National Park Service
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Natural Resource Program Center

Vegetation Classification and Mapping Project Report, Colorado National Monument

Natural Resource Technical Report NPS/NCPN/NRTR—2007/061



ON THE COVER
Monument Canyon, Colorado National Monument (Photograph courtesty of National Park Service)

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Natural Resource Report NPS/NCPN/NRTR—2007/061

Jim Von Loh
engineering-environmental Management, Inc.
Englewood, Colorado

Keith Landgraf
U.S. Geological Survey, Mid-Continent Geographic Science Center
Lawrence, Kansas

Angela Evenden
National Park Service, Northern Colorado Plateau Network
Moab, Utah

Tom Owens and Steve Blauer
U.S. Geological Survey, Rocky Mountain Geographic Mapping Center
Denver, Colorado

Marion Reid
NatureServe
Boulder, Colorado

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Acronyms and Abbreviations

AA	Accuracy Assessment
APFO	Aerial Photography Field Office
BLM	United States Bureau of Land Management
BPU	Biophysical Unit
CCC	Civilian Conservation Corps
CEGL	Community Element Code – Global
cm	Centimeter
COLM	Colorado National Monument
DBH	Diameter at Breast Height
DEM	Digital Elevation Model
DOQQ	Digital Orthophoto Quarter Quadrangle
DRC	Diameter at Root Crown
e^2M	engineering-environmental Management, Inc.
ERDAS	Earth Resources Data Analysis System
ES	Ecological System
ESRI	Environmental Systems Research Institute
FGDC	Federal Geographic Data Committee
ft	Foot/Feet
GIS	Geographic Information System
GPS	Global Positioning System
Gradsect	Gradient-Oriented Transect
ha	Hectares
I&M	Inventory and Monitoring Program
in	Inch
ITIS	Integrated Taxonomic Information System
km	Kilometer
m	Meters
mi	Miles
MMU	Minimum Mapping Unit
NAD83	North American Datum of 1983
NCPN	Northern Colorado Plateau Network
NPS	National Park Service
NVC	National Vegetation Classification
NVCS	National Vegetation Classification Standard
QA/QC	Quality Assessment / Quality Check
RMGSC	Rocky Mountain Geographic Science Center
TNC	The Nature Conservancy
TSN	Taxonomic Serial Number
UNESCO	United Nations Education, Science, and Cultural Organization
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator

Summary

The Northern Colorado Plateau Inventory and Monitoring Network (NCPN) cooperated with the U.S. Geological Survey (USGS) and National Park Service (NPS) Vegetation Mapping Program and NPS Fire Program to classify, describe, and map vegetation and fuels at Colorado National Monument (COLM). This collaborative project involved many partners, including engineering-environmental Management, Inc. (e^2M), USGS Rocky Mountain Geographic Science Center (RMGSC), the Western Region office of NatureServe, and their cooperators.

The total project mapping area is 12,685 hectares (31,344 acres), encompassing the monument and environs. Ecologists, botanists, and photo interpreters cooperated to identify plant associations for COLM and determine how best to map them using 1:12,000-scale, true color aerial photography. The team documented the project area's vegetation by sampling 288 plots and 218 observation points. These data were analyzed and assigned to 67 associations of the National Vegetation Classification. Fuels data were collected for woodland and shrubland communities during sampling, but were not analyzed as part of this project. Fieldwork and mapping were completed between 2003 and 2005.

Vegetation and land use were interpreted from high-resolution, true color digital orthoimagery and 9" x 9" stereo pairs of 1:12,000-scale true color photographs flown specifically for this project. Polygons representing vegetation or land use map classes defined by RMGSC, in consultation with other project partners, were delineated on orthophotos in a digital environment. With few exceptions, occurrences smaller than approximately 0.5 ha were not delineated.

Vegetation within the monument boundary was mapped at as detailed a level as possible using a combination of computer modeling and aerial photo interpretation. A total of 4,359 map polygons were developed within the COLM mapping project area. Average polygon size is 2.9 ha (7.2 acres). Lands within the monument comprise 8,252 ha (20,391 acres), divided into 2,850 polygons representing natural and semi-natural vegetation map classes as well as geologic and developed land classes.

The urbanized environs northeast of the monument were mapped using standardized land cover classes instead of the vegetation map classes used within COLM. ?One thousand five hundred and nine polygons totaling 4,428 ha (10,945 acres) of unvegetated, developed, and natural/semi-natural vegetated map classes were delineated in the environs.

Of the 38 map classes interpreted within the monument boundary, 20 occurred consistently in patches smaller than the minimum mapping unit of 0.5 ha and are represented by point data instead of polygons. Seventeen vascular and nonvascular map classes were delineated by landscape modeling techniques using ERDAS Imagine software, as were four unvegetated geologic types. Twenty-six vegetation map classes were interpreted and mapped using traditional photo interpretation methods and an on-screen digitizing process.

Map accuracy was assessed within the COLM boundary only. Results from a thematic accuracy assessment of 23 vegetation map classes indicated an overall map accuracy of 68% (Kappa index = 64%). Several individual map classes exceeded the Vegetation Mapping Program standard of

80%. Other map classes did not meet the 80% accuracy standard, but were retained because of their value to monument managers. Twenty additional vegetation map classes were mapped as points directly from the field data; these are assumed to be 100% accurate.

Products resulting from the COLM vegetation mapping project include:

Available in this report:

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

Available elsewhere[1]:

- ground photography of vegetation plots, observation points, and accuracy assessment points in hard copy and digital formats
- 360-degree digital videos acquired from the center of each vegetation plot
- all field data (plot, observation point, and accuracy assessment point) stored in a Microsoft Access database
- original hardcopy and scanned digital copies of the field data forms
- 9” x 9” 1:12,000-scale true-color stereo aerial photographs acquired for this project
- 1:12,000-scale, geo-referenced true color digital orthophotography acquired for this project
- geospatial coverages of vegetation, land use, aerial photography flight lines, monument and project boundaries
- hard copy vegetation maps
- metadata for all digital products

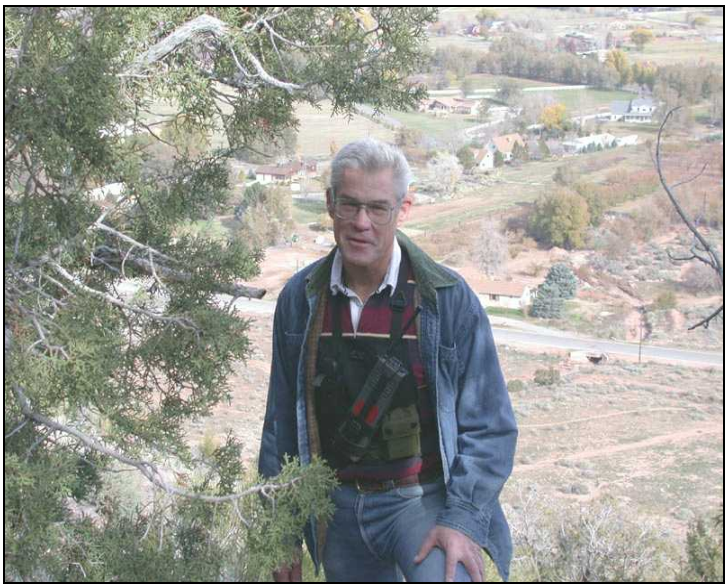
Geospatial products are in Universal Transverse Mercator (UTM) projection, Zone 12, using the North American datum of 1983.

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

Dedication

This report is dedicated to the memory of Pete Larson (1942–2004), who was a valued member of the Colorado National Monument staff. He contributed to the vegetation classification and mapping project by providing logistical support and valuable suggestions on areas to sample, as well as identifying safe routes for accessing canyons. Locations of tamarisk and Russian-olive observed during the study were reported to Pete so that he could continue his efforts to eradicate these invasive plants from the monument. Congressman Scott McInnis, to honor Pete, entered the following tribute, in part, into the Congressional Record of the United States of America:

> "Peter Larson, a seasonal employee of the Bureau of Land Management for five years and the National Park Service for ten years, was killed in an all-terrain vehicle accident on August 2, 2004, near the South Shale Ridge, twenty miles north of Grand Junction. He was conducting land health assessments for the BLM when the accident occurred.
>
> ". . . Pete was ever ready to help a friend or stranger, ever ready to share his knowledge and love of the land. He knew its plant and animal inhabitants, its soils and water, its weather and moods.
>
> "His love of the land and the people of Mesa County led him to continue his service to others. He developed his passion for fighting tamarisk while working at Colorado National Monument. He was instrumental in creating the Tamarisk Coalition, served on their Board of Directors, and was the organization's first president.
>
> "Pete will be remembered as an active, enthusiastic individual who loved what he did, who he did it for, and where he did it. Pete's curiosity and love of learning how things worked inspired those who know him. As the sun rises, his family and friends will think of him walking the canyons. . ."



Acknowledgements

This project was completed through the effort and dedication of numerous individuals and organizations. Angela Evenden (National Park Service), Mike Story (NPS), and Karl Brown (U.S. Geological Survey) provided project oversight and coordination with support from Jim Von Loh, Senior Biologist with engineering-environmental Management, Inc. Funding for this project was provided through the USGS-NPS National Vegetation Mapping Program, NPS Fire Program, and the Northern Colorado Plateau Inventory and Monitoring Network.

Many thanks to Alan Bell of the Bureau of Reclamation's Remote Sensing and Geographic Information Group for facilitating the acquisition of new digital orthophotography through Horizons, Inc. of Rapid City, South Dakota. Aerial stereo photography for this project was obtained through the USDA Farm Services Aerial Photo Field Office in Salt Lake City, Utah.

Numerous individuals collected plot, observation point, and accuracy assessment field data. We appreciate the hard work of Travis Belote, Arne Buechling, Steve Blauer, Sarah Boyes, Bruce Condie, Maureen DeCoursey, Brett Fletcher, Keith Landgraf, Liz Rodgers, and Sarah Topp. Special thanks to Pete Williams and Brian Davis who used their technical climbing skills to rappel into canyons and scale steep slopes to reach remote plots.

Tom Owens, Mike Steir, Keith Landgraf, and Steve Blauer of the USGS-Rocky Mountain Geographic Mapping Center produced the spatial database. Tom, Keith, Steve, and Bev Friesen convened the accuracy assessment meeting. Final map production and spatial database refinement was completed by NCPN cartographic technician Aneth Wight.

Karin Decker of the Colorado Natural Heritage Program prepared the preliminary vegetation classification; final association names were assigned by Marion Reid of NatureServe. Marion also created and supplied a local association description template and worked with Janet Coles on preparing the global association descriptions. Janet also developed a method to test and improve the field key.

Database management support and development were skillfully performed by Margaret Beer (NPS) and Jack Doria (e^2M). Their preparation of a new MS Access database for plot, observation point, and accuracy assessment data simplified entry and analysis. Both Margaret and Jack provided assistance to database users to allow analyses to proceed on schedule.

The staff of Colorado National Monument, under the guidance of Natural Resource Chief Dave Price, was instrumental in the success of this project. Lisa Claussen and Shirley Winterhalder facilitated research permits and made NPS housing available. Pete Larson assisted with project scoping and provided information on safe access routes until his death in August 2004. Bill Rodgers was a rich source of information concerning the monument's natural resources, access issues, and neighbors. Bill also watched for the safe return of field crews at the end of the day. Joe Wulfman, a property owner at the mouth of Red Canyon, allowed field researchers to access the monument through his land.

Introduction

Colorado National Monument Vegetation Classification and Mapping Project

The Colorado National Monument (COLM) Vegetation Mapping Project was organized and coordinated by the Northern Colorado Plateau Network Inventory and Monitoring Program (NCPN I&M) between 2001 and 2006, with assistance from several project cooperators. The purpose of this project was to describe and map existing plant associations and fuels on 12,685 hectares (31,344 acres) within and adjacent to COLM, and to provide this information in written, tabular, digital, and spatial formats useful to monument resource managers, the NCPN I&M Program, and others. Basic project components included vegetation classification and description, vegetation map and spatial database development, and map accuracy assessment.

In 2001, the NCPN I&M Program launched a multi-year effort to complete vegetation classifications, descriptions, and maps for 15 network park units. To support this effort, the NCPN acquired 1:12,000-scale true color aerial photography for each park unit in 2002. The COLM Vegetation Classification and Mapping Project was initiated at a 2003 scoping meeting with engineering-environmental Management, Inc. (e^2M), U.S. Geological Survey (USGS) – Rocky Mountain Geographic Service Center (RMGSC), NatureServe, U.S. Bureau of Land Management (BLM), and the National Park Service (NPS). Project work was coordinated with the national USGS-NPS Vegetation Mapping Program. Vegetation plot and observation point data collection occurred in 2003, the AA was conducted in 2004, and post-AA revisions completed in 2005.

The products resulting from this project provide baseline information and valuable planning tools to COLM resource managers and scientists. These include a classification of the Monument's vegetation to National Vegetation Classification (NVC) associations, an illustrated field key to plant associations, detailed descriptions of each plant association, species lists, ground photographs and digital movies, and a Microsoft Access database with vegetation plot, observation point, and AA point data. Spatial data products include aerial photographs, digital orthoimagery, description of map classes, an attribute table including spatial, vegetational, and environmental characteristics of each polygon, hard copy vegetation maps, metadata, and an AA of the vegetation map.

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 COLM 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 an interagency initiative established to inventory, classify, describe, and map vegetation in more than 270 national park units within the United States. It 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 National Park Service the opportunity to move forward with dozens of new park unit vegetation classification and mapping projects, including COLM. 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 National Park Service developed a long-term inventory and monitoring program for natural resources in park units over the past two decades. This effort was significantly enhanced by the NPS Natural Resource Challenge (NPS 1999). The NCPN was formed in 2000 to develop an integrated long-term inventory and monitoring program for 16 park units in Utah, Colorado, Arizona, and Wyoming.

An overall goal of the NPS I&M Program is to complete baseline inventories of biological and geophysical resources for each park unit with significant natural resources. These inventories cover 12 basic data sets needed by park staff to guide resource management. Vegetation mapping and classification constitute one of these data sets. Early in the development of its I&M program, the NCPN identified the need to complete vegetation maps for each network park unit, both to assist park managers as well as supporting the design of long-term monitoring programs. In 2001, the network implemented a strategy to approach and complete vegetation mapping in all network park units. The COLM vegetation mapping project is the first 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

- documenting a National Vegetation Classification System (TNC and ESRI 1994a)
- standards for field methods and mapping procedures (TNC and ESRI 1994b, USGS 2004)
- producing rigorous and consistent accuracy assessment procedures (ESRI et al. 1994)
- establishing standards 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 (NatureServe 2003a, TNC and ESRI 1994a), and is based on the National Vegetation Classification Standard adopted by the Federal Geographic Data Committee (FGDC 1997). The NVC 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 NVC is based in part on earlier vegetation classification produced by the United Nations Educational, Cultural, and Scientific Organization (UNESCO) (UNESCO 1973, Driscoll et al. 1984). Use of a standardized classification system helps ensure data compatibility throughout the National Park Service and other agencies. The FGDC Vegetation Subcommittee works to keep this standard current and relevant (URL: http://biology.usgs.gov/fgdc.veg/standards/vegstd.htm).

Patterns of vegetation vary continuously over landscapes, and classification systems attempt to recognize and describe repeating assemblages of plants in similar habitats. The NVC 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 variability in floristic composition. The physiognomic units have a broad geographic perspective and the floristic units have utility in local and site-specific applications (TNC and ESRI 1994a, Grossman et al. 1998). The physiognomic levels of the NVC 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 at the base of the NVC are determined by the most abundant or diagnostic species comprising the strata of a homogenous vegetation community (Table 1). 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 ESRI 1994a). The 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 manages and coordinates plant association data for the NCPN vegetation mapping projects. New associations are added to the NVC and existing concepts are refined as new data become available.

Table 1. National Vegetation Classification System hierarchy for terrestrial vegetation.

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
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 osteosperma / Amelanchier utahensis* Woodland

Other Standards

The FGDC oversees standards for vegetation classification, map attribution, and spatial accuracy, and for metadata employed in NPS vegetation mapping projects. For example, standards for vegetation mapping require that each map class be mapped with at least 80% thematic accuracy. 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 12.2 m (40.0 ft.) on the ground for 1:24,000-scale maps.

All digital vegetation products 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

President William Howard Taft's 1911 proclamation established Colorado National Monument to preserve "extraordinary examples of erosion which are of great scientific interest" (NPS 2005). The monument is located on the northeast flank of the Uncompahgre Plateau immediately west of Grand Junction, Colorado (Figure 1). COLM encompasses 8,310 ha (20,534 acres) of rugged canyon and plateau topography ranging from 1,402 m to 2,165 m (4,600 ft to 7,100 ft) in elevation. The project mapping area includes the entire monument and 4,375 ha (10,810 acres) of adjacent BLM and private land (Figure 2) for a total project area of 12,685 ha (31,344 acres).



Figure 1. Location of COLM within the Northern Colorado Plateau Network of parks.

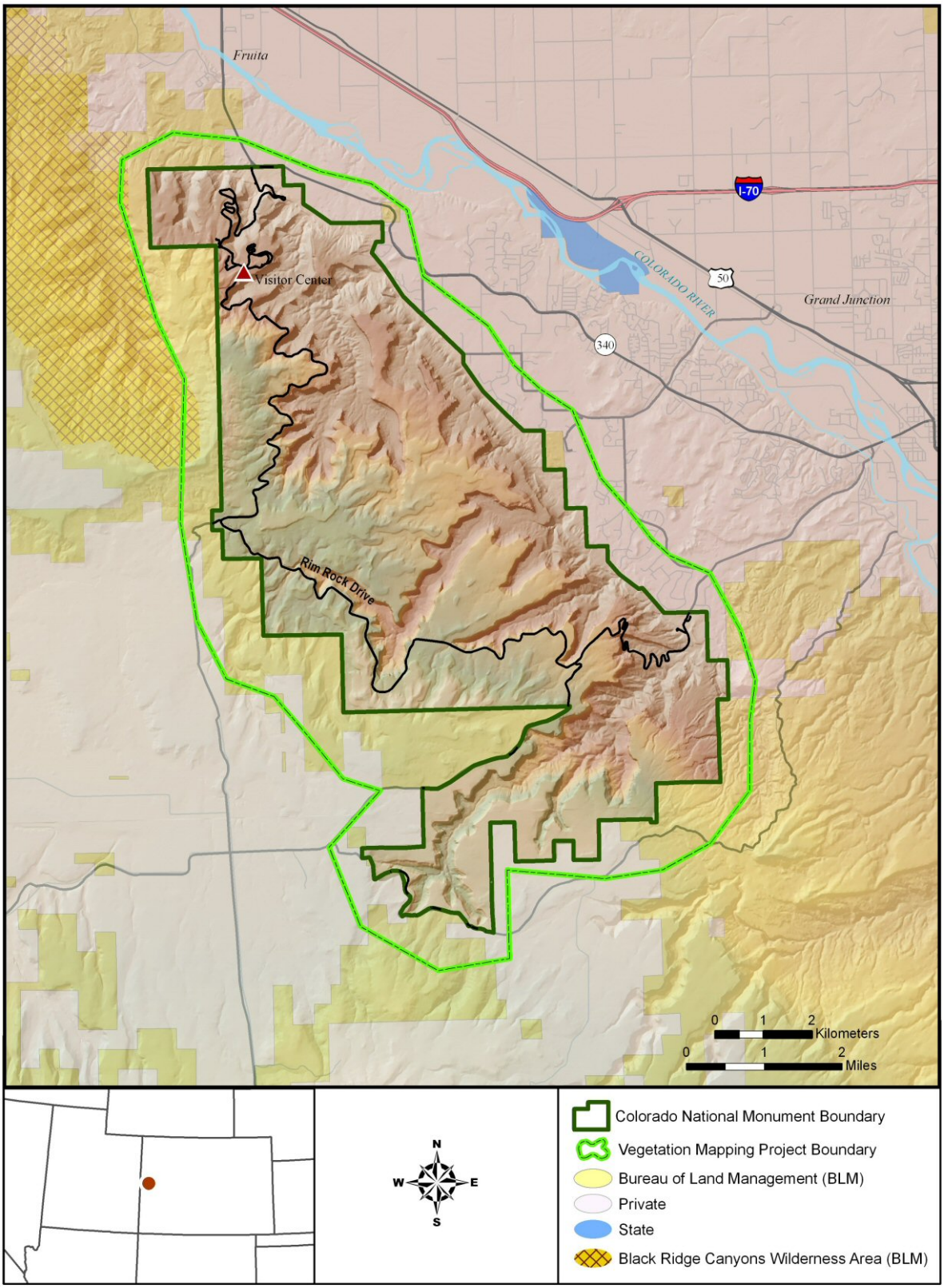


Figure 2. The COLM vegetation project mapping area, showing adjacent land ownership.

COLM is located within rapidly developing Mesa County, Colorado, and is a popular destination among local residents for hiking, biking, wildlife viewing, and other recreational activities. Approximately 275,000 people visit COLM each year. In recent decades, suburban development adjacent to the eastern COLM boundary has increased significantly. As a result, monument managers are faced with intensifying urban interface management issues, including fire management, invasive species introductions, and domestic pet trespass.

Lands managed by the BLM adjoin COLM's southeastern and southwestern boundary (Figure 2). These lands are part of the 49,500 ha (122,300 acre) McInnis Canyons National Conservation Area, established in 2000 to protect outstanding scenery, cultural and paleontologic values, naturalness, recreation, wildlife, and geologic and scientific values. The Black Ridge Canyons Wilderness (created at the same time as the NCA) is located on the northwestern boundary of the COLM mapping area (Figure 2).

Topography

COLM lies within the Uinta Basin section of the Colorado Plateaus physiographic province (Fenneman and Johnson 1946). The monument occupies the eastern edge of the Colorado Plateau and the northern end of the Uncompahgre Plateau (Taylor 1999). Landscapes are characterized by exposures of colorful, gently dipping sedimentary rocks that have been differentially eroded by wind and water to form scenic monoliths, plateaus, escarpments, and deep canyons (NPS 2005). Elevations range from 2,164 m (7,100 ft) on Black Ridge to 1,402 m (4,600 ft) in the Grand Valley of the Colorado River.

Viewed from the Grand Valley, the monument is visually dominated by Black Ridge. Fruita and Monument mesas are the tilted tablelands east of Black Ridge. The mesas are dissected into a series of canyons, which reach depths of more than 200 m (650 ft) from rim to the resistant Precambrian bedrock that forms their floors.

Climate

COLM is characterized by a semiarid climate averaging 18 cm (11 in) of precipitation annually (Figure 3). The precipitation pattern is distributed roughly evenly throughout the year, with minor peaks in the spring and late summer due to convective thunderstorms (Figure 4). Total annual snowfall averages 81.3 cm (32 in), with December and January being the snowiest months. Precipitation is greater at the higher elevations near Glade Park than at lower elevations near Fruita.

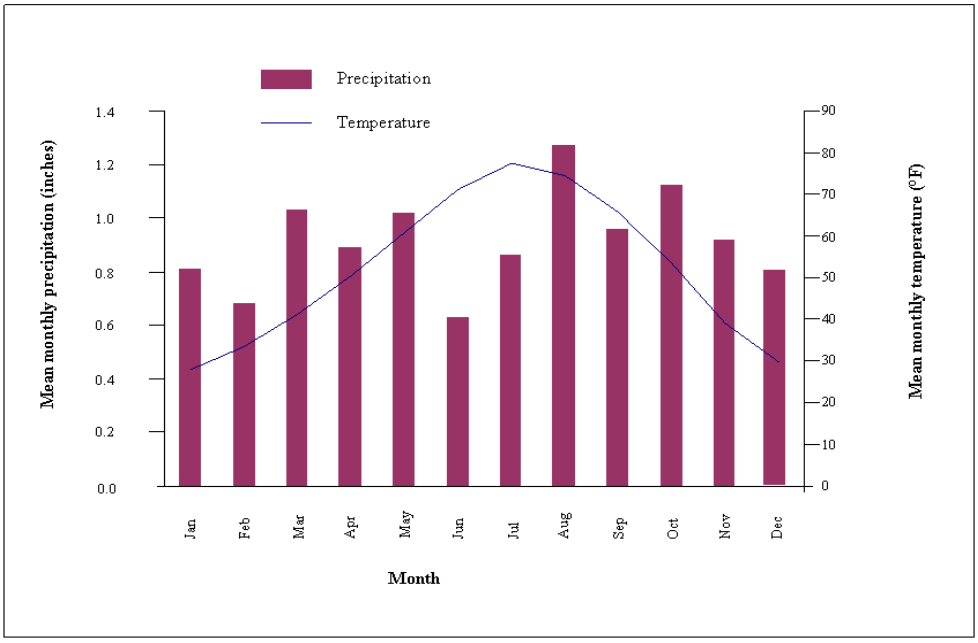


Figure 3. Climate data for COLM (Western Regional Climate Center 2004)

Weather records have been maintained at the COLM visitor center since 1948. Summers are long with hot days averaging 33.2ºC (91.8 ºF) and warm nights averaging 17.1ºC (62.7 ºF) in July (Western Regional Climate Center 2004). The hottest days can reach up to 43.3 ºC (110 ºF) (NPS 2005). Winters are relatively mild with an average maximum temperature of 2.8 ºC (37.1 ºF) and an average minimum temperature of -7.4 ^{o}C (18.6 ºF) in January. The coldest days occasionally drop to single digit temperatures. Conditions can vary noticeably during a single day, from low to high elevations, and between seasons.



Photo Credit: Jim Von Loh

Figure 4. Typical summer afternoon thunderstorm forming over COLM.

Geology and Vegetation

Geologic uplift and erosion over a period of 1.7 billion years created the features visible within COLM (Figure 5). A geologic history and map of COLM and adjacent areas were completed recently (Brunstein et al. 2006, Scott et al. 2001). Geologic substrate greatly influences vegetation patterns within the monument, by controlling elevation, slope angle, aspect, soil depth, nutrient levels, and soil moisture holding capacity. The rest of this section summarizes the relationship of geologic and vegetation features within the COLM mapping area.

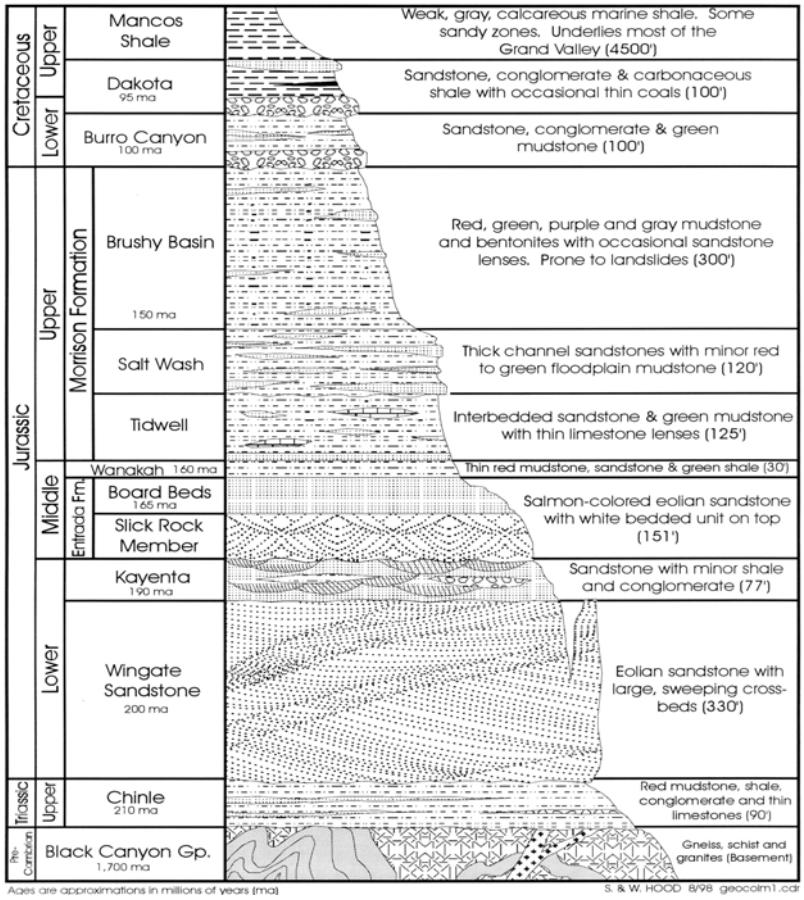


Figure 5. Geologic cross-section for COLM.

COLM's vegetation can be broadly characterized as semi-desert (West 1988), occupying rugged topography distributed over 762 m (2,500 ft) of elevation. Dwarfed woodlands and sparse shrublands are the dominant vegetation types. Harder rocks such as gneiss and sandstone tend to form plateaus supporting woody plant communities. When these rocks begin to break down, they form fissures in which soil collects, moisture gathers and shrubs and trees can root. The density of the woody vegetation is therefore controlled by the degree of fracturing of the underlying bedrock. Softer rocks like shale break down into fine-textured soils that are difficult for precipitation to penetrate. Unless these slopes are modified by a veneer of sandstone colluvium, their plant communities tend to be sparse shrublands or grasslands. Unconsolidated sediments deposited by wind or water provide the deep soils within the mapping area. These sites support denser shrublands and grasslands, or woodlands in areas that have not burned recently.

Precambrian rocks are exposed in the bottoms of major canyons and along the eastern flank of COLM. They consist of metamorphosed and folded schist and migmatitic pegmatite (Scott et al. 2001) and tend to form coarse soils with poor water-holding capacity. The dark color increases surface temperatures. Vegetation on this substrate tends to be relatively sparse and dwarfed in stature. The most common plant communities found on these substrates include woodlands of two-needle pinyon (*Pinus edulis*) and/or Utah juniper (*Juniperus osteosperma*), Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) or prickly-pear cactus (*Opuntia*

polyacantha) shrublands, and James' galleta (*Pleuraphis jamesii*) grasslands (Figure 6a). Nearly pure stands of stunted Utah juniper occupy gravels in the gaps among migmatite boulders.





Figure 6 Photo Credits: Jim Von Loh

Figure 6a. Precambrian metamorphic rocks (migmatite).

Steep slopes immediately above the dark Precambrian rocks are cut into the Late Triassic Chinle Formation, but the reddish-brown outcrops are usually small and mostly covered by blocks of sandstone fallen from cliffs above. Chinle exposures are typically deeply eroded and the soils sealed to a hard surface so that rain and snow have difficulty infiltrating. The sandstone colluvium creates microhabitats with slightly higher water availability, stable soils, and moderated soil temperatures. Plant communities on the Chinle include sparse Utah serviceberry (*Amelanchier utahensis*), mountain mahogany (*Cercocarpus montanus*), and fendlerbush (*Fendlera rupicola*) shrublands (Figure 6b).





Figure 6b. Triassic Chinle Formation

Exposures of Jurassic rocks make up a large portion of COLM. Upper Jurassic Morrison Formation exposures include rounded slopes formed in the multicolored mudstone of the Brushy Basin Member. The sandstone-dominated Salt Wash Member is a cliff-forming unit; and the mudstone Tidwell Member forms slopes broken by thin ledges of sandstone and the only limestone within COLM. The mix of substrates supports a broad range of plant communities. The coarser but generally deeper soils formed in the Salt Wash member support woodlands and shrublands, whereas the shallow, fine-textured shale substrates support shadscale (*Atriplex*

confertifolia) shrublands and grasslands of Salinas lyme grass (*Leymus salinus*) or James' galleta (Figure 6c).

