 0122, GLCA 0321, GLCA 0542, GLCA 0759).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles

REFERENCES: Annable 1985, Bourgeron and Engelking 1994, Branson and Owen 1970, Branson et al. 1976, CONHP unpubl. data 2003, Campbell 1977, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, 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, Singh and West 1971, Soil Conservation Service 1978, Thomas et al. 2010, Tuhy and MacMahon 1988, U.S. Bureau of Reclamation 1976, Von Loh 2000, Von Loh et al. 2007, Von Loh et al. 2008, Welsh 1957, West and Ibrahim 1968, Western Ecology Working Group n.d.

Atriplex confertifolia Great Basin Shrubland

Shadscale Great Basin Shrubland

Great Basin Shadscale Shrubland

CODE	CEGL001294
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*ATRIPLEX CONFERTIFOLIA* SHRUBLAND ALLIANCE (A.870) Shadscale Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This shrub association occurs in scattered stands on ridges, flats, alluvial fans, talus slopes and badlands throughout the Colorado Plateau and Great Basin, often in a matrix of other high desert shrublands. Sites tend to occur on level to gentle slopes between 1158 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. Total vegetation cover rarely exceeds 20% and is clearly dominated by *Atriplex confertifolia*. Many other species of shrubs may also be present, although they contribute little to the total canopy, including *Gutierrezia sarothrae, Krascheninnikovia lanata, Kochia americana, Picrothamnus desertorum, Acamptopappus shockleyi, Atriplex canescens, Ephedra nevadensis, Sarcobatus vermiculatus*, and *Ericameria nauseosa*. 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*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare association is known was sampled in Potato Bottom Basin and in Trail Canyon.

Globally

This association has been documented from plots in western Colorado and southern Utah. It is also reported to occur in Nevada (Rickard and Beatley 1965, Blackburn et al. 1968a) and the Cottonwood Mountains in Death Valley National Park, California (Peterson 1984).

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare association was documented on a flat bench formed on top of the Mossback member of the Chinle layer and on a steep talus slope (26 degrees) oriented to the west, and occurred between 1355 to 1435 m elevation. The unvegetated surface is dominated by small rocks and large rocks, with lesser cover by exposed bare soil, bedrock, and biological soil crusts.

Globally

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 1158 and 2194 m (3800-7200 feet) elevation. Soils tend to be alkaline, shallow, well-drained and have clay loam 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparse and species-poor association is rare in the park. The sampled sites are characterized by a shrub layer of *Atriplex confertifolia* with 9-12% cover. Other species that were present in the shrub stratum include *Gutierrezia sarothrae* and *Ephedra torreyana*, but do not exceed 2% cover. The herbaceous layer included *Pleuraphis jamesii, Descurainia pinnata, Lappula occidentalis,* and *Plantago patagonica,* each with trace to 1% cover.

Globally
This association often occurs in a matrix of other high desert shrublands. Total vegetation cover rarely exceeds 20% and is clearly dominated by *Atriplex confertifolia*. Many other species of shrubs may also be present, although they contribute little to the total canopy, including *Gutierrezia sarothrae, Krascheninnikovia lanata, Kochia americana, Picrothamnus desertorum, Acamptopappus shockleyi, Atriplex canescens, Ephedra nevadensis, Sarcobatus vermiculatus*, and *Ericameria nauseosa*. 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 more than trace cover in unusually wet years; *Atriplex powellii, Sphaeralcea coccinea, Chaenactis douglasii, Phacelia crenulata*, and *Mentzelia albicaulis* and the exotic annual *Salsola tragus* are widespread. Disturbed sites have high cover of *Bromus tectorum*.

MOST ABUNDANT SPECIES
*Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)*Data are not available.

Globally

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Vulnerable: *Acamptopappus shockleyi* (vulnerable, G3?); **Exotic/Invasive**: *Bromus tectorum* (invasive/exotic, High), *Salsola tragus* (invasive/exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This broadly defined association describes *Atriplex confertifolia* shrublands that have either a sparse understory or lack any diagnostic species in the understory. It also includes degraded stands that have an understory dominated by weedy species.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2007 Accuracy Assessment (2 points: CANY_AA.0453, CANY_AA.0598).
Local Description Authors: M.E. Hall and A. Tendick
Global Description Authors: J. Coles, mod. G. Kittel

REFERENCES: Beatley 1976, Blackburn et al. 1968a, Bourgeron and Engelking 1994, Bradley 1964, Clark et al. 2009, Coles et al. 2008a, Driscoll et al. 1984, Leary and Peterson 1984, Peterson 1984, Peterson 2008, Rickard and Beatley 1965, Romme et al. 1993, Western Ecology Working Group n.d.

Atriplex confertifolia Sparse Shrubland

Shadscale Sparse Shrubland

CODE	CEGL003830
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*ATRIPLEX CONFERTIFOLIA* SHRUBLAND ALLIANCE (A.870) Shadscale Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

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 moderately to steeply sloping (to 35 degrees) and may occur on any aspect between 1187 and 1544 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, sandy loams, sandy clay loams, sandy clays, or loams. 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. Associated shrubs include *Ericameria nauseosa, Ephedra viridis, Eriogonum corymbosum, Chrysothamnus viscidiflorus, Opuntia polyacantha, Xylorhiza glabriuscula, Gutierrezia sarothrae*, and *Brickellia microphylla*. Herbaceous associates include *Pleuraphis jamesii, Bromus tectorum, Aristida purpurea, Salsola tragus, Tiquilia latior, Stanleya pinnata*, and *Eriogonum inflatum*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparsely vegetated association occurs on shale soils within the park and recreation area and was sampled along the White Rim Road, near Murphy Campground, along the Colorado River, and approximately 1.5 km south of Millard Canyon Campground in Canyonlands National Park and in Millard Canyon in Glen Canyon National Recreation Area.

Globally

This sparse shadscale shrubland occurs in Canyonlands National Park and Glen Canyon National Recreation Area in Colorado Plateau of southeastern Utah and is likely more widespread.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparsely vegetated association occurs on steep colluvial slopes, cliffs, escarpments, terraces, and benches with poor, alkaline soils. Sites are moderately to steeply sloping (to 35 degrees) and may occur on any aspect between 1187 and 1544 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, sandy loams, sandy clay loams, sandy clays, or loams derived from the Chinle or Moenkopi formations.

Globally

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 moderately to steeply sloping (to 35 degrees) and may occur on any aspect between 1187 and 1544 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, sandy loams, sandy clay loams, sandy clays, or loams derived from the Chinle or Moenkopi formations.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparse shadscale shrubland grows on poor shale soils within the park and recreation area. 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; *Ericameria nauseosa, Ephedra viridis, Eriogonum corymbosum, Chrysothamnus viscidiflorus, Opuntia polyacantha, Xylorhiza glabriuscula, Gutierrezia sarothrae*, and *Brickellia microphylla* are common shrub associates. Herbaceous associates include *Pleuraphis jamesii, Bromus tectorum, Aristida purpurea, Salsola tragus, Tiquilia latior, Stanleya pinnata*, and *Eriogonum inflatum*.

Globally
This sparse shadscale shrubland rarely exceeds 5% total vegetation cover 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. Associated shrubs include *Ericameria nauseosa, Ephedra viridis, Eriogonum corymbosum, Chrysothamnus viscidiflorus, Opuntia polyacantha, Xylorhiza glabriuscula, Gutierrezia sarothrae*, and *Brickellia microphylla*. Herbaceous associates include *Pleuraphis jamesii, Aristida purpurea, Salsola tragus, Tiquilia latior, Stanleya pinnata*, and *Eriogonum inflatum*. The exotic annual grass *Bromus tectorum* is common on some stands.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*
Herb (field)	*Bromus tectorum*, *Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*
Herb (field)	*Bromus tectorum*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jun-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: These south-facing slopes receive high amounts of solar radiation. *Atriplex confertifolia* seems to be the only plant that can survive on these dry slopes.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (11 plots: CANY 0180, CANY 0382, CANY 0592, CANY 0827, CANY 9007, CANY 9016, CANY 9039, CANY 9045, CANY 9349, CANY 9508, GLCA 0725).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Peterson 2008, Western Ecology Working Group n.d.

Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. *tuckeri Shrubland*

Blackbrush - Stansbury's Cliffrose - Tucker Sand Shinnery Oak Shrubland

CODE	CEGL002348
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*COLEOGYNE RAMOSISSIMA* SHRUBLAND ALLIANCE (A.874) Blackbrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

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 (0-7 degrees) between 1275 and 1670 m (4185-5475 feet) elevation. Bare soil, sand, and gravel cover much of the unvegetated surface. Litter cover is sparse to low. Covers of bedrock and biological soil crust are variable; either 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 or shales. Total vegetation cover ranges from 5 to 70%. The shrub layer is characterized by an open canopy 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 *Artemisia bigelovii, Brickellia microphylla, Ephedra torreyana, Ephedra viridis, Eriogonum leptocladon, Fraxinus anomala, Gutierrezia sarothrae, Opuntia polyacantha*, and *Yucca harrimaniae*. 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*, and *Muhlenbergia pungens*. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association was sampled near Junction Butte, near Horseshoe Canyon, on Elaterite Basin, 1 km southeast of Horsethief Spring, in Chesler Park, and on Murphy Hogback Ridge in Canyonlands National Park, and near Hans Flat Ranger Station and northeast of Ekker Butte in Glen Canyon National Recreation Area.

Globally

This association is locally common on sandy sites at middle elevations at Arches, Canyonlands, and Capitol Reef national parks, and Glen Canyon National Recreation Area in the Colorado Plateau of southeastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This mixed upland shrubland association occurs in shallow soils on canyon rims, sand dunes, ridges and mesatops. Sites are flat to moderately sloping (to 7 degrees) and lie between 1413 and 1668 m elevation. Sand, bare soil, bedrock and gravel cover most of the unvegetated surface, with sparse cover by large rocks, litter, biological soil crusts and dead wood. 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 or Kayenta formations, or shales of the Moenkopi Formation.

Globally
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 (0-7 degrees) between 1275 and 1670 m (4185-5475 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 or Entrada formations, or shales of the Moenkopi Formation or Salt Wash Member of the Morrison Formation.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This mixed shrubland occurs throughout the park and recreation area on thin soils. Total vegetation cover ranges from 1 to 16% and is characterized by an open short shrub canopy of *Coleogyne ramosissima* codominated by either or both *Quercus havardii* var. *tuckeri* or more commonly by *Purshia mexicana*. A few stands have *Quercus* and *Purshia* but lack *Coleogyne*. *Fraxinus anomala, Ephedra viridis, Artemisia bigelovii, Ephedra torreyana, Gutierrezia sarothrae, Yucca angustissima, Opuntia polyacantha*, and *Brickellia microphylla* are present in most stands. Exceptionally cool or moist sites support *Cercocarpus intricatus* and *Amelanchier utahensis* as part of the mix; these stands belong in phase *Cercocarpus intricatus*. The herbaceous layer is diverse but contributes only sparse cover. Common graminoids include *Achnatherum hymenoides, Aristida purpurea, Pleuraphis jamesii, Erioneuron pilosum*, and *Sporobolus cryptandrus*. Forbs vary from site to site and include *Chamaesyce fendleri, Arenaria fendleri, Machaeranthera canescens, Cryptantha flava, Tetraneuris acaulis (= Hymenoxys acaulis)*, and *Chenopodium album*.

Globally
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 *Artemisia bigelovii, Brickellia microphylla, Ephedra torreyana, Ephedra viridis, Eriogonum leptocladon, Fraxinus anomala, Gutierrezia sarothrae, Opuntia polyacantha*, and *Yucca harrimaniae*. 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*, and *Muhlenbergia pungens*. 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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Purshia mexicana*
Short shrub/sapling	*Coleogyne ramosissima*, *Quercus havardii* var. *tuckeri*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*, *Yucca angustissima*
Herb (field)	*Chamaesyce fendleri*
Herb (field)	*Achnatherum hymenoides*, *Aristida purpurea*, *Pleuraphis jamesii*

Globally

Stratum	Species
Tall shrub/sapling	*Purshia stansburiana*
Short shrub/sapling	*Cercocarpus intricatus*, *Ephedra viridis*, *Quercus havardii* var. *tuckeri*

Herb (field)	*Yucca angustissima*
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Salsola tragus* (exotic)

Globally
Vulnerable: *Quercus havardii* var. *tuckeri* (vulnerable, G4T3?Q); **Exotic/Invasive**: *Bromus tectorum* (invasive/exotic, 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.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Quercus havardii var. *tuckeri* is also referred to in Utah as *Quercus undulata* and *Quercus welshii*. The literature for Utah should be reviewed for material relating to this association but using these other names.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Effects of wind erosion are obvious here, with *Quercus havardii* var. *tuckeri* growing on dune tops and *Coleogyne ramosissima* growing in between the dunes.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (10 plots: CANY 0186, CANY 0230, CANY 0231, CANY 0247, CANY 0337, CANY 0552, CANY 0644, CANY 0716, GLCA 0317, GLCA 0546).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.

Coleogyne ramosissima / Pleuraphis jamesii Shrubland

Blackbrush / James' Galleta Shrubland

CODE	CEGL001334
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*COLEOGYNE RAMOSISSIMA* SHRUBLAND ALLIANCE (A.874) Blackbrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This shrubland association occurs in the Colorado Plateau and Mojave Desert in areas with hot summers and cold winters. 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. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association occurs on deep soils in the park and recreation area. Areas sampled include 500 m east of the Island in the Sky Entrance, near the head of South Fork Canyon, in Musselman Canyon, near Lathrop Canyon, 2 km southwest of Airport Tower, and along White Rim Road in Canyonlands National Park and near Deadhorse Canyon, north of Ekker Butter, and on the bench between Panorama Point and Horse Canyon in Glen Canyon National Recreation Area.

Globally
This shrubland association occurs in the Colorado Plateau and Mojave Desert from southwestern Colorado across southern Utah and possibly into Arizona and California.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association occurs on plateaus, canyon rims, ledges, alluvial fans, toeslopes, valleys and washes. Sites are flat to moderately sloped (0-11 degrees), include all aspects, and lie between 1335 and 1811 m elevation. The unvegetated surface tends to be covered by either bare soil or sand or gravel. There is sparse cover by litter and early-stage biological soil crusts. Soils are rapidly drained loamy sands, silt loams, silty clay loams, or sandy loams derived from sandstones or shales, including Navajo sandstone and Moenkopi Formation. Some stands are on sandsheets, others on shale barrens.

Globally
This shrubland association occurs in the Colorado Plateau and Mojave Desert in areas with hot summers and cold winters. Elevation ranges from 1200-1850 m (3950-6070 feet). Sites are located on level to gently sloping plateaus, canyon rims, ledges, hills, alluvial fans, toeslopes, 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This common blackbrush shrubland occurs widely within the park and recreation area. Total vegetation cover tends to be relatively sparse, ranging from 5 to 13%. The shrub canopy consists overwhelmingly of *Coleogyne ramosissima*; *Ephedra torreyana, Atriplex confertifolia, Ericameria nauseosa, Ephedra viridis, Gutierrezia sarothrae*, and *Opuntia polyacantha* may be present with much less cover. Unlike *Coleogyne ramosissima* Shrubland (CEGL001332), this type has a developed herbaceous understory dominated by *Pleuraphis jamesii* with between 1 and 5% cover. Additional graminoids include *Achnatherum hymenoides, Aristida purpurea*, and *Bromus tectorum*. Forbs are highly variable in species composition among sites and include *Amsonia tomentosa, Eriogonum inflatum, Sphaeralcea leptophylla, Stenotus acaulis (= Haplopappus acaulis), Salsola tragus*, and *Heterotheca villosa*. Some stands have scattered mature *Juniperus osteosperma* trees.

Globally
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 *Atriplex canescens, Atriplex confertifolia, Ephedra nevadensis, Ephedra torreyana, Ericameria nauseosa, Eriogonum corymbosum, Gutierrezia sarothrae, Opuntia* spp., *Psorothamnus fremontii, Sclerocactus whipplei*, 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*, or the 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 *Amsonia tomentosa, Astragalus* sp., *Calochortus nuttallii, Eriogonum inflatum, Eriogonum nutans, Heterotheca villosa, Ipomopsis polycladon, Phacelia* spp., *Sphaeralcea leptophylla, Stenotus acaulis (= Haplopappus acaulis)*, and the introduced annual forb *Salsola tragus*. Annuals provide abundant cover during wet years. Occasional *Juniperus osteosperma* or *Pinus edulis* trees are present in some stands.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*, *Coleogyne ramosissima*
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Amsonia tomentosa*
Herb (field)	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Ephedra nevadensis*
Short shrub/sapling	*Coleogyne ramosissima*
Short shrub/sapling	*Gutierrezia sarothrae*
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Halogeton glomeratus* (exotic, High/Medium), *Salsola tragus* (exotic)

Globally
Vulnerable: *Sclerocactus whipplei* (globally imperiled, G1G3)

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Slopes are stable, hot and south-facing. Sites are subject to wind erosion.

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (13 plots: CANY 0116, CANY 0130, CANY 0149, CANY 0150, CANY 0156, CANY 0157, CANY 0353, CANY 0515, CANY 9312, CANY 9512, CANY 9727, GLCA 0117, GLCA 0548, GLCA 0596, GLCA 0709, GLCA 0741).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, Bowns and West 1976, CONHP unpubl. data 2003, 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

Coleogyne ramosissima Shrubland

Blackbrush Shrubland

CODE	CEGL001332
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*COLEOGYNE RAMOSISSIMA* SHRUBLAND ALLIANCE (A.874) Blackbrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)
Mojave Mid-Elevation Mixed Desert Scrub (CES302.742)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This broadly defined, common 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 on level to steep slopes, rarely exceeding 24 degrees. 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, benches and colluvial slopes oriented to any aspect. 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. 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. Shrub cover is usually around 20%, although it can range as low as 5% or as high as 50%. 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*. 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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This common shrubland grows in diverse habitats within the park and recreation area. Sites sampled in Canyonlands National Park include along Upheaval Dome Road, along the White Rim Road, in and along the rim of Horseshoe Canyon, in Shot Canyon, on Aztec Butte, south of Syncline Trail, along Lathrop Trail, the north end of the "Big Draw," on the rim of Buck and Little Bridge canyons, 400 m north of the Maze Overlook, adjacent to Holeman Spring Basin Trail, in Buck Canyon, west of Horseshoe Canyon parking area, and along the rim of Salt Creek

Canyon. Areas sampled in Glen Canyon National Recreation Area include in Deadhorse Canyon, northeast of Hans Flat Ranger Station, between Deadhorse Canyon and Anderson Bottom, in Range Canyon, along the north rim of Deadhorse Canyon, along North Trail Canyon Trail, in Big Spring Canyon, on Waterhole Flat, and near Sunset Pass.

Globally
This widespread and common desert shrubland association occurs in the Colorado Plateau, southern Great Basin, Mojave Desert, and Sierra Nevada foothills.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association occurs throughout the park and recreation area on plateaus, ridges, toeslopes, bench ledges, mesas, plains, valleys, canyon rims, sand dunes and hills. Sites are flat to steep (0- to 25-degree slopes), include all aspects, and lie between 1198 and 1878 m elevation. Bare soil covers most of the unvegetated surface, with lesser cover by bedrock, litter, gravel and large rocks. Depending on substrate, biological soil crust communities provide sparse to moderate cover. The soils fall into two groups: those derived from sandstones or coarse eolian sands or those derived from shales. Texture varies accordingly, with loamy sands and sandy loams in the former group, silt loams and clay loams in the other group.

Globally
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 11 degrees but have also been found on steep slopes (>24 degres). 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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This is the most common and widespread association in the park and recreation area. Total vegetation cover ranges from 5 to 36% and is characterized by an open short-shrub canopy of *Coleogyne ramosissima*. No species was codominant with *Coleogyne ramosissima*, and most sites support fewer than 10 species. Other shrubs present may include scattered individuals of *Ephedra torreyana, Atriplex confertifolia, Ephedra viridis, Ericameria nauseosa, Atriplex canescens, Gutierrezia sarothrae, Opuntia polyacantha, Opuntia erinacea, Yucca angustissima*, and *Sclerocactus whipplei*. The herbaceous layer is usually sparse, but common species (usually present with only trace cover) include the grasses *Pleuraphis jamesii, Achnatherum hymenoides, Aristida purpurea, Vulpia octoflora (= Festuca octoflora), Bouteloua gracilis*, and *Bromus tectorum*. Forbs vary from site to site and include *Chamaesyce fendleri, Phacelia crenulata, Amsonia tomentosa, Sphaeralcea leptophylla, Streptanthella longirostris*, and *Salsola tragus*. Cryptogam cover is variable, with stands on shale-derived substrates having none, but sand-derived substrates support biological soil crusts with as much as 49% cover.

Globally
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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*, *Coleogyne ramosissima*
Short shrub/sapling	*Ephedra torreyana*, *Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*, *Opuntia polyacantha*
Herb (field)	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Coleogyne ramosissima*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Halogeton glomeratus* (exotic, High/Medium), *Malcolmia africana* (exotic), *Salsola paulsenii* (exotic, Low), *Salsola tragus* (exotic)

Globally
Vulnerable: *Ephedra funerea* (globally imperiled, G2); **Exotic/Invasive**: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: G4G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This widespread plant association is broadly 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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Plant communities are controlled by slope exposure and wind, and sites are subject to sheet runoff.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (114 plots: CANY 0100, CANY 0126, CANY 0154, CANY 0155, CANY 0167, CANY 0187, CANY 0194, CANY 0229, CANY 0243, CANY 0246, CANY 0255, CANY 0276, CANY 0285, CANY 0301, CANY 0305, CANY 0306, CANY 0313, CANY 0320, CANY 0330, CANY 0332, CANY 0338, CANY 0339, CANY 0340, CANY 0352, CANY 0357, CANY 0363, CANY 0364, CANY 0365, CANY 0366, CANY 0368, CANY 0376, CANY 0409, CANY 0426, CANY 0430, CANY 0456, CANY 0506, CANY 0508, CANY 0511, CANY 0512, CANY 0513, CANY 0514, CANY 0526, CANY 0532, CANY 0537, CANY 0541, CANY 0542, CANY 0572, CANY 0645, CANY 0646, CANY 0647, CANY 0648, CANY 0651, CANY 0663, CANY 0702, CANY 0714, CANY 0715, CANY 0718, CANY 0738, CANY 0770, CANY 0775, CANY 0780, CANY 0781, CANY 0824, CANY 9013, CANY 9015, CANY 9021, CANY 9023, CANY 9029, CANY

9030, CANY 9031, CANY 9032, CANY 9043, CANY 9066, CANY 9067, CANY 9071, CANY 9072, CANY 9075, CANY 9119, CANY 9331, CANY 9333, CANY 9357, CANY 9367, CANY 9372, CANY 9504, CANY 9505, CANY 9513, CANY 9707, CANY 9709, CANY 9719, CANY 9720, CANY 9722, CANY 9723, CANY 9724, GLCA 0116, GLCA 0310, GLCA 0313, GLCA 0314, GLCA 0322, GLCA 0324, GLCA 0325, GLCA 0330, GLCA 0336, GLCA 0537, GLCA 0540, GLCA 0551, GLCA 0593, GLCA 0720, GLCA 0733, GLCA 0734, GLCA 0736, GLCA 0739, GLCA 0740, GLCA 0761, GLCA 0770).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. 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, Ostler et al. 2000, Peterson 1984, Peterson 2008, Romme et al. 1993, Schultz et al. 1987, Shields et al. 1959, Warren et al. 1982, Wells 1960, West 1983d, Western Ecology Working Group n.d., Wright 1980

Coleogyne ramosissima Sparse Shrubland

Blackbrush Sparse Shrubland

CODE	CEGL003834
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*COLEOGYNE RAMOSISSIMA* SHRUBLAND ALLIANCE (A.874) Blackbrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)
Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This sparse shrubland occurs in canyonlands of the Colorado Plateau in southeastern Utah on canyon rims and valley bottoms. Canyon rim sites slope gently to the southwest at 1442 m elevation. The sampled valley bottom site slopes moderately (14 degrees) to the northwest at 1366 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 rapidly drained sandy loams, loamy sands, or sands. 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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparsely vegetated association grows along the rim of Deadhorse Canyon in Glen Canyon National Recreation Area and along the rim of the North Fork of Dead Leg Canyon in Canyonlands National Park.

Globally
This sparse shrubland occurs in canyonlands of the Colorado Plateau in southeastern Utah on canyon rims and valley bottoms.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparse shrubland occurs on canyon rims and valley bottoms. Canyon rim sites slope gently to the southwest at 1442 m elevation. The valley bottom site slopes moderately (14 degrees) to the northwest at 1366 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 rapidly drained sandy loams, loamy sands, or sands derived from White Rim sandstone or Moenkopi Formation.

Globally
This sparse shrubland occurs in canyonlands of the Colorado Plateau on canyon rims and valley bottoms. Canyon rim sites slope gently to the southwest at 1442 m elevation. The sampled valley bottom site slopes moderately (14 degrees) to the northwest at 1366 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 rapidly drained sandy loams, loamy sands, or sands derived from White Rim sandstone or Moenkopi Formation.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare blackbrush type 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.

Globally
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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Coleogyne ramosissima*
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Gutierrezia sarothrae*, *Yucca angustissima*
Herb (field)	*Chamaesyce fendleri*, *Tetraneuris acaulis*
Herb (field)	*Aristida purpurea*, *Bromus tectorum*, *Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Coleogyne ramosissima*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Halogeton glomeratus* (exotic, High/Medium), *Salsola tragus* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jun-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Sparse examples of *Coleogyne ramosissima / Pleuraphis jamesii* Shrubland (CEGL001334) may be hard to distinguish from this association.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: White Rim slickrock supports vegetation in soil-filled depressions. Runoff is rapid but accumulates in these depressions.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (5 plots: CANY 0536, GLCA 0536, GLCA 0543, GLCA 0544, GLCA 0545).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Opuntia polyacantha / Pleuraphis jamesii Shrubland

Panhandle Prickly-pear / James' Galleta Shrubland

CODE	CEGL002299
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Succulent extremely xeromorphic evergreen shrubland (III.A.5.N.c.)
ALLIANCE	*OPUNTIA* SPP. SHRUBLAND ALLIANCE (A.2650) Prickly-pear species Shrubland Alliance

ECOLOGICAL SYSTEM(S): Mojave Mid-Elevation Mixed Desert Scrub (CES302.742)
Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This low-succulent association occurs on hot, dry, relatively undisturbed sites on benches, valley floors, and slopes in the northern Colorado Plateau. Stands occur on gentle to steep (3-36 degrees) 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. 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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This dwarf-shrubland association is uncommon within the park and recreation area and is represented by sampled plots on the White Rim Road just past Musselman Arch, west of Upheaval Bottom, north of Muffin Arch, and in Spanish Bottom in Canyonlands National Park and in Calf Canyon within Glen Canyon National Recreation Area.

Globally
This association occurs on xeric sites in the northern Colorado Plateau of Colorado and Utah and is likely more widespread.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This dwarf-shrubland association was documented on an alluvial fan, in a canyon bottom, and on a terrace. Sites are on gentle slopes with an eastern, southeastern, or northern orientation between 1173 and 1628 m elevation. Exposed soil covers most of the unvegetated surface, with lesser cover by litter and biological soil crusts. Soils are rapidly drained silty loams or sandy clays derived from alluvium rich in shale.

Globally
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 (3-36 degrees) slopes with are oriented to eastern and southern aspects between 1457 and 1628 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, alluvium and colluvium. Parent materials are variable and include sandstone, shale, Precambrian gneiss, and deposits of eolian, sheetwash, and rockfall material.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparsely vegetated prickly-pear dwarf-shrubland is rare within the park and recreation area. Total vegetation cover is around 5-13%. Stands are characterized by clumps of *Opuntia polyacantha* with openings dominated by *Pleuraphis jamesii*. Scattered *Juniperus osteosperma* trees and seedlings may be present. Associated shrubs include *Atriplex canescens, Ephedra viridis, Ephedra torreyana, Atriplex confertifolia, Sclerocactus whipplei*, and *Gutierrezia sarothrae*. Associated herbaceous species include *Hesperostipa comata, Achnatherum hymenoides, Sporobolus cryptandrus, Lepidium montanum, Hymenopappus filifolius, Cryptantha flava, Bromus tectorum, Salsola tragus*, and *Sphaeralcea leptophylla*. Biological soil crusts are generally in an early stage of development and cover up to 66% of the soil surface.

Globally
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 viridis, Ephedra torreyana, 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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Opuntia polyacantha*
Herb (field)	*Pleuraphis jamesii*

Globally

Stratum	Species
Herb (field)	*Opuntia polyacantha*
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Salsola tragus* (exotic)

Globally
Vulnerable: *Sclerocactus whipplei* (globally imperiled, G1G3); **Exotic/Invasive**: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (11-Jan-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: One plot is on an alluvial terrace above Calf Canyon drainage. The abundance of *Opuntia polyacantha* is most likely due to past grazing.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY.0543, CANY.9130, GLCA.0574) and 2008 and 2009 Accuracy Assessment (2 points: CANY_AA.4036, CANY_AA.4377).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Von Loh et al. 2007, Western Ecology Working Group n.d.

Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. *tuckeri Wooded Shrubland*

Utah Juniper - (Two-needle Pinyon) / Blackbrush - Stansbury's Cliffrose - Tucker Sand Shinnery Oak Wooded Shrubland

CODE	CEGL003774
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Extremely xeromorphic evergreen shrubland with a sparse tree layer (III.A.5.N.e.)
ALLIANCE	*PINUS EDULIS - JUNIPERUS OSTEOSPERMA* WOODED SHRUBLAND ALLIANCE (A.2649) Two-needle Pinyon - Utah Juniper Wooded Shrubland Alliance
ECOLOGICAL SYSTEM(S):	Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765) Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association has been documented only in the canyonlands of the Colorado Plateau in eastern Utah. 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 35 degrees), 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. This wooded shrubland association has a mixed shrub canopy, occasionally 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 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This wooded shrubland type is common within the park and recreation area and was sampled on the canyon rim 300 m north of Alcove Spring, on Calamity Mesa, on the south rim of Horse Canyon, on the rim of Taylor Canyon, the southwest side of Aztec Butte, adjacent to Lathrop Trail, 2 km northwest of Horsehoof Arch, 2 km north of Wilhite Trailhead, above Imperial Valley, and along the rim of Teapot Canyon in Canyonlands National Park and along the rim of Calf and Millard canyons in Glen Canyon National Recreation Area.

Globally

This association is known only 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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This wooded shrubland occurs on slickrock exposures interrupted by shallow, sand-filled depressions on mesas, canyon rims, plateaus, ledges, and canyon sides. Sites are on flat to steep slopes between 1447 and 1890 m elevation. Exposed soil or bedrock comprises most of the unvegetated surface, with low cover by rocks, litter and dead wood. Biological soil crusts provide sparse to moderate cover. Soils are rapidly drained sandy loams, sandy clay loams, or loamy sands derived from sandstone and shale bedrock or colluvium, including the Kayenta Formation, Cedar Mesa sandstone, and the Chinle Formation.

Globally

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 35 degreees), 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This community generally takes the form of a wooded shrubland in which the shrub understory has as much or more cover than the pinyon and juniper trees that form an open canopy. Total vegetation cover ranges from 5 to 23% depending on the availability of rooting sites. Stands are characterized by a sparse to open, dwarfed canopy of

Juniperus osteosperma and occasional *Pinus edulis* with 1 to 8% cover. Shrubs dominate the understory, and in this community, most stands have *Coleogyne ramosissima* and *Purshia stansburiana* or *Cercocarpus intricatus* as codominants. Stands with deeper sands may also have *Quercus havardii* var. *tuckeri* as a codominant. Xeric stands have a diversity of associated shrubs with low cover: *Fraxinus anomala, Ephedra viridis, Artemisia bigelovii, Glossopetalon spinescens* var. *meionandrum, Rhus trilobata, Ericameria nauseosa, Ephedra torreyana, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Yucca angustissima, Opuntia polyacantha*, and *Sclerocactus whipplei*. Mesic stands include *Amelanchier utahensis*. The herbaceous layer is diverse but provides only sparse cover. Grasses include *Achnatherum hymenoides, Vulpia octoflora (= Festuca octoflora), Aristida purpurea*, and *Bromus tectorum*. Forbs include *Machaeranthera grindelioides, Cryptantha* sp., *Chamaesyce fendleri, Arenaria fendleri, Streptanthella longirostris, Petradoria pumila, Tetraneuris acaulis (= Hymenoxys acaulis), Cryptantha flava*, and *Lepidium montanum* var. *jonesii*. Biological soil crust cover is generally sparse, although some stands have nearly 50% cover, and is usually well-developed.

Globally
This wooded shrubland association has a mixed shrub canopy, occasionally 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, Chrysothamnus viscidiflorus, Ephedra torreyana, Ephedra viridis, Fraxinus anomala, Glossopetalon spinescens* var. *meionandrum, Gutierrezia sarothrae, Opuntia polyacantha, Rhus trilobata, 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, 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, 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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Short shrub/sapling	*Coleogyne ramosissima*
Short shrub/sapling	*Cercocarpus intricatus*, *Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*, *Yucca angustissima*
Herb (field)	*Chamaesyce fendleri*
Herb (field)	*Achnatherum hymenoides*, *Aristida purpurea*

Globally

Stratum	Species
Tree (canopy & subcanopy)	*Juniperus osteosperma*
Shrub/sapling (tall & short)	*Purshia stansburiana*
Tall shrub/sapling	*Fraxinus anomala*
Short shrub/sapling	*Coleogyne ramosissima*, *Quercus havardii* var. *tuckeri*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Vulnerable: *Quercus havardii* var. *tuckeri* (vulnerable, G4T3?Q), *Sclerocactus whipplei* (globally imperiled, G1G3)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (15-Mar-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Ledges have collected enough soil to support a woodland community. Large slickrock slopes above contribute runoff to the plants. Soils are minimal and thin where they occur.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (42 plots: CANY 106, CANY 0131, CANY 0133, CANY 0197, CANY 0236, CANY 0252, CANY 0267, CANY 0269, CANY 0286, CANY 0302, CANY 0307, CANY 0324, CANY 0334, CANY 0336, CANY 0371, CANY 0380, CANY 0425, CANY 0440, CANY 0453, CANY 0524, CANY 0565, CANY 0571, CANY 0576, CANY 0578, CANY 0701, CANY 0703, CANY 0729, CANY 0732, CANY 0766, CANY 0769, CANY 0782, CANY 0783, CANY 0784, CANY 0814, CANY 0844, GLCA 0126, GLCA 0315, GLCA 0316, GLCA 0557, GLCA 0575, GLCA 0711, GLCA 0722, GLCA 0749).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: G. Kittel, mod. K.A. Schulz

REFERENCES: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis) Wooded Shrubland

Two-needle Pinyon - Utah Juniper / (Roundleaf Buffaloberry, Utah Serviceberry) Wooded Shrubland

CODE	CEGL002334
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Extremely xeromorphic evergreen shrubland with a sparse tree layer (III.A.5.N.e.)
ALLIANCE	*PINUS EDULIS - JUNIPERUS OSTEOSPERMA* WOODED SHRUBLAND ALLIANCE (A.2649) Two-needle Pinyon - Utah Juniper Wooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This wooded shrubland association occurs on the slopes of mesas, buttes and plateaus in southern 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. Most sites are moderately steep to steep (up to 40 degree slope), occur between 1422 and 2348 m (4665-7700 feet) elevation, and are oriented to cooler north to northeastern aspects. A smaller number of occurrences, usually at higher elevations, occupy west-facing slopes. 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. Parent materials are typically shales of the Moenkopi, Chinle, Cutler or Carmel formations, modified by colluvial fragments of overlying conglomerate or sandstones. Soils are rapidly drained silt loams, sandy loams and clay loams. The vegetation is characterized by a sparse to moderately closed canopy (5-30%) of *Pinus edulis*, often accompanied by *Juniperus osteosperma*. In rare cases on barren shales, the tree element is nearly absent. The shrub layer is mixed, but *Amelanchier utahensis* or *Shepherdia rotundifolia* are present (usually both). Other shrubs often present include *Cercocarpus montanus, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Gutierrezia sarothrae, Symphoricarpos longiflorus*, and *Mahonia fremontii*. The herbaceous layer is moderate to high in terms of species diversity and typically provides sparse to moderate cover. Common graminoids include *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Leymus salinus*, and *Pleuraphis jamesii*. Forbs that are occasionally present include *Cryptantha flava, Machaeranthera grindelioides, Penstemon utahensis, Phlox austromontana, Lepidium montanum, Stanleya pinnata, Streptanthella longirostris*, and *Tetraneuris acaulis*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland is common within the park and recreation area. It is represented by plots sampled in Horse Canyon, adjacent to Neck Spring Trail, in Water Canyon, and north of Elaterite Butte in Canyonlands National Park. In Glen Canyon National Recreation Area, it was sampled in Red Cove, 1.5 km north-northeast of Hans Flat Ranger Station, in Water Canyon, north of Bagpipe Butte, in Big Water Canyon, near Teapot Rock Campsite, near China Neck, and near Sunset Pass.

Globally
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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This wooded shrubland occurs on canyon bottoms, rims, and sides, as well as on colluvial slopes, buttes, and ridges. Stands slope gently to steeply (up to 40 degrees), lie between 1422 and 1974 m elevation and may be oriented to any aspect. Biological soil crusts provide sparse to low cover. Soils are rapidly drained sandy loams, sandy clays, loams, clay loams, sandy clay loams, sands, or loamy sands derived from a variety of sandstone and shale parent materials.

Globally
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 (3-40 degree 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 Moenkopi, Chinle, Cutler or Carmel formations, modified by colluvial fragments of overlying conglomerate or sandstones. Soils are rapidly drained silt loams, sandy loams and clay loams. Parent materials are typically shales of the Moenkopi, Chinle, Cutler or Carmel formations, modified by colluvial fragments of overlying conglomerates (Shinarump) or sandstones (Navajo). Soils are rapidly drained silt, silt loam, clay loam, sandy loam, and loamy sand.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This mesic pinyon-juniper wooded shrubland is common within the park and recreation area. Total vegetation cover ranges from 5 to 90%. Stands are characterized by an open canopy, typically 2 to 5 m tall, of *Pinus edulis* and *Juniperus osteosperma* with between 10 and 20% cover. The understory is generally a mix of shrubs, among which *Amelanchier utahensis* and *Shepherdia rotundifolia* are conspicuous. The remaining shrub layer may contain as many as six other species, including scattered *Fraxinus anomala, Ephedra viridis, Eriogonum corymbosum, Chrysothamnus viscidiflorus, Symphoricarpos longiflorus*, and *Gutierrezia sarothrae*. The herbaceous layer is diverse but provides only sparse cover. Grasses include *Achnatherum hymenoides, Leymus salinus*, and *Pleuraphis jamesii*. Forbs include *Machaeranthera grindelioides, Stenotus armerioides (= Haplopappus armerioides),*

Chamaesyce fendleri, and *Stanleya pinnata*. Biological soil crust cover is variable and generally in an early stage of development, with some stands having none and others with as much as 35% cover.

Globally
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 a minority of stands with little colluvial rock cover, the trees may be too sparse to be considered a layer, 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 tree layer. The shrub layer is mixed, but *Amelanchier utahensis* or *Shepherdia rotundifolia* are present (usually both). Other shrubs often present include *Cercocarpus montanus, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Gutierrezia sarothrae, Mahonia fremontii, 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 hymenoides, Bouteloua gracilis, Bromus tectorum, Hesperostipa comata, Leymus salinus*, and *Pleuraphis jamesii*. Forbs that are occasionally present include *Cryptantha flava, 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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Chrysothamnus viscidiflorus*, *Shepherdia rotundifolia*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Stanleya pinnata*
Herb (field)	*Achnatherum hymenoides*, *Leymus salinus*, *Pleuraphis jamesii*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Shepherdia rotundifolia*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Lactuca serriola* (exotic, 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.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Some stands occur in a Moenkopi slope environment: clay soils with a flaky or platy rock surface that facilitates sheet runoff.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (25 plots: CANY 0248, CANY 0266, CANY 0415, CANY 0429, CANY 0434, CANY 0675, CANY 0841, CANY 0842, 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 0769).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Clark et al. 2009, Coles et al. 2008c, Romme et al. 1993, Western Ecology Working Group n.d.

Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland

(Utah Serviceberry, Saskatoon Serviceberry) - Alderleaf Mountain-mahogany Shrubland

CODE	CEGL001070
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*AMELANCHIER UTAHENSIS* SHRUBLAND ALLIANCE (A.916) Utah Serviceberry Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
The description for this association is based on information from Colorado and Utah; its characteristics in Nevada are unknown and will be described when more information becomes available. This plant association is found on moderate to steeply sloping colluvial slopes, canyons, ridges and in alcoves. Sites may be oriented to any aspect. Elevation ranges between 1586 and 2595 m (5200-8500 feet). Relative to other mixed mountain shrub types, it is found on the driest sites with the least soil development and relatively low diversity. Soils range from shallow to deep but are generally always rocky with a high cover of surface rock. The vegetation is characterized by a more open shrub layer and a sparse understory relative to other mixed mountain shrub types. Total vegetation cover often does not exceed 50%. *Amelanchier utahensis* and *Cercocarpus montanus* are the dominants of as many as 16 shrub species in this association. Typical associated shrub species include *Artemisia bigelovii, Artemisia tridentata, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Peraphyllum ramosissimum, Purshia tridentata, Rhus trilobata, Fraxinus anomala*, and *Tetradymia canescens*. *Symphoricarpos oreophilus* can dominate the lower shrub layer, which may also include *Brickellia microphylla, Eriogonum microthecum, Gutierrezia sarothrae, Mahonia repens*, and *Paxistima myrsinites*. Succulents such as *Opuntia* spp. or *Yucca* spp. may also have minor cover. If *Quercus gambelii* is present, cover is low (<5%). Scattered trees of *Juniperus osteosperma, Juniperus scopulorum*, or *Pinus edulis* may be present in some stands. *Achnatherum hymenoides (= Oryzopsis hymenoides)* is the most common species in the diverse herbaceous layer. Other graminoid

species may include *Poa fendleriana, Koeleria macrantha, Achnatherum lettermanii, Pseudoroegneria spicata, Elymus lanceolatus, Hesperostipa comata*, and *Leymus salinus*. Forb species may include *Arenaria fendleri, Chaenactis douglasii, Cryptantha flava, Cymopterus purpureus, Balsamorhiza sagittata, Eriogonum umbellatum, Galium coloradoense, Heterotheca villosa, Lepidium montanum, Lithospermum ruderale, Petradoria pumila, Phlox longifolia, Physaria acutifolia, Senecio integerrimus, Sphaeralcea coccinea, Stanleya pinnata, Stenotus acaulis*, and *Streptanthella longirostris*. Disturbed sites may have high cover of *Bromus tectorum*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This mixed mountain shrubland is rare within the park and was represented by one plot located on the north-facing slope of the saddle between Horse and Davis canyons.

Globally
This association is documented from stands in western Colorado and southern and eastern Utah. It has been reported from Nevada and is likely to occur in xeric areas of mixed mountain shrubland throughout the plateaus and foothills of Colorado and in higher elevations of the Colorado Plateau, western Rocky Mountains and Intermountain West.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland was sampled once on an unstable ridge slope. The stand is on a steep, north-facing slope (32 degrees) at 1851 m elevation. The unvegetated surface has a high cover of large and small rocks and moderate exposure of bare soil. The soil is a rapidly drained loam derived from Organ Rock shale.

Globally
The description for this association is based on information from Colorado and Utah; its characteristics in Nevada are unknown and will be described when more information becomes available. This plant association is found on moderate to steeply sloping colluvial slopes, canyons, ridges and in alcoves. Sites may be oriented to any aspect. Elevations range between 1586 and 2500 m (5200-8200 feet). Relative to other mixed mountain shrub types, it is found on the driest sites with the least soil development and relatively low diversity. Exposed ground is moderate to extensive, averaging 40%. Soils range from shallow to deep, from loams to silty clays, but are generally always rocky with a high cover of surface rock.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This mixed mountain shrubland is rare within the park. Total vegetation cover is 16% in a stand characterized by *Amelanchier utahensis* and *Cercocarpus montanus* shrubs that provide 6% and 2% cover, respectively. Scattered individuals of *Juniperus osteosperma* and *Pinus edulis* attain heights of between 2 and 5 m and provide sparse cover. The remaining shrub layer contributes sparse cover and includes *Fraxinus anomala, Symphoricarpos longiflorus, Chrysothamnus viscidiflorus*, and *Ephedra viridis*. The herbaceous layer is low in terms of species diversity and contributes sparse cover of *Cryptantha tenuis, Tetraneuris acaulis (= Hymenoxys acaulis)*, and *Stanleya pinnata*.

Globally
The vegetation is characterized by a more open shrub layer with a sparse understory relative to other mixed mountain shrub types. Total vegetation cover often does not exceed 50%. *Amelanchier utahensis* and *Cercocarpus montanus* are the dominants of as many as 16 shrub species in this association. Typical shrub species include *Artemisia bigelovii, Artemisia tridentata, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Peraphyllum ramosissimum, Purshia tridentata, Rhus trilobata, Fraxinus anomala*, and *Tetradymia canescens*. *Symphoricarpos oreophilus* can dominate the lower shrub layer, which may also include *Brickellia microphylla, Eriogonum microthecum, Gutierrezia sarothrae, Mahonia repens*, and *Paxistima myrsinites*. Scattered individuals of *Juniperus osteosperma* and *Pinus edulis* may occur. Succulents such as *Opuntia* spp. or *Yucca* spp. may also have minor cover. *Achnatherum hymenoides (= Oryzopsis hymenoides)* is the most common species in the diverse herbaceous layer. Other graminoid species may include *Poa fendleriana, Koeleria macrantha, Achnatherum lettermanii, Cymopterus purpureus, Pseudoroegneria spicata, Elymus lanceolatus, Hesperostipa comata*, and *Leymus salinus*. Forb species may include *Arenaria fendleri, Chaenactis douglasii, Cryptantha flava, Balsamorhiza sagittata, Eriogonum umbellatum, Galium coloradoense, Heterotheca villosa, Lepidium montanum, Lithospermum ruderale, Petradoria pumila, Phlox longifolia, Physaria acutifolia, Senecio integerrimus,*

Sphaeralcea coccinea, Stanleya pinnata, Stenotus acaulis, and *Streptanthella longirostris, Tetraneuris acaulis (= Hymenoxys acaulis)*. Disturbed sites may have high cover of *Bromus tectorum*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*, *Fraxinus anomala*
Tall shrub/sapling	*Cercocarpus montanus*

Globally

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Cercocarpus montanus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Vulnerable: *Sclerocactus whipplei* (globally imperiled, G1G3); **Exotic/Invasive**: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: G2? (12-Nov-2008). This association is well-known from Colorado and throughout Utah. It also occurs in Nevada, but no information is available on its conservation status there. Very little is known about the larger scale abiotic factors that contribute to the distribution. The global rank should be at least a G3 based on the numbers of sites documented at several National Park Service units.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Steep, loose, flaky rock surfaces characterize these soils, making for a difficult place for plants to establish. Shrubs have scree piled against their uphill sides. Most rainfall probably fails to penetrate the soil surfaces and is shed downslope quickly.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY 0801).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: L. Tasker, mod. J. Coles and G. Kittel

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data, CONHP unpubl. data 2003, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2010, Driscoll et al. 1984, Thomas et al. 2009b, Tiedemann 1978, Von Loh et al. 2007, Vories 1974, Western Ecology Working Group n.d.

Amelanchier utahensis Shrubland

Utah Serviceberry Shrubland

CODE	CEGL001067
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*AMELANCHIER UTAHENSIS* SHRUBLAND ALLIANCE (A.916) Utah Serviceberry Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)
Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

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. 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. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Sites sampled include Shafer Canyon, 400 m south-southwest of Gooseberry Campground, adjacent to South Fork Canyon Road, Buck Canyon, and along Shafer Road in Canyonlands National Park, and in Water Canyon and southwest of Teapot Campground in Glen Canyon National Recreation Area.

Globally

This shrubland association occurs in the foothills and mountain areas in north-central Utah, Colorado Plateau and Great Basin of the western U.S.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association occurs on steep canyon slopes, colluvial slopes, rockfalls and mesa sides. Sites are moderate to steep (10- to 33-degree slopes), oriented between northwest and northeast and are located between 1326 and 1900 m elevation. The unvegetated surface has low to moderate cover of small and large rocks, sparse exposure of bare soil and sand, and sparse cover of litter and downed wood. There is sparse cover of lichens on rocks. Soils include rapidly drained silt loams, sands, sandy clay loams or sandy loams derived from the Chinle Formation, Organ Rock shale of the Cutler Group, or the Moenkopi Formation.

Globally

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 degrees) 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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This Utah serviceberry shrubland is locally common within the park. Total vegetation cover ranges from 1 to 40% and is characterized 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 cover. Common associated shrubs include *Fendlera rupicola, Fraxinus anomala, Rhus trilobata* var. *simplicifolia (= Rhus aromatica* var. *simplicifolia), Chrysothamnus viscidiflorus, Ephedra torreyana, Eriogonum corymbosum, Coleogyne ramosissima, Ephedra viridis, Ericameria nauseosa, Frangula betulifolia, Brickellia microphylla*, and *Gutierrezia microcephala*. The herbaceous layer is low in terms of species diversity and provides sparse cover. Common bunch grasses include *Achnatherum hymenoides, Leymus salinus, Pleuraphis jamesii*, and *Achnatherum coronatum*. Forbs include *Amsonia tomentosa, Chamaesyce fendleri, Cryptantha* sp., and *Stanleya pinnata*.

Globally
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 grandidentatum, Artemisia tridentata, Chrysothamnus viscidiflorus, Ephedra viridis, 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. Herbaceous species include *Bromus carinatus, Koeleria macrantha, Achnatherum nelsonii* ssp. *dorei (= Stipa columbiana), Poa fendleriana, Balsamorhiza sagittata, Chenopodium fremontii, Machaeranthera canescens*, and species of *Astragalus, Eriogonum, Mertensia*, and *Penstemon* (Yake and Brotherson 1979). Introduced species such as *Agropyron cristatum* and *Bromus tectorum* are common in disturbed stands.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Rhus trilobata* var. *simplicifolia*
Herb (field)	*Brickellia microphylla*
Herb (field)	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Globally

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Symphoricarpos oreophilus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Malcolmia africana* (exotic)

Globally
Exotic/Invasive: *Agropyron cristatum* (exotic, Medium/Low), *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: G4 (19-Sep-2000).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This association is not well known. More survey work and classification work are needed to further define this type.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This community is controlled by slope steepness, exposure and geology. Some plants have piles of rocks and dirt on their uphill sides.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (9 plots: CANY 0148, CANY 0375, CANY 0377, CANY 0527, CANY 0531, CANY 0545, CANY 0726, GLCA 0112, GLCA 0571).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Drake

REFERENCES: Bourgeron and Engelking 1994, Carmichael et al. 1978, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Crane 1982, Driscoll et al. 1984, Eddleman and Jaindl 1994, Romme et al. 1993, 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

Quercus gambelii - Cercocarpus montanus / (Carex geyeri) Shrubland

Gambel Oak - Alderleaf Mountain-mahogany / (Geyer's Sedge) Shrubland

CODE	CEGL001113
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*QUERCUS GAMBELII* SHRUBLAND ALLIANCE (A.920) Gambel Oak Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This mixed montane shrubland is reported from foothills, mountains and mesatops in western Colorado and Utah. Stands occur on gentle, moderate and steep slopes. Aspect varies with elevation with low-elevation stands restricted to more mesic northern and eastern aspects, and higher elevation stands occurring on southern and western aspects. Substrates are typically shallow and rocky, derived from sandstone and shale parent materials, and range from sandy- to clayey-textured soil. The vegetation is characterized by a moderately dense to dense thicket of tall (2-5 m) deciduous shrubs (on unstable, eroding or talus slopes the shrub canopy may be open). Codominance of *Quercus gambelii* and *Cercocarpus montanus* (at least 10% cover of each) is diagnostic of this plant association, but *Amelanchier utahensis* is often also abundant to codominant. Low cover of other mixed shrub associates is common. *Arctostaphylos patula, Arctostaphylos pungens, Artemisia tridentata, Fendlera rupicola, Fraxinus anomala, Peraphyllum ramosissimum, Physocarpus monogynus, Purshia tridentata, Prunus virginiana, Rhus trilobata, Rosa woodsii, Quercus turbinella, Symphoricarpos oreophilus*, and *Yucca* spp. may be present depending on geography. Occasional *Juniperus osteosperma* and *Pinus edulis* trees may also be present. The herbaceous layer is generally sparse because of the dense overstory, but *Carex geyeri* may provide low to moderate cover.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association is rare within the park and was sampled in a tributary of Salt Creek Canyon, in Davis Canyon, and 150 m from Lost Creek Campground.

Globally
This montane shrubland association occurs in the foothills, mountains and mesatops of Utah and western Colorado.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This tall shrubland association occurs on steep canyon sides and in a wash bottom. Sites are flat to steep (0- to 34-degree slopes), oriented to the north or northwest, and lie between 1549 and 1621 m elevation. The unvegetated surface has low to moderate cover of gravel and large rocks, sparse to low exposure of bare soil, and the wash bottom has high exposure of sand. One canyon side has moderate exposure of bedrock. Litter and dead wood have low cover. Soils are rapidly drained loamy sands or sands derived from alluvium or colluvium.

Globally
This mixed montane shrubland association is reported from foothills, mountains and mesa tops in western Colorado and Utah. Elevation ranges from 1550-2500 m (5850-8200 feet). Stands occur on flat to steep slopes. Aspect varies with elevation with low elevation stands restricted to more mesic northern and eastern aspects, and higher elevation stands occurring on southern and western aspects. Substrates range from shallow and rocky, derived from sandstone, shale and alluvium or colluvium parent materials. Soil textures range from sandy to clayey to rapidly drained loamy sands.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This mixed mountain shrubland has low total cover of between 16 and 26%. The canopy consists of scattered *Quercus gambelii* and *Cercocarpus montanus* with between 3 and 9% cover and not exceeding 5 m tall. *Amelanchier utahensis, Pinus edulis*, and *Juniperus osteosperma* contribute sparse cover. Associated shrubs include *Fraxinus anomala, Rhus trilobata, Artemisia bigelovii, Ephedra viridis, Mahonia fremontii, Gutierrezia sarothrae, Yucca* spp., *Brickellia microphylla*, and *Opuntia polyacantha*. The herbaceous layer is diverse but contributes only modest cover; *Achnatherum hymenoides, Pleuraphis jamesii, Poa fendleriana, Sporobolus cryptandrus, Bromus tectorum, Heterotheca villosa, Lepidium montanum, Tetraneuris acaulis (= Hymenoxys acaulis), Packera multilobata (= Senecio multilobatus), Artemisia ludoviciana, Cirsium neomexicanum, Hymenopappus filifolius*, and *Erigeron utahensis* are common species.

Globally
This association is characterized by a moderately dense to dense thicket of tall deciduous shrubs 2-5 m tall (on unstable, eroding or talus slopes the shrub canopy may be more open). Codominance of *Quercus gambelii* and *Cercocarpus montanus* (at least 10% cover of each) is diagnostic of this plant association, but *Amelanchier utahensis* is often also abundant to codominant. Low cover of other mixed shrub associates is common. *Arctostaphylos patula, Arctostaphylos pungens, Artemisia bigelovii, Artemisia tridentata, Ephedra viridis, Fendlera rupicola, Fraxinus anomala, Mahonia fremontii, Peraphyllum ramosissimum, Physocarpus monogynus, Purshia tridentata, Rhus trilobata, Rosa woodsii, Quercus turbinella, Symphoricarpos oreophilus, Tetradymia canescens*, and *Yucca* spp. may be present depending on geography. Occasional *Juniperus osteosperma, Juniperus scopulorum*, and *Pinus edulis* trees may be present also. The herbaceous layer is generally sparse because of dense overstory. It is typically composed of scattered graminoids such as *Achnatherum hymenoides, Carex geyeri, Pleuraphis jamesii, Poa fendleriana, Sporobolus cryptandrus*, and forbs such as *Artemisia ludoviciana, Chaetopappa ericoides, Cirsium neomexicanum, Erigeron utahensis, Heterotheca villosa, Hymenopappus filifolius, Lathyrus* spp., *Lepidium montanum, Lupinus* spp., *Packera multilobata (= Senecio multilobatus), Pedicularis centranthera, Tetraneuris acaulis (= Hymenoxys acaulis)*, and *Vicia americana*. The non-native grass *Bromus tectorum* may also be present to abundant in disturbed stands.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Shrub/sapling (tall & short)	*Quercus gambelii*
Shrub/sapling (tall & short)	*Cercocarpus montanus*
Tall shrub/sapling	*Amelanchier utahensis*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Heterotheca villosa*

Herb (field)	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Globally

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*, *Quercus gambelii*
Tall shrub/sapling	*Cercocarpus montanus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Exotic/Invasive: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: G3 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This plant association is similar to other montane Gambel oak shrublands except for the codominance of *Cercocarpus montanus* (10% cover or more). Other shrubs species may be present to codominant.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The north-facing aspect may increase density in contrast to the opposite (south-facing) side of the canyon, although this density may be as much the result of more ledges and greater soil development on this side.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY.0218, CANY.0740, CANY.0818).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles and G. Kittel

REFERENCES: Baker 1982b, Bourgeron and Engelking 1994, Bradley et al. 1992, CONHP unpubl. data 2003, Clary 1992, Cogan et al. 2004, Coles et al. 2010, Dillinger 1970, Driscoll et al. 1984, Ellis and Hackney 1981, Erdman 1962, Ferchau 1973, Hanson and Ball 1928, Keammerer and Peterson 1981, Muldavin et al. 1998b, Pase and Lindenmuth 1971, Schmoll 1935, Thomas et al. 2009b, Vories 1974, Western Ecology Working Group n.d.

Quercus gambelii / Artemisia tridentata Shrubland

Gambel Oak / Big Sagebrush Shrubland

CODE	CEGL001111
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*QUERCUS GAMBELII* SHRUBLAND ALLIANCE (A.920) Gambel Oak Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally
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 37 degrees) 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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This is an uncommon association only known from three sites at Upper Salt Springs, Salt Creek, and Lost Canyon.

Globally
This montane shrubland association occurs in mountains and plateaus of Utah and western Colorado.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This is a rare association known from three observations. Sites include a drainage, cove and a terrace at 1512-1732 m elevation. Slopes are flat to gentle (<5%) on eastern and western aspects. Soils are deep and derived from alluvial deposits.

Globally
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 37 degrees), 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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This uncommon association is characterized by a tall moderately dense shrub layer (30-45% cover) clearly dominated by *Quercus gambelii*. *Quercus havardii* may be important on some sites with occasional *Juniperus osteosperma*. The short-shrub stratum is characterized by a sparse to open layer (5-20%) of *Artemisia tridentata* ssp. *tridentata*. Other shrubs occur at lower covers and include *Fraxinus anomala, Rhus trilobata, Atriplex canescens, Mahonia fremontii, Amelanchier utahensis*, and *Artemisia dracunculus*. The herbaceous layer is very sparse to absent.

Globally
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 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*.

MOST ABUNDANT SPECIES
*Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)*Data are not available.

Globally

Stratum	Species
Tall shrub/sapling	*Quercus gambelii*
Tall shrub/sapling	*Artemisia tridentata*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Vulnerable: *Penstemon teucrioides* (vulnerable, G2G3Q)

CONSERVATION STATUS RANK
Global Rank & Reasons: G4G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2008 Accuracy Assessment (3 points: CANY_AA.2079, CANY_AA.2709, and CANY_AA.3299).
Local Description Authors: M.E. Hall
Global Description Authors: K.A. Schulz

REFERENCES: Blackhawk Coal Company 1981, Boucek 1986, Bourgeron and Engelking 1994, Bunting 1987, Christensen 1955,a Clary 1992, Cogan et al. 2004, Coles et al. 2010, Driscoll et al. 1984, Everett 1987, Western Ecology Working Group n.d., Wright et al. 1979

Quercus gambelii / Rhus trilobata Shrubland

Gambel Oak / Skunkbush Sumac Woodland

CODE	CEGL002338
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*QUERCUS GAMBELII* SHRUBLAND ALLIANCE (A.920) Gambel Oak Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

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 (3-21 degree slopes), occur between 1685 and 2337 m elevation, and are oriented to north and east aspects. Total vegetation cover may range from 67% to well over 100%. 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*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare woodland or tall shrubland community was sampled in Lavender Canyon, in Salt Creek and upper Salt Creek, in Lost Canyon, Horseshoe Canyon, and Horse Canyon.

Globally

This association is known from narrow canyons in western Colorado and eastern Utah. It is likely a rare and restricted type because of its preferred habitat and combination of species.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This mesic tall shrubland occurs on flat to steep sites (up to 42-degrees), oriented to the north or northeast, between 1489 and 1777 m elevation. Sampled sites include canyon walls just below sandstone cliffs, stream terraces, falling dunes, canyon bottoms, coves, and valleys/bottomlands. Oak leaf litter covers most of the unvegetated surface, with lesser cover by bare soil, and with a small contribution by dead wood and biological soil crusts. The soil is a rapidly drained sandy loam derived from colluvium.

Globally

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 (3-21 degree slopes), occur between 1685 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare oak shrubland has a dense canopy of single-stemmed *Quercus gambelii* shrubs more than 2 m tall, with 10 to 55% cover. *Rhus trilobata* is generally codominant and contributes 2-40% cover to the canopy. Associated shrubs providing sparse to low cover include scattered individuals of *Cercocarpus montanus, Amelanchier utahensis, Fraxinus anomala, Forestiera pubescens, Fendlera rupicola*, *Salix exigua, Mahonia fremontii* (with up to 8%), *Shepherdia rotundifolia, Artemisia tridentata* ssp*. tridentata, Ericameria nauseosa, Rosa woodsii*, and *Gutierrezia sarothrae*. The herbaceous layer is poorly developed because of the dense shade and thick leaf litter, though in one sampled stand, *Bromus tectorum* contributed 28% cover. Associated herbaceous species include *Poa fendleriana, Bouteloua gracilis, Hesperostipa comata, Achnatherum hymenoides, Artemisia dracunculus, Apocynum cannabinum, Phragmites australis,* and *Senecio amplectens*. The vine *Clematis ligusticifolia* provides sparse to low cover.

Globally

This minor Gambel oak association may take the form of a woodland, with a canopy of *Quercus gambelii* 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, 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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Quercus gambelii*
Tall shrub/sapling	*Quercus gambelii*
Tall shrub/sapling	*Cercocarpus montanus*
Short shrub/sapling	*Rhus trilobata*, *Rosa woodsii*

Globally

Stratum	Species
Tall shrub/sapling	*Quercus gambelii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Exotic/Invasive: *Agropyron cristatum* (exotic, Medium/Low), *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Mentha arvensis* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (13-Jan-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This type is located on a steep north-facing slope just below sandstone cliffs. The cliffs shelter the area and combine with a northern aspect to make this area mesic compared to surrounding areas. Litter is deep and only an occasional small outcrop of sandstone interrupts continuous leaf litter.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plotsCANY.0625, CANY.9335) and 2007 and 2008 Accuracy Assessment (7 points: CANY_AA.0820, CANY_AA.0917, CANY_AA.2711, CANY_AA.2769, CANY_AA.3021, CANY_AA.3186, CANY_AA.3232).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Coles et al. 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.

Quercus gambelii / Sparse Understory Shrubland

Gambel Oak / Sparse Understory Shrubland

CODE	CEGL002337
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*QUERCUS GAMBELII* SHRUBLAND ALLIANCE (A.920) Gambel Oak Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association occurs on flat to gently sloping valley floors, canyon bottoms, or narrow high terraces in canyons of the Colorado Plateau and high plateaus of southern Utah. Stands are usually at least 1 m above bankfull stage and rarely, if ever, flood. Elevations range from 1220 to 2190 m (4000-7200 feet). The substrate is a fine sandy alluvium, and oak leaf litter generally covers nearly all the unvegetated surface. The canopy consists of even-aged *Quercus gambelii* stems 5-15 m high with 50-80% canopy closure. The understory consists primarily of oak sprouts less than 0.5 m tall. Scattered individuals of other woody species may occur throughout stands, including *Juniperus scopulorum, Ericameria nauseosa, Rhus trilobata*, and *Acer negundo*. Herbaceous species are usually sparse because of the dense shade cast by the relatively closed canopy but may include *Piptatherum micranthum, Maianthemum stellatum, Stanleya pinnata*, and *Clematis ligusticifolia*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland is distributed along broad valleys and plateaus within the park and was observed near Cabin Spring, along White Rim Road, and in Red Lake Canyon.

Globally

This association has been documented in the Colorado Plateau of eastern Utah and from high plateaus of southern Utah. It has been observed at Mesa Verde National Park (not sampled) and in the Front Range foothills of eastern Colorado as well (Castlewood Canyon State Park). It is likely to occur sporadically anywhere high alluvial terraces develop within the range of *Quercus gambelii*.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association occurs on stream terraces, canyon floors, and in ravines. Sites are on level to moderately steep slopes (up to 28 degrees) oriented to any aspect except north and lying between 1535 and 1824 m elevation. Litter covers most of the unvegetated surface. Soils are rapidly drained sandy loams or loamy sands derived from alluvium.

Globally

This association occurs on flat to gently sloping valley floors, canyon bottoms and narrow high terraces in canyons of the Colorado Plateau and high plateaus of southern Utah. Stands are usually at least 1 m above bankfull stage and rarely, if ever, flood. Elevations range from 1220 to 2190 m (4000-7200 feet). The substrate is a fine sandy alluvium, and the soils may have a dark surface horizon with a relatively high percentage of organic matter. Oak leaf litter generally covers nearly all the unvegetated surface, although wood litter from fallen branches and trunks may be significant in some older stands.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This tall Gambel oak shrubland is relatively rare within the park. Total vegetation cover ranges from 68 to 95%. The canopy is dominated by single-trunked clones of *Quercus gambelii* up to 10 m tall with between 55 and 90% cover.

Scattered individuals of *Pinus edulis* and *Juniperus osteosperma* appear in the canopy of some plots. Scattered individuals of other tall shrubs such as *Forestiera pubescens, Mahonia fremontii, Prunus virginiana*, and *Rhus trilobata* may be present. The understory is sparse, generally totaling much less than 5%. Graminoids present may include *Bromus tectorum* and *Piptatherum micranthum*. Forbs are variable; *Artemisia ludoviciana, Comandra umbellata, Heterotheca villosa*, and *Tetraneuris acaulis (= Hymenoxys acaulis)* were recorded. *Clematis ligusticifolia* is also often present.

Globally
Stands of this community usually take the form of a dwarf-woodland, with the canopy high enough that it is possible to walk upright through a stand. Stands usually consist of a single clone of *Quercus gambelii* with roughly even-aged stems 8-20 cm in diameter, 5-15 m tall, and with 50 to 80% canopy closure. They may also include scattered individuals of other woody species such as *Acer grandidentatum, Acer negundo, Juniperus scopulorum*, and *Pinus edulis*. Other shrubs that may be present include *Ericameria nauseosa, Forestiera pubescens, Mahonia fremontii, Prunus virginiana, Rhus trilobata, Rosa woodsii*, and *Symphoricarpos oreophilus*. The vines *Clematis columbiana* and *Clematis ligusticifolia* may also be present in the shrub canopy. Graminoid species are usually sparse because of the dense shade cast by the relatively closed canopy but may include *Piptatherum micranthum*. Forbs present include *Artemisia ludoviciana, Comandra umbellata, Heterotheca villosa, Maianthemum stellatum, Tetraneuris acaulis (= Hymenoxys acaulis), Stanleya pinnata, Thalictrum fendleri*, and *Packera multilobata (= Senecio multilobatus)*. The exotic annual grass *Bromus tectorum* is common in some stands.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Tree canopy	*Quercus gambelii*
Tall shrub/sapling	*Forestiera pubescens*, *Quercus gambelii*
Tall shrub/sapling	*Mahonia fremontii*
Short shrub/sapling	*Rhus trilobata*

Globally

Stratum	Species
Tree canopy	*Quercus gambelii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Exotic/Invasive: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jan-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This association is distinguished from other Gambel oak associations occurring in the Colorado Plateau by its position on level, abandoned alluvial terraces and the lack of a developed understory.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: A thick layer of oak leaves covers the entire plot.

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (4 plots: CANY.0109, CANY.0312, CANY.0745, CANY.0751).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz and G. Kittel

REFERENCES: Clark et al. 2009, Coles et al. 2008c, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.

Quercus havardii var. *tuckeri Shrubland*

Tucker Sand Shinnery Oak Shrubland

CODE	CEGL002486
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*QUERCUS HAVARDII VAR. TUCKERI* SHRUBLAND ALLIANCE (A.2654) Tucker Sand Shinnery Oak Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Active and Stabilized Dune (CES304.775)
Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
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 (27 degree) 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. 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 *Coleogyne ramosissima, Ephedra viridis, Gutierrezia sarothrae, Shepherdia rotundifolia*, and *Opuntia polyacantha*. 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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association is rare within the park and recreation area. It was sampled adjacent to the road between Chimney Rock, above Horseshoe Canyon, and the Dollhouse in Canyonlands National Park, and on the road to Horseshoe Canyon in Glen Canyon National Recreation Area.

Globally
This association occurs in southeastern Utah.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association occurs on deep sand deposits and stabilized and active sand dunes on mesatops and along washes. Sites are flat or slope gently (5 degrees), are oriented to the northeast, and lie between 1555 and 1772 m elevation. Bare soil or sand cover most of the unvegetated surface, with lesser cover by litter, gravel, and biological

soil crusts. Soils are rapidly drained sandy loams or loamy sands derived from Entrada sandstone, Cedar Mesa sandstone, alluvium or eolian deposits.

Globally
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 (27-degree) colluvial slopes. Elevations range between 1335 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 Cedar Mesa, Dakota, Entrada or Morrison formation sandstones that have eroded and been distributed to alluvium or eolian deposits.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare shrubland has a total vegetation cover ranging between 16 and 48%. The shrub canopy is dominated by clumps of *Quercus havardii* var. *tuckeri* with between 5 and 44% cover. Associated shrubs include *Vanclevea stylosa, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Poliomintha incana, Shepherdia rotundifolia, Eriogonum microthecum, Eriogonum leptocladon, Ephedra torreyana, Ephedra viridis, Gutierrezia sarothrae, Yucca angustissima*, and *Opuntia erinacea*. The herbaceous layer tends to be sparse and depauperate. Grasses present include *Pleuraphis jamesii, Achnatherum hymenoides, Muhlenbergia pungens, Pleuraphis jamesii, Hesperostipa comata, Sporobolus cryptandrus*, and *Bromus tectorum*. Forbs include *Tetraneuris acaulis, Eriogonum shockleyi, Rumex hymenosepalus, Artemisia campestris, Chenopodium album, Plantago patagonica, Packera multilobata (= Senecio multilobatus), Cordylanthus wrightii, Comandra umbellata*, and *Chenopodium atrovirens*. Biological soil crusts do not exceed 10% cover and tend to be in an early stage of development (mostly mosses and dark cyanobacteria). Scattered *Juniperus osteosperma* and *Pinus edulis* may be present, and *Juniperus osteosperma* seedlings were observed near one stand.

Globally
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 *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Eriogonum microthecum, Ephedra torreyana, Ephedra viridis, Fraxinus anomala, Gutierrezia sarothrae, Shepherdia rotundifolia, Opuntia erinacea, Opuntia polyacantha, Purshia stansburiana, Shepherdia rotundifolia*, 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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Pinus edulis*
Short shrub/sapling	*Quercus havardii* var. *tuckeri*

Globally

Stratum	Species
Short shrub/sapling	*Quercus havardii* var. *tuckeri*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic)

Globally
Vulnerable: *Quercus havardii* var. *tuckeri* (vulnerable, G4T3?Q); **Exotic/Invasive**: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (29-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Slope and aspect do not seem to matter to this community since it inhabits both sides of the wash with varying slopes and opposite aspects. Much of the vegetation at this end of the mesa and inside the plot is extremely stunted, possibly due to poor soils and hot exposures.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY.0455, GLCA.0108) and 2007 Accuracy Assessment (3 points: CANY_AA.0859, CANY_AA.0872, CANY_AA.0900).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.

Fraxinus anomala - Rhus trilobata Talus Shrubland

Singleleaf Ash - Skunkbush Sumac Talus Shrubland

CODE	CEGL003963
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*RHUS TRILOBATA* SHRUBLAND ALLIANCE (A.3569) Skunkbush Sumac Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This shrubland association occurs on steep, rocky colluvial slopes as well as on thin soils near the edges of canyon and mesa rims. Sites are located on gentle to steep (1- to 34-degree) slopes between 1195 and 1536 m elevation, with a strong orientation toward northerly aspects. The unvegetated surface is mostly covered by rocks, gravel,

boulders, bedrock and bare soil, with little litter or dead wood evident. Soils tend to be sandy, with a few stands on silt loams or clay loams derived from sandstone and shale. 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. 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. Biological soil crust formation is rare on these active slopes.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association is widespread in the park and recreation area. Sites sampled include Buck, Millard, Red Lake and Gooseberry canyons, Murphy's Hogback, along the Colorado River at Mile 24, White Rim Road and Rustler Canyon rim, near Neck Spring, and in Soda Springs Basin in Canyonlands National Park and near Ekker Butte and Buttes of the Cross in Glen Canyon National Recreation Area.

Globally
This associations is described from Canyonlands National Park and Glen Canyon National Recreation Area and likely occurs elsewhere in canyons of the Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association occurs on steep, rocky colluvial slopes as well as with thin soils near the edges of canyon and mesa rims. Sites are located on gentle to steep (1- to 34-degree) slopes between 1195 and 1536 m elevation, with a strong orientation toward northerly aspects. The unvegetated surface is mostly covered by rocks, gravel, boulders, bedrock and bare soil, with little litter or dead wood evident. Soils tend to be sandy, with a few stands on silt loams or clay loams derived from Moenkopi shale and Cutler Group, including Cedar Mesa sandstone.

Globally
This shrubland association occurs on steep, rocky colluvial slopes as well as on thin soils near the edges of canyon and mesa rims. Sites are located on gentle to steep (1- to 34-degree) slopes between 1195 and 1536 m elevation, with a strong orientation toward northerly aspects. The unvegetated surface is mostly covered by rocks, gravel, boulders, bedrock and bare soil, with little litter or dead wood evident. Soils tend to be sandy, with a few stands on silt loams or clay loams derived from sandstone and shale.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This mixed shrubland occurs on steep colluvial slopes. Total vegetation cover ranges from 2 to 13%. Characteristic of this association is 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. Biological soil crust formation is rare on these active slopes.

Globally
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. 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. Biological soil crust formation is rare on these active slopes.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Fraxinus anomala*, *Rhus trilobata*
Short shrub/sapling	*Chrysothamnus viscidiflorus*, *Coleogyne ramosissima*, *Eriogonum corymbosum*
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Gutierrezia microcephala*, *Gutierrezia sarothrae*
Herb (field)	*Pleuraphis jamesii*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (10-Jul-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Steep colluvial slopes with small mesic microenvironments on the downslope sides of the large boulders create this community.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (15 plots: CANY 0153, CANY 0183, CANY 0188, CANY.0349, CANY.0404, CANY 0516, CANY 0534, CANY 0547, CANY 0591, CANY 0598, CANY 0708, CANY 0830, GLCA 0119, GLCA 0329, GLCA 0729).
Local Description Authors: J. Coles
Global Description Authors: K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Rhus trilobata - Ephedra (viridis, torreyana) Talus Shrubland

Skunkbush Sumac - (Mormon-tea, Torrey's Joint-fir) Talus Shrubland

CODE	CEGL003776
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*RHUS TRILOBATA* SHRUBLAND ALLIANCE (A.3569) Skunkbush Sumac Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

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- to 35-degrees), 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. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association is widespread in the park and recreation area. Sites sampled include Stillwater Canyon and on Murphy Hogback in Canyonlands National Park, and Deadhorse Canyon, above Anderson Bottom, and on benches in Millard Canyon in Glen Canyon National Recreation Area.

Globally

This association is known from Arches National Park but likely is widespread in the canyonlands of the Colorado Plateau in eastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association occurs on steep, rocky colluvial slopes and bedrock canyon rims associated with mesas, canyons, benches, ravines, hills, and escarpments. Sites are located on level to steep (0- to 35-degree) slopes between 1262 and 1424 m elevation. Rocks, bedrock and bare soil cover most of the unvegetated surface. There is little dead wood, biological soil crust or litter. Soils vary in texture and parent materials; most are sandy or clayey in texture and are derived from Moenkopi shale.

Globally

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- to 35-degree), 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 range from rapidly drained clay loams to sandy loams. Parent materials include shales (Moenkopi, Chinle) and sandstones (Cedar Mountain, Navajo, Wingate). 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparse mixed shrubland occurs on steep colluvial slopes as well as in thin soils near canyon rims. Total vegetation cover ranges from 2 to 10%. 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. 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 and is by no means a codominant. The herbaceous layer may include many species but never provides more than a few percent cover; *Pleuraphis jamesii, Aristida purpurea*, and *Stanleya pinnata* are the most consistent species. Biological soil crust formation is rare on these active slopes.

Globally

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 *Amelanchier utahensis, Artemisia bigelovii, Atriplex confertifolia, Brickellia microphylla, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ericameria nauseosa, Eriogonum corymbosum*, and *Philadelphus microphyllus*. *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, Aristida purpurea, Elymus elymoides, Pleuraphis jamesii, Leymus salinus*, and exotic annual grasses *Bromus rubens* or *Bromus tectorum* are common grasses. Forbs compositions are variable with frequent species including *Artemisia ludoviciana, Chaetopappa ericoides, Cryptantha crassisepala, Stanleya pinnata*, and *Plantago patagonica*. Biological soil crust formation is rare on these active slopes.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Rhus trilobata*
Short shrub/sapling	*Atriplex confertifolia*, *Eriogonum corymbosum*
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Amsonia tomentosa*

Globally

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*, *Rhus trilobata* var. *trilobata*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Exotic/Invasive: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (20-Mar-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Steep colluvial slopes with small mesic microenvironments on the downslope sides of the large boulders create this community.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (6 plots: CANY 0739, CANY 0828, GLCA 0538, GLCA 0539, GLCA 0549, GLCA 0732).
Local Description Authors: J. Coles
Global Description Authors: G. Kittel and K.A. Schulz

REFERENCES: Coles et al. 2009a, Thomas et al. 2009a, Western Ecology Working Group n.d.

Suaeda moquinii Shrubland

Shrubby Seepweed Shrubland

CODE	CEGL001991
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Intermittently flooded cold-deciduous shrubland (III.B.2.N.c.)
ALLIANCE	*SUAEDA MOQUINII* INTERMITTENTLY FLOODED SHRUBLAND ALLIANCE (A.941) Shrubby Seepweed Intermittently Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S):

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

These shrublands occur in desert basins or playas in Nevada, Arizona, and southern and eastern California. 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. 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 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is found at Sheep Bottom, Colorado River, Fort Bottom, Green River, Anderson Bottom, Opposite Little Bridge Canyon, Salt Creek, Buck Canyon, Turk's Head, Potato Bottom, and the mouth of Musselman Canyon.

Globally

This broadly defined shrubland association occurs in saline overflow areas in bottomlands in the 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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association occurs on low level positions including floodplains, stream terraces, alluvial terraces, alluvial fans, point bars and mudflats at elevations ranging from 1166-1453 m (3777-4704 feet). Soils are derived of new alluvium.

Globally

These shrublands occur in desert basins or playas in Nevada, Arizona, and southern and eastern California. 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 derived from alluvium.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is characterized by a sparse to open dwarf-shrub layer dominated by *Suaeda moquinii* which averages about 10% cover. Other characteristic shrubs include *Atriplex canescens, Ericameria nauseosa (= Chrysothamnus nauseosus), Lycium torreyi*, and *Sarcobatus vermiculatus*. *Tamarix chinensis* is constant in all stands sampled and may overtop other shrubs. Herbaceous cover is sparse to nearly absent although *Halogeton glomeratus, Salsola tragus, Distichlis spicata, Machaeranthera canescens*, and *Sporobolus cryptandrus* may be present.

Globally
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 polycarpa, Atriplex canescens, Allenrolfea occidentalis*, or *Sarcobatus vermiculatus*. The sparse herbaceous layer may include the forbs *Bassia hyssopifolia* and *Salicornia maritima (= Salicornia europaea)*. Graminoids are not abundant except for *Distichlis spicata* and occasional *Sporobolus airoides* or *Sporobolus cryptandrus*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Suaeda moquinii*

Globally

Stratum	Species
Short shrub/sapling	*Suaeda moquinii*
Herb (field)	*Distichlis spicata*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (invasive/exotic, High), *Tamarix chinensis* (invasive/exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2008 Accuracy Assessment (25 points: CANY_AA.1013, CANY_AA.1081, CANY_AA.1106, CANY_AA.1108, CANY_AA.1175, CANY_AA.1180, CANY_AA.1181, CANY_AA.1182, CANY_AA.1183, CANY_AA.1185, CANY_AA.1186, CANY_AA.1187, CANY_AA.1189, CANY_AA.1190, CANY_AA.1194, , CANY_AA.1228, CANY_AA.1248, CANY_AA.1249, CANY_AA.1253, CANY_AA.1254, CANY_AA.1255, CANY_AA.1256, CANY_AA.1261, CANY_AA.1262, CANY_AA.2033).
Local Description Authors: M.E. Hall
Global Description Authors: K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Donnelly et al. 2006, Driscoll et al. 1984, Faden 1977, Peterson 2008, Thomas et al. 2009a, Western Ecology Working Group n.d.

Betula occidentalis / Cornus sericea Shrubland

Water Birch / Red-osier Dogwood Shrubland

CODE	CEGL001161
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d.)
ALLIANCE	*BETULA OCCIDENTALIS* TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.967) Water Birch Temporarily Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland (CES304.045)
Rocky Mountain Subalpine-Montane Riparian Shrubland (CES306.832)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This is a wide-ranging but locally limited riparian association found from the Great Basin and central Utah cordillera, north to the Columbia Basin and northern Rocky Mountains, as far south as northern California, and east to Montana, the Black Hills of South Dakota and the Southern Rocky Mountains in Wyoming at elevations ranging from about 610 to 2288 m (2000-7500 feet). It occurs on gently sloping, often undulating, streambanks and terraces of low- to high-gradient perennial or intermittent, spring-fed streams and rivers. Stands sometimes occur within the flood-prone zone, although water tables are typically deep during the growing season. Soils are alluvial and textures are coarse to fine, ranging from loamy skeletal and fine-loamy over sandy-skeletal, to coarse-loamy. *Betula occidentalis*, averaging 5 to 6 m tall, clearly dominates the tall-shrub overstory, usually with over 30% cover. The understory is characterized by an open to dense tall-shrub layer dominated by *Cornus sericea* with 15-90% cover. *Alnus incana, Rosa woodsii*, and tall *Salix* spp., are frequently present with up to 20% cover each. At low elevations in southwestern Idaho and eastern Washington, *Philadelphus lewisii, Symphoricarpos albus*, and/or *Toxicodendron rydbergii* are sometimes present with less than 10% cover each. The cover of the herbaceous layer varies inversely with that of the shrub layer. Consistently present herbaceous species include *Elymus glaucus, Equisetum* spp., *Galium* spp., *Maianthemum stellatum, Poa pratensis*, and *Urtica dioica*, all with low cover.

The type is also known from the Upper Rio Grande watershed in northern New Mexico at elevations around 2400 m (7875 feet) along montane streams with gradients near 1.5%. Soils have been reported as coarse-loamy Aeric Fluvaquents. It is characterized by dense thickets of short deciduous shrubs codominated by *Betula occidentalis* and *Cornus sericea* ssp. *sericea*. A diverse number of shrub species can also be present, including *Acer glabrum, Amelanchier utahensis, Alnus incana* ssp. *tenuifolia, Rosa woodsii, Rubus idaeus* ssp. *strigosus, Rubus parviflorus*, and *Ribes americanum*. Like alders and willows that are common at this elevation, these river birch communities overhang streambanks and can be thicket-forming and quite shrubby. The herbaceous understory is represented by scattered grasses and forbs. The most common native wetland species are *Carex microptera, Carex rostrata, Aconitum columbianum, Argentina anserina, Equisetum laevigatum*, and *Mentha arvensis*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland or short-statured woodland is rare within the park and is represented by one plot located in the center alcove of Neck Spring.

Globally

This is a wide-ranging but locally limited riparian association found from the Great Basin and central Utah cordillera, north to the Columbia Basin and northern Rocky Mountains, as far south as northern California and the Upper Rio Grande watershed in northern New Mexico, and east to Montana, the Black Hills of South Dakota, and the southern Rocky Mountains in Wyoming.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association occurs in cool, sheltered sites in ravines. The one sampled site is on a moderate, north-facing slope at 1738 m elevation. Rocks and boulders cover most of the unvegetated surface, with low cover of bare soil, litter, and dead wood. The soil is a rapidly drained loamy sand derived from Navajo sandstone and alluvium.

Globally

Stands of this association are known from streams at low elevations (4730-6020 feet), on loam or clay soils. In Utah, soils supporting stands of this association classify mainly as Cryoborolls and Haploborolls, with some Cryaquents, Udifluvents, and Xerofluvents.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare water birch shrubland has total vegetation cover of up to 60%. The tall-shrub canopy is dominated by *Betula occidentalis* between 2 and 10 m tall with between 26 and 35% cover. *Pinus edulis* seedlings contribute sparse cover. Short shrubs in the understory provide up to 25% cover and may include *Prunus virginiana, Cornus sericea, Rosa woodsii, Mahonia repens*, and *Rhus trilobata* var. *trilobata (= Rhus aromatica* var. *trilobata)*. The herbaceous layer is sparse because of the dense shade provided by the taller shrubs; *Aquilegia micrantha, Packera multilobata (= Senecio multilobatus)*, and a species of *Carex* were recorded in the sample plot.

Globally

The tall-shrub layer is dominated by *Betula occidentalis*. *Cornus sericea* often codominates the tall-shrub layer with *Betula occidentalis*, but it may be shorter and it may contribute less cover. Scattered *Populus angustifolia* often are present, but the trees contribute little cover (<10%). A number of other shrubs and trees may be present (Evans 1989a, Hansen et al. 1988b, Padgett et al. 1988b, 1989, Youngblood et al. 1985b, Marriott and Faber-Langendoen 2000).

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Betula occidentalis*
Tall shrub/sapling	*Cornus sericea*, *Prunus virginiana*
Short shrub/sapling	*Rosa woodsii*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Vulnerable: *Aquilegia micrantha* (rare/endemic, G5)

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (18-Oct-2002). This association is well-documented and widely distributed, but relatively infrequently encountered throughout its range. It is locally common in eastern Idaho and the mountains of central Utah, but it occurs only in widely scattered locations in Montana and is rare elsewhere. Although there are over 69 documented occurrences, many of these stands are in degraded ecological condition due to a long history of livestock grazing and hydrologic alteration. Exotic species, especially *Poa pratensis*, frequently occur in stands sampled. Most stands also have high constancy and moderate cover of less palatable, livestock-disturbance indicator species, such as *Rosa woodsii* and various weedy forbs. Until more stands in good to excellent ecological condition are documented and protected, this association is ranked G3, rather than G3? (as it was formerly ranked).

CLASSIFICATION COMMENTS

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally
This association was previously described in the northern Rocky Mountains by Youngblood et al. (1985b), Hansen et al. (1988b), and Padgett et al. (1988b, 1989). It is a well-documented type with classification based on plots from 9 stands in Nevada (Manning and Padgett 1995), 9 stands in Utah (Padgett et al. 1989), 3 stands in Washington (Crawford 2001), up to 23 stands in southeastern Idaho (Padgett et al. 1989, Hansen and Hall 2002), 2 stands from southwest Idaho (Jankovsky-Jones et al. 2001), and up to 12 stands in Montana (Hansen et al. 1995, MTNHP 2002a). From stand tables it appears as if up to 11 stands sampled in Montana (Hansen et al. 1995) and 18 stands sampled in southeastern Idaho (Hansen and Hall 2002) were included in a broader *Betula occidentalis* community type. This association is similar to *Betula occidentalis / Philadelphus lewisii - Symphoricarpos albus* Shrubland (CEGL000489) (Crawford 2001). It is distinguished from that type by always having moderate to high cover (15-90%) of *Cornus sericea*, and zero to low cover of both *Philadelphus lewisii* and *Symphoricarpos albus* (less than 10% each). The *Betula occidentalis*/Bench community type described by Manning and Padgett (1995) is not yet incorporated into the National Vegetation Classification and may be an early-seral stage of this association.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: North aspect, deep ravine, and overhanging cliff with seepage make for a cool dark habitat. There is no understory growth, possibly because of light-blocking tree canopy. Floods and erosion have played a role here, but things seem stabilized now.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY 0311).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: D. Faber-Langendoen, mod. C. Murphy

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Crawford 2001, Driscoll et al. 1984, Evans 1989a, Hansen and Hall 2002, Hansen et al. 1988b, Hansen et al. 1995, IDCDC 2005, IDCDC unpubl. data 2002, Jankovsky-Jones et al. 2001, Jones 1992b, Kagan et al. 2004, MTNHP 2002b, MTNHP unpubl. data 2002a, Manning and Padgett 1995, Marriott and Faber-Langendoen 2000, Muldavin et al. 2000a, Padgett et al. 1988b, Padgett et al. 1989, WNHP unpubl. data, WNHP unpubl. data 2002, Western Ecology Working Group n.d., Youngblood and Mauk 1985, Youngblood et al. 1985b

Cornus sericea Rocky Mountain Shrubland

Red-osier Dogwood Rocky Mountain Shrubland

CODE	CEGL001165
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d.)
ALLIANCE	*CORNUS SERICEA* TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.968) Red-osier Dogwood Temporarily Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland (CES304.045)
Rocky Mountain Subalpine-Montane Riparian Shrubland (CES306.832)
Western Great Plains Wooded Draw and Ravine (CES303.680)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This riparian tall shrubland is widespread in the Columbia Basin, the Intermountain Basin, and in the Rocky Mountains, and is discontinuously scattered in sheltered areas of the Colorado Plateau. It often forms continuous, narrow bands along streambanks, benches and bars, as well as in slot canyons. Many stands are located on nearly

level, frequently flooded banks, in burns in steep avalanche chutes, or otherwise experience periodic disturbance. It also can form very dense, small stands with limited disturbance, often at the base of a cliff. Soils are relatively deep, well-drained silty to sandy clay loams derived from alluvium, colluvium or glacial till. Elevations range from 715 to 2700 m (2300-8800 feet), with the lower elevations occurring at the northern end of the range in Montana, the higher elevations in Utah and Colorado. The tall (1-2 m) deciduous shrub canopy is dominated by *Cornus sericea*, generally accompanied by other tall shrubs, including *Prunus virginiana, Ribes aureum, Crataegus douglasii, Acer glabrum, Alnus incana, Salix bebbiana, Salix scouleriana, Cercocarpus ledifolius*, and *Juniperus scopulorum*. Short shrubs have sparse to moderate cover and include *Rosa woodsii, Symphoricarpos* spp., *Paxistima myrsinites, Mahonia repens, Arctostaphylos patula, Ribes cereum*, and the liana *Clematis ligusticifolia*. The understory is diverse and ranges from sparse to dense depending on how closed the tall-shrub layer is. Common forbs include *Thalictrum occidentale, Solidago canadensis, Aralia nudicaulis, Heracleum maximum, Heliomeris multiflora, Erythronium grandiflorum, Equisetum arvense, Maianthemum stellatum, Sanicula marilandica, Angelica arguta*, and *Symphyotrichum laeve (= Aster laevis)*. Graminoids are generally less important but may include significant cover by *Elymus glaucus* or *Calamagrostis canadensis*. The majority of the herbaceous layer may consist of non-native species, including *Cirsium arvense, Dactylis glomerata, Agrostis stolonifera, Poa palustris, Phalaris arundinacea*, and *Phleum pratense*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland is rare within the park and is represented by one plot located at the base of Cabin Spring.

Globally
This is a widespread western riparian shrubland that is documented by plot data in Washington, Oregon, Idaho, Nevada, Utah, Montana, Wyoming and Colorado.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This riparian shrubland occurs on saturated soils below permanent seeps in canyons. The one sampled site is on a steep (36-degree), north-facing slope at 1396 m elevation. Large rocks and litter cover most of the unvegetated surface, with lesser exposure by bare soil, dead wood and bedrock. The soil is a moderately well-drained loamy sand derived from alluvium.

Globally
This tall shrubland association occurs as a narrow stringer adjacent to stream channels, near seeps on moist toeslopes of canyon walls, on narrow benches in ravines, narrow terraces of wider valleys, as well as floodplains. Stands have been documented in the Columbia Basin, the Great Basin, throughout the lower elevations of the Rocky Mountains, and in sheltered riparian areas of the Colorado Plateau. Elevations range from 715 m (3600 feet) near the Canadian border in Montana to 2700 m (8800 feet) in southern Utah and Colorado. Stands may occur on nearly level riparian sites or on steep, wet, rocky slopes or at the base of cliffs. Rocks and litter often cover most of the unvegetated surface. The soils are generally derived from glacial till, alluvium or colluvium and are often sandy loams or clay loams.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare red-osier dogwood shrubland has total vegetation cover between 66 and 90%. The shrub canopy of *Cornus sericea* is 2 to 5 m tall and contributes up to 75% cover. *Rosa woodsii* contributes sparse cover and is the only other shrub present. The herbaceous layer includes typical hanging garden species such as *Carex aurea, Calamagrostis scopulorum, Mimulus eastwoodiae, Aquilegia micrantha, Platanthera zothecina (= Habenaria zothecina), Maianthemum stellatum*, and *Artemisia ludoviciana*. Moss species provide sparse cover.

Globally
This shrubland can be a pure stand of impenetrable *Cornus sericea* or more open with several other shrub species. Typically *Cornus sericea* is the dominant shrub; other shrubs commonly present include *Prunus virginiana, Crataegus douglasii, Acer glabrum, Alnus incana, Ribes aureum, Rosa woodsii, Salix bebbiana, Salix scouleriana, Cercocarpus ledifolius*, and *Juniperus scopulorum*. Short shrubs have sparse to moderate cover and include *Rosa woodsii, Symphoricarpos oreophilus, Symphoricarpos albus, Paxistima myrsinites, Mahonia repens, Arctostaphylos patula*, and *Ribes cereum*. The understory is diverse and ranges from sparse to dense depending on how closed the

tall-shrub layer is. Total vegetation cover is rarely less than 75% and often exceeds 100%. Some stands are dominated by *Heracleum maximum*, others by *Equisetum arvense*, and others by *Maianthemum stellatum* with other forbs, such as *Thalictrum occidentale, Solidago canadensis, Aralia nudicaulis, Heliomeris multiflora, Erythronium grandiflorum, Mimulus eastwoodiae, Aquilegia micrantha, Platanthera zothecina (= Habenaria zothecina)*, and *Artemisia ludoviciana*. *Sanicula marilandica, Angelica arguta*, and *Symphyotrichum laeve (= Aster laevis)*. Graminoids are generally less important but may include significant cover by *Carex aurea, Elymus glaucus, Calamagrostis canadensis*, and *Calamagrostis scopulorum*. The majority of the herbaceous layer may consist of non-native species, including *Cirsium arvense, Dactylis glomerata, Agrostis stolonifera, Poa palustris, Phalaris arundinacea*, and *Phleum pratense*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Cornus sericea*

Globally

Stratum	Species
Tall shrub/sapling	*Cornus sericea*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Vulnerable: *Aquilegia micrantha* (rare/endemic, G5), *Mimulus eastwoodiae* (globally vulnerable, G3G4), *Platanthera zothecina* (globally imperiled endemic, G2)

Globally
Vulnerable: *Arabis crandallii* (globally imperiled, G2G3), *Mimulus eastwoodiae* (rare/endemic, G3G4), *Platanthera zothecina* (globally imperiled, G2); **Exotic/Invasive**: *Agrostis stolonifera* (exotic, Medium/Low), *Cirsium arvense* (exotic, High/Medium), *Dactylis glomerata* (exotic, Medium/Insignificant), *Linaria vulgaris* (exotic, High/Low), *Medicago lupulina* (exotic, Medium/Insignificant), *Phalaris arundinacea* (exotic, High), *Phleum pratense* (exotic, Medium), *Poa pratensis* (exotic, Medium), *Taraxacum officinale* (exotic), *Trifolium pratense* (exotic, Low/Insignificant)

CONSERVATION STATUS RANK
Global Rank & Reasons: G4Q (27-Apr-2000).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This association appears to be a broadly defined type that may be split in the future as more information becomes available. As such it is low-confidence. All references are surprising similar in their acceptance of variability within this type.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Water is constant so there is typical seep community plant behavior. There is thick moss growing throughout the plot. Large, loose boulders are scattered throughout the plot (from pour-off above).
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY 0111).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: G. Kittel, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Carsey et al. 2003a, Clark et al. 2009, Cogan et al. 2005, Coles et al. 2010, Crawford 2001, Crawford 2003, Crowe and Clausnitzer 1997, Crowe et al. 2004, Diaz and Mellen 1996, Driscoll et al. 1984, Hansen et al. 1988b, Hansen et al. 1991, Hansen et al. 1995,

IDCDC 2005, Jankovsky-Jones et al. 2001, Jones 1992b, Jones and Ogle 2000, Kagan et al. 2004, Kittel et al. 1994, Kittel et al. 1999a, Kittel et al. 1999b, Kovalchik 1993, MTNHP 2002b, MacKenzie and Moran 2004, Manning and Padgett 1995, Padgett et al. 1989, Reid et al. 2004, Romme et al. 1993, WNHP unpubl. data, Western Ecology Working Group n.d., Youngblood et al. 1985a

Forestiera pubescens Shrubland

Stretchberry Shrubland

CODE	CEGL001168
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d.)
ALLIANCE (A.969)	*FORESTIERA PUBESCENS* TEMPORARILY FLOODED SHRUBLAND ALLIANCE Stretchberry Temporarily Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This shrubland association is reported from canyon bottoms, floodplains, sandy terraces along major rivers, and washes in southwestern Colorado, northeastern Arizona and southeastern Utah. Elevation ranges from 1340 to 1680 m (4400-5500 feet). Stands typically form a narrow, but continuous, band about 3 m above the channel on streambanks and natural levees at the interface between the riparian zone and drier uplands. They occur on the outer edge of the active floodplain. Soils range from silty clays over clay loam to sandy loam derived from alluvium. This shrubland consists of a dense to open canopy of *Forestiera pubescens*, often with *Atriplex canescens, Ericameria nauseosa*, or *Rhus trilobata*, on the flat benches and floodplains adjacent to and above the river channel. There is often a mix of riparian and upland vegetation in these areas, with *Salix exigua* forming a dense band along the stream edge. This dense riparian shrubland can form a narrow, unfragmented, continuous cover that may alternate creekside to creekside, as part of the natural mosaic of the floodplain for one-tenth of a mile to several miles. *Phragmites australis*, a tall erect grass, or *Sporobolus airoides* often occur among the shrubs, with *Artemisia tridentata, Ericameria nauseosa (= Chrysothamnus nauseosus)*, or pinyon-juniper dominating the adjacent upland vegetation. The dominance or codominance *Forestiera pubescens* in the shrub layer characterizes this association.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This riparian shrubland is distributed along riparian corridors of rivers and streams within the park and was sampled along White Rim Road, on the banks of the Green River, south of Potato Bottom, and on the banks of the Colorado River.

Globally

This association is known from Colorado in the San Miguel/Dolores River Basin.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This riparian tall shrubland occurs in occasionally flooded areas, including canyon bottoms, floodplains, and terraces. Sites are flat to moderately sloped (0- to 16-degree slopes) between 1173 and 1183 m elevation. Litter and dead wood cover most of the unvegetated surface, with low cover of bare soil. Soils are moderately well-drained to rapidly drained sandy loams, silts, loams, or clay loams derived from alluvium.

Globally
This shrubland association is reported from canyon bottoms, floodplains, sandy terraces along major rivers, and washes in southwestern Colorado, northeastern Arizona and southeastern Utah. Elevation ranges from 1340 to 1680 m (4400-5500 feet). Stands typically form a narrow, but continuous, band about 3 m above the channel on streambanks and natural levees at the interface between the riparian zone and drier uplands. They occur on the outer edge of the active floodplain. Soils range from silty clays over clay loam to sandy loam derived from alluvium.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association occupies the outer margins of floodplains and riparian corridors within the park. Total vegetation cover ranges from 63 to 100%. The mixed shrub canopy is dominated by *Forestiera pubescens* 2 to 10 m tall and with between 15 and 100% cover. Associated shrubs include *Salix exigua* with as much as 70% cover, as well as *Tamarix chinensis* and *Rhus trilobata* with sparse cover. Dense shade limits the density and diversity of the herbaceous layer; *Phragmites australis, Bromus tectorum, Descurainia pinnata, Chenopodium album*, and *Stanleya pinnata* were the only species recorded in the sample plots.

Globally
This shrubland consists of a dense to open canopy of *Forestiera pubescens*, often with *Atriplex canescens, Ericameria nauseosa*, or *Rhus trilobata*, on the flat benches and floodplains adjacent to and above the river channel. There is often a mix of riparian and upland vegetation in these areas, with *Salix exigua* mixing or forming a dense band along the stream edge. This dense riparian shrubland can form a narrow, unfragmented, continuous cover that may alternate creekside to creekside, as part of the natural mosaic of the floodplain for one-tenth of a mile to several miles. *Phragmites australis*, a tall erect grass, or *Sporobolus airoides* often occur among the shrubs. Common forbs include *Descurainia pinnata, Chenopodium album*, and *Stanleya pinnata*. The invasive, exotic shrub *Tamarix chinensis* may be present to codominant in some stands. *Artemisia tridentata, Ericameria nauseosa*, or pinyon-juniper often dominate the adjacent upland vegetation. This appears to be a flood-tolerant association which may be excluded from grazing due to the density of shrub cover.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Forestiera pubescens*, *Salix exigua*

Globally

Stratum	Species
Tall shrub/sapling	*Forestiera pubescens*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Descurainia pinnata* (exotic), *Phragmites australis* (exotic, High), *Tamarix chinensis* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G1G2 (30-Nov-1998). The *Forestiera pubescens* riparian shrubland has not been documented outside of a few locations in Colorado. It probably occurs in Utah, Arizona, and New Mexico, although not in any great abundance. Indications of its possible presence are inferred from (1) the Flora of Utah, which lists fourteen collections of *Forestiera pubescens* from sandy terraces along the Colorado and San Juan rivers, and smaller tributaries in Emery, Garfield, Grand, Kane, San Juan, and Wayne counties (Welsh et al. 1987), and (2) Arizona floras that list *Forestiera pubescens* as *Forestiera neomexicana* (a synonym), but do not record the number or location of the collections. Livestock grazing is limited in this plant association due to the dense shrub cover, and *Forestiera pubescens* is not very palatable to livestock.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
More survey and classification work are needed to clarify the concept of this association throughout its range. It may be possible to split into more associations based on understory dominants.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This dense community is influenced by its proximity to the river. High water table and silty soils determine the species composition.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (6 plots: CANY 0145, CANY 0202, CANY 0213, CANY 0505, CANY 0585, CANY 0609).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: L. Tasker, mod. K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Carsey et al. 2003a, Driscoll et al. 1984, Kittel and Lederer 1993, Kittel et al. 1999b, Thomas et al. 2009a, Welsh et al. 1987, Western Ecology Working Group n.d.