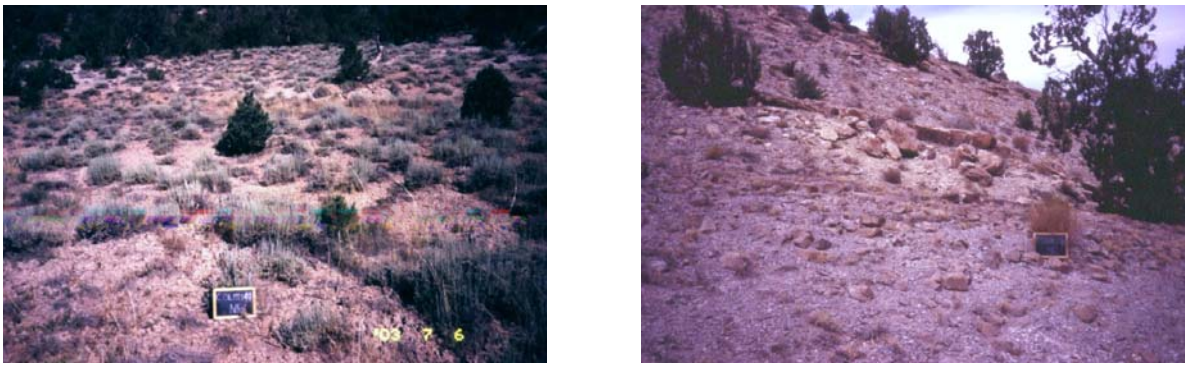


Figure 6c. Upper Jurassic Morrison Formation: Tidwell (l) and Brushy Basin (r) members.

The middle Jurassic Wanakah Formation is a slope-forming mudstone and the Entrada Sandstone appears in slabs, cliffs, and benches (Figure 6d). These formations support sparse vegetation at best. The white cap of the Entrada sandstone is called the Board Beds Unit and provides habitat for a unique community of lichens and mosses. Where sparse plant communities have become established on Middle Jurassic exposures, pinyon pine, Utah juniper, and mountain mahogany are the common species.



Figure 6d. Middle Jurassic Entrada Formation (l) and Board Beds Unit (r).

The lower Jurassic Kayenta Formation forms small cliffs and ledges above the massive Wingate sandstone. The Kayenta consists of sandstone intermixed with conglomerate and mudstone, with numerous fractures in which vegetation can root. The Wingate sandstone forms vertical cliffs up to 200 m (650 ft) high that support little vegetation. Plant communities that have become established on Kayenta Formation ledges include Two-needle pinyon and Utah juniper woodlands, and mountain mahogany, littleleaf mountain mahogany (*Cercocarpus intricatus*), and Bigelow sagebrush (*Artemisia bigelovii*) shrublands (Figure 6e). Seeps discharging from the base of Wingate sandstone cliffs at their contact with impermeable Chinle shale sometimes support hanging gardens (Figure 7).





Figure 6e. Lower Jurassic Wingate (l) and Kayenta (r) formations

Cretaceous rocks are exposed only on Black Ridge where ledges and ridges of Dakota Formation sandstone and conglomerate cap Burro Canyon Formation mudstone slopes. Plant communities that have become established on Cretaceous exposures include two-needle pinyon and Utah juniper woodlands, mountain mahogany and Utah serviceberry shrublands (on sandy substrates), and Salinas lyme grass and James' galleta grasslands on sandy or shale substrates (Figure 6f).





Figure 6f. Cretaceous rocks.

Unconsolidated Quaternary deposits occur throughout the monument and support a diversity of plant communities. Pleistocene substrates include landslide deposits, alluvial slope deposits, and river gravels. Plant communities established on these surfaces include two-needle pinyon, Utah juniper, and single-leaf ash (*Fraxinus anomala*) woodlands; Wyoming big sagebrush, shadscale, fourwing saltbush (*Atriplex canescens*), and black greasewood (*Sarcobatus vermiculatus*) shrublands; and James' galleta, needle-and-thread (*Hesperostipa comata*), and sand dropseed (*Sporobolus cryptandrus*) grasslands (Figure 6g).

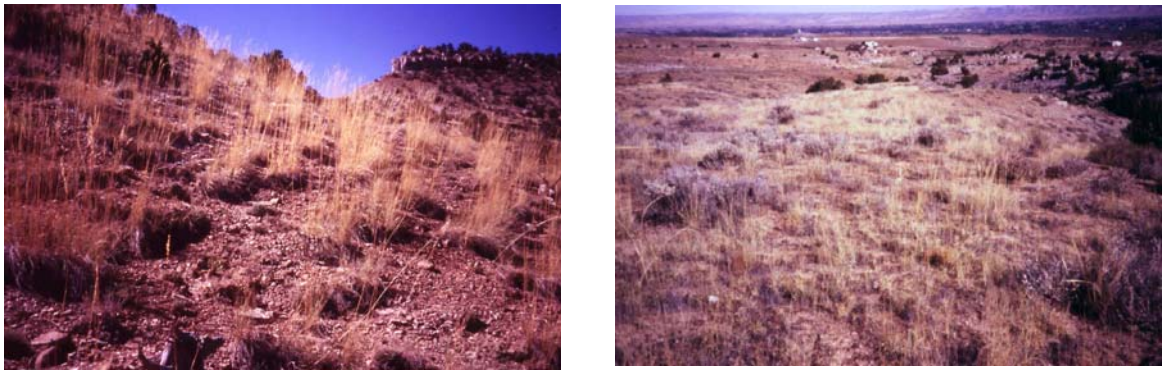


Figure 6g. Quaternary (Pleistocene) deposits.

Holocene deposits dominate the eastern boundary of COLM, including eolian sands, sheet wash, rock falls, valley fill, floodplain and stream channel deposits, cienega muds, landslides, alluvial fans, and debris flows. Plant communities on these substrates include woodlands of two-needle pinyon and Utah juniper, single-leaf ash, box elder (*Acer negundo*) or Rio Grande cottonwood, Wyoming big sagebrush, basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*), shadscale, fourwing saltbush, black greasewood, sandbar willow (*Salix exigua*) and rubber rabbitbrush (*Ericameria nauseosa*), shrublands, and James' galleta, needle-and-thread, Indian ricegrass (*Achnatherum hymenoides*), and cheatgrass (*Bromus tectorum*) grasslands (Figure 6h).



Figure 6h. Holocene deposits.



Photo Credit: Brian Davis

Figure 7. Seep supporting a hanging garden at COLM.

Soils

Soil maps and descriptions for Mesa County are being updated (USDA-Soil Conservation Service 1978, Park 2004). Twenty-three soil types have been described for COLM. These include deep, well-drained soils formed in sandy eolian deposits; moderately deep to deep soils formed in alluvium of mixed lithology; shallow, well-drained soils formed in residuum weathered from sandstone, in colluvium derived from sandstone, granite, or shale, and in residuum weathered from sandstone, clayey shale, and calcareous sandstone. Eolian deposits occur on mesas where they sometimes form dunes; alluvium is found on fans, benches, and terraces, and residuum is found on the summits and slopes of mesas, hills, and benches. Soil textures range from loamy sands (coarse textured) to expansive sandy clay loams (fine textured).

Biological Soil Crusts

Biological soil crusts are best developed within COLM on sites protected from disturbance. They are re-developing on areas that were grazed or otherwise disturbed (Figure 8). Biological soil crusts are a complex community of cyanobacteria, green algae, lichens, mosses, microfungi, and true bacteria (Belnap et al. 2001). The cyanobacteria and microfungi weave their filaments through the top few millimeters of soil, creating a matrix that stabilizes and protects the soil surface from wind and water erosion. The crusts fix atmospheric nitrogen, contribute to soil organic matter (Eldridge and Green 1994), and also function as living mulch that retains soil moisture and discourages growth of annual non-native plant species such as cheatgrass (Belnap et al. 2001).

Biological soil crusts occupy the openings between tree canopies and clumps of vascular plants and hold thin soils overlying bedrock. They are diverse in terms of species composition, often containing more species than the associated vascular plant community (Ponzetti et al. 1998, Rosentreter 1986). On some sites, biological soil crusts are elevated above the soil surface, forming low, mounded patches or small spires. Sites that experienced heavy historic disturbance, such as bison grazing or construction equipment staging, lack developed biological crusts.



Photo Credit: Jim Von Loh

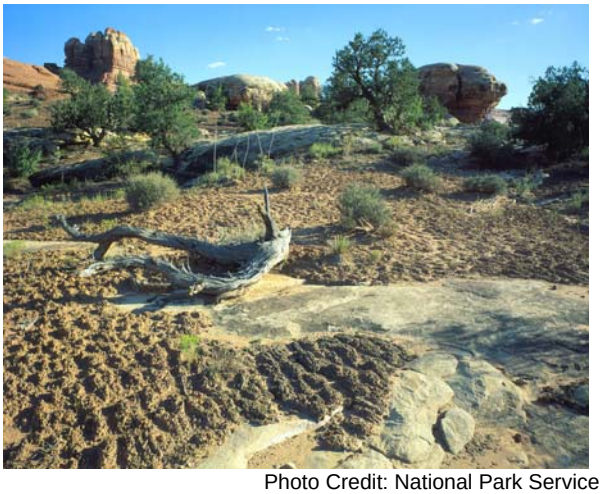


Photo Credit: National Park Service

Figure 8. Examples of biological soil crusts on the Colorado Plateau.

Hydrology and Water Resources

The monument contains limited water resources in the form of intermittent streams, ephemeral bedrock potholes (tinajas), seeps, and springs. Spatially intermittent streams in No Thoroughfare, Red, Ute, and Monument canyons support stands of emergent wetland and riparian vegetation. Tinajas appear on all bedrock exposures, particularly the Kayenta sandstone cap rock that is common in much of the monument. Seeps and springs provide localized surface flows and saturated soils where they emerge in the heads of canyons. Seeps also emerge from cliff faces and deposit dissolved salts as the water evaporates, staining the rock surface white.

Water flowing from COLM is delivered to the Colorado River via intermittent drainages and washes. Surface flows occur during and shortly after precipitation events. Debris lines and channel scour indicate that intense flash flooding occurs periodically. Flash floods can remove vegetation, redeposit boulders and sediments, incise drainages, and bury canyon floor vegetation.

Land Use

Current land uses within the COLM project area include transportation, NPS facilities, residential housing developments, livestock grazing, and recreation. All land uses influence vegetation distribution, condition, composition, and development.

Impacts on COLM vegetation from historic land use include American bison grazing. Bison were introduced in 1925 into a 1,165 ha (2,879 acre) fenced section of the monument at the mouths of Red and Monument canyons. There is no evidence to suggest that American bison were native to this part of Colorado. The herd reached its maximum size of 46 animals in 1942. Between 1975 and 1977, a study conducted by the National Park Service examined the herd and found that the animals were malnourished, the population was becoming inbred, and soils and plant communities were sustaining damage (Wasser 1977). The herd was relocated to Badlands National Park in South Dakota in 1983; rehabilitation of the area began the following year, including removal of nonnative plants and restoration of soils and native vegetation.

Previous Vegetation Studies

Dr. William Weber (then curator of the University of Colorado Herbarium in Boulder) and colleagues studied the flora of COLM and adjacent Mesa County during the 1970s and 1980s. Their work documented 66 families, 250 genera, and 450 species within their project area (Weber et al. 1982). In 2005, the NCPN hired University of Colorado plant taxonomists to conduct a review of the COLM plant collections. No field work was involved and no new collections resulted from the review. An updated and verified vascular plant list for the monument (Appendix D) resulted from this work.

Wasser (1977) conducted a two-year study of the effects of an introduced herd of American bison on the vegetation and soil resources of COLM, as well as the effects of climate and nutrient availability on the animals' health. In the mid 1980s, Abbey initiated a study (1984, 1985) to determine the condition and trend of plant communities affected by the bison herd. Around this time, Abbey (undated) also developed a vegetation map for COLM using 24 map classes. Documentation of these studies is incomplete; the available information supporting the Abbey vegetation map appears in the COLM Vegetation Classification and Mapping Project Work Plan (Von Loh et al. 2002).

In 1996, the Colorado Natural Heritage Program completed a natural heritage inventory for Mesa County (Lyon et al. 1996). The survey area included COLM and documented the locations of 14 state-sensitive plant species within the monument.

During the past decade, resource management staff at COLM mapped and removed tamarisk populations within the monument. In 2003, NCPN funded a monument-wide invasive plant inventory and mapping project (Dewey and Anderson 2005).

Project Overview

General Approach and Timeline

The goal of this project was to describe and map existing vegetation within COLM and its environs, an area totaling 12,685 ha (31,344 acres). The COLM project is part of a larger effort undertaken by the NCPN to classify and map existing vegetation in all 16 network parks. As part of the coordinated effort, the NCPN created and adapted standards for databases, mapping, and reporting, in order to ensure that data are comparable across park units. Other preparatory tasks included obtaining new 1:12,000-scale stereo photography and orthoimagery and developing a work plan. Additional contracts and interagency agreements based on the work plan were negotiated to complete all phases of the project. Table 2 illustrates the overall project timeline.

The COLM vegetation classification and mapping project was officially launched at a 2003 meeting. Vegetation plot and observation point data were collected and analyzed in 2003. Aerial photo interpretation and initial spatial database development was completed in 2004. An illustrated field key to COLM plant associations was developed prior to map AA, and field tested during the AA in 2004. AA data were entered into the COLM plots database and then analyzed, with results tabulated into a contingency matrix. An AA analysis meeting was held in February 2005. Local and global plant association descriptions were completed in 2005. Final revisions were made to the vegetation classification, descriptions, and spatial database in 2006.

Table 2. Timeline for COLM vegetation mapping project tasks.

TASK DESCRIPTION	2001	2002	2003	2004	2005	2006
Planning and Scoping						
Acquire Aerial Imagery						
Field Data Collection						
Photo Interpretation						
Vegetation Classification						
Local & Global Descriptions						
Spatial Database						
Field Key to Plant Associations						
Accuracy Assessment						
Final Report and Products						

Primary Partners and Project Roles

The employees of a number of agencies and organizations were involved in the Colorado National Monument Vegetation Classification and Mapping Project. The roles of each are described below.

engineering-environmental Management, Inc.

- *Jim Von Loh, Senior Biologist* – Managed or assisted with every component of the project. Wrote project work plan; prepared agendas and compiled meeting minutes; managed plot, observation point, and AA data collection and entry; created and tested field key; prepared local descriptions; wrote final report
- *Sharon Anderson, PhD,. Plant Taxonomist* – Work plan development
- *Brian Davis, GIS Specialist and Field Technician* – Created coverages for initial modified gradsect, assisted with plot and observation point data collection, including technical climbing in remote areas
- *Dan Niosi, Natural Resource Specialist* – Work plan development, production, and project meeting minutes
- *Sarah Boyes, Field Technician* – Plot and observation point data collection and entry
- *Travis Belote, Staff Ecologist* – Collected and entered AA point data
- *Arne Beuchling, Staff Ecologist* – Collected and entered AA point data
- *Jack Doria, Database Programmer* – Programming assistance for plots database
- *Matthew Smith* – Final report support
- *Wanda Lafferty, Technical Publications Specialist* – Prepared draft and final work plan and project report, technical editing, and contracted the printing
- *Maureen DeCoursey, Consulting Ecologist* – Collected vegetation plot and observation point data
- *Peter Williams, Consulting Field Technician and Technical Climber* – Collected vegetation plot and observation point data
- *Karin Decker (Colorado Natural Heritage Program, Consulting Ecologist)* – Analyzed field data and prepared preliminary vegetation classification

National Park Service, Northern Colorado Plateau Network

- *Angie Evenden, Ph.D., Vegetation Program Manager* – Coordinated and managed overall project, established NCPN project standards, organized project meetings, managed budgets, agreements and contracts, co-authored final report, coordinated final product completion, and data management support
- *Margaret Beer, Data Manager* – Oversaw plots database development and data management support, assisted with completing final products
- *Amy Tendick, Biological Technician* – QA/QC of plots databases, managed project photographs
- *Aneth Wight, GIS Technician* – Provided project boundary coverage, assisted with final report, spatial and plots databases and other products
- *Bruce Condie, Field Technician* – Collected plot and observation point data
- *Sarah Topp, Field Technician* – Collected plot and observation point data

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 of 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 orthophotography

USGS Rocky Mountain Geographic Mapping Center

- *Tom Owens, Project Leader* – Overall point of contact for USGS throughout project
- *Mike Stier, Mapping Program Manager* – Provided administrative oversight and QA/QC analyses
- *Keith Landgraf, Mapping Team Leader* – Image processing and photo interpretation and attribution, accuracy assessment lead, spatial database development, report preparation, and final product completion
- *Steve Blauer, Cartographer* – Completed image processing and photo interpretation
- *Beverly Friesen, Cartographer* – Participated in accuracy assessment meeting
- *Stewart Wright, Cartographer* – Metadata and guide to map classes

NatureServe

- *Marion Reid, Senior Regional Ecologist* –project manager, supported classification
- *Janet Coles, Regional Ecologist* – Reviewed field key, reviewed draft local descriptions, prepared global association descriptions, and edited final report
- *Mary Russo, Ecology Data Manager* – Entered COLM local and global descriptions into NatureServe's Biotics database, provided final reports of descriptions, completed plant species crosswalk
- *Kristin Snow, Assistant Ecologist/Ecological Information Manager* – Developed reporting format for NCPN plant association local and global descriptions

National Park Service Colorado National Monument

- *Dave Price, Resource Specialist* – Acted as primary monument contact for project
- *Pete Larson, Biologist (deceased)* – Provided overall project support and logistics and located sample sites for unique and rare plant communities
- *Bill Rodgers, Chief Ranger* – Provided logistical support, safety oversight, and collected observation point data
- *Liz Rodgers, Seasonal Technician* – Collected plot and observation point data
- *Brett Fletcher, Seasonal Technician* – Collected AA point data
- *Bruce Fields, Zone Fire Management Specialist* – Assisted with developing fuels data protocols
- *Lisa Claussen, Natural Resources Staff* – Coordinated project research permits and logistics
- *Shirley Winterhalder, Administrative Staff* – Arranged monument housing

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

Aerial Photography

High-quality aerial photography of an appropriate scale is an important component of the USGS-NPS National Vegetation Mapping Program. This imagery not only provides the base data for mapping vegetation in a digital format, but also provides a tool for interpreting vegetation patterns. Stereo photographs acquired vertically from the air, with the proper amount of overlap, permit three-dimensional interpretation when viewed under a stereoscope (Avery 1978). At the beginning of the NCPN vegetation mapping project, the network decided to acquire stereo pair aerial photography, as well as orthorectified digital imagery at a 1:12,000 scale for each park.

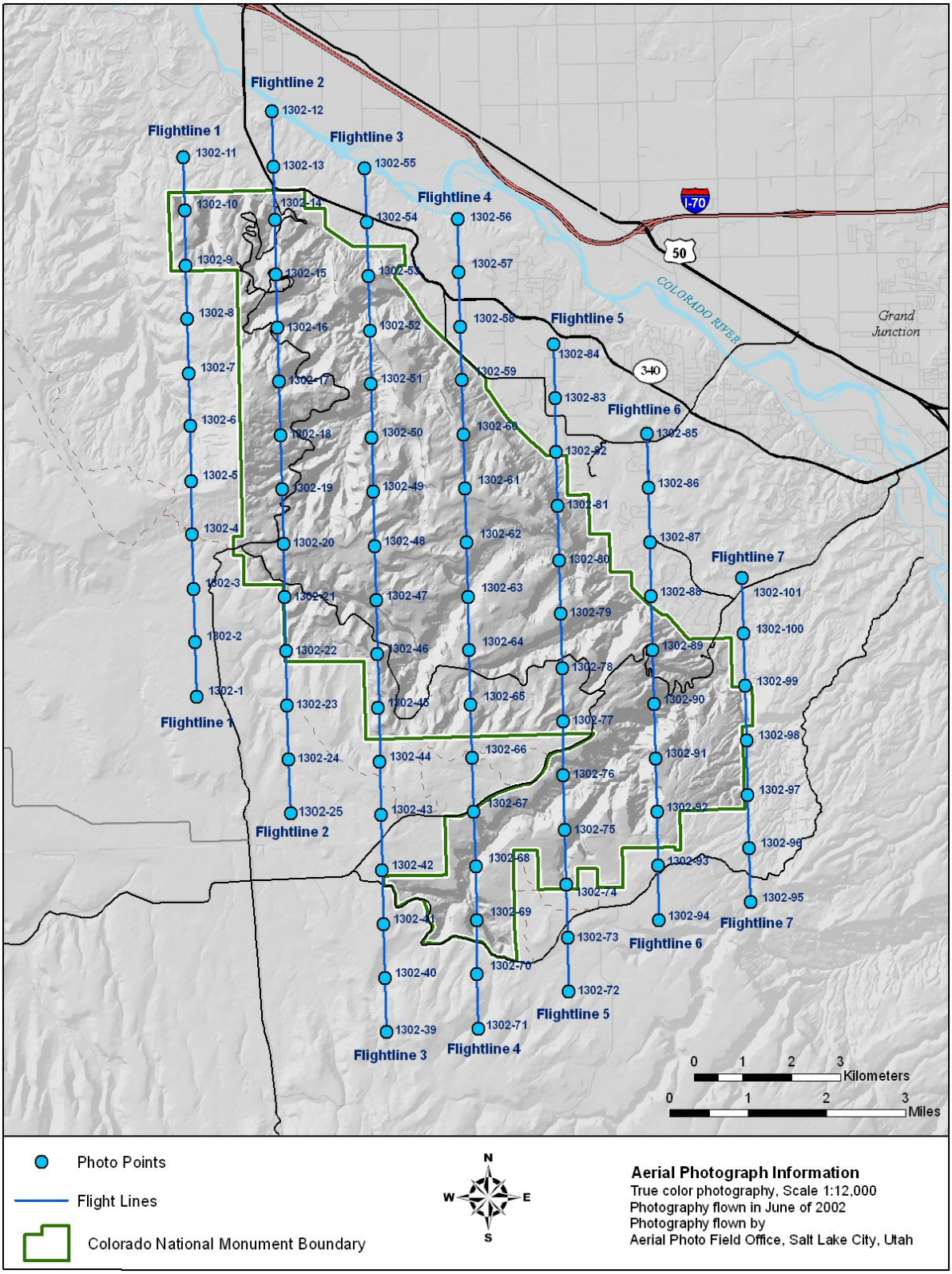
To maximize cost savings, the NCPN planned to acquire aerial photography concurrently for several park units. In order to minimize shadow effects associated with canyon topography and maximize vegetative expression, the goal was to minimize the sun angle by flying as close as possible to noon on the 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.

Most NCPN park units are characterized by semi-arid and desert landscapes. Herbaceous vegetation in these systems tends to cure early. The year 2002 presented special challenges in photography acquisition due to extreme drought conditions across the Colorado Plateau. As a result, photography acquired in 2002 represents exceptionally arid conditions and did not capture typical vegetation expression. Many annual plants emerged minimally or not at all in 2002, and many perennial plants, including dominant grasses, died during the drought or dropped their leaves by June and July when the new photos were acquired.

Initial vegetation mapping project boundaries were determined prior to aerial photography acquisition. The boundary for aerial photography coverage extended slightly beyond the project mapping area boundary, which included the monument and its environs.

Stereoscopic Pair Aerial Photo Coverage

Through an agreement between the USDA, Farm Services Agency, Aerial Photo Field Office (APFO), and the NCPN, 23 cm x 23 cm (9 in x 9 in) true color aerial photography was acquired for COLM on July 10, 2002. Blue Skies Consulting, LLC (Albuquerque, New Mexico) was subcontracted by APFO to conduct the overflight of the monument. 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 such that approximately 30% sidelap occurred between flight lines and 60% overlap occurred between photos, with a minimum sun angle of 45º. The project encompassed 54 linear miles divided among seven flight lines and 88 individual photos (Figure 9). Figure 10 is an example of the 23 cm x 23 cm photographs for COLM. These photographs were used for photo interpretation during the mapping phase of the project, as well as by field crews during plot data collection.



(1:12,000 scale)

Figure 9. Aerial photograph flight lines for 2002 stereo coverage of COLM

The film negatives for this aerial photo coverage are permanently stored at the APFO in Salt Lake City, Utah. The APFO made two sets of color prints. One of these was distributed to COLM and the other is retained at the NCPN offices in Moab, Utah.

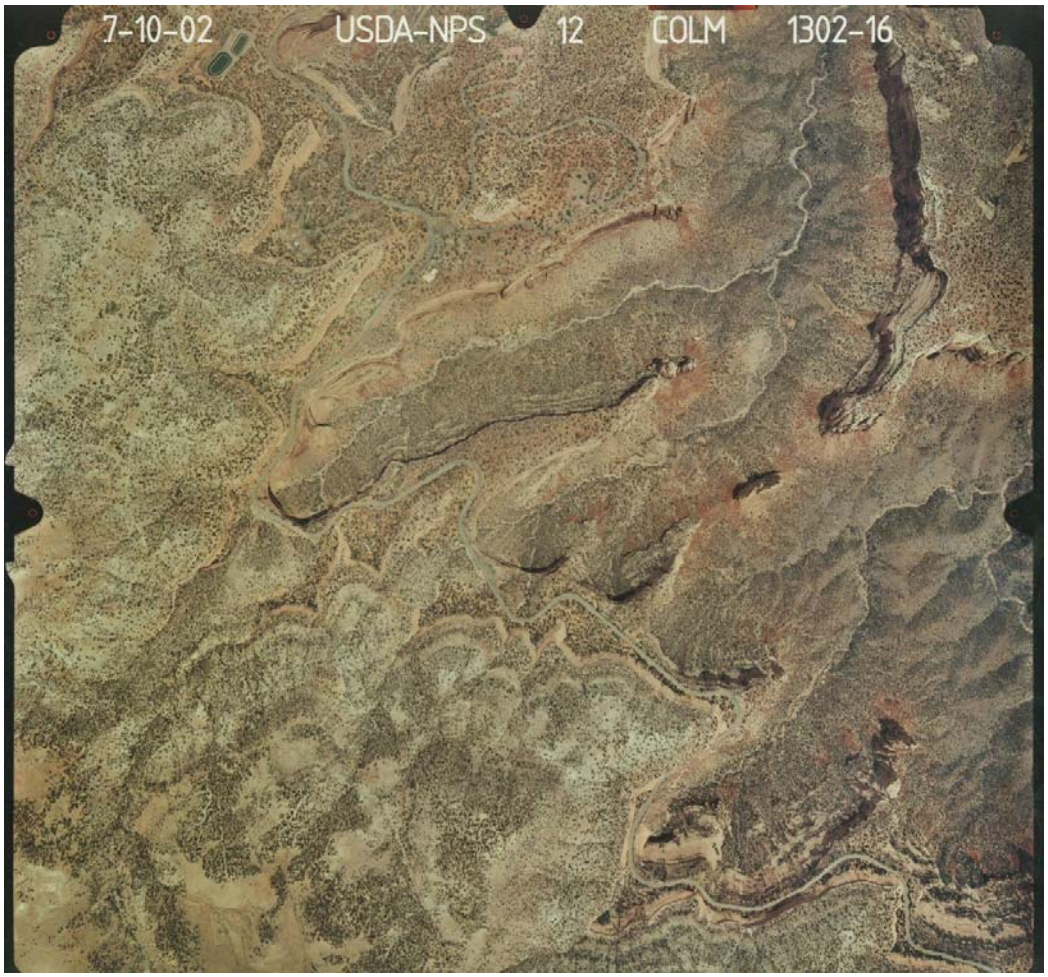


Figure 10. Example of a 9” x 9” aerial photograph for the COLM vegetation classification and mapping project.

Digital Orthophotos

The U.S. Bureau of Reclamation Remote Sensing and Geographic Information Group (BOR) in Denver, Colorado, produced 1:12,000 scale digital orthophotography for COLM from new imagery. This work was subcontracted to Horizons Inc. of Rapid City, South Dakota. The photography was flown on June 18, 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. The project extended over 81 linear km (50.2 miles) divided among four flight lines and 26 individual photos (Figure 11).

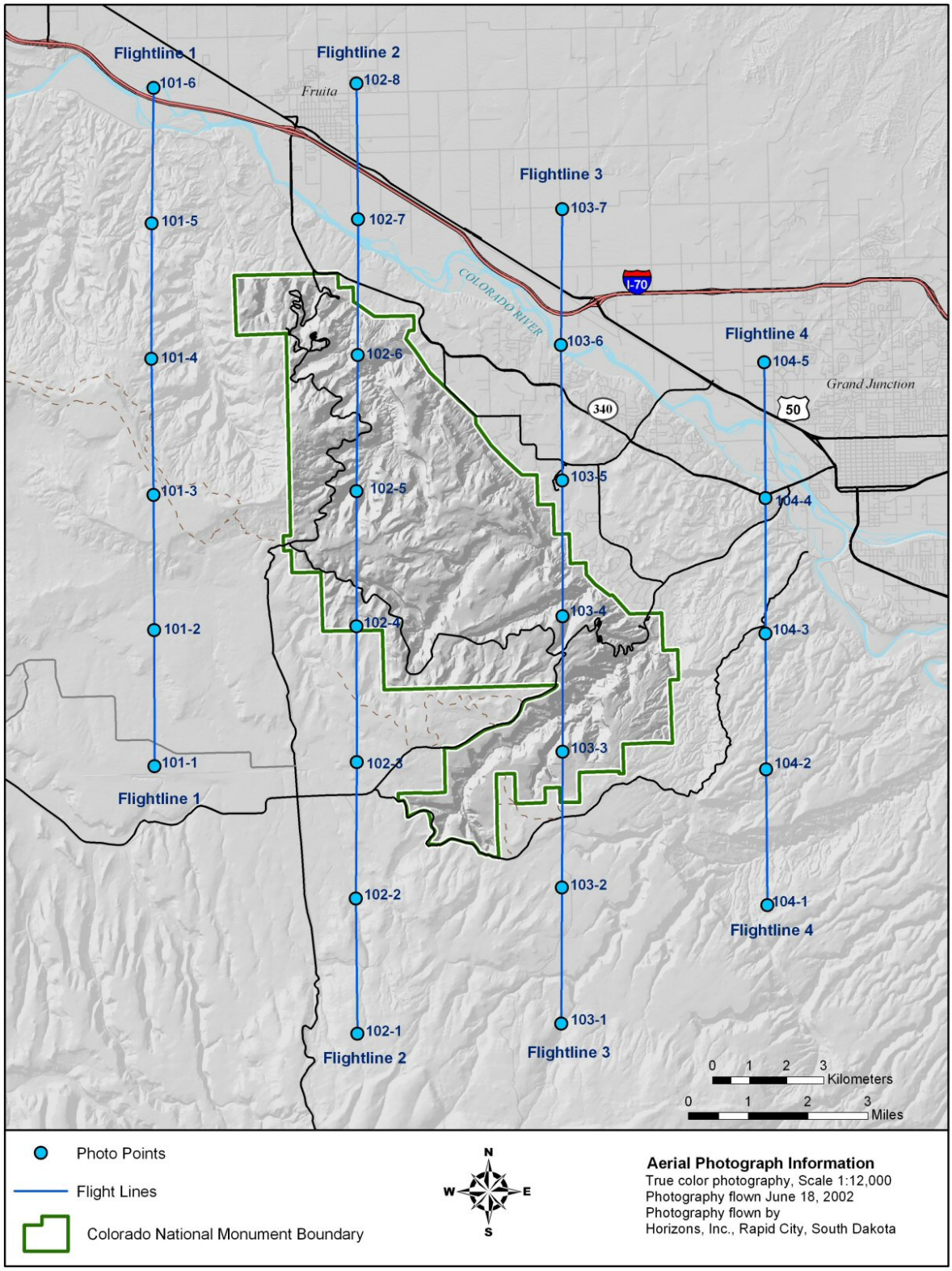


Figure 11. Flight lines for 2002 orthophotography coverage of COLM

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 area 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 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 program that 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, better imagery (usually from a slightly different angle on an adjacent photo) was inserted where possible. The final 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 COLM 2002 color digital orthophotos are permanently archived in airtight containers at the NPS Denver Service Center Technical Information Center.

Scoping Meeting

The initial project meeting was held at COLM in March 2003. At this gathering, COLM staff met with network staff, cooperators, and other interested parties to discuss the project and provide input to the project planning process. During the meeting, resource management concerns were discussed, a project mapping area boundary was determined, a fuels sampling approach selected, a project schedule developed, and logistic needs identified.

Work Plan

A vegetation classification and mapping project work plan for COLM was completed early in the project timeline (Von Loh et al. 2002). It provided detailed descriptions, estimates of effort needed, and proposed timelines for each of 11 project tasks:

1. planning and scoping
2. aerial photography acquisition
3. preliminary plant association and species list development
4. field plot and observation point data collection
5. aerial photo interpretation
6. vegetation classification and characterization
7. local and global plant association description preparation
8. spatial database and map development
9. plant association field key preparation

10. accuracy assessment
11. report and metadata compilation

The work plan also reviewed and summarized existing vegetation data (legacy data), including vegetation maps, vegetation classifications, and environmental data.

Project Boundary and Map Extent

A variable project boundary around the monument boundary was chosen by COLM staff and project cooperators at the March 2003 scoping meeting (Figure 2). The area outside the monument boundary, but within the project mapping area, is called the "environs." The total project mapping area is 12,685 ha (31,345 acres). Of this area, 8,257 ha (20,404 acres) occur within the COLM boundary and 4,428 ha (10,942 acres) in the environs. The environs were delineated to provide data to support management of the urban-wildland interface, as well as coordinate management on adjacent public lands. The environs consist of private lands (largely in housing developments) and lands managed by the BLM.

Minimum Mapping Unit

The national standard 0.5 ha (1.2 acre) minimum mapping unit (MMU) was employed in the COLM vegetation mapping project. The only polygons that are smaller than the MMU are those split by the park boundary into smaller polygons.

Ecological System Classification

The network elected to use the ecological system (ES) classification structure developed by NatureServe (Comer et al 2003, NatureServe 2003b) 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. This approach complements the NVC where the finer-scale association units provide a basis for interpreting larger-scale ES patterns and concepts. A description of each of these units appears in Appendix A.

The ecological system classification addresses natural landscapes. Land-use categories used to organize developed areas are described elsewhere in this report. Current science suggests that Colorado and Utah contain more than 80 ecological systems (NatureServe Explorer 2006). Twenty ES units are known to occur within the COLM vegetation mapping project area. They are (with their unique NatureServe identifying codes):

Upland Ecological Systems

- Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)
- Rocky Mountain Aspen Forest and Woodland (CES306.813)
- Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

- Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)
- Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)
- Colorado Plateau Mixed Low Sagebrush Shrubland (CES304.762)
- Inter-Mountain Basins Greasewood Flat (CES304.780)
- Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
- Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783)
- Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)
- Great Basin Semi-Desert Chaparral (CES304.001)
- Inter-Mountain Basins Semi-Desert Grassland (CES304.787)
- Inter-Mountain Basins Playa (CES304.786)
- Inter-Mountain Basins Shale Badland (CES304.789)
- Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

Riparian, Wetland and Mesic Ecological Systems

- Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.821)
- Rocky Mountain Subalpine-Montane Riparian Woodland (CES306.833)
- Inter-Mountain Basins Wash (CES304.781)
- North American Arid West Emergent Marsh (CES300.729)
- Colorado Plateau Hanging Garden (CES304.764)

Vegetation Classification and Description

Pre-Field Methods

Preliminary Classification List

A preliminary list of vegetation associations and alliances for COLM was compiled during work plan development in 2002. E^2M developed this list by selecting from NVC plant associations and alliances (NatureServe Explorer 2002) known to occur in the Northern Canyonlands section of the Intermountain Semi-Desert and Desert Province (Bailey 1995) within which COLM is located. Previous vegetation classification work, floristic information for COLM (Weber et al. 1982), and expert local knowledge were used to refine the list. This analysis created a preliminary list of approximately 176 plant associations for the project area (Von Loh et al. 2002). This list assisted with planning field work and with assigning provisional association names to vegetation plots and observation points.

Legacy Data Review

Existing vegetation data for COLM were reviewed for possible use in the classification. This legacy data review is documented in the COLM project work plan (Von Loh et al. 2002). It was determined that existing data did not meet the standards for classification analysis. The final vegetation classification was derived from new field data collected specifically for the vegetation mapping project.

Field Methods

The primary purpose of plot data collection was to obtain quantitative data describing the composition and structure of COLM's vegetation and associated environmental conditions. These data became the basis for classifying the vegetation at the monument. Field methods used in the COLM vegetation mapping project followed national program standards (Appendix B1, Appendix B3; TNC-ESRI 1994b). The plot dataset was supplemented by observation point data, whose primary purpose was to support photo interpretation. Data gathered during this project contributed to understanding vegetation relationships across broader landscapes beyond the boundaries of the Monument.

In addition to the basic vegetation data set collected at each plot, the NCPN defined data fields to meet needs of the network and fire managers. Plot forms and individual data field descriptions appear in Appendix B1. Fuels data protocols are described in a separate section of this report. A summary of the vegetation plot methodology as it was applied at COLM is described in this section.

Field Sampling Approach

The sampling area included the entire monument as well as BLM-managed lands in the environs (Figure 2). A modified gradient-oriented transect (gradsect) technique was used to determine sampling locations. This technique divides the landscape into biophysical units based on environmental or other factors thought to have the greatest influence on the distribution of

vegetation. For COLM, geology, soils, slope, aspect, and elevation information were combined to stratify the COLM landscape into five biophysical classes: relatively flat mesa tops, gently sloping alluvial fans, steep-walled canyons, ridges, and tilted bedrock formations. The biophysical classes were divided into smaller biophysical units (BPUs) based on aspect and geology. A randomized, weighted, stratified sampling design created the final set of biophysical units to be visited by field crews for vegetation data collection. The final BPU set was designed to include multiple examples of every combination of relevant environmental conditions represented within the mapping project area.

The selected biophysical units were overlaid onto digital orthophotos to create maps for field data collection. These maps worked best on flat to rolling topography when used in conjunction with aerial photo signatures to locate sampling sites. In narrow canyons, the BPU maps were of limited value because of the small size and narrow dimensions of the polygons. In these situations, the geology map was more useful to field crews. Field crews made an effort to sample homogenous aerial photo signatures and landscape features when selecting representative vegetation stands within BPUs.

Field crews for this project were led by investigators with experience sampling plant communities on national parks and other landscapes. The sampling goal was to collect between three and five plots in every vegetation association within the COLM project area. However, some common associations were sampled more often and some rare types were sampled less often. An effort was made to achieve good spatial distribution of plots across the landscape to capture the full range of variation of each association. Most areas within COLM were accessible for sampling with the exception of cliffs and Lizard Mesa. The plant communities on Lizard Mesa are described by Van Pelt et al. (1991).

To support interagency land management, public lands managed by the BLM adjacent to the southern, eastern, and western COLM boundaries were also sampled. The same techniques were applied to these lands, taking into account public access and a longer history of management for livestock use. A few associations occurred only on the BLM-managed lands.

Plots used in the vegetation classification were sampled between May and October 2003. This permitted progressive sampling from the lowest to the highest elevations, and identification of early and late-flowering plant species. Field data were collected in trips of approximately eight days by one to two teams consisting of two researchers each. A sampling trip in early October focused on the most difficult canyon, cliff, ridge, and slope sites, and was made by researchers with technical climbing expertise (Figure 12). October is cooler and allowed climbers safer access to canyons.

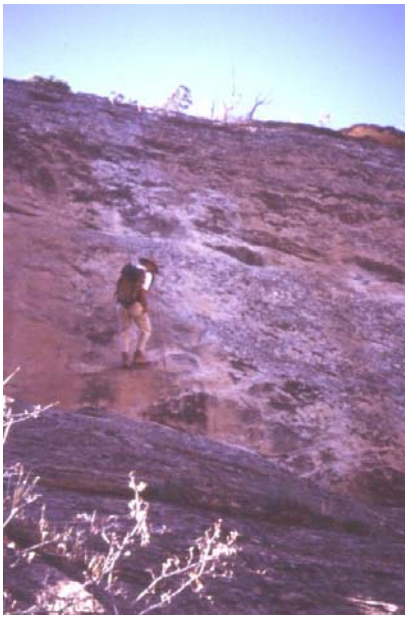


Photo Credit: Brian Davis

Figure 12. Experienced climber en route to a vegetation data plot in No Thoroughfare Canyon.

Plot Data Collection

Once a field crew reached a biophysical unit, they used the methods manuals, supplemented by their experience and judgment to locate plots in order to represent the association(s) present within the BPU. Vegetation outside of BPUs was also sampled if it appeared to represent types missed by the BPU model. In most cases, plots were located in stands exceeding the MMU of 0.5 ha. Smaller vegetation patches were sampled only if they consisted of distinctive or rare species aggregations such as hanging gardens, wetlands, or relict plant communities. Ecotones (areas where two or more plant communities intermix) were avoided. Highly disturbed areas were also avoided unless they represented an area of at least 0.5 ha. Sample plot size and shape were consistent with Vegetation Mapping Program guidelines (TNC, ESRI 1994a) and were adjusted according to the dimensions of the community being sampled (Table 3). COLM plots were typically circular, but rectangular plots were used to sample narrow bands of vegetation in drainage bottoms.

Table 3. Plot sizes used for vegetation classification sampling at COLM.

Vegetation Class	Area (m^2)	Radius (m)
Forest and Woodland	400	22.6
Shrubland	400	22.6
Herbaceous	100	11.3

COLM staff requested that the vegetation plot locations not be permanently marked. Locations were recorded on a master set of BPU maps following each field trip to track progress and to avoid duplication of effort.

Within each plot, researchers estimated and recorded an array of vegetation and environmental data using the field form (Appendix B3) and data definitions in Appendix C. Four general types of data were collected for vegetation plots (Table 4):

- location and plot identifiers
- environmental description
- vegetation description
- fuels model factors.

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

Plot Data Category	Data Components
Location and Plot Identifiers	Plot code, park name, site name, state, county, quad name, 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
Fuels Model Factors	Tree species diameter at root crown, age class or structural stage, litter depth, duff depth, crown height, crown width, crown base height, crown ratio, structural stage, fuel model guide match

Location and Plot Identifiers: The bounds of each plot were marked using measuring tapes. The Universal Transverse Mercator (UTM) XY coordinates at the center of each plot were recorded (zone 12, NAD83) on recreational-grade Garmin GPS receivers. Other data fields documenting the location of each plot are listed in Table 4 and are described in detail in Appendix C.

Environmental Description: The physical characteristics of each plot were documented in both categorical and narrative fields (Table 4). These included categories of physical site features (elevation, slope, aspect, topography), hydrology, geology, and soils. Characterization of the ground surface was made by estimating 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.

An effort was made to document biological soil crusts because they are of significant concern across the Colorado Plateau. Field crews were trained in the identification of soil crust components (cyanobacteria, lichens, and mosses), made notes on soil crust distribution and characterization, and took a representative photograph of the soil crust in each plot. Because biological soil crusts are fragile, all researchers were instructed on how to avoid damaging them to the extent possible during sampling.

Vegetation Description: Every vascular plant species in each plot was assigned to one of 14 physiognomic strata (Appendix B3). Within each stratum, the investigator noted the dominant plant species and recorded average height and percent canopy cover for all species using the scales in Table 5. 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. The list of provisional plant association names and number of plots sampled within each was updated throughout the field season.

Table 5. Vegetation cover and height classes used in the COLM vegetation mapping project.

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

Fuels Model Factors: A description of these fields begins on page 50.

Descriptive information: The field form allowed the field crews to record general observations on how well the plot represented the stand, the relationship of site conditions to vegetative patterns, and site disturbance history. The overall character of the vegetation and features of each plot were recorded in two 35 mm color slide photographs. In most plots, a photograph was taken to document soil crusts.

Data Processing and Analysis

Two hundred eighty-eight vegetation plots were sampled within the mapping project area during the 2003 field season (Figure 13). Plot data were manually entered into the COLM Vegetation Mapping Project Database, developed by e²M and 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 COLM project database offers NCPN greater flexibility in overall data management and reporting than does the PLOTS database. The NCPN database was designed to accommodate all project data including plots, observation points, fuels data, and accuracy assessment points. Data standards were established by NCPN for

use in all network vegetation mapping projects, allowing compatibility between COLM data and that of other NCPN park units. Fields associated with the COLM database are described in Appendix C.

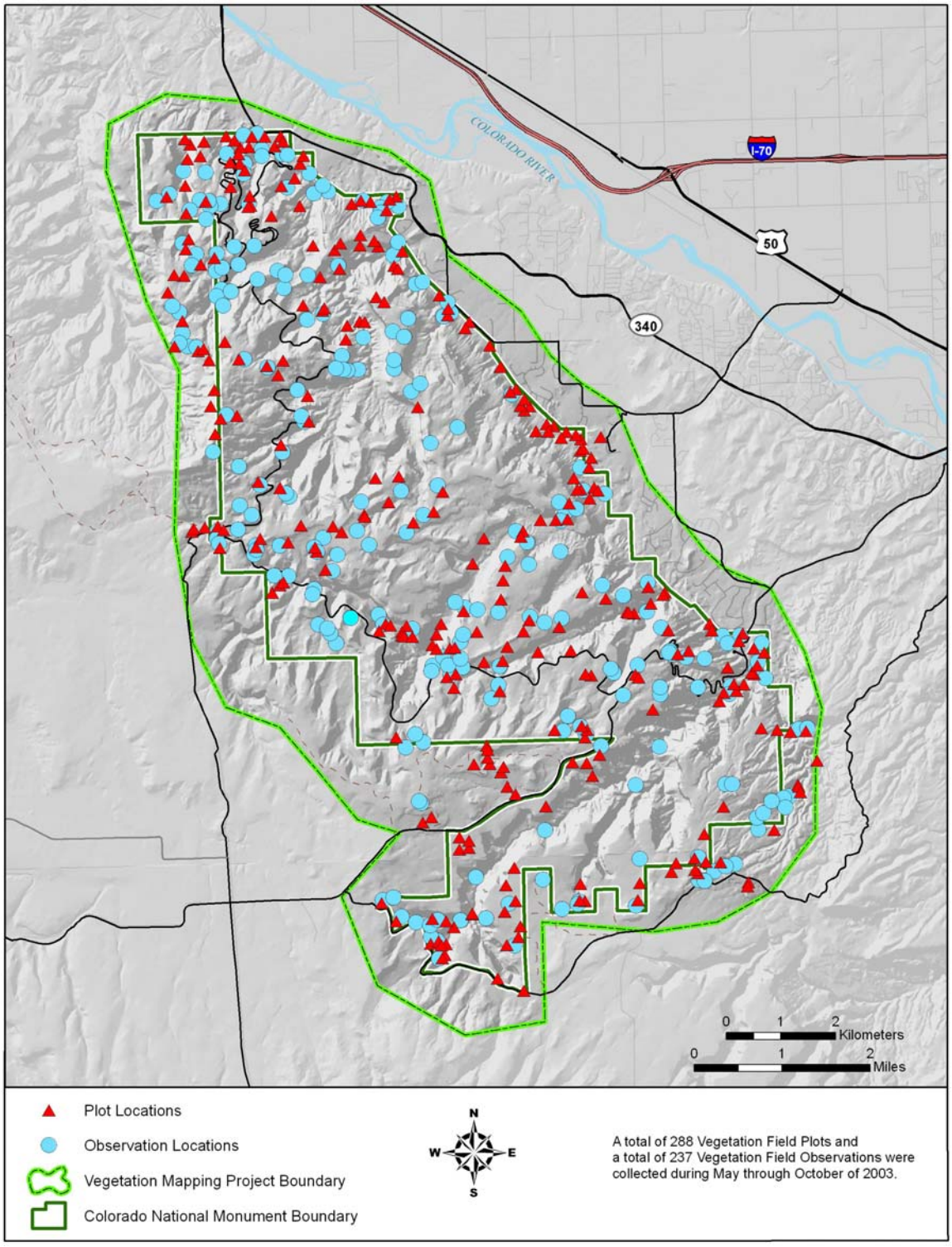


Figure 13. Vegetation plot and observation point locations within the COLM mapping area.

Each 35 mm slide associated with the project was scanned into digital format. The 685 digital images were stored and managed in a photograph database. Of these, 106 photos document soil crust conditions. 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 237 observation points (Figure 13). Data collected at observation points reflected the vegetation of an undefined area around the point rather than a measured plot, and were less detailed (Appendix B1, Appendix B4). These data were intended primarily to support modeling and interpretation of the aerial imagery, but were also used to help describe plant associations. Field crews could choose to sample an observation point instead of a full classification plot if:

- they wished to document the vegetation of a BPU, but already had sufficient classification plots for that vegetation type in that area of the Monument
- the vegetation of a BPU was highly disturbed, ecotonal, or otherwise anomalous
- cartographers requested documentation of a specific photo signature or area
- vegetation could only be viewed from a distance, not accessed directly
- they wished to document special features or vegetation occurring in stands smaller than 0.5 ha.

A thorough quality assessment and quality check (QA/QC) was performed on all plot and observation point data following entry to 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 COLM 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, follows 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 e2M and NatureServe ecologists for vegetation classification analysis. Slide labels were printed from the final database. A spatial GIS data layer (point data) was developed to document classification plot locations.

Classification Data Analysis

Vegetation classification was accomplished through a multivariate analysis of the 288 classification plots. Observation point data were not included in the quantitative analysis. Species cover data were exported into spreadsheet format and arranged into a plot by species data matrix. Midpoints of canopy cover classes were used in all data analysis procedures. Exploratory multivariate statistical analyses were used with the objectives of summarizing the compositional and structural characteristics of the vegetation and assessing possible patterns related to environmental gradients.

The matrix was first evaluated for outliers, which potentially distort the matrix. The only potential outliers were two plots representing a riparian community dominated by smooth horsetail (*Equisetum laevigatum*). The horsetail plots were retained in the matrix in subsequent analyses because it was determined that they represented a valid vegetation type (Decker 2003).

A cluster analysis was performed on the data using the Flexible Beta method; seven clusters were interpreted from the results of this analysis (Grossman et al. 1998, McCune and Mefford 1999; Figure 14). Data were then ordinated using the Bray-Curtis polar ordination technique, with the seven clusters as a grouping variable (Figure 15). The seven groups exhibited separation in species-dimensional space and were interpreted as representing

1. grassy or weedy types and riparian vegetation
2. shadscale / James' galleta shrublands
3. two-needle pinyon pine - Utah juniper woodlands
4. Wyoming big sagebrush communities
5. miscellaneous shrub types
6. Salinas lyme grass vegetation
7. black sagebrush (*Artemisia nova*) vegetation.

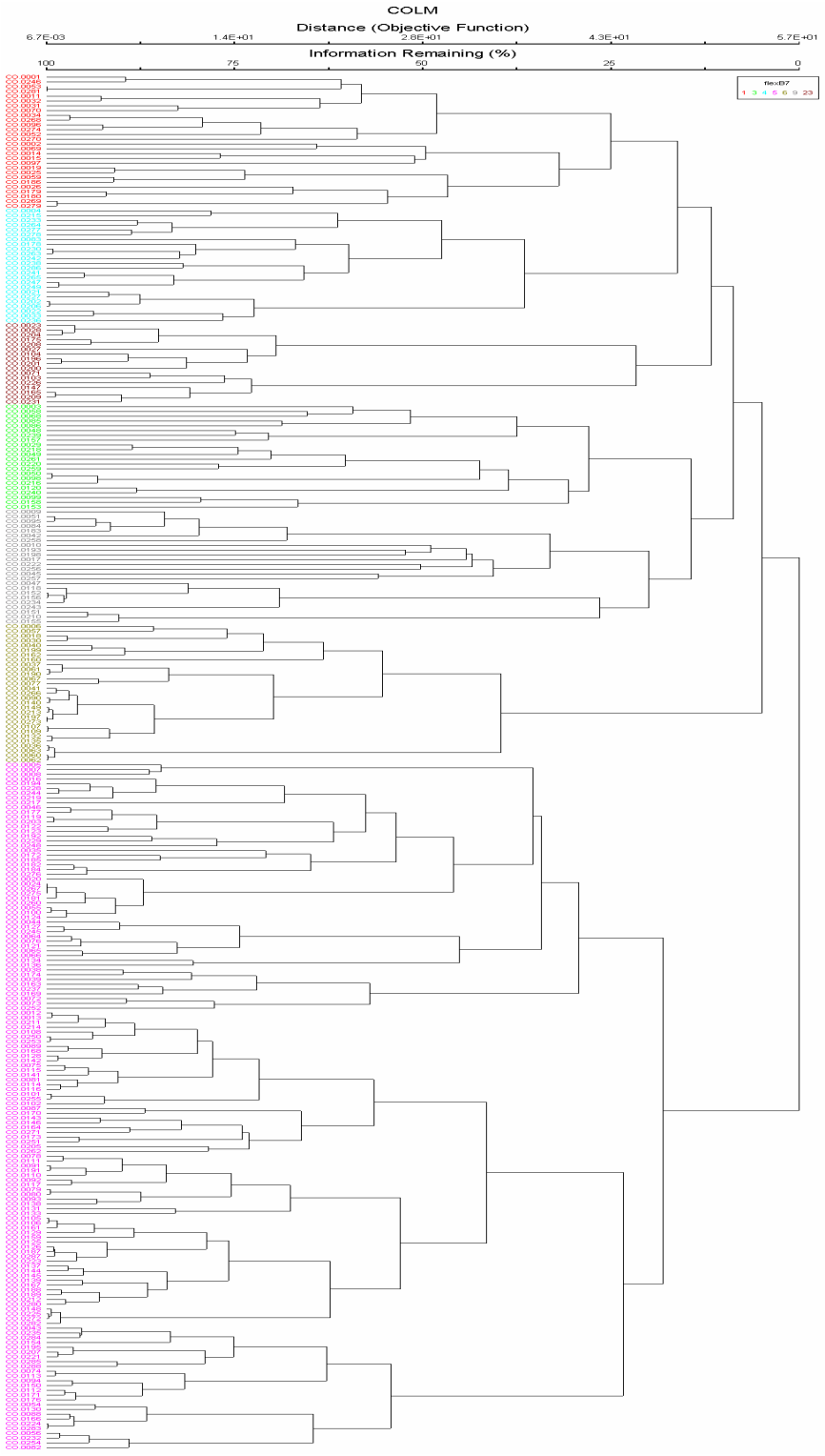


Figure 14. Dendrogram resulting from cluster analysis of 288 vegetation plots. The colors represent the seven clusters that were interpretable as ecological groups of associations.

Additional cluster analyses and ordinations failed to reveal smaller groups within the seven major groups. Tabular analysis (Mueller-Dombois and Ellenberg 1974) was used to compare species presence within plots and determine relationships among plots to differentiate vegetation associations.

As part of the preliminary classification, each plot was assigned a provisional association name and reviewed by NatureServe ecologists. Field investigators and NatureServe ecologists met in February 2004 to review the classification and discuss problems. Pinyon-juniper woodlands and shadscale shrublands were especially challenging to classify. Following a number of revisions based in part on data collected in other NCPN parks, the classification for COLM was finalized in February 2006 (Appendix E).

The vegetation of the COLM project mapping area was classified into 67 plant associations representing 38 NVC alliances and 20 ecological systems (Table 6). The vegetation includes 4 forest, 19 woodland, 31 shrubland, and 13 herbaceous communities. Most of the plant associations are characterized by indigenous native plants; however, four associations are semi-natural types dominated by nonnative species and/or characterized by anthropogenic disturbance. Six additional plant communities could not be classified into the NVC, because they occur as small, unique patches and are known only from the monument. These communities were designated "park specials". One additional plant community (a park special) was documented during the accuracy assessment phase of this project.

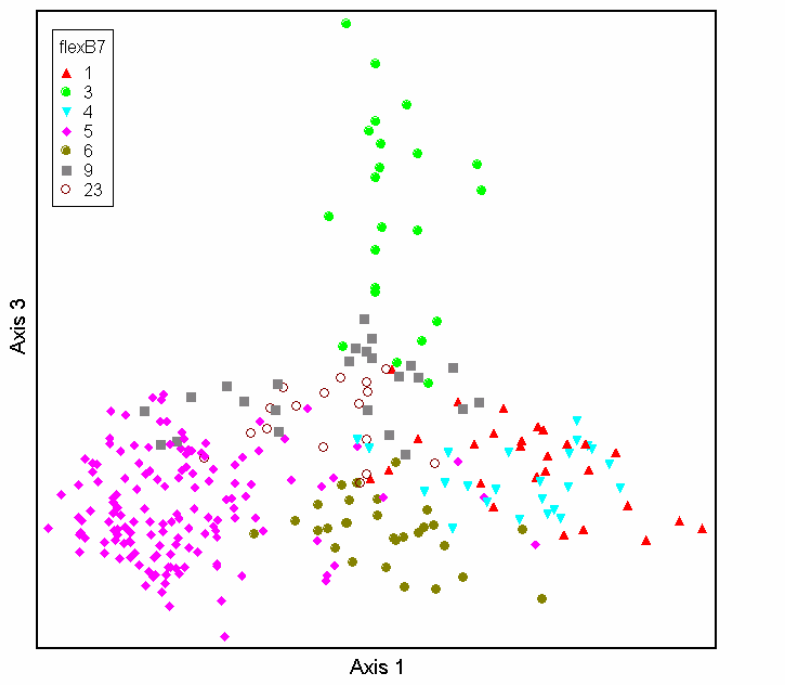


Figure 15. Bray-Curtis ordination of COLM vegetation data. The different colors and symbols correspond to the seven ecological groups identified in the cluster analysis shown in Figure 14.

Table 6. Plant associations identified within the COLM vegetation mapping project area*, organized by ecological system.

NVC Association	Common Name	CEGL Code†
UPLAND ASSOCIATIONS		
FORESTS		
Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)‡		
Pseudotsuga menziesii / Quercus gambelii Forest	Douglas-fir /Gambel Oak Forest	CEGL000452
Rocky Mountain Aspen Forest and Woodland (CES306.813)		
Populus tremuloides / Prunus virginiana Forest	Quaking Aspen / Chokecherry Forest	CEGL000596
WOODLANDS		
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)		
Pinus edulis – Juniperus osteosperma / Amelanchier utahensis Woodland	Two-needle Pinyon – Utah juniper / Utah Serviceberry Woodland	CEGL002329
Pinus edulis – Juniperus osteosperma / Artemisia bigelovii Woodland	Two-needle Pinyon – Utah juniper / Bigelow Sagebrush Woodland	CEGL002118
Pinus edulis – Juniperus osteosperma / Artemisia nova Woodland	Two-needle Pinyon – Utah juniper / Black Sagebrush Woodland	CEGL002331
Pinus edulis – Juniperus spp. / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland	Two-needle Pinyon – Juniper / Big Sagebrush Woodland	CEGL000776
Pinus edulis – Juniperus osteosperma / Cercocarpus intricatus Woodland	Two-needle Pinyon – Utah juniper / Curl-leaf Mountain-mahogany Woodland	CEGL000779
Pinus edulis – Juniperus spp. / Cercocarpus montanus – Mixed Shrub Woodland	Two-needle Pinyon –Juniper / Mountain-mahogany Mixed Shrub Woodland	CEGL000780
Pinus edulis – Juniperus osteosperma /Hesperostipa comata Woodland	Two-needle Pinyon – Juniper /Needle-and-Thread Woodland	CEGL00797
Pinus edulis – Juniperus spp. / Leymus salinus Woodland	Two-needle Pinyon – Juniper / Salinas Lyme Grass Woodland	CEGL002340
Pinus edulis – Juniperus osteosperma / Mixed Shrubs Talus Woodland	Two-needle Pinyon – Utah juniper / Mixed Shrubs Talus Woodland	CEGL002328
Pinus edulis – Juniperus osteosperma / Petradoria pumila Woodland	Two-needle Pinyon – Utah juniper / Grassy Rock-goldenrod Woodland	CEGL002332
Pinus edulis – Juniperus osteosperma / Sparse Understory Woodland	Two-needle Pinyon – Utah juniper / Sparse Understory Woodland	CEGL002148

Table 6. Plant associations identified within the COLM vegetation mapping project area*, organized by ecological system.

NVC Association	Common Name	CEGL Code†
Juniperus osteosperma / Artemisia tridentata ssp. wyomingensis Woodland	Utah Juniper / Wyoming Big Sagebrush Woodland	CEGL000730
Juniperus osteosperma / Cercocarpus montanus Woodland	Utah Juniper / Mountain-mahogany Woodland	CEGL000735
Juniperus osteosperma / Hesperostipa comata Woodland	Utah Juniper / Needle-and-Thread Woodland	CEGL002815
Juniperus osteosperma / Mixed Shrubs Talus Woodland	Utah Juniper / Mixed Shrubs Talus Woodland	CEGL002266
SHRUBLANDS		
Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)		
Amelanchier (utahensis, alnifolia) – Cercocarpus montanus Shrubland	Serviceberry – Alderleaf Mountain-mahogany Shrubland	CEGL001070
Amelanchier utahensis Shrubland	Utah Serviceberry Shrubland	CEGL001067
Mahonia repens Shrubland [PARK SPECIAL]	Creeping Oregon Grape Shrubland	None
Quercus gambelii / Rhus trilobata Shrubland	Gambel Oak / Skunkbush Woodland	CEGL002338
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)		
Artemisia tridentata ssp. tridentata – (Ericameria nauseosa) / Bromus tectorum Shrubland	Basin Big Sagebrush – (Rubber Rabbitbrush) / Cheatgrass Semi-natural Shrubland	CEGL002699
Artemisia tridentata ssp. tridentata / Sporobolus airoides Shrubland	Basin Big Sagebrush / Alkali Sacaton Shrubland	CEGL002200
Artemisia tridentata ssp. wyomingensis – Atriplex confertifolia Shrubland	Wyoming Big Sagebrush – Shadscale Shrubland	CEGL001040
Artemisia tridentata ssp. wyomingensis / (Agropyron cristatum, Psathyrostachys juncea) Seeded Grasses Semi-natural Shrubland	Wyoming Big Sagebrush / Seeded Grasses Semi-natural Shrubland	CEGL002185
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 / Pleuraphis jamesii Shrubland	Wyoming Big Sagebrush / James' Galleta Shrubland	CEGL002761
Artemisia tridentata ssp. wyomingensis / Poa fendleriana Shrubland	Wyoming Big Sagebrush / Muttongrass Shrubland	CEGL002775

Table 6. Plant associations identified within the COLM vegetation mapping project area*, organized by ecological system.

NVC Association	Common Name	CEGL Code†
Colorado Plateau Mixed Low Sagebrush Shrubland (CES304.762)		
Artemisia nova / Leymus salinus Shrub Herbaceous Vegetation	Black Sagebrush / Salinas Lyme Grass Shrub Herbaceous Vegetation	CEGL001421
Artemisia nova Shrubland	Black Sagebrush Shrubland	CEGL001417
Inter-Mountain Basins Greasewood Flat (CES304.780)		
Sarcobatus vermiculatus / Artemisia tridentata Shrubland	Black Greasewood / Basin Big Sagebrush Shrubland	CEGL001359
Sarcobatus vermiculatus Disturbed Shrubland	Black Greasewood Disturbed Shrubland	CEGL001357
Sporobolus airoides Southern Plains Herbaceous Vegetation	Alkali Sacaton Southern Plains Herbaceous Vegetation	CEGL001685
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)		
Atriplex canescens – Ephedra viridis Talus Shrubland	Fourwing Saltbush – Mormon Tea Talus Shrubland	CEGL001287
Atriplex canescens Shrubland	Fourwing Saltbush Shrubland	CEGL001281
Atriplex confertifolia / Pleuraphis jamesii Shrubland	Shadscale / James' Galleta Shrubland	CEGL001304
Atriplex confertifolia – Sarcobatus vermiculatus Shrubland	Shadscale – Black Greasewood Shrubland	CEGL001313
Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783)		
Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland	Gardner's Saltbush / James' Galleta Dwarf-shrubland	CEGL001441
Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)		
Krascheninnikovia lanata / Pleuraphis jamesii Dwarf-shrubland	Winterfat / James' Galleta Dwarf-shrubland	CEGL001322
Artemisia frigida / Heterotheca villosa Dwarf-shrubland [PARK SPECIAL]	Fringed Sagebrush / Hairy Goldenaster Dwarf-shrubland	None
Great Basin Semi-Desert Chaparral (CES304.001)		
Arctostaphylos patula Shrubland	Greenleaf Manzanita Shrubland	CEGL002696
GRASSLANDS		
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)		
Achnatherum hymenoides – Bromus tectorum Herbaceous Vegetation [PARK SPECIAL]	Indian Ricegrass – Cheatgrass Semi-natural Herbaceous Vegetation	None

Table 6. Plant associations identified within the COLM vegetation mapping project area*, organized by ecological system.