Salix exigua / Barren Shrubland

Coyote Willow / Barren Shrubland

CODE	CEGL001200
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d.)
ALLIANCE	*SALIX (EXIGUA, INTERIOR)* TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.947) (Coyote Willow, Sandbar Willow) Temporarily Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): North American Warm Desert Riparian Woodland and Shrubland (CES302.753)
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This riparian shrubland is common in the Rocky Mountains, Colorado Plateau and 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, but an undergrowth of a few, scattered forbs and grasses is usually present. This association occurs within the annual flood zone of rivers on point bars, islands, sand or cobble bars, and streambanks.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This riparian shrubland is distributed along the floodplains of rivers and streams within the park and was sampled in and along the Green River, in Horseshoe Canyon, and along the Colorado River.

Globally
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 out into the western Great Plains along major rivers.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland occurs on intermittently flooded low-lying areas in active floodplains, including canyon bottoms, washes, terraces, river islands, and riverbanks. Sites slope gently (0-5 degrees) between 1155 and 1380 m elevation. Bare soil and litter cover most of the unvegetated surface; large rocks have low cover. Soils are poorly drained to rapidly drained sands, silt loams, clay loams, and loamy sands derived from alluvium.

Globally
This riparian shrubland is common in the Rocky Mountains, Colorado Plateau and Great Basin. Elevation ranges from 780-2600 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This willow shrubland occurs within the active floodplain of rivers and streams and less often in seeps and springs within the park. Total vegetation cover ranges from 52 to 100%. The shrub canopy is typically 1 to 5 m tall and dominated by *Salix exigua*. *Tamarix chinensis* may also be present. Flooding is too frequent to permit the development of a dense herbaceous layer, but species present with low cover include *Bromus tectorum, Elymus canadensis, Spartina pectinata, Juncus balticus, Artemisia ludoviciana, Heterotheca villosa, Salsola tragus*, and *Packera multilobata (= Senecio multilobatus)*.

Globally
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, Ericameria nauseosa, Rhus trilobata, Salix monticola, Salix ligulifolia (= Salix eriocephala* var. *ligulifolia), Salix irrorata, Salix lucida, Abies lasiocarpa, Acer negundo, Populus angustifolia, Populus deltoides, Populus fremontii*, and *Salix gooddingii*. 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.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Salix exigua*, *Tamarix chinensis*

Globally

Stratum	Species
Tall shrub/sapling	*Salix exigua*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic), *Tamarix chinensis* (exotic)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Elaeagnus angustifolia* (exotic, High), *Elymus repens* (exotic, High/Medium), *Lepidium latifolium* (exotic, High), *Melilotus officinalis* (exotic, Medium/Low), *Tamarix chinensis* (exotic), *Taraxacum officinale* (exotic), *Xanthium strumarium* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (15-Jun-2001).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
In the western Great Plains this association includes 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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Seasonal flooding controls the vegetation. Intermittent flooding creates germination conditions for *Salix exigua* and *Tamarix chinensis* seeds.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (6 plots): (Plots: CANY 0200, CANY 0205, CANY 0212, CANY 0588, CANY 0604, CANY 0820).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, 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, Donnelly et al. 2006, Dorn 1997, Driscoll et al. 1984, Durkin et al. 1995b, Hall and Hansen 1997, Hansen et al. 1995, Hansen et al. 2004b, IDCDC 2005, Johnston 1987, Jones and Walford 1995, Kagan et al. 2004, Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1995, Kittel et al. 1996, Kittel et al. 1999a, Kovalchik 1987, Manning and Padgett 1995, Muldavin et al. 2000a, Padgett 1981, Padgett et al. 1988b, Padgett et al. 1989, Peterson 2008, Richard et al. 1996, Romme et al. 1993, Thomas et al. 2009a, Tuhy and Jensen 1982, Von Loh et al. 2002, Western Ecology Working Group n.d.

Salix exigua / Mesic Graminoids Shrubland

Coyote Willow / Mesic Graminoids Shrubland

CODE	CEGL001203
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d.)
ALLIANCE	*SALIX (EXIGUA, INTERIOR)* TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.947) (Coyote Willow, Sandbar Willow) Temporarily Flooded Shrubland Alliance
ECOLOGICAL SYSTEM(S):	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821) Western Great Plains Floodplain (CES303.678) Northwestern Great Plains Canyon (CES303.658)
USFWS WETLAND SYSTEM:	Palustrine

CONCEPT SUMMARY

Globally

This riparian association is found primarily in the central Great Plains but also occurs in parts of the Rocky Mountains and Intermountain semi-desert regions. It generally occurs along backwater channels and other perennially wet but less scoured sites such as floodplain swales and irrigation ditches. 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. Other common shrubs include saplings of *Populus deltoides* or *Salix amygdaloides, 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 exigua* shrubs, with a dense herbaceous layer of at least 30% cover of mesic graminoids.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This riparian shrubland is rare and was sampled in Salt Creek Canyon 3.5 km south-southeast of Peekaboo Springs and 900 m from the Salt Creek Campground.

Globally

This association is found primarily in the central Great Plains, but also parts of the Rocky Mountains and Intermountain Semi-desert regions, ranging from Wyoming west to possibly Idaho, south to Utah, and east to Oklahoma.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland occurs on intermittently flooded stream banks with standing pools of water. Sites slope gently (0-2 degrees) between 1570 and 1640 m elevation. Litter covers most of the unvegetated surface, with lesser cover by sand and water. Soils are somewhat poorly drained to rapidly drained sands or loamy sands derived from alluvium.

Globally

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 sandbars, islands, and shorelines of stream channels and braided rivers in Nebraska (Steinauer and Rolfsmeier 2000). 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare riparian shrubland has 46 to 81% vegetation cover, characterized by 2- to 5-m tall clumps of *Salix exigua*. The graminoid *Juncus balticus* contributes 23 to 40% cover to the understory. *Salix lutea* is sometimes present in the shrub layer with low cover, and *Chrysothamnus viscidiflorus* provides sparse cover. Additional grasses include native species *Pascopyrum smithii, Elymus trachycaulus*, and *Panicum virgatum*, and the non-native grasses *Bromus inermis* and *Bromus tectorum* provide sparse cover. Forbs include the non-native *Melilotus officinalis* and *Lepidium alyssoides*, as well as natives *Comandra umbellata, Artemisia campestris*, and the fern ally *Equisetum laevigatum*. *Clematis ligusticifolia* provides sparse cover. Young *Populus fremontii* trees occur scattered throughout this type.

Globally

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 shrubs may include saplings of *Populus*

deltoides, Salix amygdaloides, Salix bebbiana, Salix eriocephala, Salix geyeriana, Salix lucida ssp. *lasiandra (= Salix lasiandra), Salix lutea, Salix monticola, Salix planifolia, Amorpha fruticosa*, or *Rosa woodsii*. Tall perennial grasses can appear to codominate the stand when *Spartina pectinata, Sorghastrum nutans, Panicum virgatum*, or other tall grasses are present. Mesic graminoids dominate the diverse understory 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*. *Agrostis stolonifera, Bromus inermis, Melilotus* spp., *Poa pratensis*, or *Phleum pratense*, and other introduced forage species may be present to abundant in disturbed stands of this community. Diagnostic features of this association include the nearly pure stands of *Salix exigua* shrubs, with a dense ground layer of at least 30% cover of graminoids.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Salix exigua*, *Salix lutea*
Herb (field)	*Melilotus officinalis*
Herb (field)	*Bromus inermis*, *Juncus balticus*

Globally

Stratum	Species
Tall shrub/sapling	*Salix exigua*
Herb (field)	*Pascopyrum smithii*, *Poa pratensis*, *Schoenoplectus americanus*, *Sorghastrum nutans*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus inermis* (exotic, High/Medium), *Bromus tectorum* (exotic, High), *Melilotus officinalis* (exotic, Medium/Low), *Tragopogon dubius* (exotic, Medium/Low)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (7-Apr-1998).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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 of descriptions from the western part of its range need further review to determine if the type should be split. In addition, western stands may all belong to *Salix exigua sensu stricto*, and Great Plains stands may belong to either *Salix exigua* or *Salix interior* (or 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* Temporarily Flooded Shrubland (CEGL001197), which is more frequently disturbed and lacks many of the more mesic herbaceous species.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: It is likely that this section of Salt Creek has a perennial pool, and it certainly gets intermittently flooded beyond the

banks of the channel; flood debris is piled at the base of cottonwood trees about 2 m (6 feet) above the channel. Plants are all bent downstream from recent floods.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY 0397, CANY 0761).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles

REFERENCES: Bourgeron and Engelking 1994, Butler et al. 2002, CONHP unpubl. data 2003, 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, Hansen et al. 1995, Hoagland 1998c, Hoagland 2000, IDCDC 2005, Jones 1992b, Jones and Walford 1995, Kittel 1994, Kittel and Lederer 1993, Kittel et al. 1996, Kittel et al. 1999a, Lauver et al. 1999, Padgett et al. 1988b, Padgett et al. 1989, Peterson 2008, Romme et al. 1993, Steinauer and Rolfsmeier 2000, Steinauer and Rolfsmeier 2003, Stevens et al. 2007, Von Loh et al. 2007, Walford et al. 2001, Western Ecology Working Group n.d.

Salix lutea / Mesic Graminoids Shrubland

Yellow Willow / Mesic Graminoids Shrubland

CODE	CEGL002073
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d.)
ALLIANCE	*SALIX LUTEA* TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.980) Yellow Willow Temporarily Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S):USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This association occurs in mountain valleys at 1645 to 2585 m (5400-8480 feet) in elevation. It occurs on stream benches, streambanks, moist terraces and occasionally on seeps and meadows. Slopes are gentle (<4 degrees). Stands are dominated by *Salix lutea*. Other tall willows present include *Salix boothii, Salix geyeriana, Salix drummondiana*, and *Salix exigua*. Other shrubs present may include *Lonicera involucrata* and *Ribes lacustre*. Common graminoids include *Agrostis stolonifera, Deschampsia caespitosa, Poa pratensis*, and *Poa palustris*. Other graminoid species include *Carex pellita (= Carex lanuginosa), Carex microptera, Carex nebrascensis, Carex utriculata, Carex aquatilis, Calamagrostis stricta*, and *Juncus balticus*. Forbs are typically present but are less abundant than graminoids. Forb species include *Achillea millefolium, Equisetum arvense, Aconitum columbianum, Geum macrophyllum, Maianthemum stellatum (= Smilacina stellata), Plantago major*, and *Mentha arvensis*.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This riparian shrubland is distributed on floodplains of rivers and streams within the park and was sampled along Squaw Canyon Trail, in Lavender and Elephant canyons, and near the Maze Overlook.

Globally
This association is known from throughout the northern half of Nevada, eastern Idaho, western Wyoming, and Montana.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland occurs on intermittently flooded low-lying areas, including canyon bottoms, washes, and drainages. Sites are nearly flat and lie between 1358 and 1740 m elevation. Litter covers most of the unvegetated surface, with lesser cover by bare soil and sand. Soils are poorly drained to rapidly drained sandy loams and loamy sands derived from alluvium.

Globally
This association occurs in mountain valleys at 1645 to 2585 m (5400-8480 feet) in elevation. It occurs on stream benches, streambanks, moist terraces and occasionally on seeps and meadows. Slopes are gentle (<4 degrees), in narrow to typically broad valleys. Soil textures range from fine clayey to loamy skeletal to sandy. Many stands have high water tables with signs of mottling, although the water table can also be below 100 cm.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This riparian shrubland grows along the rivers and streams within the park. Total vegetation cover ranges from 55 to 97%. The vegetation is characterized by a dense shrub canopy, typically 1 to 10 m tall, of *Salix lutea*. Other shrubs present include *Quercus gambelii, Artemisia tridentata, Ericameria nauseosa, Forestiera pubescens*, and *Rhus trilobata*. The herbaceous layer is diverse but poorly developed and contributes little cover; *Juncus balticus, Phragmites australis, Elymus repens, Eleocharis rostellata, Typha domingensis, Equisetum laevigatum, Equisetum arvense, Comandra umbellata, Apocynum cannabinum, Solidago canadensis*, and *Clematis ligusticifolia* were recorded at the sample sites. Young *Populus fremontii* trees between 5 and 15 m tall provide sparse cover.

Globally
Stands are dominated by *Salix lutea*. Other tall willows present include *Salix boothii, Salix geyeriana, Salix drummondiana*, and *Salix exigua*. Other shrubs present may include *Lonicera involucrata* and *Ribes lacustre*. Higher elevation stands have a shorter shrub component, with species such as *Dasiphora fruticosa* ssp. *floribunda* and *Salix wolfii*. Common graminoids include *Agrostis stolonifera, Deschampsia caespitosa, Poa pratensis*, and *Poa palustris*. Other graminoid species include *Carex pellita (= Carex lanuginosa), Carex microptera, Carex nebrascensis, Carex utriculata, Carex aquatilis, Calamagrostis stricta*, and *Juncus balticus*. Forbs are typically present but are less abundant than graminoids. Forb species include *Achillea millefolium, Equisetum arvense, Aconitum columbianum, Geum macrophyllum, Maianthemum stellatum (= Smilacina stellata), Plantago major*, and *Mentha arvensis*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Populus fremontii*
Tall shrub/sapling	*Quercus gambelii*, *Salix lutea*
Herb (field)	*Apocynum cannabinum*, *Comandra umbellata*
Herb (field)	*Eleocharis rostellata*, *Juncus balticus*, *Phragmites australis*
Herb (field)	*Equisetum arvense*, *Equisetum laevigatum*

Globally

Stratum	Species
Tall shrub/sapling	*Salix lutea*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Agrostis stolonifera* (exotic, Medium/Low), *Elymus repens* (exotic, High/Medium), *Hordeum jubatum* (exotic), *Phragmites australis* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (26-Jul-2004).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Seems likely this type occurs in Utah, but it has not been documented there. *Salix lutea* has been reported to occur with *Salix exigua* in Utah (Padgett et al. 1989). The species *Salix lutea* may have different subtaxa in eastern Montana than western Montana according to Dorn (1995). However, at the current time Kartesz (1999) does not recognize Dorn's work.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This wash is likely subject to flooding during large rain events.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (5 plots: CANY 0220, CANY 0618, CANY 0623, CANY 0785, CANY 0840).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: G. Kittel

REFERENCES: Cogan et al. 2005, Dorn 1995, Hansen et al. 1995, Kartesz 1999, Manning and Padgett 1995, Padgett et al. 1989, Western Ecology Working Group n.d., Youngblood et al. 1985a

Sarcobatus vermiculatus / Sporobolus airoides Shrubland

Greasewood / Alkali Sacaton Shrubland

CODE	CEGL001368
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic deciduous shrubland (III.B.3.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic deciduous shrubland (III.B.3.N.)
FORMATION	Intermittently flooded extremely xeromorphic deciduous subdesert shrubland (III.B.3.N.b.)
ALLIANCE	*SARCOBATUS VERMICULATUS* INTERMITTENTLY FLOODED SHRUBLAND ALLIANCE (A.1046) Greasewood Intermittently Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Greasewood Flat (CES304.780)
Inter-Mountain Basins Wash (CES304.781)
Inter-Mountain Basins Playa (CES304.786)
Central Mixedgrass Prairie (CES303.659)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
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. 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. *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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparse shrubland association is rare within the park and was sampled across the Green River from Potato Bottom, 500 m southwest of the Upheaval Bottom Trailhead, and 100 m west-northwest of Potato Bottom Camp.

Globally
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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparsely vegetated shrubland occurs in low-lying areas, including plains, canyon mouths, and mudflats. Sites are flat and lie at 1179 m elevation. Bare soil covers most of the unvegetated surface, with a little cover of litter. Soils are well-drained to rapidly drained sandy loams, sandy clays, or clay loams derived from alluvium.

Globally
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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare bottomland shrubland type has between 13 and 35% total vegetation cover. It is characterized by a shrub canopy dominated by *Sarcobatus vermiculatus* with 6 to 55% cover, and an understory dominated by *Sporobolus airoides* with 3 to 13% cover. Associated shrubs include scattered individuals of *Suaeda moquinii (= Suaeda torreyana), Ericameria nauseosa, Atriplex canescens, Atriplex confertifolia*, and *Atriplex gardneri*. The herbaceous layer has few species other than *Sporobolus*, but *Lappula occidentalis, Chenopodium* sp., and *Stanleya pinnata* may be present. *Bromus tectorum* may be codominant in degraded stands. Biological soil crusts are absent or poorly developed.

Globally
Sarcobatus vermiculatus dominates the shrub layer with between 10 and 50% cover. Other shrubs present with low cover may include *Atriplex canescens, Atriplex confertifolia, Allenrolfea occidentalis, Chrysothamnus viscidiflorus, Ericameria nauseosa, Suaeda moquinii (= Suaeda torreyana), Artemisia tridentata* ssp. *wyomingensis*, and *Artemisia tridentata* ssp. *tridentata*. The herbaceous understory contains and 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*, and *Distichlis spicata*. Forbs generally contribute little cover, although several weedy or exotic forbs may be abundant.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*, *Sarcobatus vermiculatus*
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Sporobolus airoides*

Globally

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus*
Herb (field)	*Sporobolus airoides*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

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.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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 Herbaceous Vegetation (CEGL001508), and this type may also be similar to *Sarcobatus vermiculatus / Distichlis spicata* 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 Herbaceous Vegetation (CEGL002146).

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Species present indicate a higher water table than neighboring areas. Water probably collects in this flat plain from runoff from talus slopes to the east.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY 0204, CANY 0370, CANY 0656).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: G.P. Jones, mod. J. Coles and K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Driscoll et al. 1984, Jones 1992b, Kagan et al. 2004, Romme et al. 1993, Shaw et al. 1989, Terwilliger et al. 1979a, Terwilliger et al. 1979b, Warren n.d., Western Ecology Working Group n.d.

Sarcobatus vermiculatus / Suaeda moquinii Shrubland

Greasewood / Shrubby Seepweed Shrubland

CODE	CEGL001370
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic deciduous shrubland (III.B.3.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic deciduous shrubland (III.B.3.N.)
FORMATION	Intermittently flooded extremely xeromorphic deciduous subdesert shrubland (III.B.3.N.b.)
ALLIANCE	*SARCOBATUS VERMICULATUS* INTERMITTENTLY FLOODED SHRUBLAND ALLIANCE (A.1046) Greasewood Intermittently Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Greasewood Flat (CES304.780)
Inter-Mountain Basins Wash (CES304.781)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This shrubland association is reported from the Colorado Plateau and Columbia Basin. Sites are generally flat to gently sloping saline valley bottoms and toeslopes, river floodplains and playas at elevations ranging from 1620 to 1680 m (5315-5500 feet). Soils are deep, saline, alkaline clay loams. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association is rare within the park and was sampled across on Anderson Bottom and Upheaval Bottom along the Green River.

Globally

This association is reported from the Colorado Plateau into western Colorado and northern Arizona, and the Columbia Basin in eastern Oregon.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland occurs on riverine terraces and floodplains. Sites are flat and lie between 1186 and 1200 m elevation. Bare soil and litter covers most of the unvegetated surface. Soils are well-drained to rapidly drained sandy loams, sandy clays, or clay loams derived from alluvium. Biological soil crusts have up to 20% cover.

Globally

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 1620 to 1680 m (5315-5500 feet). Soils are deep, saline, alkaline clay loams.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare bottomland shrubland type has between 26 and 79% total vegetation cover. It is characterized by a shrub canopy codominated by *Sarcobatus vermiculatus,* with 5 to 15% cover, and *Suaeda moquinii (= Suaeda torreyana),* with 8 to 28% cover. Several sites documented emergent *Populus fremontii* and *Tamarix chinensis* with low to moderate cover, where they were invading from neighboring stands. Associated shrubs include scattered individuals of *Forestiera pubescens* and *Atriplex canescens.* The herbaceous tends to be weedy and may include low to moderate cover of *Centaurea repens, Salsola tragus, Bromus tectorum,* and *Elymus repens*. Biological soil crusts are absent or poorly developed.

Globally
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. Common species include *Distichlis spicata* and *Sporobolus cryptandrus.*

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus*
Short shrub/sapling	*Suaeda moquinii*
Herb (field)	*Bromus tectorum*
Herb (field)	*Salsola tragus*

Globally

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus*
Short shrub/sapling	*Suaeda moquinii*
Herb (field)	*Sporobolus cryptandrus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Centaurea repens* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Compare this association with *Sarcobatus vermiculatus / Distichlis spicata - (Puccinellia nuttalliana)* Shrub Herbaceous Vegetation (CEGL002146).

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Good early biocrust development under shrubs. Soil surface cracked and eroded between shrubs.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2008 Accuracy Assessment (4 points: CANY_AA.1085, CANY_AA.1086, CANY_AA.1111, CANY_AA.1128).
Local Description Authors: A. Tendick
Global Description Authors: K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Branson and Owen 1970, CONHP unpubl. data 2003, Donnelly et al. 2006, Driscoll et al. 1984, Kagan et al. 2004, Peterson 2008, andWestern Ecology Working Group n.d.

Sarcobatus vermiculatus Disturbed Shrubland

Greasewood Disturbed Shrubland

CODE	CEGL001357
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic deciduous shrubland (III.B.3.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic deciduous shrubland (III.B.3.N.)
FORMATION	Intermittently flooded extremely xeromorphic deciduous subdesert shrubland (III.B.3.N.b.)
ALLIANCE	*SARCOBATUS VERMICULATUS* INTERMITTENTLY FLOODED SHRUBLAND ALLIANCE (A.1046) Greasewood Intermittently Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Greasewood Flat (CES304.780)
Inter-Mountain Basins Wash (CES304.781)
Inter-Mountain Basins Playa (CES304.786)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

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. Black greasewood will increase in density at the expense of grasses such as *Sporobolus airoides* under conditions of heavy grazing, since the shrub is only moderately palatable and is somewhat poisonous to livestock. Soil textures in these communities range from sandy loam to silty clay and may have a white salt crust on the soil surface. *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* 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland association is rare within the park and was sampled approximately 100 m east of the parking area for the Zeus and Moses Trail, 0.75 km east of Tower Ruin, and adjacent to the Fort Bottom Trail.

Globally

This association is likely to be widespread on floodplains and valley floors throughout the interior western United States. It is currently documented from the Colorado Plateau, Great Basin, Uinta Basin and San Luis Valley from northwestern New Mexico, southern and western Colorado, Utah, Nevada, and eastern California.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland occurs in low-lying areas, including floodplain, canyon bottom, and stream terrace. Sampled sites are flat to gently sloping (0- to 2-degree slopes) between 1180 and 1545 m elevation. Most of the unvegetated surface consists of bare soil and litter. Biological soil crusts have up to 20% cover and are well-developed in areas lacking recent grazing. Soils are rapidly drained sandy loams or loamy sands derived from alluvium.

Globally

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 1200 and 2308 m (3940-7570 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 25%) cover . Bare ground values tend to be high, up to 80%, unless *Bromus tectorum* is a major component of the system, in which case litter cover values are high.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This bottomland black greasewood shrubland has a total vegetation cover of 6 to 57%. The canopy is overwhelmingly dominated by *Sarcobatus vermiculatus*. Other shrubs present, rarely with more than trace cover, may include *Suaeda moquinii (= Suaeda torreyana), Ericameria nauseosa, Atriplex canescens, Krascheninnikovia lanata*, and *Opuntia polyacantha*. No herbaceous species provides more than 1% cover except for the forb *Iva axillaris*. Associated grasses include sparse cover by *Sporobolus cryptandrus, Pleuraphis jamesii*, and *Sporobolus airoides*. Forbs tend to be weedy and generally dominate the understory; *Salsola tragus, Chenopodium album, Cryptantha crassisepala*, and *Lappula occidentalis* are commonly present. The invasive shrub *Tamarix chinensis* occurs outside of one sampled plot.

Globally

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, 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. The dominant herbaceous 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.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus*
Short shrub/sapling	*Suaeda moquinii*
Herb (field)	*Iva axillaris*
Herb (field)	*Sporobolus airoides*

Globally

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Chenopodium album* (exotic), *Salsola tragus* (exotic)

Globally

Exotic/Invasive: *Alyssum desertorum* (exotic), *Bromus tectorum* (exotic, High), *Descurainia pinnata* (weedy native), *Erodium cicutarium* (exotic, Medium/Low), *Halogeton glomeratus* (exotic, High/Medium), *Salsola tragus* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION COMMENTS

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) 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.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY 0144, CANY 0633, CANY 0707).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

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, Dastrup 1963, 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, Shantz and Piemeisel 1940, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d., Young et al. 1986

Krascheninnikovia lanata / Hesperostipa comata Dwarf-shrubland

Winterfat / Needle-and-Thread Dwarf-shrubland

Winter-fat / Needle-and-Thread Dwarf-shrub Prairie

CODE	CEGL001327
PHYSIOGNOMIC CLASS	Dwarf-shrubland (IV)
PHYSIOGNOMIC SUBCLASS	Evergreen dwarf-shrubland (IV.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.N.)
FORMATION	Extremely xeromorphic evergreen subdesert dwarf-shrubland (IV.A.2.N.a.)
ALLIANCE	*KRASCHENINNIKOVIA LANATA* DWARF-SHRUBLAND ALLIANCE (A.1104) Winterfat Dwarf-shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This association is known from the Colorado Plateau in northwestern Colorado and eastern and southeastern 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 elevation and a canyon bottom at 1780 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. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This dwarf-shrubland was sampled in the environs 1 km south of the southern entrance to Canyonlands National Park, on Murphy Hogback, in Ernie's Country, near Range Canyon, and southwest of Bobby Jo Camp in the Grabens.

Globally
This association is known from the Colorado Plateau in northwestern Colorado and eastern and southeastern Utah. It has also been reported from northeastern Montana (DeVelice et al. 1991), Utah and Washington, and may occur in Saskatchewan, Canada.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This dwarf-shrubland was sampled in a canyon bottom, on alluvial valley floors, aeolian sandsheets, on mesas, terraces, and rolling hills, on flat to moderately sloping sites (up to 7 degrees slope), oriented from the northeast to the south, and occurring between 1479 and 1780 m elevation. Exposed soil or litter cover most of the unvegetated surface, with lesser cover by biological soil crusts, sand or small rocks. Biological soil crusts have up to 32% cover. The soils are mostly rapidly drained silty clay loams.

Globally
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 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.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association has a total vegetation cover of between 9 and 39%. Stands are characterized by a sparse shrub canopy dominated by *Krascheninnikovia lanata* (with 2 to 12% cover) and an herbaceous understory dominated by *Hesperostipa comata* (1-6% cover) or *Achnatherum hymenoides* (up to 14% cover), and in a few cases may be dominated by *Pleuraphis jamesii* (with up to 12%), but *Hesperostipa comata* is always present. Associated shrubs include *Coleogyne ramosissima, Atriplex canescens, Opuntia* spp., and *Ephedra* spp. Additional graminoids include *Bouteloua gracilis, Sporobolus cryptandrus,* and *Bromus tectorum* (with up to 10% cover). Forbs include *Oenothera albicaulis, Machaeranthera canescens, Salsola tragus* (with up to 7% cover), *Plantago patagonica, Chaenactis stevioides, Sphaeralcea coccinea*, and *Delphinium andersonii*. Biological soil crusts are generally in an early stage of development and contribute low to moderate cover.

Globally
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.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Krascheninnikovia lanata*
Herb (field)	*Achnatherum hymenoides*, *Hesperostipa comata*, *Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Krascheninnikovia lanata*
Herb (field)	*Hesperostipa comata*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Exotic/Invasive: *Bromus japonicus* (invasive exotic), *Bromus tectorum* (invasive exotic, High), *Melilotus officinalis* (invasive exotic, 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.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This associations 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 the 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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The continuum described in the plot representiveness section may be along a moisture gradient, where *Hesperostipa comata* performs better in drier upland areas and *Krascheninnikovia lanata* increases in lower, more mesic areas. This gradient may affect how these species interact, where moisture availability increases the competitive ability of *Krascheninnikovia lanata* over *Hesperostipa comata*.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0575) and 2007 and 2008 Accuracy Assessment (7 points: CANY_AA.0112, CANY_AA.2828, CANY_AA.2905, CANY_AA.4047, CANY_AA.4412, CANY_AA.4425, CANY_AA.4437).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Coles et al. 2008a, DeVelice et al. 1991, DeVelice et al. 1995, Driscoll et al. 1984, MTNHP 2002b, Western Ecology Working Group n.d.

Kraschenninnikovia lanata / Pleuraphis jamesii Dwarf-shrubland

Winterfat / James' Galleta Dwarf-shrubland

CODE	CEGL001322
PHYSIOGNOMIC CLASS	Dwarf-shrubland (IV)
PHYSIOGNOMIC SUBCLASS	Evergreen dwarf-shrubland (IV.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.N.)
FORMATION	Extremely xeromorphic evergreen subdesert dwarf-shrubland (IV.A.2.N.a.)
ALLIANCE	*KRASCHENINNIKOVIA LANATA* DWARF-SHRUBLAND ALLIANCE (A.1104) Winterfat Dwarf-shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This minor dwarf-shrubland association is reported from throughout the Colorado Plateau. 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%). 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, Helianthus petiolaris, Machaeranthera pinnatifida*, and *Sphaeralcea* spp. Exotic annuals may include *Bromus tectorum, Salsola kali*, and *Sisymbrium altissimum*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This dwarf-shrubland is moderately common on deep soils within the park and recreation area. Areas sampled in Canyonlands National Park included Shot Canyon, along the road to the Dollhouse, near Horseshoe Arch, 1.25 km northwest of Devil's Loop Trail, on Butler Flat, 2 km from the south entrance to the park, near the head of Horse Canyon, Chesler Park, and Davis Canyon. This association was also sampled in Glen Canyon National Recreation Area in Calf Canyon and near Teapot Rock Campsite.

Globally

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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This dwarf-shrubland occurs on the deep soils of valley floors, plains, canyon bottoms, flats, benches, alluvial fans, and stabilized sand dunes. Sites are on flat to moderate slopes on any aspect between 1429 and 1748 m elevation. Exposed soil covers most of the unvegetated surface, with sparse to low cover of litter. Biological soil crust cover varies from low to high cover depending on the substrate and degree of disturbance. Soils are rapidly drained loamy sands, sandy loams, silty clays, sandy clay loams, or silt loams derived from alluvium.

Globally

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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This dwarf-shrubland is restricted to deep soils within the park and recreation area, where it is moderately common. Total vegetation cover ranges from 5 to 28%. Stands are characterized by a shrub canopy dominated by *Krascheninnikovia lanata* with between 2 and 12% cover. *Pleuraphis jamesii* dominates the herbaceous layer with between 1 and 12%. Associated shrubs include *Atriplex canescens, Ephedra viridis, Ephedra torreyana*, and *Opuntia polyacantha*. Additional graminoids include *Achnatherum hymenoides, Sporobolus cryptandrus*, and *Hesperostipa comata* with sparse cover. Forbs present include *Sphaeralcea coccinea, Salsola tragus, Plantago patagonica, Chenopodium album*, and *Gaillardia pinnatifida*. Some plots have no biological soil crust cover, others have as much as 67% cover of crusts in an early stage of development.

Globally

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)*, and *Sporobolus airoides*. Scattered perennial forbs may be present, such as *Chaetopappa ericoides, Helianthus petiolaris, Machaeranthera pinnatifida, Oenothera pallida, Sphaeralcea coccinea*, and *Sphaeralcea parvifolia*. Exotic annuals may include *Bromus tectorum, Salsola kali*, and *Sisymbrium altissimum*.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Krascheninnikovia lanata*
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Opuntia erinacea*
Herb (field)	*Achnatherum hymenoides*, *Pleuraphis jamesii*, *Sporobolus cryptandrus*

Globally

Stratum	Species
Short shrub/sapling	*Gutierrezia sarothrae*, *Krascheninnikovia lanata*
Herb (field)	*Bromus tectorum*, *Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Salsola tragus* (exotic)

Globally

Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola kali* (exotic), *Sisymbrium altissimum* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G4 (23-Feb-1994).

CLASSIFICATION COMMENTS

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally
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* (winter-fat) 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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Grazing has an effect on the community because no biological soil crusts remain. The ground is exposed, hot, and dry. The site is subject to wind erosion and erosion from runoff.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: **Plots and Observation Points**: The description is based on 2004 field data (12 plots): (Plots: CANY 0257, CANY 0450, CANY 0546, CANY 0555, CANY 0566, CANY 0570, CANY 0643, CANY 0665, CANY 0772, CANY 0802, GLCA 0576, GLCA 0763).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles

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. 2007, Western Ecology Working Group n.d.

Krascheninnikovia lanata Dwarf-shrubland

Winterfat Dwarf-shrubland

CODE	CEGL001320
PHYSIOGNOMIC CLASS	Dwarf-shrubland (IV)
PHYSIOGNOMIC SUBCLASS	Evergreen dwarf-shrubland (IV.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.N.)
FORMATION	Extremely xeromorphic evergreen subdesert dwarf-shrubland (IV.A.2.N.a.)
ALLIANCE	*KRASCHENINNIKOVIA LANATA* DWARF-SHRUBLAND ALLIANCE (A.1104) Winterfat Dwarf-shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This association is known from Colorado Plateau west into to the Great Basin and northern Mojave Desert and east into the northern panhandle of Texas and is likely to be more widespread in similar habitats in the southwestern Great Plains. 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 flat to steep (up to 22 degree 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 on low to high levels of soil salinity and alkalinity. 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*, 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This dwarf-shrubland occurs on deep soils within the park. It is represented by plots sampled in Cow Canyon, near Bobby's Hole, 2 km northeast of Tower Ruin parking area, and in Davis Canyon.

Globally
This association is known from the Colorado Plateau west into the Great Basin and northern Mojave Desert.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This dwarf-shrubland occurs on deep soils of valley floors, grabens, canyon bottoms, and canyon sides. Sites are on gentle to steep slopes between 1559 and 1846 m elevation. Exposed soil covers most of the unvegetated surface with sparse to moderate cover by litter and biological soil crusts. Soils are rapidly drained loamy sands, sandy loams, or silt loams derived from alluvial or eolian deposits.

Globally
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 22 degree 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 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 on 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This winterfat dwarf-shrubland is uncommon on deep soils within the park. Total vegetation cover ranges from 11 to 27%. Stands are characterized by an open canopy of *Krascheninnikovia lanata* with between 7 and 21% cover. Associated shrubs include *Atriplex canescens* and *Opuntia erinacea* that provide sparse cover. The herbaceous layer is moderately diverse but provides little cover or is dominated by exotic species. *Hesperostipa comata* and *Achnatherum hymenoides* occur in most stands with sparse cover, and the non-native annual grass *Bromus tectorum* may have moderate cover. Forbs include *Sphaeralcea coccinea, Machaeranthera tanacetifolia, Sphaeralcea parvifolia, Gaillardia pinnatifida, Salsola tragus, Chenopodium album*, and *Plantago patagonica*. Biological soil crusts are in an early stage of development.

Globally
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 grass *Achnatherum hymenoides*. Forbs commonly present include *Eriogonum* spp., *Opuntia polyacantha, Oenothera pallida, Plantago patagonica*, 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*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Krascheninnikovia lanata*
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Opuntia erinacea*
Herb (field)	*Achnatherum hymenoides*, *Hesperostipa comata*

Globally

Stratum	Species
Short shrub/sapling	*Krascheninnikovia lanata*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Chorispora tenella* (exotic, Insignificant), *Salsola tragus* (exotic)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: G5? (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: *Bromus tectorum* has thoroughly invaded this area. There is no evidence of surficial erosion, except for the typical horizontal trailing or terracing often found on such steep dirt hillsides.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (5 plots: CANY 0199, CANY 0407, CANY 0631, CANY 0798, CANY 0803).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz and J. Drake

REFERENCES: Bourgeron and Engelking 1994, Clark et al. 2009, Coles et al. 2009a, Driscoll et al. 1984, Faden 1977, Mitchell et al. 1966, Peterson 2008, Romme et al. 1993, Thomas et al. 2009a, Western Ecology Working Group n.d.

Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland

Gardner's Saltbush / James' Galleta Dwarf-shrubland

CODE	CEGL001441
PHYSIOGNOMIC CLASS	Dwarf-shrubland (IV)
PHYSIOGNOMIC SUBCLASS	Evergreen dwarf-shrubland (IV.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.N.)
FORMATION	Facultatively deciduous subdesert dwarf-shrubland (IV.A.2.N.b.)
ALLIANCE	*ATRIPLEX GARDNERI* DWARF-SHRUBLAND ALLIANCE (A.1110) Gardner's Saltbush Dwarf-shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783)
Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

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 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This dwarf-shrub association is rare within the park and recreation area. It was sampled 3 km southeast of Taylor Camp, in Taylor Canyon, and in Upheaval Canyon in Canyonlands National Park and 8 km south of Millard Canyon Campground in Glen Canyon National Recreation Area.

Globally

This association is known from the Colorado Plateau of eastern Utah, including the Grand Valley and the Four Corners area of western Colorado.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This dwarf-shrubland occurs on colluvial slopes and drainages near canyon rims. Sites are moderately to steeply sloped (up to 30 degrees), oriented to the east and northeast, and lie between 1226 and 1452 m elevation. Rocks and gravel cover most of the unvegetated surface. Soils are rapidly drained sandy loams or sandy clay loams derived from Moenkopi Formation.

Globally

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 (6-33 degrees). 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This alkaline dwarf-shrubland was rarely encountered during sampling within the park. Total vegetation cover is between 3% and 7% in these sparsely vegetated stands, which are dominated by the dwarf-shrub *Atriplex gardneri* and the perennial short bunchgrass *Pleuraphis jamesii*. A diversity of other species may be present, but none has more than a trace cover; they include *Atriplex confertifolia, Ephedra torreyana, Ericameria nauseosa, Xylorhiza tortifolia, Chrysothamnus viscidiflorus, Rhus aromatica* var. *trilobata, Gutierrezia sarothrae, Yucca angustissima,*

Tiquilia latior, Achnatherum hymenoides, Sphaeralcea leptophylla, Plantago patagonica, Astragalus mollissimus, Eriogonum inflatum, and *Oenothera caespitosa*.

Globally
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 *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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Atriplex gardneri*, *Xylorhiza tortifolia*
Herb (field)	*Bromus tectorum*, *Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex gardneri*
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Vulnerable: *Sclerocactus whipplei* (globally imperiled, G1G3); **Exotic/Invasive**: *Ceratocephala testiculata* (exotic), *Malcolmia africana* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: G3G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Wind and rain have washed the area leaving a rock and pebble surface. Shallow erosion gullies cross the slope, exposing lighter clay subsoil.

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (4 plots: CANY.0136, CANY.0178, CANY.9005, GLCA.0115).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Clark et al. 2009, Coles et al. 2009a, Driscoll et al. 1984, Ibrahim et al. 1972, Romme et al. 1993, Singh and West 1971, U.S. Bureau of Reclamation 1976, Utah Environmental and Agricultural Consultants 1973, Von Loh et al. 2007, West and Ibrahim 1968, Western Ecology Working Group n.d.

Atriplex gardneri Dwarf-shrubland

Gardner's Saltbush Dwarf-shrubland

CODE	CEGL001438
PHYSIOGNOMIC CLASS	Dwarf-shrubland (IV)
PHYSIOGNOMIC SUBCLASS	Evergreen dwarf-shrubland (IV.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.N.)
FORMATION	Facultatively deciduous subdesert dwarf-shrubland (IV.A.2.N.b.)
ALLIANCE	*ATRIPLEX GARDNERI* DWARF-SHRUBLAND ALLIANCE (A.1110) Gardner's Saltbush Dwarf-shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783)
Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This dwarf-shrubland association is reported from northern and eastern Utah, western Colorado, Wyoming and Montana. Sites are flat to steep (58%). Soils are calcareous, alkaline, and typically saline and fine-textured. One site has a gravelly/cobbly substrate. Total vegetation cover is generally sparse, rarely exceeding 15%. The vegetation is composed solely of or dominated by *Atriplex gardneri* without an herbaceous layer. Associated shrubs may include minor cover of *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. The dominance of *Atriplex gardneri* and the lack of a significant herbaceous layer are diagnostic of this association.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This common dwarf-shrubland type occurs on alkaline and saline soils throughout the park and recreation area. Areas sampled included 1.5 miles west of Taylor Camp, Lathrop Canyon, west of the Syncline Campground, above Upheaval Canyon, near Fort Bottom Overlook Trailhead, along Holeman Spring Basin, along the Syncline Loop Trail, Upheaval Dome, along the Green River, and along the Fort Bottom Trail in Canyonlands National Park and near the Buttes of the Cross, on Anderson Bottom, and Millard Canyon in Glen Canyon National Recreation Area.

Globally
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.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This dwarf-shrubland association occurs on saline or alkaline sites of canyon sides, colluvial slopes, ridges, badlands, mesas, and benches. The sampled plots are on flat to steep (0- to 37-degree) slopes, include all aspects, and occur between 1196 and 1510 m elevation. Bare soil covers most of the unvegetated surface. Soils are rapidly drained loamy sands, clays or loams derived from Chinle Formation, Moenkopi Formation, or colluvium.

Globally
This dwarf-shrubland association is reported from northern and eastern Utah, western Colorado, Wyoming and Montana. Elevation ranges from 1196-2101 m. Climate is temperate and semi-arid. In Utah stands occur in Curlew Valley, a dry Pleistocene lakebed north of the Great Salt Lake, and alluvial fans and hillsides along the Green River and slopes of badland ridges and canyonsides, colluvial slopes, ridges, hills, badlands, mesas, and benches along the Colorado River. Sites are flat to steep (30 degrees). Soils are calcareous, alkaline, and typically saline and fine-textured, often derived from alluvium or shale from Chinle, Moenkopi, Mancos, Morrison, and Wasatch formations. One site has a gravelly/cobbly substrate. Bare soil covers much of the unvegetated surface.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This saltbush dwarf-shrubland grows on alkaline to saline soils within the park and recreation area. Total vegetation cover rarely exceeds 5% and is characterized by scattered *Atriplex gardneri* shrubs. Other shrubs may be present, rarely with more than 1% cover, and include *Ephedra torreyana, Atriplex confertifolia, Eriogonum corymbosum*, and *Gutierrezia sarothrae*. The herbaceous layer is either sparse or consists of exotic annual weedy species; *Pleuraphis jamesii, Bromus tectorum, Aristida purpurea, Achnatherum hymenoides, Stanleya pinnata, Tiquilia latior, Eriogonum inflatum, Stenotus acaulis (= Haplopappus acaulis), Plantago patagonica*, and *Sphaeralcea leptophylla* were all reported from sampled plots. Biological soil crusts 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.

Globally
This association is broadly defined as a dwarf-shrubland composed solely of or dominated by *Atriplex gardneri* 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 scattered *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 such as *Achnatherum hymenoides, Pleuraphis jamesii (= Hilaria jamesii)*, and *Elymus elymoides* or occasional *Eriogonum inflatum* 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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Atriplex gardneri*
Herb (field)	*Bromus tectorum*, *Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex gardneri*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Exotic/Invasive: *Agropyron cristatum* (invasive, Medium/Low), *Bromus tectorum* (invasive, High), *Ceratocephala testiculata* (invasive), *Halogeton glomeratus* (invasive, High/Medium), *Malcolmia africana* (invasive)

CONSERVATION STATUS RANK
Global Rank & Reasons: G3G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This association is 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 over-grazing by livestock. More classification work is needed to further define this association.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Plants are controlled by soils and slope exposure. The soils shed water rapidly. Most of the plants appear stressed and much dead growth is evident.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (23 plots: CANY 0139, CANY 0158, CANY 0174, CANY 0175, CANY 0176, CANY 0177, CANY 0501, CANY 0503, CANY 0510, CANY 0518, CANY 0519, CANY 0653, CANY 0705, CANY 9010, CANY 9011, CANY 9028, CANY 9309, CANY 9310, CANY 9502, CANY 9702, GLCA 0319, GLCA 0550, GLCA 0730).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles

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, Gates et al. 1956, Johnston 1987, MTNHP 2002b, MTNHP unpubl. data, Mitchell et al. 1966, Romme et al. 1993, Von Loh 2000, Western Ecology Working Group n.d.

Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii Dwarf-shrubland

Broom Snakeweed - (Prickly-pear species) / James' Galleta Dwarf-shrubland

CODE	CEGL002690
PHYSIOGNOMIC CLASS	Dwarf-shrubland (IV)
PHYSIOGNOMIC SUBCLASS	Deciduous dwarf-shrubland (IV.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous dwarf-shrubland (IV.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous dwarf-shrubland (IV.B.2.N.)
FORMATION	Cespitose cold-deciduous dwarf-shrubland (IV.B.2.N.a.)
ALLIANCE	*GUTIERREZIA (MICROCEPHALA, SAROTHRAE)* DWARF-SHRUBLAND ALLIANCE (A.2528) (Broom Snakeweed, Threadleaf Snakeweed) Dwarf-shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This dwarf-shrubland is described from Utah and northern Arizona where it occurs 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. This broadly defined 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 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*. Introduced species such as *Bromus tectorum* or *Salsola kali* may dominate the herbaceous layer of some disturbed stands.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association was sampled along the road to Davis Canyon 3 km outside the park boundary, in Taylor Canyon, Squaw Flat, near the Needles Entrance and Visitor Center, in Salt Creek Pocket, north and east of Butler Wash, near Woodenshoe Arch, and in the Land of Standing Rocks.

Globally

This association is described from Utah and northern Arizona, but is likely more widespread throughout the semi-arid western U.S.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This disturbed dwarf-shrubland occurs on flat to gently sloping valley floors and terraces (up to 8 degrees slope) at all aspects and lies between 1226 and 1725 m elevation. Most of the unvegetated surface is bare soil, sand or biological soil crusts, with lesser cover by litter and small rocks. The soil is a rapidly drained sandy loam derived from alluvium. Biological soil crusts can have up to 33% cover.

Globally

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.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This degraded dwarf-shrubland has total vegetation cover between 3 and 32% and is characterized by a sparse dwarf-shrub canopy of *Gutierrezia sarothrae* (with 2 to 20% cover) with or without *Opuntia erinacea*, and understory with *Pleuraphis jamesii* present to abundant (trace to 6% cover) but not always the dominant graminoid species. Other common to dominant graminoid species include *Achnatherum hymenoides* (up to 6% cover) and *Bouteloua gracilis* (up to 3% cover). Other shrubs present may include *Atriplex canescens, Atriplex confertifolia, Coleogyne ramosissima, Chrysothamnus viscidiflorus, Ephedra torreyana, Ephedra viridis* (up to 7% cover in one plot), *Krascheninnikovia lanata, Artemisia bigelovii, Eriogonum leptocladon* with sparse cover. Associated graminoid species include *Sporobolus cryptandrus, Sporobolus airoides, Sporobolus contractus,* and *Aristida purpurea* and forb species include *Lepidium montanum, Salsola tragus* (up to 9% cover), and *Plantago patagonica* (up to 8% cover). Scattered individuals of *Juniperus osteosperma* (up to 5% cover), with sparse cover, occur in some stands.

Globally

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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Gutierrezia sarothrae*, *Opuntia erinacea*
Herb (field)	*Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Gutierrezia sarothrae*
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (26-Jul-2001).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Plot is in a site with deep, fine soils on a broad valley floor that had been influenced by grazing (lots of dung and tracks). The high cover by *Gutierrezia sarothrae* may result from these impacts.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY.0805, CANY.9307, CANY.9380) and 2008 Accuracy Assessment (14 points: CANY_AA.2076, CANY_AA.2085, CANY_AA.2170, CANY_AA.2394, CANY_AA.2418, CANY_AA.2650, CANY_AA.2786, CANY_AA.2799, CANY_AA.3041, CANY_AA.3109, CANY_AA.3191, CANY_AA.3325, CANY_AA.4600, CANY_AA.4604).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: K.A. Schulz

REFERENCES: Cogan et al. 2004, Hansen et al. 2003, Hansen et al. 2004d, Stubbendieck et al. 1992, Thomas et al. 2009a, USFS 1937, Von Loh et al. 2002, Western Ecology Working Group n.d.

Achnatherum hymenoides Colorado Plateau Herbaceous Vegetation

Indian Ricegrass Colorado Plateau Herbaceous Vegetation

CODE	CEGL002343
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d.)
ALLIANCE	*ACHNATHERUM HYMENOIDES* HERBACEOUS ALLIANCE (A.1262) Indian Ricegrass Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This herbaceous vegetation association usually occurs in small patches (<1 hectare) 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. 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 bunch grasses *Aristida purpurea, Sporobolus cryptandrus*, and *Pleuraphis jamesii*. Forbs present include *Abronia fragrans* and *Sphaeralcea parvifolia*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This herbaceous association occurs on sandy soils in low-lying areas throughout the park. Areas sampled included Gray's Pasture, Junction Butte, the Maze, near White Crack Junction, Hardscrabble Bottom, Chesler Park, Squaw Flat, Lower Jump, and in Shafer, Horse, Trail, Red Lake, Horseshoe, and Lavender canyons in Canyonlands National Park and in Big Spring Canyon in Glen Canyon National Recreation Area.

Globally

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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This herbaceous association occurs in deep, fine-textured soils of low-lying areas, including plains, sand dunes, stream terraces and canyon bottoms. One site is on a climbing dune. Sites tend to have flat to gentle slopes not exceeding 4 degrees, although climbing dunes may have up to a 15-degree slope. Elevations range between 1239 and 1816 m. The unvegetated surface has moderate to high exposure of bare soil or sand and sparse to low cover of litter. Biological soil crust provides sparse to moderate cover. The parent materials are predominantly sandstones and shales that have eroded and been redeposited as alluvium or eolian soils. Soils are rapidly drained and variable in texture; most have a sandy texture, but a few stands are on sandy or silt loams.

Globally

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 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.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparse Colorado Plateau grassland becomes established on deep sandy soils in low-lying areas throughout the park. Total vegetation cover ranges from 7 to 23% and is characterized by 3 to 10% cover of the medium-tall bunchgrass *Achnatherum hymenoides*. Other herbaceous species contribute very little cover but may include *Pleuraphis jamesii, Sporobolus cryptandrus, Aristida purpurea, Bromus tectorum, Abronia fragrans, Dalea candida* var. *oligophylla (= Dalea oligophylla), Salsola tragus, Hymenopappus filifolius*, and *Sphaeralcea parvifolia*. Shrubs occur scattered throughout this association but do not have high enough cover to constitute a layer. The more common associated shrubs include *Atriplex canescens, Ephedra torreyana, Gutierrezia sarothrae, Opuntia erinacea*, and *Opuntia polyacantha*. Biological soil crust cover varies, with some stands having none, but in a few stands cover is as high as 36%.

Globally

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 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 bunch grasses *Aristida purpurea, Sporobolus cryptandrus*, and *Pleuraphis jamesii*. Forbs present include *Abronia fragrans* and *Sphaeralcea parvifolia*.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex canescens*, *Ephedra torreyana*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Abronia fragrans*
Herb (field)	*Achnatherum hymenoides*, *Pleuraphis jamesii*, *Sporobolus cryptandrus*

Globally

Stratum	Species
Herb (field)	*Achnatherum hymenoides*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Descurainia pinnata* (exotic), *Salsola paulsenii* (exotic, Low), *Salsola tragus* (exotic)

Globally

Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (16-Mar-2005).

CLASSIFICATION COMMENTS

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Deep, fine soils on a relatively broad, flat park floor characterize this community's habitat. There are a fair number of dead grass bunches and dead shrubs, possibly the result of past drought.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (18 plots: CANY 0165, CANY 0251, CANY 0272, CANY 0381, CANY 0424, CANY 0432, CANY 0439, CANY 0449, CANY 0539, CANY 0549, CANY 0629, CANY 0637, CANY 0666, CANY 0721, CANY 0773, CANY 0776, CANY 0791, GLCA 0719).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles

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.

Hesperostipa comata Great Basin Herbaceous Vegetation

Needle-and-Thread Great Basin Herbaceous Vegetation

CODE	CEGL001705
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d.)
ALLIANCE	*HESPEROSTIPA COMATA* BUNCH HERBACEOUS ALLIANCE (A.1270) Needle-and-Thread Bunch Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
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. 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 28 degree 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. Biological soil crusts are often present with low cover. 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 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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This herbaceous association is rare within the park and recreation area. It is represented by stands sampled near Salt Creek Campground, north of "the All-American Man," near Zeus and Moses, in Davis Canyon, and in Bull Valley in Canyonlands National Park, and near Teapot Campground in Glen Canyon National Recreation Area.

Globally
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.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This grassland type occurs primarily on flat to gently sloping valley and canyon floors, with one sample on a steep canyon side. Elevations range from 1288 to 1846 m. Most of the unvegetated surface is bare soil with sparse cover of litter and biological soil crusts. Soils are rapidly drained sandy loams, loamy sands or silt loams derived from eolian deposits or alluvium. The deep, fine soils have accumulated in large dune-like hills or slopes at fairly regular intervals along the south side of this canyon branch.

Globally
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 28 degree 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.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This needle-and-thread grassland becomes established on deep soils of valley bottoms and on a canyon side. Total vegetation cover ranges from 8 to 37%. The vegetation association is dominated by *Hesperostipa comata* with between 3 and 30% cover. Other grasses are commonly present, but needle-and-thread is clearly dominant. *Achnatherum hymenoides, Bouteloua gracilis, Pleuraphis jamesii, Elymus elymoides, Sporobolus airoides*, and *Sporobolus cryptandrus* were recorded in the sample plots. Forbs provide sparse cover, rarely exceeding 5%, including *Sphaeralcea parvifolia, Gaillardia pinnatifida, Hymenopappus filifolius, Lappula occidentalis, Abronia fragrans, Oenothera pallida, Chenopodium* spp., *Comandra umbellata*, and *Tetraneuris acaulis (= Hymenoxys acaulis)*. Scattered shrubs may be present, but total cover does not exceed 5%. Common species include *Atriplex canescens, Krascheninnikovia lanata, Artemisia tridentata* ssp. *wyomingensis, Brickellia longifolia, Chrysothamnus viscidiflorus* ssp. *lanceolatus, Coleogyne ramosissima, Ephedra torreyana, Ephedra viridis, Gutierrezia sarothrae, Opuntia erinacea*, and *Opuntia fragilis*. Biological soil crusts are variable, ranging from 1 to 50%, but tend to be in an early developmental stage dominated by moss and dark cyanobacteria. *Pinus edulis* seedlings are rare but may contribute up to 1% cover.

Globally
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, Elymus elymoides, Koeleria macrantha, Leymus salinus, Pleuraphis jamesii, Poa fendleriana, Poa secunda, Sporobolus airoides*, 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).

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Krascheninnikovia lanata*
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Ambrosia acanthicarpa*, *Cleome lutea*, *Plantago patagonica*, *Salsola tragus*, *Sphaeralcea coccinea*
Herb (field)	*Achnatherum hymenoides*, *Bouteloua gracilis*, *Hesperostipa comata*, *Pleuraphis jamesii*

Globally

Stratum	Species
Herb (field)	*Hesperostipa comata*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Salsola tragus* (exotic)

Globally
Vulnerable: *Arabis crandallii* (globally imperiled, G2G3), *Astragalus anisus* (globally imperiled, G2G3), *Cirsium arizonicum* (UT state -vulnerable, G5); **Exotic/Invasive**: *Bassia scoparia* (exotic, Low), *Bromus tectorum* (exotic, High), *Poa pratensis* (exotic, Medium), *Salsola tragus* (exotic), *Sisymbrium altissimum* (exotic), *Tragopogon dubius* (exotic, Medium/Low)

CONSERVATION STATUS RANK
Global Rank & Reasons: G2G4 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This association 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 a shrub layer.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (7 plots: CANY 0389, CANY 0392, CANY 0717, CANY 0758, CANY 0795, CANY 0810, GLCA 0582).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, 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 pers. comm., Daubenmire 1970, Driscoll et al. 1984, FEIS 1998, Kleiner 1968, Kleiner 1983, Kleiner and Harper 1977, Peterson 2008, Romme et al. 1993, Thilenius et al. 1995, Von Loh et al. 2007, Western Ecology Working Group n.d.

Poa fendleriana Herbaceous Vegetation

Muttongrass Herbaceous Vegetation

CODE	CEGL001925
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d.)
ALLIANCE	*POA FENDLERIANA* HERBACEOUS ALLIANCE (A.1336) Muttongrass Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This herbaceous association was observed on lower slopes of hills and midslopes of ridges and mesas in western Colorado, eastern and southern Utah and is likely more widespread. Sites are flat, moderately steep to steep (6-29 degree 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. This sparsely to moderately vegetated grassland is characterized by the bunchgrass *Poa fendleriana* that provides from 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is rare within the park and is represented by one plot located below a cliff band south of Cabin Spring.

Globally

This herbaceous association was observed on lower slopes of hills and midslopes of ridges and mesas in western Colorado and eastern Utah and is likely more widespread.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This grassland community was sampled only once, in a canyon on a north-facing toeslope at 1750 m elevation. The unvegetated surface has a high exposure of bare soil and sparse cover by litter and biological soil crusts. The soil is a rapidly drained loamy sand derived from alluvium.

Globally

This herbaceous association was observed on lower slopes of hills and midslopes of ridges and mesas. Sites occur on moderately steep to steep (6-29 degree slopes) between 1750 and 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 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This grassland type is rare within the park. Total vegetation cover does not exceed 25% and is characterized by up to 20% cover of *Poa fendleriana*. Scattered shrubs present may include *Fraxinus anomala, Mahonia fremontii,*

Krascheninnikovia lanata, Artemisia frigida, and *Gutierrezia sarothrae*, but total shrub cover is not enough to constitute a stratum. Additional graminoids include *Vulpia octoflora (= Festuca octoflora), Bromus tectorum*, and *Achnatherum hymenoides*. The sparse forb component may include *Phlox hoodii, Senecio spartioides* var. *multicapitatus (= Senecio multicapitatus), Lepidium montanum* var. *jonesii*, and *Sphaeralcea parvifolia*. *Juniperus osteosperma* seedlings may be present.

Globally
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 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*. The cryptogamic soil community provides low cover and includes dark cyanobacteria, moss, *Collema* sp., and *Fulgensia* sp.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Fraxinus anomala*
Short shrub/sapling	*Krascheninnikovia lanata*
Herb (field)	*Phlox hoodii*
Herb (field)	*Bromus tectorum*, *Poa fendleriana*

Globally

Stratum	Species
Herb (field)	*Poa fendleriana*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Exotic/Invasive: *Agropyron cristatum* (invasive/exotic, Medium/Low), *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: GU (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data from Loder (1964) and Olgeirson (1972, 1974) indicate that this association may also occur in the subalpine/alpine zones. The data contained in these references do not give enough information to say for certain that this is a valid association. More field inventories are needed.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Plot is on a steep slope and lacks rock or boulder debris from slickrock cliff above. This is the only grassland in the area, as all other exposures in the canyon on similar slopes at this elevation are barren.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0110).
Local Description Authors: M. Smith and J. Von Loh

Global Description Authors: K.A. Schulz, mod. G. Kittel

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Coles et al. 2010, Driscoll et al. 1984, Loder 1964, Olgeirson 1972, Olgeirson 1974, Western Ecology Working Group n.d.

Sporobolus airoides Southern Plains Herbaceous Vegetation

Alkali Sacaton Southern Plains Herbaceous Vegetation

Alkali Sacaton Southern Plains Grassland

CODE	CEGL001685
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d.)
ALLIANCE	*SPOROBOLUS AIROIDES* HERBACEOUS ALLIANCE (A.1267) Alkali Sacaton Herbaceous Alliance

ECOLOGICAL SYSTEM(S):
Chihuahuan-Sonoran Desert Bottomland and Swale Grassland (CES302.746)
Inter-Mountain Basins Greasewood Flat (CES304.780)
Western Great Plains Floodplain (CES303.678)
Western Great Plains Saline Depression Wetland (CES303.669)
Western Great Plains Shortgrass Prairie (CES303.672)
Inter-Mountain Basins Wash (CES304.781)
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

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. 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. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This herbaceous association was sampled in canyon bottoms and on stream terraces in the park and recreation area. Sites include Potato Bottom, Horse Canyon, and Fort Bottom in Canyonlands National Park, and Millard Canyon Benches and the Elaterite Basin in Glen Canyon Recreation Area.

Globally

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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This herbaceous association occurs in mesic sites on canyon bottoms and stream terraces. Sites are flat or slope gently between 1183 and 1618 m elevation. Bare soil or litter covers most of the unvegetated surface depending on the density of grasses. Soils are well-drained to rapidly drained fine sandy loams or clay loams derived from alluvium.

Globally
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 17-degree 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 lavaflow, cinders, relict Pleistocene river cobbles, and sandstone.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This alkali sacaton grassland grows along canyon bottoms and stream terraces within the park and recreation area. Total vegetation cover ranges from 5%to 75% and is dominated by the bunchgrass *Sporobolus airoides*. Shrubs may be present but do not have enough cover to constitute a stratum (<5%). Common species include *Atriplex confertifolia, Sarcobatus vermiculatus, Ericameria nauseosa, Ephedra torreyana, Atriplex canescens, Suaeda moquinii (= Suaeda torreyana), Atriplex gardneri, Opuntia erinacea*, and *Sclerocactus whipplei*. Other herbaceous species present may include *Phragmites australis, Juncus balticus, Pleuraphis jamesii, Iva acerosa, Stanleya pinnata, Comandra umbellata*, and *Salsola tragus*.

Globally
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, Symphyotrichum subulatum (= Aster subulatus), Buchloe dactyloides, Distichlis spicata, Hordeum jubatum, Bouteloua gracilis, Panicum obtusum, Pleuraphis jamesii, Sphaeralcea* spp., *Sporobolus cryptandrus*, 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, Ephedra* spp., *Ericameria nauseosa, Gutierrezia sarothrae*, or *Sarcobatus vermiculatus*. Total shrub cover is low (<10%), and forb cover is minor.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Herb (field)	*Sporobolus airoides*

Globally

Stratum	Species
Herb (field)	*Sporobolus airoides*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Salsola tragus* (exotic)

Globally
Data are not available.

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.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Compare this association with *Sporobolus airoides - Bouteloua gracilis* Herbaceous Vegetation (CEGL001686) and *Pleuraphis jamesii - Sporobolus airoides* Herbaceous Vegetation (CEGL001778). Stands in Montana are placed with *Sporobolus airoides* Northern Plains Herbaceous Vegetation (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)* Herbaceous Vegetation (CEGL002042).

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The vegetation of this canyon bottom seems changed due to the age or position of the alluvial material. Sampled site is subject to rain runoff from slopes above, and the soil appears to be alkaline with a salt crust.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (6 plots: CANY 0362, CANY 0504, CANY 0669, CANY 0706, GLCA 0541, GLCA 0751).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Drake, mod. K. Schulz and J. Coles

REFERENCES: Aldous and Shantz 1924, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, 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, 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.

Sporobolus cryptandrus Great Basin Herbaceous Vegetation

Sand Dropseed Great Basin Herbaceous Vegetation

CODE	CEGL002691
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d.)
ALLIANCE	*SPOROBOLUS CRYPTANDRUS* HERBACEOUS ALLIANCE (A.1252) Sand Dropseed Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
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 1226 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. The vegetation is dominated by the warm-season perennial graminoid *Sporobolus cryptandrus*. *Hesperostipa comata (= Stipa comata), Pleuraphis jamesii, Sporobolus contractus, Sporobolus giganteus*, or *Equisetum variegatum* 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 species such as *Bromus rigidus, 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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This herbaceous association was sampled on the Spanish Bottom, in upper Salt Creek and in the Salt Creek Pocket, in Squaw Flat, Red Lake Canyon, and near the mouth of Musselman Canyon in Canyonlands National Park.

Globally
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.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparse bottomland bunchgrass association occurs on valley floors, toeslopes, plains, grabens, abandoned meanders, and floodplains. Sites are flat to gentle (0- to 4-degree slopes), oriented to all aspects, and located between 1168 and 1646 m elevation. Bare soil and litter cover most of the unvegetated surface, with lesser cover by moss and dark cyanobacteria. Soils are rapidly drained loamy sands or sandy clays derived from alluvium.

Globally
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 1226-1630 m. Sites are flat to gently 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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This somewhat disturbed grassland type is rare within the park. Total vegetation cover ranges from 12 to 60% and is dominated by the perennial bunchgrass *Sporobolus cryptandrus* with between 3 and 40% cover. The remaining herbaceous layer can be weedy and includes the graminoids *Bromus tectorum, Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii, Sporobolus flexuosus,* and *Sporobolus contractus,* and the forbs *Salsola tragus* (with up to 30% cover), *Rumex hymenosepalus, Asclepias subverticillata, Lepidium latifolium, Erodium cicutarium, Sphaeralcea parvifolia, Cryptantha crassisepala* var. *elachantha, Grindelia squarrosa, Machaeranthera canescens, Mentzelia multiflora*, and *Plantago patagonica*. Shrubs may be present but do not have high enough cover to constitute a stratum; *Ericameria nauseosa, Atriplex canescens, Krascheninnikovia lanata*, and *Gutierrezia sarothrae* are the most consistent species.

Globally
This plant association is found on alluvial terraces of large rivers and on sand deposits on mesas and plains. The sparse to moderately dense (10-30% cover) herbaceous layer is characterized by the dominance of the warm-season perennial graminoid *Sporobolus cryptandrus*. *Hesperostipa comata (= Stipa comata), Pleuraphis jamesii, Sporobolus contractus, Sporobolus giganteus*, or *Equisetum variegatum* may occur in low abundance. Low cover of native forbs, such as *Abronia fragrans, Chamaesyce fendleri, 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 species such as *Bromus rigidus, 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 may occur, but they are not dense enough to form a shrub layer. Moss is important in some stands.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Herb (field)	*Asclepias subverticillata*, *Salsola tragus*
Herb (field)	*Sporobolus cryptandrus*

Globally

Stratum	Species
Herb (field)	*Sporobolus cryptandrus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Salsola tragus* (exotic)

Globally
Exotic/Invasive: *Bromus rigidus* (exotic), *Bromus tectorum* (exotic, High), *Helianthus annuus* (weedy native), *Salsola kali* (exotic), *Sisymbrium altissimum* (exotic), *Tribulus terrestris* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (26-Jul-2001).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
The association is broadly defined to include *Sporobolus cryptandrus*-dominated stands from both riparian and sandy upland sites. 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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: One plot supports lush growth compared to the almost barren site to the south; the water table may be higher here. The ground seems hard and compacted. This is a flat park-like area with deep, fine soils. What currently drives this plant community is its past grazing history.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY.0447, CANY.0808) and 2007 and 2008 Accuracy Assessment (7 points: CANY_AA.0490, CANY_AA.2093, CANY_AA.2176, CANY_AA.2412, CANY_AA.2734, CANY_AA.2800, CANY_AA.3241).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: K.A. Schulz

REFERENCES: Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2009a, Cowardin et al. 1979, Thomas et al. 2009a, USFS 1937, Von Loh et al. 2002, Western Ecology Working Group n.d.

Bouteloua gracilis Herbaceous Vegetation

Blue Grama Herbaceous Vegetation

Blue Grama Shortgrass Prairie

CODE	CEGL001760
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Short sod temperate or subpolar grassland (V.A.5.N.e.)
ALLIANCE	*BOUTELOUA GRACILIS* HERBACEOUS ALLIANCE (A.1282) Blue Grama Herbaceous Alliance
ECOLOGICAL SYSTEM(S):	Inter-Mountain Basins Semi-Desert Grassland (CES304.787) Western Great Plains Foothill and Piedmont Grassland (CES303.817) Western Great Plains Shortgrass Prairie (CES303.672)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This minor plant association is reported from Arizona, Colorado, New Mexico, Utah and Wyoming. Sites are flat to gently sloping and include plains, plateaus and montane meadows at elevations ranging from 1660-2780 m (5420-9115 feet). Substrates are variable and range from coarse-textured soils derived from sand, gravel, old lavaflows, kipukas, alluvium, limestone, sandstone, granite or cinder to silty clay loam prairie soils. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is rare within the park and recreation area and is represented by one plot on a windswept mesatop near Hans Flat Ranger Station and one plot in the West Fork of Salt Creek.

Globally

This minor plant association occurs in Arizona, Colorado, New Mexico, Utah and Wyoming.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This grassland association occurs on mesatops and in valley bottoms. The sampled sites slope gently, face east to south and occur between 1712 m and 1968 m elevation. The unvegetated surface has high exposure of bare ground and biological soil crust and low cover of litter. The soil is a rapidly drained silty clay derived from eolian deposits.

Globally

This minor plant association is reported from Arizona, Colorado, New Mexico, Utah and Wyoming. Elevation ranges from 1660-2780 m (5420-9115 feet). Sites are flat to 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 prairie 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This blue grama grassland association is rare and is characterized by sparse (8%) cover of *Bouteloua gracilis*. A few scattered shrubs of *Atriplex canescens, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Opuntia erinacea*, and *Krascheninnikovia lanata* are present. Other grass species present can include *Hesperostipa comata, Achnatherum hymenoides,* and *Pleuraphis jamesii*. *Bromus tectorum* indicates a history of grazing. Forbs include *Eriogonum cernuum, Packera multilobata (= Senecio multilobatus), Lappula occidentalis*, and *Plantago patagonica*.

Globally

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.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Herb (field)	*Eriogonum cernuum*
Herb (field)	*Bouteloua gracilis*

Globally

Stratum	Species
Herb (field)	*Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: G4Q (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This is a low-confidence association. There are many other associations in the *Bouteloua gracilis* Herbaceous Alliance (A.1282). This association often represents 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.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Historic grazing and a dry exposure has selected for *Bouteloua gracilis*, in addition to a dry exposure. Wind erosion and desiccation are prevalent.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plost: CANY_AA.3292, GLCA.0526).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles and M.E. Hall

REFERENCES: Bourgeron and Engelking 1994, Bradley et al. 1992, CONHP unpubl. data 2003, Coles et al. 2008c, Driscoll et al. 1984, Dwyer and Pieper 1967, Fisser 1970, Fisser et al. 1965, Hansen et al. 2003, Hansen et al. 2004a, Hansen et al. 2004c, Hansen et al. 2004d, Muldavin et al. 2000b, Pieper 1968, Salas and Bolen 2010a, Salas et al. 2005, Thomas et al. 2009a, Thomas et al. 2009b, Thomas et al. 2010, Western Ecology Working Group n.d., Williams 1961, Zimmerman 1967

Pleuraphis jamesii - Sporobolus airoides Herbaceous Vegetation

James' Galleta - Alkali Sacaton Herbaceous Vegetation

CODE	CEGL001778
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Short sod temperate or subpolar grassland (V.A.5.N.e.)
ALLIANCE	*PLEURAPHIS JAMESII* HERBACEOUS ALLIANCE (A.1287) James' Galleta Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Apacherian-Chihuahuan Semi-Desert Grassland and Steppe (CES302.735)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

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. 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 (<9 degrees) 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. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This grassland association is rare within the recreation area and was sampled at the head of Deadhorse Canyon and on the road leading to Teapot Rock Campground.

Globally

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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This grassland type occurs on stream terraces and benches. Sites are flat to gently sloping and between 1413 and 1676 m elevation. Bare soil covers most of the unvegetated surface and there is only sparse cover by litter. Soils are rapidly drained loamy sands or loams derived from alluvium.

Globally

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 (<9 degrees) 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This valley bottom grassland is rare within the recreation area. Total vegetation cover is around 15% and is characterized by *Pleuraphis jamesii* and *Sporobolus airoides* that together contribute between 7 and 8% cover. The remaining herbaceous layer consists of scattered individuals of *Achnatherum hymenoides, Hesperostipa comata*, and *Bouteloua gracilis*. *Bromus tectorum* may be sparse to abundant depending on disturbance history and seasonal rainfall. Forbs may include *Chenopodium fremontii, Salsola tragus, Salsola paulsenii, Sphaeralcea parvifolia,*

Plantago patagonica, and *Stanleya pinnata*. Shrubs are usually present, although lacking enough cover to constitute a stratum; *Ericameria nauseosa, Ephedra torreyana, Krascheninnikovia lanata, Coleogyne ramosissima*, and *Opuntia erinacea* are the most consistent species. *Tamarix chinensis* occurs near the sampled plots.

Globally
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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Krascheninnikovia lanata*
Herb (field)	*Pleuraphis jamesii*, *Sporobolus airoides*

Globally

Stratum	Species
Herb (field)	*Pleuraphis jamesii*, *Sporobolus airoides*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola paulsenii* (exotic, Low), *Salsola tragus* (exotic), *Tamarix chinensis* (exotic)

Globally
Data are not available.

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 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.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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. *Sporobolus airoides* is larger and often more abundant than *Pleuraphis jamesii* which suggests that this association should be moved to the *Sporobolus airoides* Herbaceous Alliance (A.1267).

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Subsurface geology may push groundwater to the surface here; certainly it is a spot where the steeper upstream gullies lose their grade and broaden into a flat area.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: GLCA 0735, GLCA 0762).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: Y. Chauvin, mod. K.A. Schulz and J. Coles

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, 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, Thomas et al. 2009a, West et al. 1972, Western Ecology Working Group n.d.

Pleuraphis jamesii Herbaceous Vegetation

James' Galleta Herbaceous Vegetation

CODE	CEGL001777
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Short sod temperate or subpolar grassland (V.A.5.N.e.)
ALLIANCE	*PLEURAPHIS JAMESII* HERBACEOUS ALLIANCE (A.1287) James' Galleta Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This widespread grassland association is found on alluvial flats, plateau parks, mesas and plains in the Colorado Plateau and elsewhere in the southwestern U.S. 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. 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. Some stands have high cover of cryptogams on the soil surface.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This grassland association is common within both the park and recreation area. Sites sampled included 500 m east of Alcove Spring, near White Rim Road, in Shafer Canyon, 200 m west of Horsehoof Camp, near Cyclone Road, near the Dollhouse, 1 km past Airport Campground, in Chesler Park, near Tower Ruin, in Taylor Canyon, adjacent to the Confluence Overlook Trail, in Davis Canyon, and in Beef Basin in Canyonlands National Park, and near Waterhole Flat in Glen Canyon National Recreation Area.

Globally
This widespread grassland association is found on alluvial flats, plateau parks and plains in the Colorado Plateau and elsewhere in the southwestern U.S.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This grassland type occurs on canyon bottoms, plains, flats, and the gentle slopes of benches, plateaus, and rims. Sites are flat or slope gently (up to 6 degrees), include all aspects, and lie between 1255 and 1835 m elevation. Soils are rapidly drained and range in texture from sand to silt loam. They are derived from a wide range of parent materials, including sandstones, shales, eolian deposits, and alluvium.

Globally
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 ranges from 1220-1930 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 28 degrees 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 lavaflow, basaltic cobbles, black or red cinders, or alluvium derived from relict Pleistocene river cobbles, sandstone, sand, or clay soils.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This grassland association grows on deep, fine-textured soils within the park and recreation area. Total vegetation cover ranges from 5 to 31% and is characterized by *Pleuraphis jamesii* with between 3 and 30% cover. Associated grasses include *Achnatherum hymenoides, Bromus tectorum*, and *Sporobolus airoides*. Forbs provide up to 5% cover and may include *Sphaeralcea coccinea, Chenopodium album, Salsola tragus, Abronia fragrans*, and *Delphinium andersonii*. Scattered shrubs are generally present and may include *Atriplex canescens, Krascheninnikovia lanata, Ephedra torreyana, Atriplex confertifolia, Gutierrezia sarothrae, Opuntia erinacea*, and *Sclerocactus whipplei*. Biological soil crust cover ranges from 0 to 51%.

Globally
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, Cymopterus newberryi, Eriogonum inflatum, 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*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Krascheninnikovia lanata*
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Chenopodium album*, *Salsola tragus*, *Sphaeralcea coccinea*
Herb (field)	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Globally

Stratum	Species
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Descurainia pinnata* (exotic), *Halogeton glomeratus* (exotic, High/Medium), *Malcolmia africana* (exotic), *Salsola tragus* (exotic)

Globally
Exotic/Invasive: *Bassia scoparia* (exotic, Low), *Bromus tectorum* (exotic, High), *Salsola kali* (exotic), *Sisymbrium altissimum* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: G2G4 (23-Feb-1994).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This association 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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Biocrusts are very well-developed. Grazing has influenced this area with livestock trails and manure present. Perhaps area has been grazed long ago, but the mature-looking cryptogamic soil crust indicates no recent disturbance. Severe drought-stress found on the few *Coleogyne ramosissima* in the plot. They appear to be dead but have some new growth.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (20 plots: CANY 0105, CANY 0163, CANY 0164, CANY 0190, CANY 0193, CANY 0457, CANY 0535, CANY 0553, CANY 0557, CANY 0632, CANY 0719, CANY 0728, CANY 0746, CANY 0768, CANY 0804, CANY 0813, GLCA 0562, GLCA 0566, GLCA 0760, GLCA 0778).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles and G. Kittel

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, 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, 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, Nichol 1937, Peterson 2008, Romme et al. 1993, Salas et al. 2009, Stewart et al. 1940, 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.

Achnatherum speciosum Herbaceous Vegetation

Desert Needlegrass Herbaceous Vegetation

Desert Needlegrass Grassland

CODE	CEGL003112
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Short bunch temperate or subpolar grassland (V.A.5.N.f.)
ALLIANCE	*ACHNATHERUM SPECIOSUM* HERBACEOUS ALLIANCE (A.1290) Desert Needlegrass Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This community is a grassland of southern California valleys which often intergrades into creosotebush scrub. Stand composition varies; *Achnatherum speciosum (= Stipa speciosa)* is the sole dominant or important grass in the ground layer. Other plants in the herb layer may include *Nassella lepida (= Stipa lepida), Achnatherum hymenoides (= Oryzopsis hymenoides), Nassella cernua (= Stipa cernua), Poa secunda*, and *Elymus elymoides*. Grasses are <1 m and cover is open.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare association was represented by one plot within the park on a colluvial slope in the West Fork of Salt Creek Canyon.

Globally

This association occurs in the valleys and lower slopes of the Mojave Desert.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This grassland association occupies the colluvial slope of a narrow canyon. The one sampled site is steep (35-degree slope), occurs at 1671 m elevation and is oriented to the south. The unvegetated surface has high cover of large and small rocks and moderate exposure of bare soil. The parent materials are derived from talus and colluvium. The soil is a rapidly drained loamy sand.

Globally

Data are not available.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This desert needlegrass association is rare within the park. Total vegetation cover is 19% and is characterized by low cover of the bunchgrass *Achnatherum speciosum* (6%) and the short shrub *Ephedra viridis* (5%). Other short shrubs provide low cover, including *Krascheninnikovia lanata, Artemisia bigelovii*, and *Atriplex canescens*. The herbaceous layer is moderately diverse and contributes sparse cover. Other grasses commonly present include *Pleuraphis jamesii, Muhlenbergia porteri, Sporobolus cryptandrus*, and the non-native annual *Bromus tectorum*. Forbs include *Sphaeralcea parvifolia* and *Stanleya pinnata*. *Juniperus osteosperma* trees were located outside the stand.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Achnatherum speciosum*, *Bromus tectorum*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally

Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G1Q (14-Nov-1997). A few stands of this association are known in the western Antelope Valley of Kern and Los Angeles counties. Additional, isolated stands are scattered east throughout the Mojave. About 10 stands are known. Like most perennial grasslands in California this association has been reduced to remnant patches. Grazing and exotics have greatly reduced the size and number of stands. It is unknown what the restoration potential of this community might be.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Grasses and shrubs grow on the small steps of flatter soils on the downhill sides of boulders, where water is also concentrated from boulder runoff.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY 0760).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: M. Schindel

REFERENCES: Sawyer and Keeler-Wolf 1995, Western Ecology Working Group n.d.

Distichlis spicata Herbaceous Vegetation

Inland Saltgrass Herbaceous Vegetation

Saltgrass Saline Prairie

CODE	CEGL001770
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Intermittently flooded temperate or subpolar grassland (V.A.5.N.i.)
ALLIANCE (A.1332)	*DISTICHLIS SPICATA* INTERMITTENTLY FLOODED HERBACEOUS ALLIANCE Inland Saltgrass Intermittently Flooded Herbaceous Alliance

ECOLOGICAL SYSTEM(S):
Inter-Mountain Basins Greasewood Flat (CES304.780)
Inter-Mountain Basins Wash (CES304.781)
Chihuahuan Mixed Salt Desert Scrub (CES302.017)
Inter-Mountain Basins Playa (CES304.786)
Sonora-Mojave Mixed Salt Desert Scrub (CES302.749)
Western Great Plains Saline Depression Wetland (CES303.669)
Inter-Mountain Basins Alkaline Closed Depression (CES304.998)
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)
North American Warm Desert Lower Montane Riparian Woodland and Shrubland (CES302.748)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

These grasslands occur in semi-arid and arid western North America from southern Saskatchewan, Canada, to Mexico. 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. 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.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Three sites were observed at Upper Salt Creek and Lower Salt Creek.

Globally

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, California, New Mexico, and possibly northern Mexico.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare and small-patch association is known only from three sites on a valley bottom and creek terrace on gentle slopes (0-1 degrees) at elevations of 1442 and 1797 m. Soils are derived from alluvial deposits and may be quite alkaline.

Globally

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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Occurrences of this association are characterized by a moderately dense herbaceous layer clearly dominated by *Distichlis spicata* (with 30-50% cover). Scattered shrubs occur and include *Ericameria nauseosa* (up to 14% cover), *Artemisia dracunculus, Atriplex canescens*, and *Sarcobatus vermiculatus*. Native grass species may be present with low cover and include *Phragmites australis* and *Sporobolus airoides.* Non-native species, including *Bromus tectorum, Poa pratensis* and *Tamarix chinensis*, are also present at low cover.

Globally

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), *Salicornia rubra, Triglochin maritima*, and *Suaeda* spp., may also be present. Shrubs are rare, but scattered *Atriplex canescens, Chrysothamnus viscidiflorus, Ericameria nauseosa*, 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.

MOST ABUNDANT SPECIES
*Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)*Data are not available.

Globally

Stratum	Species
Herb (field)	*Distichlis spicata*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Exotic/Invasive: *Bassia scoparia* (exotic, Low), *Bromus tectorum* (exotic, High), *Elymus repens* (exotic, High/Medium), *Lepidium latifolium* (exotic, High), *Lepidium perfoliatum* (exotic, Low/Insignificant)

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This graminoid association is characteristically dominated by *Distichlis spicata*. Closely related communities include *Pascopyrum smithii - Distichlis spicata* Herbaceous Vegetation (CEGL001580), *Sporobolus airoides - Distichlis spicata* Herbaceous Vegetation (CEGL001687), and several others.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2008 Accuracy Assessment (2 points: CANY_AA.3002, CANY_AA.3286).
Local Description Authors: M.E. Hall
Global Description Authors: K.A. Schulz, mod. J. Coles, G. Kittel, J. Evens

REFERENCES: Baker 1984a, Beatley 1976, Bourgeron and Engelking 1994, Brotherson 1987, Bunin 1985, CONHP unpubl. data 2003, Carsey et al. 2003a, Coles et al. 2008a, Costello 1944b, Crouch 1961a, Daniels 1911, Daubenmire 1970, Dodd and Coupland 1966, Driscoll et al. 1984, Franklin and Dyrness 1973, Graham 1937, Hansen et al. 1991, Hansen et al. 1995, Hyder et al. 1966, IDCDC 2005, Johnston 1987, Jones and Walford 1995, Kagan et al. 2004, Keeler-Wolf and Vaghti 2000, Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1999a, Kittel et al. 1999b, Klipple and Costello 1960, MTNHP 2002b, Muldavin et al. 2000a, Osborn 1974, Peterson 2008, Pickart 2006, Ralston 1969, Ramaley 1942, Rogers 1953, Sawyer and Keeler-Wolf 1995, Shanks 1977, Shupe et al. 1986, Soil Conservation Service 1978, Stearns-Roger, Inc. 1978, Tuhy and Jensen 1982, Ungar 1967, Ungar 1968, Ungar 1970, Ungar et al. 1969, Vestal 1914, WNHP unpubl. data, Weaver and Albertson 1956, Western Ecology Working Group n.d.

Juncus balticus Herbaceous Vegetation

Baltic Rush Herbaceous Vegetation

Baltic Rush Wet Meadow

CODE	CEGL001838
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k.)
ALLIANCE	*JUNCUS BALTICUS* SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1374) Baltic Rush Seasonally Flooded Herbaceous Alliance

ECOLOGICAL SYSTEM(S):
Inter-Mountain Basins Interdunal Swale Wetland (CES304.059)
Boreal Wet Meadow (CES103.873)
North American Arid West Emergent Marsh (CES300.729)
Northern Columbia Plateau Basalt Pothole Pond (CES304.058)
Western Great Plains Open Freshwater Depression Wetland (CES303.675)
Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)
Temperate Pacific Subalpine-Montane Wet Meadow (CES200.998)
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This Baltic rush community is found widely throughout the western United States and into western Canada. This herbaceous wet meadow occurs as small to extensive, open to typically dense patches on flat stream benches, along overflow channels, and near springs. Habitats are often alkaline meadows and may have long-term grazing disturbance. Soils are variable and range from poorly to well-drained, sandy clay loam to fine sand-textured and are usually mottled or gleyed. Stands are characterized by dense swards of *Juncus balticus*. In montane zones and the Great Basin, minor cover of *Carex* species, including *Carex aquatilis, Carex praegracilis, Carex nebrascensis*, or *Carex utriculata*, is often present; other common species include *Deschampsia caespitosa, Distichlis spicata, Glyceria striata, Hordeum jubatum, Muhlenbergia asperifolia, Pascopyrum smithii, Phleum alpinum*, and *Sporobolus airoides*. The introduced perennial sod grasses *Poa pratensis* or *Agrostis stolonifera* codominate some stands. Forb cover is generally low and includes wetland species such as *Caltha leptosepala, Rumex aquaticus*, and *Dodecatheon pulchellum*. *Iris missouriensis* can be common in heavily grazed stands. Shrubs are not common. This association is often considered to be a grazing-induced community since it increases with disturbance, though it can be a stable late-seral community.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This herbaceous association is rare within the park and is represented by one plot located in a wash bottom 75 m southeast of the Neck Spring Trail and one plot on a floodplain terrace in Squaw Flat north of Salt Creek.

Globally

This Baltic rush wet meadow community is found widely throughout the western United States, ranging from South Dakota and Nebraska west to Washington, south to California, and east to New Mexico. It also occurs in western Canada.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This herbaceous association was sampled on the saturated soils of a wash bottom and on a low area of a terrace. The sites are flat and occur between 1475 m 1729 m elevation. The unvegetated surface had moderate exposure of bare soil and moderate to high cover of litter. The soil was a moderately well-drained loamy sand derived from alluvium.

Globally
This broadly defined and widespread herbaceous wetland community is found throughout western North America. Elevation ranges from 138 to 3500 m (454-11,475 feet). Far northern stands in the Boreal Plains are at about 800 m (2625 feet). Stands usually occur as small, dense patches on flat to gently sloping sites near seeps and streams. Stream channels are highly variable in size and type, ranging from narrow to moderately wide, and from deeply entrenched to very sinuous (Kittel et al. 1999b). In the boreal regions, this community occurs more commonly on gradual sandy shorelines. Soils are also variable and range from sandy well-drained to poorly drained silty clay loam or silty clay alluvium to organic muck; however, soils tend to be finer-textured, alkaline and may be saline (Brotherson and Barnes 1984, Padgett et al. 1989, Kittel et al. 1999b). Sites with sandy soils are usually saturated for part of the growing season or have high water tables. Cobbles and gravel are common on many sites, and gleyed and mottled horizons are often present because of flooding or high water tables (Kittel et al. 1999b).

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This wet meadow association is rare within the park. Total vegetation cover is between 85 and 100%. The dominant species are *Juncus balticus* (with up to 80% cover) and *Agrostis stolonifera* (with up to 55% cover), which is often codominant. Associated herbaceous species include *Bromus inermis, Phragmites australis, Carex nebrascensis*, and *Muhlenbergia andina*. Forbs include *Arabis hirsuta, Symphyotrichum ascendens (= Aster chilensis* ssp*. adscendens), Cirsium vulgare, Castilleja linariifolia*, and *Solidago canadensis*. Shrubs grow on the fringes of the community and contribute sparse to low cover; *Rosa woodsii, Ericameria nauseosa, Rhus trilobata, Quercus gambelii*, *Salix exigua,* and the exotic invasive *Tamarix chinensis.*

Globally
This broadly defined association is characterized by a low (<50 cm), open to typically dense graminoid layer dominated by the rhizomatous perennial *Juncus balticus*. In montane zones and the Great Basin, minor cover of *Carex* species, including *Carex aquatilis, Carex praegracilis, Carex microptera, Carex nebrascensis*, or *Carex utriculata*, is often present. Other common graminoids include *Deschampsia caespitosa, Distichlis spicata, Glyceria striata, Hordeum brachyantherum, Hordeum jubatum, Muhlenbergia andina, Muhlenbergia asperifolia, Pascopyrum smithii, Poa nemoralis* ssp*. interior, Phleum alpinum*, and *Sporobolus airoides*. Forb cover is generally low but may include *Achillea millefolium, Artemisia ludoviciana, Caltha leptosepala, Cirsium scariosum (= Cirsium tioganum), Dodecatheon pulchellum, Glaux maritima, Iris missouriensis, Maianthemum stellatum, Rumex aquaticus, Polygonum bistortoides, Potentilla plattensis*, and *Solidago canadensis*. Many other forb species may be present, given the wide elevational amplitude and broad geographic spread of this type. Shrubs and dwarf-shrubs are not common; however, *Artemisia frigida* cover may be significant in some stands, and occasional *Artemisia cana, Artemisia tridentata* ssp*. tridentata, Dasiphora fruticosa* ssp*. floribunda, Ericameria nauseosa, Populus* spp., *Rosa woodsii, Salix* spp., or *Sarcobatus vermiculatus* shrubs may occur. Some stands may be codominated by the introduced perennial sod grasses *Poa pratensis, Bromus inermis*, or *Agrostis stolonifera*. Other introduced species, such as *Cirsium arvense, Cirsium vulgare, Erodium cicutarium, Iva axillaris, Lactuca serriola, Phleum pratense, Taraxacum officinale, Thinopyrum intermedium, Trifolium* spp., *Tragopogon dubius, Xanthium strumarium*, and others, may occur in disturbed stands.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Herb (field)	*Juncus balticus*

Globally

Stratum	Species
Herb (field)	*Juncus balticus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus inermis* (exotic, High/Medium), *Cirsium vulgare* (exotic, Medium/Low)

Globally
Exotic/Invasive: *Agrostis stolonifera* (weedy native, Medium/Low), *Bromus inermis* (exotic, High/Medium), *Cirsium arvense* (exotic noxious weed, High/Medium), *Cirsium vulgare* (exotic noxious weed, Medium/Low), *Erodium cicutarium* (exotic, Medium/Low), *Iva axillaris* (noxious weed), *Lactuca serriola* (exotic, Low/Insignificant), *Phleum pratense* (exotic, Medium), *Poa pratensis* (invasive, Medium), *Taraxacum officinale* (exotic), *Thinopyrum intermedium* (exotic, Medium/Insignificant), *Tragopogon dubius* (exotic, Medium/Low), *Xanthium strumarium* (noxious weed)

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This association is often considered to be a grazing-induced community since it increases with grazing disturbance. Based on the extensive geographic and environmental range (from alpine meadows to sagebrush-dominated landscapes), it verges on astonishing that any number of *Juncus balticus* associations have not been recognized.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Shrubs on the plot list describe the low bank/riparian community, while herb species are on the level wash bottom. High bank species include oak, rabbitbrush, pinyon, juniper and cheatgrass.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0108) and 2008 Accuracy Assessment (1 point: CANY_AA.3111).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Drake, mod. D. Faber-Langendoen, K.A. Schulz, L. Allen, G. Kittel

REFERENCES: ANHIC n.d., Baker 1984a, Bell et al. 2009, Bourgeron and Engelking 1994, Brotherson and Barnes 1984, Bunin 1985, Butler et al. 2002, CONHP unpubl. data 2003, Carsey et al. 2003a, Carsey et al. 2003b, Christy 2004, Cogan et al. 2004, Cogan et al. 2005, Coles et al. 2008a, Coles et al. 2010, Cowardin et al. 1979, Crowe and Clausnitzer 1997, Crowe et al. 2004, Donnelly et al. 2006, Driscoll et al. 1984, Evans 1989b, Evenden 1990, Faber-Langendoen 2001, Flowers 1962, Hall and Hansen 1997, Hansen et al. 1995, Henderson and McAllister 1983, Hess 1981, IDCDC 2005, Jankovsky-Jones et al. 1999, Jankovsky-Jones et al. 2001, Johnston 1987, Jones 1992b, Jones and Walford 1995, Kagan et al. 2004, Kartesz 1994a, Kierstead and Pogson 1976, Kittel and Lederer 1993, Kittel et al. 1997a, Kittel et al. 1999a, Kittel et al. 1999b, Klein et al. 2007, Komarkova 1986, Kovalchik 1987, Kunze 1994, MTNHP 2002b, Manning 1988, Manning and Padgett 1991, Manning and Padgett 1992, Muldavin et al. 2000a, Muldavin et al. 2003, Muldavin et al. 2006, Murray 2000, Mutel 1973, Mutz and Graham 1982, Olson and Gerhart 1982, Owns et al. 2004, Padgett 1981, Padgett 1982, Padgett et al. 1989, Peterson 2008, Rector 1979, Reid et al. 2004, Richard et al. 1996, Salas et al. 2005, Shupe et al. 1986, Stewart 1940, TNC 1998d, Taylor 1980, Taylor and Teare 1979a, Thomas et al. 2009b, Thompson and Hansen 2002, Titus and Christy 1996a, Tuhy and Jensen 1982, Volland 1976, Von Loh et al. 2007, WNHP unpubl. data, Wasser and Hess 1982, Western Ecology Working Group n.d., Youngblood et al. 1985a

Poa pratensis Semi-natural Seasonally Flooded Herbaceous Vegetation

Kentucky Bluegrass Semi-natural Seasonally Flooded Herbaceous Vegetation

CODE	CEGL003081
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k.)
ALLIANCE	*POA PRATENSIS* SEMI-NATURAL SEASONALLY FLOODED HERBACEOUS ALLIANCE *(A.1382)* Kentucky Bluegrass Semi-natural Seasonally Flooded Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)
Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This semi-natural grassland is widespread in the western U.S. and northern Great Plains where it has invaded natural meadows and riparian areas. Sites are generally flat to moderately sloping and occur on all aspects. Stands typically occur on pastures found in the plains, montane meadows, stream benches and terraces. In the semi-arid region it is restricted to relatively mesic sites. Soils are highly variable, but *Poa pratensis* grows best on moist, fertile sandy to clayey alluvium with high organic content. It does not tolerate prolonged flooding, high water tables or poor drainage well. However, it can tolerate mildly alkaline and saline soils, and some drought. The vegetation is characterized by a moderate to dense herbaceous canopy that is strongly dominated by the introduced perennial, sod-forming graminoid *Poa pratensis*. *Poa pratensis* has invaded many natural plant associations, but the diagnostic character in this association is that there is typically not enough of the native grassland left to classify it as a poor condition natural type. Associates are often those early-seral and weedy species that tolerate the historic heavy livestock grazing or other disturbance well, such as *Achillea millefolium, Cirsium arvense, Elymus repens, Equisetum* spp., *Fragaria virginiana, Hordeum* spp., *Juncus balticus, Linaria vulgaris, Potentilla gracilis, Taraxacum officinale*, and introduced forage species such as *Agrostis stolonifera, Bromus inermis*, and *Phleum pratense*. Remnant natives *Pascopyrum smithii, Deschampsia caespitosa*, and *Carex* spp. are often present in low cover. Occasional trees and shrubs may also be present.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This non-native herbaceous association is rare within the park and is represented by one plot located in Salt Creek Canyon due west of Wedding Ring Arch.

Globally

This semi-natural grassland is widespread in the western U.S. and northern Great Plains.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This non-native herbaceous association was sampled in a single site on permanently saturated soils of a canyon floor. The site is flat and lies at 1799 m elevation. The unvegetated surface has a high cover of litter. The soil is a poorly drained silty clay derived from alluvium (primarily shale).

Globally

This semi-natural grassland is widespread in the western U.S. and northern Great Plains where it has invaded natural prairies, meadows and riparian areas. Elevation ranges from 1100-3200 m (3600-10,500 feet). Sites are generally flat to moderately sloping and occur on all aspects. Stands typically occur on pastures found in the plains, montane meadows, stream benches and terraces. In the semi-arid regions it is restricted to relatively mesic sites. Soils are

variable, but *Poa pratensis* grows best on moist, fertile sandy to clayey alluvium with high organic content (Hansen et al. 1995). It does not tolerate prolonged flooding, high water tables or poor drainage well. However, it can tolerate USGS-NPS mildly alkaline and saline soils, and some drought (Hansen et al. 1995, Hall and Hansen 1997, Kovalchik 1987, Manning and Padgett 1995, Padgett et al. 1989).

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This exotic-dominated herbaceous association is rare within the park, restricted to sites with saturated soils. Total vegetation cover is 53% and at the sampled site is characterized by a nearly pure stand of *Poa pratensis*. Other graminoids provide sparse cover, including *Elymus trachycaulus, Juncus balticus*, and *Carex* sp. *Rosa woodsii* provides sparse cover. The invasive tall shrub *Tamarix chinensis* occurs in adjacent habitats but not in the sampled plot.

Globally
This widespread, semi-natural plant association is characterized by a moderate to dense herbaceous canopy that is strongly dominated by the introduced perennial, sod-forming graminoid *Poa pratensis*. *Poa pratensis* has invaded many natural plant associations, but the diagnostic character in this association is that there is typically not enough of the native grassland left to classify it as a poor condition natural type. Associates are often those early-seral and weedy species that tolerate the historic heavy livestock grazing or other disturbance well, such as *Achillea millefolium, Cirsium arvense, Elymus repens, Equisetum* spp., *Fragaria virginiana, Hordeum* spp., *Juncus balticus, Linaria vulgaris, Potentilla gracilis, Taraxacum officinale*, and introduced forage species such as *Agrostis stolonifera, Bromus inermis*, and *Phleum pratense*. Remnant natives *Pascopyrum smithii, Deschampsia caespitosa*, and *Carex* spp. are often present in low cover. Occasional trees and shrubs may also be present.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Herb (field)	*Poa pratensis*

Globally

Stratum	Species
Herb (field)	*Poa pratensis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Exotic/Invasive: *Achillea millefolium* (invasive), *Agrostis stolonifera* (invasive, Medium/Low), *Bromus inermis* (invasive, High/Medium), *Cirsium arvense* (invasive, High/Medium), *Elymus repens* (invasive, High/Medium), *Linaria vulgaris* (invasive, High/Low), *Phleum pratense* (invasive, Medium), *Poa pratensis* (invasive, Medium), *Taraxacum officinale* (invasive)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNA (invasive) (17-Jun-1999).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

This type could be narrowly restricted to mixed-grass prairie stands where *Poa pratensis* dominates to the exclusion of most other species, or it could be expanded to include almost any naturalized stand dominated by *Poa pratensis*. Where native species are conspicuous enough to identify the native plant association that could occupy the site, the

stand should be typed as such. This type includes only naturalized examples of *Poa pratensis* stands. Maintained lawns are treated as cultural types.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Soggy, lowland soils collect water from the Salt Creek water table/drainage and several short side canyons to the east. It is unclear why neighboring *Tamarix chinensis* hasn't invaded. The hole created for soil texture test collected standing water.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0749).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: D. Faber-Langendoen, mod. K.A. Schulz

REFERENCES: Cogan et al. 2004, Franklin and Dyrness 1973, Hall 1973, Hall and Hansen 1997, Hansen et al. 1995, Kauffman et al. 1983, Kauffman et al. 1985, Kovalchik 1987, MTNHP 2002b, Manning and Padgett 1995, Marriott pers. comm., Padgett et al. 1989, Sawyer and Keeler-Wolf 1995, Tuhy and Jensen 1982, Volland 1978, Volland and Dell 1981, Western Ecology Working Group n.d., Youngblood et al. 1985a

Typha domingensis Western Herbaceous Vegetation

Southern Cattail Western Herbaceous Vegetation

CODE	CEGL001845
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k.)
ALLIANCE	*TYPHA DOMINGENSIS* SEASONALLY FLOODED TEMPERATE HERBACEOUS ALLIANCE (A.1392) Southern Cattail Seasonally Flooded Temperate Herbaceous Alliance

ECOLOGICAL SYSTEM(S): North American Arid West Emergent Marsh (CES300.729)
Inter-Mountain Basins Interdunal Swale Wetland (CES304.059)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This wetland association is widespread across the southwestern United States and Great Basin. 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. 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 *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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This herbaceous association is rare within the park and was represented by one plot located in Horseshoe Canyon, approximately 7.2 km (4.5 miles) from the west entrance and one plot at the confluence of Shot and Water Canyons.

Globally
This wetland association is widespread across the southwestern United States and Great Basin.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This herbaceous wetland association occurs on wash terraces and along intermittent streams where groundwater intercepts the surface. The sampled sites are flat and occur between 1200 and 1438 m elevation; the soils were saturated when sampled or water was at the surface. The unvegetated surface has moderate to high cover of litter, low exposure of bare soil, and low to moderate exposure of gravel, rocks, and bedrock. The soil is a somewhat poorly drained loam derived from alluvium.