NVC Association	Common Name	CEGL Code†
Agropyron cristatum Semi-natural Herbaceous Alliance	Crested Wheatgrass Semi-natural Herbaceous Alliance	A. 3563
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
Opuntia polyacantha / Pleuraphis jamesii Shrubland	Panhandle Prickly-pear / James' Galleta Shrubland	CEGL002299
Pascopyrum smithii Herbaceous Vegetation	Western Wheatgrass Herbaceous Vegetation	CEGL001577
Pleuraphis jamesii Herbaceous Vegetation	James' Galleta Herbaceous Vegetation	CEGL001777
Inter-Mountain Basins Playa (CES304.786)		
Hordeum jubatum Herbaceous Vegetation	Foxtail Barley Herbaceous Vegetation	CEGL001798
SPARSE/TALUS/BEDROCK		
Inter-Mountain Basins Shale Badland (CES304.789)		
Leymus salinus Shale Sparse Vegetation	Salinas Lyme Grass Shale Sparse Vegetation	CEGL002745
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)		
Cercocarpus intricatus Slickrock Sparse Vegetation	Littleleaf Mountain-mahogany Slickrock Sparse Vegetation	CEGL002977
Fendlera rupicola Talus Shrubland	Fendlerbush Talus Shrubland	CEGL002765
Eriogonum lonchophyllum Sparse Herbaceous Vegetation [PARK SPECIAL]	Spearleaf Buckwheat Sparse Vegetation	None
Nonvascular Cover- Board Beds Unit, Entrada Sandstone [PARK SPECIAL]	Nonvascular Cover- Board Beds Unit, Entrada Sandstone	None
RIPARIAN, WETLAND AND MESIC ASSOCIATIONS		
WOODLANDS		
Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.821)		
Picea pungens – Pinus edulis – Juniperus osteosperma / Quercus gambelii Woodland [PARK SPECIAL]	Blue Spruce- Two-needle Pinyon-Utah juniper / Gambel Oak Woodland	None
Equisetum laevigatum Herbaceous Vegetation	Smooth Horsetail Herbaceous Vegetation	CEGL002241
Acer negundo / Disturbed Understory Woodland	Box elder / Disturbed Understory Woodland	CEGL002693

Table 6. Plant associations identified within the COLM vegetation mapping project area*, organized by ecological system.

NVC Association	Common Name	CEGL Code†
Betula occidentalis / Maianthemum stellatum Shrubland	Water Birch / Starflower False Solomon's-seal Shrubland	CEGL001162
Populus deltoides ssp. wislizeni (ssp. monilifera) / Salix exigua Forest	Cottonwood / Coyote Willow Forest	CEGL002685
Rhus trilobata Intermittently Flooded Shrubland	Skunkbush Intermittently Flooded Shrubland	CEGL001121
Salix exigua / Mesic graminoids Shrubland	Coyote Willow – Shining Willow Shrubland	CEGL001203
Rocky Mountain Subalpine-Montane Riparian Woodland (CES306.833)		
Populus tremuloides / Betula occidentalis Forest	Quaking Aspen / Water Birch Forest	CEGL002650
Inter-Mountain Basins Wash (CES304.781)		
Ericameria nauseosa Desert Wash Shrubland	Rubber Rabbitbrush Desert Wash Shrubland	CEGL002261
Fraxinus anomala Woodland	Single-leaf Ash Woodland	CEGL002752
OTHER TYPES		
North American Arid West Emergent Marsh (CES300.729)		
Juncus balticus Herbaceous Vegetation	Baltic Rush Herbaceous Vegetation	CEGL001838
Colorado Plateau Hanging Garden (CES304.764)		
Aquilegia micrantha Herbaceous Vegetation	Mancos Columbine Herbaceous Vegetation	CEGL002762

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

† The CEGL code is assigned by NatureServe to track NVC associations within their databases.

‡ The NatureServe codes following each Ecological System unit name provide a means of tracking the evolution of the concept. Even if the name or concept of an ES changes over time, searching for the code on the NatureServe information website (www. natureserve.org/explorer) will connect the user to the current name and concept.

Plant Community Descriptions

This section provides a summary of COLM vegetation by physiognomic group. Appendix F provides detailed local and global descriptions of the plant associations and communities found within the monument. Local descriptions are based on plot and observation point data from the monument and environs. Global descriptions characterize the association across its entire range and are based primarily on published and unpublished literature.

Greater numbers of shrubland types were classified than other physiognomic groups; however, woodland types were the most abundant. Herbaceous types (dominated by graminoids and/or forbs) are scattered throughout the monument.

Forest Associations

Vegetation classified into forest associations is uncommon within COLM, and the term "forest" (suggesting a closed canopy) is a misnomer for most stands. Small quaking aspen (*Populus tremuloides*) and Douglas-fir (*Pseudotsuga menziesii*) stands occupy cool, relatively mesic alcoves and canyon bottoms below pouroffs or springs. The forest associations at COLM include:

- *Populus tremuloides / Betula occidentalis* Forest
- *Populus tremuloides / Prunus virginiana* Forest
- *Pseudotsuga menziesii / Quercus gambelii* Forest

Woodland Associations

Woodland vegetation types at COLM are diverse, occupying all habitats within the monument. They are either deciduous woodlands limited to mesic sites in alcoves, drainages, and canyon bottoms, or evergreen woodlands occupying drier habitats on mesas, eolian deposits, canyon rims, slopes, or alluvial fans. Warmer sites or deep soils tend to consist solely of Utah juniper, while rocky sites usually have a component of pinyon pine. The deciduous and evergreen woodland associations of COLM include:

- *Acer negundo* / Disturbed Understory Woodland
- *Fraxinus anomala* Woodland
- *Juniperus osteosperma / Artemisia tridentata* ssp. *wyomingensis* Woodland
- *Juniperus osteosperma / Cercocarpus montanus* Woodland
- *Juniperus osteosperma / Hesperostipa comata* Woodland
- *Juniperus osteosperma* / Mixed Shrubs Talus Woodland
- *Picea pungens – Pinus edulis – Juniperus osteosperma / Quercus gambelii* 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 spp. / Artemisia tridentata* (ssp. *wyomingensis*, ssp. *vaseyana*) Woodland
- *Pinus edulis – Juniperus osteosperma / Cercocarpus intricatus* Woodland
- *Pinus edulis – Juniperus* spp. */ Cercocarpus montanus* - Mixed Shrub Woodland
- *Pinus edulis – Juniperus (monosperma, osteosperma) / Hesperostipa comata* Woodland

- *Pinus edulis – Juniperus spp. / Leymus salinus* Woodland
- *Pinus edulis – Juniperus osteosperma* / Mixed Shrubs Talus Woodland
- *Pinus edulis – Juniperus osteosperma / Petradoria pumila* Woodland
- *Pinus edulis – Juniperus osteosperma* / Sparse Understory Woodland
- *Populus deltoides* ssp. *wislizeni / Salix exigua* Woodland

Deciduous woodlands are uncommon at COLM. Stands of box-elder occur only in sheltered, wet sites near the heads of canyons. Small Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*) stands with a diverse woody understory occur along mesic canyon bottoms where they are supported by a high water table. The presence of Baltic rush and smooth horsetail indicates that these stands experience scouring floods. A few, small, open stands of single-leaf ash occur in rocky drainages bounded by talus slopes.

Cooler talus slopes and rocky outcrops at COLM support open stands of pinyon and/or juniper with a mixed shrub understory in which true mountain mahogany, Utah serviceberry and single-leaf ash are prominent. Woodlands on thin soils on canyon rims have an understory dominated by Bigelow sagebrush, littleleaf mountain mahogany, or grassy rock goldenrod. Shale substrates support open stands with an understory in which Salinas lyme grass or black sagebrush is dominant

Stands of pinyon-juniper with a needle-and-thread understory are scattered on deep soils throughout the monument. Deeper soils also support denser pinyon-juniper stands with a Wyoming sagebrush understory. A sparse form of this association occurs on xeric Precambrian gravel ridges in the major canyons. A third form of the association occurs on a few canyon talus slopes where Wyoming big sagebrush from the canyon bottom extends up the talus to mix with scattered Utah juniper trees.

Pinyon-juniper woodlands with a sparse understory (less than 5% total cover by shrubs and herbaceous species) are widespread at COLM. Naturally occurring sparse understory cover may result from dense canopy cover, limited rooting sites due to bedrock exposure, nutrient poor soils, or sites with poor water-holding capacity. Stands occupy exposed bedrock, shale, eolian or alluvial deposits, and Precambrian gravels.

Rare woodlands types include a single small stand of Colorado blue spruce (*Picea pungens*) below a pouroff in Echo Canyon, growing with pinyon pine, Utah juniper, and Gambel oak. The stand may be relict from a cooler, wetter period of the Holocene, or it may have been introduced more recently; similar stands occur throughout the canyons of the Uncompahgre Plateau.

Shrubland Associations

Shrubland vegetation associations are the most diverse physiognomic group within the monument, occupying all habitats. They include:

- *Amelanchier utahensis* Shrubland
- *Amelanchier* (*utahensis, alnifolia*) – *Cercocarpus montanus* Shrubland
- *Arctostaphylos patula* Shrubland
- *Artemisia frigida* / *Heterotheca villosa* Dwarf-shrubland
- *Artemisia nova* Shrubland

- *Artemisia nova / Leymus salinus* Shrub Herbaceous Vegetation
- *Artemisia tridentata* ssp. *tridentata- (Ericameria nauseosa) / Bromus tectorum* Semi-natural Shrubland
- *Artemisia tridentata* ssp. *tridentata / Sporobolus airoides* Shrubland
- *Artemisia tridentata* ssp. *wyomingensis – Atriplex confertifolia* Shrubland
- *Artemisia tridentata* ssp. *wyomingensis / (Agropyron cristatum, Psathyrostachys juncea)* Seeded Grass Semi-natural Shrubland
- *Artemisia tridentata* ssp. *wyomingensis /* Disturbed Understory Semi-natural Shrubland
- *Artemisia tridentata* ssp. *wyomingensis / Hesperostipa comata* Colorado Plateau Shrubland
- *Artemisia tridentata* ssp. *wyomingensis / Pleuraphis jamesii* Shrubland
- *Artemisia tridentata* ssp. *wyomingensis / Poa fendleriana* Shrubland
- *Atriplex canescens* Shrubland
- *Atriplex canescens – Ephedra (torreyana, viridis)* Talus Shrubland
- *Atriplex confertifolia* / *Pleuraphis jamesii* Shrubland
- *Atriplex confertifolia – Sarcobatus vermiculatus* Shrubland
- *Atriplex gardneri / Pleuraphis jamesii* Dwarf-shrubland
- *Betula occidentalis / Maianthemum stellatum* Shrubland
- *Cercocarpus intricatus* Slickrock Sparse Shrubland
- *Ericameria nauseosa* Desert Wash Shrubland
- *Fendlera rupicola* Talus Shrubland
- *Krascheninnikovia lanata / Pleuraphis jamesii* Dwarf-shrubland
- *Mahonia repens* Shrubland
- *Opuntia polyacantha / Pleuraphis jamesii* Dwarf-shrubland
- *Quercus gambelii / Rhus trilobata* Shrubland
- *Rhus trilobata* Intermittently Flooded Shrubland
- *Salix exigua* / Mesic Graminoids Shrubland
- *Sarcobatus vermiculatus* Disturbed Shrubland
- *Sarcobatus vermiculatus – Artemisia tridentata* Shrubland

Mesic and riparian shrublands are restricted to sites with deep soils and a high water table. Stands of water birch (*Betula occidentalis*), skunkbush (*Rhus trilobata*), Gambel oak (*Quercus gambelii*)or coyote willow are restricted to heads of canyons, in alcoves or the banks of intermittent drainages. Downstream, where the water table is farther below the surface, scattered clumps of rubber rabbitbrush dot the banks of intermittent drainages.

Wyoming sagebrush shrublands are abundant at COLM. Stands on silty clay soils have shadscale as a co-dominant. Stands that have been manipulated for livestock have an understory dominated by exotic grasses and forbs such as Russian wild-rye (*Psathyrostachys juncea*), filaree (*Erodium cicutarium*), and cheatgrass. Stands with native bunchgrass understory occupy well-drained deep soils, with needle-and-thread, James' galleta and muttongrass (*Poa fendleriana*) as the most common species.

Heavily disturbed sites within Wyoming sagebrush stands support altered communities. Prairie dogs and livestock grazing resulted in the establishment of a prairie sagebrush (*Artemisia filifolia*) and hairy golden aster (*Heterotheca villosa*) community within a matrix of Wyoming big sagebrush shrubland seeded to crested wheatgrass (*Agropyron cristatum*). Another altered

sagebrush site in the southwestern part of the mapping project area appears to be used to yard livestock. It is dominated by a dwarf shrubland of winterfat and James' galleta.

Cool canyon slopes, often covered by broken sandstone talus, support open mixed shrublands in which Utah serviceberry, true mountain mahogany or fendlerbush are prominent. Sparse stands of littleleaf mountain mahogany are present on mesa rims. Plant cover is limited by the availability of cracks in the bedrock that can hold soil.

Stands of black sagebrush, sometimes with Salinas lyme grass, occupy rocky slopes with thin soils derived from the Morrison Formation. Along Liberty Cap Trail and on Monument Mesa, black sagebrush and Wyoming big sagebrush appear to have hybridized to form shrubs with intermediate characteristics.

Alluvial fans support a diversity of shrublands. Fourwing saltbush stands, sometimes with green Mormon tea, are restricted to alluvial fans and Chinle Formation toeslopes. Shadscale forms a sparse association with James' galleta or with black greasewood on alluvial fans and in shallow drainages and canyon bottoms. Stands of panhandle prickly-pear and James' galleta are locally common on the east side of the monument on alluvial fans and Precambrian gravel ridges in the large canyons. Bison, cattle and sheep grazed this area beginning in the late 1800s. The animals helped to spread panhandle prickly-pear by carrying or kicking the pads to new sites. The spiny cacti protected James' galleta from grazing ungulates.

Decadent stands of 2-3 m (7-10 ft) tall basin big sagebrush occupy many of the canyon bottoms. The stands occupy terraces elevated one or more meters above the water table by stream incision. They typically have an understory dominated by cheatgrass, or less often, alkali sacaton (*Sporobolus airoides*). Fire in these stands could result in replacement by cheatgrass annual grasslands.

Rare shrubland types within the monument include one stand of greenleaf manzanita (*Arctostaphylos patula*) at the base of a Kayenta sandstone slab near the Liberty Cap Trail. It is thought to be a Pleistocene relict that survived because of the protection and supplemental runoff provided by the uptilted sandstone slab (Van Pelt et al. 1991). Similarly, a single stand of creeping Oregon-grape (*Mahonia repens*) and littleseed mountain ricegrass (*Piptatherum micranthum*) occurs in a site sheltered by Fallen Rock in upper Ute Canyon. Unusual patches of gravel on BLM land along Black Ridge Trail west of COLM support an occurrence of Gardner's saltbush (*Atriplex gardneri*).

Graminoid Associations

Graminoid associations are uncommon within the mapping area, with most occurring as small patches on alluvial fans and in drainage bottoms in the east side of the monument. These stands represent varying ecologic situations and habitats, both natural and human-influenced. They are affected by fire, grazing livestock, grazing wildlife, and in rare instances, burrowing mammals. Few are pure grasslands; shrubs or trees are often minor components of the community. Graminoid associations of COLM include:

- *Achnatherum hymenoides – Bromus tectorum* Semi-natural Herbaceous Vegetation
- *Bromus tectorum* Semi-natural Herbaceous Vegetation

- *Hesperostipa comata* Great Basin Herbaceous Vegetation
- *Hordeum jubatum* Herbaceous Vegetation
- *Juncus balticus* Herbaceous Vegetation
- *Leymus salinus* Shale Sparse Vegetation
- *Pascopyrum smithii* Herbaceous Vegetation
- *Pleuraphis jamesii* Herbaceous Vegetation
- *Sporobolus airoides* Southern Plains Herbaceous Vegetation

Disturbed sites support grasslands that are dominated by exotic species or a mix of natives and exotics. Road fill slopes and gravel pits support a community of Indian ricegrass and cheatgrass. Juniper are present in some stands; these will transition to woodland associations unless disturbed again. Cheatgrass forms dense stands on sandy sites that represent burned Wyoming big sagebrush shrublands or former livestock holding areas. Re-establishment of some Wyoming big sagebrush and fourwing saltbush shrubs is occurring in some of the cheatgrass stands. A stand of foxtail barley (*Hordeum jubatum*) is associated with the margins of a stock pond in the environs west of the COLM boundary. Western wheatgrass (*Pascopyrum smithii*), which may be an introduced species at COLM, dominates stands associated with swales and stock ponds.

Grasslands with lower levels of historic and recent disturbance tend to be dominated by native species. Bottomland sites may support Baltic rush stands, whereas alkali sacaton occurs on sandy alluvial terraces. Two small patches of needle-and-thread grass occupy sandy alluvial and eolian deposits on canyon floors. Stands of Salinas lyme grass are locally common on north-facing shale slopes. James' galleta dominates most of the grasslands in COLM, especially on alluvial fans on the east side and on Precambrian gravel ridges in the major canyons.

Other Herbaceous and Non-vascular Associations

Forb-dominated and non-vascular plant communities are rare in COLM. Forb and non-vascular plant associations at COLM include:

- *Aquilegia micrantha* Herbaceous Vegetation
- *Equisetum laevigatum* Herbaceous Vegetation
- *Eriogonum lonchophyllum* Sparse Herbaceous Vegetation
- Non-vascular Cover – Board Beds Unit, Entrada Sandstone

Mesic, forb-dominated associations include hanging gardens and horsetail beds. Hanging gardens consist of wetland vegetation growing below seeps emerging from the contact between porous sandstone and underlying impervious shale. Well-developed gardens occur in two large alcoves near the east tunnel on Rim Rock Drive. Hanging garden vegetation also appears as thin strips of vegetation in minor seeps on cliff faces. Mancos columbine (*Aquilegia micrantha*) is the common forb often dominating COLM's hanging gardens. Small but dense stands of smooth horsetail and Baltic rush (*Juncus balticus*) grow in perennially moist soils on the floor of Ute Canyon. The only upland herbaceous association occurs in small stands on xeric shale outcrops and is dominated by spearleaf buckwheat (*Eriogonum lonchophyllum*). An unusually dense lichen-dominated community occurs on slabs of Entrada sandstone.

Field Key Preparation

An illustrated dichotomous field key to plant associations of the COLM mapping area was developed for this project (Appendix G). The key is designed to assist users in identifying vegetation associations in the field. The key has two levels; the first is defined by the physiognomy of the vegetation, i.e., forest, woodland, tall shrubland, shrubland, dwarf-shrubland, graminoid, or forb. The second level is driven by cover of the dominant species. Brief environmental descriptions are included with the floristic descriptions to assist in identifying plant associations. To increase the utility of the key, individual plant associations are cross-referenced to map classes.

The 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 associations occurring within the monument, nor does it explain the full range of variation of all associations as they appear in the monument.

The field key was tested by NatureServe using COLM vegetation plot data prior to its use by accuracy assessment field crews. A NatureServe ecologist selected random plots representing each association, removed the association identifier from the data and attempted to run each plot through the key using information contained in the plots database. Additional testing of the key occurred in the field during the accuracy assessment phase of this project. Areas where the key was confusing or unclear were identified and solutions proposed. The field key in Appendix G was revised based on these suggestions.

Assessment of Global Rarity

COLM represents the dry eastern edge of the Colorado Plateau. Because water is a limiting factor, riparian and wetland plant species, although regionally common, are rare within the monument. Of special concern are plants associated with hanging gardens and seeping ledges. Few plant associations at COLM are considered globally imperiled (NatureServe 2005); however, not enough is known about the abundance or distribution of many of COLM's associations to evaluate global rarity. As more field data are evaluated, NatureServe will develop rankings of global rarity and post them on its Explorer Web site (http://www.natureserve.org/explorer).

NatureServe and its network of state natural heritage programs indicate the rarity and degree of imperilment of plant communities by assigning a global conservation status rank 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. Four COLM associations are considered imperiled to vulnerable (G2G3): *Juniperus osteosperma / Leymus salinus* Woodland, *Juniperus osteosperma / Cercocarpus montanus* Woodland (Figure 16), *Amelanchier (utahensis, alnifolia) – Cercocarpus montanus* Shrubland, and *Aquilegia micrantha – Mimulus eastwoodiae* Herbaceous Vegetation. Twenty-three associations are ranked secure (G4 or G5) and the remaining associations are not yet ranked or are new to the NVC.

All vegetation communities change over time. Within the mapping project area, cycles of drought, insect infestation, and fire shape the upland communities. Flash floods shape

communities on canyon floors. Recent regional drought and global climate changes threaten riparian and wetland plant communities within COLM. The introduction of nonnative plant species into mesic habitats is an additional threat. Plant communities susceptible to change or likely to disappear from COLM over time include the small patches and individuals of:

- *Arctostaphylos patula* Shrubland – isolated population is susceptible to climate change and stochastic events; if destroyed by fire, might not regenerate
- *Mahonia repens* Dwarf Shrubland – isolated stand whose continued existence depends on placement of potentially unstable geologic feature; associated aspen have already died
- *Pseudotsuga menziesii / Quercus gambelii* Forest – isolated relict stand is susceptible to climate change and stochastic events
- *Populus tremuloides / Prunus virginiana* Forest - isolated relict stand is susceptible to climate change and stochastic events
- *Populus deltoides* ssp. *wislizeni / Salix exigua* Woodland – isolated stand dependent on unstable water table
- *Picea pungens, Pinus ponderosa, Acer negundo* – isolated populations of these species are vulnerable to climate change and stochastic events
- *Populus tremuloides / Betula occidentalis* Woodland – isolated, relict stand depends on unstable water table
- *Betula occidentalis* Shrubland – isolated stand depends on unstable water table
- *Salix exigua* Shrubland – depends on water table
- *Hesperostipa comata, Pascopyrum smithii, Sporobolus airoides* – very small stands vulnerable to invasion by noxious exotic plants or trespass grazing



(Photo Credit: Jim Von Loh)

Figure 16. *Juniperus osteosperma* / *Cercocarpus montanus* Woodland association at COLM.

Fuels Data Collection

Background

Rapidly expanding residential development along COLM boundaries presents a significant challenge to park resource managers. Of particular concern is fire management, as subdivisions have been built adjacent to the NPS boundary and downwind of any fire that might start within the monument. Fire fuels data were collected as part of the COLM vegetation mapping project in order to assist managers with fire planning and management. The attributes described below were selected in consultation with fuels management experts to supplement the vegetation plot data and map class attributes in providing a complete picture of fire fuels for COLM. These data were entered in the COLM plots database. Fuels data were not analyzed as part of this project.

Fuels Data

Field forms and definitions for collecting fuels data appear in Appendix B1 and Appendix B3. Quantitative fuels data collected in the vegetation plots at COLM included measurements of each trunk of true tree species (ponderosa pine or Douglas-fir) exceeding 5 cm (2 in) in diameter:

- trunk diameter (breast height = DBH)
- crown height
- crown base height
- crown ratio
- structural stage (position in the canopy)

Different variables were measured for woodland tree species (two-needle pinyon, Utah juniper). Fuels data gathered for each stem or tree greater than 1.4 m (4.5 ft) in height included:

- stem diameter at root crown (DRC)
- crown height
- crown width

Qualitative information to support fuels categorization was collected at each plot. Each woodland plot was placed in an age class category. Fuel conditions for each woodland or shrubland plot were characterized by comparing the site to a photo series depicting different fuel loading conditions (e.g., Ottmer et al. 2000) and recording the most representative photo number. Two 35 mm color slides were taken of each plot, and a digital 360^{o} video of 30–40 seconds duration was shot from plot center. Nikon Coolpix cameras, hand-held at shoulder height or mounted on a 1.4 m (4.5 ft) high monopod were used to acquire the digital movies. Digital movies were collected at 282 locations (281 plots and one observation point) within the COLM project area. Color slides are available for all 288 plots.

Vegetation Mapping

Methods

The process of mapping vegetation and land use of the COLM project area was divided into four steps:

1. Field reconnaissance
2. Map class and attribute development
3. Mapping
4. Spatial database development

Each step was contingent on completion of the previous one. Field reconnaissance was intended to familiarize RMGSC cartographers with the monument, patterns of vegetation distribution, and environmental factors useful for developing mapping models. Map class development followed this reconnaissance and intensive review of the aerial imagery. Computer and photo interpretation models based on the field data were used to draw consistent, homogenous polygons on the base orthoimagery (mapping) and attribute them (spatial database development).

Field Reconnaissance

RMGSC cartographers joined the lead project ecologist during field sessions in May and October 2003. Field sessions had multiple goals:

- Compare actual vegetation with signatures on the ortho- and stereo imagery
- Understand environmental factors influencing local vegetation patterns
- Identify the information that could be extracted from the project imagery.

Field notes written on photocopies of the stereo photographs helped guide subsequent photo interpretation, modeling and mapping. Observation point data were collected during these reconnaissance trips to provide supplemental documentation of the vegetation.

Map Class and Polygon Attribute Development

The goal of map classification was to identify meaningful units to represent existing vegetation, bedrock exposures, and land uses for the COLM vegetation mapping project area. Map classes specific to this project were developed to characterize vegetation types within the monument and most of the environs. Standard land-use map classes (Anderson et al. 2002) were used to map urbanized parts of the environs northeast of the COLM boundary.

The current standard for the USGS-NPS Vegetation Mapping Program projects is to map to the association level of the NVC. However, the level of detail possible in a vegetation map is limited by the imagery, the skill and experience of the photo interpreter, and the availability of supporting information. At COLM, the relationships between map classes and plant associations are more complex. Similar plant associations may be grouped into a single map class because they cannot be distinguished consistently or accurately using remote sensing or modeling.

A preliminary set of map classes was developed by RMGSC cartographers in consultation with project ecologists, using the initial vegetation classification produced by e2M and NatureServe. Some map classes represented a single plant association, while other classes represented a complex of plant associations. Unvegetated portions of the project area were mapped using classes defined by the surface geology or dominant land use. Map class definitions and concepts were adjusted throughout the project as more information became available.

A subset of map classes represented features of particular interest to monument resource managers ("park specials"), although they generally were smaller than the 0.5 ha MMU. At COLM, these features included springs, seeps, and colonies of the invasive shrub tamarisk (*Tamarix chinensis*). Tamarisk location data were given directly with COLM staff and are not included in this report. Springs and seeps were documented either by plots or observation points and were combined into a single map class represented by points in a separate coverage.

The NCPN adopted a convention for naming and presenting map class information. If a map class represented a single plant association, the common form of the NatureServe name (e.g., Utah Juniper / Mixed Shrubs Talus Woodland) was used. If the map classes represented multiple associations or non-vegetated features, names incorporating vegetation and landscape features were used.

Cartographers initially assigned an arbitrary number to represent each map class. These numeric codes were supplemented by a five-letter alpha code developed by NCPN. Each alpha code begins with the first letter of the NVC vegetation class it represents (F = Forest, W = Woodland, S = Shrubland, H = Herbaceous, and N = nonvascular). Non-vegetated map class codes begin with G = geology or L = land cover/land use. The subsequent four letters abbreviate the map class name. For example, the map class code "W-JUTA" stands for the Woodland-Juniper-Talus map class containing the Utah Juniper / Mixed Shrubs Talus Woodland association.

Vegetation map classes or individual polygons were assigned additional codes representing physiognomic attributes, such as canopy density, pattern, and height (Table 7). Theses attributes provide additional ways of sorting the spatial database and increase the potential uses of the map for analyses and planning.

Table 7. Physiognomic attributes assigned to COLM vegetation polygons.

Category	Attribute	Description
Cover density (Applied to forest, woodland, and sagebrush 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 Sagebrush Canopy (> 40% cover)
	E	Light Sagebrush Canopy (10 – 40% cover)
Pattern (Applied to all vegetation map classes)	1	Clumped/Bunched
	2	Linear
	3	Gradational/Transitional
	4	Regularly Alternating

	5	Homogenous
Height (Applied to woody terrestrial vegetation map classes only)	F	Forest and Woodlands > 30 meters
	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 photo interpretation standards defined a suite of modifiers to capture information on altered vegetation, landforms, and transportation and utility corridors (Table 8; Evenden 2004). These modifiers were assigned either to an entire map class or to individual polygons, as appropriate.

Table 8. Modifiers used to provide additional information for map polygons in the COLM vegetation mapping project area.

Category	Attribute	Name	Description
Altered System Modifiers	c	Mined	Applied to systems disturbed by mining, including gravel and sand quarries
	h	Over-grazed	Applied to polygons in which the original vegetation was altered by domestic livestock grazing over long periods
	i	Invasive	Applied to systems dominated by invasive non-native plants
Landform Modifiers	r	Bare exposed rock/sandstone cliffs	Bedrock outcrops forming flat expanses, ledges, and hills, and vertical exposures of sedimentary rock
Transportation & Utility Modifiers	t	Paved road	A transportation corridor consisting of a roadbed topped by an asphalt or concrete surface. Right-of-way typically extends to the limit of the cut and fill slopes
	u	Gravel/dirt road	A transportation corridor consisting of a roadbed of imported gravel or graded native soil. Cut and fill slopes may or may not be present. A special case is the Serpent's Trail, an historic road now closed and used by hikers

All map polygons were assigned a land use/land cover attribute (Anderson et al. 2002; Appendix H). Table 9 indicates the level of the Anderson Land Use / Land Cover Classification used for different cover categories. All polygons were assigned to a corresponding level of the NVC with the exception of unvegetated map classes. Unvegetated polygons were coded as "unclassified" or "unvegetated" in the NVC columns.

Table 9. Classification level of land use/land cover categories used in mapping the developed part of the environs adjacent to the northeast Monument boundary.

Category	Level
1.0 Water	Level 3
2.0 Developed	Levels 2 to 4
3.0 Bare	Level 2
4.0 Vegetated	Levels 2 to 6

Mapping

The COLM project used both traditional photo interpretation and a biophysical modeling approach to mapping. In traditional photo interpretation, trained interpreters examine stereo photography and use their experience and any ground data to decide where to delineate map polygons. Biophysical modeling uses a computer to delineate map polygons based on known or assumed relationships between vegetation and environmental variables. The intent in the COLM project was to develop a hybrid vegetation mapping procedure that is more cost-effective and consistent than traditional techniques and more accurate than automated methods.

The COLM mapping project area includes private lands and residential developments in the environs along the northeast COLM boundary. These lands are characterized by altered and developed landscapes that do not fit the natural vegetation map class definitions developed for the monument. Management issues associated with the wildland-urban interface on the northeast boundary include invasive species, fire management, and recreation. To address these management concerns, map classes derived from the Anderson Land Use/Land Cover classification (Appendix H; Anderson et al. 2002) were applied to 958 ha (2,376 acres) of the environs (Figure 17). The Anderson classification was applied at the most detailed level possible in this area (in most cases Level 3). Natural landscapes were initially mapped using generalized Anderson classes and later moved to vegetation map classes. Developed areas were mapped in detail using the Anderson hierarchy.

Seventeen map classes, including rare vegetation classes and non-vegetated land-use areas, were delineated and attributed manually by photo interpreters. Thirty-four map classes were delineated and attributed using computer-assisted biophysical modeling. The modeling approach used environmental spatial datasets obtained from imagery and existing data.

Mapping with On-screen Digitizing: In this technique, the cartographer created map polygons on an electronic version of the orthophotos at a computer workstation. Digitizing was performed using raster editing with ERDAS Imagine software or vector editing using ArcGIS. The cartographer used field data (plot and observation point), field reconnaissance notes, and the 9” x 9” stereo photographs to interpret patterns of color, texture, and landscape position as map classes.

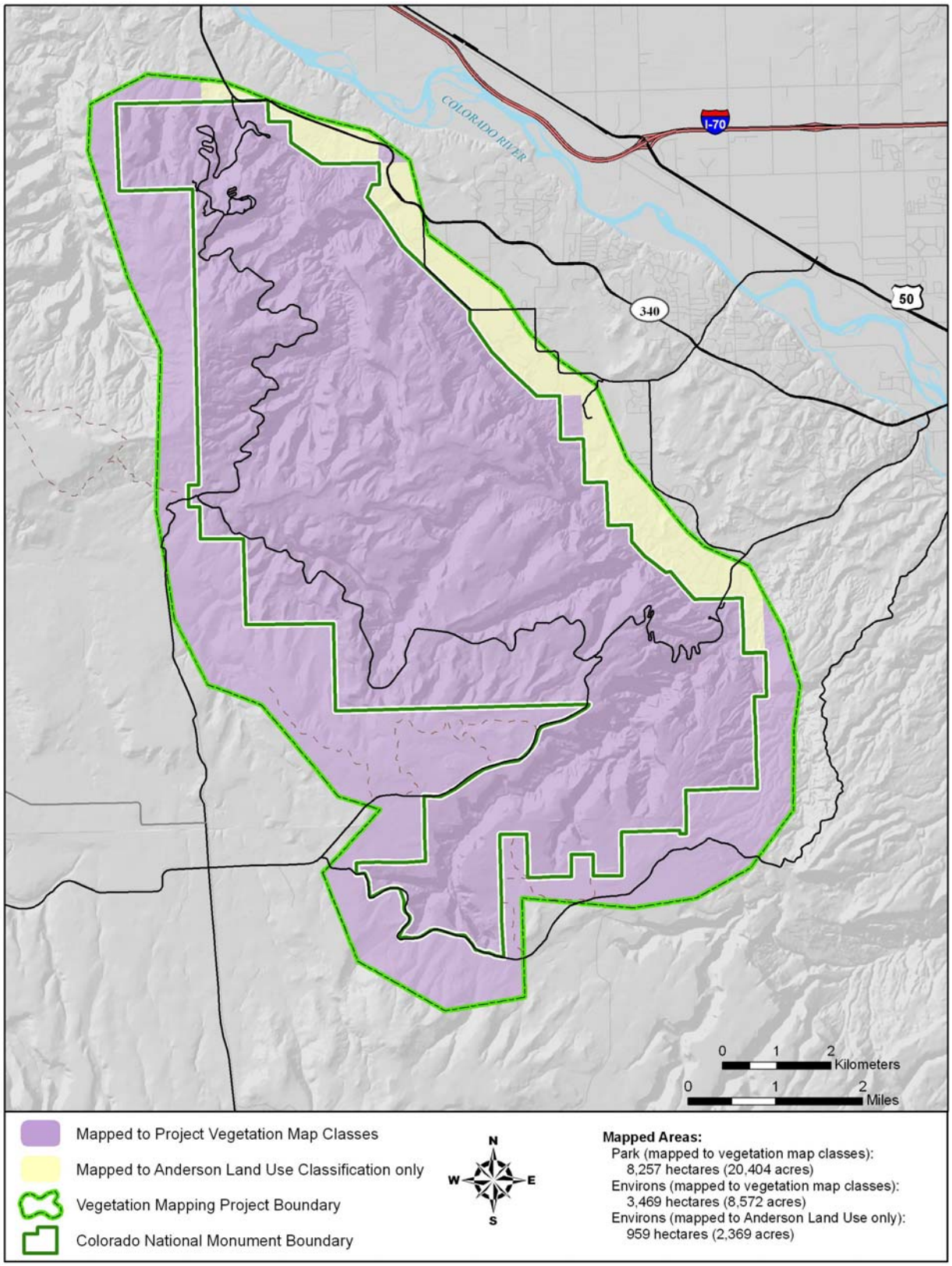


Figure 17. Map showing where in the COLM vegetation mapping project area cartographers used standard (purple) and Anderson (yellow) map classes.

On-screen digitizing was only used to create map polygons if:

- the map class appeared in few locations and all occurrences were easily identified by project ecologists or were easily interpreted from the stereo photographs
- the map class had a moderate number of locations, but was not suitable for modeling
- the map class was unvegetated or represented a land-use type
- a lack of geology data in the northwestern corner, the southern edge, and the southeastern corner of the mapping project area precluded the use of biophysical modeling.

Mapping with Biophysical Modeling: A modeling approach was selected as a potentially cost-saving alternative to the labor-intensive, traditional manual photo interpretation process. The modeling approach automated the photo interpretation process by allowing the computer to create polygons using models based on relevant environmental data. The cartographers, in consultation with field ecologists, identified elevation zone, geology, slope, aspect, and physiognomic class as the principal ecologic drivers of each vegetation map class. The following sections describe the preparation of the spatial data as well as the modeling process.

Environmental Datasets: To support the modeling effort, RMGSC cartographers acquired or created a number of ancillary spatial datasets. The acquired datasets were the 10-meter digital elevation model (DEM), surface geology (Scott et al. 2001), and monument and project boundaries. Slope and aspect information were derived from the DEM coverage. Tree density and vegetation physiognomy were derived from the orthoimagery, while an elevation zone dataset was developed using the DEM and geology layers.

Tree Density Analysis: A tree density spatial dataset was created to assist with attributing polygons (Table 7) and to support the analysis of vegetation physiognomic classes. Using ERDAS Imagine software, spectral values in the orthophoto image were used to identify "tree" pixels. This dataset was analyzed using a routine that sums the number of tree pixels in a 15 by 15 pixel "neighborhood" of any pixel and outputs values for that pixel between 0 and 225. Values were then translated into tree canopy density percentages and assigned to one of four density classes (0–10%, 10–25%, 25–60%, and 60–100%). These density classes correspond to breaks between major physiognomic groups in the NVC (e.g., non-forested, sparse wooded, wooded, and forested).

Physiognomic Class Image Analysis: A spatial layer of vegetation physiognomy was developed through image analysis of the digital orthophoto using ERDAS Imagine software. Cartographers analyzed the image for non-tree vegetation in a process similar to the tree density analysis described above. The non-tree subset of the image was classified into six physiognomic types: shrubs, grasses, shrub/grass mix, shrub/grass/sparse mix, 'green' (areas of high green reflectance), and shadow. A sieving process eliminated groups of pixels that did not meet the MMU threshold and recoded them to adjacent pixel values. This resulted in a spatial dataset of non-tree vegetation classified to physiognomic type.

Composite Physiognomic Class Data: The physiognomic class and tree density datasets were combined and recoded. Ten physiognomic classes were designated for the COLM project area (Table 10). All areas in deep shadow were assigned to class 1. Tree densities of 25 to 60% and

60 to 100% were assigned to classes 3 and 4, respectively. Tree densities of 0 to 10% were assigned to non-tree classes 5 through 9. Tree densities of 10 to 25% were assigned to class 10 or 11, depending on the associated understory vegetation. Class 2 was discarded during analysis.

Table 10. Physiognomic classes developed for biophysical modeling.

No.	Category	Description
1	Shadow Areas	Deep shadow
2	N/A	This category discarded during analysis
3	25%–60% Trees	25–60% tree coverage density
4	60%–100% Trees	60–100% tree coverage density
5	Shrubs/Grasses	Mix of shrubs and grasses, with neither as the dominant type, less than10% trees
6	Shrubs/Grasses/Sparse	Overall high reflectance areas and less than 10% trees
7	Shrubs	Areas of predominantly shrubs and not high reflectance areas
8	Grasses	Areas of predominantly grasses and not high reflectance areas
9	“Green”	Areas of high green reflectance
10	10%–25% Trees/Shrubs	10–25% tree coverage density with shrub understory
11	10%–25% Trees/Shrubs/Grasses	10–25% tree coverage density with a mixed understory

Elevation Zones: This coverage was created in ArcGIS by combining 10m DEM elevation data with the COLM geology map (Scott et al. 2001). It modeled the strong relationship between vegetation and three distinct physical settings within the monument: above the rim, canyons, and lowlands. Although the computer was used to generate the zone boundaries, they were adjusted manually using stereo photo interpretation and the cartographers' professional judgment.

1. Above the rim – Defined as the area above 1,430 m (4,691ft.) elevation, corresponding to the top of the major cliffs formed by Wingate Sandstone. This area roughly follows the main segments of Rim Rock Drive and includes the isolated plateaus north of lower Monument Canyon and Lizard Canyon. Landforms in this zone include mesa tops with eolian deposits, ridge tops and slopes, and shallow upland drainages. Geologic units include all of the Cretaceous and all of the Jurassic except the Wingate Sandstone.

2. Canyons – Defined as deep canyons cut into the anticline that defines the northeastern edge of the monument. Landforms in this zone include steep canyon walls and associated talus slopes, valley bottoms, ridges and hills, and mesic drainages. Geologic units include Wingate Sandstone, Chinle, Precambrian gneiss and migmatitic meta-sedimentary rocks, and Quaternary deposits. Elevations are intermediate.

3. Lowlands – Defined as semiarid lowlands along the northeastern part of the project area, including the urban interface. Landforms in this zone include alluvial fans and shallow drainages interspersed among a low ridges. Much of this area was grazed historically by cattle, sheep and American bison. This zone contains a wide variety of geologic units, but all are located below the steep northwest to southeast-trending slope paralleling this boundary. This zone occurs at the lowest elevations of the project area.

Vegetation-Environment Relationships Matrix: RMGSC cartographers constructed a matrix of ecologic relationships among the environmental datasets and the 17 map classes. Appendix I lists the elevation zone, geology, slope, aspect, physiognomic class, and special-case relationships defined for each map class model. At the outset, all NVC plant associations were examined for uniqueness or overlap in environmental relationships. If the ecologic relationships appeared to be unique, an attempt was made to map the plant association as a map class. If there was overlap between two or more plant associations, they were combined in a map class.

Biophysical Modeling: RMGSC cartographers used ArcGIS to combine spatial environmental data into one polygon layer. From this dataset, the computer selected sets of polygons meeting the relationship criteria for each map class as expressed in the matrix. Each selection was saved as a separate polygon shapefile representing the map class and converted to an ERDAS Imagine raster file. For example, the criteria used to select polygons for Map Class 9 (Fourwing Saltbush – Mormon tea Sandstone Talus Shrubland) were:

- Elevation Zone = lowlands or canyons, and
- Geology = Quaternary rock fall, Kayenta, Chinle, or Wingate formations, and
- Slope = 37%–100%, and
- Aspect = 113–248 degrees (south), and
- Physiognomic Class = 5, 6, 7, or 8, and
- Elevation > 1563 m.

The cartographers evaluated the modeled map class distribution using orthoimagery as well as the stereo photographs. The vegetation plots and observation points, as well as a digital version of the reconnaissance field notes, were also compared to the model. The matrix was adjusted as needed and the distribution models redeveloped. For example, if the field data indicated steeper slopes or different aspects than the model used, then the criteria were changed accordingly.

Using ERDAS Imagine, the map class files created using on-screen digitizing were combined with the map class files generated by biophysical modeling. Files were combined in order of confidence in the quality of the individual map class. Most of the map class images created using on-screen digitizing had a higher level of confidence than those generated by biophysical modeling alone. The combination order of map class images was (by map class code in descending order of confidence): 42, 43, 44, 46, 47, 48, 49, 50, 51, 52, 3, 10, 13, 15, 17, 18, 23, 29, 30, 37, 14, 5, 9, 16, 7, 31, 32, 33, 34, 36, 41, 25, 2, 12, 4, 8, 19, 20, 22, 28, 40. Areas in the environs that were delineated as land-use/land cover map classes were excluded.

Combining the map class files in this order allowed the higher confidence map classes to take precedence in areas of overlap. The combined image contained many polygons smaller than the 0.5 ha MMU as well as “gaps” where none of the model results applied. Using the “eliminate” and “neighborhood” processes in ERDAS Imagine, the sub-MMU polygons were absorbed into adjacent map classes. Shadows and gaps larger than the MMU were resolved through on-screen digitizing. The resulting ERDAS Imagine raster file was converted to an ArcGIS polygon file using the “generalize lines” function in ArcGIS Spatial Analyst. Finally, the vectors were smoothed in ArcGIS to create a better fit to the terrain.

Spatial Database Development

Each polygon was assigned a map class number, alpha code and name, Anderson land use class, and vegetation density, pattern, and height attributes. In order to improve the utility of the map and related data, the spatial database was moved into a geodatabase format, the structure of which is illustrated in Figure 18. A more detailed description of the geodatabase is provided in Appendix C.

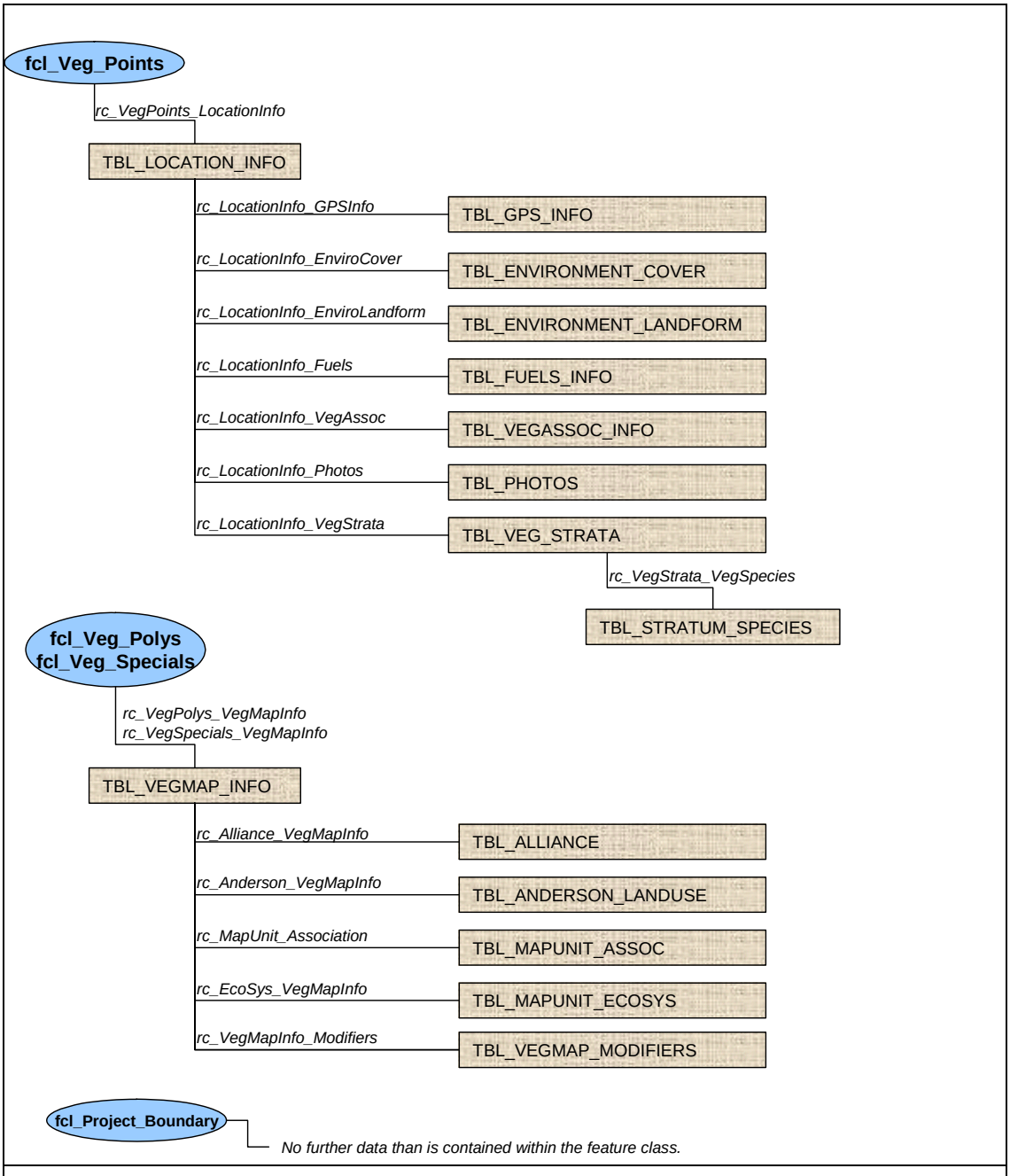


Figure 18. Structure of the COLM geodatabase.

Results

Map Classes

Fifty-one map classes were developed to describe the COLM vegetation mapping project area (Table 11). Of these, 26 are NVC-based vegetation map classes, four are geology map classes, seven are vegetated land use map classes and 14 are non-vegetated land-use map classes. Of the 26 vegetation map classes, 16 represent single NVC plant associations; the other 10 map classes contain multiple plant associations. One map class consists of point data representing seep and spring vegetation. It is contained in a separate coverage from the polygon map classes.

Of the 67 plant associations described for this project, 47 were mapped individually or as related groups of associations (Table 11). The other 20 associations occur in stands smaller than the 0.5 ha MMU and for the most part were not mapped (Table 12). Instead, information regarding these types can be retrieved from the plots database.

Ecological systems (Comer et al. 2003) were used to organize the vegetation map classes. They were developed by NatureServe to complement the finer-scale 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.

Of the 26 map classes representing NVC associations, 23 were grouped into 12 ecological systems; three map classes spanned multiple ecological systems. Table 11 shows the relationship of vegetation map classes to ecological systems. Appendix A provides summary descriptions of each ecological system. Twenty-one Anderson land use/land cover map classes and four unvegetated map classes could not be placed within the ecological system classification.

Map Class Descriptions

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

- A summary of the ecological concept of the map class. Summaries of map classes consisting of multiple plant associations include an explanation of why associations were grouped. Reference is made to the abundance of the map class within the 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
- Spatial statistics and accuracy assessment results.

Table 11. Map classes used in the COLM vegetation mapping project, organized by ecological system.

Map Class #	Map Class Code	Map Class Name	Associations Assigned to Map Classes/ Description	Relations	How Delineated
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)					
19	**W-PJWS**	Two-Needle Pinyon Pine – Utah Juniper / Wyoming Big Sagebrush Woodland	*Juniperus osteosperma* / *Artemisia tridentata* ssp. *wyomingensis* Woodland *Pinus edulis* - *Juniperus* spp. / *Artemisia tridentata* (ssp. *wyomingensis,* ssp. *vaseyana*) Woodland	1 to many	Biophysical modeling
20	**W-PJSH**	Two-Needle Pinyon Pine – Utah Juniper / Multiple Shrub Woodland	*Juniperus osteosperma* / *Cercocarpus montanus* Woodland *Pinus edulis* - *Juniperus* spp. / *Cercocarpus montanus* – Mixed Shrub Woodland *Pinus edulis* - *Juniperus osteosperma* / *Amelanchier utahensis* Woodland *Pinus edulis* - *Juniperus osteosperma* / *Artemisia bigelovii* Woodland *Pinus edulis* – (*Juniperus monosperma, Juniperus osteosperma*) / *Hesperostipa comata* Woodland *Pinus edulis* - *Juniperus* osteosperma / Mixed Shrubs Talus Woodland *Pinus edulis* - *Juniperus osteosperma* / *Cercocarpus intricatus* Woodland	1 to many	Biophysical modeling
22	**W-JUTA**	Utah Juniper / Talus Mixed Shrub Woodland	*Juniperus osteosperma* / *Hesperostipa comata* Woodland *Juniperus osteosperma* / Mixed Shrubs Talus Woodland	1 to many	Biophysical modeling
25	**W-PJBS**	Two-Needle Pinyon Pine – Utah Juniper / Black Sagebrush Woodland	*Pinus edulis* - *Juniperus osteosperma* / *Artemisia nova* Woodland	1 : 1	Biophysical modeling
28	**W-PJSP**	Two-Needle Pinyon Pine – Utah Juniper / Sparse Understory Woodland	*Pinus edulis* - *Juniperus osteosperma* / Sparse Understory Woodland	1 : 1	Biophysical modeling
Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)					
30	**S-OAKG**	Gambel Oak / Skunkbush Woodland	*Quercus gambelii* / *Rhus trilobata* Shrubland	1 : 1	On-screen
2	**S-UTSE**	Utah Serviceberry Shrubland	*Amelanchier utahensis* Shrubland *Amelanchier* (*utahensis, alnifolia*) - *Cercocarpus montanus* Shrubland	1 to many	Biophysical modeling
3	**S-MANZ**	Greenleaf Manzanita Shrubland	*Arctostaphylos patula* Shrubland	1 : 1	On-screen
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)					
5	**S-BASA**	Basin Big Sagebrush / Cheatgrass Semi-natural Shrubland	*Artemisia tridentata* - (Ericameria nauseosa) / *Bromus tectorum* Semi-natural Shrubland	1 : 1	Biophysical modeling

Table 11. Map classes used in the COLM vegetation mapping project, organized by ecological system.

Map Class #	Map Class Code	Map Class Name	Associations Assigned to Map Classes/ Description	Relations	How Delineated
7	**S-WSGR**	Wyoming Big Sagebrush / Seeded Grasses Semi-natural Shrubland	*Artemisia tridentata ssp. wyomingensis / (Agropyron cristatum, Psathyrostachys juncea)* Seeded Grasses Semi-natural Shrubland	1 : 1	On-screen
8	**S-WYSA**	Wyoming Big Sagebrush Shrubland	*Artemisia tridentata* ssp. *wyomingensis – Atriplex confertifolia* Shrubland *Artemisia tridentata* ssp. *wyomingensis / Pleuraphis jamesii* Shrubland *Artemisia tridentata* ssp. *wyomingensis / Poa fendleriana* Shrubland *Artemisia tridentata* ssp. *wyomingensis* / Disturbed Understory Semi-natural Shrubland *Artemisia tridentata* ssp. *wyomingensis* / *Hesperostipa comata* Colorado Plateau Shrubland	1 to many	Biophysical modeling
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)					
9	**S-FWMT**	Fourwing Saltbush – Mormon Tea Talus Shrubland	*Atriplex canescens - Ephedra viridis* Talus Shrubland	1 : 1	Biophysical modeling
10	**S-FWSH**	Fourwing Saltbush Shrubland	*Atriplex canescens* Shrubland	1 : 1	On-screen
Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783)					
13	**S-GSJG**	Gardner's Saltbush / James' Galleta Dwarf-shrubland	*Atriplex gardneri / Pleuraphis jamesii* Dwarf-shrubland	1 : 1	On-screen
Inter-Mountain Semi-Desert Shrub-Steppe (CES304.788)					
23	**S-WFSH**	Winterfat / James' Galleta Dwarf-shrubland	*Krascheninnikovia lanata / Pleuraphis jamesii* Dwarf-shrubland	1 : 1	On-screen
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)					
15	**H-CGHB**	Cheatgrass Semi-natural Herbaceous Vegetation	*Bromus tectorum* Semi-natural Herbaceous Vegetation	1 : 1	On-screen
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)					
16	**S-LLMM**	Littleleaf Mountain Mahogany / Slickrock Sparse Vegetation	*Cercocarpus intricatus* Slickrock Sparse Vegetation	1 : 1	Biophysical modeling

Table 11. Map classes used in the COLM vegetation mapping project, organized by ecological system.

Map Class #	Map Class Code	Map Class Name	Associations Assigned to Map Classes/ Description	Relations	How Delineated
34	**N-BIOC**	Nonvascular Cover - "Board Beds" Unit of the Entrada Sandstone	Nonvascular Cover - Board Beds Unit, Entrada Sandstone	1 : 1	Biophysical modeling
Rocky Mountain Lower Montane Riparian Woodland (CES306.821)					
14	**F-ASWB**	Quaking Aspen - Water Birch Forest-Shrubland	*Populus tremuloides* / *Betula occidentalis* Forest *Betula occidentalis* / *Maianthemum stellatum* Shrubland	1 to many	On-screen
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland (CES306.833)					
29	**W-COTW**	Cottonwood /Coyote Willow Woodland	*Populus deltoides* (ssp. *wislizeni,* ssp. *monilifera*) / *Salix exigua* Woodland	1 : 1	On-screen
37	**S-COWI**	Coyote Willow / Mesic Graminoids Shrubland	*Salix exigua* / Mesic Graminoids Shrubland	1 : 1	On-screen
Inter-Mountain Basins Wash (CES304.781)					
17	**S-RURB**	Rubber Rabbitbrush Desert Wash Shrubland	*Ericameria nauseosa* Desert Wash Shrubland	1 : 1	On-screen
North American Arid West Emergent Marsh (CES300.729)					
18	**H-BRHB**	Baltic Rush Herbaceous Vegetation	*Juncus balticus* Herbaceous Vegetation	1 : 1	On-screen
MIXED ECOLOGICAL SYSTEMS **Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)** **Inter-Mountain Basins Greasewood Flat (CES304.780)**					
12	**S-SSGR**	Shadscale – Black Greasewood Shrubland	*Atriplex confertifolia* - *Sarcobatus vermiculatus* Shrubland *Sarcobatus vermiculatus* Disturbed Shrubland	1 to many	Biophysical modeling
MIXED ECOLOGICAL SYSTEMS **Colorado Plateau Mixed Low Sagebrush Shrubland (CES304.762)** **Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)** **Inter-Mountain Basins Semi-Desert Grassland (CES304.787)** **Colorado Plateau Pinyon-Juniper Woodland (CES304.767)** **Inter-Mountain Basins Cliff and Canyon (CES304.799)**					

Table 11. Map classes used in the COLM vegetation mapping project, organized by ecological system.

Map Class #	Map Class Code	Map Class Name	Associations Assigned to Map Classes/ Description	Relations	How Delineated
4	**S-BSGR**	Black Sagebrush and Grasses Shrubland - Graminoids	*Artemisia nova* / *Leymus salinus* Shrub Herbaceous Vegetation *Artemisia nova* Shrubland *Atriplex confertifolia* / *Pleuraphis jamesii* Shrubland *Opuntia polyacantha* / *Pleuraphis jamesii* Shrubland *Pleuraphis jamesii* Herbaceous Vegetation *Pinus edulis – Juniperus* spp. / *Leymus salinus* Woodland *Leymus salinus* Shale Sparse Vegetation	1 to many	Biophysical modeling
MIXED ECOLOGICAL SYSTEMS Colorado Plateau Pinyon-Juniper Woodland (CES304.767) Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777) Inter-Mountain Basins Semi-Desert Grassland (CES304.787)					
31	**H-CWHB**	Crested Wheatgrass Semi-natural Herbaceous	*Agropyron cristatum* Semi-natural Herbaceous Alliance	1 : 1	On-screen
GEOLOGIC MAP CLASSES					
32	**G-ENTR**	Slickrock Member of the Entrada Sandstone	Forms a pale-orange, ribbon-like cliff or rounded bench that is almost totally free of vegetation below the white cap of the 'board beds' unit	N/A	Biophysical modeling
33	**G-WING**	Wingate Sandstone	Forms 100 m high, reddish-orange cliffs and monuments	N/A	Biophysical modeling
36	**G-MORR**	Brushy Basin Member of the Morrison Formation	Forms gentle rounded slopes of multicolored mudstone	N/A	Biophysical modeling
41	**G-KAYN**	Kayenta Formation	Forms resistant ledges or cliffs above the cliff-forming Wingate Sandstone	N/A	Biophysical modeling
LAND USE MAP CLASSES (within primary project mapping area)					
42	**L-ROAD**	Roads	All types of roads including paved, dirt gravel and the Serpent's Trail	N/A	On-screen
46	**L-MBLD**	Monument Buildings and Grounds	Buildings with associated driveways, parking areas, and immediate developed and undeveloped land	N/A	On-screen
47	**L-TOUT**	Viewpoint Parking Area	Widened portions of major roads used for parking at viewpoints	N/A	On-screen
48	**L-RNWY**	Unpaved Runway	A runway for aircraft that is not paved	N/A	On-screen
49	**L-PICN**	Picnic Area	Picnic area	N/A	On-screen

Table 11. Map classes used in the COLM vegetation mapping project, organized by ecological system.

Map Class #	Map Class Code	Map Class Name	Associations Assigned to Map Classes/ Description	Relations	How Delineated
50	**L-SEWG**	Sewage Pond	Artificial body of water in a man-constructed basin for the treatment of sewage	N/A	On-screen
51	**L-RFIL**	Road Fill Slope	Embankment supporting the bed of a road	N/A	On-screen
52	**L-BPIT**	Old Borrow Pit	Borrow pit	N/A	On-screen
LAND USE MAP CLASSES (within environs along northeastern monument boundary, see Fig. 19)					
53	**L-RESV**	Reservoir	Artificial body of water	N/A	On-screen
54	**L-RESD**	Residential Development	Lands containing structures for human habitation. This map class is further subdivided by single-family and multi-family residential in the spatial database	N/A	On-screen
56	**L-NONR**	Non-Residential Development	Developed areas used for purposes other than habitation. This map class is further subdivided by offices and institutions in the spatial database	N/A	On-screen
58	**L-TRAN**	Transportation	Roads, railroads, airports and their associated lands	N/A	On-screen
59	**L- GOLF**	Golf Course	Structures, associated grounds, and interspersed natural areas used for golf	N/A	On-screen
60	**L-BARE**	Bare	Undeveloped areas of earth with less than 5% vegetative cover	N/A	On-screen
63	**L-DFOR**	Deciduous Forest Vegetation	Area dominated by trees where 75% or more of the canopy cover can be determined to be trees that lose all their leaves for a specific season of the year	N/A	On-screen
64	**L-SHRU**	Shrubland Vegetation	Areas where trees have less than 25% canopy cover and the vegetation is dominated by woody or semi-woody shrubs	N/A	On-screen
65	**L- ORCH**	Orchards and Vineyards	Areas containing plantings of evenly spaced trees, shrubs, or other cultivated climbing plants. Includes orchards, groves and vineyards	N/A	On-screen
66	**L-MIXD**	Mixed Forest and Shrubland Vegetation	Areas of forest and shrubs where neither type comprises more than 75% of the canopy	N/A	On-screen
67	**L-HERB**	Natural Herbaceous Vegetation	Areas dominated by native or naturalized grasses or forbs. It can be maintained or improved for ecologic purposes such as weed/brush control	N/A	On-screen
68	**L-AGRI**	Agricultural Field	Areas of herbaceous vegetation planted and/or cultivated for agronomic purposes. This map class is further subdivided by: fallow/bare fields, irrigated row crops, pasture/hay, and irrigated pasture/hay in the spatial database	N/A	On-screen

Map Spatial Database

Figure 19 is a generalized map of the vegetation of COLM, based on ecological systems. Table 13 provides summary statistics for COLM vegetation map polygons. Four thousand three hundred fifty-nine polygons totaling 12,685 ha (31,345 acres) were mapped within the COLM project area. Average polygon size was 2.9 ha (7.2 acres). Lands within the Monument made up 8,257 ha (20,404 acres) or 65% of the total area. A total of 3,835 polygons (88%) represent natural or semi-natural vegetation map classes covering 81% of the mapping project area. Map classes representing non-vegetated geologic formations account for 272 polygons (6%) of the total polygons and cover 5% of the total area. Human-made features inside the Monument account for less than 1% of the area; human-made features account for 16% of the environs.

Twenty vegetation associations within COLM consistently occurred in stands too small to map as polygons (Table 12). These are represented by point data contained within the plots database.

Table 12. Plant associations represented only by point (plot) data in the COLM vegetation classification and mapping project, arranged by ecological system.

COLM ASSOCIATION	COLM ASSOCIATION COMMON NAME
Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)	
Pseudotsuga menziesii / *Quercus gambelii* Forest	Douglas-fir / Gambel Oak Forest
Rocky Mountain Aspen Forest and Woodland (CES306.813)	
Populus tremuloides / *Prunus virginiana* Forest	Quaking Aspen / Chokecherry Forest
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)	
Pinus edulis – Juniperus osteosperma / *Petradoria pumila* – Cushion Plant Woodland	Two-needle Pinyon Pine – Utah Juniper / Grassy Rock Goldenrod – Cushion Plant) Woodland
Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)	
Mahonia repens Shrubland	Creeping Oregon-grape Shrubland
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)	
Artemisia frigida / *Heterotheca villosa* Dwarf-shrubland	Prairie Sagebrush / Hairy Golden-aster Dwarf-shrubland
Artemisia tridentata ssp. *tridentata* / *Sporobolus airoides* Shrubland	Basin Big Sagebrush / Alkali Sacaton Shrubland
Inter-Mountain Basins Greasewood Flat (CES304.780)	
Sarcobatus vermiculatus – Artemisia tridentata Shrubland	Black Greasewood – Big Sagebrush Shrubland
Sporobolus airoides Southern Plains Herbaceous Vegetation	Alkali Sacaton Southern Plains Herbaceous Vegetation
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)	

Table 12. Plant associations represented only by point (plot) data in the COLM vegetation classification and mapping project, arranged by ecological system.