Globally
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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This wetland type is rare within the park; it was sampled only twice on seasonally wet sites. Total vegetation cover is 8-56% and is characterized by variable cover by *Typha domingensis* with 2-25% total cover. Additional herbaceous species present include *Elymus canadensis, Equisetum arvense, Equisetum laevigatum, Phragmites australis, Juncus balticus, Muhlenbergia asperifolia, Panicum virgatum, Bromus tectorum, Xanthium strumarium, Cirsium* sp., *Iva acerosa*, and *Artemisia campestris*. Scattered *Populus fremontii* and *Salix exigua* provide sparse cover along the margins of the community and form dense stands on adjacent sites. *Populus fremontii* trees and seedlings occur within the plot and provide sparse cover, as do scattered *Tamarix chinensis* shrubs.

Globally
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)*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Herb (field)	*Juncus balticus*, *Phragmites australis*, *Typha domingensis*
Herb (field)	*Equisetum arvense*

Globally

Stratum	Species
Herb (field)	*Schoenoplectus acutus*, *Typha domingensis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G5? (20-Sep-2000).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The sampled plot represents a stand of *Typha domingensis* in an interfluve between two wash channels (which recently flowed). Ground in plot is completely saturated, and subsurface horizons must remain saturated all or most of the year to support this density of *Typha domingensis* and other wetland species. Plot area is probably seasonally flooded when water levels are high enough to fill the two main channels. *Typha domingensis* must out-compete *Populus fremontii* and *Salix exigua* because they are sparse in plot area but are dominant in surrounding areas along the wash that lack *Typha domingensis*.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY.0225, CANY.9054).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: M.S. Reid, mod. K. Schulz

REFERENCES: Baker 1982b, Baker 1983b, Bourgeron and Engelking 1994, Bundy et al. 1996, CONHP unpubl. data 2003, Driscoll et al. 1984, Haase 1972, Western Ecology Working Group n.d.

Phragmites australis Western North America Temperate Semi-natural Herbaceous Vegetation

Common Reed Western North America Temperate Semi-natural Herbaceous Vegetation

Western Reed Marsh

CODE	CEGL001475
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Semipermanently flooded temperate or subpolar grassland (V.A.5.N.l.)
ALLIANCE	*PHRAGMITES AUSTRALIS* SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1431) Common Reed Semipermanently Flooded Herbaceous Alliance

ECOLOGICAL SYSTEM(S): North American Arid West Emergent Marsh (CES300.729)
Northern Columbia Plateau Basalt Pothole Pond (CES304.058)
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

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, Schoenoplectus acutus (= Scirpus acutus)*, and *Typha latifolia* may be present.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This wetland association is rare within the park and recreation area and was sampled adjacent to Lost Canyon Trail, near Fort Bottom, in Water Canyon, in a canyon on the Green River below Candlestick Tower, and in Horse Canyon in Canyonlands National Park and near Flint Seep Road in Glen Canyon National Recreation Area.

Globally

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 and Texas. Its distribution is somewhat incomplete as not all states have listed semi-natural types in their state.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This wetland association occurs on perennially moist sites on canyon bottoms, terraces, and less often below seeps. Sites are on flat to steep slopes oriented generally to the south and lying between 1171 and 1967 m elevation. Litter covers most of the unvegetated surface, with lower cover by exposed soil and woody debris. Soils are poorly to moderately well-drained clay loams, sands, or sandy loams derived from colluvial or alluvial material.

Globally

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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This wetland association is restricted to perennially wet sites and is rare within the park and recreation area. Total vegetation cover ranges from 41 to over 100%. Stands are characterized by monocultures of *Phragmites australis* with between 22 and 98% cover. Other graminoids contribute sparse cover and include *Juncus balticus, Calamagrostis scopulorum, Distichlis spicata, Typha domingensis,* and *Equisetum* spp. Forbs are sparse but include *Comandra umbellata, Apocynum cannabinum, Iva acerosa*, and *Salsola tragus*. *Populus fremontii* and *Juniperus osteosperma* trees are scattered along the canyon bottoms and provide sparse cover in most stands. Shrubs present may include scattered individuals of *Salix lutea, Frangula betulifolia, Forestiera pubescens*, and *Tamarix chinensis*. Along seep margins, *Rhus trilobata, Shepherdia rotundifolia, Ericameria nauseosa, Eriogonum corymbosum*, and

Gutierrezia sarothrae provide sparse cover. The riparian vine *Clematis ligusticifolia* provides sparse cover in stands on canyon bottoms.

Globally
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. 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., *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, Solidago canadensis*, and *Taraxacum officinale*. Introduced species such as *Lepidium latifolium* and *Cirsium arvense* may be present and compete well against *Phragmites australis* in disturbed sites.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Salix lutea*
Herb (field)	*Clematis ligusticifolia*
Herb (field)	*Phragmites australis*
Herb (field)	*Equisetum hyemale*

Globally

Stratum	Species
Herb (field)	*Phragmites australis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Salsola tragus* (exotic), *Tamarix chinensis* (exotic)

Globally
Exotic/Invasive: *Agrostis gigantea* (exotic, Medium/Low), *Cirsium arvense* (exotic, High/Medium), *Lepidium latifolium* (exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (20-Sep-2000).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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* Eastern North America Temperate Semi-natural Herbaceous Vegetation (CEGL004141). The two types need to be better distinguished, both conceptually and nomenclaturally.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Herbaceous vegetation is dense and the ground surface is obscured by 5-7 cm of live litter. The seep community is controlled by the availability of water at or near the ground surface.

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (7 plots: CANY.0216, CANY.0673, CANY.9026, CANY.9051, CANY.9364, CANY.9375, GLCA.0530).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: D. Faber-Langendoen, mod. K. Schulz and J. Coles

REFERENCES: Bailey 1997, Bailey 1998, Baker 1982a, Baker 1984a, Bourgeron and Engelking 1994, Butler et al. 2002, CONHP unpubl. data 2003, 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. 2004, Kittel et al. 1995, Kittel et al. 1999b, MTNHP 2002b, NDNHI unpubl. data, Pool 1914, Romme et al. 1993, Steinauer and Rolfsmeier 2000, Von Loh 2000, Western Ecology Working Group n.d.

Calamagrostis scopulorum Hanging Garden Herbaceous Vegetation

Ditch Reedgrass Hanging Garden Herbaceous Vegetation

CODE	CEGL002751
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Saturated temperate or subpolar grassland (V.A.5.N.m.)
ALLIANCE	*CALAMAGROSTIS SCOPULORUM* SATURATED HANGING GARDEN HERBACEOUS ALLIANCE (A.2655) Ditch Reedgrass Saturated Hanging Garden Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Hanging Garden (CES304.764)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
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 chinensis, 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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This herbaceous association is rare and was sampled along seeps near Alcove Spring, in the South Fork of Horse Canyon, on the Neck Springs Trail, at the head of Taylor Canyon, and in a wash accessed by a trail from Lizard Rock.

Globally
This association has been documented from canyons in northwestern Colorado and eastern Utah.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This wet herbaceous type occurs on intermittently flooded wash banks and in seeps and hanging gardens underneath alcoves. Sites are flat to nearly vertical on walls (0- to 70-degree slopes), oriented from the southeast to the north,

and occur between 1397 and 1738 m elevation. Litter, rocks, and bedrock cover most of the unvegetated surface, with lesser cover by sand and bare soil. Soils are rapidly drained sands derived from Navajo sandstone or alluvium.

Globally
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 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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare wetland/hanging garden association has total vegetation cover ranging from 7 to 84%. *Calamagrostis scopulorum* dominates the community with up to 50% cover. In a few examples of this type, *Calamagrostis scopulorum* is codominant with either *Aquilegia micrantha* or *Primula specuicola.* A diversity of herbaceous species is generally present, including graminoids *Phragmites australis, Eleocharis rostellata, Muhlenbergia asperifolia, Equisetum laevigatum*, and *Schizachyrium scoparium* and forbs *Iva acerosa, Solidago velutina (= Solidago sparsiflora), Solidago canadensis, Castilleja linariifolia, Cirsium calcareum, Mimulus eastwoodiae, Comandra umbellata*, and *Heterotheca villosa*. Scattered shrubs occur around the margins of stands, which are sharply limited by water availability. Shrub species reported include *Salix eriocephala, Frangula betulifolia (= Rhamnus betulifolia)*, and *Yucca angustissima*.

Globally
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 chinensis, 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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Herb (field)	*Iva acerosa*
Herb (field)	*Calamagrostis scopulorum*, *Eleocharis rostellata*, *Phragmites australis*

Globally

Stratum	Species
Herb (field)	*Calamagrostis scopulorum*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Other: *Primula specuicola* (G4Q)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (11-Apr-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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*.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Debris piles upstream of plants in the wash and on lower bank suggest that this wash flows intermittently throughout the year. The abundance of *Phragmites australis* suggests that this part of the wash is more mesic. Seep includes flowing water. Fire scars and ash are seen throughout plot, as well as down slope of plot.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (10 plots: CANY.0103, CANY.0264, CANY.0433, CANY.9081, CANY.9113, CANY.9300, CANY.9379, CANY.9408, CANY.9409, CANY.9410).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: 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.

Krascheninnikovia lanata / Bouteloua gracilis Dwarf-shrub Herbaceous Vegetation

Winterfat / Blue Grama Dwarf-shrub Herbaceous Vegetation

Winterfat / Blue Grama Shrub Prairie

CODE	CEGL001321
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland with a sparse dwarf-shrub layer (V.A.8.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland with a sparse dwarf-shrub layer (V.A.8.N.)
FORMATION	Short temperate or subpolar lowland grassland with a sparse needle-leaved or microphyllous dwarf-shrub layer (V.A.8.N.a.)
ALLIANCE	*KRASCHENINNIKOVIA LANATA* DWARF-SHRUB HERBACEOUS ALLIANCE (A.1565) Winterfat Dwarf-shrub Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)
Central Mixedgrass Prairie (CES303.659)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This widespread, open dwarf-shrub type is found in the western Great Plains from eastern Wyoming, western Kansas, Colorado, and New Mexico to the Colorado Plateau and semi-desert mountains in the northern Chihuahuan Desert. This shrub herbaceous association occurs on alluvial flats, plains, mesas, and desert mountains. Stands occupy flat to moderate slopes between 1630 and 2130 m (5360-7000 feet) elevation. The sometimes rocky soils are typically shallow, alkaline, calcareous, and loamy or clayey in soil texture and are derived from shale or alluvium; elsewhere sites may have sandy, alluvial soil at the foot of sandstone cliffs. Ground cover ranges from bare soil to scattered bunch grasses and litter with exposed soil and gravel in the intergrass spaces. In Colorado Plateau stands, there is often significant cover of biotic crusts (to 30% cover). This community contains open shrub and graminoid

layers dominated by the shrub *Krascheninnikovia lanata* with a sparse to dense herbaceous understory dominated by *Bouteloua gracilis*. Other shrubs may be present with very low cover, including *Artemisia nova, Atriplex* spp., *Chrysothamnus greenei, Ephedra viridis, Gutierrezia sarothrae, Opuntia imbricata*, and *Opuntia polyacantha*. Associated graminoids present may include *Achnatherum hymenoides, Aristida purpurea, Elymus elymoides, Hesperostipa comata, Muhlenbergia torreyi, Pascopyrum smithii, Pleuraphis jamesii, Sporobolus airoides*, and *Sporobolus cryptandrus*. Forb cover is typically low but may be diverse.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This dwarf-shrubland is rare within the park and was sampled in a graben to the northwest of "Bobby's Hole" along a 4x4 road and east of Bobby Jo Camp.

Globally
This widespread, open dwarf-shrub type is found in the western Great Plains from western Kansas and eastern Colorado, to semi-desert mountains (Oscura and San Andres mountains) in south-central New Mexico, within Salinas Pueblo Missions National Monument in central New Mexico and El Malpais National Monument in western New Mexico, and the Colorado Plateau (northern Arizona and southern Utah). It is also reported from Wyoming. This associations is likely more widespread as the dominant/diagnostic species are common in the western U.S.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This dwarf-shrubland occurs in a graben and valley floor. Sites are flat to gently sloping (up to 3-degrees) and lie between 1691 and 1797 m elevation. Exposed soil covers most of the unvegetated surface, with moderate cover by litter. Well-developed biological soil crusts provide up to 30% cover. The soil is a deep, rapidly drained sandy loam.

Globally
This widespread, open dwarf-shrub type is found in the western Great Plains from eastern Wyoming, western Kansas, Colorado, and New Mexico semi-desert mountains (Oscura and San Andres mountains in south-central New Mexico; Salinas Pueblo Missions National Monument in central New Mexico) and the Colorado Plateau. This shrub herbaceous association occurs on alluvial flats, plains, mesas, and desert mountains. Stands occupy flat to moderate slopes between 1630 and 2130 m (5360-7000 feet) elevation. The sometimes rocky soils are typically shallow, alkaline, calcareous, and loamy or clayey in soil texture and are derived from shale or alluvium (Francis 1986, Lauver et al. 1999, Muldavin et al. 2000b); elsewhere sites may have sandy, alluvial soil at the foot of sandstone cliffs. In Kansas, stands occur in areas with sparse vegetation on uplands and flats. Soils are shallow, rocky, and alkaline (Lauver et al. 1999). Ground cover ranges from bare soil to scattered bunch grasses and litter with exposed soil and gravel in the intergrass spaces. In Colorado Plateau stands, there is often significant cover of biotic crusts (to 30% cover).

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This dwarf-shrubland is rare within the park. Total vegetation cover is 16-26%. Stands are characterized by an open shrub canopy dominated by *Krascheninnikovia lanata* (with between 5 and 20% cover) and an understory dominated by *Bouteloua gracilis* (with 4-5% cover). Associated shrub species include *Atriplex canescens* and *Coleogyne ramosissima*, each with no more than 1% cover. Associated herbaceous species include *Achnatherum hymenoides, Hesperostipa comata, Sporobolus cryptandrus, Bromus tectorum, Sphaeralcea coccinea, Alyssum alyssoides, Machaeranthera canescens, Cryptantha crassisepala, Gilia leptomeria, Helianthus petiolaris, Plantago patagonica*, and *Mentzelia albicaulis*.

Globally
This community contains open shrub and graminoid layers dominated by the shrub *Krascheninnikovia lanata* with a sparse to dense herbaceous understory dominated by *Bouteloua gracilis*. The dwarf-shrub layer is about 0.5 m tall, containing annual stems from a woody rootstock, and microphyllous leaves. Other shrubs may be present with very low cover, including *Artemisia nova, Atriplex* spp., *Chrysothamnus greenei, Ephedra viridis, Gutierrezia sarothrae, Opuntia imbricata*, and *Opuntia polyacantha*. Associated graminoids present may include *Achnatherum hymenoides, Aristida purpurea, Elymus elymoides, Hesperostipa comata, Muhlenbergia torreyi, Pascopyrum smithii, Pleuraphis jamesii, Sporobolus airoides*, and *Sporobolus cryptandrus* (Francis 1986, Muldavin et al. 2000b). Forb cover is typically low but may be diverse. Common species in the Colorado Plateau are *Chaetopappa*

ericoides, Cryptantha crassisepala, Gilia leptomeria, Helianthus petiolaris, Machaeranthera canescens, Mentzelia albicaulis, Plantago patagonica, Senecio spartioides, and *Sphaeralcea coccinea*; *Glandularia bipinnatifida* is the most constant in mountains of south-central New Mexico. In central New Mexico, *Lycium pallidum* is a common associate, possibly indicating disturbance. Forbs are common but variable; the most abundant are *Erysimum capitatum, Physalis hederifolia* var. *fendleri, Solanum jamesii*, and *Sphaeralcea incana*. In Kansas, *Stanleya pinnata*, a subshrubby perennial from a woody base, can be over 1 m tall and is often present; *Echinacea angustifolia* and *Liatris punctata* are often codominate with *Bouteloua gracilis* in the herbaceous layer. Exotic annual grass *Bromus tectorum* is frequently present in disturbed stands.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Krascheninnikovia lanata*
Herb (field)	*Bouteloua gracilis*

Globally

Stratum	Species
Short shrub/sapling	*Krascheninnikovia lanata*
Herb (field)	*Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: G4 (1-Feb-1996).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This plot represents a large homogenous area of many acres. The vegetation is quite homogenous on the gentle slopes of the graben bottom. The plot captures the density and diversity of the vegetation well.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0408) and 2008 Accuracy Assessment (1 point: CANY_AA.2825).
Local Description Authors: M. Smith, J. Von Loh and A. Tendick
Global Description Authors: K.A. Schulz, mod. K.S. King and M.E. Hall

REFERENCES: BIA 1979, Bourgeron and Engelking 1994, Daubenmire 1970, Driscoll et al. 1984, Francis 1986, Johnston 1987, Lauver et al. 1999, Muldavin and Mehlhop 1992, Muldavin et al. 1998d, Muldavin et al. 2000b, Rasmussen and Brotherson 1986, Soil Conservation Service 1978, Thomas et al. 2009a, Western Ecology Working Group n.d.

Sphaeralcea (coccinea, parvifolia) Herbaceous Vegetation

(Scarlet Globemallow, Narrowleaf Globemallow) Herbaceous Vegetation

CODE	CEGL005366
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial forb vegetation (V.B.)
PHYSIOGNOMIC GROUP	Temperate or subpolar perennial forb vegetation (V.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar perennial forb vegetation (V.B.2.N.)
FORMATION	Low temperate or subpolar perennial forb vegetation (V.B.2.N.b.)
ALLIANCE	*SPHAERALCEA (COCCINEA, PARVIFOLIA)* HERBACEOUS ALLIANCE (A.2688) (Scarlet Globemallow, Narrowleaf Globemallow Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This herbaceous association occurs in valleys in the Colorado Plateau. Sites are flat to gently sloping on stream terraces, grabens, and canyon and valley bottoms at 1197-1687 m elevation. There is moderate to high ground surface cover of bare soil and low to moderate cover of litter (1-50 %). Some stands have moderate cover of biological soil crusts (30-40%). Substrate is sandy soil derived from alluvium or eolian sand. Disturbance appears important in some stands; small mammal burrows are present on some sites. Presence of ruderal species indicates recent or past disturbance. The vegetation is characterized by an open to moderately dense, perennial herbaceous layer dominated by *Sphaeralcea coccinea* or *Sphaeralcea parvifolia* (less often) with 4-15% cover, often with *Achnatherum hymenoides* and/or *Sporobolus cryptandrus*. Scattered shrubs and dwarf-shrubs may be present such as *Atriplex canescens, Ephedra* spp., *Krascheninnikovia lanata*, and *Opuntia* spp. Other herbaceous species include *Cryptantha* spp., *Plantago patagonica, Pleuraphis jamesii, Oenothera pallida*, and *Rumex hymenosepalus*. Introduced annual species such as *Bromus tectorum* and *Salsola tragus* may be present.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is known from several sites on stream terraces or canyon bottoms in Butler Wash, Devil's Kitchen, Horsethief Bottom, Horse Canyon, northeast of Cow Deep Canyons and Red Lake Canyon, near the South Entrance of Canyonlands National Park, and a graben bottom near S.O.B. Hill.

Globally

This herbaceous association occurs in disturbed canyon bottoms and stream terraces in Arches and Canyonlands national parks and is likely widespread in the Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stands occur in valleys at 1197-1687 m elevation. Sites are flat to gently sloping on stream terraces, grabens, and canyon and valley bottoms. Ground surface ranges from 46-97% cover bare soil and low cover of litter (1-15%). A couple stands have moderate cover of biological soil crusts (30-40%). Substrate is sandy soil with one site occurring on eolian sand. Disturbance appears important in some stands; small mammal burrows are present on some sites. Presence of ruderal species indicates recent or past disturbance.

Globally

Stands occur in valleys in the Colorado Plateau. Sites are flat to gently sloping on stream terraces, grabens, and canyon and valley bottoms at 1197-1687 m elevation. Ground surface ranges from 46-97% cover bare soil and low cover of litter (1-15%). A few known stands had moderate cover of biological soil crusts (30-40%). Substrate is sandy soil with one known site occurring on eolian sand. Disturbance appears important in some stands; small mammal burrows are present on some sites. Presence of ruderal species indicates recent or past disturbance.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is characterized by an open to moderately dense herbaceous layer dominated by *Sphaeralcea coccinea* or *Sphaeralcea parvifolia* with 8-14% cover, often with *Achnatherum hymenoides* and *Sporobolus*

cryptandrus. Scattered shrubs and dwarf-shrubs may be present such as *Atriplex canescens, Ephedra torreyana, Krascheninnikovia lanata*, and *Opuntia erinacea*. Other herbaceous species include *Cryptantha crassisepala, Hesperostipa comata, Mentzelia albicaulis, Oenothera pallida, Plantago patagonica, Pleuraphis jamesii, Rumex hymenosepalus*, and *Townsendia annua*. Introduced species such as *Bromus tectorum, Helianthus annuus*, or *Salsola tragus* are frequently present.

Globally
This association is characterized by an open to moderately dense, perennial herbaceous layer dominated by *Sphaeralcea coccinea* or *Sphaeralcea parvifolia* with 4-15%, often with *Achnatherum hymenoides* and/or *Sporobolus cryptandrus*. Scattered shrubs and dwarf-shrubs may be present such as *Atriplex canescens, Ephedra torreyana, Hesperostipa comata, Krascheninnikovia lanata, Opuntia erinacea*, and *Opuntia polyacantha*. Other herbaceous species include *Cryptantha crassisepala, Machaeranthera tanacetifolia, Mentzelia albicaulis, Plantago patagonica, Pleuraphis jamesii, Oenothera pallida, Rumex hymenosepalus*, and *Townsendia annua*. Introduced annual species such as *Bromus tectorum, Helianthus annuus*, or *Salsola tragus* are frequently present.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Herb (field)	*Sphaeralcea coccinea*, *Sphaeralcea parvifolia*

Globally

Stratum	Species
Herb (field)	*Sphaeralcea coccinea*, *Sphaeralcea parvifolia*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (6-May-2008).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (8 plots: CANY 0198, CANY 0222, CANY 0372, CANY 0556, CANY 0558, CANY 0560, CANY 0564, CANY 0573).
Local Description Authors: K.A. Schulz
Global Description Authors: K.A. Schulz

REFERENCES: Coles et al. 2009a, Western Ecology Working Group n.d.

Salsola spp. Semi-natural Herbaceous Vegetation [Provisional]

Russian-thistle species Semi-natural Herbaceous Vegetation

CODE	CEGL004004
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial forb vegetation (V.B.)
PHYSIOGNOMIC GROUP	Temperate or subpolar perennial forb vegetation (V.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar perennial forb vegetation (V.B.2.N.)
FORMATION	Intermittently flooded temperate perennial forb vegetation (V.B.2.N.c.)
ALLIANCE	*SUAEDA CALCEOLIFORMIS* INTERMITTENTLY FLOODED HERBACEOUS ALLIANCE (A.2689) Pursh Seepweed Intermittently Flooded Herbaceous Alliance

ECOLOGICAL SYSTEM(S):

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This herbaceous association is known from Canyonlands National Park and Great Sand Dunes National Monument and occurs on floodplains, canyon bottoms, playas, and on active sand dunes. Sites are on flat to steep slopes (0-25 degrees) between 1195 and 2297 m elevation. 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. Soils are moderately well-drained to rapidly drained sands, silt loams, or clays derived from alluvium. 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. Some areas with fine-textured soils lack biological soil crusts, but sandy sites can have as much as 60% cover.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This herbaceous association was sampled on sandy soils in low-lying areas and on sand dunes within the park. Sites sampled include Anderson Bottom, Valentine Bottom, Surprise Valley, Potato Bottom, Fort Bottom, Millard Canyon Benches, the Gap, and Horse, Horseshoe, and Little Bridge canyons.

Globally

This herbaceous association is known from Canyonlands National Park in Utah and Great Sand Dunes National Monument in Colorado.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This herbaceous association occurs on floodplains, canyon bottoms, and on active sand dunes. Sites are on flat to steep slopes (0-25 degrees) between 1195 and 1692 m elevation. 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. Soils are moderately well-drained to rapidly drained sands or silt loams derived from alluvium or from Elephant Canyon Formation.

Globally

This herbaceous association is known from Canyonlands National Park and Great Sand Dunes National Monument and occurs on floodplains, canyon bottoms, playas, and on active sand dunes. Sites are on flat to steep slopes (0-25 degrees) between 1195 and 2297 m elevation. 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. Soils are moderately well-drained to rapidly drained sands, silt loams, or clays derived from alluvium.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This Russian-thistle type occurs in disturbed areas within the park. Total vegetation cover varies depending on spring precipitation and the time of year the site is sampled, ranging from 3 to 34%. The 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*, 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. Some areas with fine-textured soils lack biological soil crusts, but sandy sites can have as much as 60% cover.

Globally

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. Some areas with fine-textured soils lack biological soil crusts, but sandy sites can have as much as 60% cover.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Herb (field)	*Cleome lutea*, *Plantago patagonica*, *Salsola tragus*, *Sphaeralcea coccinea*
Herb (field)	*Bromus tectorum*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High), *Halogeton glomeratus* (exotic, High/Medium), *Salsola tragus* (exotic)

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (14-Jul-2006).

CLASSIFICATION COMMENTS

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Sites are subject to wind erosion and shifting sands, as shown by shrubs sitting atop mounds of sand. Areas on a bench above the Colorado River appear to be highly disturbed by grazing cattle. *Atriplex* spp. shrubs are dead or dying throughout the area due to ongoing drought.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (9 plots: CANY 0206, CANY 0210, CANY 0279, CANY 0282, CANY 0544, CANY 0574, CANY 0586, CANY 0636, CANY 0819).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: M.E. Hall

REFERENCES: Peterson 2008, Western Ecology Working Group n.d.

Aquilegia micrantha Herbaceous Vegetation

Mancos Columbine Herbaceous Vegetation

CODE	CEGL002762
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial forb vegetation (V.B.)
PHYSIOGNOMIC GROUP	Temperate or subpolar perennial forb vegetation (V.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar perennial forb vegetation (V.B.2.N.)
FORMATION	Saturated temperate perennial forb vegetation (V.B.2.N.f.)
ALLIANCE	*AQUILEGIA MICRANTHA* SATURATED HANGING GARDEN HERBACEOUS ALLIANCE (A.2506) Mancos Columbine Saturated Hanging Garden Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Hanging Garden (CES304.764)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This association is restricted to perennial seeps in crevices, ledges, and alcoves in sandstone canyon walls in western Colorado. Sites may be on inaccessible cliff faces or moderate to steep ledgy canyon slopes oriented to any aspect. Soils are sandy, poorly drained and often have a white salt crust on the surface. The underlying geology is usually sandstone or a fine conglomerate, and is often extensively exposed throughout stands of this association. Stands are often linear, following horizontal joints in the bedrock from which groundwater emerges. Changes in the seasonality, quantity or chemistry of the groundwater may result in changes in community extent, density and composition. The vegetation consists primarily of forb species, among which *Aquilegia micrantha* is always present and often patchily dominant. Other forb species that are often present include *Cirsium calcareum* and *Solidago simplex*, as well as the lianas *Toxicodendron rydbergii* and *Clematis ligusticifolia*. *Calamagrostis scopulorum* and *Mimulus eastwoodiae* are absent. Graminoids contribute little cover within the garden but may be more abundant in the plunge pools at the base of the cliff or the apron of eroded debris below the seep. Scattered shrubs and trees are often present, either within the garden or also rooted in the debris apron. Woody species vary from site to site but often include *Pinus edulis, Juniperus osteosperma, Fraxinus anomala, Cercocarpus intricatus*, and *Amelanchier utahensis*.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
These hanging gardens occur in alcoves set within sandstone cliffs in the south fork of Horse Canyon, Water Canyon, Ernie's Country and west of Whitmore Arch within the park.

Globally
This association has been documented only from hanging gardens in Colorado National Monument in western Colorado. It is likely to occur elsewhere in the canyons of western Colorado and possibly eastern Utah in sites where *Calamagrostis scopulorum* and *Mimulus eastwoodiae* do not grow.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This hanging garden association occurs in alcove seeps on steep sandstone cliffs. Sites are steep and include nearly vertical backwalls of alcoves (12-35 degree slope). Sites occur on all aspects between 1480 and 1604 m elevation. The unvegetated surface has moderate to high exposure of bare soil, bedrock, and litter and little cover by gravel. Soils are somewhat poorly drained to moderately well-drained sandy loams, loams, silt loams, or silt clay loams derived from Cedar Mesa sandstone, Wingate sandstone, or White Rim sandstone.

Globally

This association is restricted to perennial seeps in crevices, ledges, and alcoves in sandstone canyon walls in the Colorado Plateau. Sites may be on inaccessible cliff faces or moderate to steep slopes oriented to any aspect. Soils are sandy, poorly drained and often have a white salt crust on the surface. The underlying geology is usually sandstone or a fine conglomerate, and is often extensively exposed throughout stands of this association.

Dynamics: These communities are dependent on a steady supply of groundwater throughout the growing season. Changes in the seasonality, quantity or chemistry of the groundwater may result in changes in community extent, density and composition.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This hanging garden community is restricted to alcoves created by perennial seeps emerging from sandstone cliffs. Total vegetation cover ranges from 28 to 72% and is characterized by the forb *Aquilegia micrantha* with between 20 and 40% cover. *Pinus edulis* trees and the tall shrubs *Frangula betulifolia (= Rhamnus betulifolia)* and *Mahonia fremontii* are rarely observed and provide up to 1% cover. The remaining herbaceous layer contributes low to moderate cover; common associated species include *Typha domingensis, Adiantum capillus-veneris, Heterotheca villosa, Muhlenbergia asperifolia,* and *Smilacina stellata*.

Globally

This cliff-based herbaceous wetland type is unique to the Colorado Plateau. Stands are often linear, following horizontal joints in the bedrock from which groundwater emerges. The vegetation consists primarily of forb species, among which *Aquilegia micrantha* is always present and often patchily dominant. Other forb species that are often present include *Cirsium calcareum, Solidago simplex*, and *Artemisia ludoviciana*. The lianas *Toxicodendron rydbergii* and *Clematis ligusticifolia* may also be present. *Calamagrostis scopulorum* and *Mimulus eastwoodiae* are absent. Graminoids contribute little cover within the garden but may be more abundant in the plunge pools at the base of the cliff or the apron of eroded debris below the seep. Scattered shrubs and trees are often present, either within the garden or rooted in the debris apron. Woody species vary from site to site but often include *Pinus edulis, Juniperus osteosperma, Fraxinus anomala, Cercocarpus intricatus*, and *Amelanchier utahensis*.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Herb (field)	*Aquilegia micrantha*
Herb (field)	*Adiantum capillus-veneris*

Globally

Stratum	Species
Herb (field)	*Aquilegia micrantha*
Herb (field)	*Cirsium calcareum*
Herb (field)	*Clematis ligusticifolia*
Herb (field)	*Toxicodendron rydbergii*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Vulnerable: *Carex curatorum* (rare/endemic, G2), *Epipactis gigantea* (rare/endemic, G4), *Mimulus eastwoodiae* (rare/endemic, G3G4), *Primula specuicola* (rare/endemic, G4Q)

Globally
Vulnerable: *Carex curatorum* (globally imperiled, G2), *Erigeron kachinensis* (globally imperiled; endemic to hanging gardens, G2), *Mimulus eastwoodiae* (endemic to hanging gardens, G3G4), *Platanthera zothecina* (globally imperiled, G2), *Zigadenus vaginatus* (globally imperiled, G2); **Exotic/Invasive**: *Tamarix chinensis* (exotic); **Other**: *Primula specuicola* (endemic to hanging gardens, G4Q), *Toxicodendron radicans* (dangerous plant - poison-ivy, G5)

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.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This association is part of a complex of herbaceous communities collectively know as "hanging gardens." Few systematic studies of these communities have been completed, and little quantitative data are available, partly because stands can be difficult or dangerous to access. 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).

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: We are observing seep/spring vegetation growing out of and beneath a crack running along a concave slope in Cedar Mesa cliff. Vegetation is growing out of powdery white soil and many layers of dead (now dry) spongy mat of litter. Moisture is only visible seeping out of one place beneath the thick mat of plants. Very lush-looking community despite the lack of visible moisture!
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (4 plots: CANY.9078, CANY.9080, CANY.9377, CANY.9420).
Local Description Authors: A. Tendick
Global Description Authors: J. Coles

REFERENCES: Spence n.d., Western Ecology Working Group n.d.

Aquilegia micrantha - Mimulus eastwoodiae Herbaceous Vegetation

Mancos Columbine - Eastwood's Monkeyflower Herbaceous Vegetation

CODE	CEGL002729
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial forb vegetation (V.B.)
PHYSIOGNOMIC GROUP	Temperate or subpolar perennial forb vegetation (V.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar perennial forb vegetation (V.B.2.N.)
FORMATION	Saturated temperate perennial forb vegetation (V.B.2.N.f.)
ALLIANCE	*AQUILEGIA MICRANTHA* SATURATED HANGING GARDEN HERBACEOUS ALLIANCE (A.2506) Mancos Columbine Saturated Hanging Garden Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Hanging Garden (CES304.764)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

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. 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 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. 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 include *Adiantum capillus-veneris, Aquilegia micrantha, Mimulus eastwoodiae, Cirsium* spp., *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, 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*, and *Cercocarpus montanus*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

These hanging gardens occur in alcoves set within sandstone cliffs in Horse Canyon, near Upheaval Dome, and below the White Rim within the park.

Globally

This association is restricted to massive sandstone cliffs and slopes in canyons of the Colorado Plateau in western Colorado and southeastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This hanging garden association occurs in alcoves on steep sandstone cliffs. Sites are steep and include vertical backwalls and ceilings of alcoves. Sites occur on all aspects between 1373 and 1550 m elevation. The unvegetated surface has sparse to moderate exposure of bare soil and bedrock and cover of rocks and litter. The parent materials are sandstones including Cutler Group. Soils are somewhat poorly drained to moderately well-drained sandy loams, loams, silt loams, or silt clay loams derived from Cedar Mesa sandstone, Wingate sandstone, or White Rim sandstone.

Globally

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.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This hanging garden community is restricted to alcoves created by perennial seeps emerging from sandstone cliffs. Total vegetation cover ranges from 30 to 66% and is characterized by the forbs *Aquilegia micrantha* and *Mimulus eastwoodiae* with between 1 and 40% cover. *Pinus edulis* seedlings and the tall shrub *Frangula betulifolia (=*

Rhamnus betulifolia) are rarely observed and provide up to 1% cover. The remaining herbaceous layer contributes low to moderate cover; common associated species include *Carex aurea, Calamagrostis canadensis, Carex curatorum, Phragmites australis, Primula specuicola, Solidago canadensis*, and *Cirsium rydbergii*.

Globally
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, 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*, and *Cercocarpus montanus*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Herb (field)	*Aquilegia micrantha*, *Mimulus eastwoodiae*, *Primula specuicola*, *Solidago canadensis*
Herb (field)	*Carex aurea*, *Carex curatorum*

Globally

Stratum	Species
Herb (field)	*Aquilegia micrantha*, *Mimulus eastwoodiae*
Herb (field)	*Adiantum capillus-veneris*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Vulnerable: *Carex curatorum* (rare/endemic, G2), *Epipactis gigantea* (rare/endemic, G4), *Mimulus eastwoodiae* (rare/endemic, G3G4), *Primula specuicola* (rare/endemic, G4Q)

Globally
Vulnerable: *Carex curatorum* (globally imperiled, G2), *Erigeron kachinensis* (globally imperiled; endemic to hanging gardens, G2), *Mimulus eastwoodiae* (endemic to hanging gardens, G3G4), *Platanthera zothecina* (globally imperiled, G2), *Zigadenus vaginatus* (globally imperiled, G2); **Exotic/Invasive**: *Tamarix chinensis* (exotic); **Other**: *Primula specuicola* (endemic to hanging gardens, G4Q), *Toxicodendron radicans* (dangerous plant - poison-ivy, G5)

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.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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).

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Small amounts of water dripping out of the base of the Cedar Mesa overhang.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY 0250, CANY 0283, CANY 0521).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Spence, mod. J. Coles and K.A. Schulz

REFERENCES: CONHP unpubl. data 2003, 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. 2010, Spence pers. comm., Welsh 1989, Welsh and Toft 1981, Western Ecology Working Group n.d.

Bromus tectorum Semi-natural Herbaceous Vegetation

Cheatgrass Semi-natural Herbaceous Vegetation

Cheatgrass Annual Grassland

CODE	CEGL003019
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Annual graminoid or forb vegetation (V.D.)
PHYSIOGNOMIC GROUP	Temperate or subpolar annual grasslands or forb vegetation (V.D.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar annual grasslands or forb vegetation (V.D.2.N.)
FORMATION	Short temperate annual grassland (V.D.2.N.d.)
ALLIANCE	*BROMUS TECTORUM* SEMI-NATURAL HERBACEOUS ALLIANCE (A.1814) Cheatgrass Semi-natural Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This herbaceous vegetation type is found throughout much of western North America from the western Great Plains to the Intermountain West. 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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Though it is common in small, often dense patches and as a component in other associations occupying disturbed sites, large, homogenous stands of cheatgrass are less common within Canyonlands National Park. Plots sampled in the park are found in Grey's Pasture, near Lathrop trailhead, upper Salt Creek, above Water Canyon, near Bobby Jo camp in the Grabens, in Cross Canyon, Chesler Park, Horse Canyon, near Butler Wash, and in Spanish Bottom. Plots sampled in the recreation are 30 m west of the road towards Red Point and 750 m southeast of Waterhole Flat.

Globally
This alliance-level herbaceous vegetation type is found throughout much of western North America from the western Great Plains to intermountain and southwestern U.S.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This non-native grassland association occurs on broad, open flats on plateaus, in grabens and in other valley or canyon bottoms, as well as on terraces, hillsides, toeslopes, and falling dunes. Sites slope gently (0 to 7 degrees), in general, though one site sampled was at 34 degrees, are oriented in all directions, and occur between 1173 and 1810 m elevation. The unvegetated surface has low to high exposure of bare soil, low to high cover by litter, absent to moderate cover by biological soil crusts, and occasionally some small rock, bedrock, and sand cover. Soils are rapidly drained loamy sands or sandy loams.

Globally
This herbaceous vegetation type is found throughout much of western North America from the western Great Plains to the Intermountain and southwestern U.S. Elevation ranges from 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). At Wind Cave National Park in South Dakota, weedy non-native graminoid vegetation occurs on recently disturbed areas, most commonly along roads. Small stands also occur in prairie dog towns (H. Marriott pers. comm. 1999). 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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Total vegetation cover in cheatgrass grasslands ranges between 2 and 93%, depending on site conditions and spring precipitation. *Bromus tectorum* forms a near monoculture (2-90%) with scattered tufts of remnant native grass species, including *Hesperostipa comata, Pleuraphis jamesii, Achnatherum hymenoides, Bouteloua gracilis, Bouteloua barbata, Sporobolus cryptandrus*. Scattered shrubs may be present, including *Fraxinus anomala, Mahonia fremontii, Ephedra viridis, Krascheninnikovia lanata, Coleogyne ramosissima, Atriplex canescens, Ericameria nauseosa, Tetradymia canescens, Vanclevia stylosa, Gutierrezia sarothrae*, and the succulents *Opuntia phaeacantha, polyacantha,* or *whipplei*. *Juniperus osteosperma* seedlings and trees occasionally provided sparse cover. Forb cover is sparse to low and includes *Plantago patagonica, Descurainia pinnata, Sphaeralcea parvifolia, Salsola tragus, Machaeranthera canescens, Streptanthella longirostris, Lappula occidentalis, Artemisia dracunculus,* and *Sphaeralcea coccinea.*

Globally
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 dwarf-shrubs, especially *Chrysothamnus viscidiflorus, Ericameria nauseosa, Ephedra viridis, Gutierrezia sarothrae*, and *Opuntia polyacantha*, may be present with low cover. At Wind Cave National Park in South Dakota, this weedy non-native graminoid vegetation is usually dominated by several perennial and annual brome grasses, including *Bromus inermis, Bromus japonicus*, and *Bromus tectorum*. Cover is variable (H. Marriott pers. comm. 1999), and in drought years, *Bromus tectorum* may be sparse or absent.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Opuntia phaeacantha*
Herb (field)	*Bromus tectorum*

Globally

Stratum	Species
Herb (field)	*Bromus hordeaceus*, *Bromus japonicus*, *Bromus madritensis*, *Bromus rigidus*, *Bromus rubens*, *Bromus tectorum*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Exotic/Invasive: *Bromus carinatus* (weedy native), *Bromus hordeaceus* (exotic), *Bromus japonicus* (exotic), *Bromus madritensis* (exotic), *Bromus rigidus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNA (invasive) (1-Dec-1997).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This alliance 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).

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This slightly sloping area was once heavily grazed, as shown by the exotic plant abundance, the *Opuntia erinacea* density, and cattle manure.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: GLCA.0591, GLCA.0595) and 2007 and 2008 Accuracy Assessment (15 points: CANY_AA.0464, CANY_AA.0513, CANY_AA.0884, CANY_AA.2037, CANY_AA.2101, CANY_AA.2415, CANY_AA.2447, CANY_AA.2694, CANY_AA.2803, CANY_AA.2810, CANY_AA.2819, CANY_AA.2963, CANY_AA.4029, CANY_AA.4163, and CANY_AA.4350).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: D. Faber-Langendoen, mod. K. 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, Daubenmire 1975, Englund 2004, Evans et al. 2001, FEIS 2001, Hansen et al. 2003, Hansen et al. 2004d, Karl et al. 1999, Marriott pers. comm., Naumann pers. comm., Peterson 2008, Redente et al. 1992, Romme et al. 1993, Sawyer and Keeler-Wolf 1995, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d., Young and Evans 1973, Young and Evans 1978

Cercocarpus intricatus Slickrock Sparse Vegetation

Littleleaf Mountain-mahogany Slickrock Sparse Vegetation

CODE	CEGL002977
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII)
PHYSIOGNOMIC SUBCLASS	Consolidated rock sparse vegetation (VII.A.)
PHYSIOGNOMIC GROUP	Sparsely vegetated pavement (VII.A.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural sparsely vegetated pavement (VII.A.2.N.)
FORMATION	Pavement with sparse vascular vegetation (VII.A.2.N.a.)
ALLIANCE	*CERCOCARPUS INTRICATUS* SPARSELY VEGETATED ALLIANCE (A.2543) Littleleaf Mountain-mahogany Sparsely Vegetated Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Cliff and Canyon (CES304.779)
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This sparse shrubland association is restricted to exposures of massive sandstones such as on the Colorado Plateau. Elevations range between 1412 and 2348 m (4630-7700 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. Most of the surface is sandstone, sometimes nearly covered by lichens. 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)*, 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* of *Juniperus osteosperma* may occur.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally

This association has been described from National Park Service units in southern and eastern Utah and western Colorado with extensive exposures of massive sandstones.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparsely vegetated association occurs on slickrock exposures on canyon rims and slopes, benches, and mesa slopes. Sites are flat to steep (up to 35-degree slope) and lie between 1367 and 1829 m elevation. Sandstone bedrock covers most of the unvegetated surface, with lesser cover by bare soil. Litter and biological soil crusts have sparse cover. Soils are rapidly drained sandy loams or loamy sands derived from Navajo sandstone, White Rim sandstone of the Cutler Group, or Cedar Mesa sandstone.

Globally

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 1412 and 2348 m (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.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparse slickrock vegetation type's total vegetation cover is limited by a lack of rooting sites for woody species; it ranges from 3 to 26%. The vegetation is characterized by scattered *Cercocarpus intricatus* shrubs with not more than 5% 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 torreyana, Ephedra viridis, Rhus trilobata* var. *simplicifolia (= Rhus aromatica* var. *simplicifolia), Gutierrezia*

sarothrae, Yucca angustissima, and *Brickellia microphylla*. The herbaceous layer contributes only a few percent cover but may be relatively diverse. Graminoids include *Pleuraphis jamesii, Achnatherum hymenoides, Aristida purpurea*, and *Bromus tectorum*. Forbs were variable among plots; common species include *Arenaria fendleri, Chamaesyce fendleri, Tetraneuris acaulis (= Hymenoxys acaulis), Lepidium montanum, Cryptantha flava*, and *Sphaeralcea leptophylla*.

Globally
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, 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* of *Juniperus osteosperma* may occur. Colorful lichens may cover much of the surface of the exposed bedrock.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Coleogyne ramosissima*
Short shrub/sapling	*Artemisia bigelovii*, *Cercocarpus intricatus*, *Ephedra torreyana*
Herb (field)	*Gutierrezia sarothrae*, *Yucca angustissima*
Herb (field)	*Achnatherum hymenoides*, *Pleuraphis jamesii*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Cercocarpus intricatus*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (22-Jan-2002).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This sparsely vegetated slickrock association is widely distributed within the park and recreation area and was sampled near Ekker Butte, near Musselman Arch, adjacent to White Crack Campground, on Horseshoe Canyon Trail, on Tuxedo Bottom Overlook, along the rim of Horse Canyon, adjacent to White Rim Road, and 750 m south of Salt Creek Campground in Canyonlands National Park and on Ekker Butte in Glen Canyon National Recreation Area.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (19 plots: CANY 0245, CANY 0268, CANY 0350, CANY 0418, CANY

0538, CANY 0540, CANY 0649, CANY 0658, CANY 0662, CANY 0664, CANY 0713, CANY 0730, CANY 0735, CANY 0750, CANY 0825, CANY 9070, CANY 9366, CANY 9743, GLCA 0547).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles

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.

Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation

Torrey's Joint-fir - (Fourwing Saltbush, Shadscale) Sparse Vegetation

CODE	CEGL005801
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII)
PHYSIOGNOMIC SUBCLASS	Unconsolidated material sparse vegetation (VII.C.)
PHYSIOGNOMIC GROUP	Sparsely vegetated soil slopes (VII.C.3.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural sparsely vegetated soil slopes (VII.C.3.N.)
FORMATION	Dry slopes (VII.C.3.N.b.)
ALLIANCE	*EPHEDRA TORREYANA* SPARSELY VEGETATED ALLIANCE (A.2571) Torrey's Joint-fir Sparsely Vegetated Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)
Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This sparsely vegetated association is widely distributed locally in Canyonlands National Park and Glen Canyon National Recreation Area in Utah, but is also found in northern Arizona. 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 1183 to 1603 m. Substrates vary from rapidly drained clay soils to sand derived from colluvium or alluvium, riverine and basaltic cobbles, and sandstone bluffs. This sparsely vegetated shrubland is characterized by *Ephedra torreyana* with between 1 and 5% cover, usually accompanied by *Atriplex confertifolia* and/or *Atriplex canescens* as codominant species with associated shrubs contributing 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*.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparsely vegetated association is common and widely distributed within the park and recreation area. It was sampled north of Taylor Camp, 1.5 km southeast of the Taylor Canyon Trailhead parking area, south of Musselman Arch, south of Little Bridge Canyon, in Shot Canyon, near Lathrop Canyon, 600 m south of Candlestick Campground, on Holeman Springs Basin, near Canyonlands Overlook, adjacent to the Syncline Loop and Upheaval Canyon trails, near South Fork Canyon Road, in Red Lake and Dog Leg canyons, along the Colorado River, and along White Rim Road in Canyonlands National Park and near Millard Canyon and Ekker Campgrounds, in Big Water Canyon, on Anderson Bottom, in Deadhorse Canyon, and in Millard Canyon in Glen Canyon National Recreation Area.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

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. Sites are flat to steep (0- to 36-degree slopes) and occur on all aspects between 1183 m and 1603 m elevation. Bare soil or gravel cover most of the unvegetated surface, with lesser cover by litter, large rocks and biological soil crusts. Soils are rapidly drained and variable in texture from clay loam to sand, being derived from alluvium, colluvium, or rocks of the Chinle Formation, Cedar Mesa sandstone, Moenkopi Formation, or Cutler Group.

Globally
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- to 36-degree slopes) on all aspects at elevations from 1183 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.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparse mixed desert shrubland is common and distributed widely throughout the park and recreation area. Total vegetation cover ranges from less than 1 to 15%. The open shrub canopy is dominated by *Ephedra torreyana* with between 1 and 5% cover, usually accompanied by *Atriplex confertifolia* and/or *Atriplex canescens* as codominant species. Other associated shrubs never contribute more than 5% cover and include *Ericameria nauseosa, Coleogyne ramosissima, Eriogonum corymbosum, Gutierrezia sarothrae, Xylorhiza tortifolia, Opuntia erinacea, Opuntia polyacantha, Gutierrezia microcephala*, and *Sclerocactus whipplei*. 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*. Biological soil crust cover is variable, with some stands having none, but cover can be as high as 59%.

Globally
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
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*, *Coleogyne ramosissima*, *Ericameria nauseosa* var. *juncea*
Short shrub/sapling	*Atriplex canescens*, *Ephedra torreyana*
Herb (field)	*Gutierrezia sarothrae*, *Xylorhiza tortifolia*
Herb (field)	*Eriogonum inflatum*
Herb (field)	*Achnatherum hymenoides*, *Bromus tectorum*, *Pleuraphis jamesii*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Halogeton glomeratus* (exotic, High/Medium), *Salsola paulsenii* (exotic, Low), *Salsola tragus* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (29-Aug-2002).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This community is controlled by runoff from uplands and exposure to sun and wind.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (54 plots: CANY 0134, CANY 0137, CANY 0151, CANY 0152, CANY 0160, CANY 0162, CANY 0256, CANY 0343, CANY 0346, CANY 0354, CANY 0367, CANY 0369, CANY 0399, CANY 0400, CANY 0402, CANY 0403, CANY 0405, CANY 0406, CANY 0507, CANY 0509, CANY 0517, CANY 0523, CANY 0525, CANY 0551, CANY 0595, CANY 0599, CANY 0602, CANY 0605, CANY 0606, CANY 0607, CANY 0652, CANY 0659, CANY 0660, CANY 0661, CANY 0674, CANY 0709, CANY 0710, CANY 0722, CANY 0794, CANY 0829, CANY 0833, GLCA 0114, GLCA 0121, GLCA 0123, GLCA 0124, GLCA 0125, GLCA 0129, GLCA 0320, GLCA 0327, GLCA 0328, GLCA 0535, GLCA 0727, GLCA 0731, GLCA 0737).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: M.E. Hall

REFERENCES: Coles et al. 2003, Hansen et al. 2004b, Western Ecology Working Group n.d.

Ephedra torreyana - (Atriplex spp.) / Nonvascular Gypsum Sparse Vegetation

Torrey's Joint-fir - (Saltbush species) / Nonvascular Gypsum Sparse Vegetation

CODE	CEGL002349
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII)
PHYSIOGNOMIC SUBCLASS	Unconsolidated material sparse vegetation (VII.C.)
PHYSIOGNOMIC GROUP	Sparsely vegetated soil slopes (VII.C.3.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural sparsely vegetated soil slopes (VII.C.3.N.)
FORMATION	Dry slopes (VII.C.3.N.b.)
ALLIANCE	*EPHEDRA TORREYANA* SPARSELY VEGETATED ALLIANCE (A.2571) Torrey's Joint-fir Sparsely Vegetated Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)
Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

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- to 36-degree 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*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare association was sampled in Potato Bottom Basin 3 km east of the Green River, on the White Rim, in Trail Canyon, Horseshoe Canyon, and on the Wilhite Trail.

Globally

This association is known from gypsum outcrops and soils in eastern Utah and western Colorado.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparsely vegetated association was sampled on gypsum badlands at all aspects, on moderate to steep slopes (5 to 31 degrees), and between 1280 m and 1596 m elevation. Gypsum-tolerant lichens, bare soil, and small rocks cover most of the unvegetated surface. The soil is a rapidly drained sandy clay loam derived from the Moenkopi Formation.

Globally

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- to 36-degree 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparse desert shrubland is restricted to gypsum-derived surfaces. Total vascular vegetation cover is between 1 and 7%; however, there is a diverse biological soil crust contributing up to 50% cover. *Ephedra torreyana* contributes up to 6% cover. Associated shrubs include *Eriogonum bicolor, Atriplex canescens, Coleogyne ramosissima, Quercus welshii, Opuntia polyacantha*, and *Atriplex gardneri*. The herbaceous layer includes only scattered *Pleuraphis jamesii, Achnatherum hymenoides, Stanleya pinnata, Tiquilia latior* and *Eriogonum inflatum*. The diverse biological soil crust is composed of dark cyanobacteria, *Psora* sp., *Fulgensia* sp., *Endocarpon* sp., *Squamarina* sp., *Aspicillia* sp., mosses and lichens.

Globally

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*.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ephedra torreyana*

Globally

Stratum	Species
Short shrub/sapling	*Ephedra torreyana*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Descurainia pinnata* (exotic), *Salsola tragus* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (21-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The eroding clay slope is thickly covered with lichen-rich biotic crust. Erosion channels dissect the badlands, but the soil is well-stabilized by the crust. Shrubs have some dead sticks in them with the *Ephedra torreyana* looking particularly stressed.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY.0360, CANY.9327) and 2007 and 2008 Accuracy Assessment (4 points: CANY_AA.0299, CANY_AA.0386, CANY_AA.0851, CANY_AA.0854).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles

REFERENCES: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.

Ephedra torreyana Sparse Vegetation

Torrey's Joint-fir Sparse Vegetation

CODE	CEGL002353
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII)
PHYSIOGNOMIC SUBCLASS	Unconsolidated material sparse vegetation (VII.C.)
PHYSIOGNOMIC GROUP	Sparsely vegetated soil slopes (VII.C.3.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural sparsely vegetated soil slopes (VII.C.3.N.)
FORMATION	Dry slopes (VII.C.3.N.b.)
ALLIANCE	*EPHEDRA TORREYANA* SPARSELY VEGETATED ALLIANCE (A.2571) Torrey's Joint-fir Sparsely Vegetated Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)
Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

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 1220 and 1780 m (4000-5840 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 tend to be rapidly drained, shallow, alkaline sandy loams, clay loams and loamy sands derived from shaly sandstones (or sandy shales) such as the Morrison, Moenkopi, Cutler and Summerville formations. 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, Eriogonum leptocladon, Eriogonum corymbosum, Ericameria nauseosa, Gutierrezia sarothrae, Xylorhiza* spp., *Opuntia* spp., and *Coleogyne ramosissima*. 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. *Bromus tectorum* may be abundant in disturbed sites.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparsely vegetated association is widely distributed throughout the park and was sampled in Canyonlands National Park along the White Rim Road, in Shot Canyon, near the Dollhouse Campground, in Surprise Valley, and adjacent to Lathrop Trail. It was sampled in Anderson Bottom and on Bagpipe Butte in Glen Canyon National Recreation Area.

Globally

This association has been documented from southeastern Utah. It is likely to be fairly restricted in both its range and in the size of occurrences.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparsely vegetated association occurs on steep colluvial slopes, cliffs, canyon sides, mesas, dunes, sand ramps and benches. Sites are flat to steep (0- to 28-degree slopes), include all aspects, and lie between 1322 and 1780 m elevation. Sand or bare soil cover most of the unvegetated surface, with lesser cover by rocks and biological soil crusts. Soils are rapidly drained and variable in texture depending on the parent material, which includes loamy sands, sands and sandy loams derived from the Kayenta Formation, or sandy clay loams, sandy clays, and silty clays derived from Halgaito and Cutler Formation shales.

Globally

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 27 degrees) between 1220 and 1780 m (4000-5840 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 surface in sandier sites. There is little litter. Parent materials are Tidwell Member of the Morrison Formation shale eroded to form old alluvial deposits. Soils tend to be rapidly drained, shallow, alkaline sandy loams, clay loams and loamy sands derived from shaly sandstones (or sandy shales) such as the Morrison Moenkopi, Cutler and Summerville formations.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparsely vegetated desert shrubland is widely established throughout the park and recreation area. Total vegetation does not exceed 11%, although most stands have 5% or less cover. The shrub layer is dominated by scattered *Ephedra torreyana* with up to 6% cover. Associated shrubs include *Coleogyne ramosissima, Ericameria*

nauseosa var. *juncea, Atriplex confertifolia, Gutierrezia sarothrae, Xylorhiza tortifolia, Opuntia polyacantha, Opuntia erinacea, Sclerocactus whipplei*, and *Yucca angustissima*. The herbaceous layer is sparse and may include *Pleuraphis jamesii, Achnatherum hymenoides, Bromus tectorum, Sporobolus cryptandrus, Achnatherum speciosum*, and *Aristida purpurea*. Forbs vary among plots; *Sphaeralcea leptophylla, Amsonia tomentosa, Tiquilia latior, Salsola tragus*, and *Sphaeralcea parvifolia* were reported from the sampled sites. Biological soil crust cover is variable, with some stands having none, but cover can be as high as 52%. Occasionally, *Juniperus osteosperma* trees may be present with trace cover.

Globally
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, Eriogonum leptocladon, Eriogonum corymbosum, Ericameria nauseosa, Gutierrezia sarothrae, Xylorhiza* spp., *Opuntia* spp., and *Coleogyne ramosissima*. 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. *Bromus tectorum* may be abundant in disturbed sites.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Coleogyne ramosissima*, *Ericameria nauseosa* var. *juncea*
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Gutierrezia sarothrae*, *Xylorhiza tortifolia*
Herb (field)	*Achnatherum hymenoides*, *Bromus tectorum*, *Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Eriogonum leptocladon*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Salsola tragus* (exotic)

Globally
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (21-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
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.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This dry slope has a substrate that is covered by physical and biological crusts. Small channels cut through the surface.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (16 plots: CANY.0184, CANY.0254, CANY.0277, CANY.0278, CANY.0315, CANY.0401, CANY.0419, CANY.0832, CANY.9124, CANY.9351, GLCA.0118, GLCA.0208, GLCA.0331, GLCA.0558, GLCA.0742, GLCA.0743).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Western Ecology Working Group n.d.

Leymus salinus Shale Sparse Vegetation

Saline Wildrye Shale Sparse Vegetation

Salinas Lyme Grass Tableland

CODE	CEGL002745
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII)
PHYSIOGNOMIC SUBCLASS	Unconsolidated material sparse vegetation (VII.C.)
PHYSIOGNOMIC GROUP	Sparsely vegetated soil slopes (VII.C.3.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural sparsely vegetated soil slopes (VII.C.3.N.)
FORMATION	Dry slopes (VII.C.3.N.b.)
ALLIANCE	*LEYMUS SALINUS* SPARSELY VEGETATED ALLIANCE (A.1258) Saline Wildrye Sparsely Vegetated Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Cliff and Canyon (CES304.779)
Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This generally sparse association typically occurs on cool, sparsely vegetated badland slopes of Mancos, Morrison, or other shale formations in the Colorado Plateau of southeastern Utah and western Colorado. Elevations range between 1341 and 1971 m (4400-6465 feet), and slopes tend to be north- to east-facing and moderately steep to steep (21-35 degree 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. 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 soils 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.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparsely vegetated association occurs on steep slopes within the park and recreation area. Areas sampled in Canyonlands National Park are adjacent to White Rim Road, along Lathrop Trail, in Trail Canyon, 200 m south-southeast of Shafer Canyon Campground, 1100 m southwest of Gooseberry Campground, near the trailhead for Fort Bottom Overlook, along the Colorado River, in Horseshoe Canyon, and near Lower Jump. Areas sampled in Glen Canyon National Recreation Area include Flint Cove, near Deadhorse Canyon, and near Sunset Pass.

Globally
This association typically occurs on cool, sparsely vegetated badland slopes of Mancos, Morrison, or other shale formations in the Colorado Plateau of southeastern Utah and western Colorado.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparse grassland occurs on steep colluvial slopes, canyon walls, ledges, cliffs, and escarpments. Sites are on steep slopes oriented generally to the north and lie between 1291 and 1891 m elevation. Large rocks and exposed soil cover most of the unvegetated surface, with low cover by litter and biological soil crusts. Soils are variable and rapidly drained. They are derived from a variety of parent materials, including the Chinle and Moenkopi formations, Organ Rock shale, White Rim sandstone, Kayenta Formation, or Cedar Mesa sandstone.

Globally

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 (21-35 degrees) 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 Formation shale and Morrison Formation shale, including the Brushy Basin, Tidwell, and Salt Wash members.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparse grassland is moderately common on steep slopes within the park and recreation area. Total vegetation cover ranges from 5 to 23%. Stands are visually dominated by *Leymus salinus* with between 2 and 13% cover. Shrubs are generally present and may have almost as much cover as the grasses. Common species include scattered individuals of *Fendlera rupicola, Fraxinus anomala, Ephedra viridis, Atriplex confertifolia, Ericameria nauseosa, Chrysothamnus viscidiflorus, Artemisia bigelovii, Ephedra torreyana, Xylorhiza tortifolia, Gutierrezia sarothrae, Gutierrezia microcephala*, and *Opuntia erinacea*. Additional grasses include *Bromus tectorum, Pleuraphis jamesii*, and *Achnatherum hymenoides*. Forbs vary among plots; common species include *Stanleya pinnata, Eriogonum inflatum, Erigeron utahensis, Lepidium montanum*, and *Plantago patagonica*.

Globally

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 10% 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, Atriplex confertifolia, Ephedra* spp., and *Gutierrezia sarothrae*. In some stands, scattered individuals of *Juniperus osteosperma* may be present.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*, *Ericameria nauseosa*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Xylorhiza tortifolia*
Herb (field)	*Achnatherum hymenoides*, *Bromus tectorum*, *Leymus salinus*, *Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*
Herb (field)	*Leymus salinus*

OTHER NOTEWORTHY SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (26-Jun-2001).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Steep, rocky colluvium creates unstable soils, but large rocks and boulders create microhabitats protecting grasses and shrubs.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (14 plots: CANY 0179, CANY 0316, CANY 0373, CANY 0374, CANY 0379, CANY 0502, CANY 0529, CANY 0608, CANY 0725, CANY 0788, GLCA 0103, GLCA 0113, GLCA 0738, GLCA 0766).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. 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.

Eriogonum corymbosum Badlands Sparse Vegetation

Crispleaf Buckwheat Badlands Sparse Vegetation

CODE	CEGL002979
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII)
PHYSIOGNOMIC SUBCLASS	Unconsolidated material sparse vegetation (VII.C.)
PHYSIOGNOMIC GROUP	Sparsely vegetated soil slopes (VII.C.3.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural sparsely vegetated soil slopes (VII.C.3.N.)
FORMATION	Dry slopes (VII.C.3.N.b.)
ALLIANCE	PAINTED DESERT SPARSELY VEGETATED ALLIANCE (A.2545) Painted Desert Sparsely Vegetated Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This unusual sparse short-shrub association occurs on barren shale badlands. Sites are flat to steep slopes, occur between 1219 and 2670 m (4000-8760 feet) elevation, and are oriented to all aspects. The unvegetated surface has high exposure of bare soil, up to 88%. Litter is sparse. Parent materials are Moenkopi, Morrison, Mancos, Tropic or Chinle shales and the Clarion Formation that erode to badlands deposits. Vegetation has difficulty taking hold on the highly erosive surface. Soils are rapidly drained clay loams or silty loams. Total vascular vegetation cover for this association rarely exceeds 20% and is usually 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 *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 *Astragalus kentrophyta, Lomatium minimum, Machaeranthera canescens, Sphaeralcea coccinea, Chamaesyce fendleri, Amsonia tomentosa, Thelesperma subnudum* var. *subnudum*, and *Cryptantha tenuis*. At Bryce Canyon, *Pinus edulis* and *Juniperus osteosperma* saplings provide sparse cover in some stands.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparse vegetation association is rare within the park and recreation area and was sampled 250 m southeast of White Rim Road and north of Teapot Campground in Canyonlands National Park and in the Millard Canyon Benches of Glen Canyon National Recreation Area.

Globally
This association has been described from southern and eastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparse dwarf-shrubland occurs on windswept badlands of Moenkopi shale. Sites are gentle to moderately steep (4- to 18-degree slopes), occur between 1340 and 1723 m elevation, and are oriented to all aspects. Rocks and gravel cover most of the unvegetated surface with low to moderate exposure of bare soil. Soils are rapidly drained sandy clay loams.

Globally
This unusual sparse short-shrub association occurs on barren shale badlands. Sites are flat to gentle to moderately steep, occur between 1219 and 2670 m (4000-8760 feet) elevation, and are oriented to all aspects. The unvegetated surface has high exposure of bare soil, up to 88%, although 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This badlands sparse shrubland is rare within the park and recreation area. Total vegetation cover does not exceed 5% and consists primarily of scattered *Eriogonum corymbosum* shrubs. Other shrubs present with less than 1% cover include *Ephedra torreyana, Ericameria nauseosa, Coleogyne ramosissima, Atriplex confertifolia, Chrysothamnus viscidiflorus, Xylorhiza glabriuscula*, and *Gutierrezia sarothrae*. The herbaceous layer is sparse and inconsistent; graminoids present may include *Pleuraphis jamesii, Aristida purpurea*, and *Achnatherum hymenoides*, and forbs may include *Chamaesyce fendleri, Amsonia tomentosa, Thelesperma subnudum* var. *subnudum*, and *Cryptantha tenuis*.

Globally
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 *Astragalus kentrophyta, Lomatium minimum, Machaeranthera canescens, Sphaeralcea coccinea, Chamaesyce fendleri, Amsonia tomentosa, Thelesperma subnudum* var. *subnudum*, and *Cryptantha tenuis*. At Bryce Canyon, *Pinus edulis* and *Juniperus osteosperma* saplings provide sparse cover in some stands.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Eriogonum corymbosum*
Herb (field)	*Xylorhiza glabriuscula*
Herb (field)	*Amsonia tomentosa*

Herb (field)	*Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Eriogonum corymbosum*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Vulnerable: *Lomatium minimum* (globally vulnerable, G3); **Exotic/Invasive**: *Bromus tectorum* (exotic, High), *Halogeton glomeratus* (exotic, High/Medium)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (22-Jan-2002).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This is a desert pavement-surfaced area with many meandering surficial drainage channels transecting the slope. Plants are often on pedestals, even on the low interfluve mounds and berms between channels.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (3 plots: CANY 0181, CANY 0435, GLCA 0323).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. G. Kittel

REFERENCES: Clark et al. 2009, Cogan et al. 2004, Coles et al. 2009a, Romme et al. 1993, Thomas et al. 2009b, Western Ecology Working Group n.d.

Eriogonum leptocladon Sparse Vegetation

Sand Buckwheat Sparse Vegetation

CODE	CEGL002822
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII)
PHYSIOGNOMIC SUBCLASS	Unconsolidated material sparse vegetation (VII.C.)
PHYSIOGNOMIC GROUP	Sparsely vegetated soil slopes (VII.C.3.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural sparsely vegetated soil slopes (VII.C.3.N.)
FORMATION	Dry slopes (VII.C.3.N.b.)
ALLIANCE	PAINTED DESERT SPARSELY VEGETATED ALLIANCE (A.2545) Painted Desert Sparsely Vegetated Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Active and Stabilized Dune (CES304.775)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This sparse shrubland association is characteristic of sheets of loose or partially stabilized sand in southeastern Utah between 1220 and 1573 m (4000-5160 feet) elevation. Stands occur on level to gently sloping sites with a tendency

toward warmer western aspects. Soils are 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. Stands of this association tend to be small and occur in a mosaic of other sandy communities. Total vegetation cover by vascular species rarely exceeds 15%. The open shrub canopy is consistently dominated by *Eriogonum leptocladon* with between 2 and 10% cover. Other shrubs present may include *Eriogonum corymbosum, Atriplex canescens*, and *Gutierrezia sarothrae*. If *Artemisia filifolia* or *Coleogyne ramosissima* are present, it is with 1% or less cover. The herbaceous layer is also generally sparse (5% or less total cover) and consists of species adapted to somewhat disturbed, sandy conditions. Common species include *Achnatherum hymenoides, Abronia fragrans, Oenothera pallida, Sporobolus* spp., and *Salsola tragus*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association was sampled in Taylor Canyon and Range Canyon in Canyonlands National Park and in Calf Canyon in Glen Canyon National Recreation Area.

Globally
This association has only been described from southeastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland occurs on sand dunes, and in one instance on a wash terrace. Stands occupy flat to rolling or gently sloping sites (0-9 degrees) between 1224 and 1550 m elevation. Most of the unvegetated surface is sand with sparse cover by litter and biological soil crusts. Soils are rapidly drained sands or loamy sands derived from eolian deposits.

Globally
This association is characteristic of sheets of loose or partially stabilized sand in southeastern Utah. Elevations range between 1220 and 1573 m (4000-5160 feet). Stands occur on level to gently sloping sites with a tendency toward warmer western aspects. Soils are loamy sands and sandy loams derived from 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.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sand dune shrubland is rare within the park and recreation area. Total vegetation cover ranges from 6 to 17%. The shrub canopy is dominated by *Eriogonum leptocladon* with between 3 and 6% cover. Associated (sometimes codominant) shrubs include *Atriplex canescens, Ericameria nauseosa, Artemisia filifolia*, and the succulents *Opuntia polyacantha* and *Sclerocactus whipplei*. Herbaceous species are sparse and inconsistent among stands, with *Achnatherum hymenoides* being the most common and dominant understory species. Other recorded species include *Hesperostipa comata, Pleuraphis jamesii, Sporobolus cryptandrus, Muhlenbergia pungens, Salsola tragus, Plantago patagonica, Abronia fragrans, Sphaeralcea parvifolia, Cryptantha crassisepala* var. *elachantha, Hymenopappus filifolius*, and *Oenothera pallida*. Biological soil crusts have up to 23% cover and are in an early stage of development.

Globally
Stands of this sparse shrubland association tend to be small and occur in a mosaic of other sandy communities. Total vegetation cover by vascular species rarely exceeds 15%. The open canopy is consistently dominated by *Eriogonum leptocladon* with between 2 and 10% cover. Other shrubs present may include *Eriogonum corymbosum, Atriplex canescens*, and *Gutierrezia sarothrae*. If *Artemisia filifolia* or *Coleogyne ramosissima* are present, it is with 1% or less cover. The herbaceous layer is also generally sparse (5% or less cover) and consists of species adapted to somewhat disturbed, sandy conditions. Common species include *Achnatherum hymenoides, Abronia fragrans, Oenothera pallida, Sporobolus* spp., and *Salsola tragus*.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Eriogonum leptocladon*
Herb (field)	*Opuntia polyacantha*
Herb (field)	*Plantago patagonica*, *Sphaeralcea parvifolia*
Herb (field)	*Achnatherum hymenoides*

Globally

Stratum	Species
Short shrub/sapling	*Eriogonum leptocladon*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Salsola tragus* (exotic)

Globally
Exotic/Invasive: *Salsola tragus* (exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (25-Aug-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The dunes are not very active here due to the biocrusts, but nearby areas appear to be subject to wind movement. Many of the shrubs here are on humps indicating that the area is not well-stabilized and that sand is free to blow out.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY.0345, GLCA.0579) and 2007 and 2008 Accuracy Assessment (6 points: CANY_AA.0048, CANY_AA.0305, CANY_AA.0611, CANY_AA.0722, CANY_AA.0724, CANY_AA.4460).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: J. Coles

REFERENCES: Clark et al. 2009, Romme et al. 1993, Western Ecology Working Group n.d.

Zuckia brandegeei Sparse Vegetation

Siltbush Sparse Vegetation

CODE	CEGL002493
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII)
PHYSIOGNOMIC SUBCLASS	Unconsolidated material sparse vegetation (VII.C.)
PHYSIOGNOMIC GROUP	Sparsely vegetated soil slopes (VII.C.3.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural sparsely vegetated soil slopes (VII.C.3.N.)
FORMATION	Dry slopes (VII.C.3.N.b.)
ALLIANCE	*ZUCKIA BRANDEGEEI* SPARSE VEGETATION ALLIANCE (A.2653) Siltbush Sparse Vegetation Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This sparsely vegetated association is common on plateaus at Petrified Forest National Park but occurs elsewhere in the Colorado Plateau of northern Arizona and eastern Utah. In Arizona, it is 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 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. 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 bunch grasses *Leymus salinus* and *Pleuraphis jamesii* are present. Forbs include *Platyschkuhria integrifolia* and *Xylorhiza venusta*.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This dwarf-shrubland was sampled on steep badland on a saddle near Airport Tower, 800 m southwest of Gooseberry Campground, adjacent to the Flint Trail and along the road system of Glen Canyon National Recreation Area.

Globally

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.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This dwarf-shrubland is very restricted in its habitat. It occurs on steep colluvial, landslide, and badland slopes, although one stand is in a saddle. Sites tend to be steep (22- to 36-degree slopes) and lie between 1486 and 1874 m elevation. Aspect does not control the distribution of this association. The unvegetated surface has low to moderate exposure of bare soil and moderate cover of small and large rocks. Soils are rapidly drained loamy sands, sandy loams, sandy clay loams, or silty clays derived from the Chinle Formation or mixed colluvium.

Globally

This sparsely vegetated association is common on plateaus at Petrified Forest National Park but occurs elsewhere on plains, alluvial fans, steep colluvial and badlands slopes or shale hogbacks in the Colorado Plateau of northern Arizona and eastern Utah. Elevation ranges from 1341-2078 m (4397-6815 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

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This sparse dwarf-shrubland is restricted to steep badland slopes within the park and recreation area. Total vegetation cover does not exceed 5% and consists of *Zuckia brandegeei* with up to 4% cover. Commonly associated shrubs include *Atriplex confertifolia, Chrysothamnus viscidiflorus, Ericameria nauseosa, Coleogyne ramosissima, Eriogonum corymbosum, Ephedra viridis, Xylorhiza glabriuscula*, and *Gutierrezia sarothrae*. The herbaceous layer provides sparse cover and may include *Bromus tectorum, Achnatherum hymenoides, Leymus salinus, Pleuraphis jamesii, Arabis holboellii, Cryptantha* sp., *Cymopterus acaulis, Eriogonum inflatum, Galium coloradoense (= Galium multiflorum* var. *coloradoense)*, and *Penstemon barbatus*. Biological soil crusts do not contribute more than a few percent cover.

Globally

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, Xylorhiza glabriuscula, Gutierrezia microcephala, Sarcobatus vermiculatus*, and *Gutierrezia sarothrae*. The herbaceous layer is low in diversity and provides sparse cover. The bunch grasses *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.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa*
Herb (field)	*Xylorhiza glabriuscula*, *Zuckia brandegeei*
Herb (field)	*Achnatherum hymenoides*, *Bromus tectorum*

Globally

Stratum	Species
Short shrub/sapling	*Zuckia brandegeei*
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Vulnerable: *Zuckia brandegeei* var. *arizonica* (globally vulnerable; endemic to northeastern Arizona and the southern Colorado Plateau, G4T3); **Exotic/Invasive**: *Bromus tectorum* (invasive/exotic, High), *Salsola tragus* (invasive/exotic)

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (29-Mar-2005).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: One plot is located on an exposure of the blue-gray member of the Chinle Formation. Colluvium from higher layers including boulders overlies some sections of this exposure. Actively eroding colluvial slopes with a pattern of surface gullies transect several plots.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (5 plots: CANY 0241, CANY 0378, GLCA 0333, GLCA 0744, GLCA 0755).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. G. Kittel

REFERENCES: Clark et al. 2009, Coles et al. 2009a, Romme et al. 1993, Thomas et al. 2009a, Western Ecology Working Group n.d.

Agrostis stolonifera Seasonally Flooded Herbaceous Alliance

Creeping Bentgrass Seasonally Flooded Herbaceous Alliance

CODE	A.1405
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k.)
ALLIANCE	*AGROSTIS STOLONIFERA* SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1405) Creeping Bentgrass Seasonally Flooded Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Data not available

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This alliance includes grasslands dominated by an introduced perennial sod grass native to Europe. Stands have been described from Montana, but the alliances is likely more widespread. *Agrostis stolonifera* has been widely planted for forage in North America and has invaded native communities from hay fields, especially more mesic areas such as riparian floodplains and seasonally flooded wetlands in the semi-arid western U.S.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This alliance was observed and sampled only once in Lost Canyon in Canyonlands National Park.

Globally

This alliance is found in Idaho, Montana, Colorado and Nevada but likely occurs more widely.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This herbaceous alliance was observed along a flat stream bottom near a spring at 1581 m elevation. The unvegetated surface has high cover of bedrock, sand and water, and low cover of gravel, boulders and moss. Sites is permanently flooded due to proximity of spring and high bedrock cover keeping water at the surface.

Globally

This alliance is typically found in more mesic areas such as riparian floodplains and seasonally flooded wetlands in the semi-arid western U.S. where it has escaped from cultivation.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Total vegetation cover is 18% in this saturated stand, characterized by *Agrostis stolonifera* with 15% cover. Only one tall shrub species was recorded, *Frangula betulifolia.* The herbaceous layer includes trace cover of *Equisetum laevigatum* and *Adiantum capillus-veneris.* Moss and algae cover is 18%.

Globally

This alliance is characterized by a moderate to dense perennial graminoid layer dominated by *Agrostis stolonifera*. Other native species may occur as well, but they are generally less than 10% cover.

MOST ABUNDANT SPECIES

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Agrostis stolonifera*

Globally

Stratum	Species
Short shrub/sapling	*Agrostis stolonifera*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
This alliance is composed of vegetation types that are dominated by weedy species not native to the western United States. The Eurasian perennial sod grass *Agrostis stolonifera* is found throughout much of North America, excepting only Oklahoma in the U.S. (Kartesz 1999). References for this alliance include Hansen et al. (1991, 1995).

CLASSIFICATION CONFIDENCE: Not applicable

ELEMENT SOURCES
Canyonlands National Park Inventory Notes: Surface water currently is ~15 meters long by 0.5-1 meter wide and moss/algae cover indicates this is probably perennial-flowing. One deep pool under overhanging rock is ~1m x 1m x1/2 meter deep. Shallow soils (~6 inches deep) with underlying bedrock keep water on surface here.
Canyonlands National Park Plots *Field Data*: This description is based on 2004 field data (1 plot*:* CANY.9058).
Local Description Authors: A. Tendick
Global Description Authors: D. Sarr, mod. K.A. Schulz

REFERENCES: Carsey et al. 2003a, Hall and Hansen 1997, Hansen et al. 1995, Hansen et al. 1991, Kartesz 1999, Kittel et al. 1999b, Manning and Padgett 1995, Western Ecology Working Group n.d.

*Artemisia tridentata (***ssp.** *tridentata,* **ssp.** *xericensis) Shrubland Alliance*

(Basin Big Sagebrush, Foothill Big Sagebrush) Shrubland Alliance

CODE	A.830
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA TRIDENTATA (SSP. TRIDENTATA, SSP. XERICENSIS)* SHRUBLAND ALLIANCE (A.830) (Basin Big Sagebrush, Foothill Big Sagebrush) Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
These shrublands occur throughout the Intermountain West from the western Great Basin to the northern Rocky

Mountains and Colorado Plateau. Sites supporting this alliance include sloping fans, footslopes, rolling hills, 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. The vegetation included in this alliance is characterized by a somewhat sparse to moderately dense (10-70% cover) shrub layer of *Artemisia tridentata* ssp. *tridentata* or *Artemisia tridentata* ssp. *xericensis*. Shrub associates include *Ericameria nauseosa (= Chrysothamnus nauseosus)* or *Chrysothamnus viscidiflorus* which increase with disturbance. Other shrubs occasionally present include *Purshia tridentata, Ephedra viridis, Gutierrezia sarothrae, Tetradymia canescens, Sarcobatus vermiculatus*, and *Atriplex* spp. Occasionally individual trees are present in some stands. The relatively sparse herbaceous layer is dominated by bunch grasses (<20% cover) that occupy patches in the shrub matrix. The most widespread species is *Pseudoroegneria spicata*, which occurs from the Columbia Basin to the northern Rockies. Other locally dominant or important species include *Leymus cinereus, Festuca idahoensis, Pascopyrum smithii, Elymus lanceolatus, Elymus elymoides, Pleuraphis jamesii (= Hilaria jamesii), Koeleria macrantha, Muhlenbergia richardsonis, Hesperostipa comata (= Stipa comata)*, and *Poa secunda*. Forbs are generally of low importance and are highly variable across the range. Mosses and lichens are important ground cover in some stands. Diagnostic of this alliance is the *Artemisia tridentata* ssp. *tridentata*- or *Artemisia tridentata* ssp. *xericensis*-dominated shrub layer that lacks a significant graminoid layer (<20% cover perennial graminoids) or has over 40% total cover of shrubs.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This alliance was observed and sampled in Lost Canyon, in upper and lower Salt Creek including 500 m northeast of Peekaboo Campground, in Horse Canyon, and in Lavender Canyon in Canyonlands National Park.

Globally
This alliance has been documented from every state in the western United States, except Arizona and New Mexico. Undoubtedly, it occurs in these two states but has not yet been documented there.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland alliance was observed on low-lying areas of stream terraces and in canyon bottoms. Sites were flat to gently sloped (up to 3 degrees) and occurred between 1513 and 1731 m elevation. The unvegetated surface has low to high exposure of bare soil or sand and low to high cover of litter. Cryptogamic soil communities provided low to moderate cover (mainly mosses and dark cyanobacteria). Parent materials were variable and included sandstones and shales that have eroded and been deposited as new alluvium. Soils were deep, rapidly drained, and texturally were silt loams, sands, and loamy sands.

Globally
This alliance occurs throughout the Intermountain West from the western Great Basin to the northern Rocky Mountains and Colorado Plateau at elevations ranging from 240 m in the Columbia Basin up to 2500 m. The climate where this alliance occurs is semi-arid with 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 variation. In drier regions, these shrublands are usually associated with perennial or ephemeral stream drainages with water tables less than 3 m from the soil surface. 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 (Hironaka et al. 1983). Although this alliance may grade into sites with alkaline soils at the edge of internally drained basins, *Artemisia tridentata* is a non-halophyte and requires low salinity for optimum growth. The importance of perennial bunch grasses, the most typical herbaceous associates, is favored with greater spring and summer rain, which increases northward and eastward. Because of the deep alluvial soils, stands have been converted to agriculture in much of the range of the alliance. Adjacent vegetation is highly variable, but some common adjacents include *Juniperus occidentalis*-, *Pinus ponderosa*-, and *Cercocarpus ledifolius*-dominated woodlands, as well as shrublands dominated by *Artemisia tridentata* ssp. *vaseyana*.

Dynamics: Complex ecological interactions between fire regimes, grazing history, and climate patterns result in equally complex patterns of species structure and composition in *Artemisia tridentata* stands. These present corresponding difficulties in the classification of these shrublands, which have been compounded by the influence of human settlement and agricultural patterns. What follows is a summary of some of the influences of altered fire regimes and grazing history on *Artemisia tridentata* shrublands and shrub herbaceous vegetation.

Artemisia tridentata is inhibited by fire, and excessive grazing may decrease fire frequency due to consumption of herbaceous forage, resulting in increased shrub density. Conversely, invasion by non-native annual grasses (e.g., *Bromus tectorum*) may increase fire frequency sufficiently to eliminate the shrubs from the stands (Daubenmire 1970). With a change in fire frequency, species composition will be altered as well (West 1983). With a high fire frequency, every 2-5 years, perennial grasses and shrubs are eliminated and non-native annual grasses dominate. At fire-return intervals of 10-30 years, short-lived resprouting shrubs such as *Chrysothamnus* or *Tetradymia* spp. dominate. At fire intervals of 30-70 years, a mixture of perennial bunch grasses and shrubs is maintained. Finally, in the complete absence of fire, deep-rooted shrubs such as *Artemisia tridentata* become the dominant shrubs.

This alliance is often found in seasonal or intermittent stream drainages. Currently, it can often be found on the benches of perennial steams which have become restricted to a downcut channel, although these are generally in poor condition with a *Bromus tectorum* understory. It is likely that these habitats are a result of livestock grazing impacts.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Total vegetation cover ranges from 10% to 66% in these sparsely to moderately vegetated stands. This tall and short shrub alliance is characterized by an open canopy, typically 1 to 5 meters tall, of *Artemisia tridentata* ssp. *tridentata* that ranged in cover from 7 to 50% cover. The remaining tall and short shrub layer includes sparse to low cover of *Quercus gambelii, Forestiera pubescens, Ericameria nauseosa, Atriplex canescens, Sarcobatus vermiculatus, Mahonia fremontii, Ephedra viridis, Rosa woodsii, Rhus aromatica* var. *trilobata.,* Dwarf-shrubs were rarely encountered and included sparse cover of the succulents *Opuntia polyacantha, Opuntia phaeacantha, and Sclerocactus whipplei* or the dwarf-shrub *Artemisia frigida*. The herbaceous layer is often very diverse and provides sparse to low cover. Common native grass species include *Achnatherum hymenoides, Sporobolus cryptandrus,* and *Elymus elymoides* and the non-native annual grass, *Bromus tectorum*. Forbs commonly present include *Machaeranthera canescens, Cleome lutea, Chamaesyce fendleri, Oenothera pallida, Hymenopapus filifolius, Sphaeralcea coccinea, Chenopodium album, Mentzelia albicaulis, Suaeda torreyana, Chaenactis stevioides, Chamaesyce glyptosperma, Lepidium densiflorum, Plantago patagonica, Artemisia campestris, Helianthus petiolaris, Lappula occidentalis, Ipomopsis longiflora, Lepidium montanum, Senecio multilobatus, Descurainia sophia,* and the non-native forb, *Salsola tragus.* Cryptogam cover was sparse to moderate (up to 44% cover) and was comprised of *Collema* sp., moss, and dark cyanobacteria.

Globally

The plant associations in this widespread western shrubland alliance are characterized by a somewhat sparse to moderately dense (10-70% cover) shrub layer of *Artemisia tridentata* ssp. *tridentata* or *Artemisia tridentata* ssp. *xericensis*. The height of the shrub layer ranges from about 0.5 m to close to 2 m. *Ericameria nauseosa (= Chrysothamnus nauseosus)* and/or *Chrysothamnus viscidiflorus* are almost always present and increase with disturbance. Other shrubs occasionally present include *Artemisia tridentata* ssp. *wyomingensis, Artemisia tridentata* ssp. *vaseyana, Grayia spinosa, Tetradymia canescens, Purshia tridentata, Ephedra viridis, Gutierrezia sarothrae, Sarcobatus vermiculatus, Artemisia frigida*, and *Atriplex* spp. Trees are very rarely present in this alliance, but scattered individuals of *Pinus ponderosa, Juniperus scopulorum, Juniperus occidentalis* or *Cercocarpus ledifolius* may occur. The herbaceous layer is relatively sparse and typically dominated by bunch grasses which occupy patches in the shrub matrix, or may form a matrix surrounding the shrubs. There is typically less than 20% cover of perennial graminoids, although the cover of exotic annual grasses, such as *Bromus tectorum*, may be very high (>20% in some cases). The most widespread species is *Pseudoroegneria spicata*, which occurs from the Columbia Basin to the northern Rockies. Other locally dominant or important species include *Leymus cinereus, Festuca idahoensis, Pascopyrum smithii, Elymus lanceolatus, Elymus elymoides, Hesperostipa comata (= Stipa comata), Koeleria macrantha, Muhlenbergia richardsonis, Pleuraphis jamesii (= Hilaria jamesii), Bouteloua gracilis*, and *Poa secunda*. Forbs are generally of low importance and are highly variable across the range, but may be diverse in

some stands. Species that often occur are *Symphyotrichum falcatum* var. *crassulum (= Aster adscendens)* and *Collinsia parviflora* in Nevada, *Penstemon caespitosus* in north-central Colorado, *Achillea millefolium, Erigeron compositus, Packera cana (= Senecio canus)*, and *Taraxacum officinale* in southwestern Montana, and *Cordylanthus ramosus* in southwestern Wyoming. Other important genera include *Astragalus, Oenothera, Eriogonum*, and *Balsamorhiza*. Mosses and lichens may be important ground cover, and a cryptogamic soil crust is present and will cover the ground surface in undisturbed stands. Diagnostic of this alliance is the *Artemisia tridentata* ssp*. tridentata*- or *Artemisia tridentata* ssp*. xericensis*-dominated shrub layer that lacks a significant graminoid layer (<20% cover perennial graminoids) or has over 40% total cover of shrubs.

Vegetation Structure Summary: The vegetation is characterized by a moderate to dense cover of microphyllous evergreen shrubs, usually 1-2 m in height. Cespitose graminoids are usually scattered in patches in the shrub matrix. The graminoids occasionally match the shrubs in height. Forb species may be frequent, but usually have low canopy cover. With increasing summer rain in the southeastern portion of the range, there is a corresponding increase in the importance of sod-forming grasses over bunch grasses. Lichens and mosses form a ground surface layer in undisturbed stands.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Short shrub/sapling	*Artemisia tridentata* ssp. *xericensis*
Herb (field)	*Agropyron cristatum*
Herb (field)	*Bromus tectorum*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Bromus tectorum, Salsola tragus, Chenopodium album, Descurainia sophia

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Stands included in this alliance occur in environments (climate or substrates) that limited the growth of perennial graminoids or may be the result heavy livestock grazing depleting the perennial graminoid layer of stands of *Artemisia tridentata (*ssp*. tridentata,* ssp*. xericensis)* Shrub Herbaceous Alliance (A.1522).

CLASSIFICATION CONFIDENCE: Not applicable

ELEMENT SOURCES
Canyonlands National Park Inventory Notes: Sandy soil is stabilized by well developed biocrust. This stream terrace is high enough above the wash bottom (12 - 15 feet) to avoid flooding.
Canyonlands National Park Plots *Field Data*: This description is based on 2004 field data (7 plots*:* CANY.0214, CANY.0383, CANY.0627, CANY.0744, CANY.0756, CANY.0765, and CANY.9344).
Local Description Authors: A. Tendick
Global Description Authors: D. Sarr, mod. K.A. Schulz

REFERENCES: Baker 1982b, Baker 1983b, Baker 1984a, Barbour and Major 1988, Barrows et al. 1977, Blackburn 1967, Blackburn et al. 1968c, Branson et al. 1976, Caicco and Wellner 1983f, Caicco and Wellner 1983k, Chappell et al. 1997, Daubenmire 1970, DeVelice and Lesica 1993, Donart et al. 1978b, Francis 1983, Francis 1986, Francis and Aldon 1983, Hess 1981, Hironaka 1978, Hironaka et al. 1983, Holland 1986b, Jensen et al. 1988a, Keammerer 1977, Kittel et al. 1999a, Kittel, et al. 1994, Kuchler 1964, McArthur and Welch1986, McLean 1970, Mooney 1985, Mueggler and Stewart 1980, Northcutt 1978, ORNHP [Oregon Natural Heritage Program] n.d., Poulton 1955, Ralston 1969, Sawyer and Keeler-Wolf 1995, Shiflet 1994, Strong 1980, Tiedemann et al. 1987, Tueller et al. 1966, Tueller and Blackburn 1974, Tweit and Houston 1980, West 1983a, West 1983c, Western Ecology Working Group n.d.

Opuntia spp. Shrubland Alliance

Prickly-pear species Shrubland Alliance

CODE	A.2650
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Succulent extremely xeromorphic evergreen shrubland (III.A.5.N.c.)
ALLIANCE	*OPUNTIA* SPP. SHRUBLAND ALLIANCE (A.2650) Prickly-pear species Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This alliance occurs in disturbed or extremely xeric sites with coarse soils throughout the Colorado Plateau. Many stands occur on eolian or alluvial deposits on gentle to moderate slopes. 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, Hesperostipa comata, Bouteloua gracilis, Pleuraphis jamesii*, and *Sphaeralcea* spp. Cryptobiotic soil crusts may be well-developed in undisturbed sites.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This alliance was sampled in Holeman Spring Basin, Spanish Bottom, Lavender Canyon, and in a canyon below Candlestick Tower in Canyonlands National Park.

Globally

This alliance is currently known from western Colorado, northern Arizona and southeastern Utah.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland alliance was observed on badlands, on a floodplain, canyon bottom slope and in a valley. Sites are flat to gently sloping (up to 9-degrees), oriented to the north or east, and occur between 1170 and 1651 m elevation. The unvegetated surface has high cover of exposed bare soil, moderate cover of dark cyanobacteria, and lesser cover by gravel and litter.

Globally

This alliance occurs on alluvial terraces, slopes and ridges throughout the Colorado. Sites are often disturbed or, if undisturbed, are extremely xeric. Slopes range from gently sloping to moderately steep, and elevations range from 1450 to 1750 m (4757-5740 feet). Substrates include sandy alluvium, eolian sands, and coarse black migmatitic gravels. Soils are usually coarse-textured, either sandy or gravelly. At Canyon de Chelly, this alliance often indicates

the location of Anasazi ruins that have become buried by eolian sands.

Dynamics: In all but the most xeric habitats, dominance by *Opuntia* species generally indicates heavy, chronic disturbance, such as grazing by domestic livestock (Rice and Westoby 1978). However, in some extremely xeric habitats, such as sandsheets or coarse dark metamorphic gravels, *Opuntia* will dominate a community that otherwise shows few signs of disturbance and may have a well-developed cryptobiotic soil crust.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Total vegetation cover ranges from 4 to 17% and is dominated by *Opuntia* species (*Opuntia polyacantha, Opuntia phaecantha, Opuntia erinacea)* with 3 to 10% cover. The remaining short and dwarf shrub layer includes trace to low cover of *Atriplex confertifolia, Ephedra torreyana, Coleogyne ramosissima, Suaeda moquinii, Gutierrezia sarothrae,* and *Sclerocactus whipplei*. The herbaceous layer is generally sparse and weedy. Associated herbaceous species include *Pleuraphis jamesii, Aristida purpurea, Achnatherum hymenoides, Bromus tectorum, Festuca octoflora, Sporobolus cryptandrus, Helianthus petiolaris, Sphaeralcea parvifolia, Salsola tragus, Plantago patagonica,* and *Halogeton glomeratus.*

Globally
This is often a somewhat sparse community, with total perennial vegetation cover rarely exceeding 30%. In wet years, weedy and native annual herbaceous species may provide more than 50% cover. *Opuntia polyacantha* and *Opuntia phaeacantha* are the most common dominant cacti in this alliance, occurring in patches or clumps throughout the community. Scattered individuals of other shrub species may also occur in this community, particularly *Atriplex canescens*. Other shrubs present may include *Artemisia tridentata* ssp. *wyomingensis, Atriplex confertifolia, Chrysothamnus viscidiflorus, Ephedra* spp., *Gutierrezia sarothrae, Grayia spinosa*, and *Sarcobatus vermiculatus*. The exotic annual grass *Bromus tectorum* frequently dominates the herbaceous layer along with weedy and exotic forbs such as *Astragalus nuttallianus* and *Erodium cicutarium*; however, even in the most disturbed sites, some native forbs and grasses may persist, including *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii*, and *Sphaeralcea* spp.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short Shrub	*Opuntia* spp.

Globally

Stratum	Species
Short shrub	*Opuntia* spp.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: Not applicable

ELEMENT SOURCES
Canyonlands National Park Inventory Notes: Shallow erosional channels wander through the area and are about the only places without much biocrust which has mature development and extensive distribution. The cacti look pretty good, with most of the pads plump and fleshy-looking, like the arms of a Midwest farm girl.
Canyonlands National Park Plots *Field Data*: This description is based on 2004 field data (4 plots: CANY. CANY.0168, CANY.0446, CANY.0628, CANY.9050).
Local Description Authors: A. Tendick
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Rice and Westoby 1978, Western Ecology Working Group n.d.

Salix (exigua, interior) Temporarily Flooded Shrubland Alliance
(Coyote Willow, Sandbar Willow) Temporarily Flooded Shrubland Alliance

CODE	A.947
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.A.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.A.2.N.)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.A.2.N.d.)
ALLIANCE	*SALIX (EXIGUA, INTERIOR)* TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.947) (Coyote Willow, Sandbar Willow) Temporarily Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Plant associations within this temporarily flooded shrubland alliance are located on floodplains and gravel bars between 780 and 2700 m (2560-9100 feet) elevation in the western U.S. Stands may be dominated either by *Salix exigua* (in the West) or *Salix interior* (in the Midwest and East). Both species or intermediates may occur in stands in the region where the range of the two species overlap. 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. The canopy is dominated by a tall, 2- to 5-m, broad-leaved deciduous shrub that is typically many-branched with continuous cover of 60-100%. The herbaceous stratum has sparse to moderate cover including a variety of pioneering species. This alliance represents an early-seral, primary successional stage on newly deposited sediments that may persist under a regime of repeated fluvial disturbance. *Salix exigua* and *Salix interior* are highly adapted to most forms of disturbance. Both species are prolific sprouters and will reestablish themselves on sites dominated by other disturbance-associated species, e.g., *Glycyrrhiza lepidota* and *Pascopyrum smithii (= Agropyron smithii)*. Associations in this shrubland alliance are common and widespread.

In the West, adjacent upland plains communities include agricultural fields and rolling hills of *Artemisia filifolia*, xeric tallgrass prairies, and *Bouteloua gracilis* shortgrass prairies. In the steep canyons of the foothills, upslope vegetation includes *Pseudotsuga menziesii* and *Pinus ponderosa* forests, *Pinus edulis* and *Juniperus* spp. woodlands, oak, sagebrush, and greasewood scrub. In the lower montane, upslope vegetation includes *Pinus contorta* and *Populus tremuloides* forests.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This alliance was sampled in lower Horseshoe Canyon, Water Canyon, and in Salt Creek in Canyonlands National Park.

Globally
Associations in this alliance are common and widespread. Their range extends from the Pacific Northwest and California, east to the Rocky Mountains (these dominated solely by *Salix exigua sensu stricto*); in the northern Great Plains and south to the Colorado plains and New Mexico (these associations possibly of mixed or ambiguous composition). The western portions of the Dakotas, Nebraska, Kansas, and Oklahoma are also in this apparent zone of ambiguity or intermediacy. Stands dominated by *Salix interior* occur in the Midwest in Iowa, Illinois, Indiana, Ohio, and the eastern portions of North Dakota, South Dakota, Nebraska, and Kansas. They also extend into Arkansas, Tennessee, Kentucky, Texas, and eastern Oklahoma, and possibly in Pennsylvania and West Virginia, as well as in Manitoba and other provinces of Canada. The alliance is also found in the Mexican state of Tamaulipas.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland alliance was observed in canyon bottoms, in washes, and on stream terraces. Sites are flat to gently sloping (up to 4-degrees), oriented to all aspects, and occur between 1396 and 1812 m elevation. The unvegetated surface has high cover of exposed bare soil and litter, with lesser cover by gravel, boulders, sand, and dead wood.

Globally
Plant associations within this alliance are located on floodplains and gravel bars at an elevational range between 780 and 2700 m (2560-9100 feet) in the western U.S. These shrublands are found on open sandbars without 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.

Soils of this alliance are typically coarse alluvial deposits of sand, silt and cobbles that are highly stratified with depth from flooding scour and deposition. The 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. Occasionally, stands may occur on deep pockets of sand. The pH of the substrate ranges from 6.0-6.8 (Johnston 1987).

Dynamics: This alliance represents an early seral primary successional stage on newly deposited sediments that may persist under a regime of repeated fluvial disturbance. *Salix exigua* and *Salix interior* are highly adapted to most forms of disturbance. Both species are prolific sprouters and will reestablish themselves on sites dominated by other disturbance associated species, e.g., *Glycyrrhiza lepidota* and *Pascopyrum smithii*.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Total vegetation cover in these temporarily flooded cold-deciduous shrublands ranges from 19 to 100% and is dominated by *Salix exigua* with 5 to 90% cover. The remaining tall and short shrub layer includes trace to low cover of *Quercus gambelii, Amelanchier utahensis, Fraxinus anomala, Mahonia fremontii, Ribes aureum* (up to 25% cover recorded in one plot), *Rosa woodsii, Rhus aromatica* var. *simplicifolia, Brickellia longifolia, Ericameria nauseosa,* and *Atriplex canescens*. The herbaceous layer is somewhat diverse and can be weedy, with dominant herbaceous species recorded including *Poa pratensis* (with 15-20% cover), *Bromus tectorum* (with up to 50%), and *Salsola tragus* (with up to 13%). Associated herbaceous species include trace to low cover of *Schizachyrium scoparium, Achnatherum hymenoides, Sporobolus airoides, Dalea oligophylla, Artemisia dracunculus, Artemisia ludoviciana, Senecio spartioides,* and *Machaeranthera canescens.*

Globally
Plant associations within this alliance are characterized as temporarily flooded cold-deciduous shrublands dominated by *Salix exigua* or *Salix interior*. The tall-shrub layer has 15-90% cover, ranging in height between 2-5 m. Other willows can occur in the canopy, including *Salix eriocephala, Salix lutea, Salix ligulifolia*, and *Salix monticola*. Occasionally, the taller *Salix amygdaloides, Populus deltoides*, or *Populus balsamifera* occur within the tree subcanopy. The herbaceous layer varies greatly over the broad range of the alliance. It may have as much as 20-35% cover of various graminoid species, including *Carex nebrascensis, Carex pellita (= Carex lanuginosa), Spartina pectinata, Phalaris arundinacea, Equisetum arvense, Panicum bulbosum*, and *Muhlenbergia rigens*. The forb cover is usually sparse. The understory can be dominated by barren ground or gravel bar. Emergent trees may be present, including *Acer negundo, Alnus rhombifolia, Juglans hindsii, Populus fremontii, Salix gooddingii, Salix laevigata*, and *Salix lucida*. Stands occur in temporarily flooded floodplains, depositions along rivers and streams, at springs and reservoir edges.

Vegetation Structure Summary: The canopy is dominated by a tall, 2-5 m, broad-leaved deciduous shrub that is typically many-branched with continuous cover of 60-100%. The herbaceous stratum is sparse to moderate cover including a variety of pioneering species.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short Shrub	*Salix exigua*

Globally

Stratum	Species
Short shrub	*Salix exigua*

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
In the West, *Salix exigua* alliances differ due to the structure of the vegetation and hydrologic regimes. The woodland alliances contain open stands of trees with crowns not touching (generally forming 25-60% cover). The hydrologic regimes differ due to the length of time that the surface water is present and depth to the water table. The surface water in the seasonally flooded alliance is present for extended periods during the growing season, and the water table is typically near the surface. It occurs in interdune depressions. On the other hand, the surface water in the temporarily flooded alliance is only present for brief periods during the growing season, and the water table is well below the surface. Its habitat is strictly riverine. In contrast, *Salix interior* does not develop stands which would be considered to have a woodland physiognomy, and all examples are considered to be temporarily flooded (e.g., riverine). G. Kittel 9-2007: This alliance has gotten very large, covering a huge geographic area. While the habitat is very similar throughout its range, the associated species do change with biogeographic region. For example California and southwestern desert stands have more in common than the Interior West (ID, MT, CO). In addition, the geographic subspecies interior may be a good way to split this alliance east to west. Currently, there is only one association in the *Salix exigua* Seasonally Flooded Woodland Alliance (A.649). This needs to be examined closely.