COLM ASSOCIATION	COLM ASSOCIATION COMMON NAME
Achnatherum hymenoides – Bromus tectorum Herbaceous Vegetation	Indian Ricegrass – Cheatgrass Herbaceous Vegetation
Hesperostipa comata Great Basin Herbaceous Vegetation	Needle-and-thread Great Basin Herbaceous Vegetation
Pascopyrum smithii Herbaceous Vegetation	Western Wheatgrass Herbaceous Vegetation
Inter-Mountain Basins Playa (CES304.786)	
Hordeum jubatum Temporarily Flooded Herbaceous Vegetation	Foxtail Barley Temporarily Flooded Herbaceous Vegetation
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)	
Fendlera rupicola Shrubland	Fendlerbush Shrubland
Eriogonum lonchophyllum Sparse Herbaceous Vegetation	Spearleaf Buckwheat Sparse Herbaceous Vegetation
Rocky Mountain Lower Montane Riparian Woodland (CES306.821)	
Picea pungens – Pinus edulis – Juniperus osteosperma / Quercus gambelii Woodland	Colorado Blue Spruce – Two-needle Pinyon Pine – Utah Juniper / Gambel Oak Woodland
Acer negundo / Disturbed Understory Woodland	Box-elder / Disturbed Understory Woodland
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland (CES306.833)	
Rhus trilobata Intermittently Flooded Shrubland	Skunkbush Intermittently Flooded Shrubland
Inter-Mountain Basins Wash (CES304.781)	
Fraxinus anomala Woodland	Single-leaf Ash Woodland
North American Arid West Emergent Marsh (CES300.729)	
Equisetum laevigatum Herbaceous Vegetation	Smooth Horsetail Herbaceous Vegetation
Colorado Plateau Hanging Garden (CES304.764)	
Aquilegia micrantha – Mimulus eastwoodiae Herbaceous Vegetation	Mancos Columbine – Eastwood Monkeyflower Herbaceous Vegetation

The polygon count includes adjacent polygons that may be in the same map class but have different modifiers. Density attributes were applied to polygons in forest and woodland map classes (19, 20, 22, 25, and 28). The most common map class was Two-Needle Pinyon Pine – Utah Juniper / Multiple Shrub Woodland (W-PJSH) with 1,337 polygons covering 28% of the mapping area. The map class with the largest average polygon size was Wyoming Big Sagebrush / Seeded Grasses Shrubland (S-WSGR) at 7.2 ha (18 acres) per polygon. These areas were cleared pastures seeded with nonnative grasses that are starting to revert to native shrublands.

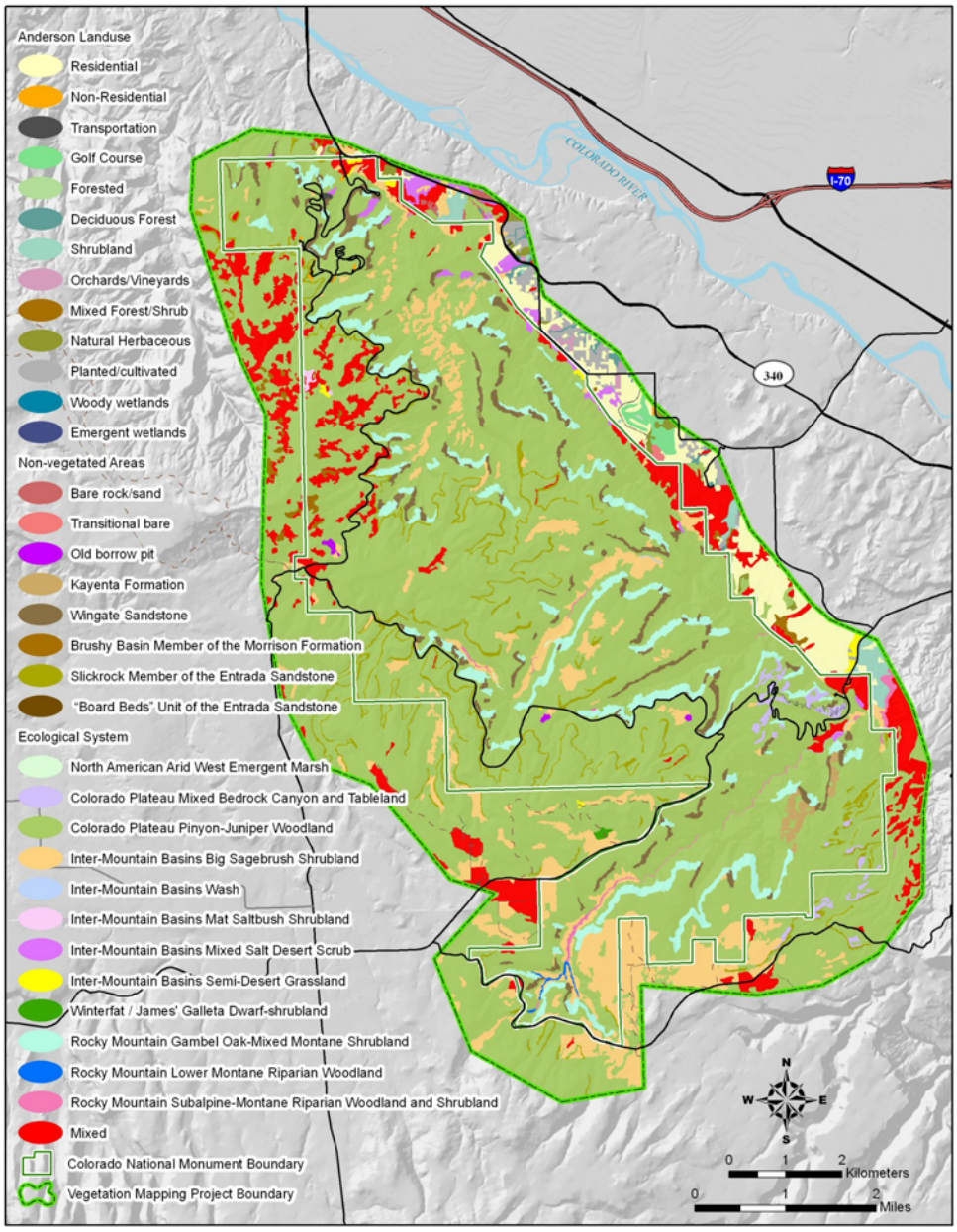


Figure 19. Generalized COLM vegetation map; the map units are Anderson land use types or ecological systems, each consisting of one or more map classes.

Discussion

Mapping the vegetation of COLM presented challenges found in most of the parks of the Colorado Plateau. Foremost among these is the extremely rugged topography with sheer cliffs presenting difficulties in field access, slope and aspect data generation, and creating shadows in the imagery. These challenges required the development and application of innovative techniques to solve them.

Things That Worked Well

Field data and association local descriptions provided by the project ecologists were extremely important data sources for the cartographers delineating map classes, and in supporting photo interpretation and GIS modeling. Additional data collected by RMGSC cartographers during two field reconnaissance trips consolidated their understanding of the project area. The lead project ecologist participated in these reconnaissance trips and shared valuable knowledge and insight with the cartographers. The ten physiognomic classes and four tree density classes derived from the orthoimagery were very useful as components of the GIS model.

Accurate base data are essential to high quality cartographic work. For the vegetation mapping at COLM, high quality, high-resolution orthoimagery allowed confident manual interpretation and provided a solid source for deriving physiognomic classes and tree coverage densities for the GIS model. The geologic data were detailed and had high horizontal spatial accuracy, both of which are important in GIS modeling.

GIS modeling reduced the compilation time and improve the consistency of polygon creation and attribution, while maintaining acceptable map class accuracy. One advantage of using the GIS modeling method was that it eliminated the subjectivity of polygon edge delineation, since the same rules are used for all polygon determinations. It also saved time, since the cartographers did not have to manually draw the polygon boundaries or determine the 0.5 ha MMU limits.

Areas for Improvement

The success of GIS modeling is directly related to the quality of the base data used. Raster elevation data with 10 m horizontal postings were used in modeling vegetation at COLM. Although these digital elevation data were high quality, a higher level of resolution would have improved the modeling effort by providing more refined slope and aspect data.

The idea behind combining a GIS modeling approach with traditional photo interpretation was to reduce compilation time and improve map class delineation while maintaining accuracy. This approach met with mixed success, as shown by the accuracy assessment results. The model’s success was limited by both the availability and quality of spatial data for the environmental drivers and the cartographers' understanding of the forces driving the vegetation in some of the map classes. In some cases, additional field data would have been helpful in clarifying map class relationships. In other situations, modeling would not be successful in distinguishing between two closely related map classes, no matter how many field plots were collected. This is especially true for the “less confident” map classes such as pinyon-juniper and sagebrush communities. Areas in the deep shadow were difficult to map accurately, but would have been problematic under any circumstances.

Table 13. Summary statistics for polygons of each map class developed for the COLM vegetation mapping project, arranged by ecological system.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Monument	Environs	Total Area	Monument	Environs	Total Area
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)							
W-PJWS	Two-Needle Pinyon Pine - Utah Juniper / Wyoming Big Sagebrush Woodland	435	246	681	1112.7	708.7	1821.4
W-PJSH	Two-Needle Pinyon Pine - Utah Juniper / Multiple Shrub Woodland	928	409	1337	2475.3	1039.9	3515.3
W-JUTA	Utah Juniper / Talus Mixed Shrub Woodland	255	10	265	1439.1	25.4	1464.5
W-PJBS	Two-Needle Pinyon Pine - Utah Juniper / Black Sagebrush Woodland	271	113	384	674.7	182.6	857.3
W-PJSP	Two-Needle Pinyon Pine - Utah Juniper / Sparse Understory Woodland	281	235	516	468.6	507.7	976.3
	Subtotal	*2170*	*1013*	*3183*	*6170.4*	*2464.3*	*8634.7*
Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)							
S-OAKG	Gambel Oak / Skunkbush Woodland	19	2	21	20.8	1.3	22.1
S-UTSE	Utah Serviceberry Shrubland	84	3	87	520.4	0.2	520.6
S-MANZ	Greenleaf Manzanita Shrubland	1	0	1	0.2	0.0	0.2
	Subtotal	*104*	*5*	*109*	*541.4*	*1.5*	*542.9*
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)							
S-BASA	Basin Big Sagebrush / Cheatgrass Semi-natural Shrubland	15	6	21	84.7	15.8	100.5
S-WSGR	Wyoming Big Sagebrush / Seeded Grasses Semi-natural Shrubland	22	53	75	139.6	397.1	536.7
S-WYSA	Wyoming Big Sagebrush Shrubland	108	35	143	323.7	68.6	392.2
	Subtotal	*145*	*94*	*239*	*548*	*481.5*	*1029.4*
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)							
S-FWMT	Fourwing Saltbush – Mormon Tea Shrubland	7	1	8	14.4	1.2	15.6
S-FWSH	Fourwing Saltbush Shrubland	6	9	15	15.3	47.3	62.6
	Subtotal	*13*	*10*	*23*	*29.7*	*48.5*	*78.2*
Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783)							
S-GSJG	Gardner's Saltbush / James' Galleta Dwarf -shrubland	2	0	2	5.3	0.0	5.3
	Subtotal	*2*	*0*	*2*	*5.3*	*0*	*5.3*
Inter-Mountain Semi-Desert Shrub-Steppe (CES304.788)							

Table 13. Summary statistics for polygons of each map class developed for the COLM vegetation mapping project, arranged by ecological system.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Monument	Environs	Total Area	Monument	Environs	Total Area
S-WFSH	Winterfat / James' Galleta Dwarf-shrubland	0	1	1	0.0	4.2	4.2
	Subtotal	*0*	*1*	*1*	*0*	*4.2*	*4.2*
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)							
H-CGHB	Cheatgrass Semi-natural Herbaceous Vegetation	7	3	10	13.1	11.8	24.9
	Subtotal	*7*	*3*	*10*	*13.1*	*11.8*	*24.9*
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)							
S-LLMM	Littleleaf Mountain Mahogany / Slickrock Sparse Vegetation	16	0	16	37.7	0.0	37.7
N-BIOC	Nonvascular Cover - "Board Beds" Unit of the Entrada Sandstone	6	8	14	6.9	16.0	22.9
	Subtotal	*22*	*8*	*30*	*44.6*	*16.0*	*60.6*
Rocky Mountain Lower Montane Riparian Woodland (CES306.821)							
F-ASWB	Quaking Aspen - Water Birch Forest	2	0	2	6.5	0.0	6.5
	Subtotal	*2*	*0*	*2*	*6.5*	*0*	*6.5*
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland (CES306.833)							
W-COTW	Cottonwood / Coyote Willow Woodland	6	2	8	10.6	11.0	21.6
S-COWI	Coyote Willow / Mesic Graminoids Shrubland	12	2	14	9.2	0.6	9.8
	Subtotal	*18*	*4*	*22*	*19.8*	*11.6*	*31.4*
Inter-Mountain Basins Wash (CES304.781)							
S-RBSH	Rubber Rabbitbrush Desert Wash Shrubland	4	0	4	2.9	0.0	2.9
	Subtotal	*4*	*0*	*4*	*2.9*	*0*	*2.9*
North American Arid West Emergent Marsh (CES300.729)							
H-BRHB	Baltic Rush Herbaceous Vegetation	3	0	3	1.6	0.0	1.6
	Subtotal	*3*	*0*	*3*	*1.6*	*0*	*1.6*
MIXED ECOLOGICAL SYSTEMS **Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)** **Inter-Mountain Basins Greasewood Flat (CES304.780)**							
S-SSGR	Shadscale – Black Greasewood Shrubland	10	20	30	31.2	105.7	136.9

Table 13. Summary statistics for polygons of each map class developed for the COLM vegetation mapping project, arranged by ecological system.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Monument	Environs	Total Area	Monument	Environs	Total Area
	Subtotal	*10*	*20*	*30*	*31.2*	*105.7*	*136.9*
MIXED ECOLOGICAL SYSTEMS Colorado Plateau Mixed Low Sagebrush Shrubland (CES304.762) Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784) Inter-Mountain Basins Semi-Desert Grassland (CES304.787) Colorado Plateau Pinyon-Juniper Woodland (CES304.767) Inter-Mountain Basins Cliff and Canyon (CES304.799)							
S-BSGR	Black Sagebrush and Grasses Shrubland - Graminoids	83	71	154	267.1	345.1	612.2
	Subtotal	*83*	*71*	*154*	*267.1*	*345.1*	*612.2*
MIXED ECOLOGICAL SYSTEMS Colorado Plateau Pinyon-Juniper Woodland (CES304.767) Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)							
H-CWHB	Crested Wheatgrass Semi-natural Herbaceous Vegetation	2	21	23	3.5	121.3	124.8
	Subtotal	*2*	*21*	*23*	*3.5*	*121.3*	*124.8*
GEOLOGIC MAP CLASSES							
G-ENTR	Slickrock Member of the Entrada Sandstone	75	55	130	195.3	69.3	264.6
G-WING	Wingate Sandstone	118	1	119	260.8	1.2	262.0
G-MORR	Brushy Basin Member of the Morrison Formation	5	14	19	11.1	18.2	29.3
G-KAYN	Kayenta Formation	4	0	4	33.7	0.0	33.7
	Subtotal	*202*	*70*	*272*	*500.9*	*88.7*	*589.6*
LAND USE MAP CLASSES (within primary project mapping area)							
L-ROAD	Major Roads	19	8	27	49.6	16.0	65.6
L_MROA	Minor Roads	2	9	11	.3	6.9	7.2
L-SERP	Serpents Trail	4	0	4	6.6	0	6.6
L-MBLD	Monument Buildings and Grounds	9	0	9	3.4	0.0	3.4
L-TOUT	Viewpoint Parking Area	22	1	23	1.6	<0.1	1.6

Table 13. Summary statistics for polygons of each map class developed for the COLM vegetation mapping project, arranged by ecological system.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Monument	Environs	Total Area	Monument	Environs	Total Area
L-RNWY	Unpaved Runway	0	1	1	0.0	0.8	0.8
L-PICN	Picnic Area	1	0	1	0.4	0.0	0.4
L-SEWG	Sewage Pond	1	1	2	0.6	0.3	.9
L-RFIL	Road Fill Slope	2	0	2	2.1	0.0	2.1
L-BPIT	Old Borrow Pit	3	0	3	6.8	0.0	6.8
	Subtotal	*63*	*20*	*83*	*71.4*	*24*	*95.4*
LAND USE MAP CLASSES (within environs along northeastern monument boundary; see Fig. 19)							
L-RESV	Reservoir	0	4	4	0.0	1.4	1.4
L-RESD	Single-family residential	0	51	51	0	375.2	375.2
L-RESM	Multi-family residential	0	1	1	0	2.3	2.3
L-NONR	Office	0	1	1	0.0	1.8	1.8
L-INST	Institutional	0	2	2	0	1.3	1.3
L-TRAN	Transportation	0	4	4	0	16.1	16.1
L-GOLF	Golf Course	0	1	1	0.0	35.5	35.5
L-BARE	Transitional Bare	0	2	2	0.0	5.4	5.4
L-BROC	Bare rock / sand	0	9	9	0	14.4	14.4
L-DFOR	Deciduous Forest Vegetation	0	19	19	0	25.6	25.6
L-SHRU	Shrubland Vegetation	0	8	8	0	70.	70.
L-ORCH	Orchards and Vineyards	0	6	6	0.0	11.2	11.2
L-MIXD	Mixed Forest and Shrubland Vegetation	0	5	5	0.0	14.2	14.2
L-HERB	Natural Herbaceous Vegetation	0	12	12	0	33.8	33.8
L-AGRI	Fallow / Bare fields	0	1	1	0.0	3.6	3.6
L-IPHA	Irrigated pasture / hay	0	11	11	0	26.3	26.3
L-IROW	Irrigated row crops	0	9	9	0	19.2	19.2
L-PHAY	Pasture / hay	0	23	23	0	46.7	46.7
	Subtotal	*0*	*169*	*169*	*0*	*704.7*	*704.7*
	Total All Map Classes	**2,850**	**1,509**	**4,359**	**8,257.4**	**4,428.2**	**12,685.5**

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 vegetation with map class polygons. Errors occur when map classes differ from the classes observed in the field. 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: “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”) (Hop et al. 2005). 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.

Sampling Design

A stratified random sampling approach was used to determine AA sampling locations. The AA included all polygon vegetation map classes and was limited to lands within the COLM boundary. Vegetation classes mapped as points (Table 12) were excluded from the AA, because these classes were based on field data and their accuracy was assumed to be 100%. Private, federal, and state lands outside of the monument were not included in the accuracy evaluation., Sample sizes for each evaluated map class were selected using the USGS-NPS Vegetation Mapping Program guidelines (TNC 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.

Accuracy assessment sampling points were selected for each map class using scenarios A–E as guidelines. Five hundred-one AA points were selected for evaluation. Polygon edges were given a 25 m (82 ft) buffer to help ensure that 0.5 ha sampling points would fall cleanly within the polygon. The 25 m buffer worked in most situations; however, for small or linear polygons the buffer was reduced or eliminated. Isolated mesa tops, sheer cliffs, and steep talus were excluded from the AA point selection pool due to poor or dangerous access. Location (UTM) coordinates for all AA points were downloaded to GPS units for field sampling. The points and polygons were printed on paper maps with an orthophoto base for field crew use.

Field Data Collection

Accuracy assessment point data were collected in 2004 by the same personnel who collected the classification plot data. Field crews used GPS receivers, digital orthophotos, and topographic maps to navigate precisely to each AA point. The crews evaluated an area approximately 5000m^2 centered on the AA point (Appendix B2, Appendix B4). Environmental data collected 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 field key was used to identify the plant association. In most cases, only one plant association name was recorded. When vegetation relationships were less clear, a secondary or tertiary plant association was also recorded. Plant associations occurring within 50 m of the AA point boundary were recorded. Two 35 mm color slides were taken at each AA point to provide visual documentation of the site.

AA data collection occurred in three phases. During the first phase, the lead ecologist collected data and tested the field key at 101 AA points. Following this field visit, minor adjustments were made to the field key. During the second phase, field crews sampled 299 of the most accessible AA points. The third phase of field sampling completed the final 100 AA points that lay in difficult terrain. Personnel with technical climbing skills completed the final phase. One AA point could not be accessed in the field.

AA point data were manually entered into the plots database. A thorough quality assessment/quality check (QA/QC) was performed on the AA point 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). Slides were converted to digital format and cataloged in the same database as the classification plot photographs.

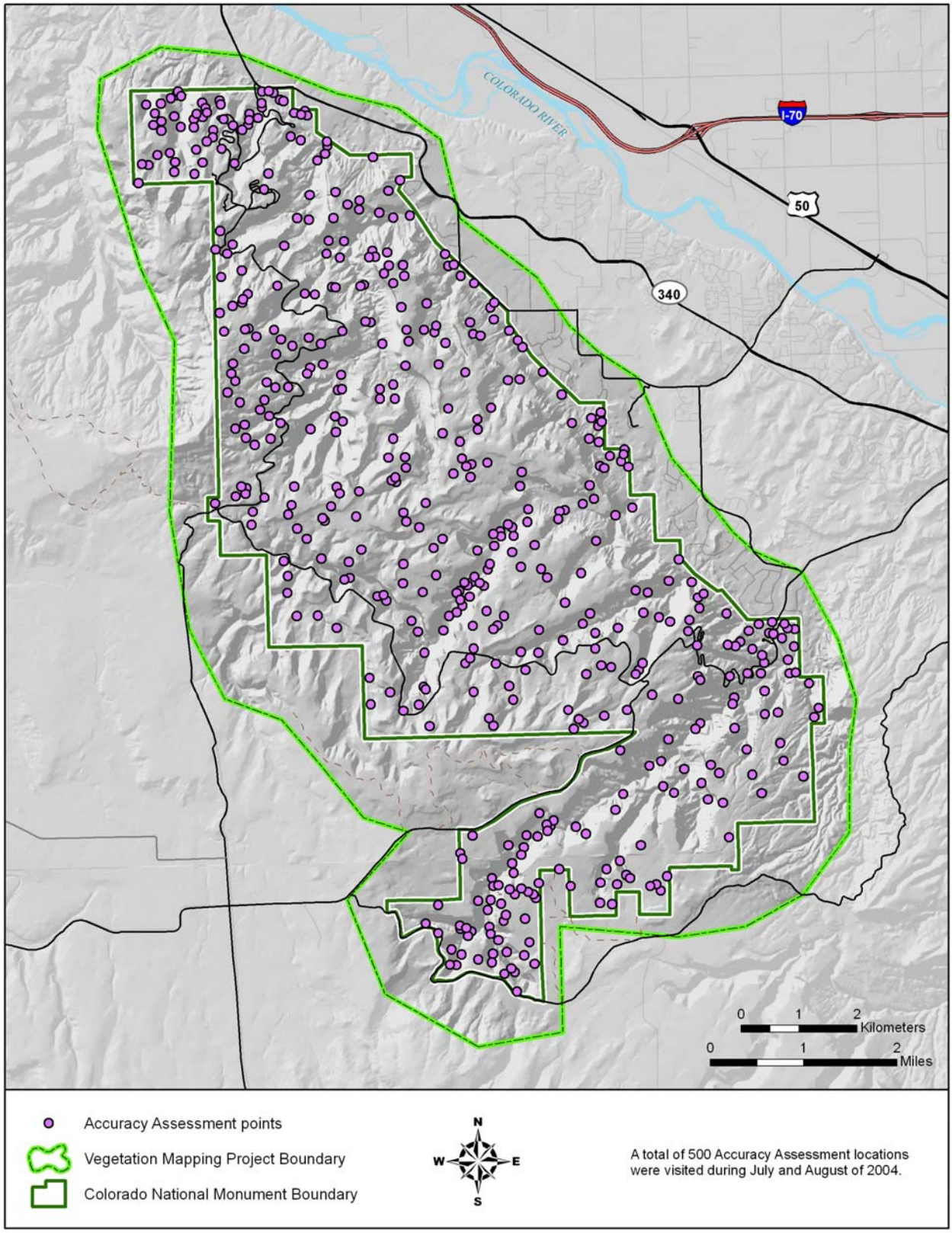


Figure 20. Location of accuracy assessment points for the COLM vegetation map.

Data Analysis

Of the 500 AA data points collected in the field, 481 were used in analysis. Nineteen points were dropped because of irresolvable problems with the data, including position errors. 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 field calls for each AA point were compared with the map class code for that polygon. If any of the three field calls agreed with the labeled map class for a given polygon, it was considered correct. All other results were marked incorrect.

The results of this analysis were arrayed in a preliminary contingency table and 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 their 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.

In February 2005, the project cooperators met to review the AA results. Participants reviewed field data sheets and spatial products to analyze the AA data and to make recommendations for adjusting the final spatial database. 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). Mismatches were corrected when a false error was identified. All other mismatches were deemed true errors.

Producer's and user's accuracy were recalculated, and the group discussed whether to merge map classes in order to reach the 80% national standard for thematic accuracy. 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. A final contingency table was produced by project cartographers (Table 14). The final spatial database was revised to reflect the new combinations of map classes.

Results and Discussion

The map classes shown in tables and figures in this document represent those that existed following combination of map classes to improve map class accuracy. Overall map accuracy is 68% (Kappa index 64%). Individual map class producer's and user's accuracy values are given in Table 14 with their 90% confidence intervals. The width of each confidence interval is affected by sample size. Individual map class accuracy ranges from 20% to 100%.

Table 14. Final contingency table for COLM showing both user's and producer's accuracy for all map units retained after the final analysis.

AA Field Call →

Map Data ↓		S-UTSE	S-MANZ	S-BSGR	S-BASA	S-WSGR	S-WYSA	S-FWMT	S-FWSH	S-SSGR	S-GSJG	F-ASWB	H-CGHB	S-LLMM	S-RURB	H-BRHB	W-PJWS	W-PJSH	W-JUTA	W-PJBS	W-PJSP	W-COTW	S-OAKG	S-COWI			90% Conf. Interval	
Map Class	**Map Code**	**2**	**3**	**4**	**5**	**7**	**8**	**9**	**10**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**22**	**25**	**28**	**29**	**30**	**37**	**Total Pts**	**User's Accuracy**	**-**	**+**
S-UTSE	**2**	8															1	25	2			2	2		40	20%	8%	32%
S-MANZ	**3**		1																						1	100%	50%	150%
S-BSGR	**4**			29						3								2	1	1					36	81%	68%	93%
S-BASA	**5**				15	1	3			2							1					1			23	65%	47%	84%
S-WSGR	**7**					23	2										1								26	88%	76%	101%
S-WYSA	**8**			1			29			1			1				2		1	2					37	78%	66%	91%
S-FWMT	**9**							3		1									3						7	43%	5%	81%
S-FWSH	**10**			1					4	2															7	57%	19%	95%
S-SSGR	**12**			1					1	5															7	71%	36%	107%
S-GSJG	**13**										2														2	100%	75%	125%
F-ASWB	**14**											3													3	100%	83%	117%
H-CGHB	**15**				1								6												7	86%	57%	115%
S-LLMM	**16**													2				5							7	29%	-7%	64%
S-RURB	**17**														4										4	100%	88%	113%
H-BRHB	**18**															4									4	100%	88%	113%
W-PJWS	**19**						1			1							25	6	2		2				37	68%	54%	82%
W-PJSH	**20**	1															2	83	3	3	7			1	100	83%	76%	90%
W-JUTA	**22**														1		2	7	24		4		1		39	62%	47%	76%
W-PJBS	**25**																2	9		21	5				37	57%	42%	72%
W-PJSP	**28**			1														17	1	1	19				39	49%	34%	63%
W-COTW	**29**																					7			7	100%	93%	107%
S-OAKG	**30**																	1					4		5	80%	41%	119%
S-COWI	**37**														1									5	6	83%	50%	117%
Total AA Pts		9	1	33	16	24	35	3	5	15	2	3	7	2	6	4	36	155	37	28	37	10	7	6	481			
Prod's Accuracy		89%	100%	88%	94%	96%	83%	100%	80%	33%	100%	100%	86%	100%	67%	100%	69%	54%	65%	75%	51%	70%	57%	83%		**Overall Accuracy = 68%**		
90% Conf. Interval	-	66%	50%	77%	81%	87%	71%	83%	41%	10%	75%	83%	57%	75%	27%	88%	55%	47%	51%	60%	36%	41%	19%	50%		**Kappa Index = 64%**		
	+	112%	150%	99%	107%	105%	95%	117%	119%	57%	125%	117%	115%	125%	107%	113%	83%	60%	79%	90%	66%	99%	95%	117%				

Overall map accuracy is below the national standard of 80%, primarily because of confusion among the pinyon-juniper map classes. Even when pinyon-juniper associations were well defined, it was not possible to map them consistently because the differences among them were based on understory elements in the understory that are impossible to model and invisible to photo interpreters. AA meeting participants decided that it was more important to retain separate pinyon-juniper map classes with lower accuracy than combine them into a single pinyon-juniper map class just to meet the 80% standard. A combined pinyon-juniper map class would have included 68% of the mapping project area, with significant loss of detail. These classes were retained because of their value to management, uniqueness, and contribution to COLM's biodiversity. However, the pinyon–juniper map classes must be used with caution, since in some cases user's accuracy is less than 50%. The remainder of this section explains why each map class that fell below the 80% accuracy standard (Table 15) was retained.

Table 15. COLM vegetation map classes for which either the user's or producer's accuracy did not meet the 80% program standard.

Map Class	Map Class #	Map Class Name	Producer's Accuracy (±90% CI)	User's Accuracy (±90% CI)	Mostly Confused with Map Class #
W-PJWS	19	Two-Needle Pinyon – Utah Juniper / Wyoming Big Sagebrush Woodland	69%±14%	68%±14%	8, 20, 22, 25, 28
W-PJSH*	20	Two-Needle Pinyon Pine – Utah Juniper / Multiple Shrub Woodland	54%± 6%	83%±7%	2, 16, 19, 22, 25, 28
W-JUTA	22	Utah Juniper / Talus Mixed Shrub Woodland	65%±14%	62%±14%	2, 9, 19, 20, 28
W-PJBS	25	Two-Needle Pinyon Pine – Utah Juniper / Black Sagebrush Woodland	75%±15%	57%±15%	8, 19, 20, 28
W-PJSP	28	Two-Needle Pinyon Pine – Utah Juniper / Sparse Understory Woodland	51%±15%	49%±15%	20, 22, 25
S-OAKG	30	Gambel Oak / Skunkbush Woodland	57%±48%	80%±39%	2
S-UTSE	2	Utah Serviceberry Shrubland	89%±23%	20%±12%	20, 22, 29, 30
S-BASA	5	Basin Big Sagebrush / Cheatgrass Semi-natural Shrubland	94%±13%	65%±18%	8, 12
S-FWMT	9	Fourwing Saltbush – Mormon Tea Talus Shrubland	100%±17%	43%±38%	22
S-FWSH	10	Fourwing Saltbush Shrubland	80%±39%	57%±38%	12
S-LLMM	16	Littleleaf Mountain Mahogany / Slickrock Sparse Vegetation	100%±25%	29%±35%	20
W-COTW	29	Cottonwood / Coyote Willow Woodland	70%±29%	100%±7%	2
S-RURB	17	Rubber Rabbitbrush Desert Wash Shrubland	67%±40%	100% ±13%	22
S-SSGR	12	Shadscale – Black Greasewood Shrubland	33%±24%	71%±36%	4, 5, 10

*Post-AA revision incorporates all polygons of pre-AA map classes 27 (PJ/Breaks) and 35 (PJ/littleleaf mountain mahogany).

W-PJWS (Map Class 19) – Two-needle Pinyon Pine – Utah Juniper / Wyoming Big Sagebrush Woodland: This map class is tightly associated with areas of deep eolian deposits and a few Precambrian gravel ridges. Confusion with other map classes occurred in the broad ecotone between this community and adjacent Wyoming big sagebrush shrublands with sparse pinyon and/or juniper cover. Another source of error resulted from characterization of mature stands with less than 5% Wyoming big sagebrush cover as mixed or sparse shrub understory.

***W-PJSH (Map Class 20) – Two-needle Pinyon Pine – Utah Juniper / Multiple Shrub Woodland*:** Errors in this map class were mostly in the ecotone with Utah serviceberry shrublands (inaccessible stands on steep slopes) and where the tree canopy obscured the understory. This map class covered several geologic formations and the most abundant woodland type in COLM, Pinyon - Juniper / Mountain Mahogany Woodland. AA analysis suggested that this map class absorb polygons oTwo-needle Pinyon Pine – Utah Juniper / Breaks Woodland and Two-needle Pinyon Pine – Utah Juniper / Littleleaf Mountain Mahogany map classes. These map classes 27 and 35 were inaccurate and were often confused with map class 20.

***W-JUTA (Map Class 22) – Utah Juniper / Talus Mixed Shrub Woodland*:** Talus as a habitat is highly variable depending on age, stability, steepness, and the composition of communities on the rims above them. Talus communities are poorly described on the Colorado Plateau. The accuracy of this map unit also suffered from the fact that steeper slopes were not sampled; this map unit is best represented on slopes that could not be accessed. Confusion with other map classes was consistent with the variable nature of plant distribution on talus slopes. Most AA points fell into map class 20, as they had developed shrub understories. The plant association field key for COLM was revised to improve the recognition of map classes 22 and 20 by allowing some pinyon pine cover and by emphasizing differences in substrate.

***W-PJBS (Map Class 25) - Two-needle Pinyon Pine – Utah Juniper / Black Sagebrush Woodland*:** This map class is closely associated with soils derived from the Tidwell Member of the Morrison Formation, and as such should be retained as a map class. Polygons were located primarily along the western boundary and along Liberty Cap Trail. Black sagebrush hybridized with Wyoming big sagebrush near Cold Shivers Point and on Monument Mesa, which contributed to mapping confusion. Other understory shrubs common to steeper slopes of the Tidwell Formation included mountain mahogany, green Mormon tea, and Utah serviceberry, which also contributed to confusion for this map class.

***W-PJSP (Map Class 28) – Two-needle Pinyon Pine – Utah Juniper / Sparse Understory Woodland*:** Much of the confusion in interpreting this map class was related to difficulties in seeing or modeling the ground layer under the pinyon-juniper canopy. This map class should be retained because pinyon-juniper stands with a sparse understory are extensive within COLM.

***S-OAKG (Map Class 30) – Gambel Oak / Skunkbush Woodland*:** Map class 2 also consists of similar tall mesic shrubs in similar habitats and therefore was a source of confusion for the cartographers. Occupied habitats included mesic talus slopes and valley fill in No Thoroughfare and Ute canyons. Other talus slope map classes with similar dark signatures were also a source of confusion. This map class was retained because of its value to wildlife management.

***S-UTSE (Map Class 2) – Utah Serviceberry Shrubland*:** This map class occupies steeper canyon sides than the field crews could sample. The most representative areas were therefore excluded from sampling. The areas available for AA sampling fell mostly in ecotones on shallower slopes, accounting for most of the error. The accuracy would have been much higher if the entire polygon could have been sampled during AA. Another potential solution may have been to increase the GIS model slope to 60%+ instead of the 50%+ used for mapping. Because this map class is very likely to be more accurate than the AA data indicated, it was retained.

***S-BASA (Map Class 5) – Basin Big Sagebrush / Cheatgrass Semi-natural Shrubland*:** The errors in this map class resulted from AA points falling by chance in drainages with ecotonal vegetation between basin big sagebrush and Wyoming big sagebrush or black greasewood stands. These were indistinguishable on the imagery. This map class was retained because of the association's contribution to habitat diversity, its layer of predominantly nonnative annual plants, and unique landscape position.

***S-FWMT (Map Class 9) – Fourwing Saltbush –Mormon Tea Talus Shrubland*:** This plant association was relatively rare and unpredictable, occupying talus slopes of large sandstone boulders. Sparse Utah juniper trees resulted in field calls corresponding to the Utah Juniper / Talus Mixed Shrub Woodland (map class 22). Polygons of map class 9 were retained an "as known" basis, following a review of plot, observation point, and accuracy assessment data for stands of this association. Other polygons were changed to map class 22.

***S-FWSH (Map Class 10) – Fourwing Saltbush Shrubland*:** Stands of fourwing saltbush are typically low to sparse in cover at COLM and sometimes intermixed with sparse shadscale shrublands, resulting in a broad ecotone that was confusing to the cartographers. Fourwing saltbush shrubs usually contributed less than 10% cover. This map class was retained because of its contribution to habitat diversity and its fidelity to alluvial fans.

***S-LLMM (Map Class 16) – Littleleaf Mountain Mahogany / Slickrock Sparse Vegetation*:** The error in this map class always resulted from 8-12% cover of dwarfed two-needle pinyon and Utah juniper. The field call in these cases was for a sparse woodland rather than shrubland, thus the error. This map class can be readily rectified in the field by delineating its boundary with a hand-held GPS receiver, because it is limited in distribution and very specific to east-tilted slickrock exposures of Kayenta sandstone. It was retained because of its uniqueness and contribution to COLM biodiversity.

***W-COTW (Map Class 29) – Rio Grande Cottonwood / Coyote Willow Woodland*:** Two of the three AA points determined to be in error were confused with map class 2, probably because of similar height and density of Utah serviceberry tall shrubs occupying similar mesic sites along drainages. The remaining AA error was confused with map class 5 where basin big sagebrush also occupies mesic sites along drainages. This map class was retained because of its contribution to biodiversity and its value to wildlife.

***S-RURB (Map Class 17) – Rubber Rabbitbrush Desert Wash Shrubland*:** Because this community occurs intermittently along drainages with narrow terraces, it was common to find gaps in cover and to find it merging with more mesic or adjacent upland communities. It was retained as a valuable contributor to the landscape diversity.

***S-SSGR (Map Class 12) – Shadscale – Black Greasewood Shrubland*:** The error was distributed across associations occupying similar topographic positions; this map class was over-mapped. Polygons of this map class were retained on an "as known" basis following a review of plot, observation point, and accuracy assessment data for sample plots of this association. Other polygons were absorbed into surrounding polygons with a similar signature.

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Appendix A

Ecological Systems of Colorado National Monument

Introduction

This appendix contains summary descriptions of 20 U.S. terrestrial ecological system (ES) units (NatureServe 2003b, Comer et al. 2003) recognized at Colorado National Monument. The ecological systems classification was developed in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. For organizational purposes, this project's plant communities and map classes are arranged by ES unit.

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 [Montane, Lower Montane]; Forest and Woodland (Treed); Aridic; Intermediate Disturbance Interval; F-Patch/Medium Intensity; F-Landscape/Medium Intensity; Needle-Leaved Tree; RM 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 at elevations ranging from 1,200 m to 3,300 m. Rainfall averages less than 75 cm per year (40 cm–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 that 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 common cold-deciduous shrub and graminoid species, 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," characterized by a high degree of variability in lethality and return interval.
Range: Occurs throughout the southern Rockies, north and west into Utah, Nevada, western Wyoming and Idaho.
Subnations: AZ, CO, ID, NV, OR, UT, WY

CES306.813 ROCKY MOUNTAIN ASPEN FOREST AND WOODLAND

Division 306 (Rocky Mountain); Forest and Woodland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Forest and Woodland (Treed); Long Disturbance Interval; F-Patch/Medium Intensity; F-Landscape/Medium Intensity; Broad-Leaved Deciduous Tree; *Populus tremuloides*
Concept Summary: This widespread ecological system is more common in the southern and central Rocky Mountains, but occurs in the montane and subalpine zones throughout much of the western U.S. and north into Canada. In California, this system is only found on the east side of the Sierra Nevada adjacent to the Great Basin. Large stands are found in the Inyo and White mountains, while small stands occur on the Modoc Plateau. Elevations generally range from 1,525 m to 3,050 m (5,000–10,000 ft), but occurrences can be found at lower elevations in some regions. Distribution of this ecological system is primarily limited by adequate soil moisture required to meet its high evapotranspiration demand.

Secondarily, it is limited by the length of the growing season or low temperatures. These are upland forests and woodlands dominated by *Populus tremuloides* without a significant conifer component (<25% relative tree cover). The understory structure may be complex with multiple shrub and herbaceous layers, or simple with just an herbaceous layer. The herbaceous layer may be dense or sparse, dominated by graminoids or forbs. In California, *Symphyotrichum spathulatum (= Aster occidentalis)* is a common forb. Associated shrub species include *Symphoricarpos* spp., *Rubus parviflorus, Amelanchier alnifolia*, and *Arctostaphylos uva-ursi*. Occurrences of this system originate and are maintained by stand-replacing disturbances such as avalanches, crown fire, insect outbreak, disease and windthrow, or clearcutting by man or beaver, within the matrix of conifer forests.
Range: This system is more common in the southern and central Rocky Mountains, but it does occur in the montane and subalpine zones throughout much of the western U.S. and north into Canada, as well as west into California. Elevations generally range from 1,525 m to 3,050 m (5,000–10,000 ft), but occurrences can be found at lower elevations in some regions.
Subnations: AB, AZ, BC, CA, CO, ID, MT, NM, NV, OR, SD, UT, WA, WY

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 [Temperate Xeric]; Aridic; *Pinus edulis, Juniperus osteosperma*
Concept Summary: This ecological system occurs in dry mountains and foothills of the Colorado Plateau region including the Western Slope of Colorado to the Wasatch Range, south to the Mogollon Rim and east into the northwestern corner of New Mexico. It is typically found at lower elevations ranging from 1,500 m to 2,440 m. These woodlands occur on warm, dry sites on mountain slopes, mesas, plateaus, and ridges. Severe climatic events occurring during the growing season, such as frosts and drought, are thought to limit the distribution of pinyon-juniper woodlands to relatively narrow altitudinal belts on mountainsides. Soils supporting this 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 the southern portion of the Colorado Plateau 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 where sympatric.
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 lower elevations ranging from 1,500 m–2,440 m.
Subnations: AZ, CO, NM, UT

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 (Shrub-dominated); 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 most commonly found along dry foothills, lower mountain slopes, and at the edge of the western Great Plains from approximately 2,000 m to 2,900 m in elevation, and are often situated above pinyon-juniper woodlands. Substrates are variable and include soil types ranging from calcareous, heavy, fine-grained loams to sandy loams, gravelly loams, clay loams, deep alluvial sand, or coarse gravel. The vegetation is typically dominated by *Quercus gambelii* alone or codominant 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 relatively 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

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 [Lowland]; Shrubland (Shrub-dominated); 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 broad basins between mountain ranges, plains, and foothills between 1,500 m and 2,300 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 1,500 m to 2,300 m elevation.
Subnations: CA, CO, ID, MT, NV, OR, UT, WA, WY

CES304.762 COLORADO PLATEAU MIXED LOW SAGEBRUSH SHRUBLAND
Division 304 (Inter-Mountain Basins); Shrubland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Lower Montane]; Lowland [Foothill]; Shrubland (Shrub-dominated); Ridge/Summit/Upper Slope; Temperate [Temperate Xeric]; Aridic
Concept Summary: This ecological system occurs in the Colorado Plateau, Tavaputs Plateau, and Uinta Basin in canyons, gravelly draws, hilltops, and dry flats at elevations generally below 1,800 m. Soils are often rocky, shallow, and alkaline. This type extends across northern New Mexico into the southern Great Plains on limestone hills. It includes open shrublands and steppe dominated by *Artemisia nova* or *Artemisia bigelovii* sometimes with *Artemisia tridentata* ssp. *wyomingensis* codominant. Semi-arid grasses such as *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii,* or *Poa fendleriana* are often present and may form a graminoid layer with over 25% cover.
Range: Occurs in the Colorado Plateau, Tavaputs Plateau, and Uinta Basin in canyons, gravelly draws, hilltops, and dry flats at elevations generally below 1,800 m.
Subnations: AZ, CO, NM

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 [Lowland]; Shrubland (Shrub-dominated); Toeslope/Valley Bottom; Alkaline Soil; Deep Soil; Xeromorphic Shrub
Concept Summary: This ecological system occurs throughout much of the western U.S. in Intermountain basins and extends onto the western Great Plains. It typically occurs near drainages on stream terraces and flats or may form rings around more sparsely vegetated playas. Sites typically have saline soils, a shallow water table and flood intermittently, but remain dry for most growing seasons. The water table remains high enough to maintain vegetation, despite salt accumulations. This 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

CES304.784 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 [Lowland]; Shrubland (Shrub-dominated); Alluvial flat; Alluvial plain; Plain; Alkaline Soil; Saline Substrate Chemistry; Calcareous; Silt Soil Texture; Clay Soil Texture; Xeromorphic Shrub; Dwarf-Shrub; *Atriplex* spp.
Concept Summary: This extensive ecological system includes open-canopied shrublands of typically saline basins, alluvial slopes, and plains across the Intermountain western 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 codominate 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 does not codominate. The herbaceous layer varies from sparse to moderately dense and is dominated by perennial graminoids such as *Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus* ssp. *lanceolatus, Pascopyrum smithii, Pleuraphis jamesii, Pleuraphis rigida, Poa secunda,* or *Sporobolus airoides*. Various forbs are also present.
Range: Intermountain western U.S., extending in limited distribution into the southern Great Plains.
Subnations: AZ, CA, CO, ID, MT, NM, 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; 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, wind-swept 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* or *Atriplex gardneri*. Other dominant or codominant dwarf-shrubs may include *Artemisia longifolia, Artemisia pedatifida,* 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. The herbaceous layer is typically sparse. Scattered perennial forbs occur, such as *Xylorhiza glabriuscula* and *Sphaeralcea grossulariifolia,* and the perennial grasses *Achnatherum hymenoides, Bouteloua gracilis, Elymus elymoides, Elymus lanceolatus* ssp. *lanceolatus, Pascopyrum smithii,* or *Sporobolus airoides* may dominate the herbaceous layer. In less saline areas, there may be inclusions 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. Annuals are seasonally present and may include *Eriogonum inflatum, Plantago tweedyi,* and the introduced annual grass *Bromus tectorum.*
Range: Occurs on gentle slopes and rolling plains in the northern Colorado Plateau and Uinta Basin on Mancos Shale and arid, wind-swept basins and plains across parts of Wyoming.
Subnations: AZ, CO, NM, UT, 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, Lowland]; Woody-Herbaceous; Temperate [Temperate Xeric]; Alkaline Soil; Aridic; Very Short Disturbance Interval; G-Landscape/High Intensity; Graminoid
Concept Summary: This ecological system occurs throughout the intermountain western U.S., typically at lower elevations on alluvial fans and flats with moderate to deep soils. This semi-arid shrub-steppe is typically dominated by graminoids (>25% cover) with an open shrub layer. Characteristic grasses include *Achnatherum hymenoides, Bouteloua gracilis, Distichlis spicata, Hesperostipa comata, Pleuraphis jamesii, Poa secunda,* and *Sporobolus airoides*. The woody layer is often a mixture of shrubs and dwarf-shrubs. Characteristic species include *Atriplex canescens, Artemisia tridentata, Chrysothamnus greenei, Chrysothamnus viscidiflorus, Ephedra* spp., *Ericameria nauseosa, Gutierrezia sarothrae,* and *Krascheninnikovia lanata*. *Artemisia tridentata* may be present but does not dominate. The general aspect of occurrences may be either open shrubland with patchy grasses or patchy open herbaceous layer. Disturbance may be important in maintaining the woody component. Microphytic crust is very important in some stands.
Range: Occurs throughout the Intermountain western U.S., typically at lower elevations.
Subnations: AZ, CA, CO, ID, MT?, NM, NV, OR, UT, WA, WY

CES304.001 GREAT BASIN SEMI-DESERT CHAPARRAL
Division 304 (Inter-Mountain Basins); Steppe/Savanna

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Lower Montane]; Lowland [Foothill]; Temperate [Temperate Continental];
Concept Summary: This system includes chaparral on sideslopes transitioning from low-elevation desert landscapes up into pinyon-juniper woodlands of the western and central Great Basin. There are limited occurrences extending as far west as the inner Coast Ranges in central California. These are typically fairly open-canopy shrublands with openings that are either bare or support patchy grasses and forbs. Characteristic species may include *Arctostaphylos patula, Arctostaphylos pungens, Ceanothus greggii, Ceanothus velutinus, Cercocarpus montanus var. glaber, Cercocarpus intricatus, Eriogonum fasciculatum, Garrya flavescens, Quercus turbinella, Purshia stansburiana*, and *Rhus trilobata*. *Cercocarpus ledifolius* is generally absent. Typical fire regime in these systems varies with the amount of organic accumulation.
Range: Occurs in western and central Great Basin and east to Colorado Plateau.
Subnations: CA, NV, UT, CO

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, Lowland]; Herbaceous; Temperate [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 1,450 m to 2,320 m (4,750–7,610 ft) elevation. These grasslands occur in lowland and upland areas and may occupy swales, playas, mesa tops, 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 codominated 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 1,450 m to 2,320 m (4,750–7,610 ft) in elevation.
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 [Lowland]; Playa; Temperate [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.
Comments: Bjork (1997) refers to these as vernal lakes in Washington; his one example was ditched and may be artificial. There might have been these in Grand Coulee prior to Columbia Basin irrigation project.
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

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

Spatial Scale & Pattern: Large patch.
Required Classifiers: Natural/Semi-natural; Upland
Diagnostic Classifiers: Lowland[Lowland]
Concept Summary: This widespread ecological 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 includes substrates derived 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 not to occur in either of those states.
Subnations: AZ, CA, CO, ID, MT, NM, NV, UT, WY

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 (Shrub-dominated); Ridge/Summit/Upper Slope; Sedimentary Rock; Temperate [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 include *Pinus edulis, Pinus ponderosa, Juniperus* spp., *Cercocarpus intricatus,* and other short-shrub and herbaceous species, utilizing moisture from cracks and pockets where soil accumulates.
Comments: Geographically restricted and distinct from the related, but broader 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

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.)
Diagnostic Classifiers: Montane [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 m to 2,800 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 stream banks. 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. Nonnative 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 m to 2,800 m.
Subnations: AZ, CO, ID, MT, NM, NV, OR, SD, UT, WY

CES306.833 ROCKY MOUNTAIN SUBALPINE-MONTANE RIPARIAN WOODLAND

Division 306 (Rocky Mountain); Woody Wetland

Spatial Scale & Pattern: Linear
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Diagnostic Classifiers: Montane [Upper Montane, Montane]; Forest and Woodland (Treed); Riverine / Alluvial; Short (<5 yrs) Flooding Interval; RM Subalpine/Montane Riparian Shrubland
Concept Summary: This riparian woodland system is comprised of seasonally flooded forests and woodlands found at montane to subalpine elevations of the Rocky Mountain cordillera, from southern New Mexico north into Montana, and west into the Intermountain region and the Colorado Plateau. It occurs throughout the interior of British Columbia and the eastern slopes of the Cascade Mountains. This system contains the conifer and aspen woodlands that line montane streams. These are communities tolerant of periodic flooding and high water tables. Snowmelt moisture in this system may create shallow water tables or seeps for a portion of the growing season. Stands typically occur at elevations between 1,500 m and 3,300 m (4,920–10,830 ft), farther north elevation ranges between 900 m and 2,000 m. This is confined to specific riparian environments occurring on floodplains or terraces of rivers and streams, in V-shaped, narrow valleys and canyons (where there is cold-air drainage). Less frequently, occurrences are found in moderate-wide valley bottoms on large floodplains along broad, meandering rivers, and on pond

or lake margins. Dominant tree species vary across the latitudinal range, although it usually includes *Abies lasiocarpa* and/or *Picea engelmannii*; other important species include *Pseudotsuga menziesii, Picea pungens, Picea engelmannii X glauca, Populus tremuloides,* and *Juniperus scopulorum*. Other trees possibly present but not usually dominant include *Alnus incana, Abies concolor, Abies grandis, Pinus contorta, Populus angustifolia, Populus balsamifera ssp. trichocarpa*, and *Juniperus osteosperma*.
Range: This system is found at montane to subalpine elevations of the Rocky Mountain cordillera, from southern New Mexico north into Montana, Alberta and British Columbia, and west into the Intermountain region and the Colorado Plateau.
Subnations: AB, AZ, BC, CO, ID, MT, NM, NV, OR, SD, 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 [Lowland]; Shrubland (Shrub-dominated); 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, nonnative 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 western U.S. extending east into the western Great Plains.
Subnations: AZ, CA, CO, ID, MT, NV, OR, UT, WA, WY

CES300.729 NORTH AMERICAN ARID WEST EMERGENT MARSH
Division 303 (Western Great Plains); Herbaceous Wetland

Land Cover Class: Herbaceous Wetland
Spatial Scale & Pattern: Small patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Diagnostic Classifiers: Herbaceous; Depressional [Lakeshore, 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*).
Comments: This ecological system occurs in the arid and semi-arid regions of western North America, where semipermanently flooded habitats are found as small patches in the matrix of a relatively dry landscape.
Range: Occurs throughout much of the arid and semi-arid regions of western North America.
Subnations: AB, AZ, BC, CA, CO, ID, MT, MXBC, MXCH, MXSO, ND, NE, NM, NV, OK, OR, SD, TX, UT, WA, WY

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.)
Diagnostic Classifiers: Montane [Montane, Lower Montane]; Cliff (Landform); Cliff (Substrate); Sedimentary Rock; Temperate [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 canyonlands with perennial water sources (seeps) forming pocketed wetlands and draping vegetation across wet cliff faces. Three main garden types exist: alcove, terrace, or windowblind. Each is determined by the nature of the geological formation and the presence or absence of joint systems. They tend to occur at all exposures of the canyon walls, but they are always shaded for much to most of each day. Temperature and humidity are relatively stable compared to the surrounding environment. Most hanging gardens are dominated by herbaceous plants, and a number of these are endemic to this region. Common species include *Adiantum capillus-veneris*, *Adiantum pedatum*, *Mimulus eastwoodiae*, *Mimulus guttatus*, *Sullivantia hapemanii*, *Cirsium rydbergii*, and several species of *Aquilegia*.
Range: Colorado Plateau.
Subnations: AZ, CO, NV?, UT

Appendix B

Plot, Observation Point, Accuracy Assessment Point Instructions and Data Forms

Appendix B.1. 2003 Plot and Observation Point Field Sampling Manual

A Basic Guide for Fieldwork
USGS/NPS Vegetation Mapping Program

This document is intended to give you general instructions and guidelines for conducting your fieldwork at Colorado National Monument. Detailed, field-by-field coding conventions for the primary form you'll be completing in the field (the plot survey form) are provided in the "cheat sheet" at the back of this guide. You will also be taking Observation Points on a form reduced from and similar to the plot survey form, it will be provided in the field. An Accuracy Assessment Point form—another form reduced from and similar to the Plot Survey form, will also be provided in the field.

OVERVIEW

The data that you collect this year will be used to create a relatively fine-scale delineation of vegetation pattern in this Northern Colorado Plateau Network (NCPN) park and its environs. The range of habitats and the corresponding diversity of vegetation types, found in this park are complex. The understanding of finer-scale, ecologically distinct vegetation types that you will help create may be used by the monument to plan appropriate management activities, monitor the results of these activities, track long-term changes in vegetation, direct searches for rare species, model fire behavior, and portray the wealth of natural diversity on park lands to the public.

Establishing a field sampling strategy that captures—in only one field season—sufficient data on all the distinct vegetation types in Colorado National Monument, an area that is very diverse and rugged, is a challenge. To make the sampling as efficient as possible, the key environmental variables thought to be driving vegetation pattern were identified. These included factors such as geology, soils, aspect, hydrology, elevation, and land use/fire history (see TNC 1998).

Initial sampling will be conducted using combinations of aerial photographs, geology maps, and topographic maps to adequately and thoroughly sample the vegetation using standard vegetation plots and ancillary observation points. A classification based on this sampling will result in interpretation of aerial photos to produce a vegetation map that will be assessed for accuracy the following field season. The photo interpreters will supply Mylar overlays with polygons delineated for accuracy assessment work. A combination of manual and electronic delineation and digitizing approaches, as well as on-screen and automated photo interpretation techniques, will be used for Colorado National Monument to delineate polygons and label the vegetation types. The vegetation "types" the photo interpreters will choose to name their polygons are those included in the preliminary classification of the parks vegetation created using the U.S. National Vegetation Classification System (Grossman et al. 1998).

The field crew will evaluate the field data, assign a preliminary vegetation type based on a list of potential vegetation types developed from the existing literature, and update the tally of vegetation types by number of plots still needed. The goal is to use your time as efficiently as possible: we are trying our best to avoid oversampling of some types and undersampling of others. Deciding where to sample to capture the full range of diversity throughout the park is going to be very much an iterative process as the field season goes along!

GETTING THERE

You will have a Digital Ortho Quarter Quad (DOQQ) print and a copy of the 1:12,000-scale aerial photography to guide you. You and your partner will navigate towards each selected photo-signature

using your park road and trail map, USGS 7.5 mm. topographic map, the DOQQ, and/or GPS. The DOQQ's will have roads and trails highlighted on them to help you as well.

Before you leave…check that you have all the materials needed to complete your field work (Please see the checklist and 'considerations for mission planning" at the end of this document to help you).

Every single morning…check your GPS receiver to make sure it is set to NAD 83.

Along the way...look around. The goal of this fieldwork is to sample all the different vegetation types that occur in Colorado National Monument. If, on the way to one vegetation type, 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. In this park, these undescribed vegetation types are more likely various pinyon – juniper woodland understories, herbaceous types, or shrublands. You will be better able to recognize these undescribed vegetation types as the season progresses and you become more familiar with the vegetation types and how they can look on the ground.

ONCE THERE

Establishing a Plot

1) Figure out where to place your plot. This 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 signature as a whole. In other words, avoid areas where the vegetation appears to be transitioning from one type to another (ecotones) and areas with anomalous or heterogeneous structure or species composition. Look at *all* the vegetation strata to determine if the area is structurally and floristically uniform and generally try to place your plots at least 30 m from what you see as the "boundary" between this vegetation type and any neighboring, distinctly different types. During the training period this step will be emphasized and discussed in detail. However, the rule-of-thumb is to conduct a reconnaissance of the plot area if time and topography allows.

Note: In cases where a signature is very heterogeneous, more than one plot or a plot and observation points may be needed. Again, look around, use that human perception.

2) Using your GPS (Global Positioning System) receiver, record the UTM (Universal Transverse Mercator) coordinates in the center of the plot under the Field UTM X and Field UTM Y on the field form. Also mark and label the location of the plot on a USGS 7.5 min. topographic map and/or on an aerial photo. If you cannot obtain a GPS reading, estimate UTMs from the USGS topographic map and note on the form that you had to resort to this method. Plots may be circular, rectangular or square. Note shape and dimensions on the field form. If the plot is rectangular or square, record the azimuth of the long side (any side if square) to help relocate the plot. It may make more sense to establish rectangular plots in linear vegetation types (e.g. riparian or ridgeline types). Standard plot sizes should be as follows:

If you're in a ...	You should usually make your plot…	Giving you a plot area of…
Forest (i.e., trees have their crowns overlapping, usually forming 60%–100% cover)	11.3 m radius OR 20 m x 20 m	400 m^2 400 m^2
Woodland (i.e., open stands of trees with crowns usually not touching. Canopy tree cover is 25%–60% OR exceeds shrub, dwarf-shrub, herb, and nonvascular cover).	11.3 m radius OR 20 m x 20 m	400 m^2 400 m^2
Shrubland (i.e., shrubs greater than 0.5 m tall are dominant, usually forming more than 25% cover OR exceeding tree, dwarf shrub, herb, and nonvascular cover)	11.3 m radius OR 20 m x 20 m	400 m^2 400 m^2
Dwarf-shrubland (heath) (i.e., Shrubs less than 0.5 m tall are dominant, usually forming more than 25% cover OR exceeding tree, shrub, herb, and nonvascular cover).	5.65 m radius OR 10 m x 10 m	100 m^2 100 m^2
Herbaceous (i.e., Herbs dominant usually forming more than 25% cover OR exceeding tree, shrub, dwarf-shrub, and nonvascular cover).	5.65 m radius OR 10 m x 10 m	100 m^2 100 m^2
Nonvascular (i.e., nonvascular cover dominant usually forming more than 25% cover).	2.82 m radius OR 5 m x *5* m	25 m^2 25 m^2

Note: You can deviate from the standard plot *shapes* where that makes sense, but the total plot *area* encompassed by the boundaries should be as listed above for each major class of vegetation. For example, forested riparian vegetation may be sampled in a more linear 10 m x 40 m (400 m^2) plot; herbaceous riparian or ridgeline vegetation in a 2 m x 50 m (100m^2) plot. You may also increase the size of the plot to the next standard size if necessary to sample the heterogeneity of the vegetation. Forests, woodlands and shrublands can be increased to 1000 m^2. Please make a note on plot form.

3) Once the plot is established, it is generally a good time to fill out the Identifiers/Locators part of your Plot Survey Form (see the cheat sheet) and take the plot photos. In Colorado National Monument we will be taking 40-second, 360° motion pictures from plot centers (but not for observation points or accuracy assessment points) for fire fuels documentation.

Taking photographs

Two color photos will be taken of each plot using slide film. The purpose is to obtain a good representation of the vegetation of the plot, not individual species. A piece of paper (or a chalk board or dry erase board) should be placed in the plot, with the plot number recorded on it, so that the photo includes the plot number. Preprinted plot numbers could be printed or copied onto colored paper (white has such strong contrast as to be unreadable in the photo) and attached to the back of a clipboard. This saves having to write plot numbers in the field. Take the photograph looking across the contour if plot is steep. Record roll #, frame # and azimuth on plot form.

Shooting Movies

A movie of 40 seconds duration will be taken outward from each vegetation plot center so that a full 360^{o} scan of the plot and its adjacent vegetation are recorded. Movies will not be taken on observation points or on accuracy assessment points, only classification plots. To begin, the plot signboard is recorded for identification of the movie segment, then the Nikon Coolpix camera is rotated at shoulder height at a speed that covers approximately 10 seconds per plot quadrant. These data are stored on a standard memory card and downloaded electronically onto the local server following each trip to the field. Remember to have extra memory cards, as the movies require a lot of storage space. If you are in dense vegetation at the plot center, please move to a nearby clearing so that stand structure can be recorded for future viewing by fire personnel.

Data Collection

Environmental Description

See the coding instructions at the end of this document for guidance on the specific fields.

Vegetation Description

For guidance on the specific fields on the second page of the form, see the coding instructions.

As you begin to collect the species, DBH (diameter at breast height – 4.5'), and cover information, keep these rules in mind they will speed your data collection considerably:

1) Except in very diverse plots, don't spend more than 20 minutes looking for new and different species to record. Remember that these plot data are to be used to classify the overall vegetation of the monument, not to make a complete species list for it. And 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. For diverse plots with over 25 taxa you may take up to 30 minutes on the listing process.

2) If you can't identify a plant to species, record it on your form as "unknown species 1,' "unknown species 2,' "*Carex* unknown sp. I", etc. Record associated cover class and other data for the unknown as you would for any other species. Then do one of two things:

If you need the species identified right away because it appears to be dominant or diagnostic (you're seeing it all over the place or you're seeing much more in this particular vegetation type than in others), take a sample of the species with as much of the plant as possible, especially intact sexual parts (flowers and fruits), if present. Place the sample in a baggie, and label the baggie (or specimen) with the plot code and the name you gave it on the data form.

If you don't need the plant keyed right away, press it. Mark the pressed specimen with the plot code and the name you gave it on the data form.

Store specimens in a cool, dry place. Bagged specimens will keep fresh longer in the refrigerator or ice chest until pressed or identified. You can, of course, key some of these out yourself if you want to, but don't let plant keying get in the way of your primary responsibility: field data *collection.* No one expects you to identify every plant but you should make an effort to learn at least the species that keep recurring in plots. A quick prioritization of what to key and what to press can be made based on the recurrence of the species in samples and on the cover-class estimate of the species in a particular plot. If the species has a high cover value (>1%) it is more of a priority to identify. Field crews should mark the specimen tag with its cover class estimate as well as its unique identifying number for the vegetation sample.