CLASSIFICATION CONFIDENCE: Not applicable

ELEMENT SOURCES
Canyonlands National Park Inventory Notes: Plot is located on a sandy stream terrace about 2m above the wash floor. Presumably the water table under this dry wash is close to the surface, and perhaps the sand here has a capillary effect- keeping the Salix's feet wet. Terrace is subject only to the largest of high water events.
Canyonlands National Park Plots: This description is based on 2004 field data (1 plot: CANY.0821) and 2007 and 2008 Accuracy Assessment (5 points: CANY_AA.0803, CANY_AA.0947, CANY_AA.0971, CANY_AA.3091, and CANY_AA.3285).
Local Description Authors: A. Tendick
Global Description Authors: D. Culver, mod. G. Kittel and A. Klein

REFERENCES: Borchert et al. 2004, Brown et al. 1979, Brown 1982, Christy1973, Cooper and Cottrell 1990, Dale and Kuroda1979, Dick-Peddie et al. 1984, Dorn 1997, Evenden 1990, Faber-Langendoen and Midwest State Natural Heritage Program Ecologists 1996, Foti et al. 1994, Hansen et al. 1995, Hansen et al. 1991, Hansen et al. 1989, Hoagland 2000, Hoagland 1998c, Johnston 1987, Jones and Walford 1995, Kagan1997, Kittel 1994, Kittel and Lederer 1993, Kittel et al. 1999a, Kittel et al. 1994, Kittel et al. 1996, Kittel et al. 1995, Kovalchik 1987, Muldavin et al. 2000a, Muldavin et al. 1994a, Muldavin et al. 1993a., Myhre and Clements 1972, Padgett et al. 1988b, Padgett et al. 1989, Phillips 1977, Sawyer and Keeler-Wolf 1995, Shelford 1954, Thompson and Hansen 2002, Tuhy and Jensen 1982, Vaghti 2003, Western Ecology Working Group n.d., Youngblood et al.1985a

Artemisia campestris Stream Terrace Herbaceous Vegetation [Park Special]

Field Sagewort Stream Terrace Herbaceous Vegetation

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): N/A

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Artemisia campestris is associated with other wash communities in Canyonlands National Park, but this association is rare within the park and is represented by only one plot on the floodplain of the East Fork of Salt Creek, 2 km from its confluence with Salt Creek.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This forb association occurs on stream terraces elevated approximately 1 m above the channel. The one sampled site is flat and lies at an elevation of 1675 m. The unvegetated surface is mostly exposed sand with low cover of litter and biological soil crust. The soil is a poorly developed, rapidly drained sand derived from alluvium.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare herbaceous association occurs on disturbed stream terraces. Total vegetation cover does not exceed 15% and is dominated by *Artemisia campestris*. Other forb species contribute little cover to the community and may include *Oenothera pallida, Heterotheca villosa, Penstemon comarrhenus, Silene antirrhina, Draba cuneifolia*, and *Solidago canadensis*. Grasses are likewise sparse; common species include *Achnatherum hymenoides, Bromus tectorum, Sporobolus cryptandrus*, and *Bouteloua gracilis*. Scattered shrubs may be present; *Artemisia tridentata* ssp. *tridentata* and the succulent dwarf-shrub *Opuntia erinacea* have been reported.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Herb (field)	*Artemisia campestris*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The height of the terrace above the wash bottom has a significant influence on the plant community. On this terrace, a few inches difference in elevation makes a huge difference in biological soil crust development.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: **Plots and Observation Points:** The description is based on 2004 field data (1 plot): (Plot: CANY.0396).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: N/A

REFERENCES: N/A

Atriplex canescens / Suaeda moquinii Shrubland [Park Special]

Fourwing Saltbush - Shrubby Seepweed Shrubland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is known from the Colorado River - opposite Gooseberry Canyon, Green River - Turk's Head, Anderson Bottom, across river from Valentine Bottom, Upheaval Bottom, and Salt Creek below Angel Arch Camp.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This saltbush community is represented by one plot and seven AA points, but appears to be isolated to a short section of the Green and Colorado Rivers with one disjunct occurrence on Salt Creek. Occurrences occupy valleys, floodplains, washes and alluvial terraces between elevations of 1176 and 1567 m with 1 to 4 degree slopes. Soils are sand, silt, silt loam, or clay derived of alluvial deposits.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland association is characterized by sparsely vegetated to open stands of *Atriplex canescens* and *Suaeda moquinii (= Suaeda torreyana)*. Both species have variable cover ranging from 3-20% and may dominate or codominate, but both are always present. Scattered individuals of *Populus fremontii, Salix exigua,* and *Tamarix chinensis* may occur. *Acroptilon repens (= Centaurea repens)* and *Sarcobatus vermiculatus* may occasionally codominate stands. Other shrubs present in stands include *Opuntia polyacantha, Ericameria nauseosa (= Chrysothamnus nauseosus), Artemisia filifolia*, and *Artemisia tridentata* ssp. *tridentata*. Native herbaceous cover is typically <10% and largely graminoid. Graminoid species may include *Distichlis spicatus, Sporobolus cryptandrus, Sporobolus contractus*, and *Sporobolus airoides*. Forb cover is trace or absent and includes *Machaeranthera canescens, Halogeton glomeratus, Conyza canadensis, Malvella leprosa, Oenothera caespitosa, Sphaeralcea parvifolia, Sesuvium verrucosum, Artemisia ludoviciana,* and the non-native *Salsola tragus*. The non-native grass *Bromus tectorum* may be well-established at some sites and have cover as high as 20%.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Data are not available.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 (1 plot: CANY.0211) and 2008 Accuracy Assessment (7 points: CANY_AA.1104, CANY_AA.1105, CANY_AA.1106, CANY_AA.1113, CANY_AA.1194, CANY_AA.1252, and CANY_AA.2024).
Local Description Authors: M.E. Hall and A. Tendick
Global Description Authors: N/A

REFERENCES: N/A

Atriplex gardneri / Sporobolus airoides Dwarf-shrubland [Park Special]

Gardner's Saltbush / Alkali Sacaton Dwarf-shrubland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare dwarf-shrubland is represented by one plot located in Potato Bottom Basin. It is located on a large sandbar along the inside portion of the wash.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This rare saltbush shrubland occurs on flat sandy wash terraces that flood intermittently. The one sampled site is at 1236 m elevation. Most of the unvegetated surface is covered by sand with sparse litter cover. The soil is a well-drained sand derived from alluvium.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This unusual sparse saltbush association is rare within the park. The total vegetation cover does not exceed 10% cover and is dominated by *Atriplex gardneri* and the moderately tall bunchgrass *Sporobolus airoides*. No other species has more than a trace cover; other shrubs include *Ericameria nauseosa* and *Atriplex confertifolia*. Herbaceous species include scattered individuals of *Pleuraphis jamesii*, *Sphaeralcea leptophylla*, and *Salsola tragus*. Cryptogams contribute sparse cover and include moss and dark cyanobacteria. The invasive tall shrub *Tamarix chinensis* was observed adjacent to the sampled plot.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex gardneri*
Herb (field)	*Sporobolus airoides*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Salsola tragus* (exotic), *Tamarix chinensis* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Data are not available.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: N/A

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This flat sand terrace is about 1 m higher than the wash bottom, but still floods occasionally as shown by debris trapped in shrubs. This soil bears no resemblance to the soil on surrounding slopes.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY 0361).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: N/A

REFERENCES: N/A

Chrysothamnus linifolius Shrubland [Park Special]

Spearleaf Rabbitbrush Shrubland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): N/A

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland is rare within the park and is represented by one plot located 200 m south of the parking lot near the Zeus and Moses formations.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This riparian shrubland was sampled once on a gently sloping, intermittently flooded stream terrace at 1285 m elevation. The unvegetated surface has high exposure of bare sand, sparse exposure of bare soil, and sparse cover of large and small rocks. The soil is a rapidly drained loamy sand derived from alluvium.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare spearleaf rabbitbrush shrubland does not exceed 10% total vegetation cover. The canopy is dominated by *Chrysothamnus linifolius* with up to 7% cover, usually accompanied by *Tamarix chinensis, Eriogonum corymbosum, Purshia mexicana*, and *Gutierrezia sarothrae* providing a few percent of additional cover. The herbaceous layer contributes sparse cover and may include *Pleuraphis jamesii, Achnatherum hymenoides, Sporobolus airoides, Bromus tectorum, Salsola tragus, Artemisia dracunculus, Descurainia pinnata, Oenothera pallida, Abronia fragrans, Sphaeralcea grossulariifolia*, and *Sphaeralcea leptophylla*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Chrysothamnus linifolius*
Herb (field)	*Salsola tragus*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High), *Descurainia pinnata* (invasive), *Salsola tragus* (exotic), *Tamarix chinensis* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (17-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The plant community is controlled by periodic flooding that causes down-cutting or sedimentation. The shrubs have helped to stabilize a terrace above the wash. The shrubland is affected by overbank flooding; no litter is present and sand deposition is occurring on the terrace.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: **Plots and Observation Points:** The description is based on 2004 field data (1 plot): (Plot: CANY.0138).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: N/A

REFERENCES: N/A

Chrysothamnus viscidiflorus - Krascheninnikovia lanata Shrubland [Park Special]

Yellow Rabbitbrush - Winterfat Shrubland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is only known from the Ant Hill Mesa area.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is rare and only known from five observation points in the Ant Hill Mesa area. Sites occupy rolling plains on the mesa at 1247-1634 m elevation with gentle slopes (0-2 degrees) on variable aspects. Substrates of all three sites are stabilized eolian dune deposits with deep sandy soils.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is characterized by a sparse to open shrub canopy of *Chrysothamnus viscidiflorus* and may be codominted by *Opuntia polyacantha* on some sites with lesser amounts of *Krascheninnikovia lanata*. *Bouteloua gracilis* and *Hesperostipa comata* are common graminoid associates with no recorded forb presence. *Bromus tectorum* is present at low cover at most sites.

Globally
Data are not available.

MOST ABUNDANT SPECIES
*Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)*Data are not available.

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (19-Feb-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes:
Data are not available.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2008 Accuracy Assessment (5 points: CANY_AA.2040, CANY_AA.2064, CANY_AA.2143, CANY_AA.2845, and CANY_AA.2852).
Local Description Authors: M.E. Hall
Global Description Authors: N/A

REFERENCES: N/A

Ephedra torreyana / Sporobolus cryptandrus Shrub Herbaceous Vegetation [Park Special]

Torrey's Joint-fir / Sand Dropseed Shrub Herbaceous Vegetation

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland is rare within the park and was sampled west of Upheaval Bottom and west of the mouth of Taylor Canyon.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrub herbaceous association occurs on falling dunes with a moderate 11-12 degree slope oriented from the northeast to the southeast between 1198 and 1206 m elevation. Most of the unvegetated surface consists of exposed bare soil and gravel, with lesser cover by litter.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare shrub herbaceous association has a total vegetation cover of 13-15% and is characterized by an open shrub layer dominated by *Ephedra torreyana*, with 3-4% cover, and an understory dominated by *Sporobolus cryptandrus*, with 6-9% cover. Shrubs commonly present with trace to 1% cover include *Artemisia filifolia, Atriplex canescens,* and *Opuntia polyacantha*. *Achnatherum hymenoides* may be present with trace to 1% cover. Common forbs include *Abronia fragrans, Sphaeralcea parvifolia, Hymenopappus filifolius,* and *Zigadenus paniculatus*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Sporobolus cryptandrus*
Herb (field)	*Abronia fragrans*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: Not applicable

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Scattered lag gravel over large sloping dune. No cryptos here. No pedestalling of shrubs, but it is very loose and sandy.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2008 Accuracy Assessment (3 points: CANY_AA.4020, CANY_AA.4039, CANY_AA.4043).

Local Description Authors: A. Tendick
Global Description Authors: N/A

REFERENCES: N/A

Ephedra viridis / Muhlenbergia pungens Shrubland [Park Special]

Mormon-tea / Sandhill Muhly Shrubland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland is rare within the park and is represented by one plot located 200 m from the road to Horseshoe Canyon and one plot on Horsethief Point.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This unusual shrubland occurs on active and inactive sand dunes atop a plateau or mesa between 1517 m and 1570 m elevation. Due to the irregular surface of the dune remnants, slope and aspect are variable. The unvegetated surface has a high exposure of bare sand and sparse to low cover of litter. Soils are rapidly drained loamy sands derived from eolian deposits.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This shrubland is rare within the park. Total vegetation cover is between 10-24%. *Ephedra viridis* is the dominant shrub, contributing 5-8% cover. Other shrubs present with sparse to low cover include *Coleogyne ramosissima* (codominant in one plot), *Eriogonum leptocladon, Artemisia filifolia, Krascheninnikovia lanata* and *Gutierrezia sarothrae*. The herbaceous layer is moderately diverse and contributes sparse to low cover. Graminoids include *Muhlenbergia pungens, Pleuraphis jamesii, Sporobolus cryptandrus*, *Sporobolus flexuosus,* and *Achnatherum hymenoides*. Forbs include *Ambrosia acanthicarpa, Amsonia tomentosa, Dithyrea wislizeni, Chenopodium leptophyllum*, and the non-native annual *Salsola tragus*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Ambrosia acanthicarpa*
Herb (field)	*Muhlenbergia pungens*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Salsola tragus* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (17-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Deep, sandy soils are of eolian origin. *Ephedra viridis* retains (or built) the dune tops, and forbs are generally in the blowouts between. These dunes are no longer active. Soils are physically crusted in blowouts and have slight cyanobacterial crusting on *Ephedra viridis* dune tops.

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0826) and 2007 Accuracy Assessment (1 point: CANY_AA.0779).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: N/A

REFERENCES: N/A

Frangula betulifolia Shrubland [Park Special]

Beechleaf Frangula Shrubland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Not applicable

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare shrubland is represented by two plots, one located below Pete's Mesa in an alcove below the White Rim and in the other in Buck Canyon.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This unusual shrubland occurs on a steep colluvial slope below a hanging garden and in a spring area in a canyon bottom. The sampled sites were nearly flat to steep (5- to 34-degree slopes) oriented to the northwest and southeast, and occurred between 1329 m and 1544 m elevation. The unvegetated surface has a low to high cover of large flat rocks and bedrock, with low exposure of bare soil, gravel and litter, and absent to moderate cover of water. The soil is a moderately well-drained sandy loam derived from Organ Rock shale.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare mesic shrubland has a total vegetation cover of 27%, limited primarily by the area not covered by large rocks or water. The tall-shrub canopy is dominated by *Frangula betulifolia (= Rhamnus betulifolia)* with 4-25% cover, and accompanied by *Salix exigua* and *Tamarix chinensis*. The short-shrub layer includes *Rhus trilobata* and *Brickellia longifolia*. The herbaceous layer has sparse to moderate cover, with grass species present including *Muhlenbergia asperifolia* (12% cover) and *Carex* sp. Forb cover is low and includes *Stanleya pinnata, Aquilegia micrantha*, and *Solidago canadensis*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Frangula betulifolia*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Vulnerable: *Aquilegia micrantha* (rare, G5)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (17-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: N/A

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This slope seems pretty unstable with the shrubs growing at angles (facing downslope) and they appear to be stabilizing the slope somewhat. Vegetation distribution is obviously determined by proximity to the seeps.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY 0284, CANY 9314).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: N/A

REFERENCES: N/A

Hymenopappus filifolius Herbaceous Vegetation [Park Special]

Fineleaf Hymenopappus Herbaceous Vegetation

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Not applicable

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This forb association is rare within the park and is represented by plot sampled in a canyon north of the "All American Man" and in Red Lake Canyon.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This forb-dominated association is restricted to sandy sites. It was sampled on a flat canyon floor and on the steep (31-degree) slope of a sand dune between 1423 and 1737 m elevation. Most of the unvegetated surface is bare soil or sand, with low cover by litter and biological soil crusts. Soils are rapidly drained loamy sands or sands derived from alluvium or eolian deposits.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This unusual herbaceous association is rare within the park. Total vegetation cover does not exceed 12%. The vegetation is dominated by the perennial forb *Hymenopappus filifolius* that ranges in cover from 4 to 6%. Associated herbaceous species include *Hesperostipa comata, Sporobolus airoides, Achnatherum hymenoides, Bromus tectorum, Comandra umbellata, Oenothera pallida, Lepidium montanum* var. *jonesii, Sphaeralcea parvifolia, Salsola tragus*, and *Sphaeralcea coccinea*. Scattered shrubs may be present with a few percent total cover; *Ericameria nauseosa, Ephedra viridis, Artemisia frigida, Atriplex canescens*, and *Opuntia erinacea* were recorded in the sample plots.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Hymenopappus filifolius*, *Oenothera pallida*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (17-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: N/A

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The dune site seems pretty well stabilized by plants and moss; however, nearby the same slope and aspect has blown

out and is devoid of vegetation. The canyon bottom plot has a complex vegetation pattern with species composition changing throughout from completely dead forbs to a mixture of flowering forbs.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY.0393, CANY.0561).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: N/A

REFERENCES: N/A

Iva acerosa Herbaceous Vegetation [Park Special]

Copperweed Herbaceous Vegetation

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Not applicable

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This herbaceous association is rare and was sampled near the trail into the Maze from Chimney Rock, in Jasper Canyon, and in the east branch of the South Fork of Horse Canyon (the Maze) in Canyonlands National Park and 100 m north of a 4x4 road near Big Water Spring in Glen Canyon National Recreation Area.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This forb association occurs on intermittently flooded wash bottoms. Sites are flat and occur between 1330 and 1509 m elevation. Bare alluvium covers most of the unvegetated surface with low to moderate cover by litter, and absent to moderate cover of bedrock. Soils are rapidly drained loamy sands or sands derived from alluvium.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This unusual herbaceous association is rare in the park. Total vegetation cover is variable and ranges from trace to 31%. *Iva acerosa (= Oxytenia acerosa)* dominates the vegetation with trace to 14% cover. Associated herbaceous species include *Distichlis spicata, Achnatherum hymenoides, Calamagrostis scopulorum, Sporobolus airoides, Glycyrrhiza lepidota*, and *Heterotheca villosa*. *Populus fremontii* saplings between 5 and 10 m tall are scattered throughout the sampled stands. Scattered tall shrubs may also be present, including *Salix exigua, Salix eriocephala*, and the invasive *Tamarix chinensis*. Short and dwarf-shrubs are uncommon, contribute less than 1% cover, and include *Artemisia bigelovii, Rhus trilobata* var. *simplicifolia (= Rhus aromatica* var. *simplicifolia), Ericameria nauseosa, Artemisia filifolia, Cercocarpus intricatus, Gutierrezia sarothrae*, and *Brickellia microphylla*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Populus fremontii*
Tall shrub/sapling	*Salix exigua*, *Tamarix chinensis*
Herb (field)	*Iva acerosa*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Tamarix chinensis* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (17-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: N/A

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The desert washes may occasionally flood and scour the vegetation out of the streambed; relatively mesic conditions determine the species composition of the area. A small alluvial terrace supports much higher vegetation density than the wash bottom, which only supports clumps of *Salix exigua*.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY.0262, GLCA.0552) and 2008 Accuracy Assessment (2 points: CANY_AA.4240, CANY_AA.4317).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: N/A

REFERENCES: N/A

Juniperus osteosperma / Quercus gambelii Woodland [Park Special]

Utah Juniper / Gambel Oak Woodland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland is rare within the park and was sampled in Lost Canyon, Horse Canyon and upper Salt Creek Canyon in the Needles District.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association occurs on valley floors and along drainages. Sites are flat to gently sloping (up to 5° slope) oriented from the northeast to the southeast, and lie between 1504 and 1784 m elevation. Most of the unvegetated surface consists of exposed bare soil and litter, with lesser cover by biological soil crusts.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare woodland association has a total vegetation cover of 24-40% and is characterized by an open canopy of *Juniperus osteosperma*, with 7-12% cover. *Pinus edulis* is absent or if present, has no more than trace cover. The understory is dominated by *Quercus gambelii*, with 10-20% cover. Associated shrubs with trace to 4% cover include *Forestiera pubescens, Rhus aromatica* var. *trilobata, Artemisia tridentata* ssp. *tridentata, Atriplex canescens, Ephedra viridis, Artemisia bigelovii, Opuntia polyacantha,* and *Gutierrezia sarothrae*. Graminoids commonly present with trace to 1% cover include *Sporobolus cryptandrus, Hesperostipa comata, Achnatherum hymenoides, Aristida purpurea,* and *Stipa speciosa*. Common forbs include *Artemisia dracunculus, Heterotheca villosa, Artemisia campestris, Castilleja linariifolia, Machaeranthera canescens,* and *Solidago canadensis*. Biological soil crusts are not well developed and have up to 30% cover.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Tall shrub/sapling	*Quercus gambelii*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: Not applicable

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Small, braided, ephemeral wash channels separated by "uplands" - sandy islands about 1m high with the shrubs, trees, and good biocrust, although they must flood periodically. The litter is concentrated under the oak clones.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2008 field data (3 AA points): (CANY_AA.2012, CANY_AA.2774, CANY_AA.3281).
Local Description Authors: A. Tendick
Global Description Authors: N/A

REFERENCES: N/A

Juniperus osteosperma / Sporobolus airoides Woodland [Park Special]

Utah Juniper / Alkali Sacaton Woodland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association is was sampled in a canyon 750 m south of the Harvest Scene pictographs in the Maze, near Maze Overlook, in lower Horse Canyon, Jasper Canyon, Shot Canyon, and north of The Plug.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association was sampled on a flat stream/wash terrace, on a canyon floor, in a box canyon, and along drainages between 1309 and 1425 m elevation. Exposed soil and sand cover most of the unvegetated surface; there is low cover of litter, rocks, and biological soil crusts. Soils are rapidly drained loamy sands derived from alluvium.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This Utah juniper woodland is somewhat rare within the park. Total vegetation cover is between 13 and 52%. Stands are characterized by an open canopy, between 5 and 10 m tall, of *Juniperus osteosperma* with 3 to 25% cover, and an herbaceous understory dominated by *Sporobolus airoides* with 2 to 10% cover. Associated shrubs include *Forestiera pubescens, Mahonia fremontii, Shepherdia rotunifolia, Ephedra torreyana, Ericameria nauseosa,*

Artemisia filifolia, Atriplex canescens, Gutierrezia sarothrae, *Yucca* spp., and *Opuntia erinacea*. The herbaceous layer contributes low cover. It may include *Achnatherum hymenoides* (up to 4% cover), *Hesperostipa comata, Pleuraphis jamesii, Bouteloua curtipendula, Phragmites australis, Amsonia tomentosa, Comandra umbellata, Machaeranthera canescens, Oxytenia acerosa, Chenopodium fremontii*, and *Lepidium montanum*. Scattered individuals of *Populus fremontii* and/or *Pinus edulis* are common, but have no more than sparse to 1% cover.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Opuntia erinacea*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (17-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: It is uncertain why *Artemisia filifolia* is nearly absent here and grasses more abundant, except that this stream terrace receives runoff from the cliff walls on its north side. Soil surface is more compact, with more physical crusting than adjacent similar sites.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY 0837, CANY.9741) and 2008 Accuracy Assessment (4 points: CANY_AA.4147, CANY_AA.4269, CANY_AA.4310, CANY_AA.4348).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: N/A

REFERENCES: N/A

Krascheninnikovia lanata / Sporobolus cryptandrus Dwarf-shrubland [Park Special]

Winterfat / Sand Dropseed Dwarf-shrubland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This dwarf-shrubland is rare and was sampled along Horse Canyon Road near the junction with the Tower Ruin spur, in Salt Creek pocket, and in the Red Lake Canyon area.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This dwarf-shrubland was sampled on a gently sloping knoll between shallow gullies, in a graben and in a valley bottom between 1409 and 1574 m elevation. Exposed soil, litter, and biological soil crusts cover most of the unvegetated surface. The soil is a rapidly drained silt loam derived from alluvium.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This winterfat dwarf-shrubland is rare within the park. Total vegetation cover ranges from 12% to 60%. The stand is characterized by an open canopy dominated by *Krascheninnikovia lanata* (3-15% cover) and an herbaceous understory dominated by *Sporobolus cryptandrus* (trace to 20% cover). Associated shrubs include *Atriplex canescens* and *Opuntia polyacantha*. The rest of the herbaceous layer provides sparse cover and includes *Achnatherum hymenoides, Poa fendleriana, Bromus tectorum*, *Salsola tragus, Machaeranthera canescens, Mentzelia albicaulis, Sphaeralcea grossulariifolia*, and *Gaillardia pinnatifida*. Biological soil crusts are in an early stage of development.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Krascheninnikovia lanata*
Herb (field)	*Sporobolus cryptandrus*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (17-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Community is located on a knoll or low hill between shallow gullies draining steep colluvial slopes on the side of the canyon. Soils here are deep and fine, with no rock. Soil surface has substantial cryptobiotic cover (mostly moss) and no evidence of any eolian or pluvial erosion.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0743) and 2008 Accuracy Assessment (2 points: CANY_AA.2312, CANY_AA.2427).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: N/A

REFERENCES: N/A

Lolium arundinaceum - Agrostis stolonifera Semi-natural Herbaceous Vegetation [Park Special]

Tall Fescue - Creeping Bentgrass Semi-natural Herbaceous Vegetation

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Not applicable

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare graminoid association is represented by one plot in Water Canyon 300 m from the confluence with Horseshoe Canyon. It is located on the bottom of the intermittently flooded wash.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This exotic graminoid association was sampled once at 1470 m elevation on the flat bottom of an intermittently flooded wash interspersed with low sand bars up to 2 feet high. The unvegetated surface has high cover of litter with 10% exposure of bare sand. The soil is a well-drained sand derived from alluvium.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This herbaceous association is rare within the park. Total vegetation cover is 70%. The stand is dominated by *Lolium arundinaceum* (30%) and *Agrostis stolonifera* (20%). Minor components include *Juncus arcticus, Equisetum laevigatum, Asclepias speciosa*, and *Solidago canadensis*. *Salix eriocephala* is present and provides sparse cover.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Herb (field)	*Agrostis stolonifera*, *Juncus arcticus*, *Lolium arundinaceum*
Herb (field)	*Equisetum laevigatum*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Lolium arundinaceum* (exotic, High/Medium)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNA (ruderal) (17-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This community grows on low sand bars up to 2 feet high that would be little islands or flooded if the wash was flowing. The soil here is noticeably damper than farther upstream.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0417).
Local Description Authors: M. Smith
Global Description Authors: N/A

REFERENCES: N/A

Mahonia fremontii Shrubland [Provisional]

Desert Oregon-grape Shrubland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Not applicable

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This shrubland is only known from Glen Canyon National Recreation Area and occurs 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. This unusual shrubland is rare and was only sampled within the recreation area. 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 was moderate to high (51%).

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This association is rare and is represented by one plot near the High Gallery in Horseshoe Canyon in Canyonlands and one plot located in a wash tributary to Big Water Canyon 1.5 km downstream from a two-track road in the recreation area.

Globally

This association represented by a single plot in Glen Canyon National Recreation Area.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This shrubland occurs on wash banks or terraces 2 to 3 m above the channel. The slope is flat to moderate, oriented to the south and lies between 1402 m and 1575 m elevation. Exposed soil and litter cover most of the unvegetated surface. A well-developed biological soil crust community covers more than half the sampled plot in the recreation area. The soil is a rapidly drained silt loam derived from alluvium rich in shale.

Globally

This association is documented from a single occurrence and will require further documentation to develop a thorough global description.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This unusual shrubland is rare within the park and recreation area. Total vegetation cover is 24-26%. *Mahonia fremontii* shrubs form an open canopy with 6-10% cover. Associated shrubs include *Ericameria nauseosa, Ephedra viridis, Fraxinus anomala, Rhus aromatica, Atriplex canescens*, and *Gutierrezia sarothrae*. The understory was dominated by the non-native, annual *Bromus tectorum* in one stand with 16% cover. Other herbaceous species contribute low cover and may include *Sporobolus airoides, Pleuraphis jamesii, Achnatherum hymenoides, Artemisia ludoviciana*, *Oenothera pallida, Sphaeralcea coccinea, Salsola tragus, Abronia fragrans, Artemisia campestris,* and *Comandra umbellata*. Biological soil crust cover was moderate to high (51%).

Globally
This association is documented from a single occurrence and will require further documentation to develop a thorough global description.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Mahonia fremontii*
Herb (field)	*Pleuraphis jamesii*, *Sporobolus airoides*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jul-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
With only one plot to represent it, this type is very provisional, and with further classification work, could be merged into some other association.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The plot captures a narrow band of *Mahonia fremontii* that occupies the wash bank about halfway up. Deep, loamy soils are covered by very well-developed crusts. Some dieback/dead branches on some of the *Mahonia fremontii*, but overall stand looks healthy.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY.9065, GLCA.0128).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: M.E. Hall

REFERENCES: Western Ecology Working Group n.d.

Oenothera albicaulis Herbaceous Vegetation [Park Special]

Prairie Evening-primrose Herbaceous Vegetation

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Not applicable

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This forb association is associated with a series of sand dunes near the intersection of the roads to Horseshoe Arch and the Grabens.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This forb association occurs on sand dunes surrounded by sandstone outcrops. The one sampled site is flat and lies at 1660 m elevation. The unvegetated surface has high exposure of sand with low cover of litter, biological soil crusts and downed wood. The soil is a rapidly drained sand derived from eolian deposits.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This evening-primrose association is rare within the park. Total vegetation cover is less than 20%. The stand is characterized by the forb *Oenothera albicaulis* with 8% cover. Associated forbs are those typical of sandsheets, including *Plantago patagonica, Abronia fragrans, Cryptantha* sp., *Sphaeralcea coccinea*, and *Helianthus annuus*. Grasses include *Hesperostipa comata, Bromus tectorum, Bouteloua gracilis*, and *Achnatherum hymenoides*. Shrubs tend to occupy the low spots of the community, provide sparse cover and include *Atriplex canescens, Ephedra viridis*, and *Opuntia erinacea*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Abronia fragrans*, *Oenothera albicaulis*, *Plantago patagonica*, *Sphaeralcea coccinea*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (17-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The presence of these stable dunes determines this distinct but patchy plant community. Microtopography has some effect on shrub density; lower areas seem to have higher *Atriplex* spp. density.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0650).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: N/A

REFERENCES: N/A

Oenothera pallida Herbaceous Vegetation [Park Special]

Pale Evening-primrose Herbaceous Vegetation

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Not applicable

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare association is represented by two plots, one located east of the south boundary gate to Canyonlands National Park in a canyon bottom and the other located in Taylor Canyon. The plot lies adjacent to the fence that separates the park from neighboring Bureau of Land Management land.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This unusual forb association occurs between 1209 m and 1732 m elevation on a level canyon floor, with dunes nearby. Exposed soil and litter cover most of the unvegetated surface, and an extensive biological soil crust contributes up to 20% cover. The soil is a rapidly drained loamy sand derived from eolian deposits.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This community is rare within the park. Total vegetation cover is between 34% and 68%. The stand is characterized by *Oenothera pallida* with 1-40% cover. Associated forbs include *Cryptantha crassisepala*, *Sphaeralcea coccinea, Hymenopappus filifolius*, *Rumex hymenosepalus, Machaeranthera tanacetifolia,* and *Plantago patagonica*. Graminoids include *Hesperostipa comata, Pleuraphis jamesii, Achnatherum hymenoides*, *Sporobolus flexuosus,* and

Poa fendleriana. *Atriplex canescens, Ephedra torreyana* is the only shrub present. Biological soil crusts in an early stage of development cover up to 21% of the soil surface.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Oenothera pallida*, *Sphaeralcea coccinea*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (17-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: Areas similar to this are frequently dominated by *Sphaeralcea coccinea*. The mechanisms determining this community are unknown. It may be as simple as which species colonized the area first and established dominance following many years of grazing disturbance.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0577) and 2007 Accuracy Assessment (1 point: CANY_AA.0740).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: N/A

REFERENCES: N/A

Ostrya knowltonii Woodland

Knowlton's Hophornbeam Woodland

CODE	CEGL003971
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association is known from a single occurrence in Glen Canyon National Recreation Area from an intermittently flooded alcove on a wash bottom. The site is a moderate slope oriented to the west at 1603 m elevation. Litter and exposed soil cover most of the unvegetated surface, with lesser cover by sand, bedrock and dead wood. The soil is a rapidly drained loamy sand derived from alluvium. This riparian woodland is rare within the recreation area. Total vegetation cover is 92%. The stand is characterized by a dense canopy of the tall shrub *Ostrya knowltonii* with up to 40% cover. Scattered *Populus fremontii, Pinus edulis*, and *Juniperus osteosperma* emerge from the shrub canopy but do not constitute a tree layer. Associated shrubs include *Amelanchier utahensis, Fraxinus anomala, Rhus trilobata, Symphoricarpos longiflorus*, and *Yucca angustissima*. The riparian vine *Clematis ligusticifolia* provides sparse cover. The herbaceous layer is diverse and provides significant cover. Common grasses include *Sporobolus airoides* and *Poa fendleriana*. The forbs *Solidago canadensis* and *Heterotheca villosa* provide low to moderate cover, and *Aquilegia micrantha, Cirsium calcareum, Thelypodium integrifolium*, and *Castilleja linariifolia* are generally present.

DISTRIBUTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland is rare within the recreation area and was sampled in Waterhole Canyon, on the Syncline Trail, in Gooseberry Canyon, south of Buck Canyon, and in Taylor Canyon.

Globally

Documented from a single plot in Glen Canyon National Recreation Area.

ENVIRONMENTAL DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This woodland association was sampled in an intermittently flooded alcove on a wash bottom, gully, and on a canyon side. Sites are flat to moderately sloping (up to 30 degrees), oriented from the west to the north, and occur between 1463 and 1603 m elevation. Litter, large rocks, sand, and gravel cover most of the unvegetated surface, with lesser cover by bedrock and bare soil. The soil is a rapidly drained loamy sand derived from alluvium.

Globally

This association is documented from a single occurrence and will require further documentation to develop a thorough global description.

VEGETATION DESCRIPTION

Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

This riparian woodland has a total vegetation cover of 18 to 92%. Stands are characterized by an open to dense canopy of the tall shrub *Ostrya knowltonii* with 4 to 50% cover. Scattered *Populus fremontii, Betula occidentalis, Acer negundo, Pinus edulis*, and *Juniperus osteosperma* emerge from the shrub canopy but do not have the cover to constitute a tree layer. There is a diversity of associated shrub species, all with sparse to low cover. Associated tall shrubs include *Quercus gambelii, Amelanchier utahensis, Frangula betulifolia, Forestiera pubescens, Fraxinus anomala, Cornus sericea, Rhus trilobata,* and *Mahonia fremontii.* Associated short and dwarf shrubs include *Ribes aureum, Brickellia longifolia, Ericameria nauseosa, Symphoricarpos longiflorus*, and *Yucca angustissima*. The riparian vine *Clematis ligusticifolia* provides sparse cover. The herbaceous layer is diverse and provides low to high cover. Common grasses include *Sporobolus airoides, Leymus salinus, Achnatherum hymenoides, Phragmites australis,* and *Poa fendleriana.* The non-native grass, *Bromus tectorum,* was rarely encountered with low cover. The forbs *Solidago canadensis* and *Heterotheca villosa* provide low to moderate cover, and *Aquilegia micrantha, Cirsium calcareum, Thelypodium integrifolium*, and *Castilleja linariifolia* are generally present.

Globally

This association is documented from a single occurrence and will require further documentation to develop a thorough global description.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tree canopy	*Populus fremontii*
Tall shrub/sapling	*Ostrya knowltonii*
Herb (field)	*Cirsium calcareum*, *Heterotheca villosa*, *Solidago canadensis*
Herb (field)	*Sporobolus airoides*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Vulnerable: *Aquilegia micrantha* (rare/endemic, G5), *Cirsium calcareum* (rare/endemic, G4)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jul-2006).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
With only one plot to represent it, this type is very provisional, and with further classification work, could be merged into some other association.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The plot is located in the bottom of a small drainage, below a pour-off forming an overhang. The drainage is fed by slickrock rims on the east side of Waterhole Canyon and is thus subject to flooding during local rain events.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY.9034, GLCA.0776) and 2007 field data (4 AA points): (CANY_AA.0176, CANY_AA.0199, CANY_AA.0238, CANY_AA.0463).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: M.E. Hall

REFERENCES: Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Rhus trilobata Woodland [Park Special]

Two-needle Pinyon - Utah Juniper / Skunkbush Sumac Woodland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association is uncommon within the park and was sampled 0.75 mile north of Cyclone Canyon Road, in Buck Canyon, Red Lake Canyon, Elephant Canyon, Davis Canyon, and Horse Canyon (The Maze).

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare association was sampled on a wash bottom at the base of a sandstone cliff, in a ravine on a talus slope and in a joint canyon, and near wash channels on canyon bottoms, on gently sloping sites (though one example was sampled on a 36 degree talus slope), oriented from the northwest to the east, and occurring between 1419 and 1631 m elevation. The unvegetated surface is dominated by boulders, gravel, bedrock, and litter. There is lesser cover by exposed soil, sand, and dead wood. The soil is a rapidly drained sand derived from recent alluvial deposits.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This pinyon-juniper woodland is somewhat rare within the park. Total vegetation cover is quite variable and ranges from 6 to 51%. The stand is characterized by an open tree canopy, between 5 and 10 m tall, of *Pinus edulis* (absent to 4% cover) and *Juniperus osteosperma* (with 2 to 9% cover). *Rhus trilobata* dominates the understory with 1 to 6% cover. There is quite a diversity of associated shrubs, each with sparse to low cover, but none being more dominant than *Rhus trilobabta.* Associated shrubs include *Fraxinus anomala, Fendlera rupicola, Amelanchier utahensis, Cercocarpus montanus, Shepherdia rotundifolia, Purshia mexicana, Ericameria nauseosa, Coleogyne ramosissima, Ephedra viridis, Symphoricarpos longiflorus, Atriplex confertifolia, Artemisia bigelovii, Brickellia microphylla, Brickellia longifolia, Gutierrezia sarothrae*, and the succulent *Yucca angustissima*. Herbaceous species contribute sparse to moderate cover. Grasses include *Achnatherum hymenoides, Hesperostipa comata, Elymus salinus, Pleuraphis jamesii, Aristida purpurea, Bromus rubens*, and *Bromus tectorum*. Forbs include *Packera multilobata (= Senecio multilobatus), Haplopappus armerioides, Heterotheca villosa, Iva acerosa, Solidago canadensis, Lepidium montanum*, and *Cryptantha flavoculata*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Fraxinus anomala*
Short shrub/sapling	*Rhus trilobata* var. *simplicifolia*
Short shrub/sapling	*Symphoricarpos longiflorus*
Herb (field)	*Yucca angustissima*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section):
Exotic/Invasive: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (22-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: N/A

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The vegetation here gets rainwater shed by a cliff face to the north. As a result, *Pinus edulis* grow up to 10 m tall. There is little to no riparian vegetation, indicating a deep water table and infrequent surface water. Sandy alluvial soils are less than 8 cm deep on top of bedrock.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0195) and 2007 and 2008 Accuracy Assessment (6 points: CANY_AA.0213, CANY_AA.0219, CANY_AA.3034, CANY_AA.3123, CANY_AA.3336, CANY_AA.4312).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: N/A

REFERENCES: N/A

Pinus edulis - Juniperus osteosperma / Symphoricarpos longiflorus Woodland [Park Special]

Two-needle Pinyon - Utah Juniper / Desert Snowberry Woodland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This association is rare within the park and recreation area and was sampled north of The Plug and above the south fork of Rough Canyon in Canyonlands National Park and sampled 1.3 km north of Teapot Rock Campground in the recreation area.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This woodland association was documented in an alcove on a canyon rim, in a wash, and in a canyon bottom. Sampled stands are on a gentle (2 to 5-degree) slopes oriented to the east-northeast and west, and occur between

1425 and 1631 m elevation. Most of the unvegetated surface is sand or exposed soil along with moderate cover by litter and some exposed bedrock and large and small rock cover. The soil is a rapidly drained loamy sand derived from Cedar Mesa sandstone.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This unusual pinyon-juniper woodland is characterized by an open tree canopy, typically 2-5 m tall, of *Pinus edulis* and *Juniperus osteosperma* totaling 7-20% cover. *Symphoricarpos longiflorus* dominates the sparse understory with 3-4% cover. Total vegetation cover ranges from 20 to 35%. Scattered *Pinus edulis* seedlings may be present. Associated shrubs include scattered individuals of *Amelanchier utahensis, Ephedra viridis, Mahonia fremontii, Fraxinus anomala, Cercocarpus intricatus, Symphoricarpos longiflorus, Gutierrezia sarothrae*, and *Yucca angustissima*. The herbaceous layer is sparse and typically consists primarily of perennial forbs, including *Comandra umbellata, Artemisia ludoviciana, Artemisia dracunculus, Tetraneuris acaulis (= Hymenoxys acaulis), Iva acerosa, Solidago canadensis, Heterotheca villosa*, *Lepidium alyssoides* var. *eastwoodiae*, and *Lepidium montanum*. Herbaceous species recorded with sparse to low cover include *Achnatherum hymenoides* and *Calamagrostis scopulorum.*

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*
Shrub/sapling (tall & short)	*Cercocarpus intricatus*
Short shrub/sapling	*Symphoricarpos longiflorus*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Comandra umbellata*, *Heterotheca villosa*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (22-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This plot captures a community that is protected or sheltered, step is alcove-like, and has collected deeper soils that

are well-supplied with runoff from sandstone bluffs above. Trees and shrubs are larger, and there's more collected litter under crowns. Upslope are slickrock bluffs and ledges with a more typical rimrock vegetation density.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: GLCA.0765) and 2007 and 2008 Accuracy Assessment (2 points: CANY_AA.0712, CANY_AA.4078).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: N/A

REFERENCES: N/A

Quercus gambelii / Symphoricarpos longiflorus Shrubland [Park Special]

Gambel Oak / Desert Snowberry Shrubland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare tall shrubland is represented by one plot located in the West Fork of Lavender Canyon.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This mesic tall shrubland occurs on canyon floors. The one sampled site is on a north-facing, 11-degree slope at 1660 m elevation. Litter covers most of the unvegetated surface, with low cover by dead wood and bare soil. Soils are well-drained sandy loams derived from alluvium.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare tall shrubland has a total vegetation cover of 47%. The shrub canopy is dominated by *Quercus gambelii* with up to 40% cover. *Juniperus osteosperma* canopy trees and seedlings are scattered throughout the stand and provide sparse cover. *Symphoricarpos longiflorus* has up to 2% cover in the understory. Other associated understory shrubs include *Amelanchier utahensis, Fraxinus anomala, Ephedra viridis, Gutierrezia sarothrae, Opuntia phaeacantha, Sclerocactus whipplei*, and *Yucca angustissima*; no species contributes more than a trace cover. Because the sampled plot includes a significant amount of edge habitat, herbaceous species diversity is moderate to high, but sparse in terms of cover. Grasses present include the bunch grasses *Achnatherum hymenoides, Poa fendleriana*, and *Sporobolus* sp. Forbs present include *Arenaria fendleri, Cryptantha flava, Hymenopappus filifolius, Machaeranthera grindelioides*, and *Lepidium montanum*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*, *Quercus gambelii*
Short shrub/sapling	*Symphoricarpos longiflorus*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Vulnerable: *Sclerocactus whipplei* (rare/endemic, G1G3)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (17-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: N/A

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The vegetation is somewhat patchy and contains a lot of edge. This canyon is pretty narrow with high walls on either side. Gambel oak creates a layer of litter/duff that is approximately 5 cm thick. A 4-WD road and drainage run through this area and fragments the vegetation, which prevents a continuous and homogenous stand from forming in this canyon bottom.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0612).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: N/A

REFERENCES: N/A

Rumex hymenosepalus Sparse Vegetation [Park Special]

Canaigre Dock Sparse Vegetation

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Not applicable

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare association was sampled at the confluence of Red Lake and Lens canyons, in Taylor Canyon, and in Gray's Pasture.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This sparse forb type occurs in a canyon bottom on the stabilized remnants of old sand dunes, in a duney area on a mesa top, or on a wash terrace. Sites are flat to gently sloping (up to 4 degrees), oriented to the south, and lie between 1204 and 1381 m elevation. Bare ground or sand covers most of the unvegetated surface, litter has low to moderate cover, and a mature biological soil crust community is absent or contributes up to 35% cover. The soil is a rapidly drained loamy sand derived from eolian sands.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This unusual sparse herbaceous association is rare within the park. Total vascular vegetation cover is 1-26%; however, in one example of this type, the biological soil crust community contributes 35% cover. The herbaceous layer consists primarily of *Rumex hymenosepalus* (with 1-14% cover), accompanied by scattered individuals of *Sphaeralcea coccinea, Salsola tragus, Helianthus annuus, Plantago patagonica*, *Hymenopappus filifolius, Cryptantha crassisepala, Descurainia pinnata, Bromus tectorum, Hesperostipa comata,* and *Achnatherum hymenoides*. A few *Atriplex canescens, Coleogyne ramosissima, Krascheninnikovia lanata, Ephedra viridis* and *Opuntia erinacea* or *polyacantha* shrubs are scattered through the community.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Rumex hymenosepalus*
Herb (field)	*Achnatherum hymenoides*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Salsola tragus* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (17-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: N/A

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: This area seems to be part of some old dunes; younger dunes surround this area. This lower lying area with more developed soils supports less vegetation, but for reasons not understood. Several dead individuals of *Achnatherum hymenoides, Atriplex canescens*, and *Plantago patagonica* appear throughout the plot.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot: CANY.0548) and 2007 Accuracy Assessment (2 points: CANY_AA.0407, CANY_AA.0704).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: N/A

REFERENCES: N/A

Sarcobatus vermiculatus / Pleuraphis jamesii Shrub Herbaceous Vegetation [Park Special]

Greasewood / James' Galleta Shrub Herbaceous Vegetation

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Greasewood Flat (CES304.780)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare shrubland was sampled north of the Needles District entrance station, in lower Salt Creek and in Salt Creek Pocket in Canyonlands National Park.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare shrubland occurs on wide valley floors, plains, and terraces with deep, fine soils. Sampled sites are flat and lie between 1460 and 1470 m elevation. Bare soil and biological soil crusts cover most of the unvegetated surface, with lesser cover by litter. Biological soil crusts contribute up to 64% cover, and can be very well-developed with several species of lichen and moss present. The soil is a rapidly drained silty loam derived from alluvium.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare bottomland shrubland is characterized by a shrub canopy of *Sarcobatus vermiculatus* with 5-10% cover and an understory dominated by *Pleuraphis jamesii* with up to 3-23% cover. Other shrubs present with low cover may include *Atriplex canescens, Atriplex confertifolia, Ericameria nauseosa, Suaeda torreyana,* and *Opuntia erinacea*. Associated graminoids may include *Achnatherum hymenoides, Sporobolus cryptandrus,* and *Sporobolus contractus.* Associated forbs with trace cover include *Sphaeralcea coccinea, Sphaeralcea parvifolia,*

Machaeranthera canescens, Cryptantha sp., and *Helianthus anomalus*, as well as the non-native species *Halogeton glomeratus* and *Salsola tragus*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus*
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Pleuraphis jamesii*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Vulnerable: *Helianthus anomalus* (rare/endemic, G3); **Exotic/Invasive**: *Halogeton glomeratus* (exotic, High/Medium), *Salsola tragus* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (17-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The sampled site is on deep, fine soils in a broad, flat valley or "park" surrounded by low slickrock ridges. Slickrock ridges and outcrops on margins of the community have the usual linear arrangement of pinyon-juniper. *Sarcobatus vermiculatus* is less dense to the east, but grasses persist.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (2 plots: CANY.0777, CANY.9728) and 2008 Accuracy Assessment (3 points: CANY_AA.2002, CANY_AA.2010, CANY_AA.2087).
Local Description Authors: M. Smith, J. Von Loh, and A. Tendick
Global Description Authors: N/A

REFERENCES: N/A

Sarcobatus vermiculatus / Sporobolus cryptandrus Shrubland [Park Special]

Greasewood / Sand Dropseed Shrubland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Greasewood Flat (CES304.780)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

DISTRIBUTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare shrubland is represented by one plot located on a valley floor approximately 1.5 km from the Needles Visitor Center and one plot in Salt Creek Pocket.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare shrubland occurs on valley floors and terraces with fine, sandy soils. Sampled site are flat and occur between 1460 and 1480 m elevation. Bare soil or biological soil crusts covers most of the unvegetated surface, litter has sparse to moderate cover, and dead wood is sparse. The soil is a rapidly drained loamy sand derived from alluvium.

Globally
Data are not available.

VEGETATION DESCRIPTION
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
This rare greasewood shrubland has a total vegetation cover of 22-30%; although in one plot of this type mature biological soil crusts have 80% cover. The shrub canopy is dominated by *Sarcobatus vermiculatus* with 16-20% cover; the understory is dominated by *Sporobolus cryptandrus* with 3-6% cover. *Atriplex canescens* and *Opuntia polyacantha* may also be present in the shrub layer with sparse cover. Other herbaceous species present include *Achnatherum hymenoides, Sporobolus contractus, Machaeranthera canescens, Suaeda moquinii (= Suaeda torreyana)*, and the exotic *Salsola tragus*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus*
Herb (field)	*Suaeda moquinii*
Herb (field)	*Sporobolus cryptandrus*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Exotic/Invasive: *Salsola tragus* (exotic)

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (17-Mar-2011).

CLASSIFICATION COMMENTS
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section)
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: N/A

ELEMENT SOURCES
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Inventory Notes: The plot is in deep, fine sandy soils. Area has a grazing history. Litter is primarily under *Sarcobatus vermiculatus* crowns.
Canyonlands National Park and Glen Canyon National Recreation Area (Orange Cliffs Section) Plots: The description is based on 2004 field data (1 plot): (Plot: CANY.0793) and 2008 field data (1 AA point): (CANY_AA.2349).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: N/A

REFERENCES: N/A

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Appendix G. Illustrated Keys to the Plant Associations of Canyonlands National Park

A diverse assemblage of plant associations were characterized by field data collection conducted in 2003-2004 under the US Geological Survey and National Park Service's Vegetation Mapping Program. This dichotomous key was developed to assist in the accurate field identification of the 168 plant associations described for Canyonlands National Park and the Orange Cliffs portion of Glen Canyon National Recreation Area.

It is the intent of the key to allow identification of plant associations with one or a combination of 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.

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, graminoid, forb, or sparse. 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 woodland key as well as the herbaceous or shrubland key. In general with any layer, if it does not cover at least 8% (tree layer) or 5% (shrub or herbaceous layers), it is ignored. The exception is in very sparse communities (see #4 below).

2. The diagnostic layer consists of woody plants that may appear in either a shrub or a tree form, depending on site conditions and age. These species include *Pinus edulis, Populus fremontii, Betula occidentalis, Fraxinus anomala, Salix gooddingii, Acer negundo, Ostrya knowltonii, Quercus gambelii,* and *Juniperus osteosperma*. In this key, *Pseudotsuga menziesii, Pinus edulis,* and *Juniperus osteosperma* are ALWAYS considered to be evergreen trees, *Populus fremontii Fraxinus anomala, Salix gooddingii, Acer negundo,* and *Ostrya knowltonii* deciduous trees, and *Betula occidentalis* and *Quercus gambelii* are considered tall shrubs, regardless of their height or growth form.

3. 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.

4. Communities that are sparsely vegetated should first be run through the physiognomic key to which they appear to belong. If this is unsuccessful, run the vegetation through the sparse key. Even though they contain trees or shrubs, they may not fall cleanly into a “woodland “or “shrubland” category." Sparse" vegetation is defined as having total vascular plant cover of < 10%.

5. Focus on the perennial species in the community, 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 Canyonlands National Park. 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. The best approach is to learn the characteristics and general locations of these communities and use the key to confirm the diagnosis, rather than attempting to key them from scratch. These communities include:

1. *Cercocarpus intricatus* Slickrock Sparse Vegetation
2. *Coleogyne ramosissima* Sparse Vegetation
3. *Ephedra torreyana* - (*Atriplex canescens, Atriplex confertifolia*) Sparse Vegetation
4. *Ephedra torreyana* - (*Atriplex* spp.) / Non-vascular Gypsum Sparse Vegetation
5. *Ephedra torreyana* Sparse Vegetation
6. *Ericameria nauseosa* Sparse Vegetation
7. *Eriogonum corymbosum* Badlands Sparse Vegetation
8. *Leymus salinus* Shale Sparse Vegetation
9. *Rumex hymenosepalus* Sparse Vegetation
10. Sparse Sand Vegetation
11. *Sphaeralcea* spp. Sparse Vegetation

Another helpful tool is 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 CANY), the more it is likely to be a "diagnostic" species that controls the assignment of a community to an association. Generalist species such as *Ericameria nauseosa, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Poa secunda, Opuntia* spp. are only considered diagnostic if they are overwhelmingly dominant. For example, if you are in a *Juniperus osteosperma* woodland on an outcrop with about equal cover of *Cercocarpus intricatus* and *Purshia tridentata,* the community will be classified as JUNOST / CERINT, not JUNOST / PURTRI.

So-called "diagnostic" species are not all equal. There is a hierarchy, and it varies depending on the habitat. Some examples:

- Uplands: CERMON > ARTNOV > ARTTRIWYO > AMEUTA
- Salt desert: ATRGAR > ATRCON > ARTSPI
- Alluvial flats and terraces: ARTTRITRI > SARVER > ATRCAN > ERINAU.
- Grasses: Strong: MUHPUN, HESCOM, SPOAIR. Medium: PLEJAM, ACHHYM, POAFEN, Weak: POASEC, ELYELY, 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.

For purposes of abbreviation, this key refers to two-needle pinyon pine (*Pinus edulis*) trees as pinyon trees only.

Key I: Major physiognomic Groups

1a Vegetation consists predominantly of trees, shrubs, or shrub-like herbs; total vegetation cover may range from sparse (approximately 10% with 5% or more cover of shrubs scattered throughout stand) to dense (>60% with >10% cover of shrubs); includes wetland, riparian, and upland habitats **(2)**

1b Vegetation consists predominantly of grasses, graminoids, or forbs. Total vegetation cover may range from sparse to dense. Characteristic genera include *Achnatherum*, *Aquilegia, Artemisia, Bouteloua, Bromus, Calamagrostis, Hesperostipa, Hymenopappus, Iva, Juncus, Leymus, Lolium, Mimulus, Oenothera, Iva, Phragmites, Pleuraphis, Poa, Rumex, Salsola, Sphaeralcea, Sporobolus, Stipa,* and *Typha* - **Key IV: Herbaceous and Shrub Herbaceous – page 77**

2a Forest (closed canopy), woodland (open canopy), or wooded shrubland communities. Wooded shrublands are shrublands with scattered trees, sometimes on sites with low total cover (<15%). In the latter case, tree cover can be as little as 2-3%. Characteristic genera include *Acer, Fraxinus, Juniperus*, *Ostrya, Pinus*, *Populus*, *Pseudotsuga,* and *Salix* - **Key II: Forest, Woodland, and Wooded Shrubland – page 2**

2b Shrubland communities; dominant species may be tall, short, or dwarf-shrubs or shrublike herbs; canopies may interlock, but are often less dense. Characteristic genera include *Amelanchier*, *Artemisia*, *Atriplex*, *Betula, Cercocarpus*, *Chrysothamnus, Coleogyne, Cornus, Ephedra*, *Ericameria, Eriogonum, Forestiera, Gutierrezia, Krascheninnikovia*, *Mahonia, Opuntia, Poliomintha, Quercus, Rhamnus,* Rhus, *Salix*, *Sarcobatus*, *Symphoricarpos, Tamarix*, and *Zuckia*. If tree species are present, they have low relative cover - **Key III: Shrubland and Shrub Herbaceous – page 31**

Key II: A Key to the Forest and Woodland Associations of Canyonlands National Park

1a Forest and woodland communities occurring in riparian, wetland, or other mesic habitats, including slopes and plunge pools below slickrock pouroffs. Canopies are dominated by species of *Acer, Ostrya, Populus,* and *Salix* **(2)**

1b Forest, woodland, sparse woodland, and wooded shrubland communities occurring in xeric habitats; may increase in density on cooler sites or on sheltered landscape positions; the canopy is dominated by species of *Fraxinus, Juniperus, Pinus*, or *Pseudotsuga* **(13)**

Riparian Forests and Woodlands

2a (1) Riparian and wetland woodland communities, typically occupying stream banks and mesic areas below pouroffs; the canopy is dominated by *Acer negundo, Ostrya knowltonii,* or *Salix gooddingii* **(3)**

2b Riparian forest and woodland communities typically occupying river and stream terraces; the canopy is dominated by *Populus fremontii* **(5)**

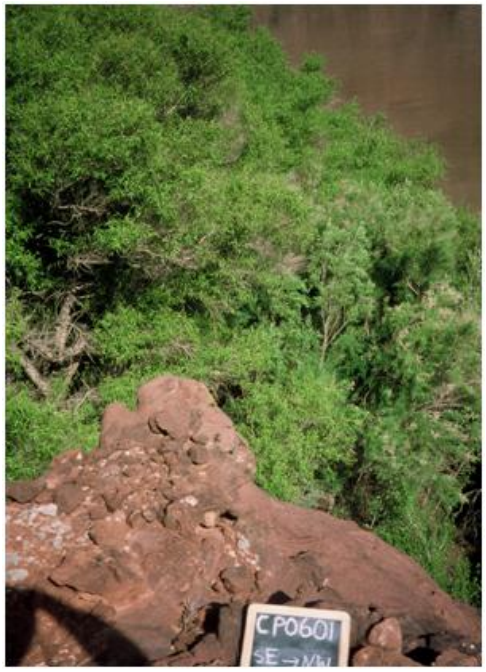
3a (2) Dense woodlands in intermittently flooded washes, alcoves, and on canyon sides with *Ostrya knowltonii* providing up to 50% cover. Scattered *Populus fremontii, Pinus edulis,* and *Juniperus osteosperma* may be present, but do not form a canopy. Other shrubs present may include *Amelanchier utahensis, Quercus gambelii* and *Rhus trilobata,* among others - ***Ostrya knowltonii* Woodland**





3b Woodlands in river terrace habitats along the Colorado River and characterized by moderately dense to dense stands of *Acer negundo* or *Salix gooddingii* **(4)**

Tamarix chinensis and *Forestiera pubescens* – ***Salix gooddingii / Salix* exigua Woodland**



4b Dense riparian stands on intermittently flooded river terraces in which *Acer negundo* provides most of the canopy cover. *Tamarix chinensis* often provides a subcanopy, sometimes with a minor component of *Forestiera pubescens* and *Salix exigua*. *Bromus tectorum* and other exotic weedy species dominate the herbaceous layer – ***Acer negundo* / Disturbed Understory Woodland**





5a (2) *Populus fremontii* forest and woodland communities with shrub understories dominated by *Ericameria nauseosa, Salix exigua, Salix lutea, or Tamarix spp.* **(6)**

5b *Populus fremontii* woodlands with understories dominated by the herbaceous species *Distichlis spicata, Equisetum* spp., or *Sporobolus airoides*, or by a mix of mesic graminoids or forbs **(9)**

6a (5) *Populus fremontii* woodlands on intermittently flooded sites that have become isolated from the water table. *Ericameria nauseosa* is the most consistent species in the understory, often with scattered *Artemisia tridentata, Rhus trilobata, Sarcobatus vermiculatus,* and relict *Forestiera pubescens*. Upland species or weeds comprise the herbaceous layer – ***Populus fremontii / Ericameria nauseosa* Woodland**




6b *Populus fremontii* forests or woodlands that are either flooded frequently or are still connected to the water table. The sparse to dense understory is dominated by *Salix exigua*, *Salix lutea* or *Tamarix spp.* **(7)**

7a (6) *Populus fremontii* woodlands with very open canopies and dense understories of *Tamarix* spp. – ***Populus fremontii* / *Tamarix* spp. Woodland**



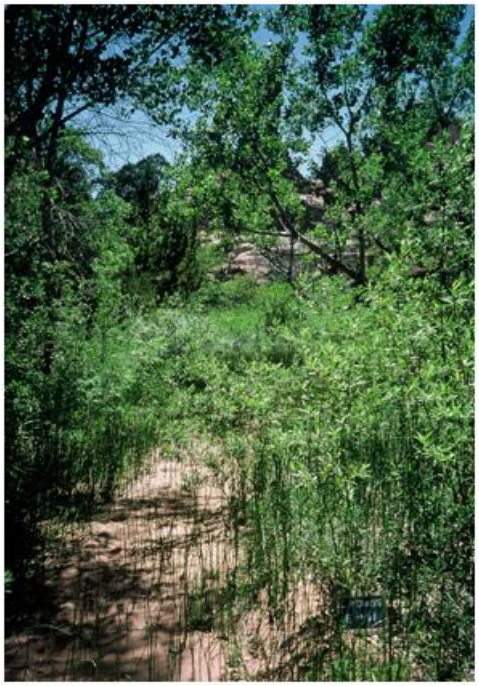

7b *Populus fremontii* woodlands with understories dominated by *Salix exigua* or *Salix lutea* **(8)**

8a (7) *Populus fremontii* woodlands on intermittently flooded stream banks and terraces that have a high water table. The understory is dominated by *Salix exigua*, although *Salix lutea* may occur and upland shrubs may be present if the site is drying out – ***Populus fremontii / Salix exigua*** **Forest**





8b Open *Populus fremontii* woodlands on intermittently flooded stream banks and in canyon bottoms with a high water table. The understory is dominated by *Salix lutea*, although *Salix exigua, Tamarix chinensis,* and *Rhus trilobata* may also occur. The herbaceous layer may be patchy or well-developed, depending on the degree of canopy closure and periodicity of flooding – ***Populus fremontii / Salix (ligulifolia, lutea)*** **Woodland**



9a (5) Open *Populus fremontii* woodlands on saturated soils of intermittently flooded drainages and with an understory dominated by mesic forbs (predominantly *Maianthemum stellatum* or *Iva acerosa*). Scattered shrubs may be present, including *Ericameria nauseosa, Rosa woodsii, Salix* spp., and *Forestiera pubescens* – ***Populus fremontii* / Mesic Forbs Woodland**





9b *Populus fremontii* woodlands with a sparse to dense herbaceous understory dominated by *Distichlis spicata, Sporobolus airoides*, *Equisetum* spp., or a mix of mesic graminoids **(10)**

10a (9) *Populus fremontii* woodlands with an herbaceous understory (often sparse) dominated by *Distichlis spicata* or *Sporobolus airoides*. Shrubs may be present but do not provide enough cover to constitute a layer **(11)**

10b *Populus fremontii* woodlands with an herbaceous understory (sometimes sparse) dominated by *Equisetum* spp. or a mix of mesic graminoids, including species of *Juncus, Bromus, Distichlis, Elymus, Phragmites,* and *Poa* **(12)**

11a (10) Open *Populus fremontii* woodlands on intermittent wash banks or stream terraces, with a usually sparse understory dominated by *Distichlis spicata*. Other graminoids present may include *Sporobolus* spp., *Achnatherum hymenoides*, and *Bromus tectorum*. Scattered shrubs typical of drier riparian terraces may also be present with low cover – ***Populus fremontii / Distichlis spicata* Woodland**



11b Open *Populus fremontii* woodlands on intermittent wash banks with a usually sparse understory dominated by *Sporobolus airoides*. *Achnatherum hymenoides* is often present – ***Populus fremontii / Sporobolus airoides*** **Woodland**





12a (10) Open *Populus fremontii* woodlands in wash bottoms with a moderate herbaceous understory dominated by *Equisetum laevigatum*. Scattered shrubs may be present, including *Forestiera pubescens*, *Salix lutea*, and *Salix exigua* – ***Populus fremontii / Equisetum*** **spp. Woodland**





12b Open *Populus fremontii* woodlands with a sparse to moderate herbaceous understory of mixed mesic graminoid species, including *Distichlis spicata, Elymus canadensis, Equisetum arvense, Equisetum laevigatum, Juncus balticus, Phragmites australis, Poa fendleriana,* and *Poa pratensis*. Scattered shrubs are usually present, including *Salix* spp., *Ericameria nauseosa,* and *Artemisia tridentata* – ***Populus fremontii*** **/ Mesic Graminoids Woodland**





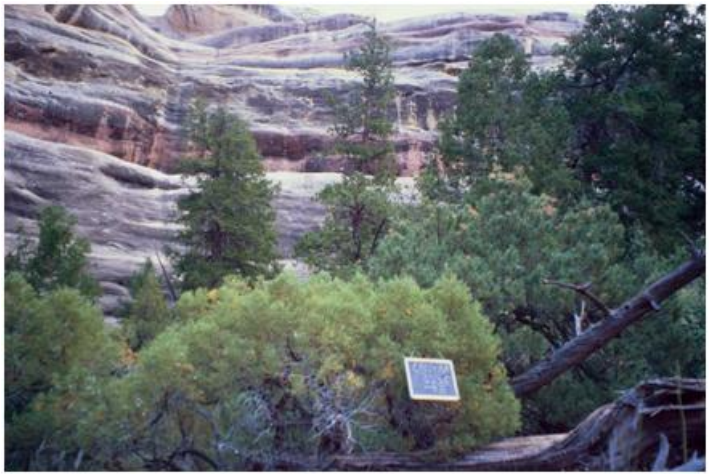
Xeric/Upland Forests and Woodlands

13a (1) Forest and woodland communities with a canopy dominated by *Pseudotsuga menziesii,* although *Pinus edulis* or *Juniperus osteosperma* may also be present **(14)**

13b Woodland and wooded shrubland communities with canopies dominated by *Fraxinus anomala, Juniperus osteosperma,* and/or *Pinus edulis* **(16)**

14a (13) Open *Pseudotsuga menziesii* woodlands on steep colluvial slopes at the heads of canyon tributaries, with a sparse understory of shrubs such as *Amelanchier utahensis, Quercus gambelii, Fraxinus anomala, Mahonia fremontii,* and *Shepherdia rotundifolia*.

Woody plants are typically clumped or widely separated by expanses of sandstone talus – ***Pseudotsuga menziesii* Scree Woodland**



14b Open *Pseudotsuga menziesii* woodlands in moist drainages or alcoves on steep talus-covered slopes with a shrub understory dominated by *Cercocarpus montanus* or *Quercus gambelii* **(15)**

15a (14) Open *Pseudotsuga menziesii* woodlands on steep, sheltered slopes or moist drainages, with an understory dominated by *Cercocarpus montanus. Quercus gambelii* is absent or accidental, but *Amelanchier utahensis, Fraxinus anomala, Fendlera rupicola,* and *Rhus trilobata* are often present – ***Pseudotsuga menziesii / Cercocarpus montanus* Woodland**



15b *Pseudotsuga menziesii* woodlands on steep, sheltered, often talus-covered slopes or moist drainages. *Pinus edulis* may form a subcanopy. The understory is dominated by *Quercus gambelii*, usually with *Amelanchier utahensis*, although *Cercocarpus montanus, Rhus trilobata, Mahonia fremontii,* and *Brickellia longifolia* may also occur with low cover. The herbaceous layer is sparse and depauperate – ***Pseudotsuga menziesii / Quercus gambelii* Forest**





16a (13) Sparse *Fraxinus anomala* woodlands, often dwarfed to shrub stature, growing in cracks and joints of the White Rim sandstone or along wash channels. Total cover is always less than 10% and often less than 5%. Other woody species present may include *Rhus trilobata, Ericameria nauseosa, Ephedra torreyana*, and *Coleogyne ramosissima* – ***Fraxinus anomala* Woodland**





16b Wooded shrublands of *Juniperus osteosperma* and/or *Pinus edulis* trees with a variety of understory species, including *Fraxinus anomala* **(17)**

17a (16) Open woodlands and wooded shrublands of *Juniperus osteosperma* with sparse bunchgrass or shrub understories; *Pinus edulis*, if present, usually has trace cover or much lower cover than *Juniperus osteosperma* **(18)**

17b Woodlands, sometimes sparse, in which *Pinus edulis* has significant cover or is codominant with *Juniperus osteosperma*. The understory may contain a variety of bunchgrasses, forbs and/or short shrubs; stands usually have > 5% cover by *Pinus edulis,* unless total tree canopy is sparse, in which case *Pinus edulis* trees may codominate with only 2-3 % cover **(29)**

18a (17) *Juniperus osteosperma* woodlands (usually at least 10% canopy cover) with less than 2-3% total cover by understory shrubs, grasses, or forbs. Stands occupy xeric, exposed sites with soils of low water-holding capacity (e.g., sand dunes) or thin soils that are almost completely covered by rocks. Soil conditions control the understory layer of these sparsely vegetated woodlands. Common species that contribute low cover include *Fraxinus anomala, Ericameria nauseosa, Eriogonum microthecum, Gutierrezia sarothrae, Pleuraphis jamesii*, and *Ephedra viridis*, and biological soil crusts may have very high cover in sandy sites – ***Juniperus osteosperma* / Sparse Understory Woodland**



18b *Juniperus osteosperma* woodlands and wooded shrublands with a developed understory dominated by grasses, shrubs, or a combination of species **(19)**

19a (18) *Juniperus osteosperma* woodlands on deeper soils and with an understory dominated by grasses such as *Hesperostipa comata, Leymus salinus*, *Pleuraphis jamesii* or *Sporobolus airoides*. Scattered shrubs are often present with very low cover **(20)**

19b *Juniperus osteosperma* woodlands and wooded shrublands on colluvial (talus-covered) slopes, dunes, deep soils of flatter sites, shallow soils covering slickrock, or in slickrock joints and with an understory dominated by shrubs including *Cercocarpus intricatus, Coleogyne ramosissima, Mahonia fremontii, Purshia stansburiana, Quercus gambelii,* and/or *Quercus havardii* var. *tuckeri*. Talus communities may not have a consistently dominant shrub, but *Artemisia bigelovii* and species of *Ephedra* and *Chrysothamnus* are usually present **(23)**

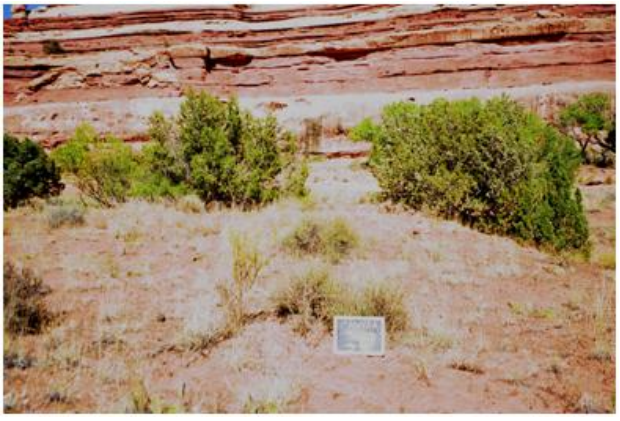
20a (19) Open *Juniperus osteosperma* woodlands on moderate to steep colluvial slopes and an understory dominated by *Leymus salinus*. Scattered shrubs such as *Ephedra viridis, Shepherdia rotundifolia, Artemisia bigelovii, Ericameria nauseosa,* and *Chrysothamnus viscidiflorus* are usually present with very low cover – ***Juniperus osteosperma / Leymus salinus* Woodland**



20b *Juniperus osteosperma* woodlands on stream terraces or canyon benches with an understory dominated by *Hesperostipa comata, Pleuraphis jamesii,* or *Sporobolus airoides* **(21)**

21a (20) *Juniperus osteosperma* woodlands on colluvial slopes, valley floors, and erosion fans with an understory dominated by Pleuraphis jamesii. *Achnatherum hymenoides* may contribute significant cover – ***Juniperus osteosperma / Pleuraphis jamesii* Woodland**





21b *Juniperus osteosperma* woodlands on stream terraces or in canyon bottom high terraces or benches with an understory dominated by *Hesperostipa comata* or *Sporobolus airoides* **(22)**

22a (21) *Juniperus osteosperma* woodlands on stream terraces; the understory is dominated by *Sporobolus airoides; Achnatherum hymenoides* may also contribute significant cover. Scattered shrubs present may include *Artemisia filifolia, Atriplex canescens,* and *Opuntia* spp. – ***Juniperus osteosperma / Sporobolus airoides*** **Woodland [Park Special]**





22b *Juniperus osteosperma* woodlands on level to moderate canyon bottom benches or rocky slopes with an understory dominated by *Hesperostipa comata. Achnatherum hymenoides* is often present to codominant, and *Bouteloua gracilis, Poa fendleriana* and *Pleuraphis jamesii* may be present. Associated shrubs include *Ericameria nauseosa, Ephedra torreyana, Coleogyne ramosissima, Atriplex canescens,* and *Ephedra viridis.* Biological soil crusts contribute moderate to high cover – ***Juniperus osteosperma / Hesperostipa comata*** **Woodland**





23a (19) *Juniperus osteosperma* woodlands and wooded shrublands on slickrock exposures and with a diverse shrub understory dominated by one or more of the following:*Cercocarpus intricatus, Coleogyne ramosissima, Purshia stansburiana,* and/or *Quercus havardii* var. *tuckeri* **(24)**

23b Woodlands or wooded shrublands on deep soils or colluvial slopes. The understory is dominated by *Coleogyne ramosissima*, *Mahonia fremontii*, or *Quercus gambelii*, or by a

combination of shrubs such as *Artemisia bigelovii* and species of *Ephedra* and *Chrysothamnus* **(26)**

24a (23) *Juniperus osteosperma* woodlands and wooded shrublands on slickrock exposures, especially near rims. Woody plants tend to root in joints in the slickrock. The diverse shrub layer is dominated by *Cercocarpus intricatus; Cercocarpus montanus, Ephedra viridis, Fraxinus anomala, Artemisia bigelovii, Philadelphus microphyllus*, and *Glossopetalon spinescens* var. *meionandrum* may be present to codominant – ***Juniperus osteosperma / Cercocarpus intricatus*** **Woodland**





24b *Juniperus osteosperma* woodlands and wooded shrublands on slickrock exposures; the diverse understory is dominated by one or more of the following: *Coleogyne ramosissima, Purshia stansburiana,* and *Quercus havardii* var. *tuckeri*; *Cercocarpus intricatus* may be present but is never dominant **(25)**

25a (24) Wooded shrublands on thin soils overlying sandstone bedrock or along dry wash channels, with a sparse canopy of *Juniperus osteosperma; Pinus edulis* may be present. The understory is dominated by a combination of at least two of the following: *Coleogyne ramosissima, Purshia stansburiana,* and *Quercus havardii* var. *tuckeri. Cercocarpus intricatus* is absent – ***Juniperus osteosperma – (Pinus edulis) / Coleogyne ramosissima – Purshia stansburiana – Quercus havardii*** **Wooded Shrubland**




25b Wooded shrublands occurring on bedrock with more mesic pockets or sheltered sites, or with deeper joints for plants to root in, with a sparse canopy of *Juniperus osteosperma. Pinus edulis* may be present. The understory is dominated by a combination of at least two of the following shrubs: *Coleogyne ramosissima, Purshia stansburiana,* and *Quercus havardii* var. *tuckeri. Cercocarpus intricatus* and *Amelanchier utahensis* are present with low cover – ***Juniperus osteosperma – (Pinus edulis) / Coleogyne ramosissima – Purshia stansburiana – Quercus havardii*** **Wooded Shrubland [*Cercocarpus intricatus* Phase]**




26a (23) *Juniperus osteosperma* woodlands on deeper soils and relatively level to rolling sites, where the understory is dominated by *Coleogyne ramosissima, Mahonia fremontii,* or *Quercus gambelii* **(27)**

26b *Juniperus osteosperma* sparse woodlands or wooded shrublands on talus slopes. Total vegetation is generally sparse and nearly always less than 15%. The shrub layer consists of a diverse and inconsistent mix of shrubs, each having no more than a few percent cover and including any combination of *Artemisia bigelovii, Atriplex confertifolia, Brickellia microphylla, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra viridis, Ephedra torreyana, Ericameria nauseosa, Eriogonum corymbosum, Fraxinus anomala, Gutierrezia sarothrae, Rhus trilobata, Amelanchier utahensis, Shepherdia*

rotundifolia, and *Fendlera rupicola* – ***Juniperus osteosperma*** **/ Mixed Shrubs Talus Woodland**





27a (26) Woodlands on valley floors or along drainages characterized by an open canopy of *Juniperus osteosperma* and a moderately dense understory dominated by *Quercus gambelii.* Associated shrubs may include *Forestiera pubescens, Rhus aromatica* var. *trilobata, Artemisia tridentata* ssp. *tridentata,* and *Artemisia bigelovii*, among others – ***Juniperus osteosperma / Quercus gambelii*** **Woodland [Park Special]**





27b *Juniperus osteosperma* woodlands on deeper soils and relatively level to rolling sites, where the understory is dominated by *Coleogyne ramosissima* or *Mahonia fremontii* **(28)**

28a (27) *Juniperus osteosperma* woodlands or dwarf woodlands on plateaus or mesa tops with an understory dominated by *Coleogyne ramosissima. Purshia stansburiana* and *Quercus havardii* var. *tuckeri*, if present, have no more than trace cover. Associated shrubs may include *Artemisia bigelovii, Ephedra* spp., and *Yucca* spp. – ***Juniperus osteosperma / Coleogyne ramosissima*** **Woodland**





28b *Juniperus osteosperma* woodlands, on deep sandy soils, usually on drainage terraces or canyon floors, with an understory dominated by *Mahonia fremontii*. Associated shrubs include *Rhus trilobata, Ephedra viridis,* and *Atriplex canescens*. Herbaceous species provide sparse cover – ***Juniperus osteosperma / Mahonia fremontii* Woodland**





29a (17) Pinyon-juniper woodlands or wooded shrublands with a shrub-dominated or grass-dominated understory on moderately steep to steep slopes of sandstone talus **(30)**

29b Pinyon-juniper woodlands or wooded shrublands with a sparse understory or one dominated by shrubs or grasses, but not on steep colluvial slopes **(32)**

30a (29) Pinyon-juniper woodlands on cooler colluvial slopes; the understory is visually dominated by the medium-tall bunchgrass *Leymus salinus*, although scattered individuals of *Fraxinus anomala, Purshia stansburiana, Ephedra viridis, Gutierrezia sarothrae, Artemisia bigelovii, Eriogonum microthecum*, and/or *Chrysothamnus viscidiflorus* var. *stenophyllus* are often present – ***Pinus edulis - Juniperus* spp. / *Leymus salinus* Woodland**





30a Pinyon-juniper woodlands with shrub dominated understories. *Leymus salinus* is not present or not noteworthy **(31)**

31a (30) Pinyon-juniper woodlands where *Fendlera rupicola* dominates or codominates the open to moderately dense tall-shrub layer – ***Pinus edulis - Juniperus osteosperma / Fendlera rupicola*** **Woodland**



31b Pinyon-juniper woodlands or wooded shrublands on colluvial slopes; the understory consists of a diverse mix of shrubs, none of which has more than a few percent cover. Common species 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* – ***Pinus edulis - Juniperus osteosperma*** **/ Mixed Shrubs Talus Woodland**




32a (29) Pinyon-juniper woodlands in which vascular plant understory cover is less than 3-5% and often less than 1%, although the cover of biotic crusts may be high. 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 (often these sites have high cover by biological soil crusts). Common shrubs with trace to low cover include scattered individuals of *Fraxinus anomala, Ephedra viridis, Chrysothamnus viscidiflorus, Shepherdia rotundifolia, Purshia stansburiana, Artemisia bigelovii, Coleogyne ramosissima,* and *Eriogonum microthecum* – ***Pinus edulis - Juniperus osteosperma*** **/ Sparse Understory Woodland**




32b Pinyon-juniper woodlands and wooded shrublands with an understory dominated by species of *Amelanchier, Artemisia, Cercocarpus, Coleogyne, Ephedra, Purshia, Quercus, Rhus, Shepherdia, Bouteloua gracilis, Achnatherum hymenoides, Atriplex, Ephedra viridis, Hesperostipa comata, Muhlenbergia montana* and/or *Symphoricarpos* **(33)**

33a (32) Pinyon-juniper woodlands with shrub dominated understories. Shrubs include species of *Amelanchier, Artemisia, Atriplex, Cercocarpus, Coleogyne, Ephedra, Purshia, Quercus, Rhus, Shepherdia,* and/or *Symphoricarpos* **(34)**

33b Pinyon-juniper woodlands with grass dominated understories. Dominant graminoids include *Bouteloua gracilis, Achnatherum hymenoides, Pleuraphis jamesii* or *Hesperostipa comata* **(48)**

34a (33) Pinyon-juniper woodlands with a sometimes mixed understory dominated by *Artemisia bigelovii, Artemisia nova,* or *Artemisia tridentata* ssp. *wyomingensis* **(35)**

34b Pinyon-juniper woodlands and wooded shrublands with an understory dominated by species of *Amelanchier, Cercocarpus, Coleogyne, Ephedra, Purshia, Quercus, Rhus, Shepherdia,* and/or *Symphoricarpos* **(37)**

35a (34) Open pinyon-juniper woodlands and wooded shrublands on steep slopes or shallow soils near slickrock rims and with a mixed understory dominated by the short shrub *Artemisia bigelovii*. Other shrubs generally present may include *Fraxinus anomala, Cercocarpus intricatus, Fendlera rupicola, Gutierrezia sarothrae*, and *Yucca baccata* – ***Pinus edulis - Juniperus osteosperma / Artemisia bigelovii*** **Woodland**





35b Pinyon-juniper woodlands on flats and gentle slopes at higher elevations of the mapping area and with an understory dominated by *Artemisia nova* or *Artemisia tridentata* ssp. *wyomingensis* **(36)**

36a (35) Pinyon-juniper woodlands on plateaus at higher elevations within Glen Canyon NRA, with deep soils and an understory dominated by *Artemisia nova* – ***Pinus edulis - Juniperus osteosperma / Artemisia nova*** **Woodland**

No photos available

36b Pinyon-juniper woodlands on mesa tops, plains, and drainage terraces, with an understory dominated by *Artemisia tridentata* ssp. *wyomingensis*. Associated shrubs include *Amelanchier utahensis* and *Ephedra viridis.* The herbaceous layer is sparse and generally

has been affected by grazing – ***Pinus edulis – Juniperus* spp. / *Artemisia tridentata* (ssp. *wyomingensis,* ssp. *vaseyana*) Woodland**





37a (34) Pinyon-juniper woodlands restricted to mesic alcove sites or along washes, with an understory dominated by *Symphoricarpos longiflorus*. Associated shrubs include scattered individuals of *Amelanchier utahensis, Ephedra viridis, Mahonia fremontii,* and *Cercocarpus intricatus*– ***Pinus edulis - Juniperus osteosperma / Symphoricarpos longiflorus* Woodland [Park Special]**



37b Pinyon-juniper woodlands and wooded shrublands with an understory dominated by species of *Amelanchier, Atriplex, Cercocarpus, Coleogyne, Ephedra, Purshia, Quercus, Rhus,* and/or *Shepherdia* **(38)**

38a (37) Open pinyon-juniper woodlands restricted to intermittent washes with a scattered to dense shrub understory dominated by *Rhus trilobata*. Scattered shrubs typical of washes, such as *Quercus gambelii, Mahonia fremontii,* and *Purshia mexicana*, and grasses may also be part of this association - ***Pinus edulis - Juniperus osteosperma / Rhus trilobata* Woodland [Park Special]**

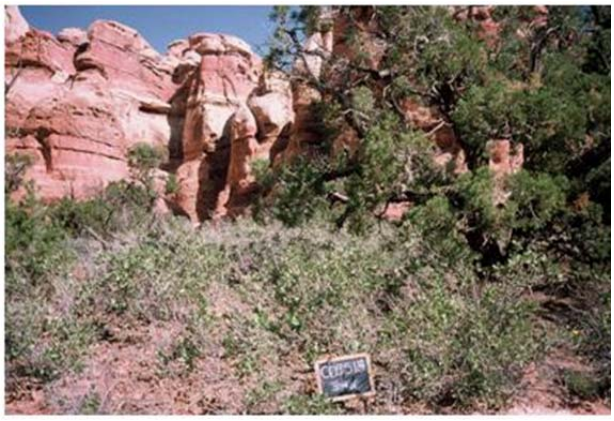



38b Pinyon-juniper woodlands with a shrub understory dominated by species of *Amelanchier, Cercocarpus, Coleogyne, Ephedra, Purshia, Quercus,* or *Shepherdia* **(39)**

39a (38) Pinyon-juniper woodlands with a shrub understory dominated by *Quercus havardii* var. *tuckeri* or *Quercus gambelii* **(40)**

39b Pinyon-juniper woodlands with a shrub understory dominated by species of *Amelanchier, Cercocarpus, Coleogyne, Ephedra, Purshia,* and/or *Shepherdia* **(41)**

40a (39) Open pinyon-juniper woodlands on sand dunes and sandy wash banks with an open understory dominated by clumps of *Quercus havardii* var. *tuckeri*. Other shrubs typical of sandy places may be present with low cover. *Purshia stansburiana* and *Coleogyne ramosissima* are absent or have no more than trace cover – ***Pinus edulis - Juniperus osteosperma / Quercus havardii* var. *tuckeri* Woodland**




40b Woodlands on deep soils of drainages, sheltered slopes, and at the base of slickrock outcrops, with an understory dominated by *Quercus gambelii*. Associated shrubs may

include *Amelanchier utahensis, Ericameria nauseosa, Ephedra viridis,* and *Mahonia fremontii* – ***Pinus edulis - Juniperus* spp. / *Quercus gambelii* Woodland**





41a (39) Pinyon-juniper woodlands on sheltered sites on mesa tops and in drainages where a mixed shrub understory is dominated by *Amelanchier utahensis.* Associated shrubs include scattered *Fendlera rupicola, Fraxinus anomala, Coleogyne ramosissima, Ericameria nauseosa, Chrysothamnus viscidiflorus, Ephedra torreyana, Eriogonum corymbosum, Purshia mexicana,* and *Eriogonum microthecum. Shepherdia rotundifolia* is absent – ***Pinus edulis - Juniperus osteosperma / Amelanchier utahensis* Woodland**





41b Pinyon-juniper woodlands with an understory dominated by species of *Cercocarpus, Coleogyne, Purshia, Ephedra* or *Shepherdia. Amelanchier utahensis* may be present to codominant **(42)**

42a (41) Woodlands with an understory dominated by *Cercocarpus intricatus* or *Cercocarpus montanus* **(43)**

42b Woodlands with a shrub understory dominated by *Coleogyne ramosissima, Ephedra viridis, Purshia stansburiana,* or *Shepherdia canadensis*, with or without *Amelanchier utahensis* **(44)**

43a (42) Sparse pinyon-juniper woodlands or wooded shrublands, occurring on slickrock or colluvial slopes, with a mixed shrub understory clearly dominated by *Cercocarpus intricatus*. Other shrubs present may include *Fraxinus anomala, Amelanchier utahensis, Ephedra viridis, Artemisia bigelovii, Rhus trilobata, Coleogyne ramosissima,* or *Ericameria nauseosa* – ***Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus* Woodland**





43b Pinyon-juniper woodlands on sheltered colluvial slopes and bedrock ledges. The mixed shrub understory is dominated by *Cercocarpus montanus*. The remainder of the shrub stratum may include scattered individuals of *Fraxinus anomala, Amelanchier utahensis, Quercus gambelii, Purshia stansburiana, Ephedra viridis, Artemisia bigelovii, Symphoricarpos longiflorus,* and *Eriogonum microthecum*. *Shepherdia rotundifolia* is absent – ***Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* – Mixed Shrub Woodland**





44a (42) Open pinyon-juniper woodlands or wooded shrublands on deeper soils of plateaus, canyon rims, and valley floors. The shrub understory is dominated by *Coleogyne ramosissima; Purshia stansburiana* and *Quercus havardii* var. *tuckeri* are absent or have

no more than trace cover – ***Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima*** **Woodland**





44b Pinyon-juniper woodlands with a shrub understory dominated by *Ephedra viridis, Purshia stansburiana,* or *Shepherdia canadensis*, with or without *Amelanchier utahensis* **(45)**

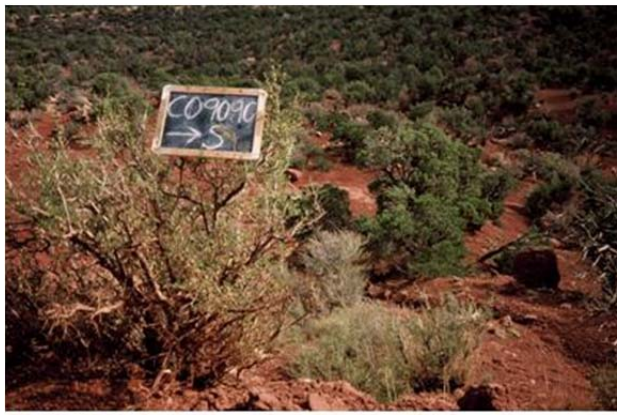
45a (44) Pinyon-juniper woodlands of canyon bottom drainages and stabilized dune slopes with a shrub understory dominated by *Ephedra viridis.* Associated shrubs with low cover may include *Amelanchier utahensis, Cercocarpus* spp., *Opuntia polyacantha, Coleogyne ramosissima, Gutierrezia sarothrae*, and *Atriplex canescens* – ***Pinus edulis - Juniperus osteosperma / Ephedra viridis*** **Woodland**





45b Open pinyon –juniper woodlands or wooded shrublands occupying a variety of bedrock exposures and soils; *Purshia stansburiana* or *Shepherdia rotundifolia* dominate the shrub understory; sometimes *Ephedra viridis* or *Amelanchier utahensis* is codominant. If *Coleogyne ramosissima* is present to codominant, return to couplet 42 **(46)**

46a (45) Pinyon-juniper woodlands or wooded shrublands on slickrock outcrops on plateaus, ridges, and canyon rims with shallow to moderate soils or along dry wash channels. The shrub understory is dominated by *Purshia stansburiana; Coleogyne ramosissima* and *Quercus havardii* var. *tuckeri* are absent or have no more than trace cover. If *Coleogyne ramosissima* and/or *Quercus havardii* var. *tuckeri* are present to codominant, return to couplet 25. Other shrubs present in low amounts include *Artemisia bigelovii, Amelanchier utahensis* and *Fraxinus anomala* – ***Pinus edulis - Juniperus osteosperma / Purshia stansburiana*** **Woodland**





46b Pinyon-juniper woodlands or wooded shrublands with an understory that has significant cover by *Shepherdia rotundifolia* with or without *Amelanchier utahensis* **(47)**

47a (46) Pinyon-juniper woodlands or wooded shrublands occurring on canyon and mesa slopes and colluvial deposits. One stand is on a rolling plain of barren Moenkopi shale. The sparse shrub understory is dominated by *Shepherdia rotundifolia. Ephedra viridis* may be present to codominant and *Leymus salinus* is often present, but *Amelanchier utahensis* is absent – ***Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia*** **Woodland**





47b Pinyon-juniper woodlands or wooded shrublands on cool colluvial slopes. The shrub layer is diverse, but *Shepherdia rotundifolia* and *Amelanchier utahensis* are present to codominant. Other shrub species present may include *Fraxinus anomala, Ephedra viridis, Eriogonum corymbosum; Leymus salinus* is a common grass – ***Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia – Amelanchier utahensis)*** **Wooded Shrubland**





48a (33) Pinyon-juniper woodlands of wind deposited aeolian sands and dunes with a sparse graminoid layer dominated by *Muhlenbergia pungens* – ***Pinus edulis - Juniperus osteosperma / Muhlenbergia pungens*** **Woodland**





48b Pinyon-juniper woodlands not as above. Understory dominated by *Hesperostipa comata, Bouteloua gracilis, Pleuraphis jamesii* or *Achnatherum hymenoides* **(49)**

49a (48) Pinyon-juniper woodlands on wash terraces and benches with grassy understories dominated by *Hesperostipa comata.* Associated shrubs with trace to low cover include *Fraxinus anomala, Cercocarpus montanus, Ephedra viridis, Mahonia fremontii, Artemisia tridentata* ssp. *wyomingensis.* Associated grasses include *Sporobolus airoides, Achnatherum hymenoides, Muhlenbergia pungens, Bouteloua gracilis,* and *Pleuraphis*

jamesii – ***Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata*** **Woodland**





49b Pinyon-juniper woodlands with grassy understories dominated by *Bouteloua gracilis, Pleuraphis jamesii* or *Achnatherum hymenoides* **(50)**

50a (49) Pinyon-juniper woodlands of mesa tops and valley sides with understories dominated by *Bouteloua gracilis. Chrysothamnus viscidiflorus* is often codominant. A variety of other shrubs and grasses may be present with trace cover – ***Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis*** **Woodland**





50b Pinyon-juniper woodlands with understories dominated by *Pleuraphis jamesii* or *Achnatherum hymenoides* **(51)**

51a (50) Pinyon-juniper woodlands of benches, valley sides, or erosion fans with an understory dominated by *Pleuraphis jamesii* – ***Pinus edulis - Juniperus osteosperma / Pleuraphis jamesii*** **Woodland**



51b Pinyon-juniper woodlands of canyon bottoms, hillslopes, and along wash channels with understories dominated by *Achnatherum hymenoides.* Shrub cover is sparse with no clear dominants and may include *Cercocarpus montanus, Ephedra viridis, Artemisia* spp., *Ericameria nauseosa, Fraxinus anomala, Gutierrezia sarothrae, Amelanchier utahensis,* and *Rhus trilobata* **– *Pinus edulis - Juniperus osteosperma* / *Achnatherum hymenoides* Woodland**





Additional woodland/forest vegetation types documented in the Park:

Acer negundo / Salix exigua Woodland
Juniperus osteosperma / Artemisia filifolia Woodland
Juniperus osteosperma / Artemisia tridentata ssp. *wyomingensis* Woodland
Juniperus osteosperma / Coleogyne ramosissima / Aristida purpurea Sparse Vegetation
Juniperus osteosperma / Ephedra torreyana Woodland
Juniperus osteosperma / Gutierrezia sarothrae - Achnatherum hymenoides Sparse Woodland
Pinus edulis - Juniperus osteosperma / Amsonia tomentosa Woodland
Pinus edulis - Juniperus osteosperma / Chrysothamnus nauseosus / Chrysopsis villosa Joint Woodland
Pinus edulis - Juniperus osteosperma / Chrysothamnus nauseosus / Sporobolus airoides Woodland
Pinus edulis - Juniperus osteosperma / Petradoria pumila Woodland
Pinus edulis - Juniperus osteosperma Intermittently Flooded Woodland Alliance
Pinus ponderosa - Pinus edulis - Juniperus osteosperma / Quercus welshii Woodland
Populus angustifolia / Forestiera pubescens var. *pubescens* Woodland
Populus fremontii / Achnatherum hymenoides Woodland
Populus fremontii / Artemisia tridentata Woodland
Populus fremontii / Celtis reticulata Woodland
Populus fremontii / Mixed shrub Woodland
Populus fremontii / Quercus gambelii Wooded Shrubland
Populus fremontii / Sporobolus cryptandrus Woodland
Pseudotsuga menziesii / Acer glabrum Forest

Key III: A Key to the Shrubland and Shrub Herbaceous Vegetation Associations of Canyonlands National Park

1a Tall and short shrublands and shrub herbaceous communities of xeric upland and mesic riparian or wetland habitats characterized by species of *Amelanchier, Artemisia, Atriplex(canescens or confertifolia), Betula, Cercocarpus, Chrysothamnus, Coleogyne, Cornus, Ephedra, Ericameria, Eriogonum, Forestiera, Fraxinus, Mahonia, Poliomintha, Quercus, Rhamnus, Rhus, Salix, Sarcobatus, Tamarix*, or *Vanclevea* **(2)**

1b Dwarf-shrublands and dwarf-shrub herbaceous communities of xeric upland habitats characterized by *Atriplex gardneri* or species of *Gutierrezia, Krascheninnikovia, Opuntia*, or *Zuckia* **(77)**

2a (1) Shrublands of upland habitats (including sheltered, sometimes mesic alcoves), sometimes sparse, dominated by species of *Amelanchier, Artemisia, Atriplex, Cercocarpus, Chrysothamnus, Coleogyne, Ephedra, Ericameria, Eriogonum, Fraxinus, Fendlera, Mahonia, Poliomintha, Quercus, Rhus, Rosa, Sarcobatus,* or *Vanclevea* **(14)**

2b Tall and short shrublands of riparian (including dry wash channels) and wetland habitats, dominated by species of *Betula, Chrysothamnus, Cornus, Ericameria, Forestiera, Rhamnus, Rhus, Ribes, Rosa, Salix*, or *Tamarix* **(3)**

Riparian Shrublands

3a (2) Stream terrace and channel shrublands characterized by *Chrysothamnus linifolius* or *Ericameria nauseosa* **(4)**

3b Riparian and wetland shrublands dominated by *Betula occidentalis, Cornus sericea, Forestiera pubescens, Rhamnus betulifolia, Salix exigua, Salix lutea*, or *Tamarix* **(5)**

4a (3) Sparse, patchy shrublands on the terraces of intermittent streams dominated by *Chrysothamnus linifolius,* usually accompanied by *Tamarix chinensis, Eriogonum corymbosum,* and *Purshia stansburiana* – ***Chrysothamnus linifolius*** **Shrubland [Park Special]**





4b Sparse shrublands characterized by patches of *Ericameria nauseosa,* occurring on the banks and in channels of intermittent streams, canyon bottoms, and washes – ***Ericameria nauseosa*** **Desert Wash Shrubland**





5a (3) Riparian and wetland shrublands dominated by *Salix exigua* or *Salix lutea* **(6)**

5b Riparian and wetland shrublands characterized by *Betula occidentalis, Cornus sericea, Forestiera pubescens, Rhamnus betulifolia*, or *Tamarix chinensis* **(9)**

6a (5) *Salix lutea* shrublands occurring on saturated to inundated washes, drainages, and canyon bottoms, with an understory of mesic graminoids such as *Juncus balticus, Typha domingensis, Elymus repens, Equisetum* spp., and *Phragmites australis.* Other shrubs present include *Quercus gambelii, Artemisia tridentata, Ericameria nauseosa, Forestiera pubescens*, and *Rhus trilobata* – ***Salix lutea*** **/ Mesic Graminoids Shrubland**





6b Tall shrublands dominated by *Salix exigua* **(7)**

7a (6) *Salix exigua* shrublands occupying intermittently flooded stream terraces with a high water table but a poorly developed understory lacking diagnostic or consistent species – ***Salix (exigua, interior)*** **Temporarily Flooded Shrubland Alliance**



7b *Salix exigua* shrublands occupying saturated to inundated sites that are either scoured annually or have a developed herbaceous understory **(8)**

8a (7) *Salix exigua* stands with sparse to no understory cover, occurring on recently exposed banks, point bars, and islands of the Green and Colorado rivers and recently scoured wash and canyon bottoms – ***Salix exigua*** **/ Barren Shrubland**





8b *Salix exigua* shrublands with a mixed understory dominated by mesic graminoids such as *Juncus balticus, Bromus inermis* or *Equisetum* spp.; stands occupy the banks of intermittently flooded streams – ***Salix exigua* / Mesic Graminoids Shrubland**





9a (5) Riparian shrubland communities occurring on banks, point bars, terraces, and islands of rivers, streams, and washes; dominants are *Suaeda moquinii*, *Forestiera pubescens* or *Tamarix chinensis* **(10)**

9b Shrub communities on seeps and springs in alcoves, canyons, and ravines; dominants include *Betula occidentalis, Cornus sericea*, and *Rhamnus betulifolia* **(12)**

10a **(**9) Riparian shrublands dominated by *Tamarix chinensis.* Stands may be open and associated with other species such as *Salix exigua, Forestiera pubescens*, and *Ribes aureum,* or may be a dense monoculture. Herbaceous species are rare – ***Tamarix* spp. Temporarily Flooded Semi-natural Shrubland**





10b Riparian shrublands on riverbanks and lower terraces dominated by *Forestiera pubescens* or *Suaeda moquinii*. Stands may be dense monocultures or may contain scattered *Tamarix chinensis, Phragmites australis,* and *Rhus trilobata* **(11)**

11a (10) Riparian shrublands on riverbanks and lower terraces, dominated by *Forestiera pubescens.* Common associates may include the shrubs *Rhus trilobata* and *Tamarix chinensis,* and the graminoid, *Phragmites australis* - ***Forestiera pubescens*** **Shrubland**





11b Sparse to dense shrublands on terraces, point bars, alluvial fans and floodplains dominated by *Suaeda moquinii.* If *Atriplex canescens* or *Sarcobatus vermiculatus* are present as codominants in the shrub layer, please see couplets 23b and 41b, respectively - ***Suaeda moquinii*** **Shrubland**



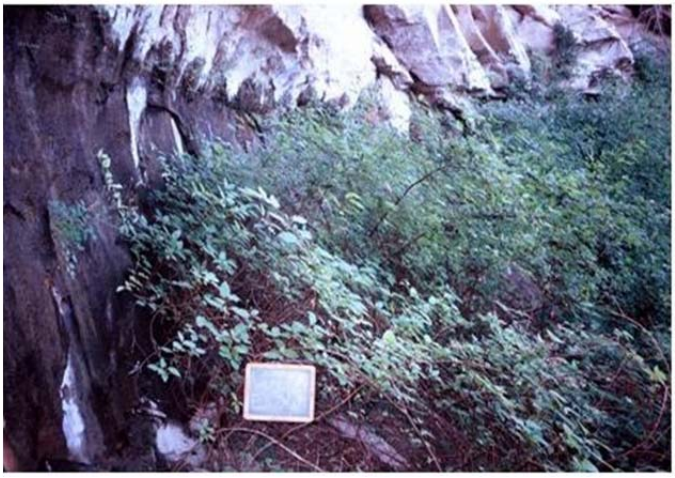


12a (9) *Rhamnus betulifolia* shrublands forming near-monotypic stands on saturated, steep, colluvial slopes. *Rhus trilobata* and *Brickellia longifolia* may also be present – ***Frangula betulifolia (Rhamnus betulifolia)*** **Shrubland [Park Special]**



12b Shrublands of *Betula occidentalis* and/or *Cornus sericea,* occurring on saturated soils of canyon heads and ravines **(13)**

13a (12) Dense *Cornus sericea* shrublands where soils are saturated by bedrock seeps. *Betula occidentalis* is absent or has only trace cover; *Rosa woodsii* is consistently present – ***Cornus sericea*** **Rocky Mountain Shrubland**



13b *Betula occidentalis* shrublands in which *Cornus sericea* is present to codominant. Other shrubs that may have significant cover include *Prunus virginiana, Rosa woodsii, Mahonia repens*, and *Rhus trilobata* – ***Betula occidentalis / Cornus sericea*** **Shrubland**



Xeric/Upland Shrublands

14a (2) Shrublands of upland habitats, dominated by tall shrubs of the species *Amelanchier, Cercocarpus, Mahonia* or *Quercus gambelii* **(15)**

14b Upland shrublands, sometimes sparsely vegetated, dominated by short shrubs of the species *Artemisia, Atriplex, Chrysothamnus, Coleogyne, Ephedra, Ericameria,*

Eriogonum, *Fraxinus*, *Poliomintha*, *Rhus*, *Sarcobatus*, *Vanclevea*, or *Quercus havardii* var. *tuckeri* **(24)**

15a (14) Sparse shrublands of exposed slickrock, dominated by *Cercocarpus intricatus* **(16)**

15b Shrublands of steep slopes, sometimes covered by sandstone colluvium, or level drainage terraces, dominated by *Amelanchier utahensis*, *Mahonia fremontii* or *Quercus gambelii* **(17)**

16a (15) Shrublands dominated by *Cercocarpus intricatus* with more than 10% cover. *Pinus edulis* trees provide sparse cover – ***Cercocarpus intricatus* Montane Shrubland**



16b Sparse shrublands on rims and other slickrock exposures dominated by *Cercocarpus intricatus* with up to 5% cover – ***Cercocarpus intricatus* Slickrock Sparse Vegetation**





17a (15) *Amelanchier utahensis* shrublands, sometimes with sparse cover by *Cercocarpus montanus*; occurring on sheltered, sometimes talus-covered slopes **(18)**

17b Shrublands dominated by *Mahonia fremontii* or *Quercus gambelii* (may have sparse to low cover by *Cercocarpus montanus*) occurring on drainage terraces, canyon bottoms, or steep slopes **(19)**

18a (17) Open shrublands co-dominated by *Amelanchier utahensis* and *Cercocarpus montanus* occurring on sheltered slopes with significant rock cover. Scattered *Fraxinus anomala, Pinus edulis,* and *Juniperus osteosperma* may be present – ***Amelanchier (utahensis, alnifolia) - Cercocarpus montanus*** **Shrubland**





18b Shrublands dominated by *Amelanchier utahensis* and occurring 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, but *Cercocarpus montanus* is absent – ***Amelanchier utahensis*** **Shrubland**





19a (17) Open shrublands on deep alluvial soils of wash terraces and banks, dominated by *Mahonia fremontii*, sometimes co-dominated by *Ericameria nauseosa. Sporobolus airoides* is a common understory species – ***Mahonia fremontii* Shrubland**



19b Shrublands dominated by *Quercus gambelii* (may have sparse to low cover by *Cercocarpus montanus*) occurring on drainage terraces, canyon bottoms, or steep slopes **(20)**

20a (19) *Quercus gambelii* shrublands or woodlands occupying stream terraces, washes and canyon floors; the understory is typically sparse or has low cover of *Symphoricarpos longiflorus* or sparse to open cover of *Artemisia tridentata* **(21)**

20b *Quercus gambelii* tall shrublands or woodlands occupying steep slopes; the understory typically is sparse or includes *Cercocarpus montanus* or *Rhus trilobata* **(23)**

21a (20) *Quercus gambelii* shrublands or woodlands on level riparian terraces with a tree-like, dense oak canopy and a sparse understory of short shrubs, lianas, and herbaceous species; no one understory species is consistent or dominan – ***Quercus gambelii* / Sparse Understory Shrubland**





21b *Quercus gambelii* woodlands with a sparse to open shrub layer of *Artemisia tridentata* or *Symphoricarpos longiflorus* **(22)**

22a (21) *Quercus gambelii* shrublands with a sparse to open shrub layer of *Artemisia tridentata* **- *Quercus gambelii / Artemisia tridentata* Shrubland**





22b *Quercus gambelii* shrublands on level riparian terraces with a sparse understory of *Symphoricarpos longiflorus.* Other associated understory shrubs include *Amelanchier utahensis, Fraxinus anomala, Ephedra viridis* – ***Quercus gambelii / Symphoricarpos longiflorus* Shrubland [Park Special]**



23a (20) *Quercus gambelii* shrublands on mesic sites with a mixed canopy that includes *Cercocarpus montanus,* with lesser cover by *Amelanchier utahensis, Fraxinus anomala, Artemisia bigelovii, Ephedra viridis,* and *Mahonia fremontii* – ***Quercus gambelii – Cercocarpus montanus / (Carex geyeri)*** **Shrubland**





23b *Quercus gambelii* shrublands on steep, mesic slopes where some *Rhus trilobata* is present. Associated shrubs may include *Fendlera rupicola*, and *Rosa woodsii.* If *Cercocarpus montanus* is present, it is with no more than trace cover – ***Quercus gambelii / Rhus trilobata*** **Shrubland**



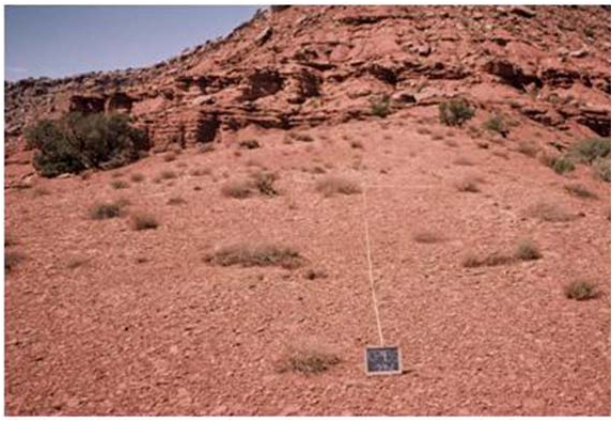


24a (14) Desert pavement, badland sites, or active sand dunes characterized by very sparse cover of *Eriogonum corymbosum* or *Eriogonum leptocladon* **(25)**

24b Shrublands dominated by species of *Artemisia, Atriplex, Chrysothamnus, Coleogyne, Ephedra, Ericameria, Fraxinus, Poliomintha, Rhus, Sarcobatus*, *Vanclevea,* or *Quercus havardii* var. *tuckeri* **(26)**

25a (24) Desert pavements and badlands where the very sparse vegetation is dominated by *Eriogonum corymbosum* – ***Eriogonum corymbosum*** **Badlands Sparse Vegetation**





25b Active dunes with sparse vegetation consisting primarily of *Eriogonum leptocladon.* If *Artemisia filifolia* or *Vanclevea stylosa* are present with significant cover, go to couplet 26 - ***Eriogonum leptocladon*** **Sparse Vegetation**




26a (25) Shrublands, sometimes sparsely vegetated, dominated by *Atriplex confertifolia* or *Atriplex canescens*. *Sarcobatus vermiculatus*, *Artemisia tridentata* and/or *Ephedra viridis* may be present to codominant **(27)**

26b Shrublands dominated by species of *Artemisia, Chrysothamnus, Coleogyne, Ephedra, Ericameria, Fraxinus, Poliomintha, Rhus, Sarcobatus*, *Vanclevea, or Quercus havardii* var. *tuckeri* **(37)**

27a (26) *Atriplex confertifolia* communities occupying various landscape positions and habitats; *Sarcobatus vermiculatus* may be present to codominant **(28)**

27b *Atriplex canescens* communities occupying various landscape positions and habitats; *Artemisia tridentata, Suaeda moquinii,* or *Ephedra viridis* may be codominant **(30)**

28a (27) Sparse shrubland of slopes, scarps, terraces, or valley floors/benches where *Atriplex confertifolia* is dominant (3-5% cover). Other species present, with trace to low cover, may include *Gutierrezia sarothrae*, *Ephedra torreyana,* and/or *Chrysothamnus nauseosus* - ***Atriplex confertifolia*** **Sparse Shrubland**




If community is otherwise similar to above but *Atriplex confertifolia* cover is greater than 6% (generally 8-12%), key to - ***Atriplex confertifolia* Great Basin Shrubland**



28b Shrublands dominated by *Atriplex confertifolia* with an understory of *Pleuraphis jamesii* or an open canopy codominated by *Sarcobatus vermiculatus* (**29)**

29a (28) Shrublands dominated by *Atriplex confertifolia* with at least 1% cover by *Pleuraphis jamesii.* Scattered *Ephedra torreyana* and *Coleogyne ramosissima* may be present; however, if *Ephedra torreyana* is codominant with *Atriplex confertifolia*, skip ahead to couplet 52 – ***Atriplex confertifolia / Pleuraphis jamesii* Shrubland**





29b Stream terraces where *Atriplex confertifolia* provides a woody understory to an open canopy of *Sarcobatus vermiculatus. Ericameria nauseosa* is often present – ***Atriplex confertifolia – Sarcobatus vermiculatus* Shrubland**





30a (27) Sparse *Atriplex canescens* shrublands in sandy washes, valley bottoms, alluvial terraces and floodplains; *Ericameria nauseosa* or *Suaeda torreyana* are often codominant and *Brickellia longifolia* is generally present, as are grasses and forbs characteristic of sandy sites **(31)**

30b *Atriplex canescens* shrublands on a variety of sandy sites; *Artemisia tridentata* ssp. *tridentata* or *Ephedra viridis* may be codominant, or the understory may have significant cover by *Pleuraphis jamesii* or *Sporobolus airoides* **(32)**

31a (30) Sparse *Atriplex canescens* shrublands in sandy washes; *Ericameria nauseosa* is often codominant and *Brickellia longifolia* is generally present, as are grasses and forbs characteristic of sandy sites - ***Atriplex canescens* Desert Wash Shrubland**





31b *Atriplex canescens* shrublands in valley bottoms, alluvial river terraces, floodplains and washes with a woody understory dominated by *Suaeda moquinii* - ***Atriplex canescens* / *Suaeda moquinii* Shrubland [Park Special]**





32a (30) *Atriplex canescens* shrublands on deep soils of plains, stream terraces, and in valley bottoms in which there are no diagnostic species or only sparse weedy species in the understory – ***Atriplex canescens* Shrubland**





32b *Atriplex canescens* shrublands in which *Artemisia tridentata* ssp. *tridentata, Ephedra viridis*, *Pleuraphis jamesii* or *Sporobolus airoides* are present to codominant **(33)**

33a (32) Sparse *Atriplex canescens* shrublands on sand dunes, alluvial flats, stream terraces or talus slopes in which *Ephedra viridis* or *Pleuraphis jamesii* is codominant **(34)**

33b *Atriplex canescens* shrublands in which *Artemisia tridentata* or *Sporobolus airoides* is codominant; habitats include river and stream terraces or upland benches **(36)**

34a (33) Sparsely vegetated shrub-herbaceous vegetation of sand dunes, alluvial flats and stream terraces where *Pleuraphis jamesii* dominates the herbaceous layer (<10 cover) - ***Atriplex canescens / Pleuraphis jamesii* Shrubland**





34b Shrublands codominated by *Atriplex canescens* and *Ephedra viridis* **(35)**

35a (34) Sparse mixed shrublands on colluvial slopes co-dominated by *Atriplex canescens* and *Ephedra viridis.* The herbaceous layer is likewise mixed and may include *Leymus salinus* – ***Atriplex canescens – Ephedra viridis*** **Talus Shrubland**

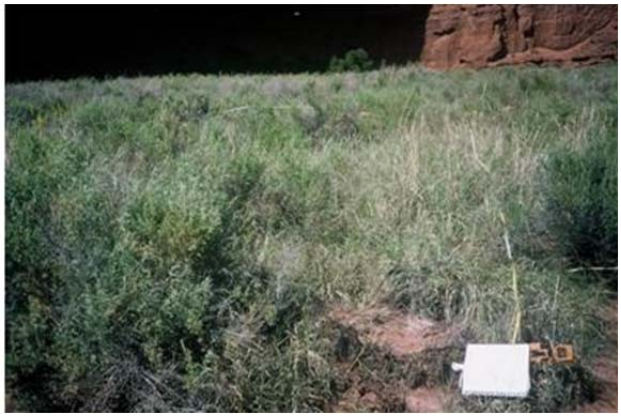
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35b Sand dunes and sand sheets supporting a sparse shrubland co-dominated by *Atriplex canescens* and *Ephedra viridis.* Minor shrubs present may include *Coleogyne ramosissima, Ericameria nauseosa, Gutierrezia sarothrae*, and *Opuntia polyacantha.* The herbaceous layer is moderately diverse, but generally contributes only sparse cover – ***Atriplex canescens – Ephedra viridis*** **Shrubland**





36a (33) Stream and river terraces supporting a shrubland dominated by *Atriplex canescens.* Other shrubs contributing sparse cover include *Atriplex gardneri* and *Suaeda moquinii. Sporobolus airoides* dominates the herbaceous layer, although *Bromus tectorum* may also be abundant – ***Atriplex canescens / Sporobolus airoides*** **Shrubland**





36b Benches, canyon floors, and stream terraces supporting a moderately dense shrubland roughly co-dominated by *Atriplex canescens* and *Artemisia tridentata* ssp. *tridentata.* *Ericameria nauseosa* and *Sarcobatus vermiculatus* may also be present – ***Atriplex canescens – Artemisia tridentata*** **Shrubland**





37a (26) Sparse shrublands on active sand dunes dominated by *Vanclevea stylosa* and *Artemisia filifolia*; *Poliomintha incana* and *Eriogonum leptocladon* may be present to codominant – ***Poliomintha incana – Artemisia filifolia – Vanclevea stylosa*** **Shrubland**





37b Shrublands dominated by species of *Artemisia, Chrysothamnus, Coleogyne, Ephedra, Ericameria, Fraxinus, Rhus, Sarcobatus* or *Quercus havardii* var. *tuckeri* **(38)**

38a (37) Shrublands dominated by large clumps of *Quercus havardii* var. *tuckeri* on sand sheets and wash banks. Associated shrubs include *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Eriogonum microthecum, Ephedra torreyana,* and *Ephedra viridis* – ***Quercus havardii* var. *tuckeri* Shrubland**





38b Shrublands dominated by species of *Artemisia, Chrysothamnus, Coleogyne, Ephedra, Ericameria, Fraxinus, Rhus,* or *Sarcobatus* **(39)**

39a (38) Shrublands or shrub herbaceous communities dominated by a sparse to open layer of *Chrysothamnus viscidiflorus* **(40)**

39b Shrublands dominated by species of *Artemisia, Coleogyne, Ephedra, Ericameria, Fraxinus, Rhus,* or *Sarcobatus* **(41)**

40a (39) Very sparse mixed shrublands on steep talus slopes dominated by *Chrysothamnus viscidiflorus.* Other shrubs present include *Atriplex confertifolia, Ericameria nauseosa, Zuckia brandegeei,* and *Xylorhiza glabriuscula*; total cover is usually less than 5% – ***Chrysothamnus viscidiflorus*** **Talus Shrubland**





40b Shrublands typically occurring on mesatops with sparse to open shrub canopies of *Chrysothamnus viscidiflorus* which may be codominant with *Opuntia polyacantha* and/or *Krascheninnikovia lanata* - ***Chrysothamnus viscidiflorus – Krascheninnikovia lanata*** **Shrubland [Park Special]**





41a (39) Shrublands dominated by *Ericameria nauseosa* and occupying stream terraces, sand dunes, and colluvial slopes in sparse to dense stands **(42)**

41b Shrublands characterized by species of *Artemisia, Coleogyne, Ephedra, Fraxinus, Rhus,* or *Sarcobatus* **(46)**

42a (41) *Ericameria nauseosa* shrublands lacking a grassy understory. *Sarcobatus vermiculatus* may have substantial cover - ***Ericameria nauseosa*** **Shrubland**





42b (33) *Ericameria nauseosa* shrublands forming sparse stands on colluvial slopes or active sand dunes/sand sheets or forming sparse to dense stands on stream terraces and washes. The understory may be sparse or may be dominated by *Bromus tectorum* or *Sporobolus airoides* **(43)**

43a (42) *Ericameria nauseosa* shrublands forming sparse to dense stands on stream terraces and washes with grassy understories dominated by *Bromus tectorum* or *Sporobolus airoides* **(44)**

43b *Ericameria nauseosa* shrublands forming sparse stands on colluvial slopes or active sand dunes/sand sheets **(45)**

44a (43) Disturbed *Ericameria nauseosa* shrublands with an understory dominated by *Bromus tectorum*; *Mahonia fremontii, Amelanchier utahensis, Ephedra viridis*, and *Opuntia erinacea* contribute diversity but little cover. Relict bunchgrasses include *Achnatherum hymenoides, Hesperostipa comata*, and *Sporobolus cryptandrus* – ***Ericameria nauseosa / Bromus tectorum*** **Semi-natural Shrubland**





44b Sparse *Ericameria nauseosa* shrublands on alluvial terraces and valley bottoms, with an understory dominated by *Sporobolus airoides*. *Atriplex canescens* and *A. confertifolia* are common associated shrubs, and *Achnatherum hymenoides* may be present – ***Ericameria nauseosa / Sporobolus airoides*** **Shrubland**





45a (43) Sparse *Ericameria nauseosa* communities on colluvial slopes; many other shrub species typical of talus slopes provide sparse to low cover, and occasionally may be codominant – ***Ericameria nauseosa*** **Sparse Shrubland**





45b Sparse *Ericameria nauseosa* communities (up to 10% cover) on active sand dunes and unstable sand sheets; many other shrub and herbaceous species typical of sandy sites provide sparse cover – ***Ericameria nauseosa*** **Sand Deposit Sparse Shrubland**





46a (41) Shrublands dominated by *Sarcobatus vermiculatus* and occupying stream terraces, plains, and valley floors in sparse to moderately vegetated stands. *Atriplex confertifolia* and/or *A. canescens* may be present to nearly codominant **(47)**

46b Shrublands characterized by species of *Artemisia, Coleogyne*, *Ephedra, Fraxinus,* or *Rhus* **(52)**

47a (46) *Sarcobatus vermiculatus* shrublands with *Atriplex confertifolia* and/or *A.canescens,* or *Suaeda moquinii* present to codominant, or with a sparse or weedy herbaceous understory **(48)**

47b *Sarcobatus vermiculatus* shrublands on plains and valley floors; total cover ranges from sparse to up to 60%; the herbaceous understory is dominated by *Pleuraphis jamesii, Sporobolus airoides*, or *Sporobolus cryptandrus* **(50)**

48a (47) *Sarcobatus vermiculatus* shrublands on floodplains and stream terraces; total cover ranges from sparse to up to 60%; the understory is of weedy species or is sparse and lacks a clearly diagnostic species. Scattered *Suaeda torreyana, Ericameria nauseosa, Atriplex canescens,* and *Krascheninnikovia lanata* may be present. Forbs tend to be weedy and generally dominate the understory –***Sarcobatus vermiculatus* Disturbed Shrubland**





48b *Sarcobatus vermiculatus* shrublands with *Atriplex confertifolia* and/or *A. canescens,* or *Suaeda moquinii* present to codominant in the shrub layer **(49)**

49a (48) *Sarcobatus vermiculatus* shrublands on stream terraces with *Atriplex confertifolia* shrubs present to codominant as a woody understory. An herbaceous understory is often absent - ***Atriplex confertifolia – Sarcobatus vermiculatus* Shrubland**

See couplet 21b photos

49b *Sarcobatus vermiculatus* shrublands on terraces of the Green River with *Suaeda moquinii* shrubs present to codominant as a woody understory. The herbaceous understory is often weedy and may include *Centaurea repens, Salsola tragus, Bromus tectorum,* and *Elymus repens* **– *Sarcobatus vermiculatus / Suaeda moquinii* Shrubland**





50a (47) Sparse *Sarcobatus vermiculatus* shrublands on valley floors with an understory dominated by *Pleuraphis jamesii. Atriplex canescens* may be present to codominant in the shrub layer – ***Sarcobatus vermiculatus / Pleuraphis jamesii* Shrub Herbaceous Vegetation [Park Special]**





50b *Sarcobatus vermiculatus* shrublands on plains and valley floors with an understory dominated by *Sporobolus airoides* or *Sporobolus cryptandrus* **(51)**

51a (50) *Sarcobatus vermiculatus* shrublands on valley floors with an understory dominated by *Sporobolus cryptandrus. Atriplex canescens* may also be present and other grasses present may include *Achnatherum hymenoides* – ***Sarcobatus vermiculatus / Sporobolus cryptandrus*** **Shrubland [Park Special]**





51b *Sarcobatus vermiculatus* shrublands on plains with an understory consisting primarily of *Sporobolus airoides.* Other shrubs present may include *Suaeda moquinii, Ericameria nauseosa, Atriplex canescens, Atriplex confertifolia*, and *Atriplex gardneri* – ***Sarcobatus vermiculatus / Sporobolus airoides*** **Shrubland**





52a (46) Shrublands dominated by *Artemisia bigelovii, Artemisia filifolia, Artemisia tridentata* ssp. *tridentata,* or *Artemisia tridentata* ssp. *wyomingensis* **(53)**

52b Shrublands dominated by species of *Coleogyne, Ephedra, Fraxinus* or *Rhus* **(62)**

53a (52) Sparse, mixed xeric shrublands on talus slopes in which *Artemisia bigelovii* and *Ephedra viridis* or *Ephedra torreyana* are conspicuous. Many other shrub species typical of colluvial sites may be present to codominant – ***Artemisia bigelovii - Ephedra (viridis, torreyana)*** **Talus Shrubland**





53b Shrublands of non-talus sites with deep soils dominated by *Artemisia filifolia, Artemisia tridentata* ssp. *tridentata,* or *Artemisia tridentata* ssp. *wyomingensis* **(54)**

54a (53) *Artemisia filifolia* shrublands of sandy, well-drained sites, including benches, stream terraces, and valley bottoms. Stands are generally sparse and often with a somewhat weedy understory. *Atriplex canescens, Ericameria nauseosa, Ephedra torreyana,* and *Opuntia* spp. are common associates – ***Artemisia filifolia*** **Colorado Plateau Shrubland**





54b Shrublands dominated by either *Artemisia tridentata* ssp. *tridentata* or *Artemisia tridentata* ssp. *wyomingensis,* sometimes with *Ericameria nauseosa* as a codominant. An herbaceous understory is generally present, and may be dominated by *Bromus tectorum, Bouteloua gracilis*, *Sporobolus cryptandrus,* or *Hesperostipa comata* **(55)**

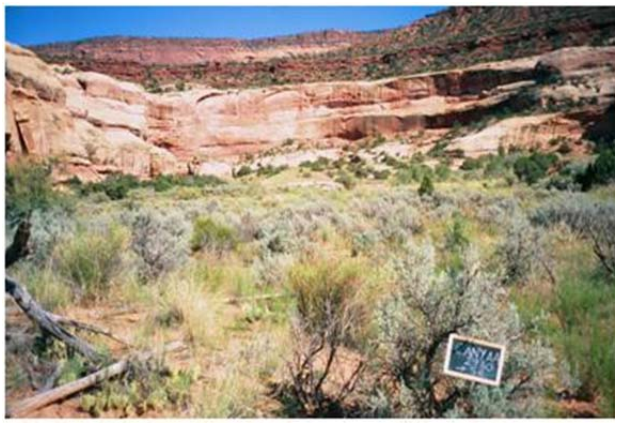
55a (54) Shrublands dominated by *Artemisia tridentata* ssp. *tridentata,* sometimes with *Ericameria nauseosa* as a codominant. An herbaceous understory is generally present, and may be dominated by *Bromus tectorum, Sporobolus cryptandrus,* or *Hesperostipa comata* **(56)**

55b Shrublands dominated by *Artemisia tridentata* ssp. *wyomingensis.* An herbaceous understory is generally present, and may be dominated by *Bromus tectorum, Bouteloua gracilis*, or *Hesperostipa comata* **(59)**

56a (55) *Artemisia tridentata* ssp. *tridentata* shrublands on drainage terraces with grassy understories dominated by either *Sporobolus cryptandrus* or *Hesperostipa comata* **(57)**

56b *Artemisia tridentata* ssp. *tridentata* shrublands on drainage terraces, sometimes with *Ericameria nauseosa* as a codominant. Understories are sparse and poorly developed or weedy and dominated by *Bromus tectorum* and other weedy species **(58)**

57a (56) Moderately dense *Artemisia tridentata* ssp. *tridentata* shrublands on upper stream terraces accompanied by scattered *Atriplex canescens, Opuntia erinacea,* and *Ephedra viridis*. The understory consists of *Sporobolus cryptandrus,* often with lesser cover by *Achnatherum hymenoides, Hesperostipa comata, Abronia fragrans, Oenothera pallida*, and *Sphaeralcea parvifolia* – ***Artemisia tridentata* ssp. *tridentata* / *Sporobolus cryptandrus* Shrubland**




57b Moderately dense *Artemisia tridentata* ssp. *tridentata* shrublands on upper stream terraces accompanied by scattered *Atriplex canescens, Ericameria nauseosa, Opuntia erinacea,* and *Ephedra viridis*. The understory is dominated by *Hesperostipa comata* with lesser cover by the associated grasses *Bromus tectorum, Sporobolus airoides, Sporobolus cryptandrus,* and *Achnatherum hymenoides*, and trace cover by a variety of forbs – ***Artemisia tridentata* ssp. *tridentata* / *Hesperostipa comata* Shrubland**




58a (56) *Artemisia tridentata* ssp. *tridentata* shrublands on stream terraces that have a history of anthropogenic disturbance. *Bromus tectorum* clearly dominates the understory, often with other weedy species, and *Ericameria nauseosa* occasionally contributes to the shrub canopy – ***Artemisia tridentata* – (*Ericameria nauseosa*) / *Bromus tectorum* Semi-natural Shrubland**




58b *Artemisia tridentata* ssp. *tridentata* shrublands commonly occurring on stream terraces and canyon bottoms, with a poorly developed or sparse understory, although *Sporobolus cryptandrus* may be present with trace cover. The remaining shrub layer may include *Atriplex canescens, Ericameria nauseosa, Sarcobatus vermiculatus,* and cacti – ***Artemisia tridentata* (ssp. *tridentata,* ssp. *xericensis)* Shrubland Alliance**




59a (55) *Artemisia tridentata* ssp. *wyomingensis* shrublands on alluvial fans or mesas with a sparse understory or a weed-dominated understory, often including *Bromus tectorum* **(60)**

59b *Artemisia tridentata* ssp. *wyomingensis* shrublands with a perennial grass understory of *Bouteloua gracilis* or *Hesperostipa comata,* occurring on stream terraces, valley floors, plains, and mesas **(61)**

60a (59) *Artemisia tridentata* ssp. *wyomingensis* shrublands on xeric, excessively well-drained sites with a sparse, non-weedy understory (less than 5% and usually with no diagnostic species present). The sparseness of the vegetation may be due to edaphic conditions and not to overgrazing – ***Artemisia tridentata* ssp. *wyomingensis* / Sparse Understory Shrubland**





60b *Artemisia tridentata* ssp. *wyomingensis* shrublands with a weedy understory in which *Bromus tectorum* and *Elymus elymoides* are present to dominant. Scattered individuals of *Chrysothamnus viscidiflorus, Krascheninnikovia lanata, Atriplex canescens*, and *Opuntia erinacea* may be present – ***Artemisia tridentata* ssp. *wyomingensis* / Disturbed Understory Semi-natural Shrubland**

No photo available

61a (59) *Artemisia tridentata* ssp. *wyomingensis* shrublands with an understory of *Bouteloua gracilis* providing up to 10% cover. Associated shrubs include *Ephedra viridis, Krascheninnikovia lanata,* and *Hesperostipa comata, Achnatherum hymenoides, Elymus elymoides, Bromus tectorum, Pleuraphis jamesii* may contribute low cover – ***Artemisia tridentata* ssp. *wyomingensis* / *Bouteloua gracilis* Shrubland**





61b *Artemisia tridentata* ssp. *wyomingensis* shrublands on terraces or plains, with an understory dominated by *Hesperostipa comata.* Associated shrubs include *Ephedra viridis, Atriplex canescens, and Chrysothamnus viscidiflorus.* The herbaceous layer may be relatively diverse and includes the grasses *Achnatherum hymenoides, Bromus tectorum, Elymus elymoides*, and *Pleuraphis jamesii*. This association was documented

primarily in the environs – ***Artemisia tridentata* ssp. *wyomingensis* / *Hesperostipa comata* Colorado Plateau Shrubland**



62a (52) Shrublands dominated by species of *Ephedra, Fraxinus* or *Rhus* **(66)**

62b Shrublands dominated by *Coleogyne ramosissima* **(63)**

63a (62) Bedrock exposures or otherwise poor soils where *Coleogyne ramosissima* provides < 5% cover. *Ephedra torreyana, Artemisia bigelovii, Gutierrezia sarothrae, Yucca angustissima*, and *Opuntia polyacantha* are common associates with sparse cover. Herbaceous species usually have not more than trace cover – ***Coleogyne ramosissima* Sparse Shrubland**





63b *Coleogyne ramosissima* shrublands with more than 5% total cover; *Pleuraphis jamesii, Quercus havardii* var. *tuckeri* or *Purshia stansburiana* may be codominant **(64)**

64a (63) *Coleogyne ramosissima* shrublands with either a sparse understory or one in which no diagnostic species occurs consistently. Scattered individuals of *Ephedra torreyana, Atriplex confertifolia, Ephedra viridis, Ericameria nauseosa, Atriplex canescens* commonly occur. Substrate is variable and *Coleogyne ramosissima* may form a monoculture – ***Coleogyne ramosissima* Shrubland**





64b *Coleogyne ramosissima* shrublands with an understory dominated by *Pleuraphis jamesii* or in which *Quercus havardii* var. *tuckeri* and/or *Purshia stansburiana* are present as codominants in the shrub layer **(65)**

65a (64) Sparse *Coleogyne ramosissima* shrublands with an understory of *Pleuraphis jamesii.* Other shrubs commonly present include *Ephedra torreyana, Atriplex confertifolia, Ericameria nauseosa, Eriogonum corymbosum,* and *Ephedra viridis. Achnatherum hymenoides* is a common component of the understory – ***Coleogyne ramosissima* / *Pleuraphis jamesii* Shrubland**





65b Shrublands of sandy sites, characterized by an open canopy of *Coleogyne ramosissima* joined by either or both *Quercus havardii* var. *tuckeri* or more commonly by *Purshia stansburiana*. A few stands have *Quercus* and *Purshia* but lack *Coleogyne*. *Fraxinus anomala, Ephedra viridis, Artemisia bigelovii, Ephedra torreyana, Gutierrezia*

sarothrae, Yucca angustissima, Opuntia polyacantha, and *Brickellia microphylla* are present in most stands – ***Coleogyne ramosissima - Purshia stansburiana – Quercus havardii* var. *tuckeri* Shrubland**





66a (62) Talus communities in which *Fraxinus anomala* and/or *Rhus trilobata* are conspicuous species **(67)**

66b Shrub communities on sites other than talus slopes, in which *Fraxinus anomala* and *Rhus trilobata* are absent or accidental; conspicuous species include *Ephedra viridis* or *Ephedra torreyana,* with or without a grass understory **(68)**

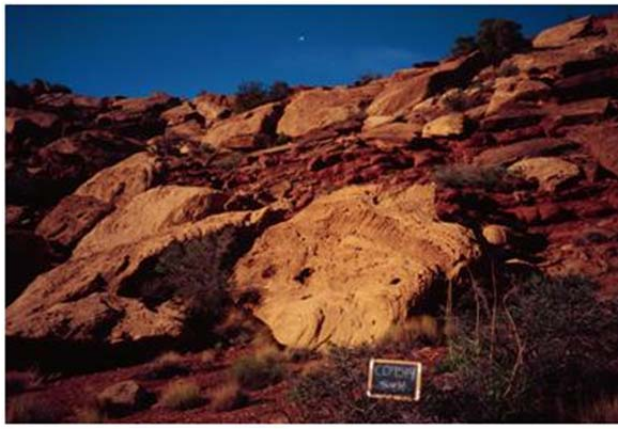
67a (66) Mixed shrublands on talus slopes or sandstone rims of mesas and canyons in which *Fraxinus anomala* is dominant or codominant, usually with *Rhus trilobata.* Many other shrub species are usually present, including *Artemisia bigelovii, Atriplex confertifolia, Ephedra torreyana,* and *Chrysothamnus viscidiflorus* var. *stenophyllus* - ***Fraxinus anomala – Rhus trilobata* Talus Shrubland**





67b Talus shrublands in which *Rhus trilobata* is consistent, usually codominant with *Ephedra viridis* or *Ephedra torreyana.* Many other shrub species may be present, including

Artemisia bigelovii, Atriplex confertifolia, Ericameria nauseosa, and *Eriogonum corymbosum*. If *Fraxinus anomala* is present, it is with no more than trace cover - ***Rhus trilobata - Ephedra (viridis, torreyana)*** **Talus Shrubland**





68a (66) *Ephedra torreyana* shrublands, sometimes with *Atriplex confertifolia* or *Atriplex* spp. codominant, or with a sparse understory dominated by *Pleuraphis jamesii* or one in which no diagnostic species is evident **(69)**

68b *Ephedra viridis* shrublands with no diagnostic species in the understory or with an understory dominated by *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata*, *Muhlenbergia pungens*, and/or *Pleuraphis jamesii* **(74)**

69a (68) *Ephedra torreyana* shrublands on deep soils of plateaus and mesas, benches, toeslopes and stream terraces, with *Sporobolus cryptandrus, Pleuraphis jamesii* and/or *Achnatherum hymenoides* dominating the understory. *Ericameria nauseosa* may co-dominate the shrub layer, and *Coleogyne ramosissima, Atriplex confertifolia,* and *Opuntia* spp. may be present **(70)**

69b Sparse to very sparse *Ephedra torreyana* shrublands; may occur in association with species of *Atriplex* **(72)**

70a (69) Sparse *Ephedra torreyana* shrublands occurring on sand dunes with a grassy understory dominated by *Sporobolus cryptandrus* **- *Ephedra torreyana / Sporobolus cryptandrus* Shrub Herbaceous Vegetation [Park Special]**





70b *Ephedra torreyana* shrublands on deep soils of plateaus and mesas, benches, toeslopes and stream terraces, with *Pleuraphis jamesii* and/or *Achnatherum hymenoides* dominating the understory. *Ericameria nauseosa* may co-dominate the shrub layer, and *Coleogyne ramosissima, Atriplex confertifolia,* and *Opuntia* spp. may be present **(71)**

71a (70) *Ephedra torreyana* shrublands on deep soils of mesas, benches, and toeslopes with *Pleuraphis jamesii* dominating the understory. *Coleogyne ramosissima, Atriplex confertifolia,* and *Opuntia* spp. may be present – ***Ephedra torreyana / Pleuraphis jamesii*** **Shrubland**





71b *Ephedra torreyana* shrublands on sand dunes and sandsheets with understories dominated by *Achnatherum hymenoides*. *Pleuraphis jamesii* is almost always present, but not dominant. *Coleogyne ramosissima, Atriplex canescens,* and *Opuntia* spp. may be present - ***Ephedra torreyana / Achnatherum hymenoides - Pleuraphis jamesii*** **Shrubland**





72a (69) Sparse *Ephedra torreyana* shrublands, always with less than 10% cover and usually with less than 5%, with no diagnostic species in the understory. Stands occur on colluvial slopes, cliffs, dunes, and benches. If on a gypsum site, go to couplet 73. Trace shrubs include *Coleogyne ramosissima, Ericameria nauseosa, Atriplex confertifolia, Gutierrezia sarothrae,* and *Xylorhiza tortifolia* – ***Ephedra torreyana*** **Sparse Vegetation**





72b Sparse *Ephedra torreyana* shrublands associated with species of *Atriplex* **(73)**

73a (72) Sparse shrublands occurring primarily on shale-derived substrates, where *Ephedra torreyana* co-dominates with *Atriplex canescens* and/or *Atriplex confertifolia.* Other shrubs never contribute more than 5% combined cover and include *Ericameria nauseosa, Coleogyne ramosissima, Eriogonum corymbosum,* and *Xylorhiza tortifolia. Pleuraphis jamesii* is often present with low cover in the herbaceous layer, which is generally sparse but may be quite diverse – ***Ephedra torreyana – (Atriplex canescens, Atriplex confertifolia)*** **Sparse Vegetation**




73b Very sparse shrublands primarily occurring on gypsum badlands, where *Ephedra torreyana* dominates, sometimes with *Atriplex gardneri* and/or *Eriogonum bicolor.* The dominant life form in this community is gypsophilous ground lichens – ***Ephedra torreyana – (Atriplex* spp.) / Non-vascular Gypsum Sparse Vegetation**




74a (68) *Ephedra viridis* shrublands with an understory of *Bouteloua gracilis* or *Muhlenbergia pungens*. *Achnatherum hymenoides* may be codominant **(75)**

74b *Ephedra viridis* shrublands with an understory of *Achnatherum hymenoides, Hesperostipa comata,* or *Pleuraphis jamesii* **(76)**

75a (74) *Ephedra viridis* shrublands with an understory of *Bouteloua gracilis* and occurring on plateaus, mesa tops, and plains – ***Ephedra viridis / Bouteloua gracilis* Shrubland**





75b *Ephedra viridis* shrublands on recently stabilized sand dunes, with *Muhlenbergia pungens* present to dominant in the understory, usually accompanied by *Pleuraphis jamesii, Sporobolus cryptandrus*, and *Achnatherum hymenoides,* which may be codominant – ***Ephedra viridis / Muhlenbergia pungens*** **Shrubland [Park Special]**



76a (74) *Ephedra viridis* shrublands or shrub-herbaceous communities with an understory of *Achnatherum hymenoides* and/or *Hesperostipa comata*; stands occur on deep soils of plateaus and mesas, sand sheets, and valley floors. Other grasses usually present with low cover include *Bouteloua gracilis, Pleuraphis jamesii, Muhlenbergia pungens, Sporobolus cryptandrus, Vulpia octoflora, Aristida purpurea*, and *Sporobolus airoides* – ***Ephedra viridis / (Achnatherum hymenoides, Hesperostipa comata)*** **Shrubland**





76b *Ephedra viridis* shrublands or shrub herbaceous communities with an understory of *Pleuraphis jamesii*; stands occur on deep, fine soils of valleys, plains, benches, and plateaus. Other grasses usually present with low cover include *Achnatherum hymenoides, Aristida purpurea, Hesperostipa comata, Bouteloua gracilis, Bromus tectorum,* and *Sporobolus cryptandrus* – ***Ephedra viridis / Pleuraphis jamesii*** **Shrubland**





Dwarf Shrublands

77a (1) Dwarf-shrublands characterized by sparse cover of *Zuckia brandegeei* and occurring on Moenkopi shale badlands – ***Zuckia brandegeei*** **Sparse Vegetation**



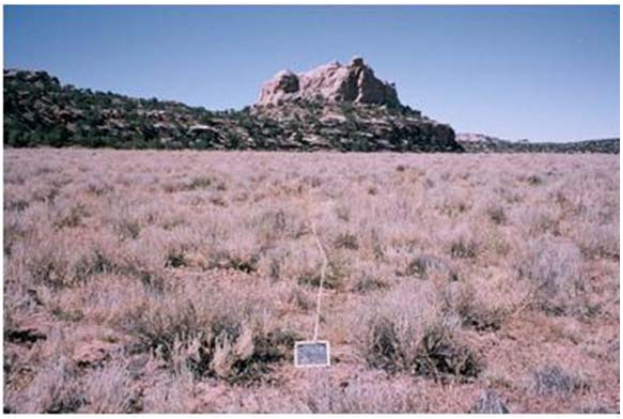


77b Dwarf-shrublands dominated by species of *Atriplex, Krascheninnikovia*, *Opuntia,* or *Gutierrezia* **(78)**

78a (77) Dwarf-shrublands characterized by *Krascheninnikovia lanata;* may have an understory of *Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii*, or *Sporobolus cryptandrus* **(79)**

78b Sparse dwarf-shrublands characterized by species of *Atriplex, Gutierrezia*, or *Opuntia* **(83)**

79a (78) *Krascheninnikovia lanata* dwarf-shrublands with an understory of *Bouteloua gracilis.* Other associated species may include *Achnatherum hymenoides, Hesperostipa comata, Sporobolus cryptandrus, Bromus tectorum,* and *Sphaeralcea coccinea* – ***Krascheninnikovia lanata / Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation**





79b *Krascheninnikovia lanata* dwarf-shrublands with an understory of *Hesperostipa comata, Pleuraphis jamesii*, or *Sporobolus cryptandrus* or with no herbaceous species clearly dominating the understory **(80)**

80a (79) Dwarf-shrublands dominated by *Krascheninnikovia lanata* with *Hesperostipa comata* or *Sporobolus cryptandrus* **(81)**

80b Dwarf-shrublands dominated by *Krascheninnikovia lanata* with *Pleuraphis jamesii* dominant in the understory or with no herbaceous species clearly dominating the understory **(82)**

81a (80) *Krascheninnikovia lanata* dwarf-shrublands with patches of *Hesperostipa comata* occupying less alkaline microhabitats within stands. *Achnatherum hymenoides* may be codominant with *Hesperostipa comata.* Associated shrubs include *Coleogyne ramosissima*. Additional grasses include *Pleuraphis jamesii, Bromus tectorum*, and *Bouteloua gracilis* – ***Krascheninnikovia lanata / Hesperostipa comata*** **Dwarf-shrubland**





81b *Krascheninnikovia lanata* dwarf-shrublands with *Sporobolus cryptandrus* dominant in the understory. Associated shrubs include *Atriplex canescens* and *Opuntia polyacantha*.The herbaceous layer may include *Achnatherum hymenoides, Poa fendleriana, Bromus tectorum*, and *Gaillardia pinnatifida* – ***Krascheninnikovia lanata / Sporobolus cryptandrus*** **Dwarf-shrubland [Park Special]**

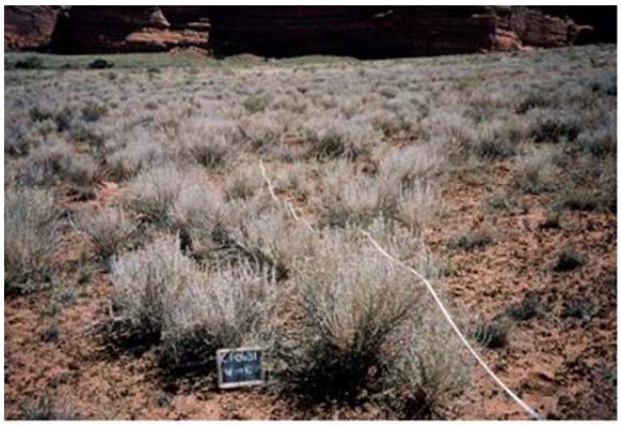



82a (80) *Kraschenninnikovia lanata* dwarf-shrublands with *Pleuraphis jamesii* dominating the understory. Associated shrubs include *Atriplex canescens, Ephedra* spp., and *Opuntia polyacantha*. *Achnatherum hymenoides, Sporobolus cryptandrus*, and *Hesperostipa comata* provide sparse cover – ***Kraschenninnikovia lanata / Pleuraphis jamesii*** **Dwarf-shrubland**




82b *Kraschenninnikovia lanata* dwarf-shrublands with a variable understory. Associated shrubs include *Atriplex canescens* and *Opuntia polyacantha* that provide sparse cover. The herbaceous layer is moderately diverse but provides little cover or is dominated by exotic species. *Hesperostipa comata* and *Achnatherum hymenoides* occur with low cover in most stands – ***Kraschenninnikovia lanata*** **Dwarf-shrubland**





83a (78) Sparse dwarf-shrublands of disturbed sites, dominated by *Gutierrezia sarothrae* and *Opuntia erinacea*. *Pleuraphis jamesii* provides a sparse understory. *Atriplex canescens* may occur with sparse cover. Associated grasses include *Achnatherum hymenoides* and *Aristida purpurea* – ***Gutierrezia sarothrae – (Opuntia spp.) / Pleuraphis jamesii*** **Dwarf-shrubland**





83b Sparse dwarf-shrublands dominated by *Atriplex gardneri* or species of *Opuntia* **(84)**

84a (83) Sparse dwarf-shrublands on floodplain terraces, alluvial fans, and badlands, dominated by *Opuntia erinacea, Opuntia phaeacantha*, and/or *Opuntia polyacantha* **(85)**

84b Sparse dwarf-shrublands dominated by *Atriplex gardneri* with or without *Pleuraphis jamesii* or *Sporobolus airoides* **(86)**

85a (84) Patchy *Opuntia polyacantha* stands on alluvial fans or stream terraces, with *Pleuraphis jamesii* growing in the openings between cactus clumps. Associated shrubs include *Atriplex canescens, Atriplex confertifolia,* and *Ephedra torreyana*. Associated

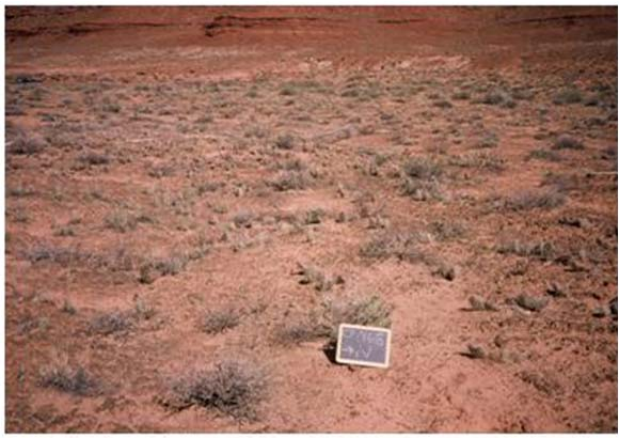
grasses include *Hesperostipa comata* and *Achnatherum hymenoides* – ***Opuntia polyacantha / Pleuraphis jamesii*** **Shrubland**





85b Stands of *Opuntia phaeacantha* or *Opuntia erinacea,* occurring on floodplains and badlands, usually with a sparse understory. Other shrubs present may include *Atriplex canescens, Atriplex confertifolia,* and *Ephedra torreyana* – ***Opuntia*** **spp. Shrubland Alliance**





86a (84) Dwarf-shrublands on alkaline sites or steep talus slopes, dominated by *Atriplex gardneri* with a sparse understory containing no diagnostic species – ***Atriplex gardneri*** **Dwarf-shrubland**





86b Dwarf-shrublands characterized by *Atriplex gardneri* with an understory of sparse *Pleuraphis jamesii* or *Sporobolus airoides* and occurring on colluvial slopes, canyon rims, or wash terraces **(87)**

87a (86) *Atriplex gardneri* stands on colluvial slopes or on drainages near canyon rims, with an understory of *Pleuraphis jamesii*; total cover does not exceed 10%. Other species present with trace cover include *Atriplex confertifolia, Ephedra torreyana, Ericameria nauseosa, Xylorhiza tortifolia,* and *Achnatherum hymenoides* – ***Atriplex gardneri / Pleuraphis jamesii*** **Dwarf-shrubland**





87b *Atriplex gardneri* stands on sandy, alkaline wash terraces, with an understory of *Sporobolus airoides*; total cover may not exceed 10%. Other species present with trace cover include *Ericameria nauseosa, Atriplex confertifolia,* and *Pleuraphis jamesii* – ***Atriplex gardneri / Sporobolus airoides*** **Dwarf-shrubland [Park Special]**



Additional shrubland/dwarf shrubland vegetation types documented in the Park:

Artemisia tridentata ssp. *wyomingensis / Pleuraphis jamesii* Shrubland
Atriplex canescens / Achnatherum hymenoides Shrubland
Atriplex canescens / Hesperostipa comata Shrubland
Atriplex canescens / Sporobolus contractus - Muhlenbergia pungens Shrub Herbaceous Vegetation
Atriplex canescens / Sporobolus flexuosus Shrubland
Atriplex confertifolia / Bromus tectorum Sparse Vegetation
Atriplex gardneri / Achnatherum hymenoides Dwarf-shrubland
Coleogyne ramosissima - Artemisia filifolia / Muhlenbergia pungens Shrub-Herbaceous Vegetation
Coleogyne ramosissima - Ephedra torreyana Shrubland
Coleogyne ramosissima / Achnatherum hymenoides Shrubland
Coleogyne ramosissima / Krascheninnikovia lanata Shrubland
Eriogonum leptocladon / Muhlenbergia pungens Dwarf-shrubland
Fendlera rupicola Talus Shrubland
Gutierrezia (microcephala, sarothrae) Dwarf-shrubland Alliance
Gutierrezia sarothrae / Hesperostipa comata Shrubland
Lycium torreyi Shrubland
Poliomintha incana / Muhlenbergia pungens Shrubland
Purshia (stansburiana, mexicana) Shrubland Alliance
Purshia mexicana / Chrysothamnus nauseosus Shrubland
Rosa woodsii Shrubland

Key IV: A Key to the Herbaceous and Shrub Herbaceous vegetation Associations of Canyonlands National Park

1a Herbaceous vegetation of mesic sites, including wetlands, swales, playas, drainages, floodplain terraces, seeps, and springs; characteristic genera include *Agrostis, Aquilegia, Distichlis, Calamagrostis, Iva, Juncus, Lolium, Mimulus, Pascopyrum, Phragmites, Poa,* and/or *Typha* **(2)**

1b Herbaceous vegetation occupying xeric and upland sites, including mesas, slopes ridges, hills, benches, alluvial fans, or dry upper floodplain terraces; community not controlled by water table or surface flow of water; characteristic genera include *Achnatherum, Artemisia, Bouteloua, Bromus, Hesperostipa, Hymenopappus, Leymus, Oenothera, Pleuraphis, Poa, Salsola, Sphaeralcea, Sporobolus*, or *Achnatherum* **(12)**

Riparian Herbaceous Vegetation

2a (1) Wetland or riparian forb communities characterized by species of *Aquilegia, Iva,* or *Mimulus*; occurring in hanging gardens, in bedrock seeps, and/or on the banks of perennial streams **(3)**

2b Wetland or riparian graminoid communities on saturated or inundated soils and characterized by species of *Agrostis, Calamagrostis, Juncus, Lolium, Pascopyrum, Phragmites, Poa,* and/or *Typha* **(5)**

3a (2) *Iva acerosa* stands occurring in linear bands along drainage banks and on first terraces of intermittently flooded washes. Associated herbaceous species include *Distichlis spicata, Achnatherum hymenoides, Calamagrostis scopulorum, Sporobolus airoides, Glycyrrhiza lepidota*, and *Heterotheca villosa*. Scattered *Populus fremontii, Salix exigua, Salix eriocephala*, and *Tamarix chinensis* may be present, as well as the occasional upland shrub species – ***Iva acerosa* Herbaceous Vegetation [Park Special]**





3b Wetland or riparian forb communities characterized by species of *Aquilegia* or *Mimulus*; occurring in hanging gardens, in bedrock seeps, and/or on the banks of perennial streams **(4)**

4a (3) Hanging gardens dominated by *Aquilegia micrantha* and/or *Mimulus eastwoodiae*; stands occur in seeps and springs where groundwater emerges at the zone of contact with an impervious geologic layer. A variety of other species may be present, depending on stand size, exposure, and hydrology; shrubs may provide low cover relative to herbaceous species – ***Aquilegia micrantha - Mimulus eastwoodiae*** **Herbaceous Vegetation**





4b Hanging gardens dominated by *Aquilegia micrantha*; stands occur in alcoves where perennial seeps emerge from cracks or joints in bedrock walls. A variety of other species may be present, depending on stand size, exposure, and hydrology; shrubs may provide low cover relative to herbaceous species; however, no other species contributes enough cover to be codominant with *Aquilegia micrantha* – ***Aquilegia micrantha*** **Herbaceous Vegetation**





5a (2) Wetland plant communities occurring on saturated terraces, stream banks, or in depressions and characterized by *Juncus balticus* or *Typha domingensis* **(6)**

5b Wetland or riparian plant communities occurring on saturated terraces, stream banks, swales, playas, depressions, or in riparian habitats and characterized by species of *Agrostis, Calamagrostis, Lolium, Pascopyrum, Phragmites*, and/or *Poa* **(7)**

6a (5) *Juncus balticus* dominant or codominant with *Agrostis stolonifera*; forming dense stands on saturated soils. *Agrostis stolonifera* is often present to codominant; *Bromus inermis, Carex nebrascensis*, and *Muhlenbergia andina* are less frequent – ***Juncus balticus* Herbaceous Vegetation**



6b *Typha domingensis* stands on saturated soils in wash bottoms. Additional herbaceous species present include *Elymus canadensis, Equisetum* spp., *Phragmites australis, Juncus balticus, Muhlenbergia asperifolia, Bromus tectorum, Xanthium strumarium, Iva acerosa*, and *Artemisia campestris*. Scattered *Populus fremontii* and *Salix exigua* provide sparse cover along the margins of the community – ***Typha domingensis* Western Herbaceous Vegetation**





7a (5) Wetland stands dominated by a near-monoculture of *Phragmites australis*, associated with seeps and springs – ***Phragmites australis* Western North America Temperate Semi-natural Herbaceous Vegetation**





7b Wetland stands occurring on mesic, not saturated, sites and dominated by *Agrostis stolonifera*, *Calamagrostis scopulorum, Distichlis spicata, Lolium arundinaceum, Pascopyrum smithii,* and/or *Poa pratensis* **(8)**

8a (7) Wetland or riparian communities dominated by *Poa pratensis,* usually occurring on saturated soils in drainages. Other graminoids provide sparse cover, including *Elymus trachycaulus, Juncus balticus*, and *Carex* sp. *Rosa woodsii* provides sparse cover – ***Poa pratensis* Semi-natural Seasonally Flooded Herbaceous Vegetation**



8b Mesic or riparian communities dominated by *Agrostis stolonifera, Distichlis spicata, Calamagrostis scopulorum,* and/or *Lolium arundinaceum*; occurring on seeps and floodplain terraces with a high water table **(9)**

9a (8) Communities of playas, swales, floodplains, and terraces along washes dominated by *Distichlis spicata* - ***Distichlis spicata*** **Herbaceous Vegetation**





9b Communities dominated by *Lolium arundinaceum, Agrostis stolonifera,* or *Calamagrostis scopulorum* (**10)**

10a (9) Diverse wetland communities on seeps and wash banks and dominated by *Calamagrostis scopulorum. Phragmites australis* may codominant some stands – ***Calamagrostis scopulorum*** **Hanging Garden Herbaceous Vegetation**





10b Communities dominated by *Lolium arundinaceum* or *Agrostis stolonifera* (**11)**

11a (10) Communities occupying the channel of intermittent washes and other disturbed mesic places; the vegetation is dominated by *Lolium arundinaceum* and *Agrostis stolonifera.* Minor components include *Juncus balticus, Equisetum laevigatum, Asclepias speciosa*, and *Solidago canadensis*. *Salix lutea* may be present with sparse cover - ***Lolium arundinaceum – Agrostis stolonifera*** **Semi-natural Herbaceous Vegetation [Park Special]**



11b Communities occupying the channel of intermittent washes; the vegetation is dominated by *Agrostis stolonifera.* Minor components include *Equisetum laevigatum* and *Adiantum capillus-veneris* - ***Agrostis stolonifera*** **Seasonally Flooded Herbaceous Alliance**



Xeric/Upland Herbaceous Vegetation

12a (1) Xeric grassland and shrub herbaceous communities of uplands and upper stream terraces; characteristic genera include *Achnatherum, Bouteloua, Bromus, Hesperostipa, Leymus, Pleuraphis, Poa, Sporobolus, Krascheninnikovia* and *Sarcobatus* **(13)**

12b Xeric forb communities, typically occupying disturbed upland sites including floodplain terraces; characteristic genera include *Artemisia, Hymenopappus, Oenothera, Rumex,* and *Salsola* **(25)**

13a (12) Annual grasslands of heavily disturbed, generally level sites, dominated by *Bromus tectorum.* Scattered relict native grasses, forbs, and shrubs may be present – ***Bromus tectorum*** **Semi-natural Herbaceous Vegetation**





13b Perennial grasslands and shrub herbaceous communities dominated by species of *Achnatherum, Bouteloua, Hesperostipa, Leymus, Pleuraphis, Poa,* or *Sporobolus*, or the shrubs *Krascheninnikovia* or *Sarcobatus* **(14)**

14a (13) Grasslands dominated by *Bouteloua gracilis,* with or without *Krascheninnikovia lanata* codominant in a shrub herbaceous community **(15)**

14b Grasslands and shrub herbaceous communities dominated by species of *Achnatherum, Hesperostipa, Leymus, Pleuraphis, Poa,* or *Sporobolus*, or the shrubs *Ephedra viridis* or *Sarcobatus vermiculatus* **(16)**

15a (14) Sparse grasslands on level to rolling terrain dominated by *Bouteloua gracilis*. Stands occur primarily in the environs. A few scattered shrubs of *Gutierrezia sarothrae, Opuntia erinacea*, and *Krascheninnikovia lanata* are often present. Associated grass species can include traces of *Achnatherum hymenoides* and *Pleuraphis jamesii* – ***Bouteloua gracilis*** **Herbaceous Vegetation**



15b Shrub herbaceous communities dominated by *Krascheninnikovia lanata* and *Bouteloua gracilis.* Most examples are in The Grabens. Associated herbaceous species include *Achnatherum hymenoides, Hesperostipa comata, Sporobolus cryptandrus, Bromus tectorum, Sphaeralcea coccinea, Helianthus petiolaris,* and *Mentzelia albicaulis*. – ***Krascheninnikovia lanata / Bouteloua gracilis*** **Dwarf-shrub Herbaceous Vegetation**





16a (14) Grasslands dominated by *Pleuraphis jamesii* or *Poa fendleriana; Sarcobatus vermiculatus* may be present with sparse to low cover **(17)**

16b Sites dominated by species of *Achnatherum, Hesperostipa, Leymus,* or *Sporobolus* **(20)**

17a (16) Rare grasslands dominated by *Poa fendleriana.* Associated grasses include *Festuca octoflora, Bromus tectorum*, and *Achnatherum hymenoides*. Scattered shrubs may include *Fraxinus anomala, Mahonia fremontii, Krascheninnikovia lanata,* and *Artemisia frigida* – ***Poa fendleriana*** **Herbaceous Vegetation**



17b Grasslands and shrub herbaceous communities dominated by *Pleuraphis jamesii,* sometimes codominant with *Sporobolus airoides*, *Sarcobatus vermiculatus,* or *Atriplex canescens* **(18)**

18a (17) Shrub herbaceous communities characterized by up to 5% cover of *Sarcobatus vermiculatus* and up to 20% cover of *Pleuraphis jamesii* – ***Sarcobatus vermiculatus / Pleuraphis jamesii*** **Shrub Herbaceous Vegetation [Park Special]**





18b Grassland communities dominated by *Pleuraphis jamesii*, some stands may be co-dominated by *Sporobolus airoides* **(19)**

19a (18) Grasslands on benches, valley bottoms, and stream terraces, dominated by a combination of *Pleuraphis jamesii* and *Sporobolus airoides.* Associated grasses include *Achnatherum hymenoides, Hesperostipa comata*, and *Bouteloua gracilis*. *Bromus tectorum* may be present. Shrubs provide sparse cover and include *Ericameria nauseosa, Ephedra torreyana, Krascheninnikovia lanata,* and *Coleogyne ramosissima* – ***Pleuraphis jamesii – Sporobolus airoides*** **Herbaceous Vegetation**

No photo available

19b Grasslands dominated by *Pleuraphis jamesii*. Associated grasses include *Bromus tectorum*, *Achnatherum hymenoides,* and *Sporobolus airoides*. Scattered shrubs are often present and may include *Atriplex canescens, Krascheninnikovia lanata, Ephedra torreyana,* and *Atriplex confertifolia* – ***Pleuraphis jamesii*** **Herbaceous Vegetation**





20a (16) Grasslands visually dominated by *Leymus salinus* and usually occurring on steep, north-facing colluvial slopes with shale-derived soils. Shrubs are generally present and may have almost as much cover as the grasses. Common species include *Fendlera rupicola, Fraxinus anomala, Ephedra viridis, Atriplex confertifolia, Ericameria nauseosa, Chrysothamnus viscidiflorus, Artemisia bigelovii, Ephedra torreyana,* and *Xylorhiza tortifolia* – ***Leymus salinus*** **Shale Sparse Vegetation**





20b Grasslands dominated by species of *Achnatherum, Hesperostipa*, or *Sporobolus*; occurring in a variety of habitats **(21)**

21a (20) Sparse grasslands on colluvial slopes, dominated by *Achnatherum speciosum;* with up to 5% cover by *Ephedra viridis*. Other shrubs and grasses present may include

Krascheninnikovia lanata, Artemisia bigelovii, *Atriplex canescens Pleuraphis jamesii, Muhlenbergia porteri,* and *Sporobolus cryptandrus* – ***Achnatherum speciosum*** **Herbaceous Vegetation**



21b Grasslands dominated by *Achnatherum hymenoides, Hesperostipa comata, Sporobolus cryptandrus*, or *Sporobolus airoides* **(22)**

22a (21) Grasslands dominated by *Achnatherum hymenoides* or *Hesperostipa comata,* usually occurring in sandy habitats **(23)**

22b Grasslands dominated by *Sporobolus airoides* or *Sporobolus cryptandrus*, occurring on floodplains and valley floors **(24)**

23a (22) Grasslands on valley floors and slopes, dominated by *Hesperostipa comata.* In some stands, *Pleuraphis jamesii* or *Achnatherum hymenoides* may have significant cover. A variety of shrubs are generally present with low cover – ***Hesperostipa comata*** **Great Basin Herbaceous Vegetation**





23b Sandy plains, dunes, stream terraces, and valley floors dominated by *Achnatherum hymenoides; Hesperostipa comata* is absent or has very low cover. Stands on unstable dunes may be very sparse. Shrubs may be present, but contribute little cover – ***Achnatherum hymenoides* Colorado Plateau Herbaceous Vegetation**





24a (22) Grasslands dominated by *Sporobolus cryptandrus.* The remaining herbaceous layer can be weedy and includes *Bromus tectorum, Salsola tragus, Rumex hymenosepalus, Asclepias subverticillata, Lepidium latifolium, Erodium cicutarium, Sphaeralcea parvifolia, Mentzelia multiflora*, and *Plantago patagonica*. Scattered shrubs may include *Atriplex canescens, Krascheninnikovia lanata*, and *Gutierrezia sarothrae* – ***Sporobolus cryptandrus* Great Basin Herbaceous Vegetation**





24b Grasslands on mesic, sandy bottomland sites dominated by *Sporobolus airoides.* Scattered shrubs may include *Atriplex confertifolia, Sarcobatus vermiculatus, Ericameria nauseosa, Ephedra torreyana, Atriplex canescens, Suaeda torreyana,* and *Atriplex gardneri*. Other herbaceous species present include *Phragmites australis, Juncus balticus, Pleuraphis jamesii, Iva acerosa,* and *Salsola tragus* – ***Sporobolus airoides* Southern Plains Herbaceous Vegetation**





25a (12) Forb communities on disturbed upper stream terraces dominated by *Artemisia campestris*. Other forb species contribute little cover to the community and may include *Oenothera pallida, Heterotheca villosa, Penstemon comarrhenus, Silene antirrhina,* and *Solidago canadensis* – ***Artemisia campestris*** **Stream Terrace Herbaceous Vegetation [Park Special]**

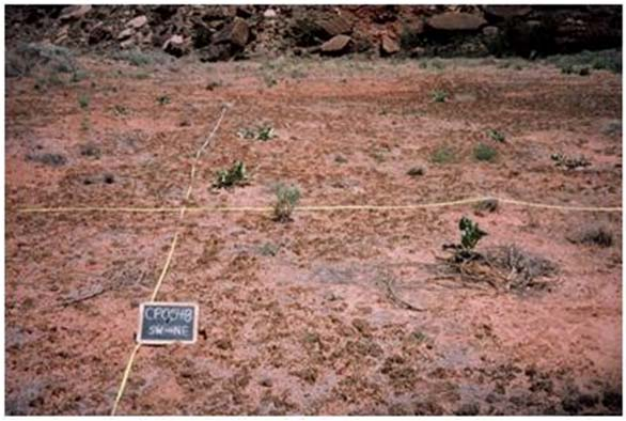


25b Forb communities dominated by species of *Hymenopappus, Oenothera, Rumex, Salsola,* or *Sphaeralcea* and occurring on a variety of sandy habitats including floodplain terraces **(26)**

26a (25) Stabilized sand dunes and sandy canyon floors supporting small stands of *Hymenopappus filifolius, Oenothera albicaulis, Oenothera pallida,* or *Rumex hymenosepalus* **(27)**

26b Sandy habitats ranging from canyon bottoms and flats to active sand dunes, supporting communities dominated by *Salsola* spp. or *Sphaeralcea* spp. **(30)**

27a (26) Sparsely vegetated stabilized sand dunes supporting little except *Rumex hymenosepalus*; total stand cover may be < 1%– ***Rumex hymenosepalus*** **Sparse Vegetation [Park Special]**





27b Sandy habitats, including dunes, supporting communities dominated by *Hymenopappus filifolius, Oenothera albicaulis*, or *Oenothera pallida*; total vegetation cover usually > 1% **(28)**

28a (27) Sand dunes supporting *Hymenopappus filifolius* communities. Associated herbaceous species include *Hesperostipa comata, Sporobolus airoides, Achnatherum hymenoides, Bromus tectorum, Comandra umbellata, Oenothera pallida, Sphaeralcea* spp., and *Salsola tragus*. Scattered shrubs may include *Ericameria nauseosa, Ephedra viridis, Artemisia frigida,* and *Atriplex canescens* - ***Hymenopappus filifolius*** **Herbaceous Vegetation [Park Special]**





28b Sandy habitats on plateaus and canyon floors supporting *Oenothera albicaulis* or *Oenothera pallida* **(29)**

29a (28) Stabilized dune habitats supporting *Oenothera albicaulis* stands. Associated forbs are those typical of sand sheets, including *Plantago patagonica, Abronia fragrans, Sphaeralcea coccinea*, and *Helianthus annuus*. Grasses include *Hesperostipa comata, Bouteloua gracilis*, and *Achnatherum hymenoides*. Scattered shrubs include *Atriplex canescens, Ephedra viridis*, and *Opuntia erinacea* – ***Oenothera albicaulis* Herbaceous Vegetation [Park Special]**



29b Sandy habitats on canyon floors supporting *Oenothera pallida* stands. Associated forbs include *Sphaeralcea coccinea, Hymenopappus filifolius*, and *Plantago patagonica*. Graminoids include *Hesperostipa comata, Achnatherum hymenoides*, and *Poa fendleriana*. *Atriplex canescens* is the only shrub present – ***Oenothera pallida* Herbaceous Vegetation [Park Special]**





30a (26) Perennial forb communities dominated by *Sphaeralcea coccinea* and/or *Sphaeralcea parvifolia*; occurring on sandy benches, plains, and canyon bottoms. Scattered shrubs are generally present – ***Sphaeralcea (coccinea, parvifolia)* Herbaceous Vegetation**





30b Sparse to dense forb communities of *Salsola tragus*; occurring on active sand dunes, floodplain terraces, and canyon bottoms. Scattered native shrubs may be present, including *Atriplex canescens, Atriplex confertifolia, Ephedra torreyana, Krascheninnikovia lanata,* or *Ericameria nauseosa.* A variety of other sand-loving forbs and grasses are generally present – ***Salsola* spp. Semi-natural Herbaceous Vegetation**





Additional herbaceous vegetation types documented in the Park:
Agrostis stolonifera - Elymus trachycaulus Semi-natural Herbaceous Vegetation
Agrostis stolonifera - Panicum virgatum Semi-natural Herbaceous Vegetation
Caesalpinia repens Herbaceous Vegetation
Calamagrostis canadensis - Oxytenia acerosa - phragmites australis Herbaceous Vegetation
Eleocharis palustris Herbaceous Vegetation
Festuca arundinacea - Solidago canadensis - Agrostis stolonifera Riparian Herbaceous Vegetation
Halogeton glomeratus Sparse Vegetation
Hesperostipa comata - Achnatherum hymenoides Herbaceous Vegetation
Iva acerosa - Chrysopsis villosa Herbaceous Vegetation
Kochia sp. Herbaceous Vegetation
Muhlenbergia asperifolia Herbaceous Vegetation
Muhlenbergia pungens Herbaceous Vegetation
Petrophyton caespitosum Seep Herbaceous Vegetation
Sporobolus contractus Herbaceous Vegetation

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Appendix H. Modified Anderson Land Use/Land Cover Classification

This classification was used as the primary attribute for areas of developed land within and around Bryce Canyon National Park. Every polygon was assigned an Anderson Land Use or Land Cover code in addition to its vegetation attributes.

Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
1.0 Water	1.1 Open Water	1.11 Stream/river			
		1.12 Canal/ditch	1.121 Lined canal/ditch		
			1.122 Unlined canal/ditch		
		1.13 Lake/pond			
		1.14 Reservoir			
		1.15 Bay/estuary			
		1.16 Sea/ocean			
	1.2 Perennial Ice/Snow	1.21 Snowfield			
		1.22 Glacier			
2.0 Developed	2.1 Residential	2.11 Single-family residential			
		2.12 Multi-family residential			
	2.2 Non-residential Developed	2.21 Commercial/Light Industry	2.211 Major Retail		
			2.212 Mixed/Minor Retail and Services		
			2.213 Office		
			2.214 Light industry		
		2.22 Heavy Industry	2.221 Petro-chemical Refinery		
		2.23 Communications and Utilities			
		2.24 Institutional	2.241 Schools		
			2.242 Cemeteries		
		2.25 Agricultural Business	2.251 Aquiculture		
			2.252 Confined feeding		
		2.26 Transportation	2.261 Airport		
		2.27 Entertainment/ Recreation	2.271 Golf Course		
			2.272 Urban Parks		
	2.3 Mixed Urban				
3.0 Bare	3.1 Transitional				
	3.2 Quarries/Strip mines/Gravel pits				
	3.3 Bare Rock/Sand				

Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
	3.4 Flats				
	3.5 Disposal				
4.0 Vegetated	4.1 Woody	4.11 Forested	4.111 Deciduous		
			4.112 Evergreen		
			4.113 Mixed		
		4.12 Shrub land	4.121 Deciduous		
			4.122 Evergreen		
			4.123 Mixed		
			4.124 Desert scrub		
		4.13 Orchards/vineyards/ groves	4.131 Irrigated Orchard/ vineyards/groves		
			4.132 Citrus		
			4.133 Non-managed Citrus		
		4.14 Mixed Forest/Shrub			
	4.2 Herbaceous	4.21 Natural Herbaceous	4.211 Natural Grassland		
		4.22 Planted/cultivated	4.221 Fallow/Bare Fields		
			4.222 Small Grains	4.2221 Irrigated small grains	
			4.223 Row Crops	4.2231 Irrigated row crops	
				4.2232 Sugar Cane	
			4.224 Planted grasses	4.2241 Pasture/ hay	4.22411 Irrigated Pasture/hay
				4.2242 Other grass	4.22421 Irrigated Other grass
			4.225 Irrigated Planted/ cultivated		
	4.3 Wetlands	4.31 Woody wetlands			
		4.32 Emergent wetlands			

Classification Definitions

1.0 WATER - area covered by water, snow, or ice with less than 25% vegetated or developed cover, unless specifically included in another category.

1.1 Open Water - all areas of open water with less than 25% vegetative or developed cover

1.11 Stream/river - a natural body of flowing water. Includes streams and rivers that

have been channelized in order to control flooding or erosion or to maintain flow for navigation.

1.12 Canal/ditch - a man-made open waterway constructed to transport water, to irrigate or drain land, to connect two or more bodies of water, or to serve as a waterway for watercraft. Collection should include the right of ways and associated dikes and levees.

1.121 Lined canal/ditch - a canal or ditch lined with concrete or other impervious material preventing passage of water into underlying strata.

1.122 Unlined canal/ditch - a canal or ditch constructed with dirt or other porous material allowing water to drain.

1.13 Lake/pond - a non-flowing, naturally-existing, body of water. Includes water impounded by natural occurrences and artificially regulated natural lakes. The delineation of a lake is based on the areal extent of water at the time the imagery was acquired.

1.14 Reservoir - any artificial body of water, unless specifically included in another category. It can lie in a natural basin or a man-constructed basin. The delineation of a reservoir is based on the areal extent of water at the time the imagery was acquired. (The water control structures are classified as Communications/Utilities).

2.0 DEVELOPED - Areas of the earth that have been improved by man. Includes all "built-up" and urban areas of the landscape. Does NOT include mining lands, croplands, or waste-disposal areas (dumps). This land use category takes precedence over a land cover category when the criteria for more than one category are met.

2.1 Residential - lands containing structures used for human habitation

2.11 Single-family Residential - Lands used for housing residents in single-family dwelling units. Includes trailer parks, mobile home parks, and entire "farmsteads" when there is a home in the complex. (If no home is in the complex, it should be classified as Agricultural Business.) Single-family residential buildings located within another category, such as military family housing, should be identified in this category.

2.12 Multi-family Residential - All lands devoted to housing more than one family on a permanent or semi-permanent basis, group living situations, and their associated grounds. Includes apartments, apartment complexes, duplexes, triplexes, attached row houses, condominiums, retirement homes, nursing homes, and residential hotels. Residential buildings located within another category, such as barracks and dormitories, should be identified in this category when possible, (except residential buildings within convents and monasteries - include these with Institutional).

2.2 Non-residential Developed - Any "developed" area or feature that is used for a purpose other than habitation.

2.21 Commercial/Light Industry - structures and associated grounds used for the sale of products and services, for business, or for light industrial activities. Includes all retail and wholesale operations. Include "industrial parks" and other features that cannot be clearly classified as either a retail service or light industry, such as heavy equipment yards, machinery repair, and junkyards.

2.211 Major Retail - This category includes shopping malls, retail "outlet centers," and "superstores" that draw clientele from a regional area. Major retail centers consist of extremely large single buildings or a complex of large buildings and their

parking lots. Malls usually house one or two major department stores and numerous small retail stores. Includes outlet centers, "superstores", multi-plex movie theaters, and huge warehouse-type stores. The structures themselves are often several acres in size and have extensive parking lots.

2.212 Mixed/Minor Retail and Services - Includes individual stores and services of various sizes and associated grounds and parking. Includes neighborhood strip malls and shopping centers, veterinarian services, small movie theaters, gas stations and auto repair shops, garden centers, motels, small auto dealerships, public parking lots, lumber yards, art galleries, farm supply stores, flea-markets, bars and restaurants, grocery stores, and commercial "truck stops". Many small office buildings will have no features to distinguish them from retail stores and will fall in this category.

2.213 Office - structures and their associated grounds and parking, that provide financial, professional, administrative, and informational type services. Includes administrative government offices (e.g., IRS and State Motor Vehicles offices) trade schools, professional medical office complexes, research facilities/centers, and banks. Usually only office buildings in office complexes or in downtown areas will be distinguishable as offices. Small, single-story office buildings may blend in with minor retail.

2.214 Light industry - structures and their associated grounds and facilities that are used primarily to produce or process some finished product; or as a wholesale distribution center. Activities include design, assembly, finishing, packaging, warehousing or shipping of products rather than processing raw materials. The materials used in light industry have generally been processed at least once. They are generally "clean" industries that do not produce lots of waste materials. Use this category as a default for those facilities with semi-truck and trailer activity around loading docks, but that cannot be classified as either retail services or heavy industry. Includes electronic firms, clothing and furniture manufacture, grain elevators, printing plants, commercial bakeries, shipping and distribution centers, sand/gravel sorting facilities, secondary buildings associated with a mining or quarrying site, and generic warehouses.

2.22 Heavy Industry - structures and their associated grounds used for heavy fabrication, manufacturing and assembling parts that are, in themselves, large and heavy; or for processing raw materials such as iron ore, timber, and animal products. Accumulated raw materials are subject to treatment by mechanical, chemical, or heat processing to render them suitable for further processing, or to produce materials from that finished products are created. Heavy industries generally require large amounts of energy and raw materials and produce a significant amount of waste products. Indicators of heavy industry may be stockpiles of raw materials, energy producing sources and fuels, waste disposal areas and ponds, transportation facilities capable of handling heavy materials, smokestacks, furnaces, tanks, and extremely large buildings that are complex in outline and roof structure. Include associated waste piles and waste ponds. Heavy industry is usually located away from residential areas. Includes steel mills, paper mills, lumber mills, cotton gins, chemical plants, cement and brick plants, smelters, rock crushing machinery, and ore-processing facilities associated with mining.

2.23 Communications and Utilities - structures or facilities and associated grounds

used for the generation of power and communications, the treatment or storage of drinking water, waste management, flood control, or the distribution and storage of gas and oil not associated with a unique feature. Includes pumping stations (oil, gas, or water), tank farms, power plants, electric substations, sewage treatment facilities and ponds, garbage collection facilities (not the final dumping ground - these are included in Bare), dams, levees, and spillways of appropriate dimensions, filtration plants, and heavy concentrations of antennas or satellite dishes; along with the related operational buildings.

2.24 Institutional - specialized government or private features that meet the educational, religious, medical, governmental, protective, and correctional needs of the public. Parking lots and associated grounds are included with these features. Includes public and private schools (not day care), state capitols, city halls, courthouses, libraries, churches, convents, monasteries, hospitals and training hospitals, post offices, police and fire departments, prisons, and military bases. Only the military-business areas of a military base are classified here; residential, airport, athletic fields, and vegetated areas are classified in the appropriate category.

2.241 Schools/Universities - public and private schools, seminaries, university campuses, and associated lands. Include the entire "core campus" area, along with athletic fields and vegetated areas. This category does not include day care centers or commercial trade schools, both of that are commercial uses.

2.242 Cemeteries - structures and lands devoted to burial of the dead. Includes mausoleums, service areas, and parking lots.

2.25 Agricultural Business - structures and all associated grounds used for raising plants or animals for food or fiber. Includes fish farms and hatcheries, feedlots, poultry farms, dairy farms, temporary shipping and holding pens, animal breeding or training facilities, and greenhouses. (Farmsteads including a dwelling are classified as residential, not agricultural business.)

2.251 Aquiculture site - a set of pools of water and related structures used for producing fish, shellfish, or aquatic plants.

2.252 Confined feeding operation - structures and associated pens, storage facilities, waste areas, and ponds that are used for raising meat and dairy cattle, hogs, poultry, or other animals. These features must have a relatively permanent and high animal population density. Temporary holding pens and thoroughbred horse farms usually do not qualify.

2.26 Transportation - Roads, railroads, airports, port facilities, and their associated lands. Roads and railroads include the right-of-way, interchanges, and median strips. Category includes railroad stations, railroad yards, bus stations, highway maintenance yards, school bus parking and service yards, and park-and-ride lots. Port facilities include loading and unloading facilities, docks, locks and, temporary storage areas. Associated warehousing and transfer stations for truck or rail are included only if they appear to be an integral part of the airport or port facility. Nearby but separate warehouses will be classified as light industry.

2.27 Entertainment and Recreational - areas and structures used predominantly for athletic or artistic events, or for leisure activities, and all associated lands and developed parking areas. Includes outdoor amphitheaters, drive-in theaters, campgrounds, zoos, sports arenas (including indoor arenas), developed parks and playgrounds, community

recreation centers, museums, amusement parks, public swimming pools, fairgrounds, and ski complexes (not the ski slopes). Marinas with over 25% of water surface covered by docks and boats are included here.

2.271 Golf Course - structures, associated grounds, driving ranges, and interspersed natural areas used for the game of golf.

2.272 Urban Parks - designated open space in urban settings used for outdoor recreation. Include grass fields and associated structures, parking lots, and facilities. Includes city parks, "green-belt" urban parks, and athletic fields not associated with a school. Does not include undeveloped "open space" on the periphery of urban areas or undeveloped regional, state, or national park areas.

2.3 Mixed Urban - developed areas that have such a mixture of residential and non-residential features where no single feature meets the minimum mapping unit specification. This category is used when more than one-third of the features in an area do not fit into a single category. Often applicable in the central, urban-core area of cities.

3.0 BARE - undeveloped areas of the earth not covered by water that exhibit less than 25% vegetative cover or less than 5% vegetative cover if in an arid area. The earth's surface may be composed of bare soil, rock, sand, gravel, salt deposits, or mud.

3.1 Transitional Bare - areas dynamically changing from one land cover/land use to another, often because of land use activities. Includes all construction areas, areas transitioning between forest and agricultural land, and urban renewal areas that are in a state of transition.

3.2 Quarries/Strip Mines/Gravel Pits - areas of extractive mining activities with significant surface disturbance. Vegetative cover and overburden are removed for the extraction of deposits such as coal, iron ore, limestone, copper, sand and gravel, or building and decorative stone. Current mining activity does not need to be identifiable. Inactive or unreclaimed mines and pits are included in this category until another land cover or land use has been established. Includes strip mines, open-pit mines, quarries, borrow pits, oil and gas drilling sites, and gravel pits with their associated structures, waste dumps, and stockpiles.

3.3 Bare Rock/Sand - includes bare bedrock, natural sand beaches, sand bars, deserts, desert pavement, scarps, talus, slides, lava, and glacial debris.

3.4 Flats - A level landform composed of unconsolidated sediments of mud, sand, gravel, or salt deposits. Includes coastal tidal flats and interior desert basin flats and playas.

3.5 Disposal - designated areas where refuse is dumped or exists, such as landfills, trash dumps, or hazardous-waste disposal sites. Reclaimed disposal areas or those covered with vegetation do not qualify.

4.0 VEGETATED - areas having generally 25% or more of the land or water with vegetation. Arid or semi-arid areas may have as little as 5% vegetation cover.

4.1 Woody Vegetation - land with at least 25% tree and (or) shrub canopy cover.

4.11 Forested - land where trees form at least 25% of the canopy cover.

4.111 Deciduous Forest - area dominated by trees where 75% or more of the canopy cover can be determined to be trees that loose all their leaves for a specific season of the year.

4.112 Evergreen Forest - area dominated by trees where 75% or more of the canopy cover can be determined to be trees that maintain their leaves all year.

4.113 Mixed Forest - areas dominated by trees where neither deciduous nor evergreen species represent more than 75% of the canopy cover.

4.12 Shrub land - areas where trees have less than 25% canopy cover and the existing vegetation is dominated by plants that have persistent woody stems, a relatively low growth habit, and that generally produce several basal shoots instead of a single shoot. Includes true shrubs, trees that are small or stunted because of environmental conditions, desert scrub, and chaparral. In the eastern US, include former cropland or pasture lands that are now covered by brush to the extent that they are no longer identifiable or usable as cropland or pasture. Clear-cut areas will exhibit a stage of shrub cover during the regrowth cycle. Some common species that would be classified as shrub land are mountain mahogany, sagebrush, and scrub oaks.

4.121 Deciduous Shrub land - areas where 75% or more of the land cover can be determined to be shrubs that lose all their leaves for a specific season of the year.

4.122 Evergreen Shrub land - areas where 75% or more of the land cover can be determined to be shrubs that keep their leaves year round.

4.123 Mixed Shrub land - areas dominated by shrubs where neither deciduous nor evergreen species represent more than 75% of the land cover.

4.124 Desert Scrub - land areas predominantly in arid and semi-arid portions of the southwestern U.S. Existing vegetation is sparse and often covers only 5-25% of the land. Example species include sagebrush, creosotebush, saltbush, black greasewood, and cactus.

4.13 Planted/Cultivated Woody (Orchards/Vineyards/Groves) - areas containing plantings of evenly spaced trees, shrubs, bushes, or other cultivated climbing plants usually supported and arranged evenly in rows. Includes orchards, groves, vineyards, cranberry bogs, berry vines, and hops. Includes tree plantations planted for the production of fruit, nuts, Christmas tree farms, and commercial tree nurseries. Exclude pine plantations and other lumber or pulp wood plantings that will be classified as Forest.

4.131 Irrigated Planted/Cultivated Woody - orchards, groves, or vineyards where a visible irrigation system is in place to supply water.

4.14 Mixed Forest/Shrub – areas dominated by forest and shrub where neither species represent more than 75% of the canopy cover.

4.2 Herbaceous Vegetation - areas dominated by non-woody plants such as grasses, forbs, ferns and weeds, either native, naturalized, or planted. Trees must account for less than 25% canopy cover while herbaceous plants dominate all existing vegetation.

4.21 Natural Herbaceous - areas dominated by native or naturalized grasses, forbs, ferns and weeds. It can be managed, maintained, or improved for ecological purposes such as weed/brush control or soil erosion. Includes vegetated vacant lots and areas where it cannot be determined whether the vegetation was planted or cultivated such as in areas of dispersed grazing by feral or domesticated animals. Includes landscapes dominated by grass-like plants such as bunch grasses, Palouse grass, palmetto prairie areas, and tundra vegetation, as well as true prairie grasses.

4.211 Natural Grasslands - natural areas dominated by true grasses. Includes undisturbed tall-grass and short-grass prairie in the Great Plains of the U.S.

4.22 Planted/Cultivated Herbaceous - areas of herbaceous vegetation planted and/or cultivated by humans for agronomic purposes in developed settings. The majority of

vegetation in these areas is planted and/or maintained for the production of food, feed, fiber, pasture, or seed. Temporarily flooded are included in this category. Do not include harvested areas of naturally occurring plants such as wild rice and cattails.

4.221 Fallow/Bare Fields - areas within planted or cultivated regions that have been tilled or plowed and do not exhibit any visible vegetation cover.

4.222 Small Grains - areas used for the production of grain crops such as wheat, oats, barley, graham, and rice. Category is difficult to distinguish from cultivated grasses grown for hay and pasture. Indicators of small grains may be a less than 10% slope, annual plowing and seeding, distinctive field patterns and sizes, different timing of green-up and harvest, different harvesting practices, a very "even" texture and tone, or regional variations discovered during field checks.

4.223 Row Crops - areas used for the production of crops or plants such as corn, soybeans, vegetables, tobacco, flowers and cotton. Fields that exhibit characteristics similar to row crops, but that do not have any other distinguishing features for a more specific category may be included.

4.2231 Irrigated Row Crops - areas used for the production of row crops where a visible irrigation system is in place to supply water.

4.224 Cultivated grasses - areas of herbaceous vegetation, including perennial grasses, legumes, or grass-legume mixtures that are planted by humans and used for erosion control, for seed or hay crops, for grazing animals, or for landscaping purposes.

4.2241 Pasture/Hay - areas of cultivated perennial grasses and/or legumes (e.g., alfalfa) used for grazing livestock or for seed or hay crops. Pasturelands can have a wide range of cultivation levels. It can be managed by seeding, fertilizing, application of herbicides, plowing, mowing, or baling. Pastureland has often been cleared of trees and shrubs, is generally on steeper slopes than cropland, is intended to graze animals at a higher density than open rangeland, and is often fenced and divided into smaller parcels than rangeland or cropland. Hay fields may be more mottled than small grain fields as they are not plowed annually and may be harvested and baled two or three times a year in some locations.

4.22411 Irrigated Pasture/Hay - areas used as pasture or hay fields where a visible irrigation system is in place to supply water.

4.2242 Other planted grasses - areas of other cultivated grass such as turf and sod farms.

4.22421 Irrigated other grasses - areas of other cultivated grasses where a visible irrigation system is in place to supply water.

4.225 Irrigated Planted Herbaceous - land that is growing some indistinguishable crop or grass, but is obviously irrigated.

4.3 Vegetated Wetland - areas where the water table is at, near, or above the land surface for a significant part of most years and vegetation indicative of this covers more than 25% of the land surface. Wetlands can include marshes, swamps situated on the shallow margins of bays, lakes, ponds, streams, or reservoirs; wet meadows or perched bogs in high mountain valleys, or seasonally wet or flooded low spots or basins. Do not include agricultural land that is flooded for cultivation purposes.

4.31 Woody Wetland - areas dominated by woody vegetation. Includes seasonally

flooded bottomland, mangrove swamps, shrub swamps, and wooded swamps including those around bogs. Wooded swamps and southern flood plains contain primarily cypress, tupelo, oaks, and red maple. Central and northern flood plains are dominated by cottonwoods, ash, alder, and willow. Flood plains of the Southwest may be dominated by mesquite, saltcedar, seepwillow, and arrowweed. Northern bogs typically contain tamarack or larch, black spruce, and heath shrubs. Shrub swamp vegetation includes alder, willow, and buttonbush.

4.32 Emergent Herbaceous Wetlands - areas dominated by wetland herbaceous vegetation that is present for most of the growing season. Includes fresh-water, brackish-water, and salt-water marshes, tidal marshes, mountain meadows, wet prairies, and bogs.

Appendix I. Accuracy Assessment Analysis Results

Introduction

This index contains the results of the analysis of accuracy assessment field data. Each of the 2,043 accuracy assessment field plots sampled at CANY 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, most of which are out of the photointerpreter's control. These sources of error include:

- Label transcription error by the technician who created the digital mapping database
- 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)
- Transcription error by persons entering AA data into the relational database
- Transcription error by persons creating the AA contingency table
- 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 mis-identifying 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
- The 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
- The photos were 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 is 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, association-map class crosswalk, field key, and in a few 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 CANY vegetation map was 65%. We therefore inspected the original AA plot data, plot photographs, and aerial imagery for approximately 2,043 plots of accuracy assessment field data to create the table that follows. The final step in the process was to present the table in August, 2010 to CANY natural resources staff and ask for their input for solutions we would apply to the final map. In some cases, their preference was different than our recommendation; in every case, we implemented the park's suggestion.

Note: All comment fields written using original map class numbers, so please refer to those numbers instead of the final map class number. Map class numbers in the PLOTS database are the original not the final map class numbers.

Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Map Class Concept	Error Source	Potential Resolution	Park Decision 8/2010
1	1	Tamarisk and Coyote Willow River Corridor Mosaic	Tamarisk (and Coyote Willow) River Corridor Shrubland	Continuous dense stands of tamarisk (sometimes mixed with coyote willow) on the banks of the big rivers.	Undermapped and confused with MC 50	(Try to pull out stands of coyote willow from stands of tamarisk) Retain MC 50 and fix couple large polygons where most of the errors between the two occurred.	yes to suggestion
2	2	Riverine Sandbar Willow and Tamarisk Low Floodplain Shrubland Mosaic	Sandbar Willow Riverine Shrubland	Often linear bands of dense willow along river's edge or dense homogenous stands on islands. These are very transitional vegetation communities and are submerged frequently when river levels are high.	None	Pull out sandbars from willow and map as a geologic class, also pull out willow from tamarisk	yes to suggestion
3	3	Fremont Cottonwood Intermittently Flooded Riverine Woodland Alliance	Fremont Cottonwood Riverine Woodland	Decadent cottonwood gallery forests on the big rivers, mostly on higher terraces, non-reproducing, mostly with upland shrubs or *Tamarix* understories.	Slight confusion with neighboring river map classes	Use AA points for verification to improve some polygons	yes to suggestion
4	4	Gambel Oak Terrace Shrubland	Gambel Oak – Mixed Mesic Shrubs Terrace and Cove Shrubland	Small pockets of oak on high alluvial terraces primarily in tributary drainages. Also included dense thickets of *Quercus havardii* along washes, which is often a hybrid with *Q. gambelii.* Signature is dark green and mappable much below MMU size.	Confused with map classes 7 and 97, but mostly AAed well, though somewhat undersampled	Absorb polygons of MC 97 (save linework) and expand description to include alcoves/pour-over areas that may have other mesic shrubs in the mix (*Rhamnus, Betula, Cornus*, etc.)	Used "c" modifier for cliff/alcove to denote polygons that were originally mapped as MC 97
97	4	Cliff and Alcove Mesic Woodland and Shrubland Complex	Gambel Oak – Mixed Mesic Shrubs Terrace and Cove Shrubland	This map unit is for dark green, dense canopy woodland or in alcoves or near seep/spring headwaters in canyons. Some areas include riparian shrub and herbaceous micro-communities within a woodland matrix.	Overmapped and confused mainly with map classes 95, 4, and 7	Absorb polygons of MC 97 into MC 4 (save linework) and expand description to include alcoves/pour-over areas that may have some of these other mesic shrubs in the mix (add a cl modifier to original 97 polys)	yes to suggestion

Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Map Class Concept	Error Source	Potential Resolution	Park Decision 8/2010
50	5	High Floodplain Riverine Shrubland and Herbaceous Complex	High Floodplain Riverine Desert Olive - Reed Grass Complex	Occurs on the higher floodplain of the Green and Colorado Rivers, usually as a narrow band hugging the inland edge of the dense TAMCHI (and/or SALEXI) thicket along the river corridor. Signature is a brighter green than that of TAMCHI and the height of shrubs is shorter (easily distinguishable with the stereoscope).	Slightly overmapped and confused with map class 1, though most errors were in one poorly labeled large polygon.	What's the management difference between 50 and 1? Is it valuable to the park to have these two teased apart? If so, should remap this type to better capture the signature of *Forestiera*, could use the new imagery to help with the remapping.	Keep separate, especially since most errors were in one polygon, and it's important to know locations of *Forestiera*. Remap to better capture the signature of FORPUB.
6	6	Greasewood Intermittently Flooded Shrubland Alliance	Greasewood Intermittently Flooded Shrubland Complex	Riverine and tributary terraces dominated by robust greasewood shrublands. May be mixed with saltbush or rabbitbrush, but greasewood is always the diagnostic species.	Overmapped on the river corridor and confused with map class18	Should we crosswalk the new name, "ATRCAN/SUATOR" to this map class? That will fix a few of the problems	Keep even if producer's accuracy is a little less than 80%. Add ATRCAN/ SUATOR new name to the crosswalk
18	7	High Terrace (Low Valley Bottom) Shrub Herbaceous Complex	High Terrace (Low Valley Bottom) Shrub Herbaceous Complex	Represents alluvial terraces and canyon bottoms dominated by *Atriplex canescens, Artemisia filifolia,* and/or *Chrysothamnus nauseosus.*	Mostly undermapped but somewhat overmapped as well and confused with map classes 6, 8, 10 , 11, 13	Rabbitbrush confused with big sagebrush. Some confusion with map class 11, but these errors were mostly fixed by going through the points and reassigning map classes where appropriate.	Keep separate and retain with lower accuracy
8	8	Basin Big Sagebrush Shrubland Terrace Complex	Basin Big Sagebrush Terrace Shrubland Complex	Alluvial terraces with a shrubland mix dominated or co-dominated by *Artemisia tridentata (*ssp*. tridentata,* ssp*. xericensis).* These are mostly on the larger stream terraces and broad valleys of the Needles and Maze districts.	None	N/A	N/A
19	9	Wyoming Sagebrush Shrubland	Wyoming Sagebrush Shrubland	Wyoming sagebrush shrublands. Very rare type in the park, mostly the south end of the Needles, and in the environs/mesa tops south of CANY.	Slightly overmapped and confused with map class 11	Issues are mostly due to it being mapped later in the game and so it was found to be more common by field crews and therefore may need some remapping.	Yes to suggestion. Remap in Salt Creek. Accuracy improved significantly by labeling two polys on Ant Mesa as the new park special CHRVIS types.

Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Map Class Concept	Error Source	Potential Resolution	Park Decision 8/2010
10	10	Blackbrush Shrubland	Blackbrush Shrubland	Smooth signature on deeper sand sheets. Low percentage tree cover can be indicated with "t" modifier. Communities often will have some grass. Included open to dense stands with a monoculture of blackbrush.	Slightly undermapped and confused with a variety of other map units	Some remapping needed where COLRAM signature is strong in polys labeled MC 35, 15 or 11.	Remapping improved accuracy enough
11	11	Sand Shinnery Oak - Blackbrush Sandsheet Shrubland Mosaic	Sand Sheet Mixed Shrubland Complex	Signature is moderately bright sand on plateaus and benches, on dunes or micro-undulating sand sheets. Signature has a mottled texture reflecting exposure of sandy soils as well as low mot form of *Ephedra* spp. and/or *Quercus havardii*. Can include scattered *Atriplex canescens* and *Artemisia filifolia* shrubs or shrub patches.	Overmapped and undermapped and confused with map classes 10, 12, 18 and 25. I think the concept was fuzzy and there were issues with dune topography vs. soil stabilization. May be a transitional community.	Issues with MC 10, where it is really a blackbrush shrubland on sand sheets and not a dune with mixed shrubs. Some confusion with MC 25. Maybe MC 25 should just be called MC 11 with a t modifier (depends what park staff want). Some remapping needed to improve accuracy.	Keep separate and retain with lower accuracy. Remapped to pull out stands of MC 10 on sand and relabeled these with a modifier (e for eolian). Pulled out sparse treed dunes (MC 25) as MC 11 with t modifier, not 25.
13	13	Dune Complex	Sand Dune Shrub-Herbaceous Complex	Represents sandy blowouts, especially on aeolian terraces in drainages/canyon bottoms. Bright signature. Eriogonum leptocladon often present in spp. list, not in association name.	Overmapped and confused with 11 or 18 (other sandy soil shrubland map classes). Look at polygons of MC 13 in Horseshoe Canyon.	Combine with MC 11, as a dune complex, but keep linework and separate with a modifier to denote more active sands or more herbaceous cover?	Keep separate and retain with lower accuracy
14	14	Green Mormon Tea - Xeric Grasses Shrub Herbaceous Vegetation Complex	Green Mormon Tea - Xeric Grasses Shrub Herbaceous Vegetation	Mostly found on top of ISKY plateau. Signature is a mosaic of dark mots and herbaceous cover in shades of greenish tan to reddish browns.	None	N/A	N/A

Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Map Class Concept	Error Source	Potential Resolution	Park Decision 8/2010
5	15	Gardner Saltbush Badlands Sparse Vegetation Complex	Shale Barrens Desert Scrub Complex	Barren looking blue-gray to nearly white Chinle badland slopes with sparse *Atriplex gardneri* dominant. Best represented by sites in the uplands near the Green River below Mineral Bottom.	Overmapped and confused with map class 15	Should be combined with MC 15, keep linework, and use a geology modifier to separate them or a modifier to denote presence of *Atriplex gardneri*	Combined with MC 15 but retained linework with a modifier for *Atriplex gardneri* ("f" for MC five)
15	15	Shale Barrens Shrub and Herbaceous Complex	Shale Barrens Desert Scrub Complex	Moenkopi or other shale barrens with sparse cover by *Atriplex sp., Ephedra torreyana,* and *Coleogyne ramosissima.* Usually a mosaic of unvegetated and sparse veg. Signature is mostly that of the underlying substrate (dark red soils).	Undermapped and confused with map classes 5 and 10	Absorb polygons of map class but retain linework and add a modifier to denote presence of *Atriplex gardneri* (5). Remap to fix confusion with MC 10.	Yes to suggestion. Absorbed polygons of map class 5, but retained linework, and did some remapping with new imagery where blackbrush signature was strong.
16	16	Plateau and Benchland Grasslands	Valley Bottom and Benchland Grasslands	Smooth green signature often dotted with shrubs, such as *Atriplex canescens, Krascheninnikovia lanata,* and *Chrysothamnus* sp. (usually <5% cover). Should be dominantly a native grassland, but an "i" modifier can indicate an area being invaded by non-natives and/or annual weedy species. Often has good crypto development.	Overmapped and confused with map class 17. 2002 was an exceptionally dry year and weed cover was therefore low, so undermapping MC 17 makes sense due to the year the imagery was flown.	Combine with map class 17, but retain linework and add degraded modifier and I modifier (heavy historic grazing).	Retain as its own map class but use AA points to fix some problem polygons and change polygons with an "I" modifier to be MC 17.
17	17	Weedy Herbaceous Complex	Weedy Herbaceous Complex	Often weedy, previously grazed grasslands and poorly drained or disturbed areas of canyon bottoms and terraces. Grabens and other valley and drainage bottoms with a dark grey to grayish tan, smooth herbaceous signature. Dominated by annual forbs, BROTEC, and occasionally by *Sporobolus cryptandrus* and/or *Pleuraphis jamesii.*	Slightly undermapped and confused with map class16.	Pull out stands where we know there are homogenous stands of BROTEC or Salsola and call them a park special? Otherwise combine with 16 with modifiers?	Retain as its own map class. See above comment.

Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Map Class Concept	Error Source	Potential Resolution	Park Decision 8/2010
71	18	Winterfat Shrublands and Shrub Herbaceous Complex	Winterfat Dwarf-shrubland	Relatively dense stands of winterfat in swales in valley or canyon bottoms, and more rarely on mesa tops. Usually with a native grass understory and some annual weedy species.	None	N/A	N/A
20	20	Pinyon - Juniper / Blackbrush Woodland	Pinyon - Juniper / Blackbrush Woodland	PJ/COLRAM woodlands on sand sheets or rocky mesa tops. Tree cover should be generally greater than 8-10% and COLRAM cover should be dominant in the understory and exceed 2 -4%.	Both under and overmapped and confused with a variety of other map units, including 10, 12, 15, 25, 33….	Problems with 10-t vs. 20, 25 overmapped where it was really a 20 on sandsheets, some confusion with 33 where higher bedrock cover was not obvious to the photointerpreter.	Some issues remain due to tree density and substrate. Problems with 10-t mostly resolved by adding a second choice of 20.
21	21	Pinyon - Juniper Upland Old Growth Woodland Complex	Pinyon – Juniper High Elevation Mesa Top Woodland	Higher elevation (montane) PJ woodlands occurring mainly in park environs, typical of Salt Creek Mesa and mesa tops in the Orange Cliffs of GLCA. Big tree crowns are diagnostic of this MU and a fairly sparse understory dominated by CERMON, SHEROT, PURSTA, and occasionally *Petradoria pumila.*	Originally confused with map classes 12, 20 and 37, due to issues with the field key.	Fix the field key to explain the concept of this map class better.	Fixed the field key, no other changes needed
22	22	Pinyon - Juniper / Wyoming Sagebrush Woodland	Pinyon - Juniper / Wyoming Sagebrush Woodland	This unit is in the lower montane transition and may be restricted to Glen Canyon areas or the environs. Very rare type in the park, mostly the south end of the Needles, and in the environs/mesa tops south of CANY.	Rare type, but some confusion with 21.	Review these points.	Both errors are in a large polygon on Cedar Mesa that was mostly called MC 21, but had a few points where sagebrush cover was high enough to call it a MC 22. Polygon is mostly correct, so no remapping done.
23	23	[Chained and Seeded Pinyon-Juniper Woodland] Sagebrush Shrubland	[Chained and Seeded Pinyon-Juniper Woodland] Sagebrush Shrubland	PJ woodlands restricted to the environs south of the park boundary on Salt Creek Mesa. These are woodlands that have been chained and seeded to *Agropyron cristatum*. ARTTRIwyo has come in once the tree canopy was removed.	Not AAed, only mapped in the environs.	N/A	N/A

Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Map Class Concept	Error Source	Potential Resolution	Park Decision 8/2010
12	24	Juniper - (Pinyon) / Sparse or Grassy Understory Woodland	Juniper - (Pinyon) / Sparse or Grassy Understory Woodland	Woodlands of canyon bottoms, plateaus, or mesa tops. Tree cover can be low to fairly high, and understory is often sparse (with or without crypto cover), but can be very grassy and have sparse scattered shrubs like ARTTRI, ARTBIG, CERMON, EPHVIR, etc. Signature of understory is generally smooth.	Undermapped and confused with the other P-J woodland map units.	Issues are mostly due to it being mapped later in the game and so it was found to be more common by field crews and may need some remapping.	Keep separate and retain with lower accuracy. Add some polygons of this type based on AA points showing it to be more common, especially in southern Salt Creek, where it was confused with MC 25.
25	25	Sand Dune Woodlands	Pinyon – Juniper Sand Dune Woodland	These are woodland and sparse woodland communities on undulating but stabilized dunes. Typically on plateaus and benches where coarser sand deposits have accumulated, either forming ridges on plateaus or at the bases of various hilly to butte-like rock formations.	Overmapped (especially in Needles where many polys are actually MC 12) and some confusion with map classes 20, 32 and 33.	Confused with map class 20 on sandsheets where there are no dune species, should be labeled MC 20 with a sand modifier. Use AA points to fix problem areas/polygons.	Yes to suggestion
7	26	Pinyon - Juniper Intermittently Flooded Woodland Alliance	Pinyon - Juniper Intermittently Flooded Woodland	Sites include dry sandy washes with junipers and pinyon and a variety of upland shrub species in the understory. Tree and shrub covers can range from widely scattered to nearly continuous.	Undermapped and confused with a variety of other map units	Concept may need refined to include only mesic washes. Dry washes with trace tree cover may need to be called MC 90 with a tree modifier,	Accept with lower accuracy (no remapping done)
95	27	Pinyon - Juniper Runoff Basin/Ring Woodland Complex	Pinyon - Juniper "Pour-over" Woodland	Represents sites where runoff is concentrated, such as basins around the base of slickrock outcrops or against the base of cliffs on the margins of sandy canyon bottoms. Big PJ tree crowns and mesic tall shrubs (oak, MAHFRE, Rhus) are diagnostic of this map unit.	Slightly undermapped and confused with a variety of other map classes.	Issues with map class 97 still unresolved, may just need a little remapping where P-J crowns are obvious in a polygon that was called MC 97.	Yes to suggestion

Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Map Class Concept	Error Source	Potential Resolution	Park Decision 8/2010
28	28	Toeslope/ Moraine Sparse Vegetation Complex	Toeslope/ Moraine Sparse Vegetation Complex	This unit identifies landslide deposits at the base of the Wingate/Chinle steep scarp. The major areas rest on the Chinle benches. The blue gray shale is often exposed at the edges of this unit. The appearance is that of an undulating moraine. Slopes < 20%. Rubble is mostly coarse textured with sparse mixed vegetation and includes scattered Junipers in some polygons.	None	N/A	N/A
29	29	Pinyon-Juniper Shale Scarps Mosaic	Cool Aspect / Wooded Shale Scarps Complex	Cooler aspects and/or concave slope shapes on steep and very steep colluvial debris slopes. Signature indicting low cover of small trees and tall shrubs and some herbaceous cover (usually *Elymus salinus*).	Both over and undermapped and confused with map classes 7, 30 and 40. No distinct ecological difference between map class 29 and 40.	Combine with map classes 40 and 30, retain linework but add a modifier.	Absorb polygons of MC 40 only; do not combine with MC 30, because accuracy between these two types is ok.
40	29	Talus Slope Ravine Woodland Complex	Cool Aspect / Wooded Shale Scarps Complex	Shallow ravines on steep escarpments below high sandstone pouroffs.	Overmapped and confused with map class 29.	Combine with MC 29.	Yes to suggestion
30	30	Steep Canyonsides and Escarpments Mixed Shrubland Mosaic	Talus Escarpments Mixed Sparse Vegetation Complex	More exposed convex and/or warmer steep and very steep colluvial debris slopes. Often appears barren.	AAed pretty well and mostly confused with map class 29.	Absorb polygons of map classes 29 and 40.	No combining needed. Type is okay on its own.

Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Map Class Concept	Error Source	Potential Resolution	Park Decision 8/2010
37	31	Cutler Bench and Ledge Canyonside Mosaic	Cutler Benches Cliffy Canyonside Mosaic	Ledged canyon slopes of undifferentiated Cutler, Organ Rock, and transitional parts of the Cedar Mesa formation. This is really a mosaic of map units 15, 30, and 32/33, where they occur in bands too narrow and intertwined to separate. Characterized by stair-step topography of mini sandstone ledges, talus slopes, and benches of shale barrens. Individual map units included in this mosaic are pulled out to the highest degree possible.	Did lots of remapping of this type to refine the concept. Opportunistic occurrences of plant communities, and high variability of vegetation microsites.	None needed	N/A
32	32	Pothole-Joint Sandstone Woodland Complex	Potholed and Jointed Sandstone Woodland Complex	This is sparsely vegetated hard sandstone represented on parts of the Navajo and Cedar Mesa sandstones (mainly) and characterized by slickrock with potholes or small solution features, as well as shallow to more deeply jointed slickrock supporting vegetation. Characterized by having generally greater than 60-70% bedrock cover.	Slightly undermapped and confused with map class 24.	Look at polys confused with 24.	Some remapping done on slickrock ramps that were mapped as MC 24 but were really just more sloping versions of MC 32. No other fixes needed, accuracy is now good.
24	33	Mesic Sandstone Slopes Woodland	Broken Bedrock Ledge and Slope Woodland Complex	Toeslopes at the base of Cedar Mesa sandstone pinnacles or among jointed areas that are a mix of broken talus fallen from pinnacles and aeolian sand. Also high elevation slopes near park boundary with Salt Creek Mesa. Vegetation is a PJ/mixed shrub talus that includes *Cercocarpus, Amelanchier,* and *Fraxinus*. Also includes rubbly talus over weathered bedrock and moist sheltered edges with good PINEDU cover.	Overmapped and confused with map classes 32 and 33.	Combine with MC 33! Concept is good for north-facing slopes of Salt Mesa, but where it is broken slickrock slopes in Grabens, etc. there doesn't seem to be enough difference to separate from 33. If there is significance of P-J / *Cercocarpus montanus*, keep linework with a modifier added.	Combine with MC 33, no need to retain ghost linework.

Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Map Class Concept	Error Source	Potential Resolution	Park Decision 8/2010
33	33	Ledge and Step Sandstone Woodland Complex	Broken Bedrock Ledge and Slope Woodland Complex	Best sampled on Kayenta rims in ISKY. Ledges of sandstone with some talus breakdown below ledges and with partial soil cover supporting *Purshia*, blackbrush, PJ. Can be more of woodland, but mostly is a wooded shrubland. Differentiated from MU 32 by having generally less (25-65%) bedrock cover.	Slightly undermapped and confused with map classes 20 and 24.	Absorb polygons of MC 24.	Yes to suggestion and change name/concept to include slope environments
34	34	Hard Buff Sandstone Slickrock Vegetation Complex	Rimrock Sparse Vegetation Complex	White Rim sandstone and similar plateau or rimrock layers of Cedar Mesa and other sandstone formations. These are relatively level rims areas with sparse, mixed vegetation. Generally lacking trees, but trees may rarely occur with very sparse cover.	None	N/A	N/A
35	35	Cryptobiotic Soil Crust - Sparse Vegetation Complex	Cryptobiotic Soil Crust - Ephedra Sparse Vegetation Complex	Chinle benches with a darkish gray, smooth signature with sparse shrubs - the color and texture probably indicate high non-vascular cover. Includes smaller areas of gypsiferous lichen-dominated communities mosaicked with sparse *Ephedra torreyana* shrublands.	This was way overmapped where there was too much shrub cover (blackbrush) and confused with MC 10.	Some remapping was done and now this type looks good and has many fewer polygons.	N/A
91	36	River Floodplain, Mud and Salt flat Complex	River Floodplain Salt Flats	Generally small polygons on high terraces/floodplains of the big rivers that are nearly devoid of vegetation and dominated by *Suaeda torreyana.*	None	N/A	N/A
90	90	Dry Wash Shrub Complex	Dry Wash Complex	Narrow to broad sandy wash channels with sparse and/or intermittent upland vegetation along the banks. May include spotty tree cover indicated with a "t" modifier.	Confused with terraces of map class18.	Did some remapping to pull out the terraces from the wash and now this map class looks good.	N/A

Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Map Class Concept	Error Source	Potential Resolution	Park Decision 8/2010
9	91	Floodplain and Tributary Mixed Shrubland Mosaic	Floodplain and Tributary Tamarisk and Coyote Willow Shrubland Complex	Dry sandy tributary drainages lined with *Tamarix*. Includes continuous stands of tamarisk, as well as open clumps in dry.	Some slight confusion with map class 93.	None needed	N/A
92	92	Tributary Mesic Herbaceous Complex	Tributary Mesic Herbaceous Complex	Includes all mesic herbaceous communities, such as rush, horsetail, reed grass, etc., along perennial streams or in wet canyon bottoms where water is near or at the surface for most of the year.	Slightly undermapped and confused with map class 94.	None needed	N/A
93	93	Fremont Cottonwood Intermittently Flooded Tributary Woodland Alliance	Fremont Cottonwood Tributary Woodland	Cottonwood communities in tributary drainages. May be mature or young. May have upland or mesic understories, depending on depth to water table, and understory may be shrub, forb, or graminoid-dominated.	Some slight confusion with map class 9.	None needed	N/A
94	94	Sporobolus airoides - (Greasewood) Shrub Herbaceous Complex	Sporobolus airoides - (Greasewood) Shrub Herbaceous Complex	Has a smooth, grey-green photo signature. Mainly an herbaceous community dominated by SPOAIR but occurs on margins of SARVER shrublands, so scattered SARVER may also occur in this type.	Slightly overmapped and confused with map class 92.	Accept with lower accuracy?	Some remapping using AA verification points and a clearer sense of the photo signature brought the accuracy above 80%.
96	96	Douglas-fir Scree Slope Woodland	Douglas-fir Scree Slope Woodland	Undocumented occurrences can be photo-interpreted on cool, sheltered seepy ledges but interpretation of tree species is less than positive and PINPON may need to be lumped with PSEMEN in these habitats. Mostly found in southern ends of Needles, Lavender and Salt Creek canyons.	Rare type	None	N/A

Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Map Class Concept	Error Source	Potential Resolution	Park Decision 8/2010
98	98	Ponderosa / P-J Wash Community	Ponderosa Pine – Pinyon Pine – Juniper spp. Wash Woodland	No plots done in this type. Undocumented occurrences were photo-interpreted in southern reaches of Salt Creek (West Fork) near the park boundary. Very rare type in the park; has only been documented twice.	Not AAed.	None	N/A
100	100	Hanging Gardens, Seeps, and Springs	Hanging Gardens Herbaceous Vegetation	Mapped as known points, not mapped as polygons. These will be added to the final map from plot data and from hanging garden data points logged by field crew members.	Not AAed	None	N/A
111	111	Rivers	Rivers				
113-A	113	Stock pond	Stock Ponds				
132	132	Barren slickrock of any formation	Slickrock	Cliffs, domes, and pouroffs of sandstone. Essentially unvegetated.	not AAed		
36	136	Wingate (and other hard) Sandstone Cliff Bands	Vertical Sandstone Cliff Bands	Very steep escarpment bounding the Island in the Sky and forming canyon walls in several canyons. This unit is largely unvegetated but does include areas of sparse trees and shrubs clinging to rock bands on sheltered slopes. Areas of very steep Kayenta, Navajo, and White Rim sandstone are included where the scarp is continuous from rim.	not AAed		
2	200	Sand bars and sand islands	Sand Bars and Sand Islands		not AAed		
212	212	Park Housing	Park Housing		not AAed		
213	213	Facilities	Park Facilities	Maintenance Shop, Visitor Center, Cache Building	not AAed		
226	226	Roads	Roadways	Roadways (paved = t, unpaved = u)	not AAed		
310	310	Maintenance Yard, Gravel Pit	Maintenance Yards		not AAed		
320	320	Heli-pad	Helicopter Pad		not AAed		
330	330	Mud Flats	Mud or Salt Flats		not AAed		

Map Class #	Final Map Class #	Map Class Name	Final Map Class Name	Map Class Concept	Error Source	Potential Resolution	Park Decision 8/2010
335	335	Outhouse	Outhouses		not AAed		

Appendix J. Map Class Descriptions for Canyonlands National Park

Introduction

This document provides a visual guide and description of the vegetation map classes for the Canyonlands National Park Vegetation Mapping Project. Forty-two map classes are described in this guide. Nine land use classes and two geologic 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.

VEGETATED MAP CLASSES OF CANYONLANDS NATIONAL PARK

Upland Forests and Woodlands 818
Pinyon – Juniper / Blackbrush Woodland (W-PJCO) 818
Pinyon – Juniper High Elevation Mesa Top Woodland (W-MEPJ) 820
Pinyon – Juniper / Wyoming Sagebrush Woodland (W-PJSA) 823
[Chained and Seeded Pinyon – Juniper Woodland] Sagebrush Shrubland (S-SEED) 826
Juniper – (Pinyon) / Sparse or Grassy Understory Woodland (W-PJGR) 829
Pinyon – Juniper Sand Dune Woodland (W-PJDU) 832
Pinyon – Juniper Intermittently Flooded Woodland (W-PJWA) 835
Pinyon – Juniper "Pour-over" Woodland (W-PJPO) 838
Cool Aspect / Wooded Shale Scarps Complex (C-WOSC) 841
Potholed and Jointed Sandstone Woodland Complex (W-POTH) 844
Broken Bedrock Ledge and Slope Woodland Complex (W-LEDG) 847
Douglas-fir Scree Slope Woodland (W-PSME) 850
Ponderosa Pine - Pinyon Pine - Juniper spp. Wash Woodland (W-POND) 853
Upland Shrublands 855
Greasewood Intermittently Flooded Shrubland Complex (S-SARV) 855
High Terrace (Low Valley Bottom) Shrub Herbaceous Complex (S-TERR) 858
Basin Big Sagebrush Terrace Shrubland Complex (S-SAGE) 861
Wyoming Big Sagebrush Shrubland (S-WYSA) 864
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Sand Sheet Mixed Shrubland Complex (S-SAND) 869
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Green Mormon Tea- Xeric Grasses Shrub Herbaceous Vegetation (S-EPVI) 875
Winterfat Dwarf-shrubland (S-WINT) 877
Dry Wash Complex (C-WASH) 880
Upland Herbaceous Communities 883
Valley Bottom and Benchlands Grasslands (H-HERB) 883
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Sparse Vegetation & Talus Slope Communities 889
Shale Barrens Desert Scrub Complex (S-SCRU) 889

Toeslope/Moraine Sparse Vegetation Complex (S-MORA) 892
Talus Escarpments Mixed Sparse Vegetation Complex (C-TALU) 895
Cutler Benches Cliffy Canyonside Mosaic (C-CUTL) 898
Rimrock Sparse Vegetation Complex (C-RIMR) 901
Cryptobiotic Soil Crust – Ephedra Sparse Vegetation Complex (C-CRUS) 904
Seepweed Salt Flats (S-SALT) 907
Riparian / Wetland Woodlands and Shrublands 910
Tamarisk River Corridor Shrubland (S-TAMX) 910
Sandbar Willow Riverine Shrubland (S-WILL) 912
Fremont Cottonwood Riverine Woodland (W-COTT) 915
Gambel Oak – Mixed Mesic Shrubs Terrace and Cove Shrubland (S-GOAK) 918
High Floodplain Riverine Desert Olive - Reed Grass Complex (S-FOPU) 921
Floodplain and Tributary Tamarisk and Coyote Willow Shrubland Complex (S-TRIB) 923
Fremont Cottonwood Intermittently Flooded Tributary Woodland (W-COTR) 925
Riparian / Wetland Herbaceous Communities 928
Tributary Mesic Herbaceous Complex (H-HETR) 928
Sporobolus airoides – (Greasewood) Shrub Herbaceous Complex (H-SPAI) 931
Hanging Gardens (H-HANG) 933

Upland Forests and Woodlands

Map Class 20
Pinyon – Juniper / Blackbrush Woodland (W-PJCO)





Photo credits: NPS

Associations

Juniperus osteosperma / Coleogyne ramosissima Woodland
Pinus edulis – Juniperus osteosperma / Coleogyne ramosissima Woodland

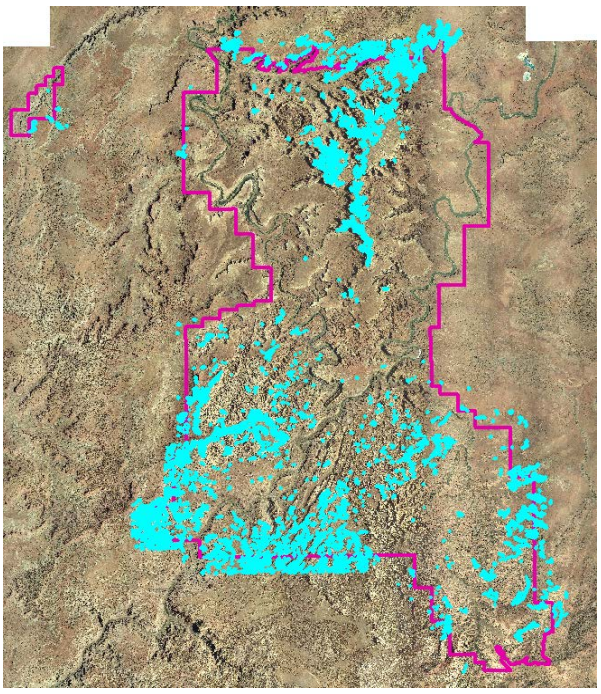
Common species

- *Pinus edulis*
- *Coleogyne ramosissima*
- *Ephedra viridis*
- *Juniperus osteosperma*
- *Purshia mexicana*
- *Pleuraphis jamesii*

W-PJCO Map Class Statistics

Type:	Complex
Frequency:	1,617 total polygons 1,226 total polygons in CANY 391 total polygons in the environs
Total project area:	7,194 hectares / 17,777 acres (4.2 %) 4,763 hectares / 1,1769 acres in CANY 2,432 hectares / 6,009 acres in the environs
Average Polygon Size:	4.4 hectares / 11 acres
Producer's accuracy:	85% ± 7%
User's accuracy:	70% ± 8%

Distribution in Mapping Area

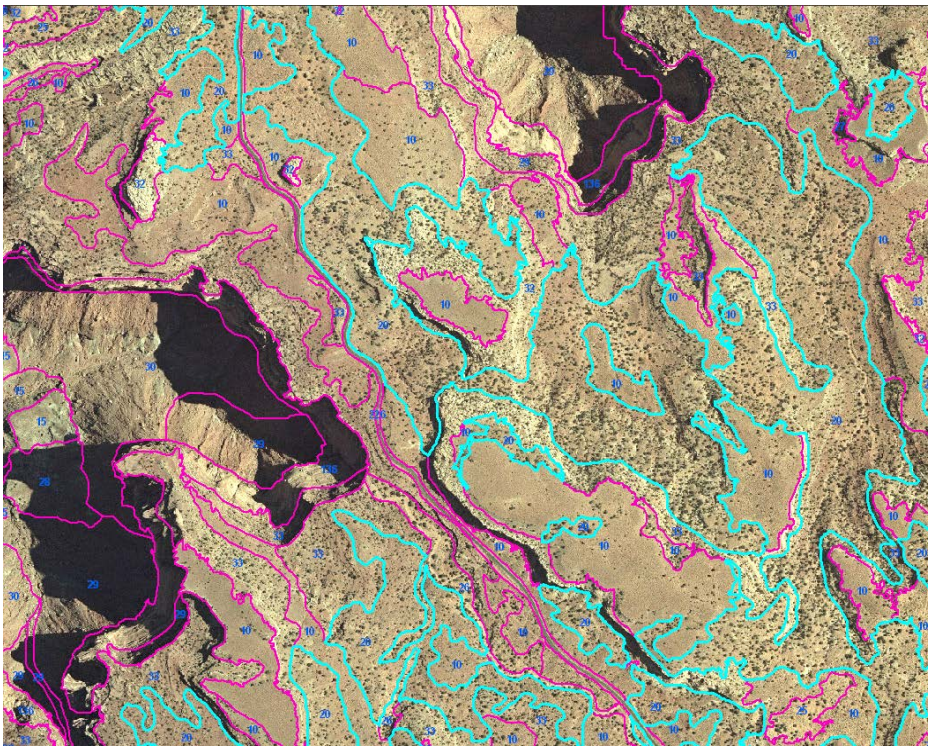


Distribution/Ecology/Composition

Stands occur primarily on gentle to moderate slopes on mesa tops, rims, benches/ledges, sand dunes, broad plateaus, and valley floors. *Pinus edulis* and *Juniperus osteosperma* are codominant in the canopy layer, with individual cover generally exceeding 5%. The most common shrub in the understory is *Coleogyne ramosissima,* with cover generally exceeding 5%. Cryptobiotic crust cover may be extensive and well developed. 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. A diversity of shrubs and grasses may be present with trace to low cover in the understory, including *Purshia mexicana, Ephedra viridis*, and *Gutierrezia sarothrae,* but *Coleogyne ramosissima* is the clear dominant.

Interpretation

This common map class appears as small to very large irregular polygons on gentle slopes and flats throughout the higher elevation areas of the Park. The color is a tan to reddish-brown, reflecting the substrate, with regularly spaced dark brown speckles of blackbrush, and fairly widely scattered tree crowns producing dark green to black spots. Common neighbors include polygons of blackbrush shrublands (map class 10), bedrock ledge and slope woodlands (map class 33), and pinyon-juniper dune woodlands (map class 25), but because this map class is so widespread it can be found adjacent to a wide variety of other map classes.



Example of photo signature for map class W-PJCO (#20).

Map Class 21
Pinyon – Juniper High Elevation Mesa Top Woodland (W-MEPJ)




Photo credits: NPS

Associations

Pinus edulis - Juniperus osteosperma / Artemisia nova Woodland
Pinus edulis - Juniperus osteosperma / Ephedra viridis Woodland
Pinus edulis - Juniperus spp. / Cercocarpus montanus - Mixed Shrub Woodland
Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland

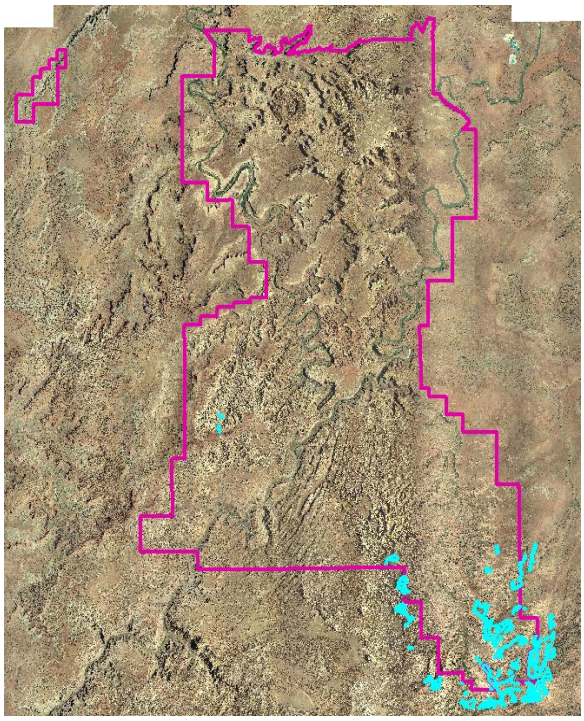
Common species

- *Pinues edulis*
- *Cercocarpus montanus*
- *Shepherdia rotundifolia*
- *Artemisia nova*
- *Petradoria pumila*
- *Juniperus osteosperma*
- *Purshia stansburiana*
- *Amelanchier utahensis*
- *Ephedra viridis*
- *Opuntia* spp.

W-MEPJ Map Class Statistics

Type:	Complex
Frequency:	98 total polygons 37 total polygons in CANY 61 total polygons in the environs
Total project area:	1,310 hectares / 3,236 acres (0.8 %) 456 hectares / 1,128 acres in CANY 853 hectares / 2,108 acres in the environs
Average Polygon Size:	13.4 hectares / 33 acres
Producer's accuracy:	85% ± 7%
User's accuracy:	70% ± 8%

Distribution in Mapping Area

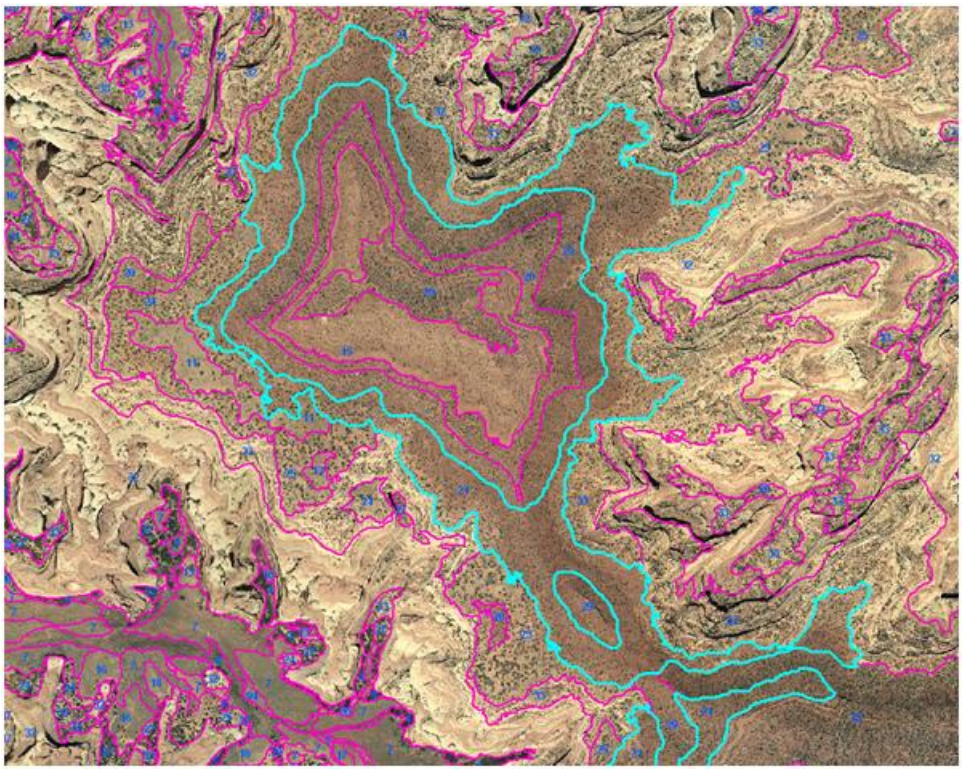


Distribution/Ecology/Composition

Stands occur on flat mesa tops at high elevation areas within the Park (1614-2263 m) as well as on steep northwest-to-northeast-facing slopes below the rims of mesa tops. Characterized by open to somewhat closed *Pinus edulis – Juniperus osteosperma* woodlands with sparse understories (often dominated by *Opuntia* spp. and/or *Petradoria pumila*) or with understories that may include low cover by some or all of the following tall and short shrubs: *Cercocarpus montanus, Artemisia nova, Purshia stansburiana, Shepherdia rotundifolia, Ephedra viridis,* and *Amelanchier utahensis.* The substrate is generally rocky (gravelly) and may include low to high cover of well-developed biological soil crusts.

Interpretation

This uncommon map class appears as medium to large irregular, often linear polygons on sheltered slopes and mesa tops in the southern-most portion of the Park, typical of Salt Creek Mesa and adjacent areas in the environs, as well as Cedar Mesa and nearby areas within the Park. The color is a dark green to black, rough and pebbled texture of pinyon-juniper tree crowns set against a fairly 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 24), wooded shale scarps (map class 29), potholed sandstone woodlands (map class 32), broken ledge and slope woodlands (map class 33), and high elevation grasslands (map class 16).



Example of photo signature for map class W-MEPJ (#21).

Map Class 22
Pinyon – Juniper / Wyoming Sagebrush Woodland (W-PJSA)



Photo credits: NPS

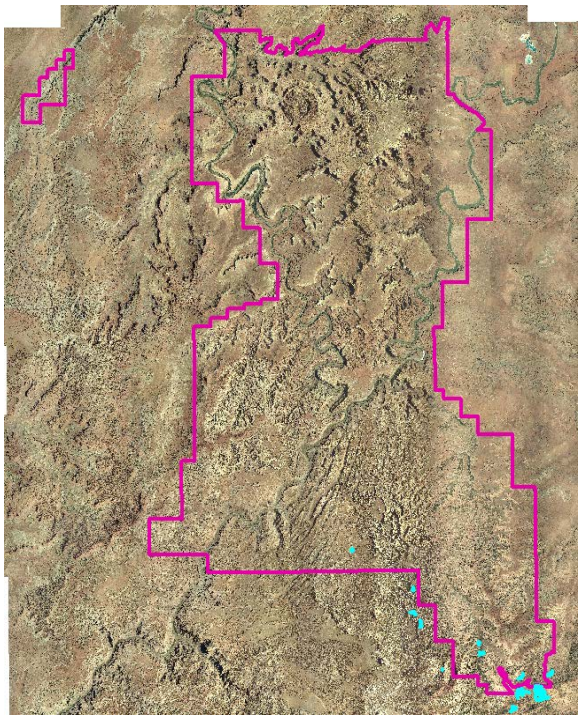
Associations
Pinus edulis - *Juniperus* spp. / *Artemisia tridentata (*ssp. *wyomingensis,* ssp. *vaseyana)* Woodland

Common species
- *Pinus edulis*
- *Artemisia tridentata* ssp. *wyomingensis*
- *Opuntia* spp.
- *Juniperus osteosperma*
- *Gutierrezia sarothrae*

W-PJSA Map Class Statistics

Type:	Complex
Frequency:	28 total polygons 9 total polygons in CANY 19 total polygons in the environs
Total project area:	143 hectares / 354 acres (0.1 %) 17 hectares / 43 acres in CANY 126 hectares / 311 acres in the environs
Average Polygon Size:	5.1 hectares / 12.6 acres
Producer's accuracy:	100%
User's accuracy:	60% ± 46%

Distribution in Mapping Area

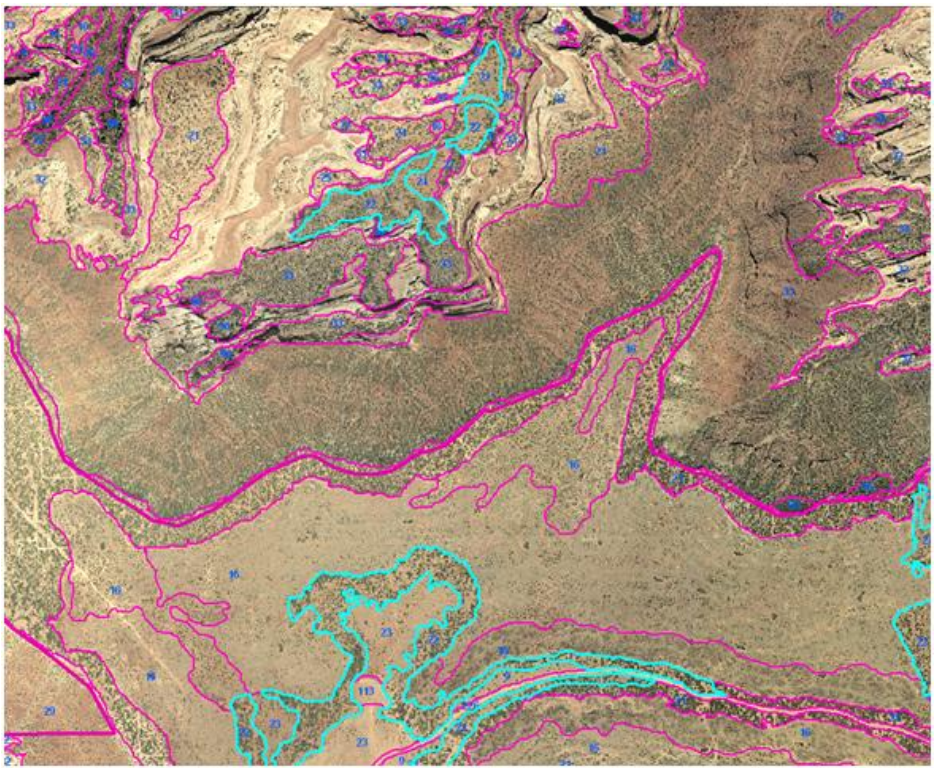


Distribution/Ecology/Composition

Stands occur on flat mesa tops at high elevation areas within the Park (1614-2263 m) and more rarely in canyon or valley bottoms; stands are characterized by open to somewhat closed *Pinus edulis – Juniperus osteosperma* woodlands with an understory clearly dominated by *Artemisia tridentata* ssp. *wyomingensis.* Associated shrubs include *Amelanchier utahensis, Atriplex canescens, Ephedra viridis, Gutierrezia sarothrae,* and *Opuntia* spp. Sites are flat with deep soils and bare soil and biological soil crusts cover most of the unvegetated surface.

Interpretation

This very rare map class appears as small to large regular polygons on gentle slopes and flats on mesa tops in the southern –most portions of the Park and environs, from Butler Wash to Salt Creek Mesa. The color is a dark green to black, rough and pebbled texture of pinyon-juniper tree crowns set against a fairly smooth background of tan to grayish-brown, depending on the substrate. Upon magnification, the grey speckles of sagebrush shrubs become more obvious. Common neighbors include polygons of the other pinyon-juniper map classes (map classes 21-25), potholed sandstone woodlands (map class 32), broken ledge and slope woodlands (map class 33), and high elevation grasslands (map class 16).



Example of photo signature for map class W-PJSA (#22).

Map Class 23
[Chained and Seeded Pinyon – Juniper Woodland] Sagebrush Shrubland (S-SEED)



Photo credits: NPS

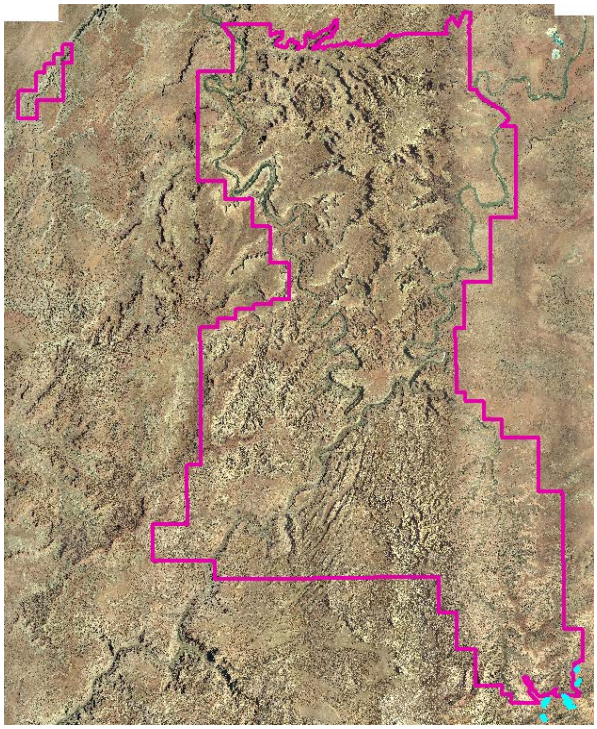
Associations
None described for the Park

Common species
- *Pinus edulis*
- *Artemisia tridentata* ssp. *wyomingensis*
- *Bouteloua gracilis*
- *Juniperus osteosperma*
- *Agropyron cristatum*

S-SEED Map Class Statistics

Type:	Alliance
Frequency:	15 total polygons 1 total polygons in CANY 14 total polygons in the environs
Total project area:	64 hectares / 158 acres (0 %) 0 hectares / 0 acres in CANY 64 hectares / 157 acres in the environs
Average Polygon Size:	4.3 hectares / 10.5 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area

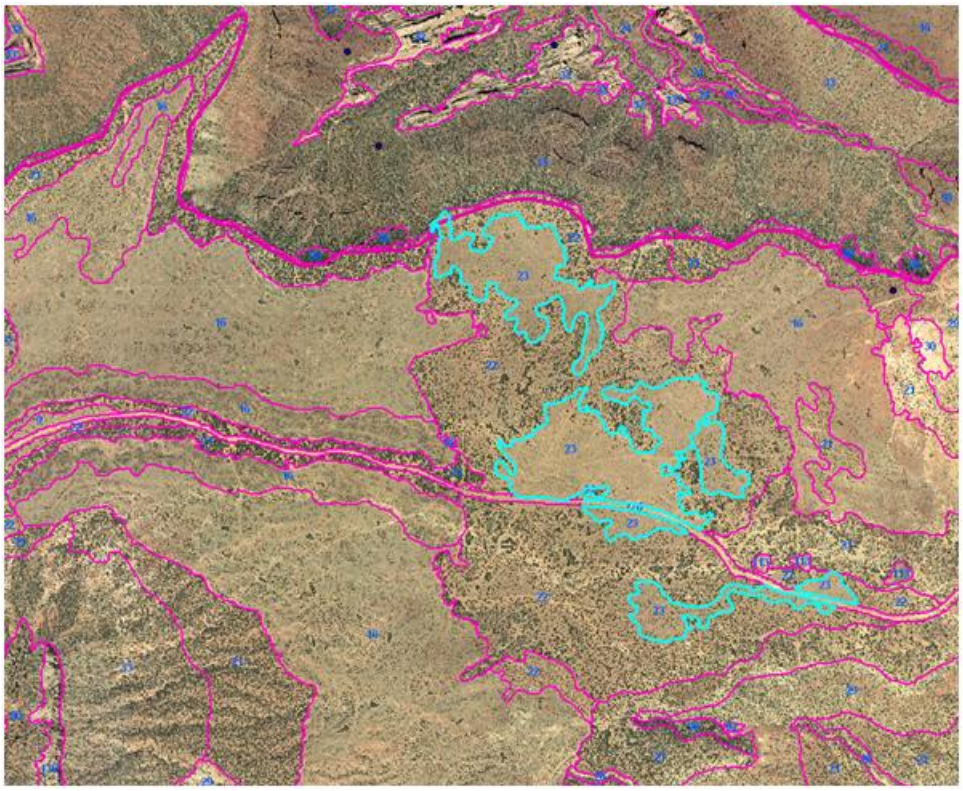


Distribution/Ecology/Composition

Stands occur on flat mesa tops at high elevation areas outside the Park boundary but in the environs and are characterized by *Pinus edulis – Juniperus osteosperma* woodlands that have been chained and seeded with *Agropyron cristatum* and are now dominated by encroaching *Artemisia tridentata* ssp. *wyomingensis* shrubs and a mixture of native (including *Bouteloua gracilis* and *Hesperostipa comata)* and non-native grasses.

Interpretation

This very rare map class appears as medium irregular polygons on flat sites on high elevation mesa tops in the environs (>2100 m) of Salt Creek Mesa. The color is a light to medium brown substrate with a speckled dark brown, rough texture representing the sagebrush shrubs and widely scattered tree crowns producing black spots. Common neighbors include polygons of high elevation grasslands (map class 16), high elevation pinyon-juniper woodlands (map class 21), and pinyon-juniper/Wyoming sagebrush woodlands (map class 22).



Example of photo signature for map class S-SEED (#23).

Map Class 24
Juniper – (Pinyon) / Sparse or Grassy Understory Woodland (W-PJGR)




Photo credits: NPS

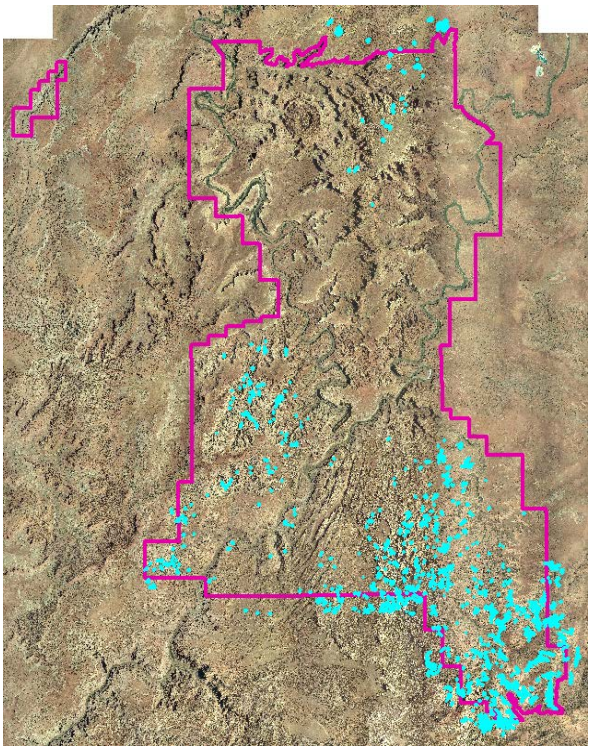
Associations
Juniperus osteosperma / Hesperostipa comata Woodland
Juniperus osteosperma / Pleuraphis jamesii Woodland
Juniperus osteosperma / Sparse Understory Woodland
Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata Woodland
Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis Woodland
Pinus edulis - Juniperus osteosperma / Achnatherum hymenoides Woodland
Pinus edulis - Juniperus osteosperma / Pleuraphis jamesii Woodland
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland

Common species
- *Pinus edulis*
- *Achnatherum hymenoides*
- *Hesperostipa comata*
- *Pleuraphis jamesii*
- *Ephedra viridis*
- *Juniperus osteosperma*
- *Bouteloua gracilis*
- *Sporobolus* spp.
- *Gutierrezia sarothrae*

W-PJGR Map Class Statistics

Type:	Association
Frequency:	944 total polygons 694 total polygons in CANY 250 total polygons in the environs
Total project area:	1,445 hectares / 3,570 acres (0.8 %) 1,000 hectares / 2,471 acres in CANY 445 hectares / 1,099 acres in the environs
Average Polygon Size:	1.5 hectares / 3.8 acres
Producer's accuracy:	76% ± 12%
User's accuracy:	81% ± 11%

Distribution in Mapping Area

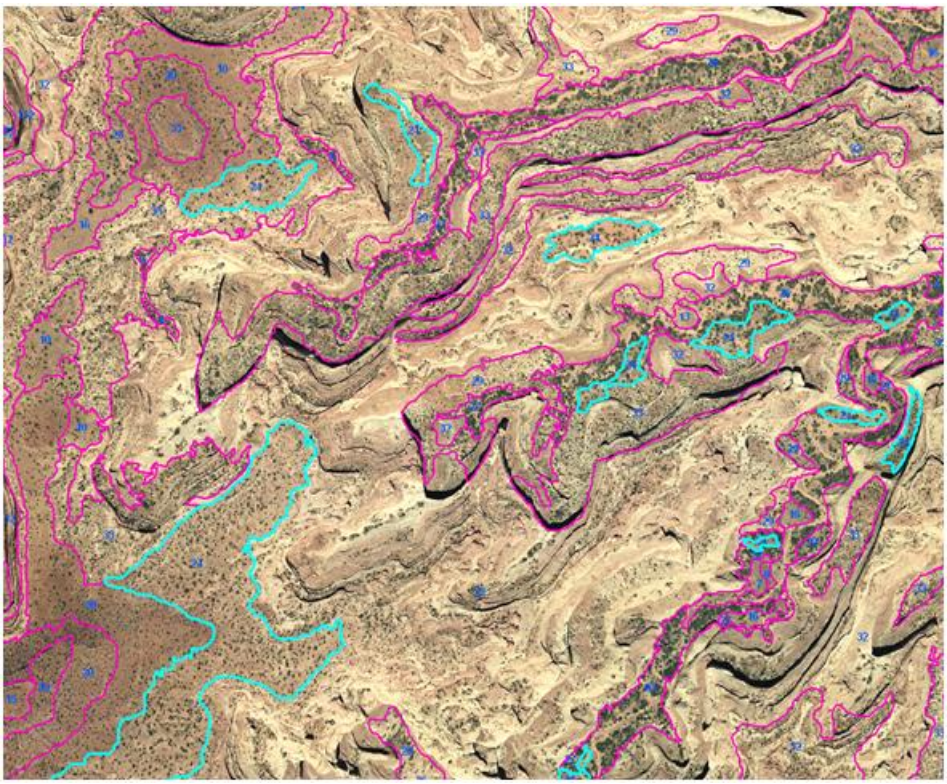


Distribution/Ecology/Composition

Stands occur on toeslopes, low slopes, and flats in canyon bottoms and on plateaus and mesa tops. Stands are characterized by open *Pinus edulis* and/or *Juniperus osteosperma* woodlands with a generally sparse understory (<5% total shrub cover) or an understory dominated by grass species such as *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii* and *Sporobolus airoides*. Scattered individuals of *Artemisia* spp., *Cercocarpus montanus* and *Ephedra* spp. may be present in the understory with very low cover. Cryptobiotic crust cover may be extensive and well developed.

Interpretation

This somewhat common map class appears as small to medium irregular polygons on gentle slopes and flats throughout the Park; most common in the Needles District, it also occurs in the canyons of The Maze, and a few scattered locations on the Island in the Sky mesa top. The background color is a smooth grey-green (grasses) to dark brown (biological soil crusts) with tree crowns producing dark green to black spots. Because this map class is so widespread in the Park and occurs in heterogeneous sites (i.e. canyon bottoms), it is bordered by polygons of nearly every other map class.



Example of photo signature for map class W-PJGR (#24).

Map Class 25
Pinyon – Juniper Sand Dune Woodland (W-PJDU)




Photo credits: NPS

Associations

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 / Coleogyne ramosissima Woodland
Pinus edulis - Juniperus osteosperma / Ephedra viridis Woodland
Pinus edulis - Juniperus osteosperma / Muhlenbergia pungens Woodland
Pinus edulis - Juniperus osteosperma / Quercus havardii var. *tuckeri* Woodland
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland

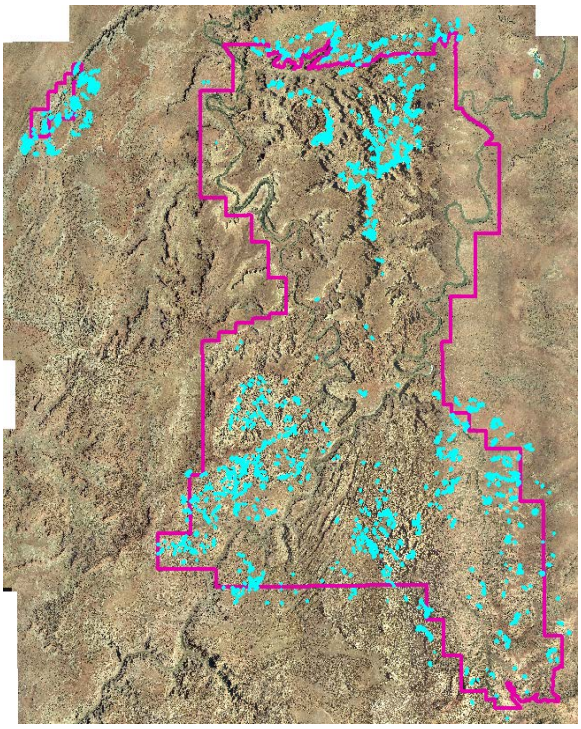
Common species

- *Pinus edulis*
- *Coleogyne ramosissima*
- *Quercus havardii* var. *tuckeri*
- *Yucca angustissima*
- *Juniperus osteosperma*
- *Purshia stansburiana*
- *Muhlenbergia pungens*
- *Ephedra viridis*

W-PJDU Map Class Statistics

Type:	Alliance
Frequency:	975 total polygons 749 total polygons in CANY 226 total polygons in the environs
Total project area:	2,266 hectares / 5,600 acres (1.3 %) 1,594 hectares / 3,940 acres in CANY 672 hectares / 1,660 acres in the environs
Average Polygon Size:	2.3 hectares / 5.7 acres
Producer's accuracy:	86% ± 8%
User's accuracy:	94% ± 7%

Distribution in Mapping Area

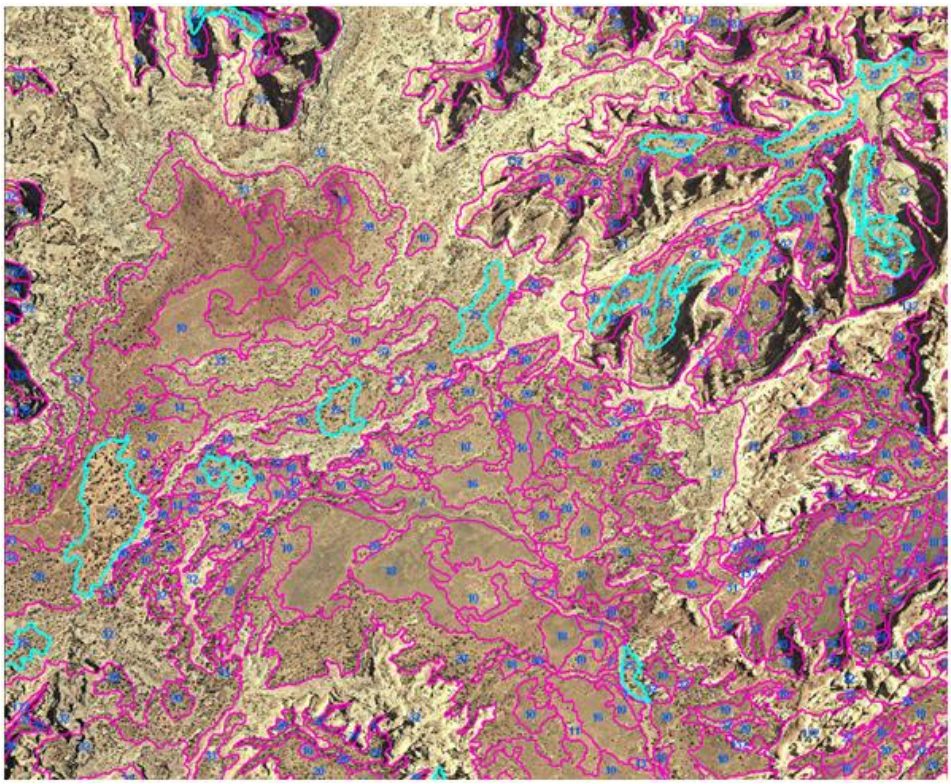


Distribution/Ecology/Composition

Stands occur primarily on plateaus and benches where coarser sand deposits accumulate or in canyon or valley bottoms at the bases of hilly to butte-like rock outcrops. This map class is characterized by woodland and sparse woodland communities (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 less than 5% total cover of *Coleogyne ramosissima, Purshia stansburiana,* and/or *Quercus havardii. Yucca angustissima, Muhlenbergia pungens* and other dune species are often present.

Interpretation

This somewhat common map class appears as small to medium regular or linear polygons on gentle slopes and undulating dunes on plateaus, benches, and canyon or valley bottoms. It is widespread within the Park, occurring wherever coarser, aeolian sand deposits have accumulated. The signature is patchy including a substrate that is light tan to gray-brown with brown to gray-green speckles and/or blotches representing shrubs and tree crowns providing dark green to black spots. Because this map class is widespread in the Park and often occurs in heterogeneous sites (i.e. canyon bottoms), it is bordered by polygons of nearly every other map class.



Example of photo signature for map class W-PJDU (#25).

Map Class 26
Pinyon – Juniper Intermittently Flooded Woodland (W-PJWA)




Photo credits: NPS

Associations

Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana - Quercus havardii Wooded Shrubland
Juniperus osteosperma / Mixed Shrubs Talus Woodland
Juniperus osteosperma / Sparse Understory Woodland
Juniperus osteosperma / Quercus gambelii Woodland [Park Special]
Juniperus osteosperma / Sporobolus airoides Woodland [Park Special]
Pinus edulis - Juniperus osteosperma / Amelanchier utahensis Woodland
Pinus edulis - Juniperus osteosperma / Quercus havardii var. *tuckeri* Woodland
Pinus edulis - Juniperus osteosperma / Rhus trilobata Woodland [Park Special]
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland
Pinus edulis - Juniperus osteosperma / Symphoricarpos longiflorus Woodland [Park Special]
Pinus edulis - Juniperus spp. */ Quercus gambelii* Woodland

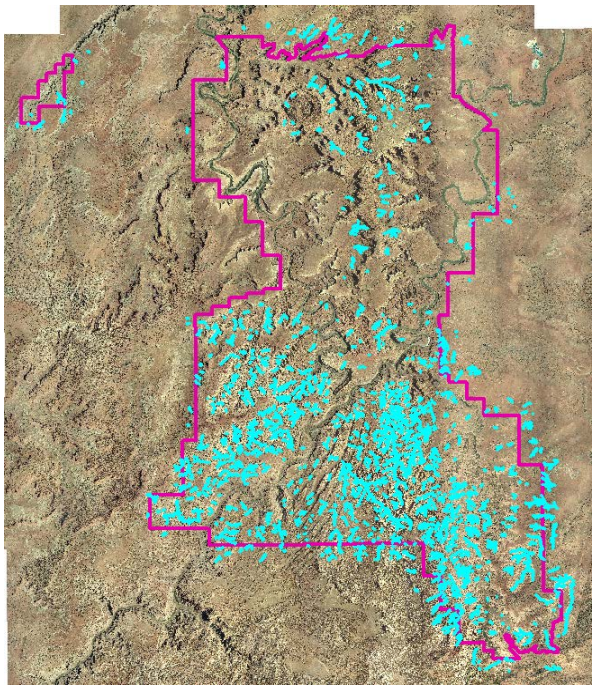
Common species

- *Pinus edulis*
- *Amelanchier utahensis*
- *Purshia stansburiana*
- *Quercus havardii* var. *tuckeri*
- *Symphoricarpos longiflorus*
- *Mahonia fremontii*
- *Sporobolus airoides*
- *Juniperus osteosperma*
- *Coleogyne ramosissima*
- *Quercus gambelii*
- *Rhus trilobata*
- *Fraxinus anomala*
- *Achnatherum hymenoides*
- *Heterotheca villosa*

W-PJWA Map Class Statistics

Type:	Complex
Frequency:	1,152 total polygons 940 total polygons in CANY 212 total polygons in the environs
Total project area:	2,240 hectares / 5,536 acres (1.3 %) 1,828 hectares / 4,517 acres in CANY 412 hectares / 1,019 acres in the environs
Average Polygon Size:	1.9 hectares / 4.8 acres
Producer's accuracy:	91% ± 7%
User's accuracy:	73% ± 10%

Distribution in Mapping Area

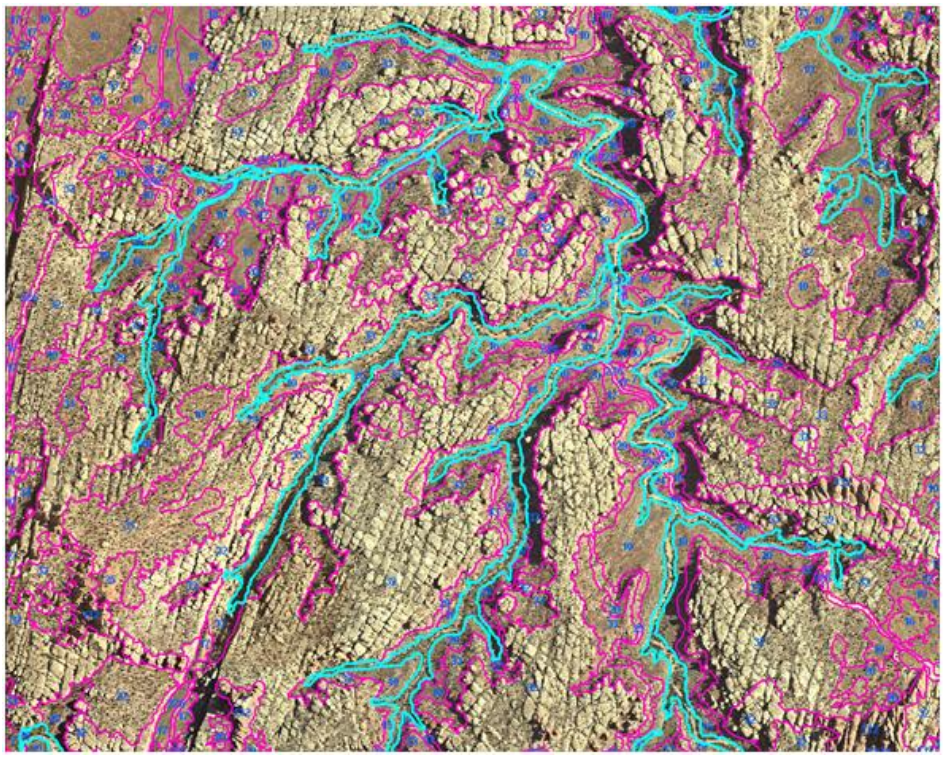


Distribution/Ecology/Composition

Stands occur on gentle slopes and flats at all aspects following drainages where runoff is channeled on plateaus, mesas, benches, canyon bottoms and broad valley bottoms. This map class is characterized by linear polygons of *Pinus edulis* and/or *Juniperus osteosperma* woodlands with mesic and xeric understories in sandy or rocky washes or in narrow canyon bottoms. Big tree crowns and shrubs such as *Rhus trilobata*, *Purshia stansburiana, Quercus* spp., *Amelanchier utahensis*, *Fraxinus anomala,* and *Symphoricarpos longiflorus* are characteristic of this map class. Tree and shrub cover can range from widely scattered to nearly continuous. The herbaceous layer is often diverse with no one species dominant or with high enough cover to be note-worthy.

Interpretation

This very common map class appears as small to large, very narrow, linear, sinuous polygons on gentle slopes and flats from mesa tops to canyon bottoms throughout the Park. The signature is a white to tan meandering line of the scoured wash channel with scattered dark green to black spots representing pinyon-juniper tree crowns and a smooth tan to light brown color representing the substrate (biological soil crusts, grass and forb cover, etc.) of the wash banks. Because this map class is so widespread and occurs throughout the Park, neighboring polygons include those from most all of the other map classes.



Example of photo signature for map class W-PJWA (#26).

Map Class 27
Pinyon – Juniper "Pour-over" Woodland (W-PJPO)




Photo credits: NPS

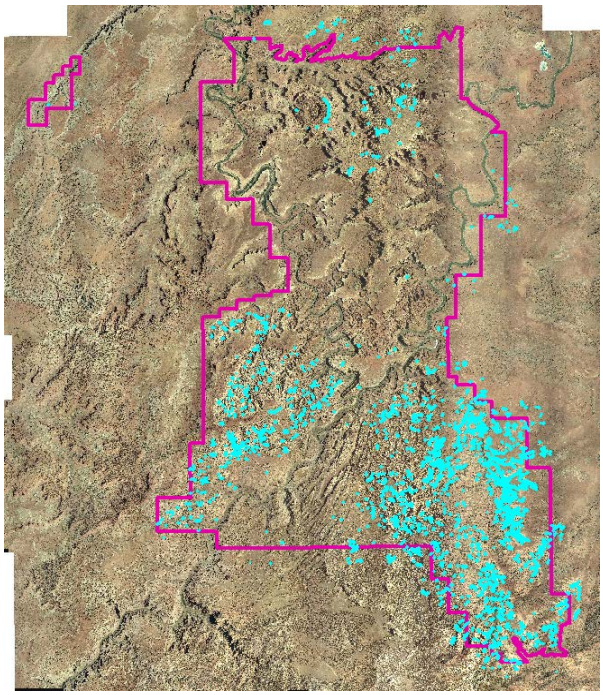
Associations
Juniperus osteosperma / Mahonia fremontii Woodland
Juniperus osteosperma / Quercus gambelii Woodland [Park Special]
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland
Pinus edulis - Juniperus spp. / Quercus gambelii Woodland

Common species
- *Pinus edulis*
- *Mahonia fremontii*
- *Artemisia tridentata* ssp. *tridentata*
- *Symphoricarpos longiflorus*
- *Juniperus osteosperma*
- *Quercus gambelii*
- *Rhus trilobata*
- *Yucca angustissima*

W-PJPO Map Class Statistics

Type:	Alliance
Frequency:	1,768 total polygons 1,515 total polygons in CANY 253 total polygons in the environs
Total project area:	975 hectares / 2,409 acres (0.6 %) 871 hectares / 2,153 acres in CANY 104 hectares / 256 acres in the environs
Average Polygon Size:	0.6 hectares / 1.4 acres
Producer's accuracy:	66% ± 14%
User's accuracy:	89% ± 12%

Distribution in Mapping Area

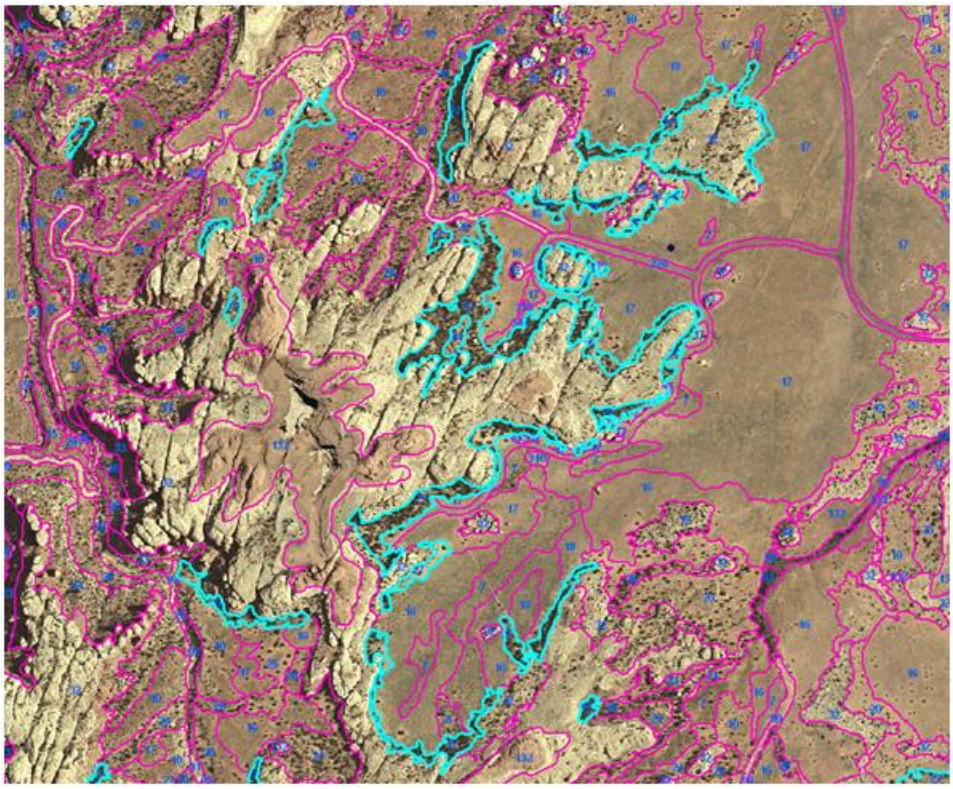


Distribution/Ecology/Composition

Stands occur in "pour-over" sites where runoff is concentrated or pooled, such as basin areas around the base of slickrock outcrops or against the base of cliffs on the margins of sandy canyon bottoms. Dense or large-crowned *Pinus edulis – Juniperus osteosperma* woodlands that form a narrow ring around the base of slickrock outcrops or dense stands in pour off basins/alcoves characterize this map class. The understory can be sparse and dominated by well-developed biological soil crusts or can include moderate to high cover of the tall shrubs *Quercus gambelii, Mahonia fremontii, Rhus trilobata* and *Artemisia tridentata.*

Interpretation

This somewhat common map class appears as small to medium, narrow, linear polygons on flat sites near the bases of cliffs or slickrock outcrops where runoff is concentrated or pooled throughout the Park, though less common in the Island in the Sky District. The signature is a dense or continuous dark green to black representing tree crowns with a smooth light to dark brown background. Generally bordered by bare slickrock domes (map class 132) or potholed sandstone woodland outcrops (map class 32), this map class is also bordered by a variety of valley bottom map classes: woodlands, shrublands, and herbaceous vegetation.



Example of photo signature for map class W-PJPO (#27).

Map Class 29
Cool Aspect / Wooded Shale Scarps Complex (C-WOSC)




Photo credits: NPS

Associations

Amelanchier utahensis Shrubland
Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland
Juniperus osteosperma / Leymus salinus Woodland
Juniperus osteosperma / Mixed Shrubs Talus Woodland
Leymus salinus Shale Sparse Vegetation
Pinus edulis - Juniperus osteosperma / Amelanchier utahensis Woodland
Pinus edulis - Juniperus osteosperma / Fendlera rupicola Woodland
Pinus edulis - Juniperus osteosperma / Leymus salinus Woodland
Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland
Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia Woodland
Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia - Amelanchier utahensis) Woodland
Poa fendleriana Herbaceous Vegetation

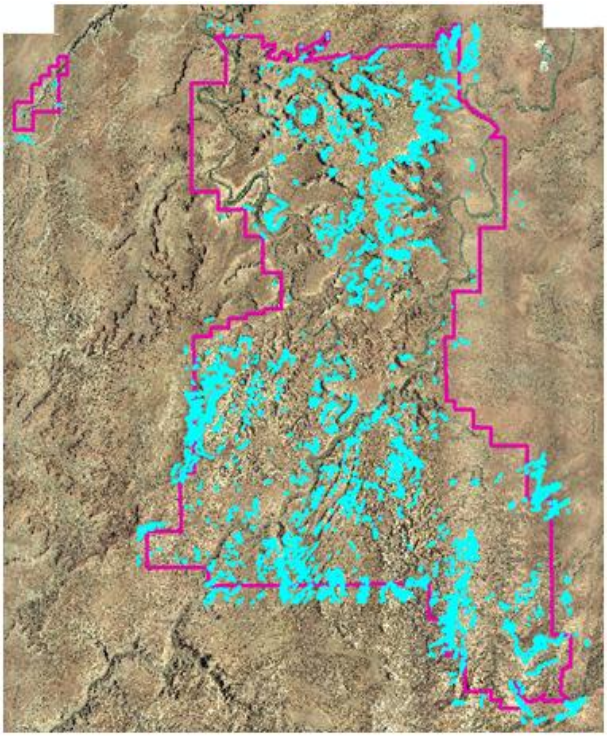
Common species

- *Amelanchier utahensis*
- *Pinus edulis*
- *Shepherdia rotundifolia*
- *Fraxinus anomala*
- *Quercus gambelii*
- *Elymus salinus*
- *Stipa hymenoides*
- *Cercocarpus montanus*
- *Juniperus osteosperma*
- *Rhus aromatica* var. *trilobata*
- *Fendlera rupicola*
- *Ephedra* spp.
- *Poa fendleriana*
- *Pleuraphis jamesii*

C-WOSC Map Class Statistics

Type:	Complex
Frequency:	1,162 total polygons 949 total polygons in CANY 213 total polygons in the environs
Total project area:	7,183 hectares / 17,749 acres (4.2 %) 5,709 hectares / 14,108 acres in CANY 1,473 hectares / 3,641 acres in the environs
Average Polygon Size:	6.2 hectares / 15.3 acres
Producer's accuracy:	75% ± 9%
User's accuracy:	83% ± 8%

Distribution in Mapping Area

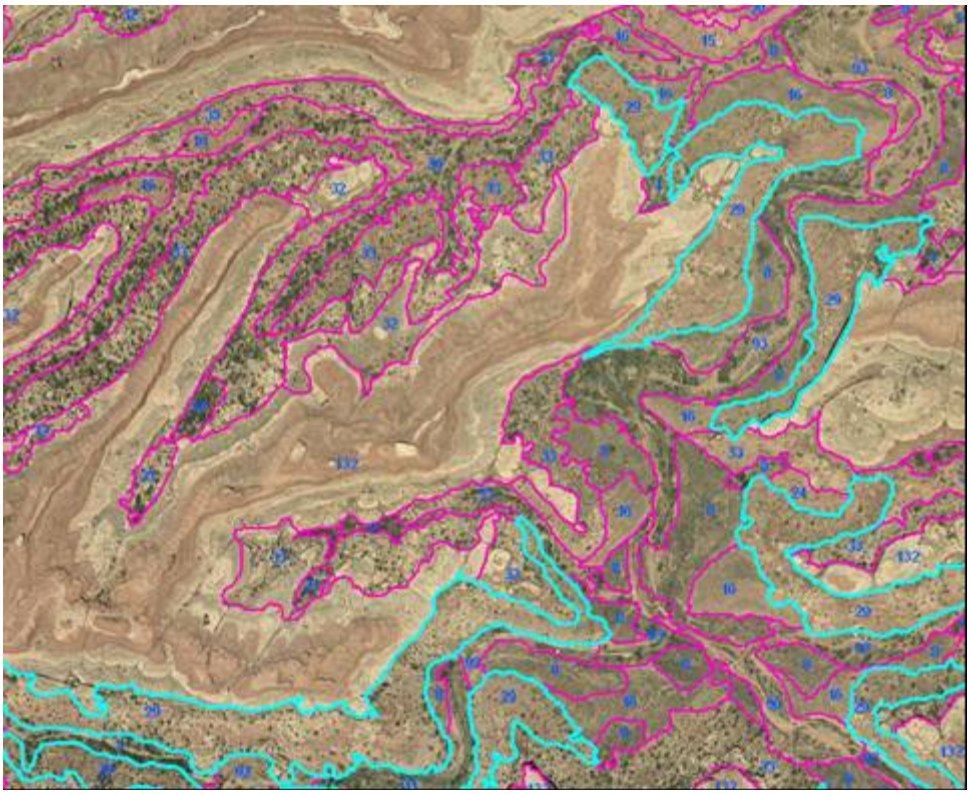


Distribution/Ecology/Composition

Stands occur on cool-aspect (north or east-facing) or sheltered talus slopes or in steep, rocky ravines on escarpments, consisting of sandstone detritus lying on shale and supporting a mixed community that includes scattered *Pinus edulis* and/or *Juniperus osteosperma* and a variety of taller shrubs (e.g., *Amelanchier utahensis*, *Fraxinus anomala, Rhus trilobata, Fendlera rupicola,* etc.), as well as a mixture of short shrubs. *Elymus salinus* is often present to abundant. Total vegetation cover usually does not exceed 10-15%.

Interpretation

This common map class appears as medium to large regular, sometimes linear, polygons on moderately steep to very steep, cool aspect or sheltered, talus on shale slopes throughout the Park. The color is tan to reddish-brown, with slopes sometimes dissected by deep gullies and ravines, and scattered large talus boulders often visible. Scattered tree crowns provide a rough and pebbled texture and produce evenly to widely-spaced black spots. Common neighbors include sparsely vegetated talus slopes (map class 30), broken bedrock ledge and slope woodlands (map class 33), and the slickrock and sandstone cliff geology map classes (map class 132 and 136 respectively). A variety of map classes can occur adjacent to this map class at the base of the slope where it meets the valley or canyon floor.



Example of photo signature for map class C-WOSC (#29).

Map Class 32
Potholed and Jointed Sandstone Woodland Complex (W-POTH)




Photo credits: NPS

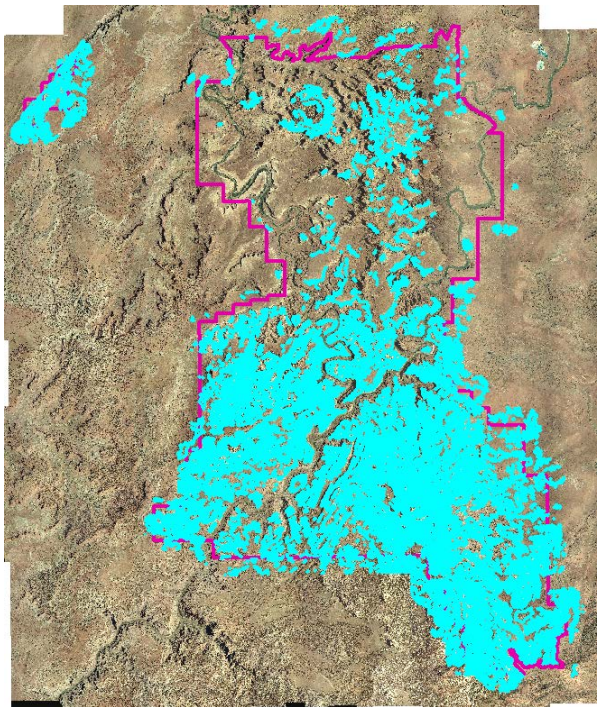
Associations
Cercocarpus intricatus Montane Shrubland
Cercocarpus intricatus Slickrock Sparse Vegetation
Fraxinus anomala Woodland
Juniperus osteosperma / Cercocarpus intricatus Woodland
Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana - Quercus havardii Wooded Shrubland *[Cercocarpus intricatus Phase]*
Juniperus osteosperma / Sparse Understory Woodland
Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland

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-POTH Map Class Statistics

Type:	Alliance
Frequency:	2,667 total polygons 2,139 total polygons in CANY 528 total polygons in the environs
Total project area:	30,495 hectares / 75,354 acres (17.9 %) 26,072 hectares / 64,425 acres in CANY 4,423 hectares / 10,929 acres in the environs
Average Polygon Size:	11.4 hectares / 28.3 acres
Producer's accuracy:	90% ± 6%
User's accuracy:	90% ± 6%

Distribution in Mapping Area

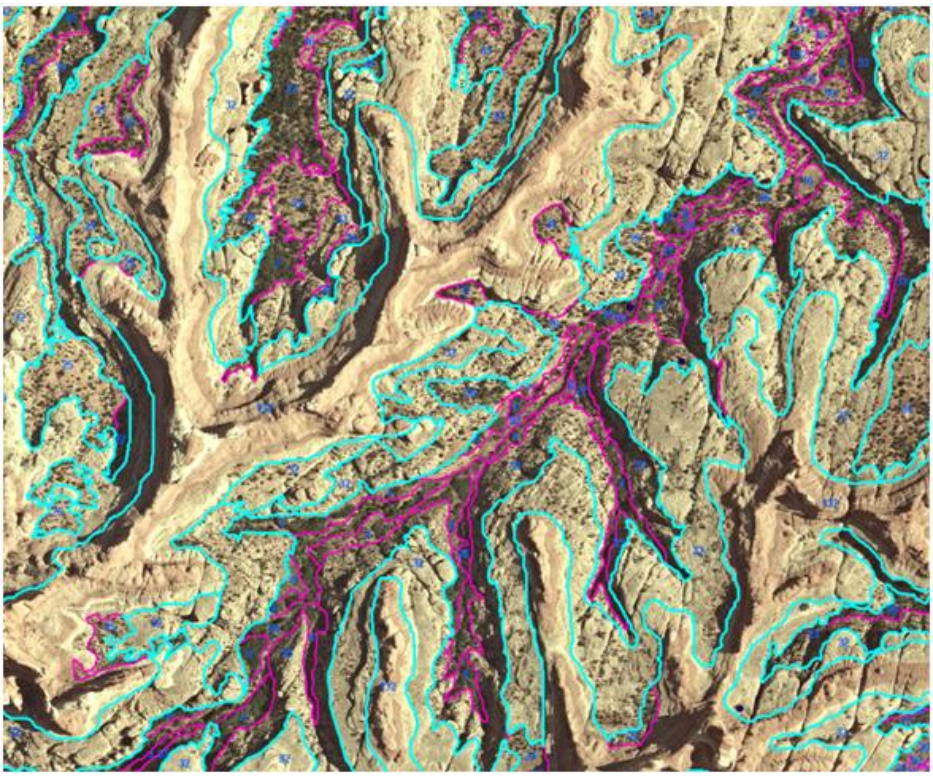


Distribution/Ecology/Composition

Sparsely vegetated hard sandstone characterized by slickrock potholes, shallow soil depressions, or joints/cracks typical of the Navajo and Cedar Mesa geologic formations, but occasionally found on other formations. Bedrock cover generally exceeds 60-70%. Vegetation often consists of scattered *Pinus edulis* and *Juniperus osteosperma* 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 often diverse.

Interpretation

This widespread and very common map class appears as medium to very large regular polygons covering large areas of the Park 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 so widespread in the Park, common neighbors include polygons of many other map classes, especially other woodland and rock-dominated map classes.



Example of photo signature for map class W-POTH (#32).

Map Class 33
Broken Bedrock Ledge and Slope Woodland Complex (W-LEDG)




Photo credits: NPS

Associations

Juniperus osteosperma - (Pinus edulis) / Coleogyne ramosissima - Purshia stansburiana - Quercus havardii Wooded Shrubland
Pinus edulis - Juniperus spp. / Cercocarpus montanus - Mixed shrub Woodland
Pinus edulis - Juniperus osteosperma / Artemisia bigelovii Woodland
Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland
Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland
Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland
Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis) Wooded Shrubland

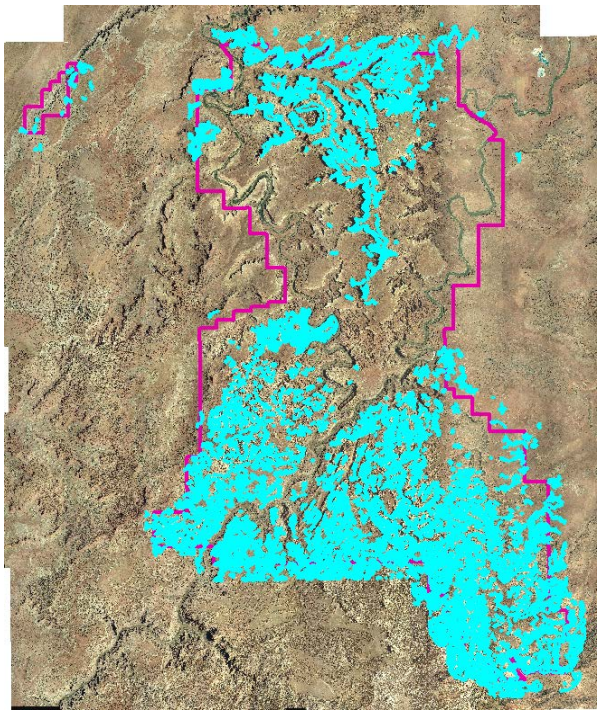
Common species

- *Pinus edulis*
- *Coleogyne ramosissima*
- *Purshia stansburiana*
- *Amelanchier utahensis*
- *Shepherdia rotundifolia*
- *Artemisia bigelovii*
- *Juniperus osteosperma*
- *Cercocarpus montanus*
- *Quercus gambelii*
- *Fraxinus anomala*
- *Ephedra viridis*
- *Stipa hymenoides*

W-LEDG Map Class Statistics

Type:	Association
Frequency:	2,804 total polygons 2,359 total polygons in CANY 445 total polygons in the environs
Total project area:	18,082 hectares / 44,683 acres (10.6 %) 13,502 hectares / 33,363 acres in CANY 4,581 hectares / 11,319 acres in the environs
Average Polygon Size:	6.4 hectares / 15.9 acres
Producer's accuracy:	86% ± 6%
User's accuracy:	89% ± 6%

Distribution in Mapping Area

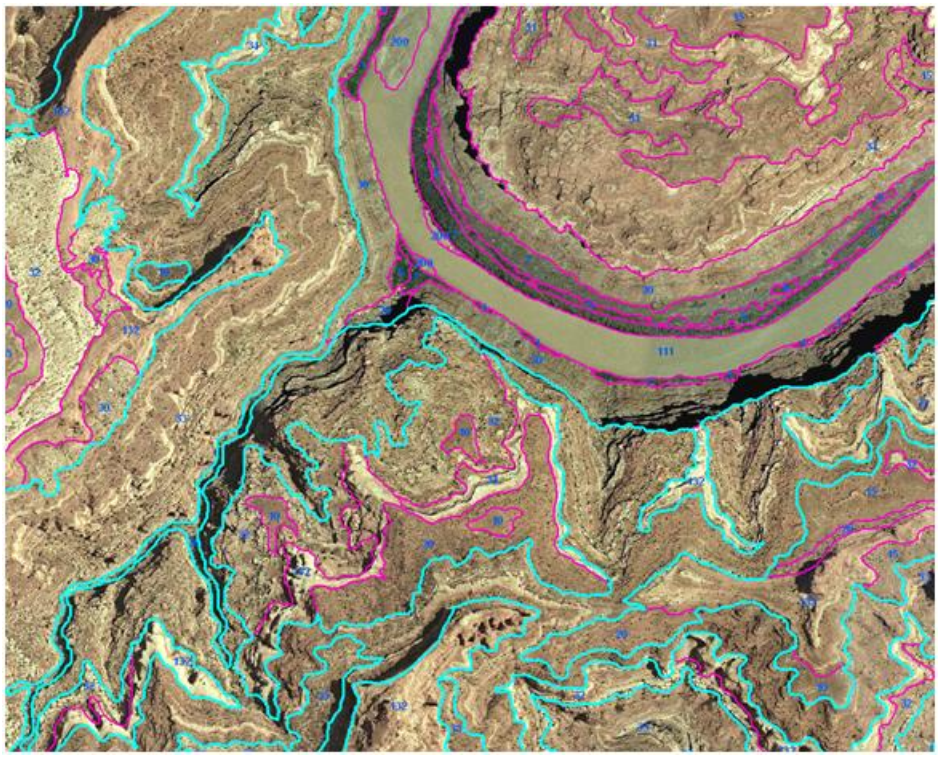


Distribution/Ecology/Composition

Stands occur on sandstone shelves or ledges with shallow soil cover typical of the Kayenta Formation, broken bedrock ledges where sandstone detritus lies on a sloping sandstone substrate, steep bedrock ramps common in the Cedar Mesa Formation, and high elevation slopes below Salt Creek Mesa. This map class is characterized by sparse woodlands and wooded shrublands dominated by *Pinus edulis* and/or *Juniperus osteosperma, Coleogyne ramosissima, Purshia stansburiana, Cercocarpus montanus,* and/or *Amelanchier utahensis.* Other species commonly present include *Ephedra viridis* and *Fraxinus anomala,* and in the Maze District, *Quercus gambelii* and *Shepherdia rotundifolia*. Total vegetation cover and species dominance vary depending on bedrock exposure (typically in the range of 25-65% cover), soil cover, and soil depth.

Interpretation

This very common map class appears as medium to large regular polygons on gentle to steep slopes across large areas of the Park where sandstone bedrock exposures dominate. The color varies from white to brown to reddish-brown depending on the underlying geology with dark green to black spots reflecting tree cover and with the shrub signature often obscured by the substrate. The most common neighbors include polygons of potholed sandstone woodlands (map class 32), pinyon – juniper woodlands with blackbrush understories (map class 20), cool-aspect wooded scree slopes (map class 29), and blackbrush shrublands (map class 10); however, because this map class is so common and widespread, it is bordered by a variety of other map classes as well.



Example of photo signature for map class W-LEDG (#33).

Map Class 96
Douglas-fir Scree Slope Woodland (W-PSME)




Photo credits: NPS

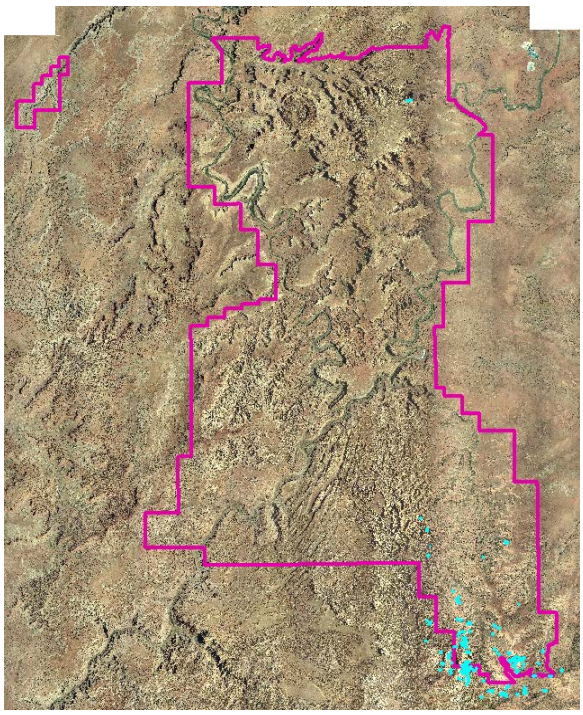
Associations
Pseudotsuga menziesii Scree Woodland
Pseudotsuga menziesii / Quercus gambelii Forest
Pseudotsuga menziesii / Cercocarpus montanus Forest

Common species
- *Pseudotsuga menziesii*
- *Cercocarpus montanus*
- *Shepherdia rotundifolia*
- *Symphoricarpos longiflorus*
- *Quercus gambelii*
- *Mahonia fremontii*
- *Rosa woodsii*

W-PSME Map Class Statistics

Type:	Complex
Frequency:	130 total polygons 70 total polygons in CANY 60 total polygons in the environs
Total project area:	74 hectares / 183 acres (0 %) 40 hectares / 100 acres in CANY 34 hectares / 83 acres in the environs
Average Polygon Size:	0.6 hectares / 1.4 acres
Producer's accuracy:	83% ± 27%
User's accuracy:	100%

Distribution in Mapping Area

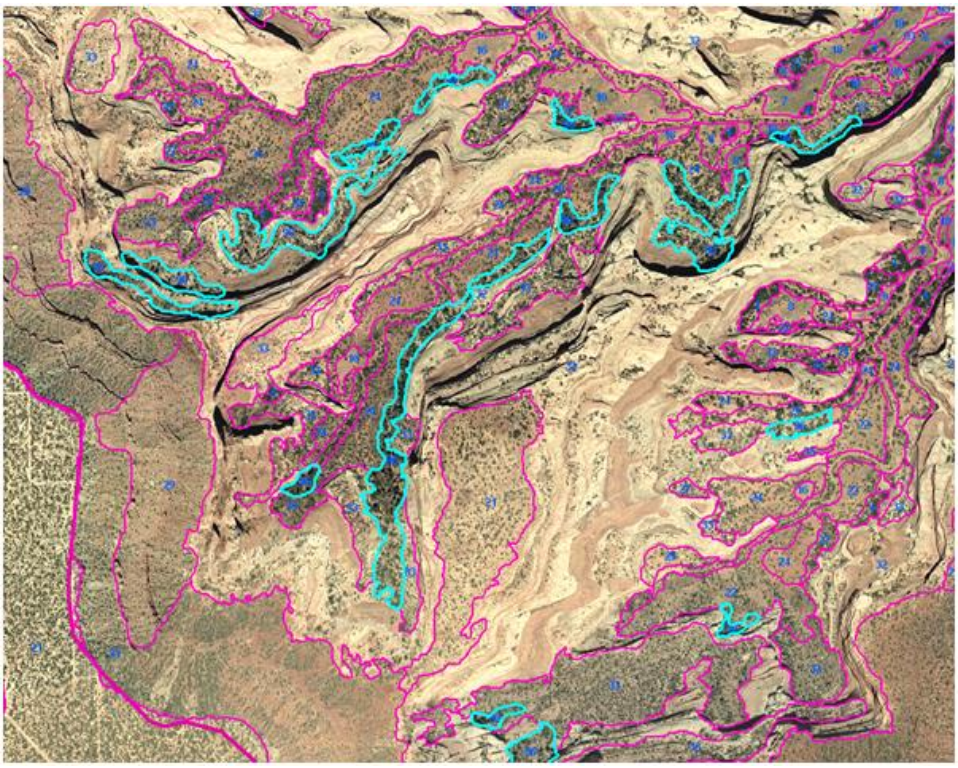


Distribution/Ecology/Composition

This map class is characterized by small, mesic stands of *Pseudotsuga menziesii* that occur near seeps, on the high slopes of escarpments, and in pouroff basins. Understories vary and may include *Pinus edulis, Amelanchier utahensis, Quercus gambelii, Mahonia fremontii, Shepherdia rotundifolia, Rosa woodsii*, and *Symphoricarpos longiflorus.*

Interpretation

This very rare map class appears as small to medium regular and linear polygons on gentle to moderately steep slopes in the heads of canyons. Other than one isolated occurrence near the Shafer Trail, this type is found exclusively in the heads of tributary canyons of the Salt Creek drainage system and in Lavender Canyon. The signature is a moderately dark gray green representing thickets of Gambel oak, a rough and pebbled texture of moderately tall pinyon tree crowns, and dark green to black emergent crowns of Douglas-fir (often only visible under stereoscopic viewing). Common neighbors include polygons of pinyon-juniper woodlands with Wyoming sagebrush understories (map class 22), sparse or grassy understories (map class 24), mixed shrub understories in intermittently flooded wash channels (map class 26), and on sandstone (map classes 32 and 33), and shrublands dominated by Gambel oak (map class 4).



Example of photo signature for map class W-PSME (#96).

Map Class 98
Ponderosa Pine - Pinyon Pine - Juniper spp. Wash Woodland (W-POND)





Photo credits: NPS

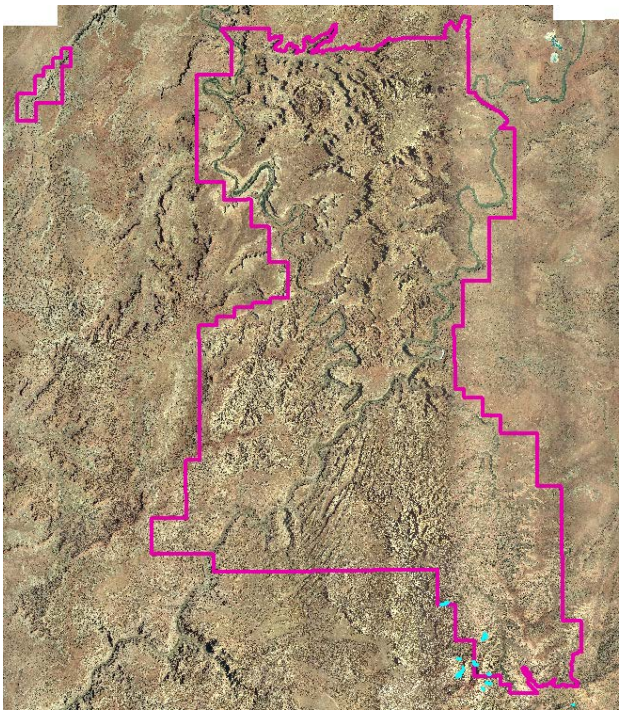
Associations
Pinus edulis - *Juniperus* spp. / *Quercus gambelii* Woodland
*No ponderosa pine associations described for the Park

Common species
- *Pinus ponderosa*
- *Juniperus osteosperma*
- *Cercocarpus montanus*
- *Amelanchier utahensis*
- *Pinus edulis*
- *Quercus gambelii*
- *Rhus trilobata*

W-POND Map Class Statistics

Type:	Complex
Frequency:	10 total polygons 4 total polygons in CANY 6 total polygons in the environs
Total project area:	17 hectares / 43 acres (0 %) 7 hectares / 16 acres in CANY 11 hectares / 26 acres in the environs
Average Polygon Size:	1.7 hectares / 4.3 acres
Producer's accuracy:	100%
User's accuracy:	100%

Distribution in Mapping Area

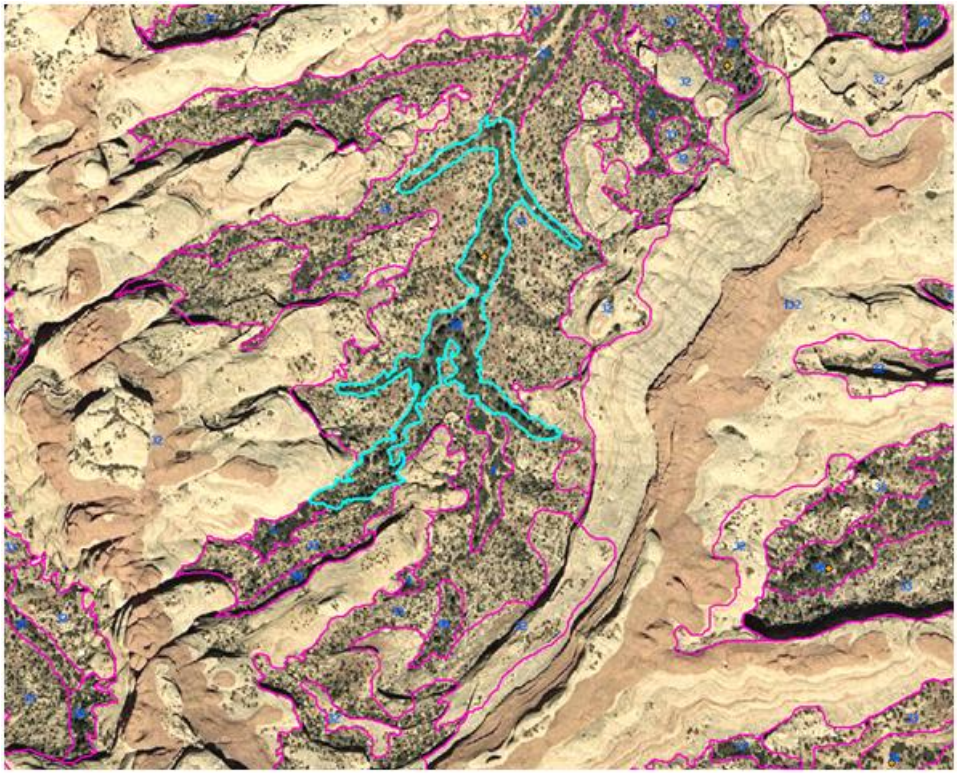


Distribution/Ecology/Composition

Stands occur on gentle slopes and flats in sandy or rocky wash channels along canyon bottoms. This map class is characterized by linear polygons of large-crowned *Pinus edulis* and/or *Juniperus osteosperma* woodlands with emergent *Pinus ponderosa* trees and mesic shrub understories, which include *Quercus gambelii, Rhus trilobata*, *Cercocarpus montanus,* and *Amelanchier utahensis*.

Interpretation

This very rare map class appears as very narrow, linear, sinuous polygons following drainages in canyon bottoms. It is restricted to the heads of tributary canyons in Lower Salt Creek and the West Fork of Salt Creek. The signature is a white to tan meandering line of the scoured wash channel with dark gray-green thickets of Gambel oak, a rough and pebbled texture of moderately tall pinyon tree crowns, and dark green to black, rounded, emergent tree crowns of ponderosa pine (often only visible under stereoscopic viewing). Common neighbors include polygons of pinyon-juniper woodlands with sparse or grassy understories (map class 24), mixed shrub understories in intermittently flooded wash channels or in pour-off basins (map class 26 and 27) and on sandstone (map classes 32 and 33), Douglas-fir woodlands (map class 96), and shrublands dominated by Gambel oak (map class 4).



Example of photo signature for map class W-POND (#98).

Upland Shrublands

Map Class 6
Greasewood Intermittently Flooded Shrubland Complex (S-SARV)




Photo credits: NPS

Associations

Atriplex confertifolia – Sarcobatus vermiculatus Shrubland
Sarcobatus vermiculatus Disturbed Shrubland
Sarcobatus vermiculatus / Pleuraphis jamesii Shrub Herbaceous Vegetation [Park Special]
Sarcobatus vermiculatus / Sporobolus airoides Shrubland
Sarcobatus vermiculatus / Sporobolus cryptandrus Shrubland [Park Special]
Sarcobatus vermiculatus / Suaeda moquinii Shrubland

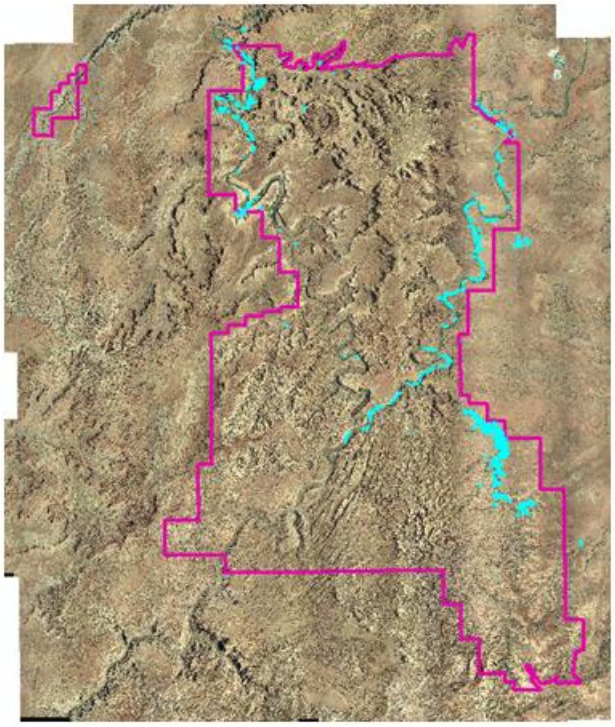
Common species

- *Sarcobatus vermiculatus*
- *Atriplex canescens*
- *Bromus tectorum*
- *Sporobolus airoides*
- *Suaeda torreyana*
- *Atriplex confertifolia*
- *Chrysothamnus nauseosus*
- *Sporobolus cryptandrus*
- *Pleuraphis jamesii*

S-SARV Map Class Statistics

Type:	Association
Frequency:	314 total polygons 282 total polygons in CANY 32 total polygons in the environs
Total project area:	604 hectares / 1,492 acres (0.4 %) 545 hectares / 1,347 acres in CANY 59 hectares / 145 acres in the environs
Average Polygon Size:	1.9 hectares / 4.8 acres
Producer's accuracy:	92% ± 7%
User's accuracy:	100%

Distribution in Mapping Area

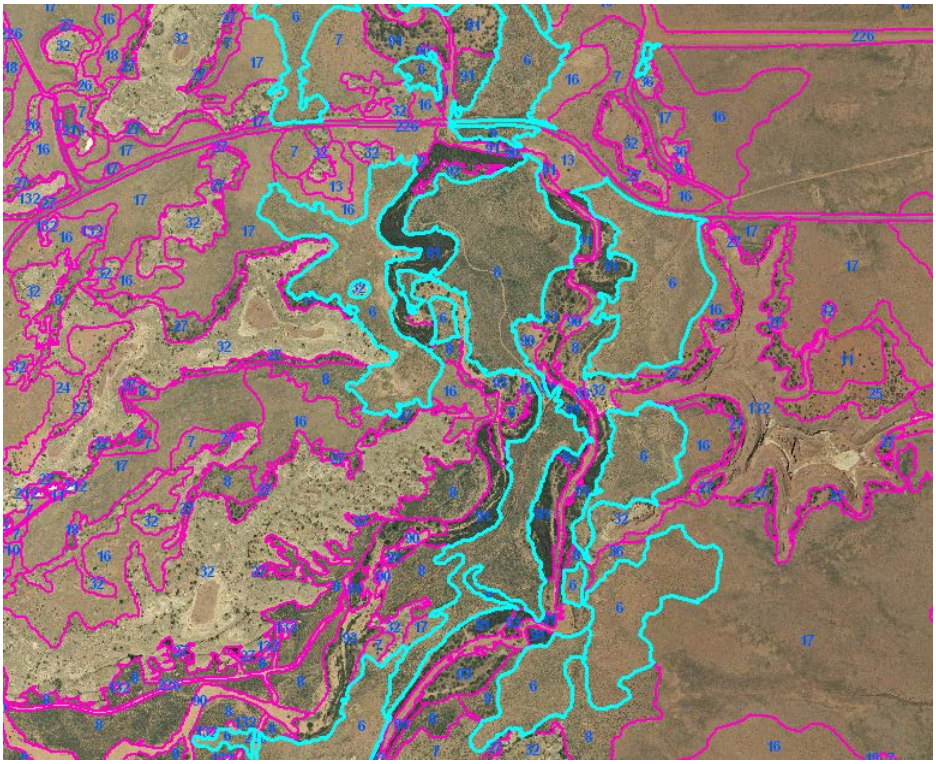


Distribution/Ecology/Composition

Stands occur on riverine (Green and Colorado rivers) and tributary (most conspicuously along lower Salt Creek) alluvial terraces and are dominated by robust *Sarcobatus vermiculatus* shrubs. *Atriplex canescens* and/or *Chrysothamnus nauseosus* may be present to nearly codominant and the understory may be sparse, weedy or grassy (dominated by *Sporobolus* spp. or *Pleuraphis jamesii*). Many stands along the river corridors are co-dominated by the sub-shrub species *Suaeda torreyana*. Cryptobiotic soil crusts are often present and may be extensive and well-developed.

Interpretation

This somewhat common but restricted map class appears as small to large regular polygons on flat alluvial terraces along the Green and Colorado River corridors and along lower Salt Creek in the Needles District. The color is a gray-green to dark gray, with widely-spaced to dense shrub cover providing a soft and speckled texture. Common neighbors include polygons of the other terrace shrublands (map classes 7 and 8), weedy herbaceous and native grassland stands (map classes 17 and 16), sandsheet and sand dune shrublands (map classes 11 and 13), riverine and tributary tamarisk shrublands (map classes 1 and 91), desert olive shrublands (map class 5), alkali sacaton grasslands (map class 94), and river floodplain salt flats (map class 36).



Example of photo signature for map class S-SARV (#6).

Map Class 7
High Terrace (Low Valley Bottom) Shrub Herbaceous Complex (S-TERR)




Photo credits: NPS

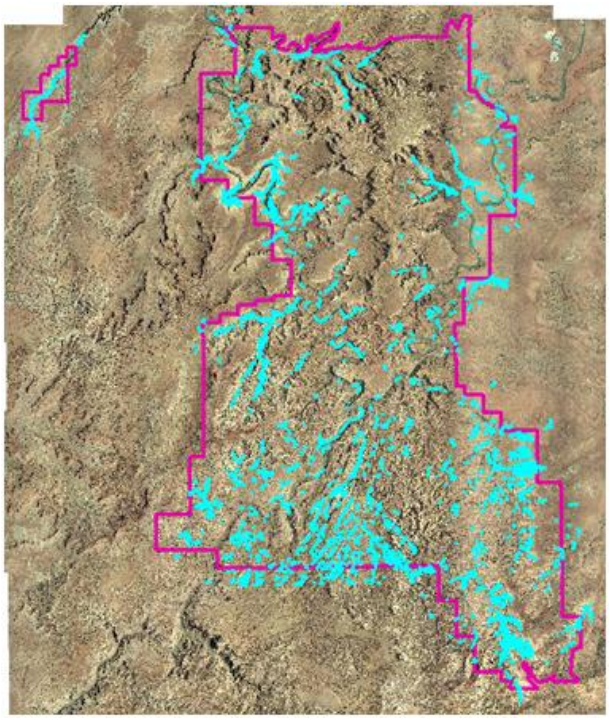
Associations
Achnatherum hymenoides Colorado Plateau Herbaceous Vegetation
Artemisia filifolia Colorado Plateau Shrubland
Atriplex canescens Shrubland
Atriplex canescens / Pleuraphis jamesii Shrubland
Atriplex canescens / Sporobolus airoides Shrubland
Atriplex canescens / Suaeda moquinii Shrubland
Ericameria nauseosa Shrubland
Ericameria nauseosa / Bromus tectorum Semi-natural Shrubland
Ericameria nauseosa / Sporobolus airoides Shrubland
Oenothera pallida Herbaceous Vegetation [Park Special]
Opuntia polyacantha / Pleuraphis jamesii Dwarf-shrubland
Opuntia spp. Shrubland Alliance

Common species
- *Atriplex canescens*
- *Chrysothamnus nauseosus*
- *Ephedra torreyana*
- *Oenothera pallida*
- *Sporobolus airoides*
- *Bromus tectorum*
- *Artemisia filifolia*
- *Ephedra viridis*
- *Opuntia polyacantha*
- *Stipa hymenoides*
- *Pleuraphis jamesii*
- *Suaeda torreyana*

S-TERR Map Class Statistics

Type:	Alliance
Frequency:	2,094 total polygons 1,736 total polygons in CANY 358 total polygons in the environs
Total project area:	3,032 hectares / 7,492 acres (1.8 %) 2,548 hectares / 6,297 acres in CANY 484 hectares / 1,195 acres in the environs
Average Polygon Size:	1.4 hectares / 3.6 acres
Producer's accuracy:	83% ± 7%
User's accuracy:	78% ± 7%

Distribution in Mapping Area

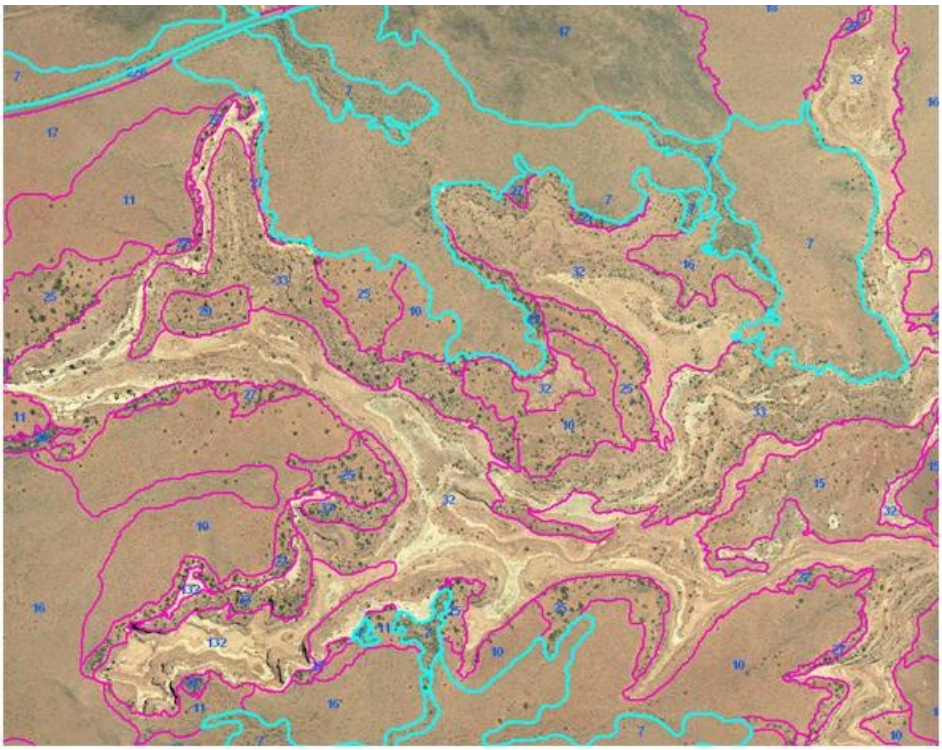


Distribution/Ecology/Composition

Upper alluvial terraces, occurring both along the major river corridors and in tributary drainages, or broad valley bottoms dominated by any combination of the following shrubs and grasses: *Atriplex canescens, Ericameria nauseosa*, *Opuntia* spp., *Sporobolus airoides, Achnatherum hymenoides*, and *Pleuraphis jamesii*. The understory may be dominated by weedy species such as *Bromus tectorum* or *Salsola tragus.* On older terraces with well-developed cryptobiotic soil crusts, *Ephedra torreyana* may be dominant with *Stipa hymenoides* and/or *Pleuraphis jamesii* in the understory. On alluvial terraces where aeolian sands have deposited, *Artemisia filifolia* and/or *Stipa hymenoides* may be dominant. *Sarcobatus vermiculatus* and *Artemisia tridentata* shrubs, if present, have only trace to very low cover. This is a floristically heterogeneous map class which was originally developed to capture just saltbush-dominated shrublands, but was expanded to include a variety of other shrub dominants due to the mosaiced nature of these high terraces and the difficulty in separating species based on their aerial photo signatures.

Interpretation

This very common map class appears as small to large regular polygons on gentle slopes and flat terraces along river corridors and in canyon or valley bottoms throughout the Park where alluvial soils dominate. The signature is a smooth, light gray-green (grass or weedy forb cover) to light reddish-brown (weedy forb or bare soil cover), with dark grey speckles representing the shrub cover. Common neighbors include polygons of greasewood shrublands (map class 6), big sagebrush shrublands (map class 8), weedy herbaceous stands (map class 17), native grasslands (map class 16), blackbrush shrublands (map class 10), and winterfat shrublands (map class 18).



Example of photo signature for map class S-TERR (#7).

Map Class 8
Basin Big Sagebrush Terrace Shrubland Complex (S-SAGE)




Photo credits: NPS

Associations

*Artemisia tridentata (*ssp. *tridentata*, ssp. *xericensis)* Shrubland Alliance
Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Semi-natural Shrubland
Artemisia tridentata ssp. *tridentata / Hesperostipa comata* Shrubland
Artemisia tridentata ssp. *tridentata / Sporobolus cryptandrus* Shrubland
Atriplex canescens – Artemisia tridentata Shrubland
Mahonia fremontii Shrubland

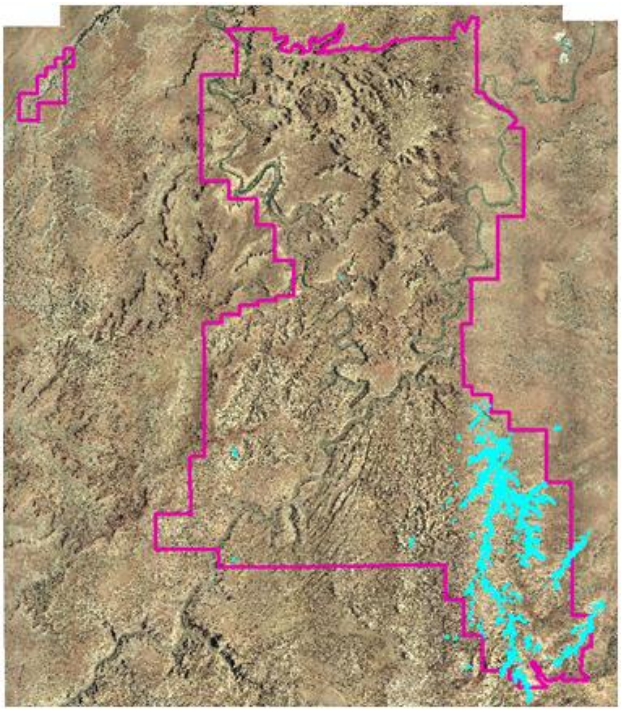
Common species

- *Artemisia tridentata* ssp. *tridentata*
- *Atriplex canescens*
- *Mahonia fremontii*
- *Sporobolus cryptandrus*
- *Stipa hymenoides*
- *Chrysothamnus nauseosus*
- *Ephedra viridis*
- *Sarcobatus vermiculatus*
- *Hesperostipa comata*
- *Bromus tectorum*

S-SAGE Map Class Statistics

Type:	Alliance
Frequency:	750 total polygons 685 total polygons in CANY 65 total polygons in the environs
Total project area:	821 hectares / 2,029 acres (0.5 %) 759 hectares / 1,876 acres in CANY 62 hectares / 153 acres in the environs
Average Polygon Size:	1.1 hectares / 2.7 acres
Producer's accuracy:	90% ± 8%
User's accuracy:	91% ± 7%

Distribution in Mapping Area

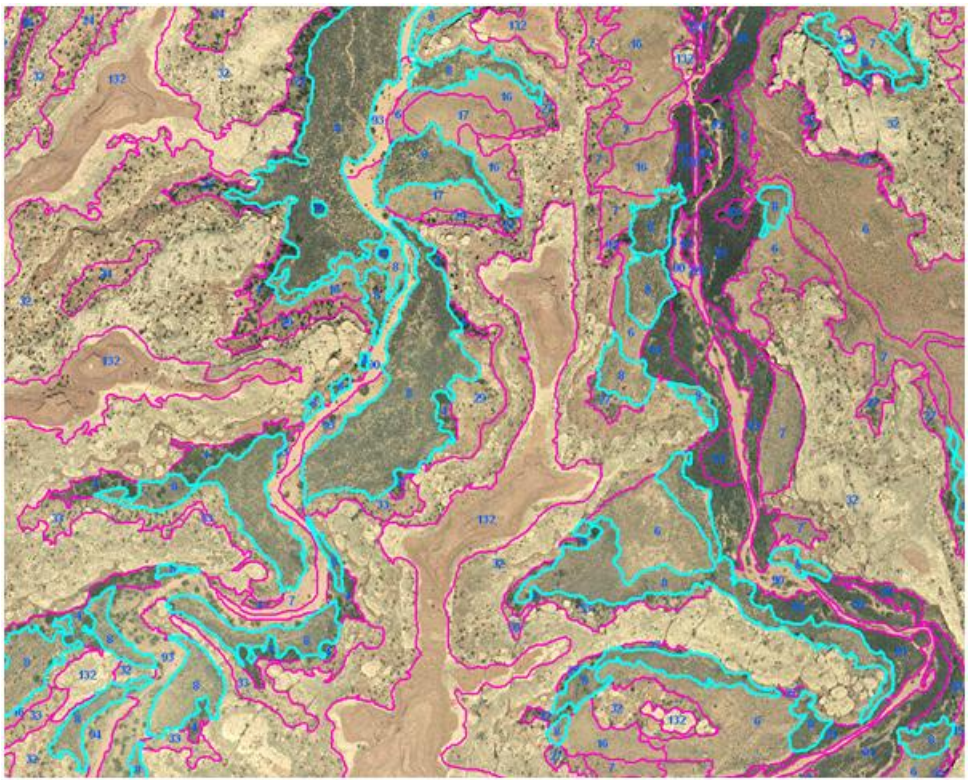


Distribution/Ecology/Composition

Stands occur on alluvial terraces of large tributary drainages and are dominated by *Artemisia tridentata* ssp. *tridentata*. *Sarcobatus vermiculatus, Chrysothamnus nauseosus* and/or *Atriplex canescens* may be present to codominant and the understory may be sparse (with or without high cryptobiotic soil crust cover), weedy (dominated by *Bromus tectorum* or by annual, weedy forbs), or grassy (dominated by *Hesperostipa comata, Sporobolus cryptandrus,* or *Achnatherum hymenoides*). Stands generally occur on the lowest terraces closest to the intermittent drainage channel (where the water table is closer to the surface), whereas stands of greasewood and saltbush are generally found on higher terraces and/or farther from the drainage channel. This is the dominant terrace shrubland type in the upper and middle Salt Creek, Horse Canyon (Needles), Lavender Canyon, and Davis Canyon drainage systems, and is only rarely found outside of these canyons.

Interpretation

This common but restricted map class appears as small to large regular polygons on flat alluvial terraces of major tributary drainages. The shrub signature is a smooth to lightly speckled, medium gray to dark gray-green color, generally dense and continuous with a smooth light gray-green background representing the grass cover or substrate. Common neighbors include polygons of greasewood shrublands (map class 6), high terrace saltbush shrublands (map class 7), native grasslands (map class 16), oak shrublands (map class 4), tributary tamarisk shrublands (map class 91), pinyon-juniper pour-off woodlands (map class 27), and tributary cottonwood woodlands (map class 93).



Example of photo signature for map class S-SAGE (#8).

Map Class 9
Wyoming Big Sagebrush Shrubland (S-WYSA)




Photo credits: NPS

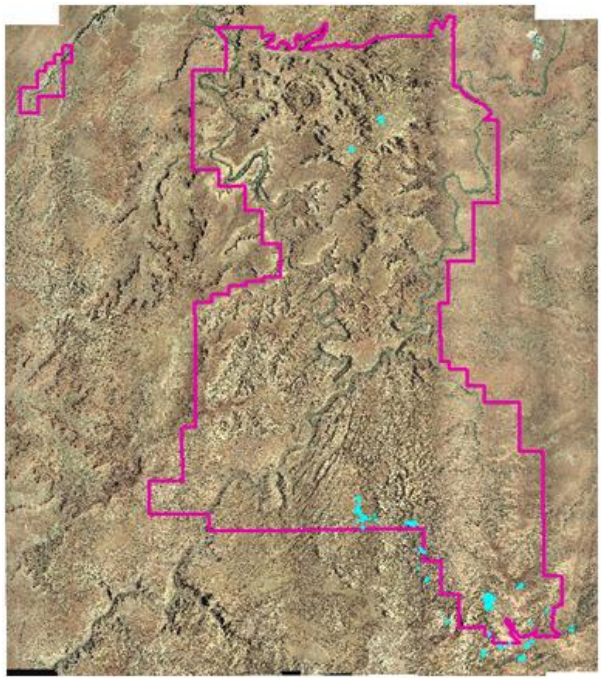
Associations
Artemisia tridentata ssp. *wyomingensis / Bouteloua gracilis* Shrubland
Artemisia tridentata ssp. *wyomingensis / Hesperostipa comata* Shrubland
Artemisia tridentata ssp. *wyomingensis /* Sparse Understory Shrubland
Artemisia tridentata ssp. *wyomingensis /* Disturbed Understory Shrubland

Common species
- *Artemisia tridentata* ssp. *wyomingensis*
- *Krascheninnikovia lanata*
- *Stipa comata*
- *Bromus tectorum*
- *Ephedra viridis*
- *Atriplex canescens*
- *Bouteloua gracilis*
- *Stipa hymenoides*

S-WYSA Map Class Statistics

Type:	Alliance
Frequency:	59 total polygons 35 total polygons in CANY 24 total polygons in the environs
Total project area:	105 hectares / 260 acres (0.1 %) 73 hectares / 179 acres in CANY 33 hectares / 81 acres in the environs
Average Polygon Size:	1.8 hectares / 4.4 acres
Producer's accuracy:	86% ± 15%
User's accuracy:	95% ± 11%

Distribution in Mapping Area

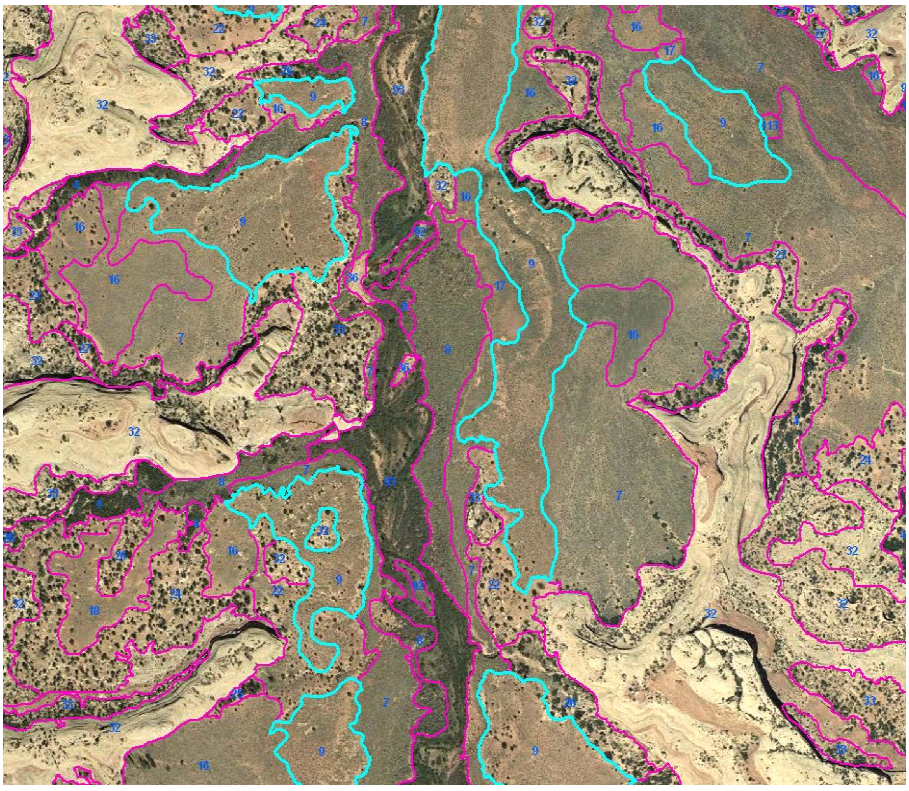


Distribution/Ecology/Composition

Stands of *Artemisia tridentata* ssp. *wyomingensis* are found on mesa tops, plains, valley floors, and canyon bottoms near the south end of the Needles District (and in the surrounding environs) with a couple isolated sites on the mesa top of the Island in the Sky District. The understory is generally grassy, and composed of *Bouteloua gracilis, Achnatherum hymenoides* and/or *Hesperostipa comata*, or in areas with potentially greater previous grazing disturbance, the understory may be sparse or weedy, and dominated by *Bromus tectorum.*

Interpretation

This very rare map class appears as small to large, regular polygons on flat mesa tops and valley/canyon floors in the southernmost portions of the Park and in the southern environs. The signature is a smooth, tan to reddish-grey representing the substrate or the herbaceous cover and a speckled or blotchy light gray representing the shrub cover. Common neighbors include polygons of high terrace saltbush shrublands (map class7), big sagebrush shrublands (map class 8), weedy herbaceous stands (map class 17), native grasslands (map class 16), and blackbrush shrublands (map class 10).



Example of photo signature for map class S-WYSA (#9).

Map Class 10
Blackbrush Shrubland (S-BLAC)




Photo credits: NPS

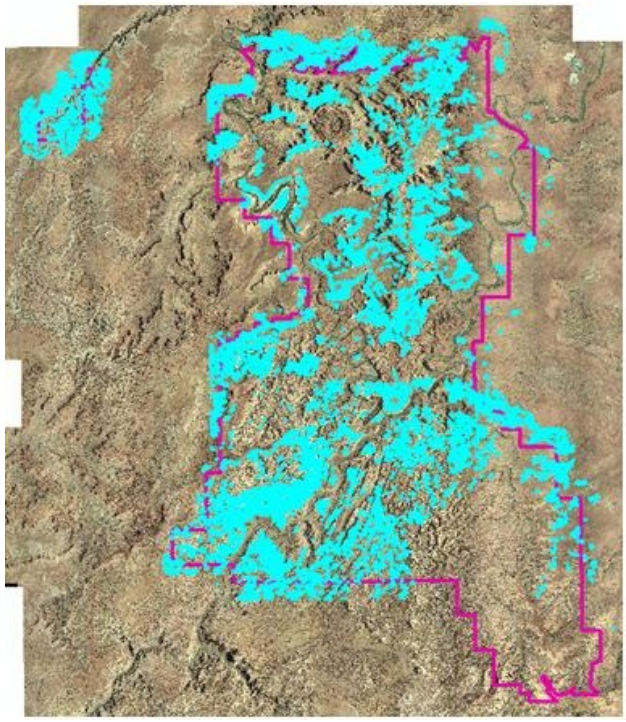
Associations
Coleogyne ramosissima / Pleuraphis jamesii Shrubland
Coleogyne ramosissima Shrubland

Common species
- *Coleogyne ramosissima*
- *Pleuraphis jamesii*
- *Ephedra viridis*
- *Gutierrezia sarothrae*
- *Ephedra torreyana*
- *Juniperus osteosperma*

S-BLAC Map Class Statistics

Type:	Association
Frequency:	3,600 total polygons 2,846 total polygons in CANY 754 total polygons in the environs
Total project area:	16,093 hectares / 39,766 acres (9.4 %) 11,149 hectares / 27,550 acres in CANY 4,944 hectares / 12,216 acres in the environs
Average Polygon Size:	4.5 hectares / 11 acres
Producer's accuracy:	91% ± 4%
User's accuracy:	91% ± 4%

Distribution in Mapping Area

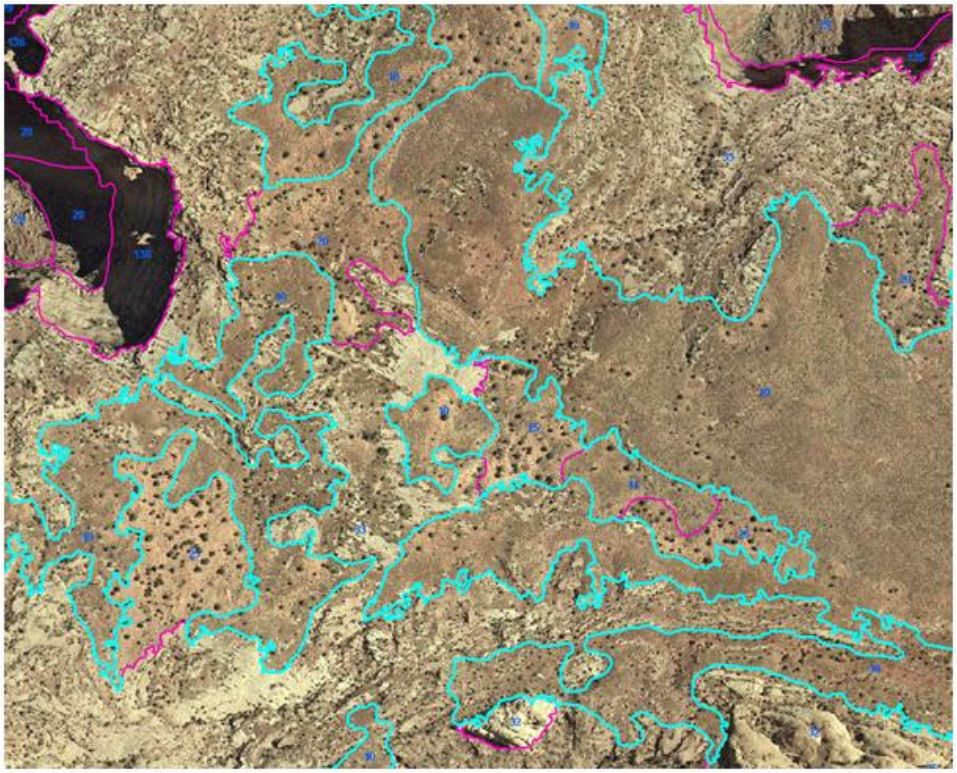


Distribution/Ecology/Composition

Map class 10 represents stands of *Coleogyne ramosissima* with usually >10% cover, and where blackbrush is often the only shrub species present with more than trace cover. Although these communities tend to be pretty homogenous, other shrub species may be present, most commonly *Ephedra* spp., but blackbrush should be at least three times the abundance of any other shrubs species. Scattered *Juniperus osteosperma* may be present as a minor component of the community (usually with 5% or less total cover). Blackbrush is tolerant of and/or finds suitable a variety of substrates, ranging from loose aeolian sands to pavement-like gravel cover to high cover by cryptobiotic soil crusts to shallow soil pockets in a slickrock mosaic. Pure blackbrush shrublands and those mixed with *Ephedra torreyana* and/or *Atriplex confertifolia* (map class 15) are the most ubiquitous vegetation types in the Park, and occur nearly everywhere except on the terraces of the Green and Colorado Rivers and in the deep canyon systems of the Maze and the Salt Creek tributary system (including Lavender, Davis, Horse, Salt Creek, Lost, Squaw, Five Fingers, and Elephant Canyons).

Interpretation

This ubiquitous map class appears as small to large regular polygons on flat to rolling sites on mesa tops, rims, plateaus, broad valley bottoms, plains, and less frequently on moderately steep slopes or in canyon bottoms throughout the Park. The blackbrush signature is one of the most easily recognizable through aerial viewing, 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 grass cover. Scattered juniper tree crowns are common and appear as large rounded black spots. Because this map class is so widespread in the Park, it is bordered by a variety of other map classes, but the most common are shale barrens desert scrub (map class 15), pinyon-juniper/blackbrush woodlands (map class 20), pinyon-juniper sand dune woodlands (map class 25), and broken ledge and slope pinyon-juniper woodlands (map class 33).



Example of photo signature for map class S-BLAC (#10).

Map Class 11
Sand Sheet Mixed Shrubland Complex (S-SAND)




Photo credits: NPS

Associations

Artemisia filifolia Colorado Plateau Shrubland
Atriplex canescens - Ephedra viridis Shrubland
Coleogyne ramosissima Shrubland
Coleogyne ramosissima / Pleuraphis jamesii Shrubland
Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. *tuckeri* Shrubland
Ephedra torreyana / Achnatherum hymenoides – Pleuraphis jamesii Shrubland
Ephedra torreyana / Pleuraphis jamesii Shrubland
Ephedra torreyana / Sporobolus cryptandrus Shrub Herbaceous Vegetation [Park Special]
Ephedra viridis / (Achnatherum hymenoides - Hesperostipa comata) Shrubland
Ephedra viridis / Muhlenbergia pungens Shrubland [Park Special]
Quercus havardii var. *tuckeri* Shrubland

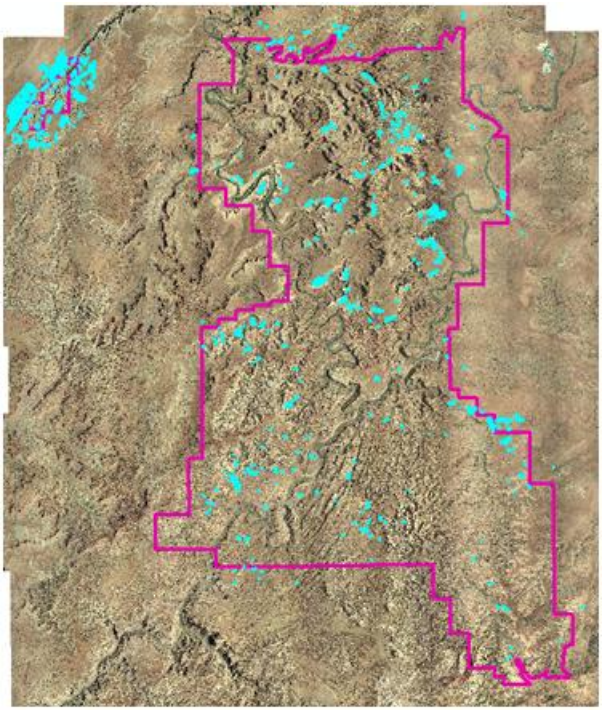
Common species

- *Artemisia filifolia*
- *Quercus havardii* var. *tuckeri*
- *Ephedra viridis*
- *Pleuraphis jamesii*
- *Muhlenbergia pungens*
- *Chrysothamnus nauseosus*
- *Coleogyne ramosissima*
- *Ephedra torreyana*
- *Stipa hymenoides*
- *Sporobolus cryptandrus*
- *Yucca angustissima*
- *Atriplex canescens*

S-SAND Map Class Statistics

Type:	Association
Frequency:	487 total polygons 366 total polygons in CANY 121 total polygons in the environs
Total project area:	1,562 hectares / 3,861 acres (0.9 %) 808 hectares / 1,996 acres in CANY 754 hectares / 1,864 acres in the environs
Average Polygon Size:	3.2 hectares / 7.9 acres
Producer's accuracy:	84% ± 10%
User's accuracy:	66% ± 11%

Distribution in Mapping Area

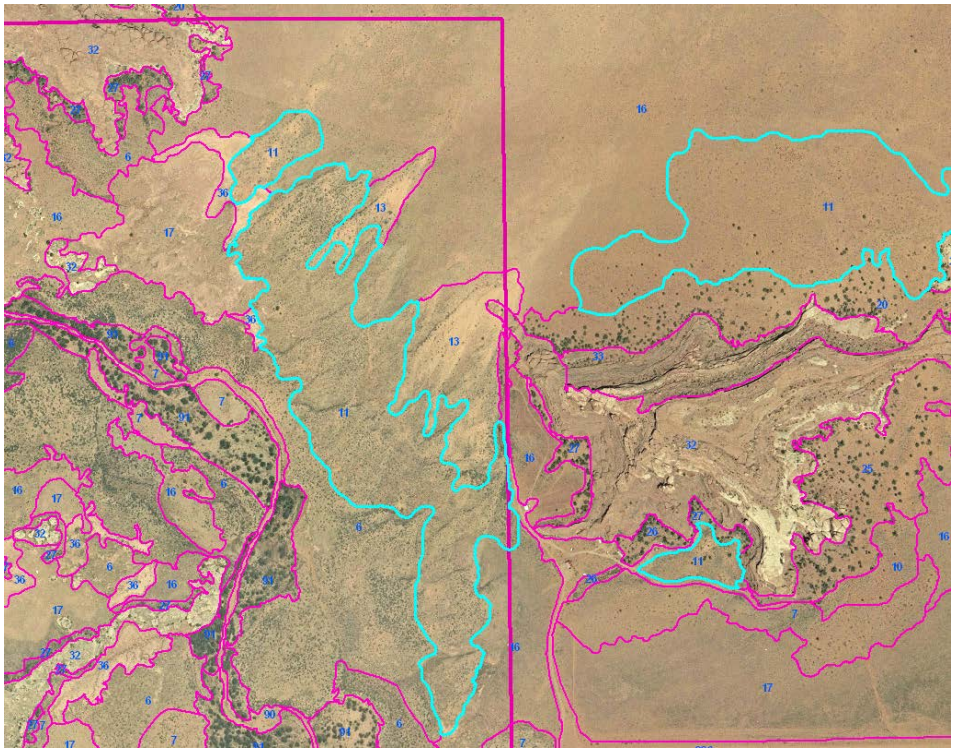


Distribution/Ecology/Composition

Stands occur on flat to moderately rolling sand sheets in transitional dune areas, where once loose/blowing aeolian sands are now mostly stabilized, but still maintain the dune topography. This map class is defined less by floristics than by soils/geology and therefore, stands may be dominated by a variety of shrubs including *Coleogyne ramosissima, Artemisia filifolia, Ephedra viridis,* and/or *Ephedra torreyana*. On looser sand sheets/dunes, *Quercus havardii* is present to dominant. Other shrubs such as *Ericameria nauseosa* and *Atriplex canescens* may be present with low cover. Grass cover is generally present to moderately abundant (but is not a major component of the community) and is dominated by *Achnatherum hymenoides* and/or *Pleuraphis jamesii,* though other grasses may be present, including *Sporobolus cryptandrus, Sporobolus* spp., and *Muhlenbergia pungens*. Cryptobiotic crust cover is absent or not well-developed, but may be well-developed in patches on more stabilized dunes.

Interpretation

This uncommon map class appears as small to large, regular polygons on flat sites to steep slopes and hills and is widely scattered throughout the Park wherever aeolian sands have been deposited, from mesa tops, plateaus and plains to valley and canyon bottoms. The signature is a mosaic of light tan to greenish-grey, smooth blown-out soils with a mottled and/or speckled shrub layer of light to dark brown or grey. Where dune ridges are high, shadows from ridgelines are evident. Because these sand sheets may 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) and true sand dunes (map class 13).



Example of photo signature for map class S-SAND (#11).

Map Class 13
Sand Dune Shrub-Herbaceous Complex (C-DUNE)




Photo credits: NPS

Associations

Achnatherum hymenoides Colorado Plateau Herbaceous Vegetation
Ericameria nauseosa Sand Deposit Sparse Shrubland
Eriogonum leptocladon Sparse Vegetation
Oenothera albicaulis Herbaceous Vegetation [Park Special]
Poliomintha incana - Artemisia filifolia - Vanclevea stylosa Shrubland
Rumex hymenosepalus Sparse Vegetation

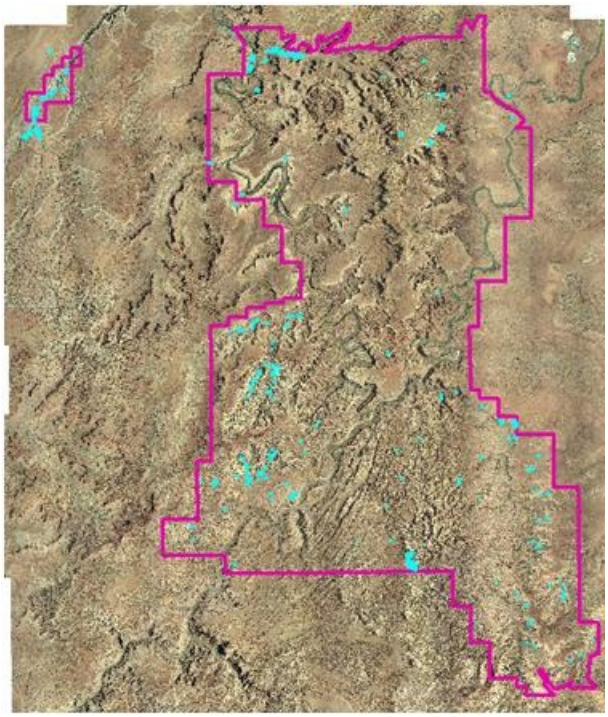
Common species

- *Poliomintha incana*
- *Artemisia filifolia*
- *Chrysothamnus nauseosus*
- *Rumex hymenosepalus*
- *Salsola tragus*
- *Oenothera albicaulis*
- *Eriogonum leptocladon*
- *Vanclevea stylosa*
- *Stipa hymenoides*
- *Muhlenbergia pungens*
- *Aristida purpurea*
- *Opuntia* spp.

C-DUNE Map Class Statistics

Type:	Alliance
Frequency:	227 total polygons 209 total polygons in CANY 18 total polygons in the environs
Total project area:	287 hectares / 708 acres (0.2 %) 255 hectares / 630 acres in CANY 32 hectares / 79 acres in the environs
Average Polygon Size:	1.3 hectares / 3.1 acres
Producer's accuracy:	68% ± 14%
User's accuracy:	84% ± 13%

Distribution in Mapping Area

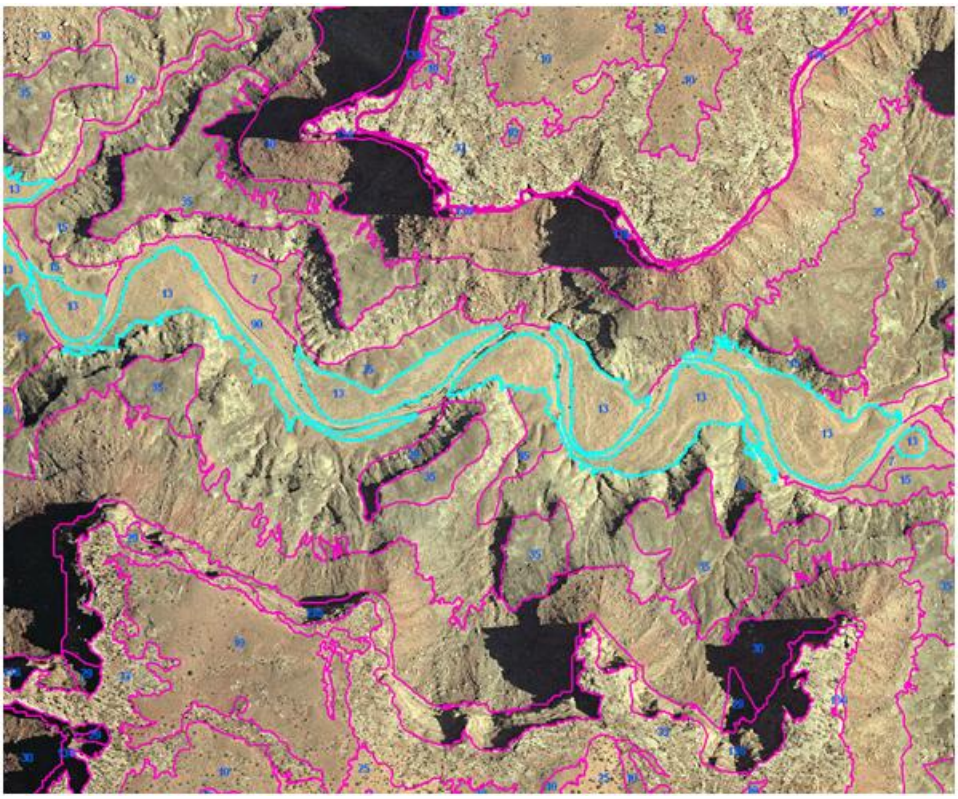


Distribution/Ecology/Composition

Stands occur on loose dunes or sand blowouts, often on aeolian terraces along drainages or in canyon bottoms, but also on the rims of mesas and on broad plains near the mouths of canyons, where aeolian sands have accumulated. These are active dunes, generally loose sand or only slightly stabilized by crust cover, and are dominated by *Achnatherum hymenoides* and sand-loving species such as *Eriogonum leptocladon*, *Vanclevea stylosa*, *Artemisia filifolia, Poliomintha incana,* and *Muhlenbergia pungens*. *Opuntia* spp. and weedy annual species, such as *Salsola tragus* and *Bromus tectorum,* may contribute low to moderate cover.

Interpretation

This rare and widely scattered map class occurs on flats to steep slopes throughout the Park, wherever loose aeolian sands have been deposited and/or have accumulated. The signature is a mosaic of light yellowish-tan, smooth blown out soils with a sparse mottled and/or speckled shrub layer of light to dark brown or grey and a smooth greenish-grey herbaceous signature; where dune ridges are high, shadows from ridgelines are evident. Because these sand dunes occur in a variety of environmental settings and are widely scattered throughout the Park, there are polygons of many different map classes adjacent to this map class.



Example of photo signature for map class C-DUNE (#13).

Map Class 14
Green Mormon Tea- Xeric Grasses Shrub Herbaceous Vegetation (S-EPVI)




Photo credits: NPS

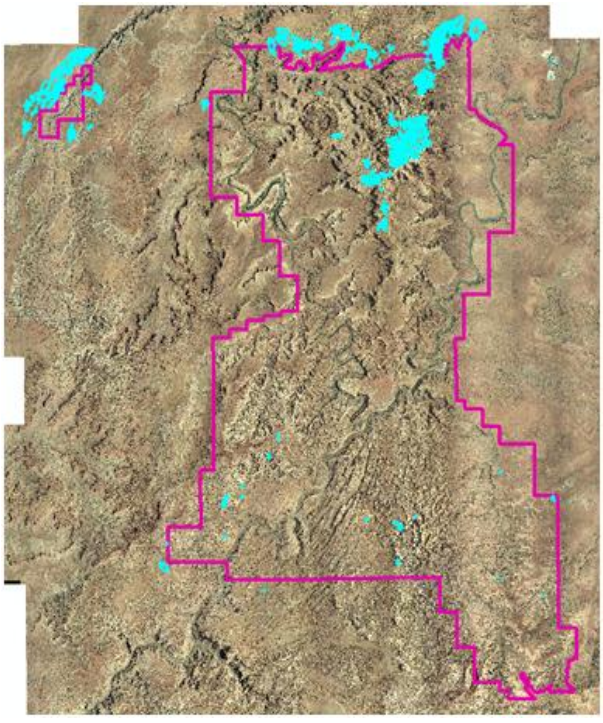
Associations
Ephedra viridis / Bouteloua gracilis Shrubland
Ephedra viridis / (Achnatherum hymenoides - Hesperostipa comata) Shrubland
Ephedra viridis / Pleuraphis jamesii Shrubland

Common species
- *Ephedra viridis*
- *Atriplex canescens*
- *Pleuraphis jamesii*
- *Stipa hymenoides*
- *Gutierrezia sarothrae*
- *Stipa comata*
- *Bouteloua gracilis*
- *Sporobolus* spp.

S-EPVI Map Class Statistics

Type:	Alliance
Frequency:	209 total polygons
	100 total polygons in CANY
	109 total polygons in the environs
Total project area:	2,782 hectares / 6,873 acres (1.6 %)
	1,256 hectares / 3,105 acres in CANY
	1,525 hectares / 3,769 acres in the environs
Average Polygon Size:	13.3 hectares / 32.9 acres
Producer's accuracy:	97% ± 4%
User's accuracy:	95% ± 6%

Distribution in Mapping Area

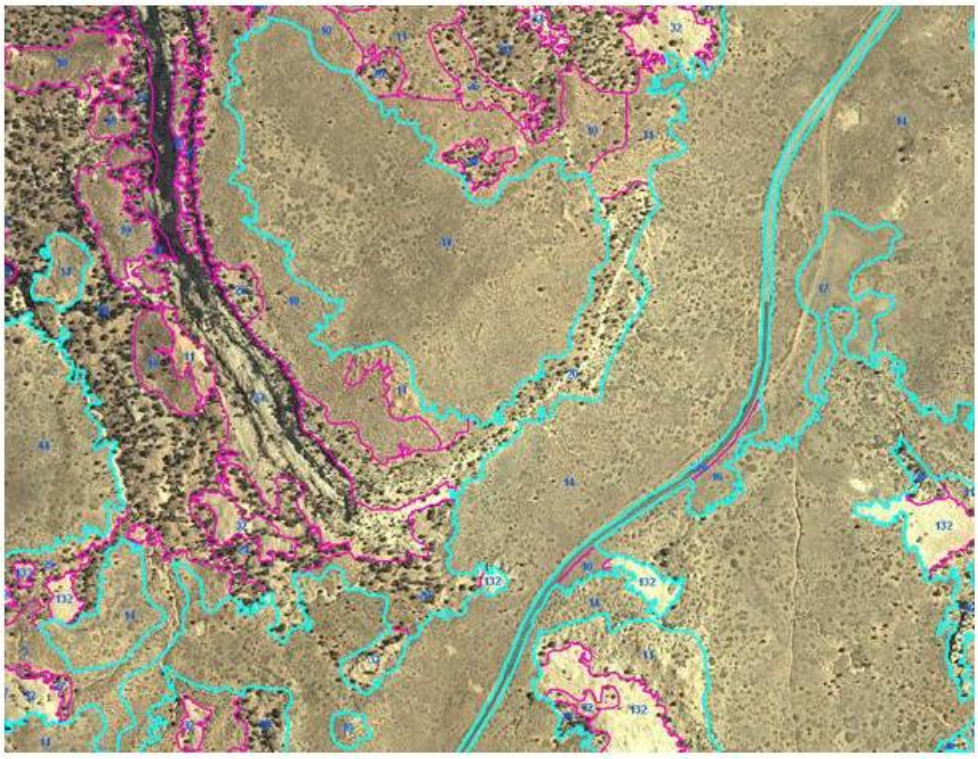


Distribution/Ecology/Composition

Stands occur on deep soils of flat sites on plateaus, mesa tops, and in broad valley bottoms and are characterized by shrub herbaceous communities of the mot form of *Ephedra viridis* (with up to 40% cover) with up to equal cover of grasses (some combination of *Achnatherum hymenoides*, *Hesperostipa comata, Bouteloua gracilis, Sporobolus cryptandrus*, *Sporobolus airoides*, and *Pleuraphis jamesii*). Cryptobiotic soil crusts are patchy and may be well-developed.

Interpretation

This somewhat common but restricted map class occurs as small to very large polygons on flat sites mainly on the Island in the Sky mesa top and neighboring environs north of the Park and in the environs around Horseshoe Canyon; a few scattered examples of this type occur in the Needles and Maze Districts of the Park. The signature is a mottled light to dark grey-green with clones of *Ephedra viridis* recognizable as darker spots or freckles within the mottled mosaic, and grass cover recognizable as a smooth lighter green background. Common neighbors include polygons of blackbrush shrublands (map class 10), sand sheet shrublands (map class 11), native grasslands (map class 16), weedy herbaceous vegetation (map class 17), and pinyon-juniper/blackbrush woodlands (map class 20.



Example of photo signature for map class S-EPVI (#14).

Map Class 18
Winterfat Dwarf-shrubland (S-WINT)




Photo credits: NPS

Associations

Chrysothamnus viscidiflorus - Krascheninnikovia lanata Shrubland [Park Special]
Krascheninnikovia lanata Dwarf-shrubland
Krascheninnikovia lanata / Bouteloua gracilis Dwarf-shrub Herbaceous Vegetation
Krascheninnikovia lanata / Hesperostipa comata Dwarf-shrubland
Krascheninnikovia lanata / Pleuraphis jamesii Dwarf-shrubland
Krascheninnikovia lanata / Sporobolus cryptandrus Dwarf-shrubland [Park Special]

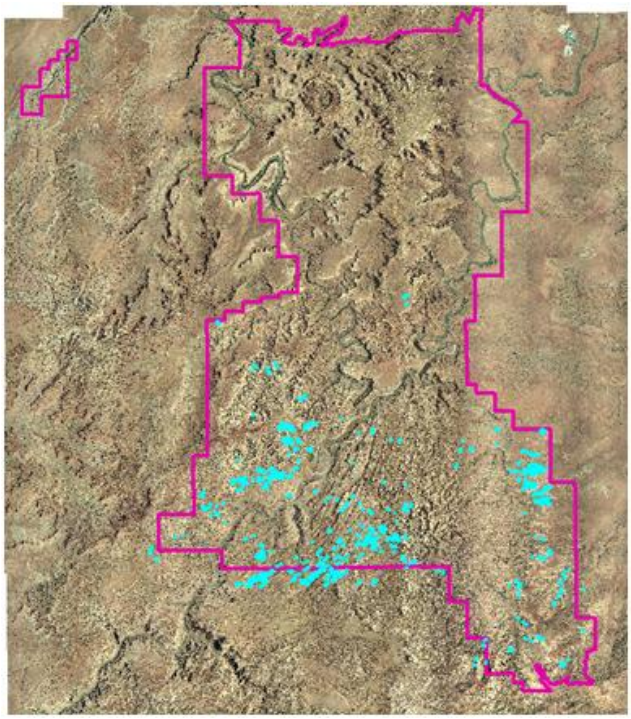
Common species

- *Krascheninnikovia lanata*
- *Stipa comata*
- *Sporobolus cryptandrus*
- *Atriplex canescens*
- *Opuntia* spp.
- *Bromus tectorum*
- *Bouteloua gracilis*
- *Pleuraphis jamesii*
- *Stipa hymenoides*
- *Ephedra viridis*
- *Coleogyne ramosissima*
- *Chrysothamnus viscidiflorus*

S-WINT Map Class Statistics

Type:	Alliance
Frequency:	377 total polygons 319 total polygons in CANY 58 total polygons in the environs
Total project area:	879 hectares / 2,172 acres (0.5 %) 705 hectares / 1,743 acres in CANY 174 hectares / 429 acres in the environs
Average Polygon Size:	2.3 hectares / 5.8 acres
Producer's accuracy:	86% ± 9%
User's accuracy:	91% ± 8%

Distribution in Mapping Area

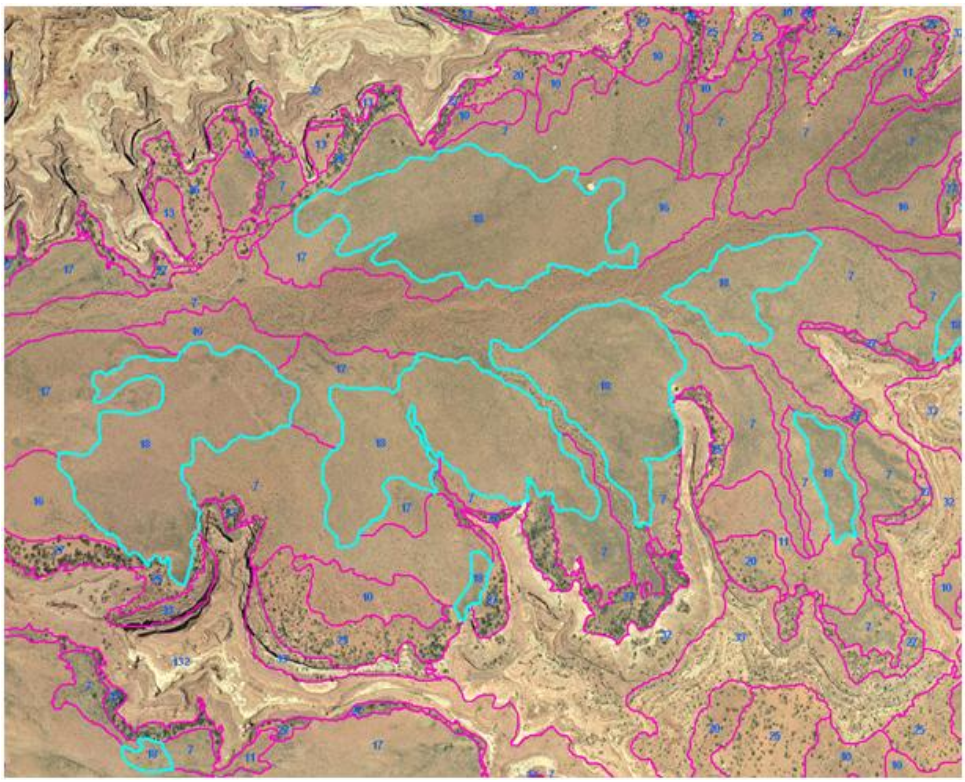


Distribution/Ecology/Composition

Open to relatively dense stands of *Krascheninnikovia lanata*, often with a grassy or weedy understory and low to high cryptobiotic crust cover. Associated shrubs may be present with low cover, and dominant grass species in the understory include *Hesperostipa comata, Pleuraphis jamesii, Bouteloua gracilis, Achnatherum hymenoides,* and *Sporobolus cryptandrus.* Stands occur on flat to moderately sloping sites in canyon bottoms, grabens, alluvial valley floors, aeolian sandsheets (including stabilized dunes), mesa tops, benches, terraces, plains, and rolling hills typical of areas near the entrance to the Needles District (west side) and areas in the Grabens (east side), as well as Ernie's Country and the Doll's House areas in the Maze District.

Interpretation

This uncommon map class appears as small to medium, regular polygons on flats and mostly gentle slopes on a variety of landforms throughout the Grabens, mesa tops, and valley bottoms typical of the Maze and Needles District of the Park. The color is a smooth, medium gray-green with the tiny speckles of winterfat shrubs generally only visible under stereoscopic magnification of hard-copy aerial photos. Common neighbors include polygons of high terrace saltbush shrublands (map class 7), blackbrush shrublands (map class 10), native grasslands (map class 16), and weedy herbaceous vegetation (map class 17).



Example of photo signature for map class S-WINT (#18).

Map Class 90
Dry Wash Complex (C-WASH)




Photo credits: NPS

Associations

Atriplex canescens Desert Wash Shrubland
Artemisia campestris Stream Terrace Herbaceous Vegetation
Chrysothamnus linifolius Shrubland [Park Special]
Ericameria nauseosa Desert Wash Shrubland
Fraxinus anomala Woodland
Iva acerosa Herbaceous Vegetation [Park Special]

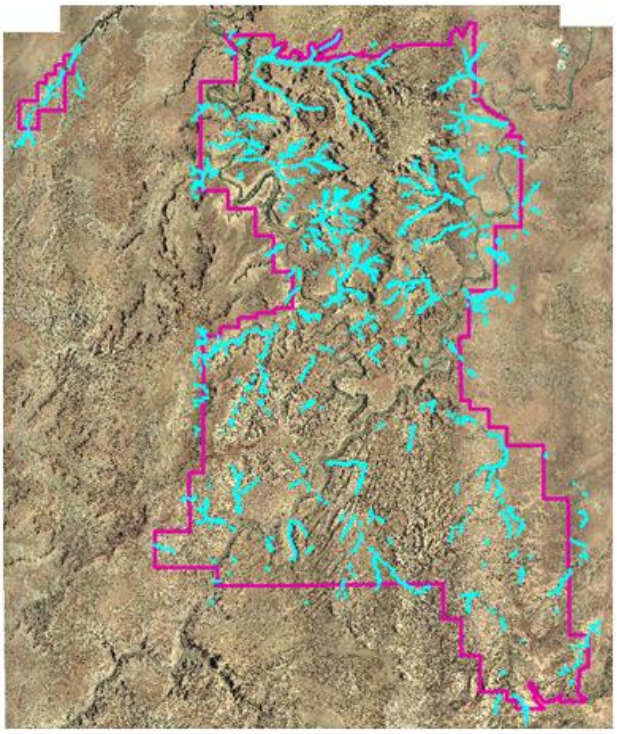
Common species

- *Chrysothamnus nauseosus*
- *Atriplex canescens*
- *Oxytenia acerosa*
- *Brickellia* spp.
- *Artemisia ludoviciana*
- *Artemisia dracunculus*
- *Mahonia fremontii*
- *Bromus tectorum*
- *Chrysothamnus linifolius*
- *Fraxinus anomala*
- *Stipa hymenoides*
- *Artemisia campestris*
- *Sporobolus* spp.
- *Purshia mexicana*
- *Artemisia filifolia*
- *Salsola tragus*

C-WASH Map Class Statistics

Type:	Complex
Frequency:	438 total polygons 350 total polygons in CANY 88 total polygons in the environs
Total project area:	1,257 hectares / 3,106 acres (0.7 %) 1,083 hectares / 2,677 acres in CANY 174 hectares / 429 acres in the environs
Average Polygon Size:	2.9 hectares / 7.1 acres
Producer's accuracy:	92% ± 7%
User's accuracy:	98% ± 5%

Distribution in Mapping Area

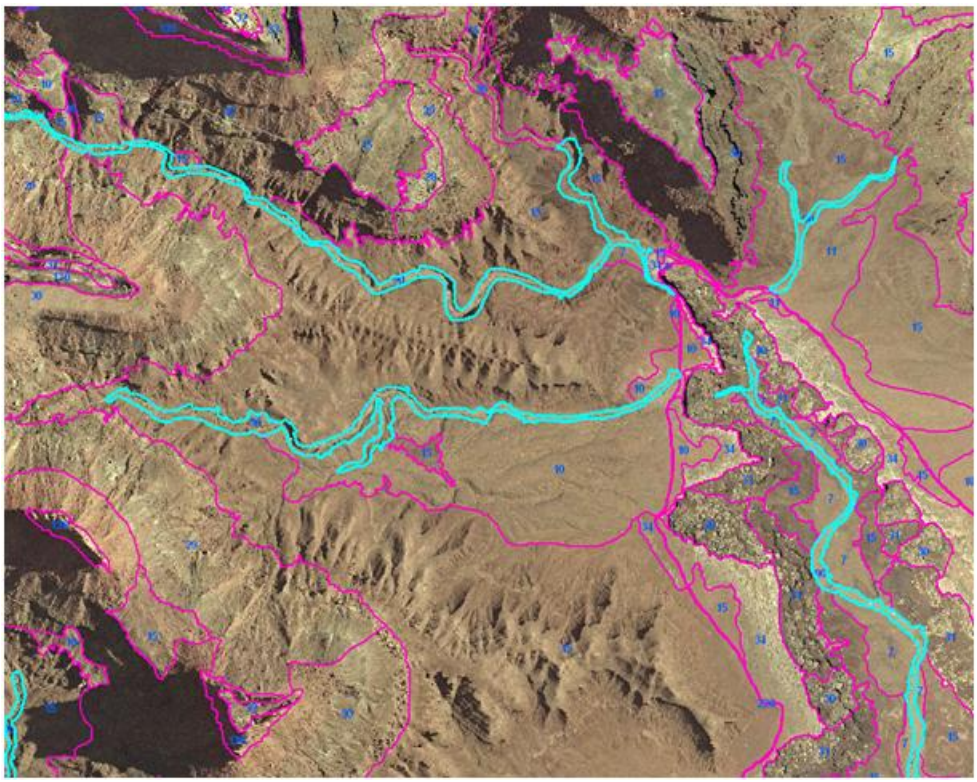


Distribution/Ecology/Composition

Stands occur in generally dry, rocky and/or sandy, intermittently flooded wash channels throughout the Park. The vegetation is generally sparse, consistent to scattered, and dominated by the shrubs *Chrysothamnus* spp., *Fraxinus anomala,* or (more rarely) *Atriplex canescens*, accompanied by herbaceous species including *Stipa hymenoides, Artemisia campestris,* and/or *Iva acerosa.* Vegetation occurs growing in the channel or on the banks. Scattered pinyon or juniper trees may be present, but provide less than 3-5% total cover.

Interpretation

This common and widespread map class appears as small to large, very narrow, linear and/or sinuous polygons on gentle to moderate slopes following drainage courses/wash channels throughout the Park. The signature is a white to light brown meandering line of the scoured wash channel with scattered dark green to dark brown spots representing shrub cover. Because this map class is so widespread and occurs throughout the Park, neighboring polygons include those of most all of the other map classes.



Example of photo signature for map class C-WASH (#90).

Upland Herbaceous Communities

Map Class 16
Valley Bottom and Benchlands Grasslands (H-HERB)





Photo credits: NPS

Associations

Achnatherum hymenoides Colorado Plateau Herbaceous Vegetation
Bouteloua gracilis Herbaceous Vegetation
Hesperostipa comata Great Basin Vegetation
Pleuraphis jamesii Herbaceous Vegetation

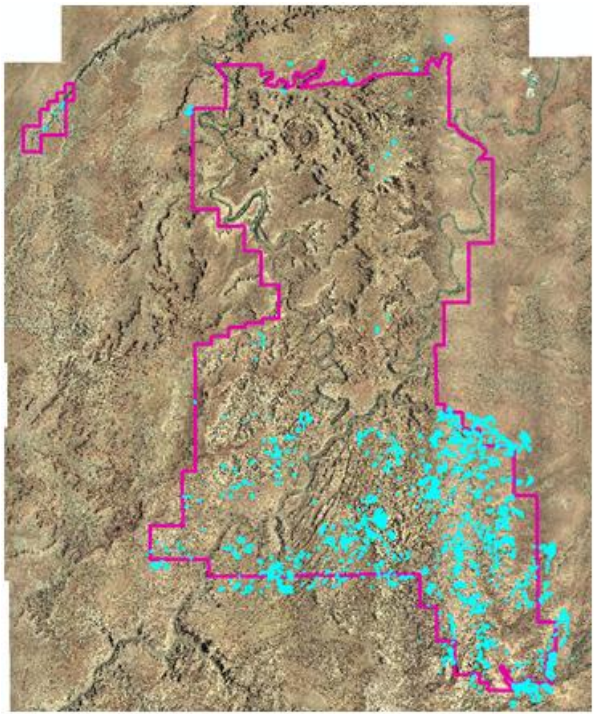
Common species

- *Stipa hymenoides*
- *Bouteloua gracilis*
- *Aristida purpurea*
- *Sporobolus airoides*
- *Bromus tectorum*
- *Elymus elymoides*
- *Atriplex canescens*
- *Gutierrezia sarothrae*
- *Stipa comata*
- *Pleuraphis jamesii*
- *Sporobolus cryptandrus*
- *Festuca octoflora*
- *Sphaeralcea spp.*
- *Krascheninnikovia lanata*
- *Ephedra* spp.
- *Opuntia* spp.

H-HERB Map Class Statistics

Type:	Complex
Frequency:	1,221 total polygons 979 total polygons in CANY 242 total polygons in the environs
Total project area:	2,341 hectares / 5,786 acres (1.4 %) 1,389 hectares / 3,432 acres in CANY 952 hectares / 2,353 acres in the environs
Average Polygon Size:	1.9 hectares / 4.7 acres
Producer's accuracy:	78% ± 11%
User's accuracy:	78% ± 11%

Distribution in Mapping Area

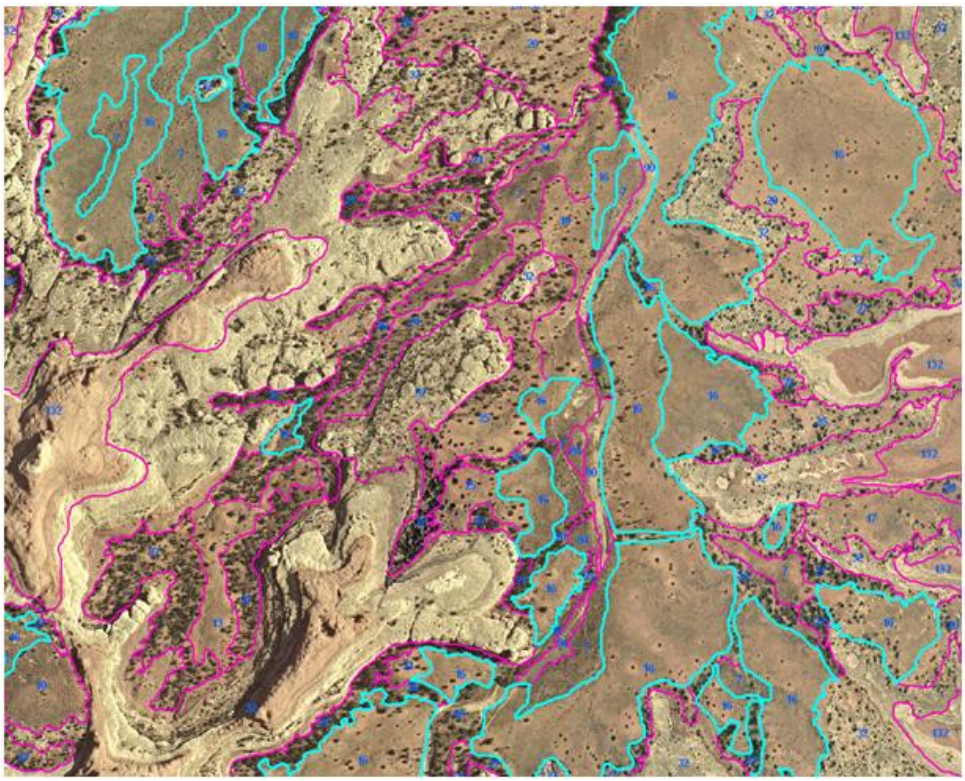


Distribution/Ecology/Composition

Native, perennial grasslands that occur on level to rolling sand sheets or older alluvium on broad plateaus, plains, and benches, or in grabens or valley bottoms and are dominated by one or a combination of the following grass species, *Achnatherum hymenoides, Hesperostipa comata, Sporobolus cryptandrus, Sporobolus airoides, Pleuraphis jamesii*, or *Bouteloua gracilis*. Scattered clumps of *Ephedra viridis, Atriplex canescens,* and *Krascheninnikovia lanata* may be present but have <25% relative cover to the grasses. Biological soil crusts have low to high cover and are slightly to well-developed.

Interpretation

This common map class appears as small to medium regular polygons on gentle slopes and flats in plains and valley bottoms throughout the Needles and Maze Districts of the Park. The signature is a smooth, sometimes blotchy light gray-green to greenish-brown with scattered shrub or tree crowns occasionally providing black spots or dark brown speckles. Because grassy openings occur in a variety of habitats in the Park, a number of map classes occur adjacent to this map class; but the most common neighbors include polygons of blackbrush shrublands (map class 10), high terrace saltbush shrublands (map class 7), and weedy herbaceous vegetation (map class 17).



Example of photo signature for map class H-HERB (#16).

Map Class 17
Weedy Herbaceous Complex (C-WEED)




Photo credits: NPS

Associations

Bromus tectorum Semi-natural Herbaceous Vegetation
Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii Dwarf Shrubland
Hymenopappus filifolius Herbaceous Vegetation [Park Special]
Rumex hymenosepalus Sparse Vegetation
Salsola spp. Semi-natural Herbaceous Vegetation
Sphaeralcea (coccinea, parvifolia) Herbaceous Vegetation
Sporobolus cryptandrus Great Basin Herbaceous Vegetation

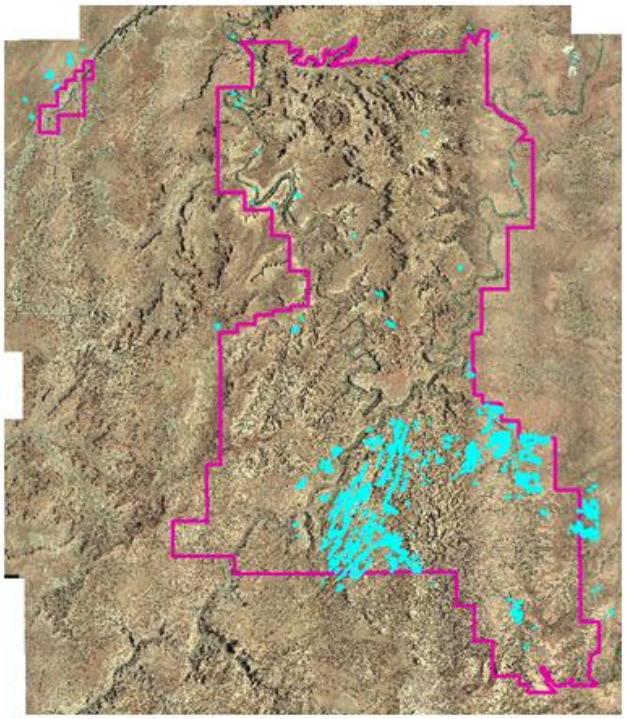
Common species

- *Bromus tectorum*
- *Salsola tragus*
- *Sphaeralcea spp.*
- *Opuntia spp.*
- *Rumex hymenosepalus*
- *Plantago patagonica*
- *Hymenopappus filifolius*
- *Sporobolus cryptandrus*
- *Gutierrezia sarothrae*
- *Pleuraphis jamesii*
- *Festuca octoflora*
- *Lappula occidentalis*

C-WEED Map Class Statistics

Type:	Complex
Frequency:	538 total polygons 471 total polygons in CANY 67 total polygons in the environs
Total project area:	2,083 hectares / 5,148 acres (1.2 %) 1,757 hectares / 4,341 acres in CANY 327 hectares / 807 acres in the environs
Average Polygon Size:	3.9 hectares / 9.6 acres
Producer's accuracy:	93% ± 6%
User's accuracy:	92% ± 6%

Distribution in Mapping Area

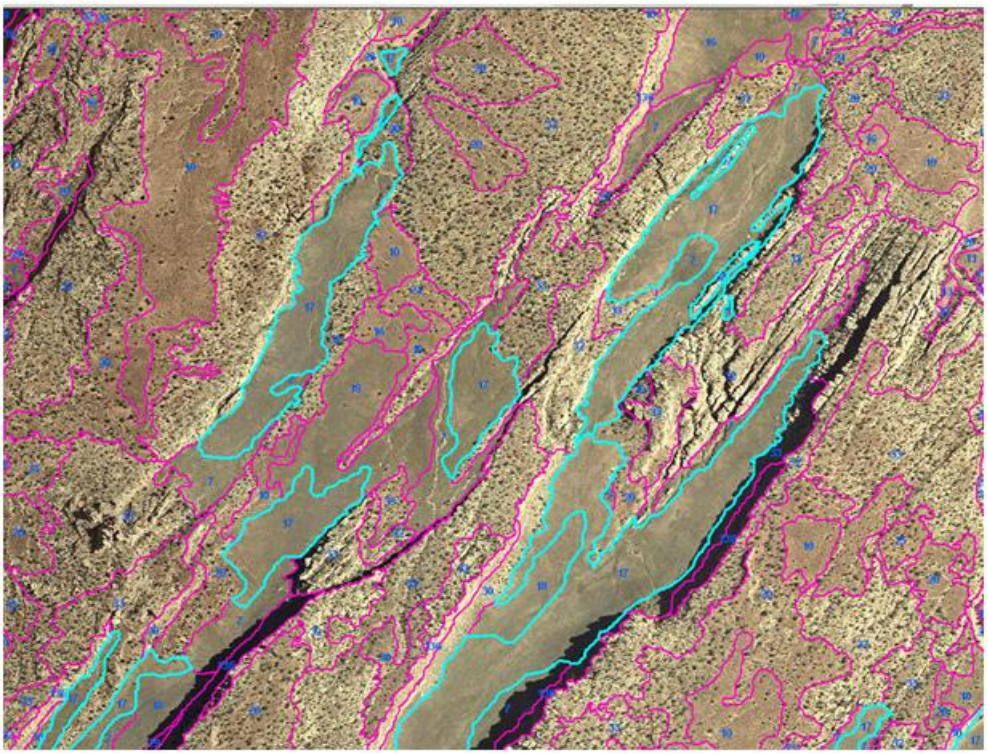


Distribution/Ecology/Composition

Stands occur on flat sites or swales in weedy, degraded areas of previously grazed valley bottoms or plains, typical of the Grabens and Needles Entrance areas in the Needles District of the Park. Native, perennial species such as *Gutierrezia sarothrae, Pleuraphis jamesii, Sporobolus cryptandrus*, and *Sphaeralcea* spp. may be abundant, but most stands are dominated by *Salsola tragus, Bromus tectorum* and other exotic, annual species.

Interpretation

This somewhat uncommon and localized map class appears as small to large rectangular or regular polygons on flats in the Grabens, Squaw Flat, and Salt Creek Pocket areas of the Needles District, as well as in a few widely scattered locations throughout the Park. The signature is light to dark grey-green to grey-brown, smooth-textured, and somewhat blotchy. Common neighbors include polygons of blackbrush shrublands (map class 10), native grasslands (map class 16), winterfat shrublands (map class 18), and high terrace saltbush shrublands (map class 7).



Example of photo signature for map class C-WEED (#17).

Sparse Vegetation & Talus Slope Communities

Map Class 15
Shale Barrens Desert Scrub Complex (S-SCRU)





Photo credits: NPS

Associations

Atriplex confertifolia Great Basin Shrubland
Atriplex confertifolia / Pleuraphis jamesii Shrubland
Atriplex gardneri Dwarf-shrubland
Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland
Coleogyne ramosissima Sparse Vegetation
Coleogyne ramosissima / Pleuraphis jamesii Shrubland
Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation
Ephedra torreyana / Pleuraphis jamesii Shrubland
Eriogonum corymbosum Badlands Sparse Vegetation
Ephedra torreyana Sparse Vegetation
Zuckia brandegeei Sparse Vegetation

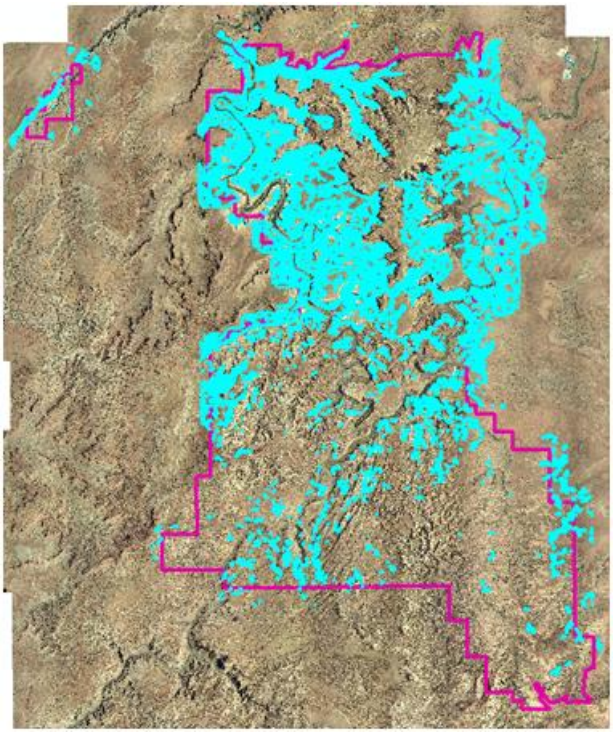
Common species

- *Ephedra torreyana*
- *Coleogyne ramosissima*
- *Zuckia brandegeei*
- *Chrysothamnus nauseosus* var. *junceus*
- *Pleuraphis jamesii*
- *Atriplex confertifolia*
- *Atriplex gardneri*
- *Eriogonum corymbosum*
- *Opuntia* spp.
- *Xylorhiza* spp.

S-SCRU Map Class Statistics

Type:	Complex
Frequency:	2,052 total polygons 1,684 total polygons in CANY 368 total polygons in the environs
Total project area:	22,735 hectares / 56,179 acres (13.3 %) 18,511 hectares / 45,740 acres in CANY 4,224 hectares / 10,439 acres in the environs
Average Polygon Size:	11.1 hectares / 27.4 acres
Producer's accuracy:	86% ± 6%
User's accuracy:	94% ± 4%

Distribution in Mapping Area

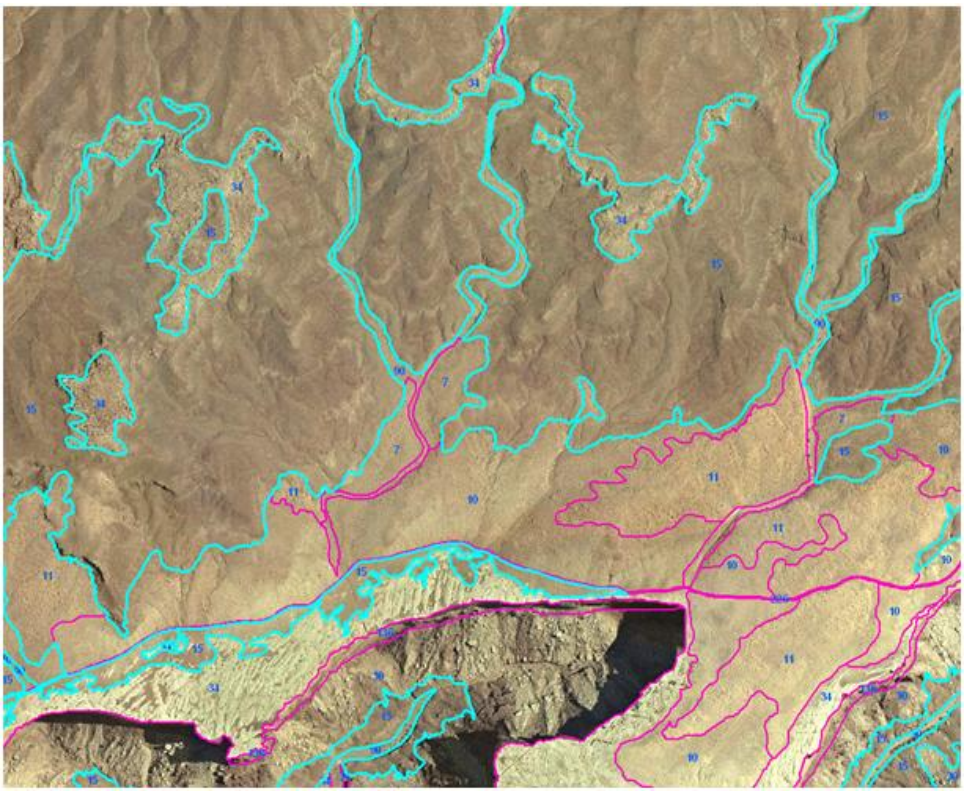


Distribution/Ecology/Composition

Stands occur on plateaus, mesa tops, benches, and toeslopes typical of the Chinle and Moenkopi Formations found on the White Rim benches in the Island in the Sky District of the Park and characterized by a surface covered in small rocks (shaley/platey/pebbly) or by mudstone-like slopes and benches. Stands support sparse mixed communities of *Coleogyne ramosissima, Ephedra torreyana, Atriplex confertifolia,* and the grass *Pleuraphis jamesii*. All three shrub species are usually present and vary in their dominance and amount of grass understory. Pockets of sparse *Eriogonum corymbosum, Atriplex gardneri,* or *Zuckia brandegeei* communities are also part of this map class. Varying degrees of cryptobiotic soil crust development are present.

Interpretation

This very common map class appears as small to very large regular polygons on gentle to steep slopes, benches, and badlands throughout the northern half of the Park and is the dominant vegetation type occurring on the Chinle and Moenkopi formations. The signature is variable due to the variety of colors in the substrate (ranging from light tan to dark grey to medium reddish-brown) and the substrate is the only thing visible to the photointerpreter since shrubs are too small and their cover too sparse as to be nearly invisible to the photointerpreter. Common neighbors include polygons of blackbrush shrublands (map class 10), sand sheet mixed shrublands (map class 11), dry wash channels (map class 90), rim rock sparse vegetation (map class 34), and talus slopes (map class 30).



Example of photo signature for map class S-SCRU (#15).

Map Class 28
Toeslope/Moraine Sparse Vegetation Complex (S-MORA)

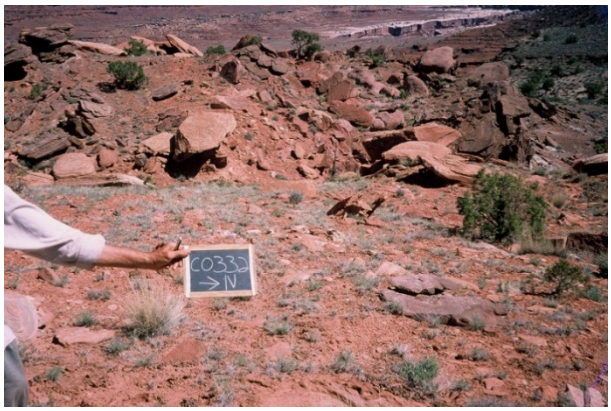




Photo credits: NPS

Associations

Atriplex confertifolia / Pleuraphis jamesii Shrubland
Chrysothamnus viscidiflorus Talus Shrubland
Ephedra torreyana / Pleuraphis jamesii Shrubland
Ericameria nauseosa Sparse Vegetation
Juniperus osteosperma / Hesperostipa comata Woodland
Juniperus osteosperma / Mixed Shrubs Talus Woodland
Zuckia brandegeei Sparse Vegetation

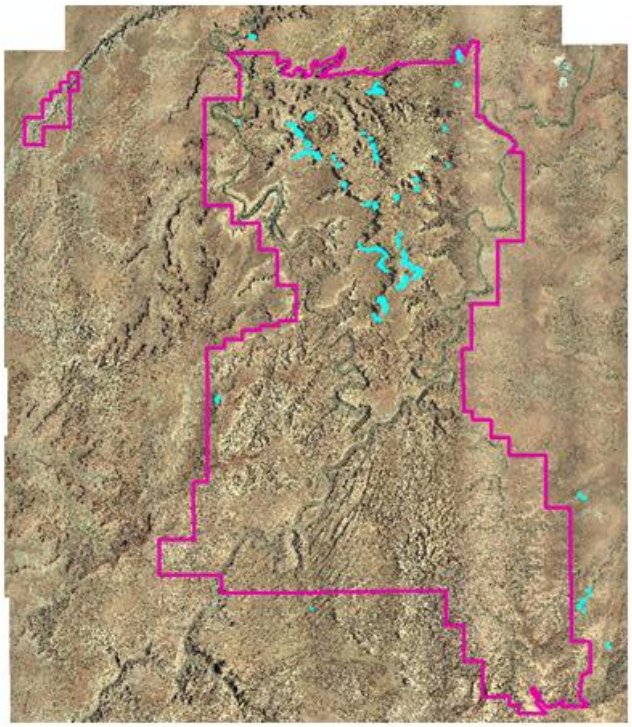
Common species

- *Ephedra torreyana*
- *Juniperus osteosperma*
- *Zuckia brandegeei*
- *Pleuraphis jamesii*
- *Xylorhiza* spp.
- *Coleogyne ramosissima*
- *Atriplex confertifolia*
- *Chrysothamnus viscidiflorus*
- *Stipa comata*
- *Eriogonum corymbosum*
- *Chrysothamnus nauseosus*

S-MORA Map Class Statistics

Type:	Association
Frequency:	58 total polygons 47 total polygons in CANY 11 total polygons in the environs
Total project area:	422 hectares / 1,044 acres (0.2 %) 391 hectares / 966 acres in CANY 31 hectares / 77 acres in the environs
Average Polygon Size:	7.3 hectares / 18 acres
Producer's accuracy:	91% ± 10%
User's accuracy:	97% ± 7%

Distribution in Mapping Area

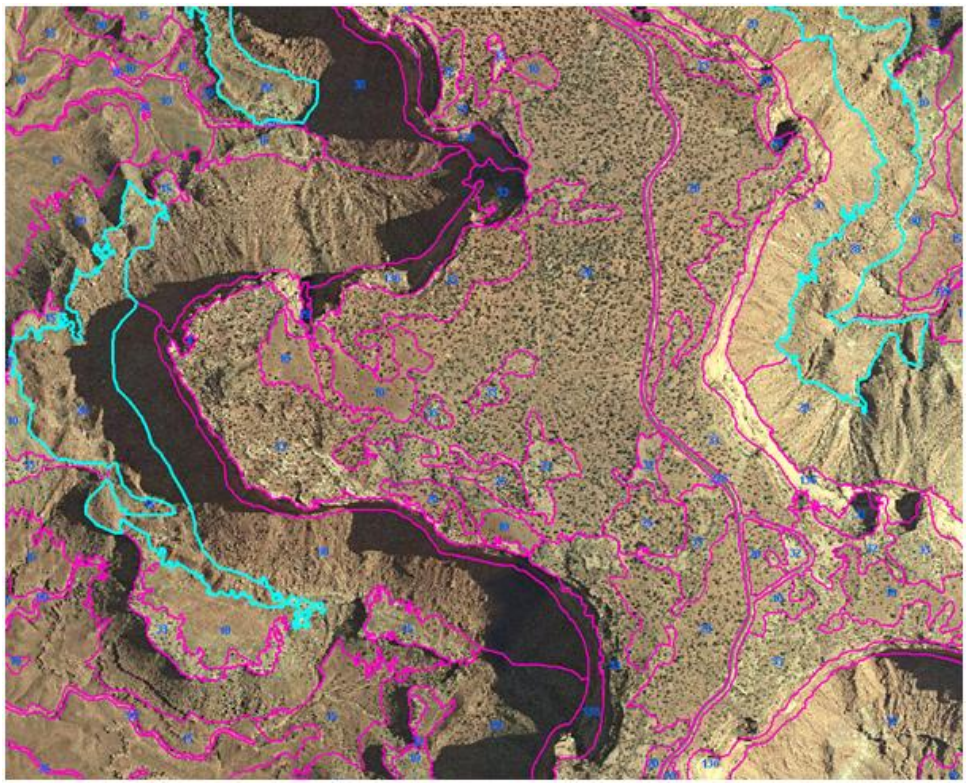


Distribution/Ecology/Composition

Stands occur on landslide deposits, of generally <20% slope, that rest on Chinle benches, typically at the base of the Wingate/Chinle scarp. Blue gray shale is often exposed at the edges of this unit, rubble is mostly coarse textured (including massive truck-sized boulders), and the landscape has an undulating moraine appearance. Vegetation is a sparse mixture of xeric short shrubs and grasses and often includes scattered *Juniperus osteosperma.* This map class is defined less by floristics than by geology and landform and therefore, stands may be floristically heterogeneous and dominated by a variety of shrubs, dwarf-shrubs, and grasses.

Interpretation

This rare map class appears as medium to large irregular or narrow, linear polygons on low slopes and toe slopes and moraines at the base of Wingate cliffs, and are located predominantly in the Island in the Sky District of the Park. The signature ranges in color from light yellowish-tan to dark reddish-brown, with scattered pinyon-juniper tree crowns providing black spots, scattered boulders visible as light to dark chunky blocks, shadows produced by high ridgelines, and a sparse shrub and grass signature obscured by the substrate. Common neighbors share similar floristics but occur on slightly different landform positions and include polygons of blackbrush shrublands (map class 10), shale barrens desert scrub (map class 15), cool-aspect shale scarps (map class 29), and sparse mixed vegetation talus slopes (map class 30).



Example of photo signature for map class S-MORA (#28).

Map Class 30
Talus Escarpments Mixed Sparse Vegetation Complex (C-TALU)




Photo credits: NPS

Associations

Achnatherum speciosum Herbaceous Vegetation
Artemisia bigelovii - Ephedra (viridis, torreyana) Talus Shrubland
Atriplex canescens - Ephedra viridis Talus Shrubland
Atriplex confertifolia / Pleuraphis jamesii Shrubland
Atriplex confertifolia Sparse Vegetation
Atriplex gardneri Dwarf-Shrubland
Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland
Chrysothamnus viscidiflorus Talus Shrubland
Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation
Ericameria nauseosa Sparse Vegetation
Fraxinus anomala - Rhus trilobata Talus Shrubland
Rhus trilobata - Ephedra (viridis, torreyana) Talus Shrubland

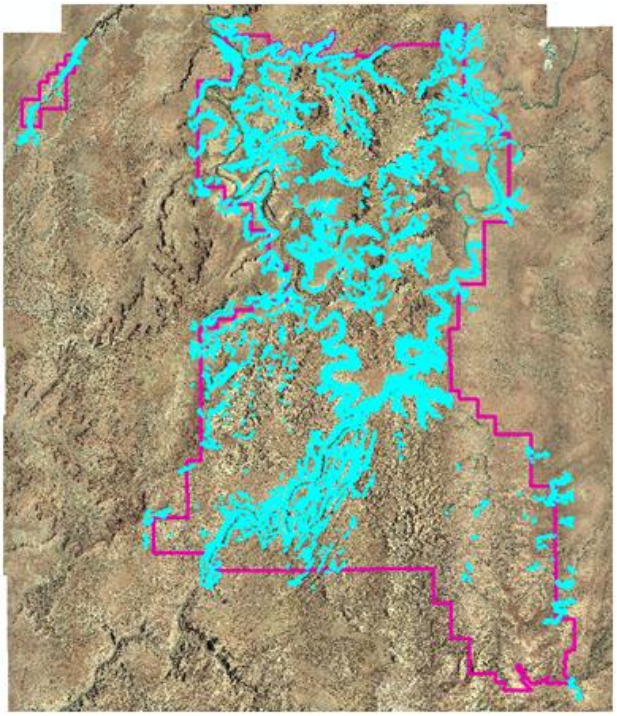
Common species

- *Ephedra torreyana*
- *Eriogonum corymbosum*
- *Ephedra viridis*
- *Chrysothamnus viscidiflorus*
- *Fraxinus anomala*
- *Stipa speciosa*
- *Chrysothamnus nauseosus*
- *Atriplex confertifolia*
- *Atriplex gardneri*
- *Stipa hymenoides*
- *Rhus trilobata*

C-TALU Map Class Statistics

Type:	Complex
Frequency:	788 total polygons 655 total polygons in CANY 133 total polygons in the environs
Total project area:	16,721 hectares / 41,317 acres (9.8 %) 14,557 hectares / 35,971 acres in CANY 2,163 hectares / 5,346 acres in the environs
Average Polygon Size:	21.2 hectares / 52.4 acres
Producer's accuracy:	94% ± 6%
User's accuracy:	86% ± 7%

Distribution in Mapping Area

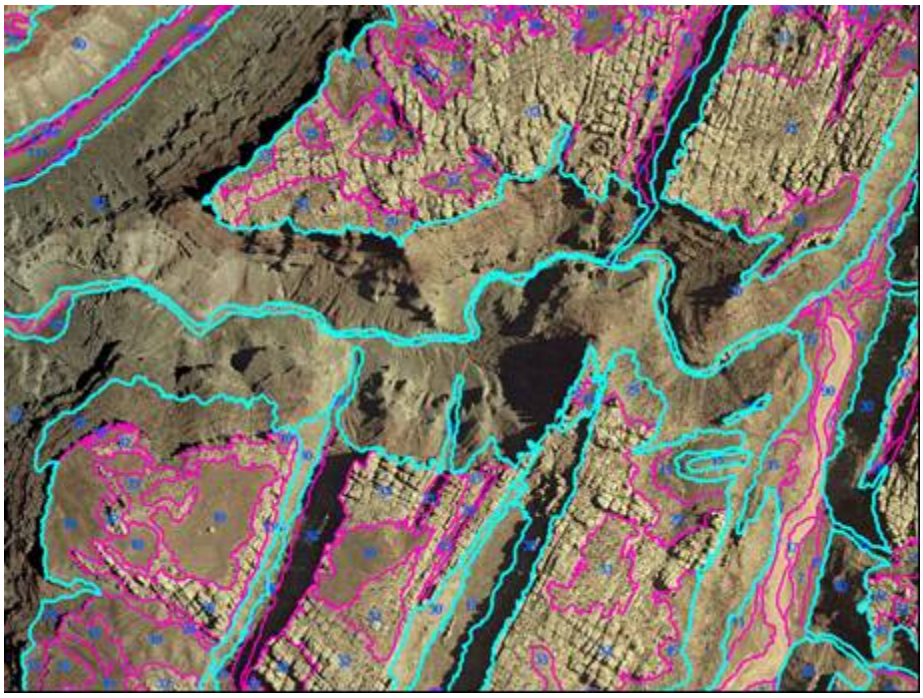


Distribution/Ecology/Composition

Stands occur on moderately steep to very steep, south and west-facing talus slopes throughout the Park, especially along the deep canyons of the major river corridors and the slopes below the Wingate and White Rim Formation cliff bands, and also in the Grabens area of the Needles District. Slopes are generally unstable and vegetation is vulnerable to rock slides, erosion, and downward slope movement. Slope environments support sparse, mixed xeric shrub communities of *Ephedra torreyana*, *Atriplex confertifolia*, *Artemisia bigelovii*, *Ericameria nauseosa* var. *junceus*, *Chrysothamnus viscidiflorus*, *Fraxinus anomala,* and *Rhus trilobata*, among others. Total vegetation cover is often less than 10%. Widely scattered and stunted *Juniperus osteosperma* 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 is predominantly that of the substrate, ranging in color from tan to dark reddish-brown, with scattered boulders visible as light to dark chunky blocks, shadows produced by high ridgelines, slopes dissected by deep gullies and ravines, and a sparse shrub and grass signature obscured by the substrate. Common neighbors include polygons of blackbrush shrublands (map class 10), shale barrens desert scrub (map class 15), cool-aspect shale scarps (map class 29), potholed sandstone woodlands (map class 32), broken ledge and slope woodlands (map class 33), and the slickrock and sandstone cliff geology map classes (map class 132 and 136 respectively). A variety of other map classes can occur adjacent to this map class at the base of the slope where it meets the valley or canyon floor.



Example of photo signature for map class C-TALU (#30).

Map Class 31
Cutler Benches Cliffy Canyonside Mosaic (C-CUTL)




Photo credits: NPS

Associations

Atriplex confertifolia / Pleuraphis jamesii Shrubland
Chrysothamnus viscidiflorus Talus Shrubland
Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation
Fraxinus anomala - Rhus trilobata Talus Shrubland
Juniperus osteosperma / Mixed Shrubs Talus Woodland
Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland

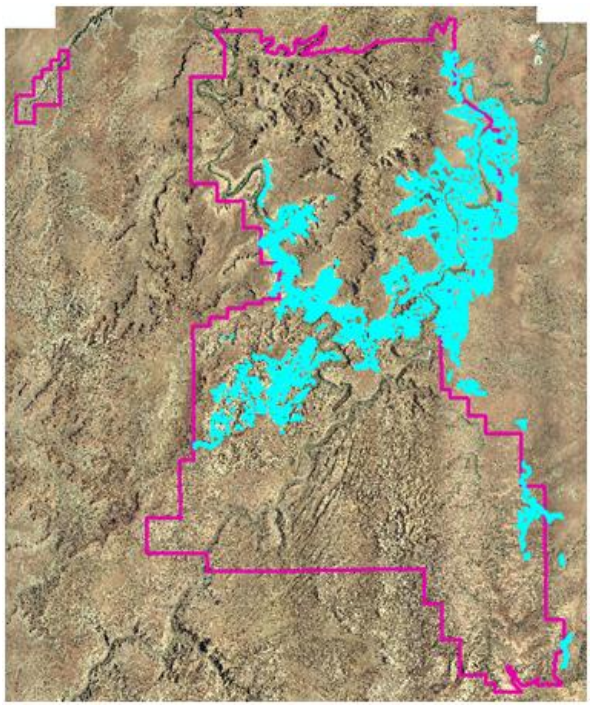
Common species

- *Pinus edulis*
- *Atriplex confertifolia*
- *Fraxinus anomala*
- *Chrysothamnus viscidiflorus*
- *Coleogyne ramosissima*
- *Purshia mexicana*
- *Juniperus osteosperma*
- *Ephedra torreyana*
- *Rhus trilobata*
- *Chrysothamnus nauseosus*
- *Eriogonum corymbosum*

C-CUTL Map Class Statistics

Type:	Complex
Frequency:	247 total polygons 185 total polygons in CANY 62 total polygons in the environs
Total project area:	11,387 hectares / 28,137 acres (6.7 %) 8,930 hectares / 22,066 acres in CANY 2,457 hectares / 6,071 acres in the environs
Average Polygon Size:	46.1 hectares / 113.9 acres
Producer's accuracy:	93% ± 9%
User's accuracy:	80% ± 13%

Distribution in Mapping Area

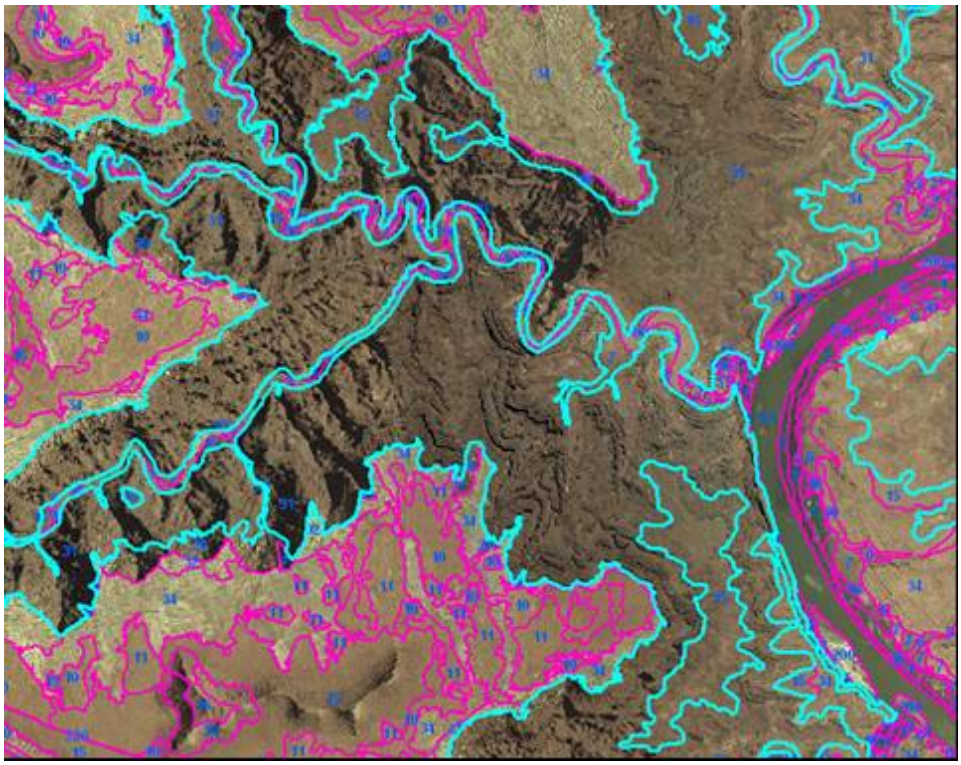


Distribution/Ecology/Composition

This map class is a mosaic of map classes 15, 29, 30, and 33 where they occur in patches too small to be pulled out separately. It is characterized by ledgy canyon sides (small flats or benches and steep slopes) in the Cutler, Organ Rock, and Elephant Canyon formations that support sparse mixed stands of the xeric shrubs, *Ephedra torreyana*, *Coleogyne ramosissima*, *Atriplex confertifolia*, *Eriogonum corymbosum*, *Ericameria nauseosa* var. *junceus*, *Chrysothamnus viscidiflorus,* the tall shrubs *Fraxinus anomala, Rhus trilobata,* and *Purshia mexicana*, and sparsely scattered junipers and more rarely pinyons.

Interpretation

This common map class appears as medium to very large regular polygons on gentle to steep slopes, mostly occurring below the White Rim formation, along the major river corridors, in Horse Canyon (The Maze), and wherever older geologic exposures are the dominant feature (mainly the Cutler undifferentiated formation). The color is a dark reddish-brown, with scattered boulders visible as light to dark chunky blocks, shadows produced by high ridgelines, slopes dissected by deep gullies and ravines, a distinct stair-step topography, and a sparse shrub and grass signature obscured by the substrate. Common neighbors include polygons of shale barrens desert scrub (map class 15), cool-aspect shale scarps (map class 29), sparse talus slopes (map class 30), and rim rock sparse vegetation (map class 34).



Example of photo signature for map class C-CUTL (#31).

Map Class 34
Rimrock Sparse Vegetation Complex (C-RIMR)




Photo credits: NPS

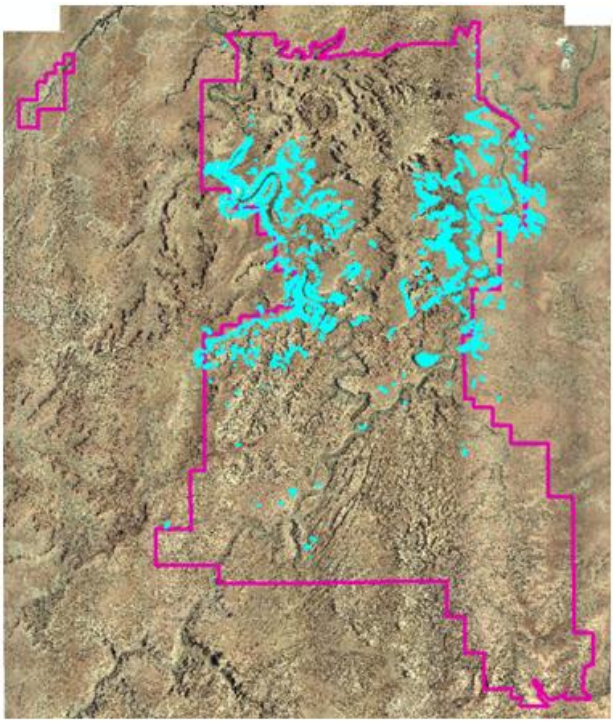
Associations
Coleogyne ramosissima Sparse Vegetation
Fraxinus anomala - Rhus trilobata Talus Shrubland

Common species
- *Coleogyne ramosissima*
- *Gutierrezia sarothrae*
- *Aristida purpurea*
- *Pleuraphis jamesii*
- *Fraxinus anomala*
- *Cercocarpus intricatus*
- *Yucca angustissima*
- *Stipa hymenoides*

C-RIMR Map Class Statistics

Type:	Complex
Frequency:	556 total polygons 445 total polygons in CANY 111 total polygons in the environs
Total project area:	3,758 hectares / 9,285 acres (2.2 %) 3,218 hectares / 7,951 acres in CANY 540 hectares / 1,334 acres in the environs
Average Polygon Size:	6.8 hectares / 16.7 acres
Producer's accuracy:	95% ± 11%
User's accuracy:	100%

Distribution in Mapping Area

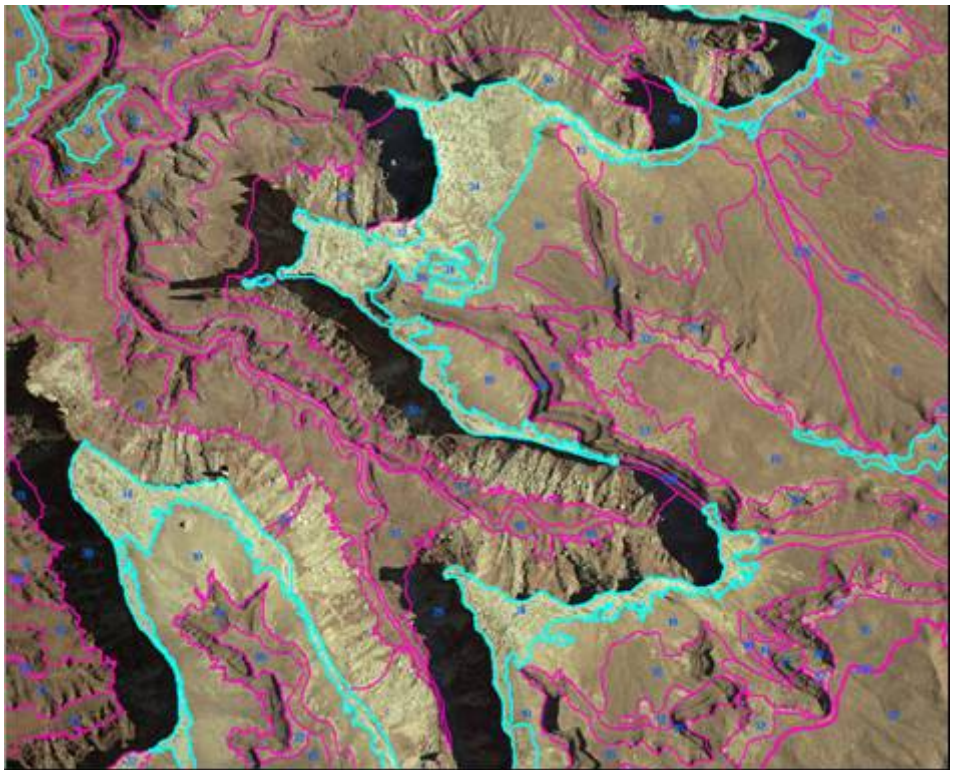


Distribution/Ecology/Composition

Relatively level, mostly rim rock, areas of hard sandstone typical of the White Rim formation that support sparse vegetation characterized by *Coleogyne ramosissima, Fraxinus anomala* and occasionally *Cercocarpus intricatus,* with scattered but often diverse grass cover, and *Gutierrezia sarothrae* and *Yucca angustissima* often present. Bedrock cover generally exceeds 75%. Plants are limited by soil availability (most commonly occurring in shallow soil pockets and joints in the bedrock) and trees are exceptionally rare.

Interpretation

This fairly common map class appears as small to large, mostly narrow and irregular polygons on gentle slopes and flats of rim rock areas in the Park, occurring mostly on the White Rim and Cutler undifferentiated formations. The color ranges from white to brown, with visible joints and cracks in the bedrock, some pockets of darker soil on top of the bedrock, and a sparsely scattered vegetation signature mostly obscured by the substrate. Common neighbors include polygons of blackbrush shrublands (map class 10), shale barrens desert scrub (map class 15), cool-aspect shale scarps (map class 29), sparse talus slopes (map class 30), Cutler cliffy canyon sides (map class 31), potholed sandstone woodlands (map class 32), and broken ledge and slope woodlands (map class 33).



Example of photo signature for map class C-RIMR (#34).

Map Class 35
Cryptobiotic Soil Crust – Ephedra Sparse Vegetation Complex (C-CRUS)




Photo credits: NPS

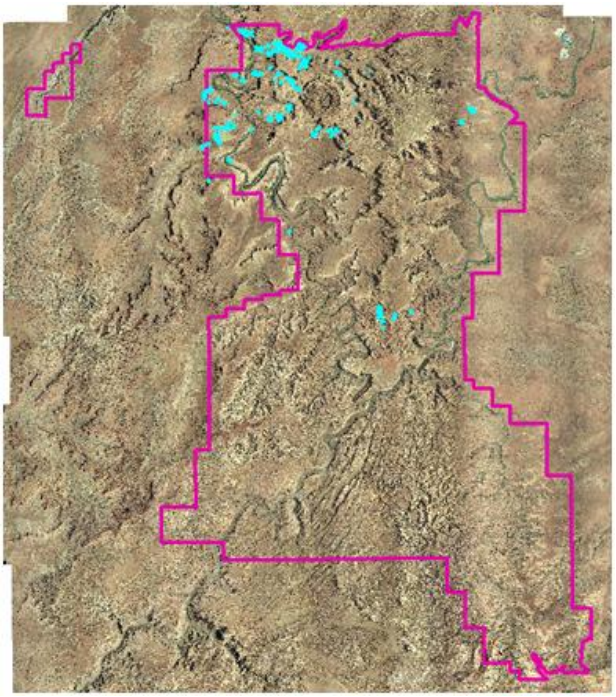
Associations
Atriplex confertifolia / Pleuraphis jamesii Shrubland
Atriplex confertifolia Sparse Vegetation
Atriplex gardneri Dwarf-Shrubland
Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland
Ephedra torreyana - *(Atriplex* spp.) / Nonvascular Gypsum Sparse Vegetation

Common species
- *Atriplex confertifolia*
- *Atriplex gardneri*
- *Ephedra torreyana*
- *Pleuraphis jamesii*

C-CRUS Map Class Statistics

Type:	Complex
Frequency:	91 total polygons 86 total polygons in CANY 5 total polygons in the environs
Total project area:	388 hectares / 959 acres (0.2 %) 370 hectares / 914 acres in CANY 18 hectares / 45 acres in the environs
Average Polygon Size:	4.3 hectares / 10.5 acres
Producer's accuracy:	95% ± 10%
User's accuracy:	83% ± 15%

Distribution in Mapping Area

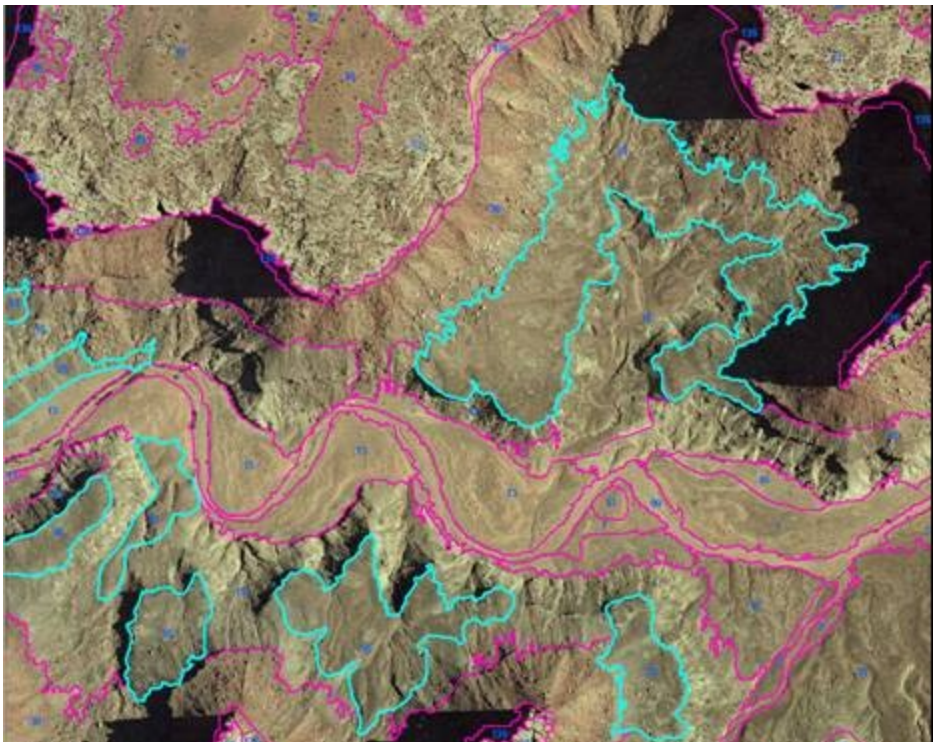


Distribution/Ecology/Composition

Stands occur on small flats or benches at the base of Chinle formation slopes, with light to dark gray, often rocky soils, very sparse vegetation, and well-developed, lichen-dominated cryptobiotic soils. Gypsiferous crystals are often present. Vegetation may include *Ephedra torreyana*, *Atriplex* spp., and scattered clumps of *Pleuraphis jamesii.*

Interpretation

This rare map class appears as small to medium, regular polygons on gentle slopes and flats in the Chinle and Moenkopi formations, mainly in the northwestern portion of the Park. The color is a light to medium-gray and grayish-brown of the substrate, and the shrubs are too small and their cover too sparse to be seen to the photointerpreter. Common neighbors include polygons of shale barrens desert scrub (map class 15) and sparse talus slopes (map class 30).



Example of photo signature for map class C-CRUS (#35).

Map Class 36
Seepweed Salt Flats (S-SALT)





Photo credits: NPS

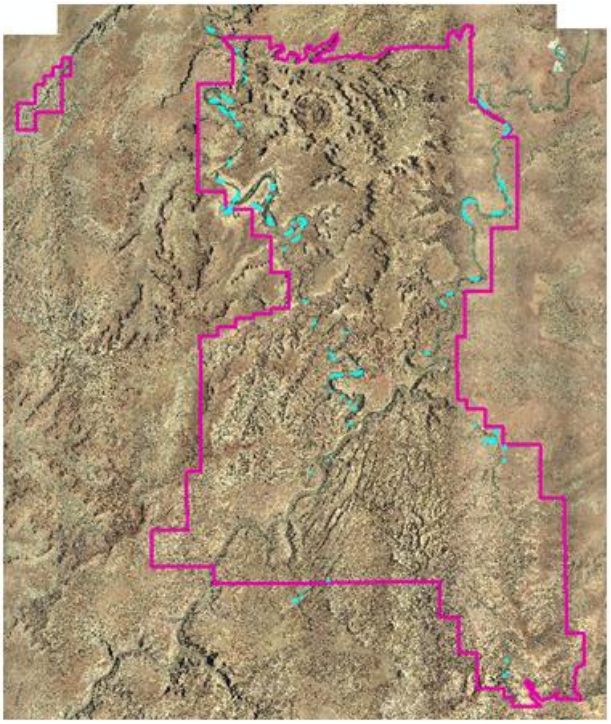
Associations
Atriplex canescens / Suaeda moquinii Shrubland [Park Special]
Suaeda moquinii Shrubland

Common species
- *Atriplex canescens*
- *Sarcobatus vermiculatus*
- *Salsola tragus*
- *Sporobolus* spp.
- *Suaeda torreyana*
- *Chrysothamnus nauseosus*
- *Distichlis spicata*
- *Bromus tectorum*

S-SALT Map Class Statistics

Type:	Complex
Frequency:	148 total polygons 138 total polygons in CANY 10 total polygons in the environs
Total project area:	147 hectares / 364 acres (0.1 %) 127 hectares / 314 acres in CANY 20 hectares / 50 acres in the environs
Average Polygon Size:	1 hectares / 2.5 acres
Producer's accuracy:	97% ± 7%
User's accuracy:	97% ± 7%

Distribution in Mapping Area

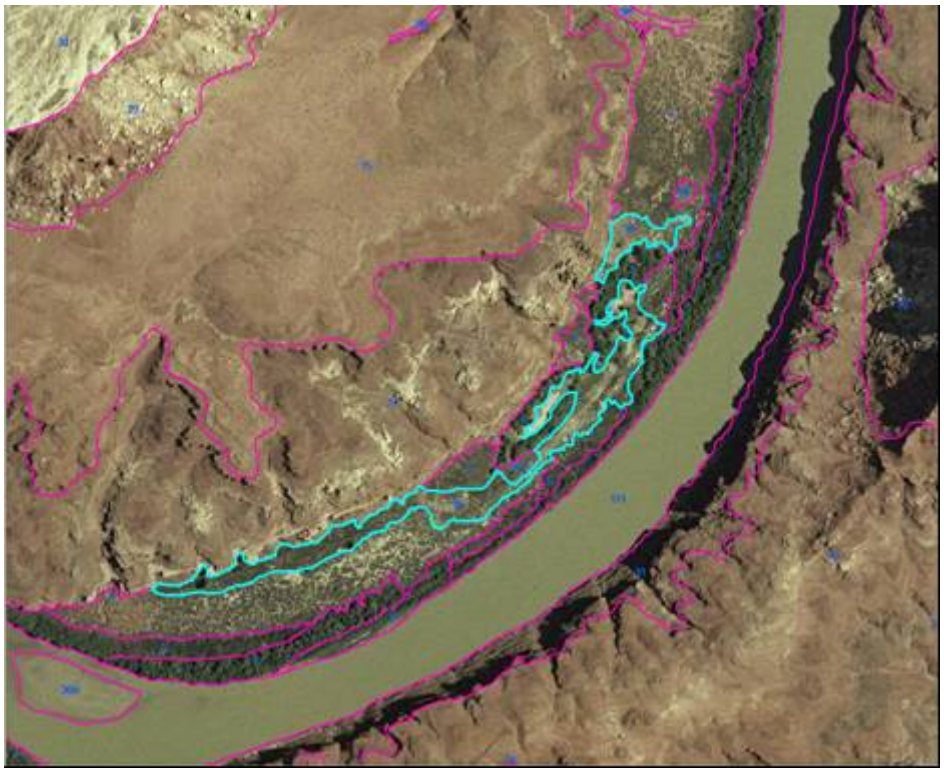


Distribution/Ecology/Composition

Saline overflow areas (salt flats and mud flats) on river terraces, and more rarely stream terraces, with sparse to low shrub cover characterized by seepweed (*Suaeda torreyana*), saltbush, and greasewood, and sparse to low cover of grasses and weedy annual species. Soils are deep, saline, alkaline clay loams derived from alluvium.

Interpretation

This rare map class appears as small to medium irregular polygons on alluvial flats along the major river corridors and in lower Salt Creek. The color is a light tan representing the substrate with a soft, medium to dark gray-green, intermittent to continuous shrub signature. Common neighbors include polygons of tamarisk shrublands (map class 1), greasewood shrublands (map class 6), saltbush and other terrace shrublands (map class 7), native grasslands (map class 16), and non-native herbaceous stands (map class 17).



Example of photo signature for map class S-SALT (#36).

Riparian / Wetland Woodlands and Shrublands

Map Class 1
Tamarisk River Corridor Shrubland (S-TAMX)





Photo credits: NPS

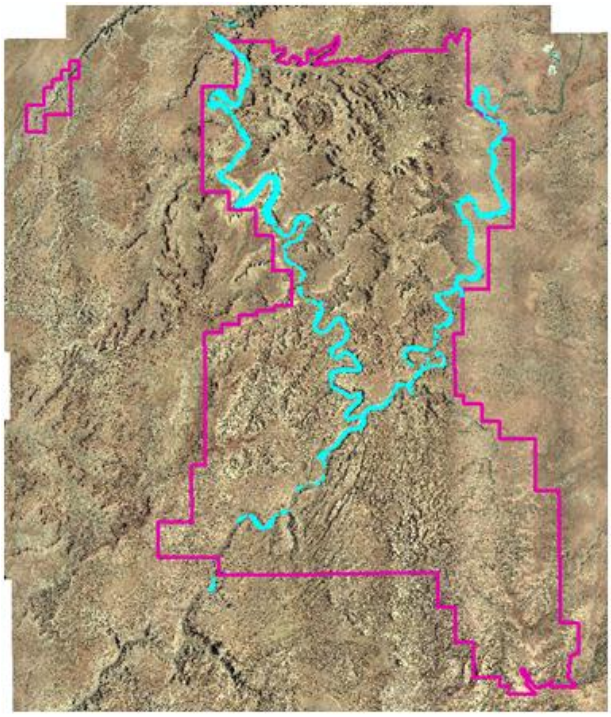
Associations
Tamarisk spp. Temporarily Flooded Shrubland

Common species
- *Tamarix chinensis*
- *Salix exigua*

S-TAMX Map Class Statistics

Type:	Complex
Frequency:	474 total polygons 441 total polygons in CANY 33 total polygons in the environs
Total project area:	878 hectares / 2,170 acres (0.5 %) 805 hectares / 1,988 acres in CANY 74 hectares / 182 acres in the environs
Average Polygon Size:	1.9 hectares / 4.6 acres
Producer's accuracy:	97% ± 7%
User's accuracy:	79% ± 12%

Distribution in Mapping Area

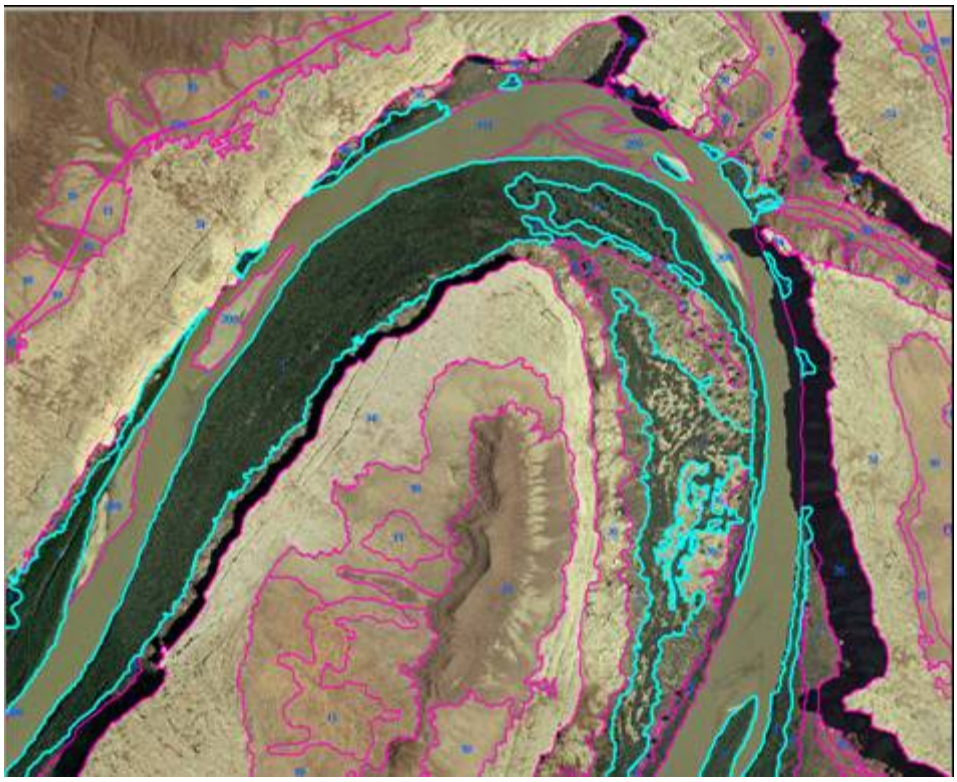


Distribution/Ecology/Composition

Stands of continuous, dense (nearly impenetrable), young to mature *Tamarix chinensis* (often mixed with *Salix exigua*) shrubs with little to no understory mapped growing along the banks or on the first terrace of the major rivers (Green and Colorado). Stands grow especially well along regulated rivers where flood-regenerated native species such as 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 cover most of the unvegetated surface. Soils are poorly drained to rapidly drained sandy loams, silty clay loams, silt loams, or silts derived from alluvium and are subject to frequent flooding.

Interpretation

This common map class occurs as small to large, linear, sinuous polygons along the edges of the major rivers and is continuous throughout the entirety of the river corridor in the Park. The photo signature is a rough-textured, medium to dark green indicating the generally dense canopy of tamarisk. Common neighbors include polygons of coyote willow shrublands (map class 2), riverine cottonwood woodlands (map class 3), desert olive shrublands (map class 5), greasewood shrublands (map class 6), saltbush and other terrace shrublands (map class 7), open river (map class 111), and sandbars (map class 200).



Example of photo signature for map class S-TAMX (#1).

Map Class 2
Sandbar Willow Riverine Shrubland (S-WILL)




Photo credits: NPS

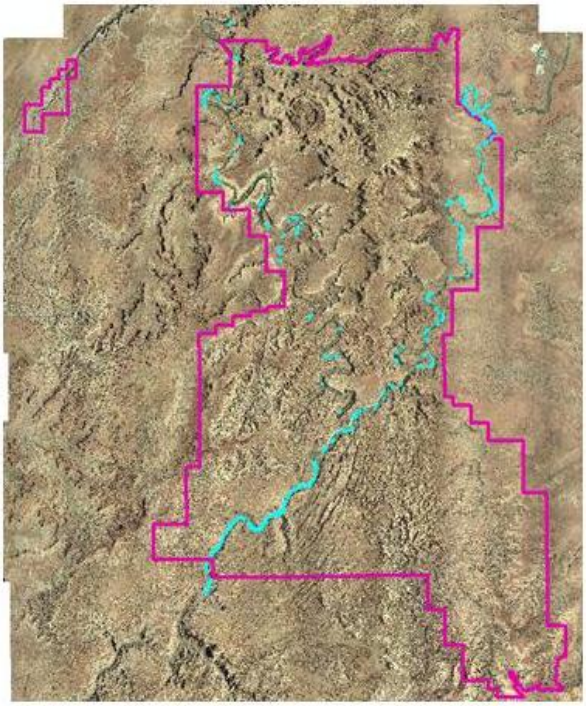
Associations
Salix exigua / Barren Shrubland
Salix exigua / Mesic Graminoids Shrubland
Salix (exigua, interior) Temporarily Flooded Shrubland Alliance

Common species
- *Salix exigua*
- *Eleocharis palustris*
- *Spartina pectinata*
- *Tanarix chinensis*
- *Elymus canadensis*
- *Bromus tectorum*

S-WILL Map Class Statistics

Type:	Association
Frequency:	208 total polygons 186 total polygons in CANY 22 total polygons in the environs
Total project area:	183 hectares / 452 acres (0.1 %) 159 hectares / 393 acres in CANY 24 hectares / 59 acres in the environs
Average Polygon Size:	0.9 hectares / 2.2 acres
Producer's accuracy:	100%
User's accuracy:	25% ± 18%

Distribution in Mapping Area

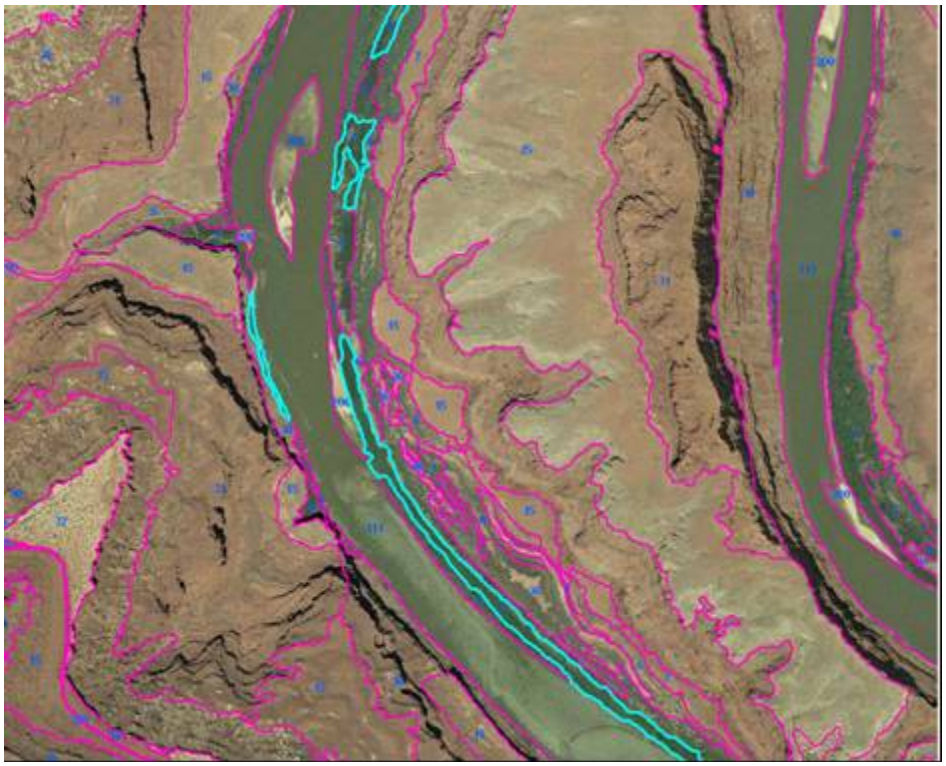


Distribution/Ecology/Composition

River sandbar communities that are submerged part of the year and become "islands" when river levels drop, or low sandy areas connected to the river bank that are part of the active channel. Communities are characterized by fairly dense stands of young/regenerating or older, established *Salix exigua. Tamarix chinensis* and/or *Forestiera pubescens* may be mixed in with low numbers, but neither one should be codominant with willow. 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 cover most of the unvegetated surface. Soils are poorly drained to rapidly drained sandy loams, silty clay loams, silt loams, or silts derived from alluvium and are subject to frequent flooding.

Interpretation

This common map class occurs as short to long, very narrow, sinuous polygons along the edges of the major rivers. The photo signature ranges from a tan to light-gray representing the sandbar with scattered gray-green clumps of willows to a continuous, smooth-textured, medium gray-green where the coyote willow canopy is denser. Common neighbors include polygons of tamarisk shrublands (map class 1), riverine cottonwood woodlands (map class 3), saltbush and other terrace shrublands (map class 7), open river (map class 111), and sandbars (map class 200).



Example of photo signature for map class S-WILL (#2).

Map Class 3
Fremont Cottonwood Riverine Woodland (W-COTT)





Photo credits: NPS

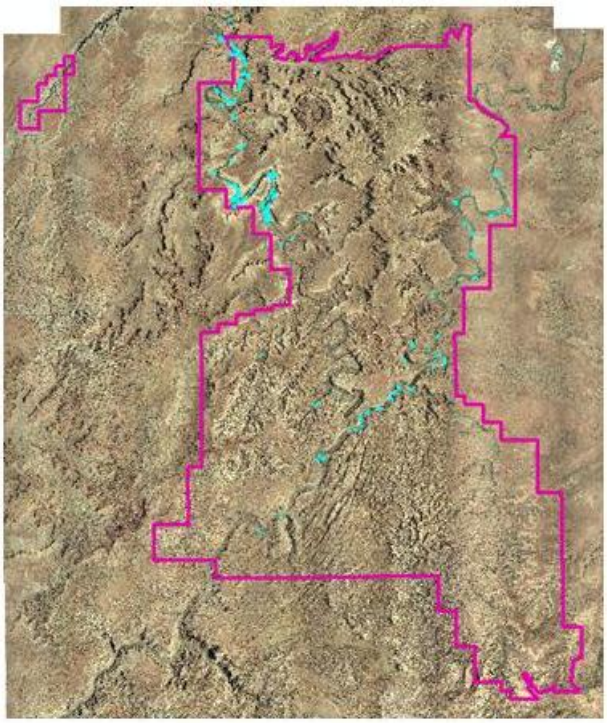
Associations
Acer negundo / Disturbed Understory Woodland
Populus fremontii / Ericameria nauseosa Woodland
Populus fremontii / Salix exigua Forest
Populus fremontii / Tamarix chinensis Woodland
Populus fremontii / Sporobolus airoides Woodland
Salix gooddingii / Salix exigua Woodland

Common species
- *Populus fremontii*
- *Salix gooddingii*
- *Tamarix chinensis*
- *Chrysothamnus nauseosus*
- *Bromus tectorum*
- *Distichlis spicata*
- *Acer negundo*
- *Salix exigua*
- *Sporobolus airoides*
- *Phragmites australis*
- *Atriplex canescens*

W-COTT Map Class Statistics

Type:	Complex
Frequency:	166 total polygons 159 total polygons in CANY 7 total polygons in the environs
Total project area:	124 hectares / 307 acres (0.1 %) 118 hectares / 292 acres in CANY 6 hectares / 15 acres in the environs
Average Polygon Size:	0.7 hectares / 1.9 acres
Producer's accuracy:	88% ± 14%
User's accuracy:	91% ± 12%

Distribution in Mapping Area

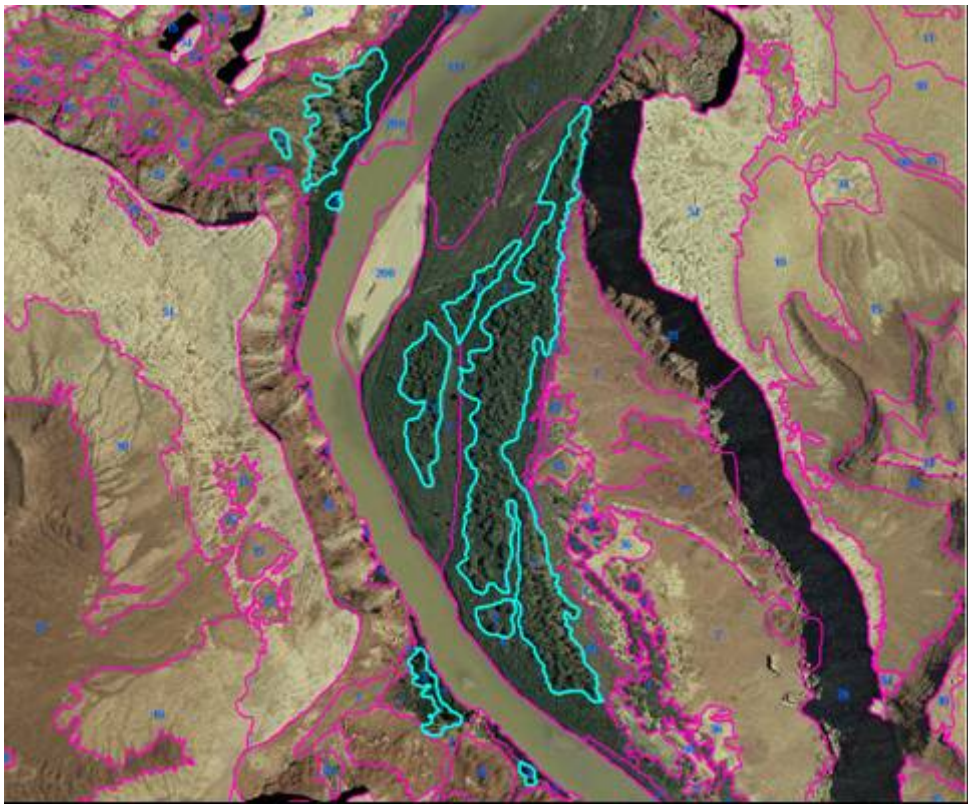


Distribution/Ecology/Composition

Open woodlands of decadent gallery cottonwood trees (or more rarely *Acer negundo* or *Salix gooddingii*) on the higher terraces of the major rivers with xeric understories of *Chrysothamnus nauseosus, Atriplex canescens, Distichlis spicata*, or *Bromus tectorum*. Some relict cottonwood stands may have dense *Tamarix* and/or *Salix exigua* understories. Woodlands occur on flat sites with deep alluvial soils. Young trees are rare because sites are rarely subject to the scouring floods required for establishment of new trees and are generally several feet above the water table, and as such, these woodlands may be considered disappearing relict communities.

Interpretation

This rare map class appears as small to medium, irregular or linear polygons on high terraces of the Green and Colorado rivers. The color is green to dark green with widely scattered, rounded tree crowns visible and often producing shadows (but most accurately identified under stereoscopic viewing). Common neighbors include polygons of tamarisk shrublands (map class 1), coyote willow shrublands (map class 2), desert olive shrublands (map class 5), greasewood shrublands (map class 6), saltbush and other terrace shrublands (map class 7), and seepweed shrublands (map class 36).



Example of photo signature for map class W-COTT (#3).

Map Class 4
Gambel Oak – Mixed Mesic Shrubs Terrace and Cove Shrubland (S-GOAK)





Photo credits: NPS

Associations

Betula occidentalis - Cornus sericea Shrubland
Cornus sericea Shrubland
Forestiera pubescens Shrubland
Frangula betulifolia Shrubland
Ostrya knowltonii Woodland
Quercus gambelii – Cercocarpus montanus / (Carex geyeri) Shrubland
Quercus gambelii / Artemisia tridentata Shrubland
Quercus gambelii – Rhus trilobata Shrubland
Quercus gambelii / Sparse Understory Shrubland
Quercus gambelii / Symphoricarpos longiflorus Shrubland

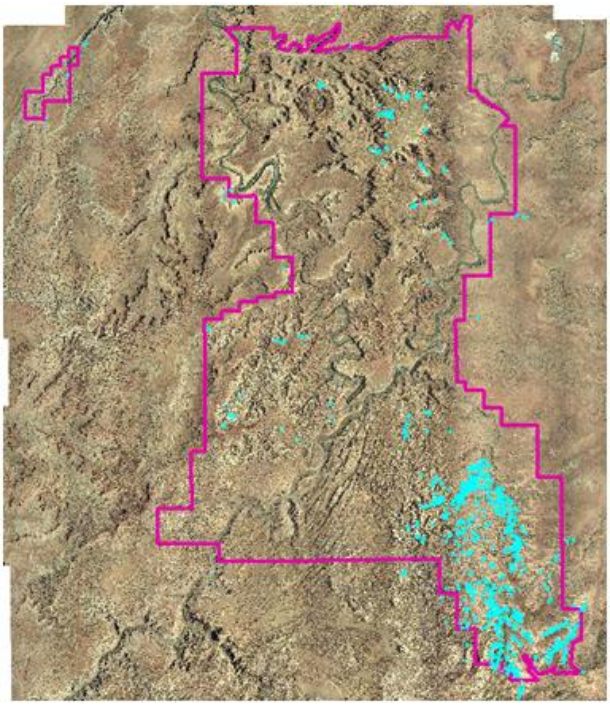
Common species

- *Quercus gambelii*
- *Betula occidentalis*
- *Forestiera pubescens*
- *Ostrya knowltonii*
- *Artemisia tridentata*
- *Prunus virginiana*
- *Rhus trilobata*
- *Cornus sericea*
- *Rhamnus betulifolia*
- *Symphoricarpos longiflorus*
- *Mahonia fremontii*
- *Clematis ligusticifolia*

S-GOAK Map Class Statistics

Type:	Association
Frequency:	761 total polygons
	703 total polygons in CANY
	58 total polygons in the environs
Total project area:	367 hectares / 907 acres (0.2 %)
	350 hectares / 865 acres in CANY
	17 hectares / 42 acres in the environs
Average Polygon Size:	0.5 hectares / 1.2 acres
Producer's accuracy:	75% ± 11%
User's accuracy:	86% ± 10%

Distribution in Mapping Area

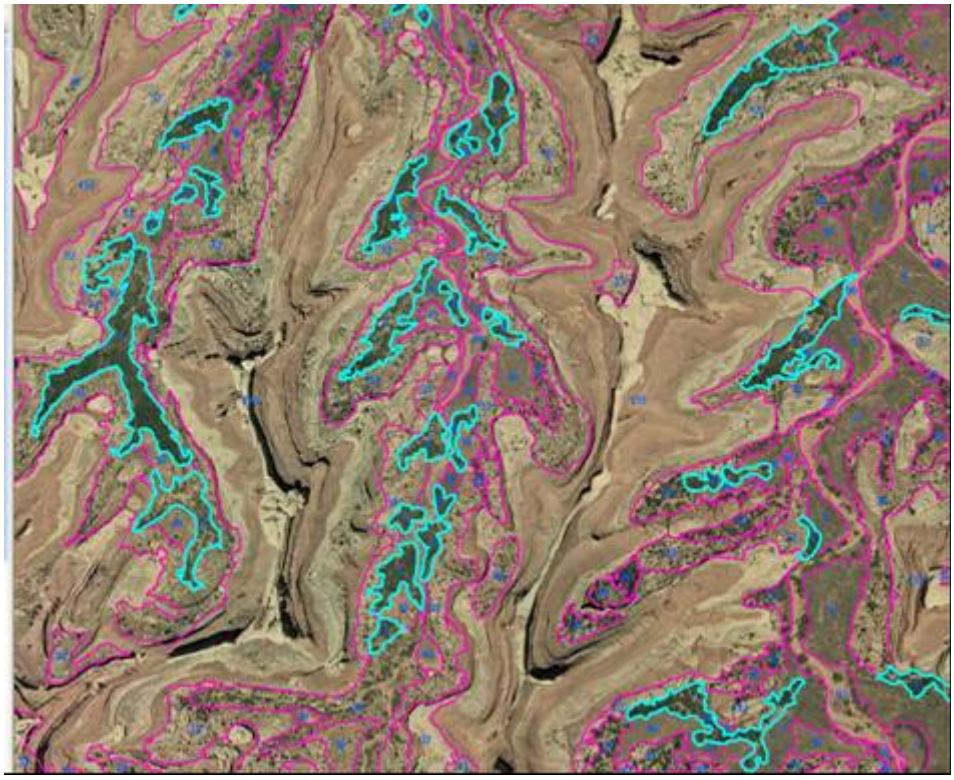


Distribution/Ecology/Composition

Map class 4 is concentrated in the Needles District, and mostly in Salt Creek Canyon and its tributaries, with a few examples scattered in the other two districts. Stands occur in wash terraces, coves, alcoves, heads of ravines, and seep/spring headwater communities and are dominated by *Quercus gambelii* or a hybrid with *Quercus havardii* and usually with a sparse understory. Other riparian species, such as *Rhus* spp., *Betula*, *Rhamnus*, *Ostrya*, *Cornus*, *Prunus*, and/or *Forestiera* (among others) may be present, but *Quercus gambelii* is generally dominant. Pinyon pine and juniper are absent or present only with trace to very low cover. Herbaceous understories, if present, are generally sparse.

Interpretation

This somewhat uncommon map class appears as small, narrow, irregular polygons on gentle toeslopes, flats, and drainages in sheltered locations where water tables are high, pour-off rainwater is concentrated, or a permanent water source is present (such as seeps and springs). This type is found most commonly in the Salt Creek Canyon drainage system. Common neighbors include polygons of bottomland shrublands: greasewood (map class 6), saltbush (map class 7), and big sagebrush (map class 8), pinyon-juniper woodlands: in washes (map class 26), pour-off basins (map class 27), on sandstone (map classes 32 and 33), and bare slickrock (map class 132).



Example of photo signature for map class S-GOAK (#4).

Map Class 5
High Floodplain Riverine Desert Olive - Reed Grass Complex (S-FOPU)





Photo credits: NPS

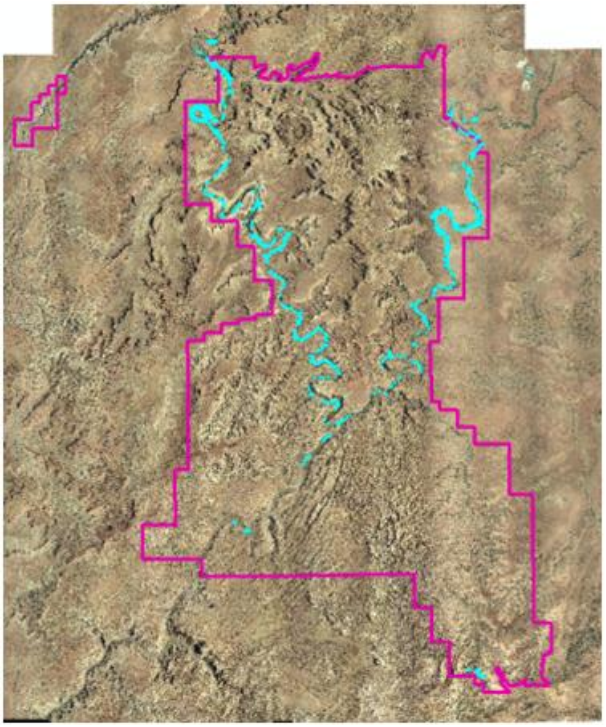
Associations
Forestiera pubescens Shrubland
Phragmites australis Western North America Temperate Semi-natural Herbaceous Vegetation

Common species
- *Forestiera pubescens*
- *Tamarix chinensis*
- *Rhus trilobata*
- *Phragmites australis*
- *Salix exigua*
- *Chrysothamnus nauseosus*

S-FOPU Map Class Statistics

Type:	Association
Frequency:	342 total polygons
	320 total polygons in CANY
	22 total polygons in the environs
Total project area:	281 hectares / 694 acres (0.2 %)
	262 hectares / 646 acres in CANY
	19 hectares / 47 acres in the environs
Average Polygon Size:	0.8 hectares / 2 acres
Producer's accuracy:	100%
User's accuracy:	96% ± 9%

Distribution in Mapping Area

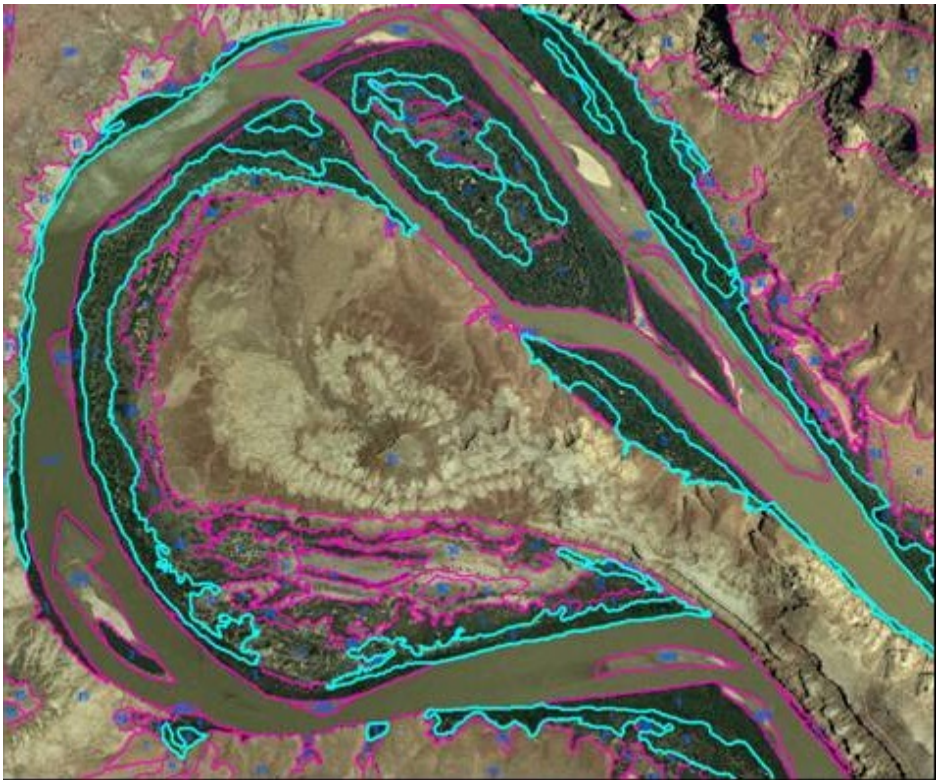


Distribution/Ecology/Composition

Continuous, narrow, and often dense stands of *Forestiera pubescens* with or without *Phragmites australis*, occurring on the higher floodplain areas (interface between the riparian zone and the drier uplands) of the major river corridors. Stands were often visible and mapped as a fairly narrow band hugging the inland edge of dense *Tamarix* stands. Other mesic tall shrub species may be included in the mosaic, including those of the genera *Rosa, Ribes,* and/or *Rhus,* as well as scattered *Salix exigua* and *Chrysothamnus nauseosus* shrubs. Sites are flat to gently sloping and downed wood and litter cover most of the unvegetated surface. Soils are mostly rapidly drained sandy loams, silt loams, or clay loams derived from alluvium.

Interpretation

This somewhat common but restricted map class occurs as small to large, narrow, sinuous polygons along the major river corridors, although less common downstream of the confluence of the Green and Colorado rivers in the Park. The photo signature was distinguished from that of neighboring tamarisk shrublands as being a darker green color and smoother-textured. Common neighbors include polygons of tamarisk shrublands (map class 1), coyote willow shrublands (map class 2), cottonwood woodlands (map class 3), greasewood shrublands (map class 6), saltbush and other terrace shrublands (map class 7), and open river (map class 111).



Example of photo signature for map class S-FOPU (#5).

Map Class 91
Floodplain and Tributary Tamarisk and Coyote Willow Shrubland Complex (S-TRIB)





Photo credits: NPS

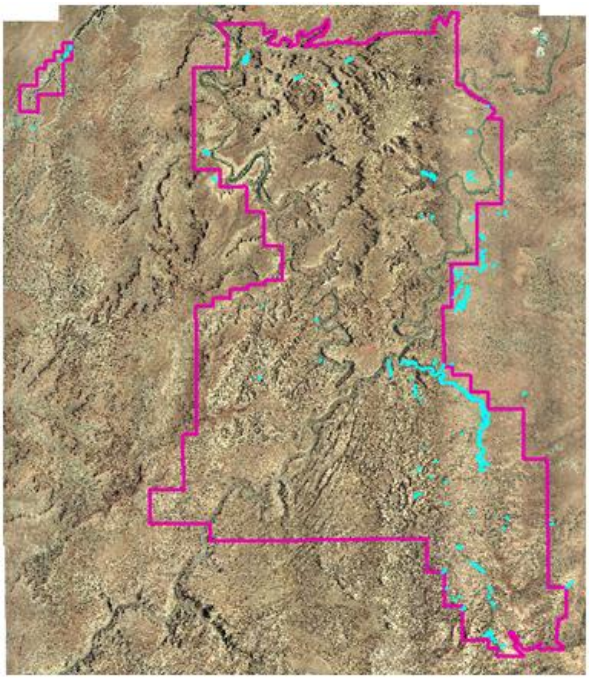
Associations
Salix exigua / Barren Shrubland
Salix exigua / Mesic Graminoids Shrubland
Salix exigua Temporarily Flooded Shrubland Alliance
Salix lutea / Mesic graminoids Shrubland
Tamarisk spp. Temporarily Flooded Shrubland

Common species
- *Tamarix chinensis*
- *Chrysothamnus nauseosus*
- *Juncus balticus*
- *Salix exigua*
- *Salix lutea*
- *Elymus* spp.

S-TRIB Map Class Statistics

Type:	Association
Frequency:	205 total polygons
	152 total polygons in CANY
	53 total polygons in the environs
Total project area:	230 hectares / 570 acres (0.1 %)
	198 hectares / 489 acres in CANY
	33 hectares / 81 acres in the environs
Average Polygon Size:	1.1 hectares / 2.8 acres
Producer's accuracy:	98% ± 6%
User's accuracy:	82% ± 10%

Distribution in Mapping Area

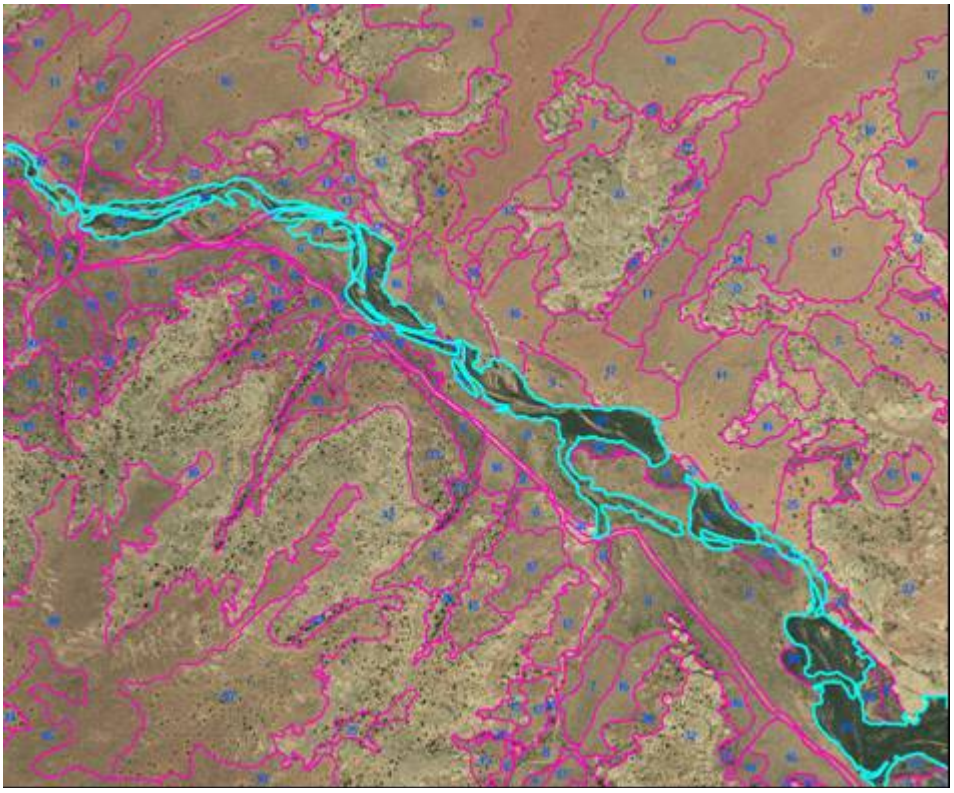


Distribution/Ecology/Composition

Stands occur in generally dry, rocky and/or sandy, intermittently flooded tributary wash channels and are dominated by *Tamarix chinensis* and/or *Salix exigua*. This includes dense stands of one or both species, as well as open clumps in intermittently flooded wash channels. More mesic examples of this type were mapped in upper Salt Creek Canyon, where dense stands of *Salix lutea* and/or *Salix exigua* with mesic herbaceous understories were present in place of tamarisk. Vegetation occurs growing in the channel or on the banks.

Interpretation

This uncommon and restricted map class appears as small to large, linear, sinuous polygons on gentle to moderate slopes following drainage courses/wash channels throughout the Park, but mostly concentrated in the Salt Creek drainage system (both upper and lower). The signature is variable depending on the density of the vegetation, ranging from a white to light brown meandering line of the scoured wash channel with scattered dark green to dark brown spots representing shrub cover to a rough-textured medium to dark-green thicket of shrub cover obscuring the underlying substrate. Because this map class occurs in wash channels throughout the Park, a variety of map classes including polygons of talus slope communities, terrace and wash communities, grasslands, and shrublands occur adjacent.



Example of photo signature for map class S-TRIB (#91).

Map Class 93
Fremont Cottonwood Intermittently Flooded Tributary Woodland (W-COTR)




Photo credits: NPS

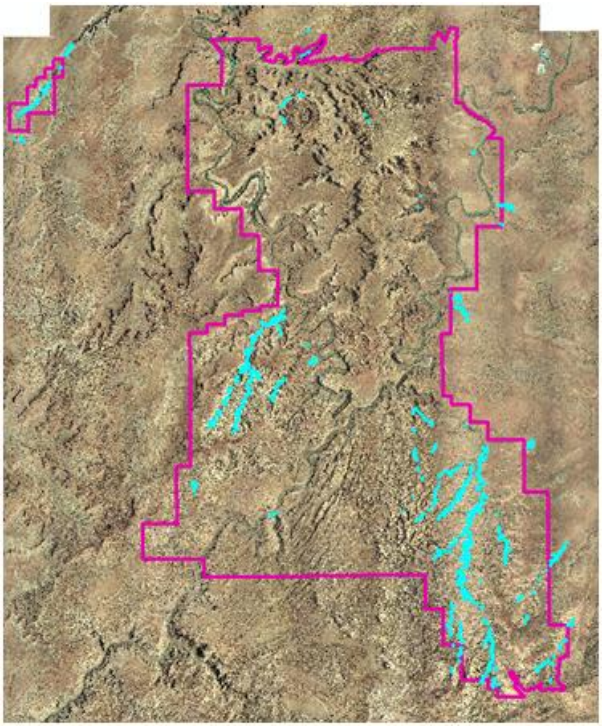
Associations
Populus fremontii / Distichlis spicata Woodland
Populus fremontii / Equisetum spp. Woodland
Populus fremontii / Ericameria nauseosa Woodland
Populus fremontii / Mesic Graminoids Woodland
Populus fremontii / Mesic Forbs Woodland
Populus fremontii / Salix exigua Forest
Populus fremontii / Salix (ligulifolia, lutea) Woodland
Populus fremontii / Sporobolus airoides Woodland
Salix lutea / Mesic graminoids Shrubland

Common species
- *Populus fremontii*
- *Chrysothamnus nauseosus*
- *Salix lutea*
- *Distichlis spicata*
- *Juncus balticus*
- *Salix lutea*
- *Salix exigua*
- *Sporobolus airoides*
- *Equisetum* spp.
- *Phragmites australis*

W-COTR Map Class Statistics

Type:	Association
Frequency:	316 total polygons 267 total polygons in CANY 49 total polygons in the environs
Total project area:	619 hectares / 1,530 acres (0.4 %) 551 hectares / 1,360 acres in CANY 68 hectares / 169 acres in the environs
Average Polygon Size:	2 hectares / 4.8 acres
Producer's accuracy:	83% ± 9%
User's accuracy:	90% ± 7%

Distribution in Mapping Area

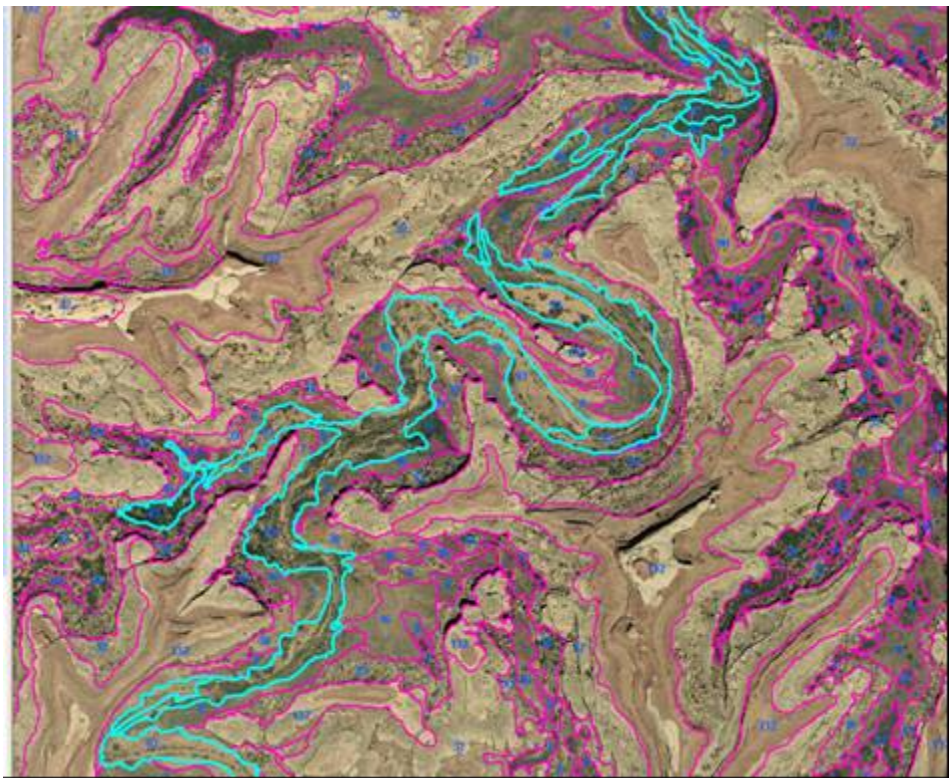


Distribution/Ecology/Composition

Map class 93 is characterized by Fremont cottonwood communities, which include young and mature trees, growing in tributary wash channels, with upland or mesic understories, depending on the depth to the water table. *Salix lutea* communities are also included in this map class. This map class is restricted to the few major tributary drainages in the Park (Salt Creek Canyon, Horse Canyon (The Maze), and Horseshoe Canyon).

Interpretation

This somewhat common map class appears as small to large, linear, sinuous polygons on flats and gentle slopes following drainage courses/wash channels throughout the Park, but mostly concentrated in the upper and middle Salt Creek drainage system, in the Maze, and in Horseshoe Canyon. 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; but the consistent signature includes a tan or light brown meandering line of the scoured wash channel with scattered light to medium green spots representing cottonwood tree crowns, which are sometimes distinguishable because of shadows produced on the imagery but are only reliably distinguished under stereoscopic viewing of aerial photographs. Because this map class occurs in wash channels throughout the Park, a variety of map classes occur adjacent, including talus slope communities, terrace and wash communities, grasslands, and shrublands.



Example of photo signature for map class W-COTR (#93).

Riparian / Wetland Herbaceous Communities

Map Class 92
Tributary Mesic Herbaceous Complex (H-HETR)




Photo credits: NPS

Associations

Agrostis stolonifera Seasonally Flooded Herbaceous Alliance
Calamagrostis scopulorum Hanging Garden Herbaceous Vegetation
Distichlis spicata Herbaceous Vegetation
Juncus balticus Herbaceous Vegetation
Lolium arundinaceum - Agrostis stolonifera Semi-natural Herbaceous Vegetation [Park Special]
Phragmites australis Western North America Temperate Semi-natural Herbaceous Vegetation
Poa pratensis Semi-natural Seasonally Flooded Herbaceous Vegetation
Typha domingensis Western Herbaceous Vegetation

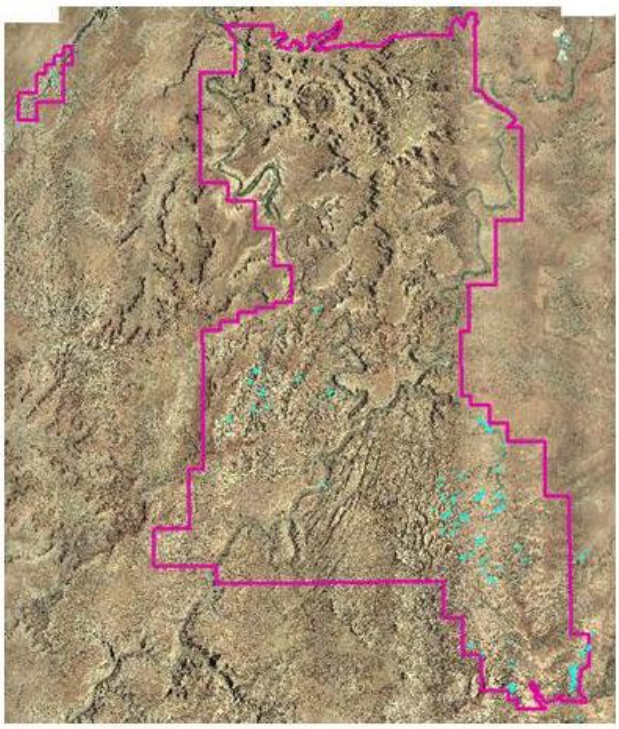
Common species

- *Juncus balticus*
- *Agrostis stolonifera*
- *Phragmites australis*
- *Lolium arundinaceum*
- *Carex spp.*
- *Poa pratensis*
- *Calamagrostis scopulorum*
- *Typha domingensis*
- *Distichlis spicata*
- *Muhlenbergia asperifolia*

H-HETR Map Class Statistics

Type:	Complex
Frequency:	94 total polygons 88 total polygons in CANY 6 total polygons in the environs
Total project area:	58 hectares / 144 acres (0 %) 54 hectares / 134 acres in CANY 4 hectares / 10 acres in the environs
Average Polygon Size:	0.6 hectares / 1.5 acres
Producer's accuracy:	88% ± 14%
User's accuracy:	100%

Distribution in Mapping Area

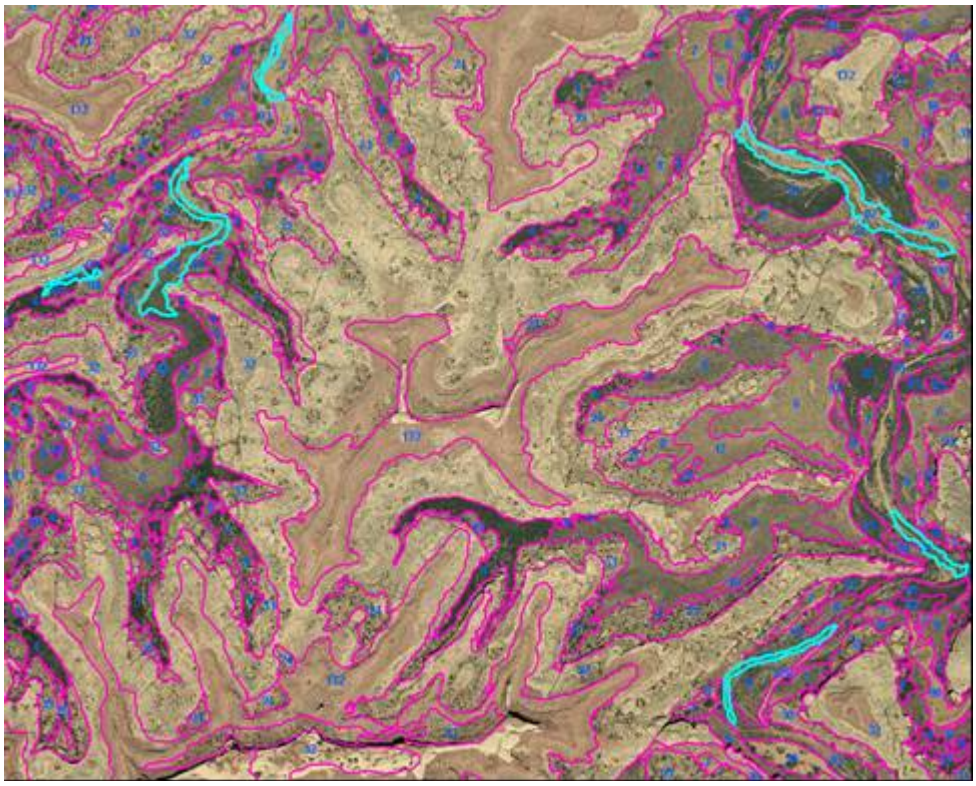


Distribution/Ecology/Composition

Generally small, mesic herbaceous communities found along tributary wash channels where perennial springs occur or where the water table is high enough that surface water is present for some or most of the growing season. A variety of herbaceous species may be present (or it may be a near monoculture of one species) and include: *Juncus balticus, Calamagrostis scopulorum, Agrostis stolonifera, Phragmites australis, Distichlis spicata,* and *Poa pratensis*.

Interpretation

This rare map class appears as small, irregular, sometimes linear and sinuous polygons on flats in tributary wash channels. The signature is a smooth-textured, light green to greenish-gray, with some tan to light brown exposures of scoured wash channel often visible. Because this map class occurs in wash channels throughout the Park, a variety of map classes occur adjacent including talus slope communities, terrace and wash communities, grasslands, and shrublands.



Example of photo signature for map class H-HETR (#92).

Map Class 94
Sporobolus airoides – (Greasewood) Shrub Herbaceous Complex (H-SPAI)





Photo credits: NPS

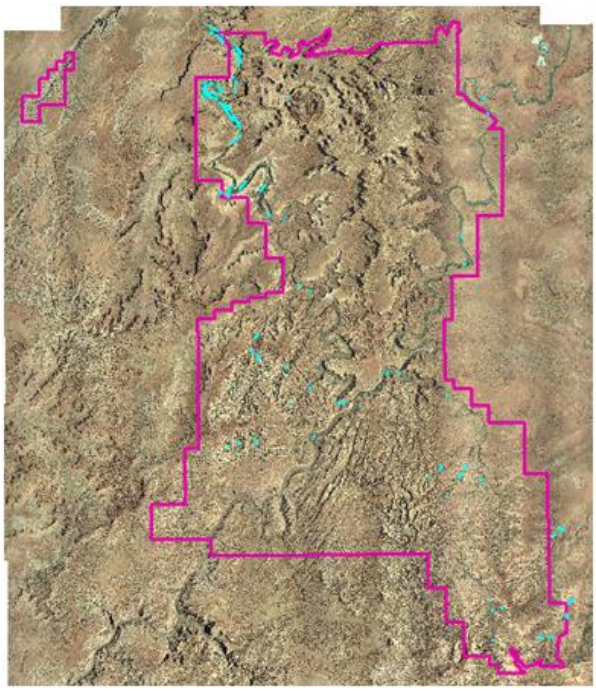
Associations
Atriplex gardneri / Sporobolus airoides Dwarf-shrubland [Park Special]
Pleuraphis jamesii - Sporobolus airoides Herbaceous Vegetation
Sarcobatus vermiculatus / Sporobolus airoides Shrubland
Sporobolus airoides Southern Plains Herbaceous Vegetation

Common species
- *Sporobolus airoides*
- *Sarcobatus vermiculatus*
- *Atriplex canescens*
- *Pleuraphis jamesii*
- *Atriplex gardneri*
- *Sporobolus cryptandrus*

H-SPAI Map Class Statistics

Type:	Complex
Frequency:	139 total polygons 119 total polygons in CANY 20 total polygons in the environs
Total project area:	85 hectares / 210 acres (0 %) 70 hectares / 173 acres in CANY 15 hectares / 37 acres in the environs
Average Polygon Size:	0.6 hectares / 1.5 acres
Producer's accuracy:	92% ± 16%
User's accuracy:	100%

Distribution in Mapping Area

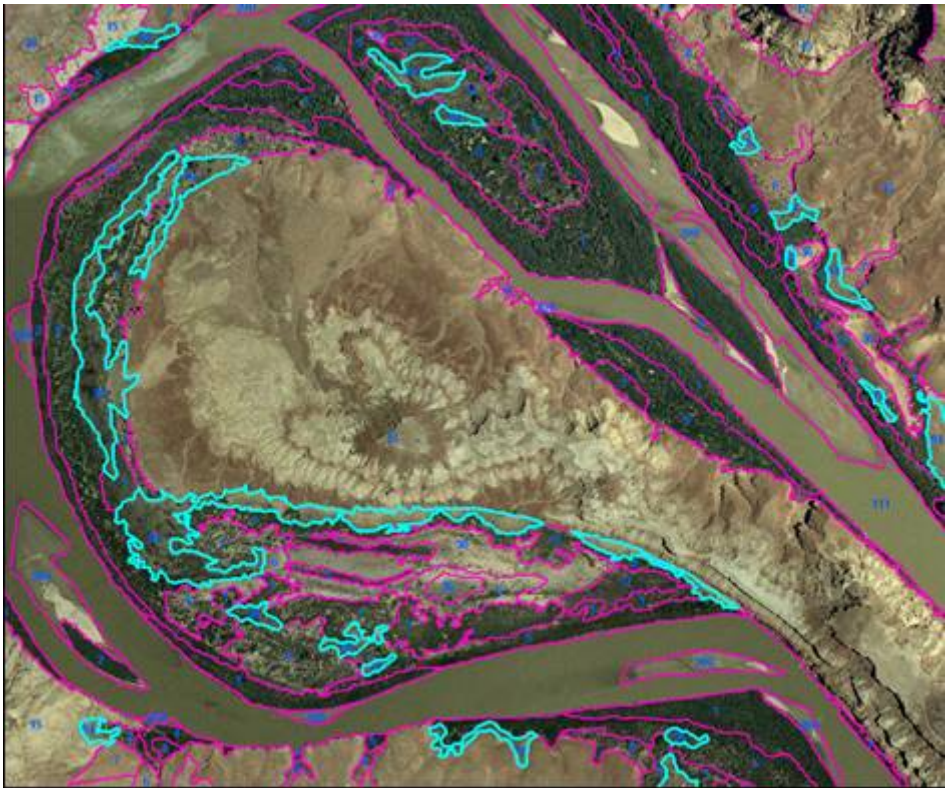


Distribution/Ecology/Composition

Dense, homogenous stands of *Sporobolus airoides,* which may include sparse to moderate cover of greasewood or *Atriplex* spp.*,* occurring both on terraces along the major river corridors and in tributary drainages. Additional moisture from washes and sheet flow runoff are important for most stands. Sites are typically flat to gently sloping with moderately deep, alkaline, often saline, sandy, silty or clay soils.

Interpretation

This rare map class appears as small irregular and often linear polygons on gentle slopes and flats concentrated mostly on higher terraces of the Green River, with a few examples along the Colorado River and in the canyon systems of the Needles and Maze Districts. The signature is a smooth-textured, light to medium grayish-green with scattered dark green blotches representing shrubs. Common neighbors include polygons of tamarisk shrublands (map class 1), desert olive shrublands (map class 5), greasewood shrublands (map class 6), and tributary cottonwood woodlands (map class 93).



Example of photo signature for map class H-SPAI (#94).

Map Class 100
Hanging Gardens (H-HANG)





Photo credits: NPS

Associations
Aquilegia micrantha - Mimulus eastwoodiae Herbaceous Vegetation
Aquilegia micrantha Herbaceous Vegetation
Calamagrostis scopulorum Hanging Garden Herbaceous Vegetation

Common species
- *Aquilegia micrantha*
- *Mimulus eastwoodiae*
- *Smilacina stellata*
- *Muhlenbergia asperifolia*
- *Calamagrostis scopulorum*
- *Adiantum capillus-veneris*
- *Primula specuicola*
- *Rhamnus betulifolia*

H-HANG Map Class Statistics

Type: Complex
Frequency: N/A

Total project area: N/A

Average Polygon Size: N/A
Producer's accuracy: N/A
User's accuracy: N/A

Distribution in Mapping Area

Feature mapped as points; data are incomplete and include sensitive species and are therefore not shown

Distribution/Ecology/Composition
Hanging gardens develop where groundwater 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 CANY, hanging gardens tend to form at the contact of different formations such as the Cedar Mesa Sandstone with the underlying Cutler 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 rarely outside of hanging gardens. Although vegetation is dense within the gardens, examples 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. Species that often surround the hanging gardens on moist, sheltered slopes below include Utah serviceberry, Gambel oak, birchleaf buckthorn, chokecherry, and large pinyon or juniper trees.

Interpretation

This type was not interpreted because it occurs on near-vertical cliff faces or beneath cliff overhangs; occurrences are not visible on the aerial imagery. Instead, this type is documented by point data derived from the plots database and from observations in the field that field crew members marked/drew on copies of the aerial imagery. There are hundreds of separate hanging gardens at CANY; this mapping project located only a portion of them.

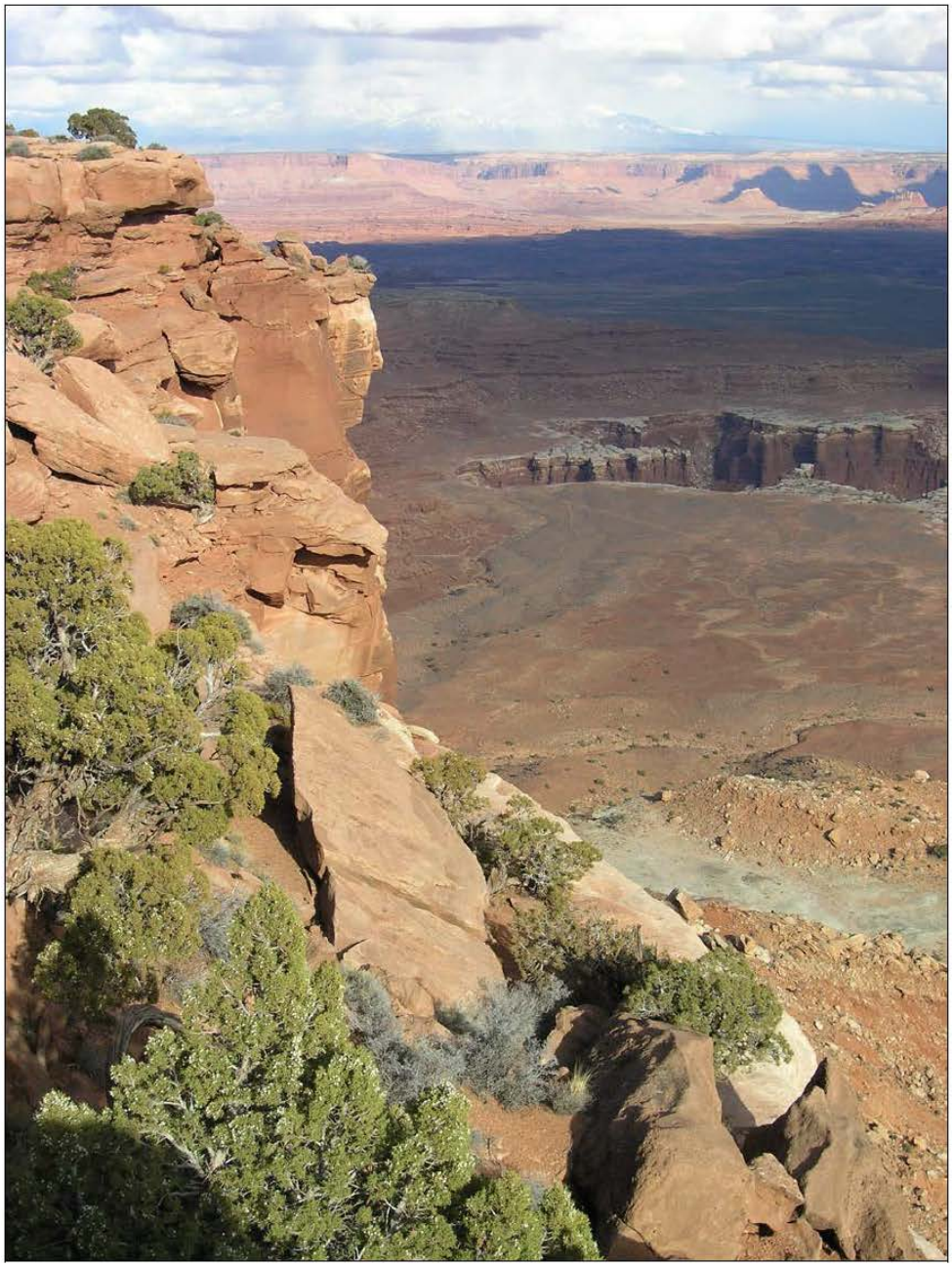
Appendix K. Illustrated Map Class Field Key

Canyonlands National Park

National Park Service
U.S. Department of the Interior

Utah

Illustrated Map Class Field Key
July 2011



INTRODUCTION

In 2004, a diverse assemblage of plant associations was characterized for Canyonlands National Park under the US Geological Survey and National Park Service's Vegetation Mapping Program. Information derived from the 168 classified associations and their habitat was used to develop 42 map classes for Canyonlands National Park. Accuracy assessment of the vegetation map was conducted in 2007 and 2008 by collecting field data at predetermined points and assigning a map class at each point. The field map class assignments were compared with the map classes assigned by the mapper to determine the overall accuracy of the map. To assist in accurate field identification of Canyonlands map classes, this dichotomous key has been developed and illustrated with photos taken during vegetation sampling.

Map class concepts for Canyonlands National Park were developed from the characterization of vegetation habitat (influenced by geology, hydrology, soil type, soil depth, rock cover, slope, aspect, etc.) as much as from the properties of the plant associations included in those map units. Therefore, this dichotomous key is based in large part on the environmental characteristics which separate groups of plant associations from one another. Dominant plant species are included in descriptions to aid in identifying particular habitats.

It should be noted that this key (including representative photos of map classes) and the map class descriptions cannot hope to capture every unique combination of environmental characteristics that will be encountered in the field. Ecotones will be very difficult to classify, and areas with environmental characteristics that are borderline between breaks in the key (for instance, 15-25% rock cover, or areas which show evidence of blowing/drifting sand but also some crust development) will make it difficult to make choices between couplets with complete confidence. It may be necessary in some instances to follow both choices through to their ends to determine the best map class for a given situation. It will also help to consider as much of the polygon as possible, in addition to the 0.5 ha area you are evaluating.

There may also be instances where the environmental characteristics match a particular map class, but the suite of species described for that map class does not. In these cases, give more weight to the environmental characteristics being evaluated than to the species described for that class. Certain map classes (such as map class 31 on the Cutler and Elephant Canyon/Honaker formations) have limited information about the communities occurring there. The data from these AA points and your detailed notes will be used to augment the definition of these map classes.

This key was updated post-AA field work to augment definitions of map classes, clarify breaks in the key, and update photos where better examples existed from 2007-2008 field work. Final map class numbers and names have been changed for the final version of the report and field keys and therefore, may not match the names or numbers listed on accuracy assessment field forms.

KEY TO THE MAP UNITS OF CANYONLANDS NATIONAL PARK

1a All upland communities, including upper terraces above washes and rivers and intermittent/dry wash channels - **2**

1b Mesic and riparian communities dominated by species typically considered as riparian (such as *Populus fremontii*, *Salix exigua*, *Tamarix chinensis*, and mesic herbaceous species such as *Juncus balticus* and *Sporobolus airoides*) **or** intermittently flooded or sheltered upland communities with *Pseudotsuga menziesii* or *Pinus edulis – Juniperus osteosperma* woodlands that may have sparse understories or have moisture-loving understory species such as *Quercus gambelii*, *Mahonia fremontii*, and *Rhus trilobata*. These environments include sandbars and lower terraces of the Green and Colorado Rivers (including sparsely vegetated salt/mud flats), their tributaries, seep/spring communities, mesic areas below pouroffs, and mesic communities around the base of slickrock outcrops or cliffs. This does **not** include shrub-dominated intermittent/dry wash channels or upper terraces above active wash channels that support species such as *Sarcobatus vermiculatus, Atriplex canescens*, *Ericameria nauseosa* and *Artemisia tridentata* - **32**

Xeric/Upland Map Classes

2a (1) Areas of generally deep soil, with little or no rock cover (generally less than 20%). This includes all aeolian deposits (stable and active), dry alluvial terraces and dry wash channels (includes rocky wash channels which may sometimes have >20% rock cover), valley bottoms, alluvial fans and sand sheets - **3**

2b Areas with any rock (including bedrock) exposure or cover >20% **or** slopes and toeslopes derived from rock-like Chinle “mudstone”. This includes areas with thin or poorly developed soils in a rock mosaic, soil lenses on sandstone exposures, areas with shaley/platey rock cover, and all talus slopes. Areas may have high cryptobiotic development in soil pockets or between rocks - **20**

3a (2) Shrub, shrub herbaceous, or grassland communities that may have scattered trees as a minor component of the community (usually <5% cover) - **4**

3b Woodlands or wooded shrubland communities with 5% or greater cover of *Pinus edulis* and/or *Juniperus osteosperma*, or in sparse communities, these trees are a significant component of the vegetation, even if total tree cover is <5% - **15**

Xeric/Upland Shrub, Shrub Herbaceous and Herbaceous Map Classes

4a (3) Unstable upland sand dunes or sand sheets that show evidence of loose, blowing sand (as in pedestalling or mounding around shrubs). Patches of cryptobiotic soil may exist,

but area is marked by light soil stabilization. If you are in a sandy, dry wash channel, skip ahead to couplet 13 - **5**

4b Majority of soil is stable enough to have at least a small degree of crust development or is not aeolian in origin, and can have very well developed crust cover. Includes all terrace and wash communities, as well as communities occurring in valley bottoms or on plateaus that are dominated by the shrubs *Sarcobatus, Atriplex, Ephedra, Ericameria, Krascheninnikovia, Artemisia, Coleogyne, Opuntia*, with or without grasses, or dominated by grasses and/or forbs - **6**

5a (4) Loose dunes or sand blowouts, often on aeolian terraces in drainages or canyon bottoms dominated by *Achnatherum hymenoides* and sand-loving species such as *Eriogonum leptocladon*, *Vanclevea stylosa*, *Artemisia filifolia, Poliomintha incana,* and *Muhlenbergia pungens*. *Opuntia* spp. and weedy annual species may contribute low to moderate cover - **Map Class 13, Sand Dune Shrub-Herbaceous Complex**





5b Flat to moderately rolling sand sheets with a mosaic of shrubs including *Coleogyne ramosissima, Artemisia filifolia, Ephedra viridis,* and/or *Ephedra torreyana*. On looser sand sheets/dunes, *Quercus havardii* is present to dominant. Other shrubs such as *Ericameria nauseosa* and *Atriplex canescens* can be present with low cover. Grass cover may be present, including *Achnatherum hymenoides* and *Pleuraphis jamesii,* but is generally not a major component of the community. Cryptobiotic crust development is usually light, but may be well-developed on stabilized dunes. If *Coleogyne ramosissima* cover exceeds 9% and sand-loving species are not present, go to couplet 7 - **Map Class 11, Sand Sheet Mixed Shrubland Complex**





6a (4) Level to rolling terrain on plateaus, benches, plains, and in broad valley bottoms (such as the Grabens) covered by stable sand sheets or older alluvium supporting shrub, shrub-herbaceous, or herbaceous communities dominated by *Coleogyne ramosissima, Krascheninnikovia lanata*, the mot form of *Ephedra viridis*, grasses such as *Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii, Bouteloua gracilis*, and *Sporobolus* spp., or by weedy annual species - **7**

6b Terrace, floodplain, dry sandy wash channels, valley or canyon bottom communities generally dominated by *Sarcobatus vermiculatus, Atriplex canescens, Ericameria nauseosa, Artemisia* spp., and/or *Opuntia* spp. In some cases, the grasses *Achnatherum hymenoides* or *Pleuraphis jamesii* may be dominant, but generally are just a component of a shrub-dominated community **- 11**

7a (6) Communities with usually >10% cover of *Coleogyne ramosissima*. Other species may be present but blackbrush should be at least three times the abundance of any other species. Scattered *Juniperus osteosperma* may be present as a minor component of the community (usually 5% or less total cover). Cryptobiotic soil crusts have low to high cover. Substrate is variable - **Map Class 10, Blackbrush Shrubland**





7b Usually previously grazed, sometimes weedy, herbaceous, shrub herbaceous and shrubland communities dominated by *Krascheninnikovia lanata* or the mot form of

Ephedra viridis along with some combination of grasses or dominated by the grass species *Stipa* spp., *Sporobolus* spp., *Bouteloua gracilis*, *Pleuraphis jamesii, Bromus tectorum* or by weedy annual forbs - **8**

8a (7) Relatively dense stands of *Krascheninnikovia lanata*, often with a grassy or weedy understory and high crust cover, found in swales in broad valley bottoms, typical of the east side of the Needles District and areas in the Grabens – **Map Class 18, Winterfat Dwarf-shrubland**





8b Communities dominated by the mot form of *Ephedra viridis* with some combination of grasses or dominated by the grass species *Stipa* spp., *Sporobolus* spp., *Bouteloua gracilis,* or *Pleuraphis jamesii* or by weedy, mostly annual herbaceous species - **9**

9a (8) Shrub herbaceous communities of the mot form of *Ephedra viridis* (up to 25% cover), with equal to higher cover of grasses (some combination of *Achnatherum hymenoides*, *Hesperostipa comata, Bouteloua gracilis, Sporobolus cryptandrus*, *Sporobolus airoides*, and *Pleuraphis jamesii*) or dense shrublands of the mot form of *Ephedra viridis*, with proportionally low cover of grasses - **Map Class 14, Green Mormon Tea- Xeric Grasses Shrub Herbaceous Vegetation**





9b Communities dominated by some combination of grasses (*Stipa* spp., *Sporobolus* spp., *Bouteloua gracilis,* or *Pleuraphis jamesii*) or very degraded areas with little to no shrub cover and dominated by weedy, mostly annual species – **10**

10a (9) Weedy, degraded areas often found in previously grazed valley bottoms or plains (typical of the Grabens). Native, perennial species such as *Gutierrezia sarothrae, Pleuraphis jamesii, Sporobolus cryptandrus*, and *Sphaeralcea* spp. may be abundant, but most stands are dominated by *Salsola tragus, Bromus tectorum* and other exotic, annual species. If it is an extremely sparse weedy community in a playa-like setting, go to couplet 39 - **Map Class 17, Weedy Herbaceous Complex**





10b Level to rolling sand sheets or older alluvium on broad plateaus, plains, benches, or in valley bottoms vegetated primarily by native perennial grasses such as *Achnatherum hymenoides, Hesperostipa comata, Sporobolus cryptandrus, Sporobolus airoides, Pleuraphis jamesii*, or *Bouteloua gracilis*. Scattered clumps of *Ephedra viridis, Atriplex canescens,* and *Krascheninnikovia lanata* may be present but have <25% relative cover to the grasses. Biological crusts are slightly to very well developed - **Map Class 16, Valley Bottom and Benchland Grasslands**





11a (6) Alluvial terraces dominated by *Sarcobatus vermiculatus*. *Atriplex canescens* may be present to nearly codominant and understory may be sparse or grassy. Cryptobiotic crust

is usually well-developed - **Map Class 6, Greasewood Intermittently Flooded Shrubland Complex**





11b Alluvial terraces, dry sandy washes, or broad valley bottoms dominated by other shrubs and grasses, such as *Atriplex canescens*, *Artemisia* spp.*, Ericameria nauseosa, Opuntia* spp., *Pleuraphis jamesii, Achnatherum hymenoides*, and/or *Sporobolus airoides* - **12**

12a (11) Alluvial terraces, dry sandy washes, or broad valley bottoms dominated by other shrubs and grasses, such as *Atriplex canescens*, *Artemisia filifolia, Ericameria nauseosa, Opuntia* spp., *Pleuraphis jamesii, Achnatherum hymenoides*, and/or *Sporobolus airoides* - **13**

12b Alluvial terraces or valley bottoms dominated by *Artemisia tridentata* - **14**

13a (12) Upper alluvial terraces or broad valley bottoms dominated by any combination of the following shrubs and grasses: *Atriplex canescens, Artemisia filifolia, Ericameria nauseosa*, *Opuntia* spp., *Sporobolus airoides, Achnatherum hymenoides*, and *Pleuraphis jamesii*. Understory may be dominated by weedy species such as *Bromus tectorum* or *Salsola tragus.* On older terraces with well-developed cryptobiotic soils, *Ephedra torreyana* may be dominant with *Achnatherum hymenoides* and/or *Pleuraphis jamesii* in the understory. *Sarcobatus vermiculatus* and *Artemisia tridentata*, if present, have only trace cover. If the community is *Sporobolus airoides* grassland, go to couplet 39 - **Map Class 7, High Terrace (Low Valley Bottom) Shrub Herbaceous Complex**




13b Generally dry, rocky and/or sandy wash channels with sparse to intermittent vegetation dominated by *Ericameria* spp. or (more rarely) *Atriplex canescens*, and often including *Achnatherum hymenoides, Artemisia campestris,* and *Iva acerosa* growing in the channel or on the banks. Scattered trees may be present, but provide less than 3-5% total cover - **Map Class 90, Dry Wash Complex**




14a (12) Alluvial terraces dominated by *Artemisia tridentata* ssp. *tridentata*. *Sarcobatus vermiculatus, Ericameria nauseosa* and *Atriplex canescens* may be present to codominant and understory may be sparse, weedy or grassy - **Map Class 8, Basin Big Sagebrush Terrace Shrubland Complex**




14b Natural shrublands of *Artemisia tridentata* ssp. *wyomingensis* found in canyon bottoms near the south end of the Needles District and, more rarely, on the mesa top of the Island in the Sky District. If a grass understory is present, it is often composed of *Bouteloua gracilis* and/or *Hesperostipa comata* - **Map Class 9, Wyoming Big Sagebrush Shrubland**





Xeric/Upland Woodland Map Classes

15a (3) *Pinus edulis – Juniperus osteosperma* woodlands with an understory clearly dominated by *Artemisia tridentata* ssp. *wyomingensis.* These woodlands are common south of the park boundary on Salt Creek Mesa, and some have been chained and seeded with *Agropyron cristatum* - **16**

15b *Pinus edulis – Juniperus osteosperma* woodlands with a sparse or grassy understory or an understory dominated by one or some combination of the following shrubs: *Coleogyne ramosissima, Purshia stansburiana, Cercocarpus montanus, Quercus havardii* - **17**

16a (15) High elevation *Pinus edulis – Juniperus osteosperma* woodlands with an understory clearly dominated by *Artemisia tridentata* ssp. *wyomingensis* – **Map Class 22, Pinyon – Juniper / Wyoming Sagebrush Woodland**



16b High elevation (occurring outside the park boundary on Salt Creek Mesa) *Pinus edulis – Juniperus osteosperma* / *Artemisia tridentata* ssp. *wyomingensis* woodlands that have been chained and seeded with *Agropyron cristatum* - **Map Class 23, [Chained and Seeded Pinyon – Juniper Woodland] Sagebrush Shrubland**



17a (15) Woodland and sparse woodland communities (typically less than 10% tree cover) of *Pinus edulis* and/or *Juniperus osteosperma* on undulating dunes which vary in their degree of stabilization. Communities are typically on plateaus and benches where coarser sand deposits accumulate or at the bases of hilly to butte-like rock outcrops. The understory may contain less than 5% total cover of *Coleogyne ramosissima, Purshia stansburiana,* and/or *Quercus havardii. Yucca angustissima, Muhlenbergia pungens* and other dune species are often present - **Map Class 25, Pinyon – Juniper Sand Dune Woodland**




17b *Pinus edulis – Juniperus osteosperma* woodlands with a sparse or grassy understory or an understory dominated by *Coleogyne ramosissima* or *Cercocarpus montanus* with other mixed shrubs – **18**

18a (17) *Pinus edulis – Juniperus osteosperma* woodlands where tree cover exceeds 5% and the most common shrub is *Coleogyne ramosissima,* with cover generally exceeding 5%. Cryptobiotic crust cover may be extensive and well developed. In some examples of this type, the substrate is very rocky (pavement-like gravel). Associated shrubs sometimes present with low relative cover include *Purshia mexicana* and *Ephedra viridis*, but *Coleogyne ramosissima* should be the clear dominant - **Map Class 20, Pinyon – Juniper / Blackbrush Woodland**




18b *Pinus edulis – Juniperus osteosperma* woodlands with a sparse or grassy understory or an understory dominated by *Cercocarpus montanus* with other mixed shrubs - **19**

19a (18) *Pinus edulis* and/or *Juniperus osteosperma* woodlands typically in canyon bottoms but also on plateaus and mesa tops with a generally sparse understory (<5% total shrub cover), but can have moderate cover of grass species such as *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii* and *Sporobolus airoides*. Scattered individuals of *Artemisia* spp., *Cercocarpus montanus* and *Ephedra* spp. may be present in the understory with very low cover. Cryptobiotic crust cover may be extensive

and well developed - **Map Class 24, Juniper – (Pinyon) / Sparse or Grassy Understory Woodland**





19b High elevation (1614-2263 m) *Pinus edulis – Juniperus osteosperma* woodlands typical of Salt Creek Mesa south of the Needles and Hans Flat in the Orange Cliffs. Substrate is generally rocky (gravelly) and the shrub understory often includes a mixture of mountain shrubs, all with low cover: *Cercocarpus montanus, Artemisia nova, Purshia mexicana, Shepherdia rotundifolia. Petradoria pumila* may dominate the understory in some stands - **Map Class 21, Pinyon – Juniper High Elevation Mesa Top Woodland**





Xeric/Upland Rock-dominated Map Classes

20a (2) Areas with >20% rock cover in the form of small rocks (pebbles, gravel, etc.) or in the form of broken bedrock shelves/benches, ledgy canyon slopes, shale plates, shallow soils present on bedrock rims, shelves, or ledges, or potholed and jointed bedrock characteristic of many geologic formations - **21**

20b Steep slopes (>20 degrees, though may be less on toeslopes and lowslopes) of generally loose talus or landslide deposits and rocky ravines below pour-offs - **26**

21a (20) Ledgy, stair-step environments, often on steep canyon sides in the Kayenta, Cedar Mesa, Cutler, Elephant Canyon, and Organ Rock formations supporting somewhat sparse vegetation, that includes tall and short shrubs, scattered Junipers (rarely Pinyons), and sparse cover by dwarf shrubs and grass species. Bedrock cover is significant (20-60% cover) - **22**

21b Extensive areas on a variety of geologic formations that are characterized by massive sandstone outcrops (bedrock cover typically exceeds 50-60%) forming rims, hills, domes, and shelves with thin soils on ledges, in pockets, and in joints/cracks or rolling terrain typical of the Moenkopi and Chinle formations where small rocks (pebbles, gravel, etc.) cover much of the unvegetated surface - **23**

22a (21) Sparsely vegetated, ledgy canyon sides in the Cutler, Organ Rock, and Elephant Canyon formations that may support *Ephedra torreyana*, *Coleogyne ramosissima*, *Atriplex confertifolia*, *Eriogonum corymbosum*, *Ericameria nauseosa* var. *junceus*, tall shrubs such as *Fraxinus anomala, Rhus trilobata,* and *Purshia stansburiana*, and sparsely scattered Junipers - **Map Class 31, Cutler Benches Cliffy Canyonside Mosaic**





22b Ledgy, or more rarely flat, sandstone outcrops with shallow soil cover typical of the Kayenta Formation, broken bedrock ledges where sandstone detritus lies on a sandstone substrate, and steep bedrock ramps common in the Cedar Mesa Formation that support wooded shrublands dominated by *Pinus edulis* and/or *Juniperus osteosperma, Coleogyne ramosissima, Purshia stansburiana, Cercocarpus montanus,* and/or *Amelanchier utahensis.* Other species commonly present include *Ephedra viridis* and *Fraxinus anomala,* and in the Maze District, *Quercus gambelii* and *Shepherdia rotundifolia*. Total vegetation cover and species dominance will vary depending on bedrock exposure, soil cover, and soil depth - **Map Class 33, Broken Bedrock Ledge and Slope Woodland Complex**





23a (21) Extensive areas on a variety of geologic formations that are characterized by massive sandstone outcrops (bedrock cover typically exceeds 50-60%) forming rims, hills, domes, and shelves with thin soils on ledges, in pockets, and/or in joints/cracks - **24**

23b Rolling terrain typical of the Moenkopi and Chinle formations, including plateaus, benches, and toeslopes, where small rocks (pebbles, gravel, etc.) cover much of the unvegetated surface and vegetation cover is sparse (≤5-10% cover) - **25**

24a (23) Sparsely vegetated hard sandstone characterized by slickrock potholes, shallow soil depressions, or joints/cracks typical of the Navajo and Cedar Mesa formations, but occasionally found on other formations. Bedrock cover generally exceeds 60-70%. Vegetation often consists of scattered *Pinus edulis* and *Juniperus osteosperma* with a sparse but diverse understory. *Cercocarpus intricatus* is usually present, and other common shrubs include *Coleogyne ramosissima*, *Purshia stansburiana*, *Fraxinus anomala*, *Amelanchier utahensis, Shepherdia rotundifolia* and *Ephedra viridis* - **Map Class 32, Potholed and Jointed Sandstone Woodland Complex**





24b Relatively level, mostly rimrock areas, of hard sandstone typical of the White Rim Formation that support sparse vegetation characterized by *Coleogyne ramosissima, Purshia stansburiana*, and occasionally *Cercocarpus intricatus,* with scattered but often diverse grass cover, *Gutierrezia sarothrae* and *Yucca angustissima.* Bedrock cover

generally exceeds 75%. Plants are limited by soil availability and trees are exceptionally rare - **Map Class 34, Rimrock Sparse Vegetation Complex**





25a (23) Dark gray, often rocky soils, at the base of Chinle Formation slopes, with very sparse vegetation and well-developed, lichen-dominated cryptobiotic soils. Gypsiferous crystals are often present. Vegetation may include *Ephedra torreyana*, *Atriplex* spp., and scattered clumps of *Pleuraphis jamesii* - **Map Class 35, Cryptobiotic Soil Crust – Ephedra Sparse Vegetation Complex**





25b Plateaus, benches, and toeslopes characterized by a surface covered in small rocks (shaley/platey/pebbly), or mudstone-like slopes and benches in the Chinle and Moenkopi formations, supporting sparse mixed communities of *Coleogyne ramosissima, Ephedra torreyana, Atriplex confertifolia,* and the grass *Pleuraphis jamesii*. All three shrub species are usually present and vary in their dominance and amount of grass understory. Pockets of sparse *Eriogonum corymbosum, Atriplex gardneri,* or *Zuckia brandegeei* communities are also part of this map unit. Varying degrees of cryptobiotic soil development are present. If cover of *Coleogyne ramosissima* exceeds 9% across a large area, return to couplet 7 – **Map Class 15, Shale Barrens Desert Scrub Complex**





26a (20) Talus slopes or steep, rocky ravines on escarpments, consisting of sandstone detritus lying on shale and supporting a mixed community that includes scattered *Pinus edulis* and/or *Juniperus osteosperma* and a variety of taller shrubs (e.g., *Amelanchier utahensis*, *Fraxinus anomala, Rhus trilobata, Fendlera rupicola*), as well as a mixture of short shrubs. *Elymus salinus* is often present to abundant. Total vegetation cover usually does not exceed 10-15% - **Map Class 29, Cool Aspect / Wooded Shale Scarps Complex**





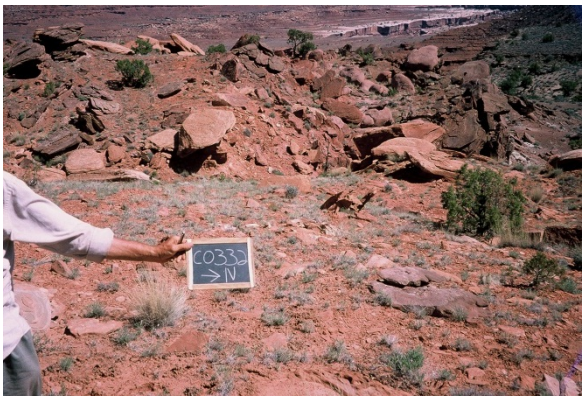
26b Talus slopes or landslide deposits, usually on warmer aspects and/or convex, exposed slopes. Vegetation is generally sparse (<10% cover) and consists of a mix of short shrubs such as *Ephedra* spp., *Coleogyne ramosissima*, *Artemisia bigelovii*, *Chrysothamnus nauseosus* var. *junceus*, *Chrysothamnus viscidiflorus, Eriogonum corymbosum*, and *Atriplex confertifolia.* Stunted *Juniperus osteosperma* and scattered tall shrubs may be present with very low cover - **27**

27a (26) Sparsely vegetated talus slopes, generally steep, that support scattered shrubs of *Ephedra torreyana*, *Atriplex confertifolia*, *Artemisia bigelovii*, *Ericameria nauseosa* var. *junceus*, *Chrysothamnus viscidiflorus*, *Fraxinus anomala,* and *Rhus trilobata*, among others. Total vegetation cover is often less than 10%. Widely scattered and stunted *Juniperus osteosperma* may be present - **Map Class 30, Talus Escarpments Mixed Sparse Vegetation Complex**





27b Landslide deposits of generally <20% slope, typically at the base of the Wingate/ Chinle scarp that rest on Chinle benches. Blue gray shale is often exposed at the edges of this unit, rubble is mostly coarse textured, and the landscape has an undulating moraine appearance. Vegetation is a sparse mixture of xeric short shrubs and grasses and can include scattered *Juniperus osteosperma* - **Map Class 28, Toeslope/Moraine Sparse Vegetation Complex**





Riparian Map Classes

28a (1) Riparian communities in side drainages, including intermittently flooded wash channels, seep/spring communities, very mesic areas below pouroffs or under alcoves, and mesic communities around the base of slickrock outcrops or cliffs - **29**

28b Riparian communities associated with the Green and Colorado River corridors - **5**

Riparian Tributary Map Classes

29a (28) Mesic or riparian communities dominated by *Populus*, *Salix, Tamarix, Rhamnus, Betula, Ostrya, Quercus gambelii,* and/or *Forestiera pubescens* among others) and a variety of mesic herbaceous species occurring in intermittently flooded wash channels, on terraces, and below pouroffs in alcoves, as well as all seep/spring communities - **30**

29b Mesic or riparian communities where *Pinus edulis – Juniperus osteosperma* or *Pseudotsuga menziesii* trees are present to dominant. Environments include dry sandy wash channels, canyon bottoms, at the base of pouroffs, or around the base of slickrock cliffs or outcrops - **33**

30a Generally small, mesic herbaceous communities found along tributaries/wash channels where springs occur or where the water table is high enough that surface water is present for most of the year. Herbaceous species present include: *Juncus balticus, Calamagrostis scopulorum, Agrostis stolonifera, Phragmites australis, Distichlis spicata,* and *Poa pratensis*. If the community is a *Sporobolus airoides* grassland, go to couplet 39 - **Map Class 92, Tributary Mesic Herbaceous Complex**





30b Mesic or riparian communities dominated by *Populus*, *Salix, Tamarix, Rhamnus, Betula, Ostrya, Quercus gambelii,* and/or *Forestiera pubescens* (among others) occurring in intermittently flooded wash channels, on terraces, and below pouroffs in alcoves, as well as all seep/spring communities - **31**

31a (30) Cottonwood communities in tributary wash channels, mature or young, that may have upland or mesic understories depending on the depth to the water table. *Salix lutea* communities are also included in this map class - **Map Class 93, Fremont Cottonwood Intermittently Flooded Tributary Woodland**





31b Mesic or riparian communities dominated by *Salix exigua, Tamarix, Rhamnus, Betula, Ostrya, Quercus gambelii,* and/or *Forestiera pubescens* (among others) occurring in intermittently flooded wash channels, on terraces, and below pouroffs in alcoves, as well as all seep/spring communities - **32**

32a **(**32) Wash terraces, coves, alcoves, heads of ravines, and seep/spring headwater communities dominated by *Quercus gambelii* or a hybrid with *Quercus havardii* and usually with a sparse understory. Other riparian species, such as *Rhus* spp., *Betula, Rhamnus, Ostrya, Cornus, Prunus,* and/or *Forestiera pubescens* (among others) may be present, but *Quercus gambelii* is generally dominant. Pinyon pine and juniper are absent or present only with very low cover. If the community has relatively high cover (nearly codominant with oak) of *Pinus edulis* and/or *Juniperus osteosperma*, go to couplet 34 - **Map Class 4, Gambel Oak – Mixed Mesic Shrubs Terrace and Cove Shrubland**





32b Tributary wash channels dominated by *Tamarix ramosissima* and/or *Salix exigua*. This includes dense stands of one or both species, as well as open clumps in intermittently flooded washes - **Map Class 91, Floodplain and Tributary Tamarisk and Coyote Willow Shrubland Complex**





33a (29) Small stands of *Pseudotsuga menziesii* on ledge seeps, on the high slope of escarpments, and in pouroff basins. Understories vary and may include *Pinus edulis, Amelanchier utahensis, Quercus gambelii, Mahonia fremontii, Shepherdia rotundifolia, Rosa woodsii*, and *Symphoricarpos longiflorus* - **Map Class 96, Douglas-fir Scree Slope Woodland**





33b *Pinus edulis – Juniperus osteosperma* dominated communities around the base of slickrock outcrops, in pouroff basins/alcoves, in narrow canyon bottoms, or in washes, usually with tall shrubs such as *Fraxinus anomala, Purshia stansburiana, Amelanchier utahensis, Mahonia fremontii, Rhus trilobata,* and/or *Quercus gambelii* present in the understory - **34**

34a (33) *Pinus edulis* and/or *Juniperus osteosperma* dominated communities in sandy or rocky washes or in narrow canyon bottoms. Big tree crowns and shrubs such as *Rhus trilobata*, *Purshia stansburiana, Quercus gambelii, Amelanchier utahensis*, *Fraxinus anomala,* and *Symphoricarpos longiflorus* are characteristic of this map class - **Map Class 26, Pinyon- Juniper Intermittently Flooded Woodland**





34b Dense or large-crowned *Pinus edulis – Juniperus osteosperma* woodlands that can form a narrow ring around the base of slickrock outcrops where runoff is concentrated or can exist as dense stands in pouroff basins/alcoves. Understory can be sparse and dominated

by well-developed soil crusts or can include moderate to high cover of the tall shrubs *Quercus gambelii, Mahonia fremontii,* and *Artemisia tridentata* - **Map Class 27, Pinyon - Juniper "Pour-over" Woodland**





Riparian Big River Map Classes

35a (28) River sandbar communities that are submerged part of the year and become "islands" when river levels drop, or low sandy areas connected to the river bank that are part of the active channel. Communities are characterized by fairly dense stands of young/regenerating or older, established *Salix exigua. Tamarix chinensis* and/or *Forestiera pubescens* may be mixed in with low numbers, but neither one should be codominant with willow - **Map Class 2, Sandbar Willow Riverine Shrubland**





35b River terrace communities dominated by dense stands of *Tamarix, Salix, Phragmites, Forestiera*, *Sporobolus airoides* or *Quercus gambelii*, as well as woodland communities of *Populus fremontii, Salix gooddingii* or *Acer negundo*. Also included here are nearly unvegetated salt/mud flats - **36**

36a (35) Decadent gallery woodlands of *Populus fremontii* (or more rarely *Acer negundo* or *Salix gooddingii*) on higher terraces of the major rivers, generally with xeric understories of *Ericameria nauseosa, Atriplex canescens, Distichlis spicata*, or mesic forbs. Some

relict cottonwood stands may have dense *Tamarix* and/or *Salix exigua* understories - **Map Class 3, Fremont Cottonwood Riverine Woodland**





36b Continuous, often dense stands of *Tamarix, Salix exigua, Forestiera, Phragmites*, *Sporobolus airoides,* or *Quercus gambelii* **or** nearly unvegetated salt/mud flats, often in a mosaic along the river corridors but not in the annual floodplain - **37**

37a (36) Continuous, dense (nearly impenetrable) mature stands of *Tamarix ramosissima* (often mixed with *Salix exigua*) along the banks or on the first terrace of the major rivers - **Map Class 1, Tamarisk (and Coyote Willow) River Corridor Shrubland**





37b Continuous, often dense stands of *Forestiera, Phragmites*, *Sporobolus airoides,* or *Quercus gambelii* **or** nearly unvegetated salt/mud flats – **38**

38a (37) Continuous, often dense stands of *Forestiera pubescens, Phragmites australis*, and (less often) *Quercus gambelii* occurring on higher floodplain areas of the major river corridors, often as a fairly narrow band hugging the inland edge of dense *Tamarix* stands. Other mesic tall shrub species may be included in the mosaic, including those of the genera *Rosa, Ribes,* and/or *Rhus* - **Map Class 5, High Floodplain Riverine Desert Olive - Reed Grass Complex**





38b Dense, homogenous stands of *Sporobolus airoides*, more rarely *Sporobolus cryptandrus,* occurring both on terraces along the major river corridors and in tributary drainages **or** unvegetated salt/mud flats on high river terraces - **39**

39a (38) Dense, homogenous stands of *Sporobolus airoides*, occurring both on terraces along the major river corridors and in tributary drainages. May include sparse cover of greasewood or *Atriplex* spp. - **Map Class 94, Sporobolus airoides – (Greasewood) Shrub Herbaceous Complex**





39b Alkali areas and mud flats on river terraces with <3% shrub cover (mainly greasewood) but may include low to moderate cover of *Suaeda torreyana* and weedy annual species - **Map Class 36, River Floodplain Salt Flats**





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