Observation Point Form

When you have sampled one particular vegetation type thoroughly, but want to further define its distribution or when you encounter small but unique vegetation patches that are below the minimum mapping unit in size (<1.5 ha), record the site on an observation point form. This is an abbreviated plot survey form and usually takes about 15 minutes to fill in the data. The major difference is that an observation point is unbounded and includes an area roughly equal to that of the minimum mapping unit (40 m radius around the observer) or it encompasses the entirety of a small but unique vegetation patch. The data fields are the same as those on the plot survey form, so use the above instructions. Minor differences in the observation point form from the plot survey form include the elimination of some data fields, more general cover classes for ground cover estimates, and only the dominant or diagnostic species are recorded. Also, only one photo is taken to record the observation point plant community.

Accuracy Assessment Point Form

You will navigate to pre-selected coordinates within polygons, scout out the polygon briefly to get a feel for what it is like, and record some general data to characterize it on an accuracy assessment point form. This is also an abbreviated version of the plot survey form, much like the observation point form, and the same cheat sheet can be used to help with filling it out. A sample completed accuracy assessment point form is provided at the end of this document.

We hope you find your field season on the northern Colorado Plateau enjoyable and rewarding. Best of luck!

LITERATURE CITED

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INSTRUCTIONS FOR FILLING OUT FIELDS IN THE PLOT AND OBSERVATION POINT SURVEY FORMS

PLOT DESCRIPTION

Plot Code

Code indicating the specific plot within the vegetation polygon. For the 2003 field season, the codes will be in the following format "PARK ACRONYM.XXX" (i.e., "Colorado National Monument = COLM.XXX"). Begin with COLM.00l and go from there. If another team is working, decide with them which plot numbers each team will use to identify the data they gather. For example, if a second team is working one week at Colorado National Monument and approximately 100 plots have already been collected, they may sample plots COLM.200 through COLM.215.

Provisional Community Name

Using the provisional classification of the parks with which you've been provided, assign the name of the vegetation type that most closely resembles this type. Enter the finest level of the classification possible. In fact, *none* of the names may be a good fit; you may have found a new type. If that is the case, create a provisional name with the dominant and diagnostic species. The 'provisional community name' that is assigned will be used to update the tally of types x number of plots needed.

State CO

Park Name COLM

Park Site Name

Provisional name assigned by field worker that describes where the data were collected. It should represent an identifiable feature on a topographic or park map.

Quad Name

Appropriate name/scale from survey map used; use 7.5-minute quadrangle if possible.

Quad Code

Code of quadrangle map.

Field UTM X

Use GPS, but if you can't obtain a GPS reading, estimate coordinates from a topographic map and note on the form that this method was used.

Field UTM Y

Use GPS, but if you can't obtain a GPS reading, estimate coordinates from a topographic map and note on the form that this method was used.

GPS Error

Note the error in the GPS reading off the unit.

Survey Date

Date the survey occurred: year, month, day.

Surveyors
Names of surveyors, with principal surveyor (usually the lead ecologist) listed first.

Directions to Plot
Precise directions to the site using a landmark (e.g., a named point on the topographic map, a major highway, using park naming conventions for roads) readily locatable on a 7.5-minute topographic or park 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 as closely as possible to the 0.1 mile and use compass directions. Give additional directions to the plot within the site. Do not take more than a couple of minutes to fill this out.

Plot Length and Plot Width
Enter diameter for circular plots and width and length dimensions for square or rectangular plots. Choose the appropriate plot size based on the following:

Vegetation Class	Standard Plot Dimensions	PLOT AREA
Forest	11.3 m radius or 20 m x 20 m	400 m^2
Woodland	11.3 m radius or 20 m x 20 m	400 m^2
Shrubland	11.3 m radius or 20 m x 20 m	400 m^2
Dwarf-shrubland	5.65 m radius or 10 m x 10m	100 m^2
Herbaceous	5.65 m radius or 10 m x 10 m	100 m^2
Nonvascular	2.82 m radius or 5 m x *5* m	25 m^2

Plot Photos / Roll Number/Frame Numbers
Indicate (Y or N) if photos of the plot have been taken at the time of sampling, and the roll and frame numbers of any photos. Also record azimuth of the photo if not taken in the standard direction.

Plot Permanent (if/when applicable)
Check off that the plot has been permanently marked.

Plot Representativeness
Does this plot represent the full variability of the photo signature? If not, were additional plots taken? Note additional species not seen in the plot in the space provided below. Note: we distinguish in this section the plot's ability to represent the stand or polygon you are sampling as one component and the ability of this sample to represent the range of variability of the association in the entire mapping area. The former comment may be ascertained by reconnaissance of the stand. The latter comment comes only after some familiarity with the vegetation type throughout the mapping area and may be left blank if you have no opinion at this time.

ENVIRONMENTAL DESCRIPTION
Elevation
Elevation of the plot. Specify whether in feet or meters (this will depend on the units used on the GPS or on the topographic map being used). In general, we have determined that the reading you get from a topographic map, provided you are certain where you are, is more accurate than the average reading from

the GPS unit. Thus, please attempt to estimate your elevation with the topographic map.

Slope
Measure the slope in degrees using a clinometer.

Aspect
Measure the slope aspect using a compass (be sure to correct for the magnetic declination). Note: all compasses should be pre-set to an average declination for the park and thus, readings from the compasses carried by the field crews may be directly noted.

Topographic Position
Topographic position of the plot. Choose one:

INTERFLUVE (crest, summit, ridge). Linear top of ridge, hill, or mountain; the elevated area between two fluves (drainageways) that sheds water to the drainageways.

HIGH SLOPE (shoulder slope, upper slope, convex creep slope). Geomorphic component that forms 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). Level top of a plateau.

MIDSLOPE (transportational midslope, middle slope). Intermediate slope position.

BACKSLOPE (dipslope). Subset of midslopes that are steep, linear, and may include cliff segments (fall faces).

STEP IN SLOPE (ledge, terraeette). 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, commonly gentle and linear and characterized by alluvial deposition.

LOW LEVEL (terrace). Valley floor or shoreline representing the former position of an alluvial plain, lake, or shore.

CHANNEL WALL (bank). Sloping side of a channel.

CHANNEL BED (narrow valley bottom, gully, arroyo, wash). Bed of single or braided watercourse commonly barren of vegetation and formed of modern alluvium.

BASIN FLOOR (depression). Nearly level to gently sloping, bottom surface of a basin.

Landform

Enter the landform that describes the site where the plot was taken. Note on the code sheet the landform choices are listed at different scales. Thus, one can select more than one for plot if appropriate (e.g., mountain could be macro and ridge could be meso scale). You can develop your own list for COLM. Please be consistent so we can analyze by landform.

arroyo	lowland
alluvial fan	mid slope
alluvial flat	mountain
alluvial terrace	mud flat
bajada	noseslope
bank	piedmont
basin	plain
bench	plateau
butte	ravine
channel	ridge
cinder cone	rim
cliff	rock fall avalanche
colluvial slope	saddle
debris slide	seep
depression	shoreline
drainage	sinkhole (undifferentiated)
drainage channel (undifferentiated)	slide
dune (undifferentiated)	slope
escarpment	slough
flood plain	soil creep slope
foothills	stream terrace (undifferentiated)
gap	streambed
gorge	swale
hills	talus
hogback	toeslope
interfluve	valley floor
lake	wash

Surficial Geology

Note the geologic substrate influencing the plant community (bedrock or surficial materials). Accurately recording the geology at the plot is especially important if the plot is on an inclusion in the type on the geology map. The list below provides types from the COLM geology map.

Colorado National Monument Geology Map Units

artificial-fill	alluvium
floodplain and stream channel deposits	valley fill deposits
river gravel deposits	young fan alluvium and debris flow deposits
younger alluvial slope deposits	older alluvial slope deposits
local gravel deposits	colluvium, undivided
rockfall deposits	younger landslide deposits
older landslide deposits	sheetwash deposits
eolian sand	eolian sand and sheetwash deposits
Cienega deposits	Mancos shale
Dakota Formation	Burro Canyon Formation
Brushy Basin Member of the Morrison Formation	Salt Wash Member of the Morrison Formation
Tidwell Member of the Morrison Formation	Wanakah Formation
Board Beds unit of the Entrada sandstone	Slick Rock Member of the Entrada sandstone
Wanakah Formation and Entrada sandstone, undivided	Kayenta Formation
Wanakah Formation and Entrada sandstone and Kayenta Formation, undivided	Wingate sandstone
Chinle Formation	Lamprophyre dikes
meta-igneous gneiss	migmatitic meta-sedimentary rocks

Cowardin System

If the system is a wetlands, check off the name of the USFWS system which best describes its hydrology and landform. Indicate “upland” if the system is not a wetlands.

Assess the hydrologic regime of the plot using the descriptions below (adapted from Cowardin et al. 1979).

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. Includes Cowardin’s Intermittently Exposed and Semipermanently Flooded modifiers.

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. Includes Cowardin’s Seasonal, Seasonal-Saturated, and Seasonal-Well Drained modifiers.

SATURATED - Surface water is seldom present, but substrate is saturated to surface for extended periods during the growing season. Equivalent to Cowardin’s Saturated modifier.

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. Equivalent to Cowardin’s Temporary modifier.

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. Equivalent to Cowardin's Intermittently Flooded modifier.

PERMANENTLY FLOODED - Water covers the land surface at all times of the year in all years. Equivalent to Cowardin's "permanently flooded."

UNKNOWN - The water regime of the area is not known. The unit is simply described as a non-tidal wetland.

Environmental Comments
Enter any additional noteworthy comments on the environmental setting. This field can be used to describe site history such as fire events (date since last fire or evidence of severity) as well as other disturbance or reproduction factors.

Unvegetated Surface
Estimate the approximate percentage of the *total* surface area covered by each category. Only include categories with over 5% cover.

Soil Texture
Using the key below, assess average soil texture.

Simplified Key to Soil Texture (Brewer and McCann 1982)

Al Soil does not remain in a ball when squeezed .....sand

A2 Soil remains in a ball when squeezed .....B

Bl Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you push up over your finger.
Soil makes no ribbon .....loamy sand

B2 Soil makes a ribbon; may be very short.....C

C1 Ribbon extends less than 1 inch before breaking..... D

C2 Ribbon extends 1 inch or more before breaking.....E

D1 Add excess water to small amount of soil
Soil feels at least slightly gritty.....loam or sandy loam

D2 Soil feels smooth..... silt loam

E1 Soil makes a ribbon that breaks when 1 2 inches long;
Cracks if bent into a ring.....F

E2 Soil makes a ribbon 2+ inches long; does not crack when bent into a ring ..... G

Fl Add excess water to small amount of soil;
Soil feels at least slightly gritty..... sandy clay loam or clay loam

F2 Soil feels smooth.....silty clay loam or silt

G1 Add excess water to a small amount of soil;
Soil feels at least slightly gritty..... sandy clay or clay

G2 Soil feels smooth ….....silty clay

Soil Drainage

The soil drainage classes are defined in terms of (l) 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. It is recognized that 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. It is further recognized that soil profile morphology, for example mottling, normally, but not always, reflects soil moisture status. Although soil morphology may be a valuable field indication of moisture status, it should not be the overriding criterion. Soil drainage classes cannot be based solely on the presence or absence of mottling. Topographic position and vegetation as well as soil morphology are useful field criteria for assessing soil moisture status.

RAPIDLY DRAINED - The soil moisture content seldom exceeds field capacity in any horizon except immediately after water addition. Soils are free from any evidence of gleying throughout the profile. Rapidly drained soils are commonly coarse textured or soils on steep slopes.

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 ft, but may be mottled below this depth. B horizons, if present, are reddish, brownish, or yellowish.

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 ft. 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.

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 Ac horizon, if present, may be mottled. The matrix generally has a lower chroma than in the well-drained soil on similar parent material.

POORLY DRA1NED - 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.

VEGETATION DESCRIPTION

Leaf Phenology

Select the value which best describes the leaf phenology of the dominant stratum. The dominant stratum is the uppermost stratum that contains at least 10% cover.

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 generally contribute 25%–75% of the total woody cover. Evergreen and cold-deciduous species admixed.

PERENNIAL - Herbaceous vegetation composed of more than 50% perennial species.

ANNUAL - Herbaceous vegetation composed of more than 50% annual species.

Leaf Type

Select one value which best describes the leaf form of the dominant stratum. The dominant stratum is the uppermost stratum that contains at least 10% cover.

BROAD-LEAVED - Woody vegetation primarily broad-leaved (generally contributes greater than 50% of the total woody cover).

NEEDLE-LEAVED - Woody vegetation primarily needle-leaved (generally contributes greater than 50% cover).

MICROPHYLLOUS - Woody cover primarily microphyllous.

GRAMINOID - Herbaceous vegetation composed of more than 50% graminoid/stipe leaf species.

FORB (BROAD-LEAF-HERBACEOUS) - Herbaceous vegetation composed of more than 50% broad-leaf forb species.

PTERIDOPHYTE - Herbaceous vegetation composed of more than 50% species with frond or frond-like leaves.

Physiognomic Class Choose one.

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 25% cover). Shrub cover may be less than 25% where it exceeds tree, dwarf-shrub, herb, and nonvascular cover, respectively. Vegetation dominated by woody vines is generally treated in this class.

Dwarf-shrubland Low-growing shrubs usually under 0.5 m tall. Individuals or clumps overlapping to not touching (generally forming more than 25% cover, trees and tall shrubs generally less than 25% cover). Dwarf-shrub cover may be less than 25% where it exceeds tree, shrub, herb, and nonvascular cover, respectively

Herbaceous Herbs (graminoids, forbs, and ferns) dominant (generally forming at least 25% cover; trees, shrubs, and dwarf-shrubs generally with less than 25% cover). Herb cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and nonvascular cover, respectively.

Nonvascular Nonvascular cover (bryophytes, non-crustose lichens, and algae) dominant (generally forming at least 25% cover). Nonvascular cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and herb cover, respectively.

Sparse Vegetation Abiotic substrate features dominant. Vegetation is scattered to nearly absent and generally restricted to areas of concentrated resources (total vegetation cover is typically less than 25% and greater than 0%).

Strata/Lifeform, Height, Cover, Diagnostic Species

Visually divide the community into vegetation layers (strata). Indicate the average height class of the stratum in the first column, using the Height Scale on the form. Enter the average percent cover class of the whole stratum in the second column, using the Cover Scale on the form. Height and Cover classes are also listed below. 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.

Herbaceous layers are: Ht = total, H1 = Graminoids (grass, sedge, rush), H2 = Forbs (Dicot herbaceous), H3 = Ferns and Fern allies, and H4 = tree seedlings. List the dominant species in each stratum. If a species present is known to be diagnostic of a particular vegetation type, list these as well, marking them with an asterisk.

Cover Scale for Strata		Height Scale for Strata	
T	<1%	01	<0.5 m
P	1-5%	02	0.5-1 m
1	5-15%	03	I-2 m
2	15-25%	04	2-5 m

3	25-35%	05	5-10 m
4	35-45%	06	l0-l5 m
5	45-55%	07	15-20 m
6	55-65%	08	20-35 m
7	65-75%	09	35-50 m
8	75-85%	10	>50 m
9	85-95%		
10	95+		

Animal Use Evidence
Comment on any evidence of use of the plot/polygon by non-domestic animals (i.e., tracks, scat, gopher or prairie dog mounds, etc.). Notes on domestic animals should be made in the field below.

Natural and Anthropogenic Disturbance
Comment on any evidence of natural or anthropogenic disturbance and specify the source.

Other Comments
Any other comments.

Species/DBH/Percent Cover Table
Starting with the uppermost stratum, list all the species present and cover class (using the 12 point scale) and percent cover of each species in that particular stratum. Indicate strata in the left-hand columns. If in the tree layer (single-stemmed woody plants, generally *5* m in height or greater at maturity), note in the "T" column if Tl (emergent tree), T2 (tree canopy), or T3 (tree sub-canopy). If in the shrub layer, note in the "5', column if S1 (tall shrub,> 2m), S2 (short shrub, <2m), or S3 (dwarf-shrub <0.5m). If in the ground layer, note in the "G" column if H1 (herbaceous - graminoid), H2 (herbaceous - forb), H3 (herbaceous - fern), H4 (tree seedlings) N (nonvascular other than ferns), V (vine/liana), or F (epiphyte).

*For plots with trees, estimate cover of seedlings, saplings, mature (all others), and total cover for each tree species. Use a separate line for each and assign the most appropriate strata class (by height). Seedlings are generally less than 1.5 m, but that may vary by species.

Also record the DBH (in cm) of all trees above *5* cm diameter. Separate the measurements with a comma. For plots with very high tree density DBH measurements will be done in a subplot. If the number of trees with a DBH greater than 5 cm is more than about 25, divide the plot into quarters and measure the DBH of trees in the southeast quadrant, or the quadrant nearest southeast. CLEARLY NOTE on the form that this is what you've done.

Appendix B.2. 2004 Accuracy Assessment Field Sampling Manual

Colorado National Monument
Northern Colorado Plateau Network

This manual documents accuracy assessment (AA) data collection procedures for Colorado National Monument (COLM). This project is directed by the Northern Colorado Plateau Network (NCPN) with assistance from engineering-environmental Management, Inc. (e^2M) and NatureServe.

OVERVIEW

The primary purpose of accuracy assessment (AA) 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 main uses of the AA data are:

- 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

There are a number of factors that contribute to error on a vegetation map and some of these are listed below. It is important for the field investigator to be aware of these situations and to take actions to minimize error when at all possible.

- Locational error (when it is not possible to acquire reliable UTM coordinates, the AA point data collected may look like it is in another polygon, or if the polygons are small/narrow and the GPS receiver isn't working well, it may be difficult to know which polygon is supposed to be sampled).
- Field key is difficult to use, leading the investigator to assign the point to the wrong association.
- Field key does not include all plant associations in the park, also leading to confusion in which 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 attribute is 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 heterogenous, including patches of varying vegetation that are too small to map individually. The AA point may happen to fall in a part of the polygon with a different community than observed by the photo interpreter in the bigger picture.

NAVIGATING TO A POINT

The field investigator will navigate to each selected AA point using a handheld GPS receiver and map consisting of a digital orthophoto (DOQQ) base overlaid with AA point locations, mapped vegetation polygons, and USGS 7.5 minute topographic quadrangle maps.

- The DOQQ map will identify the location of the AA points, as well as the location, size and shape of the polygons.
- Topographic maps are useful in identifying the landscape when navigating to a point, and in determining the elevation of a point. They are also helpful for obtaining names of topographic features used for assigning site names.
- GPS receivers indicate the direction and the distance (as the crow flies) to the AA point. This can obviously lead to trouble if one were to navigate as the crow flies to AA points, not being aware of canyons or other obstacles in the way. Use the DOQQ and topo maps to plan the route! ***Note***: *In very homogenous terrain, acquire the UTM coordinates of the field vehicle so one can find their way back!*

Use the GPS receiver to locate the point within 1 m of the UTM coordinates, but do not spend a lot of time trying to be exact. A 5000m^2 area around each AA point will be evaluated, which is the size of the project Minimum Mapping Unit (MMU = 0.5 ha). The MMU is the smallest area that the photo interpreters are required to map to vegetation class. (However, mappers can choose to delineate smaller polygons if the map class is distinctive). Typically the AA plot will be circular in shape (40 m radius), however, in some situations the plot shape will need to be varied to accommodate the map unit being sampled (e.g. a long-narrow riparian area).

At each AA point the investigator will key the vegetation to plant association using the field key. The MMU is a relatively large area - approximately the size of a football field with endzones (50 m x100 m rectangle, 71 m x 71 m square, 80 m diameter circle). The shape of the MMU may need to vary depending on the shape of the mapping polygon, but for large polygons, an 80 m diameter circle may be easiest. If the polygon is smaller than the MMU, evaluate the whole polygon

Along the way... Identify the mapping polygons where the target AA points are located 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 upon arrival at the point.

A word about safety… As with all fieldwork, navigation will occur through rough terrain, often off-trail, to reach the destination. However, particularly in AA work, there is a desire to reach as many points as possible in a day, and to get as close to each point as feasible. No AA point is worth risking ones health or life! Use good judgment. Alternate points will be provided in case an AA point cannot be reached due to difficult terrain or other reasons. If this happens, PLEASE document that the point was not reachable so that the effort is not repeated by someone else.

Occasionally the AA point will fall on the edge of two vegetation types or at the edge of a polygon. In these instances the field crew member will need to use judgment on how to record the data. If two distinct plant associations are present on a site record separate species lists for each of the communities on the field form. In addition, both types would be keyed and recorded on the field form. There will be many times where the point falls at the edge of a polygon. In selecting AA points, a 25 m buffer from the polygon edge is used to ensure that most AA points fall cleanly with the polygon boundaries. However, in some cases the AA point will partially include some of the adjacent polygon. In this situation the field crew member will need to clearly describe in the comments fields the situation and be clear about what is represented within and outside the polygon targeted for sampling.

INSTRUCTIONS FOR FILLING OUT FIELDS IN THE ACCURACY ASSESSMENT POINT SURVEY FORMS

This section documents field by field instructions for AA point data collection and serves as guidance for completing the AA Point Data Form. Upon arrival at an AA point location, the field investigator will take a waypoint with the GPS receiver. Please make sure the GPS receiver is set for NAD83, and that the WAAS is on (see 3D differential, below). UTM coordinates and other locational data will be recorded manually to serve as a backup in case of GPS receiver failure. Park-specific cheatsheets are provided at the end of this section to assist ecologists with AA point data collection.

IDENTIFIERS / LOCATORS SECTION

AA Point Code
AA point codes are derived from the codes assigned to points on the DOQQ photo map, with "_AA." inserted between the 4-letter park alphacode and point number. The four-letter park code for this project is COLM. An example of an AA point would be COLM_AA.0101. Please note that park-specific datasheets already have the parkcode and '_AA.' delimiter listed. The field investigator will only need to record the 4-digit AA point number on the form.

Quad Name
Record the full name of the 7.5-minute quadrangle.

County
Enter county in which AA point occurs, e.g., Mesa County.

State
Enter state in which AA point occurs, e.g., CO.

Park Site Name
This is best determined from the topographic map. Select a nearby feature that is an obvious waypoint, such as the name of a canyon, road, pinnacle, etc. This name does not need to be unique. If a number of AA points are sampled in a small area the same site name may be used for all of them.

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

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

AA Point Shape
Select one of the following choices to describe the AA plot shape: circular or other. In the case of other please provide dimensions and comments in the classification comments field below.

GPS File
Enter the name given to the waypoint when the AA point was marked in the GPS receiver. It would be useful to assign a name that incorporates the AA point number.

Field UTM X, Field UTM Y
Record the UTM easting and northing coordinates saved as a waypoint in the GPS receiver. 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 obtain UTM coordinates (the GPS receiver has to be able to "see" at least three or four satellites). If it is not possible to acquire UTM coordinates, or if the PDOP is greater than 8 (or EPE is greater than ±50m), first try to obtain a signal from a higher point nearby (but still close to) the AA point. If that fails then estimate the UTM coordinates from the digital orthophoto (NAD83), and manually enter them into the GPS receiver.

GPS Receiver
Record the name and model of the GPS receiver being used to record data for the AA point. If a GPS receiver was not used to determine UTM coordinates record 'none' here and be sure to complete the "GPS Comments" field below.

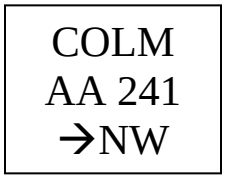
GPS Error
Note the "Estimated Position Error" (EPE) displayed on the GPS receiver. The lower the number the more accurate the reading.

3D Differential?
3D differential is obtained when the GPS receiver 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 the location coordinates are as accurate as possible. It is in geosynchronous orbit in the southern sky, so if the southern sky is visible, one will generally be able to acquire 3D differential. This system is known as the Wide-Area Augmentation System, or WAAS. Please make sure that WAAS is **always** on.

GPS Receiver Comments
VERY IMPORTANT: If the field investigator resorted to estimating the AA point location, UTM coordinates on the digital orthophoto, note that in this field. If the investigator had to leave the point to acquire a reading from a higher site, record that here, along with the compass bearing and distance of the GPS location from the point center.

Camera
Circle the appropriate camera name and model, or enter it next to "other" if it is not on the datasheet.

Taking Photographs
Expose two color slides of each AA point. The purpose is to acquire a good representation that accurately captures the vegetative stand of the AA point. If the area is heterogeneous please represent this in the photos. Try to include a little sky, approximately 10% sky, for perspective. Use a chalkboard to record the point number and the direction the photo is exposed. Thus, for AA point 241, the board in the photo taken from the SE facing NW across the point will read "COLM AA 241, →NW." Take the photographs looking across the contour if the AA point is on a steep slope. In addition, a photograph log for all photos not taken at AA points will need to be maintained. It is not anticipated that crews would routinely take additional photos, however, if a crew member finds a new vegetation type not previously described it would be good to document this situation with a photograph.



Photos: Type/Roll Number/Frame Number/Photographer/Direction and Comments
For each photo taken at the AA point 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 exposed from and towards (SE→NW) and any other comments to clarify contents of the photo.

ASSOCIATION INFORMATION SECTION

Primary Name, Secondary Name, Tertiary Name

Fill out this section last, after all the vegetation information is 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. A tertiary name field has also been provided for the few occasions where a third call is needed. If vegetation near the AA point does not key well, make the best effort 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 the selection and/or reasoning. If vegetation near the AA point does not fit the plant association key at all then create a new name using the dominant species of each stratum (as if for a plot). Provide information to characterize the new association in the comments field.

Is Primary/Secondary/Tertiary Name a New Association?

If the investigator encountered a new vegetation type and applied a new name (not in the field key) then please check the "box" to the right of the name indicating that the name is a new association.Please be sure to provide comments in the classification comments field.

Other Vegetation Associations Within 50 m

List other associations that are within 50 m of the outside border of the half-hectare AA point being evaluated.

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 plant 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 the investigator pay attention not only to the vegetation within the 0.5 ha sample area, but the larger area as well. For the primary plant association call please rank the representativeness of this AA point for the polygon (Good, Fair, Poor, or Unknown). Please note in the Classification Comments field if the AA point falls in an ecotone or inclusion, or in an anomalous situation such as in a gully or on a rock outcrop. If the polygon is extremely large and the observer is unable to make an assessment then please use the "unknown" field.

Fit of plant association to description in the key

The key does not provide a lot of descriptive information for each association, and is likely not to contain all the associations that may be encountered. Rank the representativeness of the AA point's association to the description in the key (Good, Fair, Poor). It would also be helpful to note specific suggestions on how to make the key work better. It will provide information for improving the key for the final report.

ENVIRONMENTAL DESCRIPTION SECTION

Elevation

Record the elevation of the AA point from the GPS receiver in feet/meters. Specify on the data sheet whether the measurement is in feet or meters, and whether it was obtained from a GPS receiver or a map.

Slope

Measure the slope in degrees using a clinometer. The degree scale is the left-hand scale when looking through the clinometer. If the slope varies at the point then estimate an average. If the point is on rolling microtopography, enter “variable.” Record any explanation in the Environmental Comments field.

Aspect
Measure 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 point wraps around different aspects on a slope, enter “variable” and describe further in the Environmental Comments section.

Topographic Position
This is the position of the point on its related landform. Determining this requires the investigator to think of the landform in cross-section, which is roughly diagramed on the back of the cheat sheet. One of the terms listed below **must** be used:

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 that best describe the site where the AA point is located. Referring to the topo map for the landscape context may help the investigator determine 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, the AA point may be on a ledge on the rim of a canyon. A suggested list of landforms and definitions is provided in attachment A. *Note: The topographic position selected above should relate to the scale of the landform chosen here.*

Surficial Geology
List the primary geologic substrate where the AA point occurs. A list of geologic types is provided on a cheatsheet at the end of this document. The geology map should help, but if one is unable to decipher the geology, then provide a general description (e.g., coarse sandstone, green shale, aeolian sands or obscured by soils).

Environmental Comments
Enter 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 good 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 the following: bedrock; litter/duff; wood (>1cm); large rocks (cobbles, boulders >10 cm); small rocks (gravel 0.1 cm–10 cm); sand (0.1 mm–2.0 mm); bare soil; other (please specify). For this estimation use the cover classes listed on the form. If an unvegetated surface category is not present in the 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 plant-dominated AA points.

Evergreen. Greater than 75% of the total woody cover is never without green foliage. (Some tricky examples: most *Artemisia, Ephedra,* and all *Atriplex* except *A. canescens,* all *Chrysothamnus*).
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 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% 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% 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 is seen at the AA point when 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 or annual 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%–7% and greater than 2%. Badlands or 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.

Begin by assessing the strata at the AA point . 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 pine or cottonwood trees would be a good example of T2 ”canopy,” but where they are absent then begin with the shrub stratum, or herbaceous stratum if no shrubs are present. If the tree crowns at the AA point are mostly touching and similar in height, but a given tree species is much taller that species would be a T1 “emergent.” As another example, a sample area may be characterized by several tall scattered cottonwoods and then shorter scattered junipers. In this case, the cottonwoods would be the “canopy” and the junipers would be the “subcanopy.” There may also be cottonwoods listed in the “subcanopy” layer, if there are a number of short 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 *Amelanchier utahensis.*
S2 Short Shrub: <2 meters tall. For example, *Artemisia,* all *Atriplex* except *gardneri* (which are dwarf).
S3 Dwarf-shrub: <0.5 meters tall. For example, *Gutierrezia, Opuntia polycantha.*
H Herbaceous: All herbaceous species including graminoids, forbs, ferns, and fern allies.
H4 Tree Seedlings: Seedlings are trees with vertical stems < 1.5 m tall, but that may vary by species (e.g., does not always apply to pinyon – juniper).
N Nonvascular: This is mainly dark cyanobacteria, mosses and lichens.

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), sagebrush 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., response of some plants to fire) 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 are placed in the T2 category. About the only rule regarding height should be that the tree layer is (usually) higher than the tall shrub layer that 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 2 m tall, they all are rolled into the tall shrub stratum. There are two exceptions: (1) each height class covers more than 10% of a point, 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 having some crew members calling *Leptodactylon* a forb and some calling it a dwarf-shrub. Same for snakeweed, *Eriogonum microthecum*, fringed sagewort, *Brickellia* and any number of other species. Consult the master plant species lists when in doubt. Crew members should keep the master plant list and strata assignments updated.

COMPLETING THE SPECIES/STRATA TABLE

Dominant Species

List the dominant plant species using full scientific name by the strata listed below for each AA point. In some cases, due to severe drought conditions of recent years, a dominant species on the site may have experienced severe levels of mortality. In this case please record "DEAD" in front of the scientific name and enter the cover value, independent of any live cover value for the same species. During data entry back in the office there will be a check field to use for "DEAD." It is also important to document these relationships in the comments field.

T1	Emergent	S3	Dwarf-shrub
T2	Canopy	H	Herbaceous
T3	Sub-canopy	H4	Tree Seedlings
S1	Tall Shrub	N	Non-vascular
S2	Short Shrub		

Diagnostic Species

Mark species that characterize the stand with an '*'.

Height Class
Use the height class code from the list below that best describes the overall height of each plant species within a given stratum.

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

Cover Class.
For each plant species use the cover class codes listed below to estimate overall canopy cover for each species listed on the form.

T	<1%	04	36-45%
P	1-5%	05	46-55%
1a	6-10%	06	56-65%
1b	11-15%	07	64-75%
02	16-25%	08	76-85%
03	26-35%	09	86-95%

Percent (%) Cover
Estimate the percent aerial cover (T-100%) for each plant species recorded in the far right hand column on the form.

If the 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 the AA point form. These will both be entered into the database for that AA point.

COLORADO NATIONAL MONUMENT – AA CHEAT SHEET

LANDFORMS

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 deposit
eolian sands
ephemeral
stream
escarpment
falling dune
finger ridge
flat
flood plain
foothills
gorge
gravel pit
gulch
gully
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

TOPOGRAPHIC POSITION

SEE THE ATTACHED DIAGRAM

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
H = herbaceous
H4 = Tree seedlings
N = nonvascular other than ferns

PARK SPECIALS (keep an eye out for)

Hanging Gardens
Invasive tamarisk

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
Wooded Herbaceous: Trees= grass/forbs
Sparsely Vegetated: Total veg<5-7%

ASPECT

Flat
Azimuth (deg.)
Variable

GPS SETTINGS

NAD1983
WAAS on

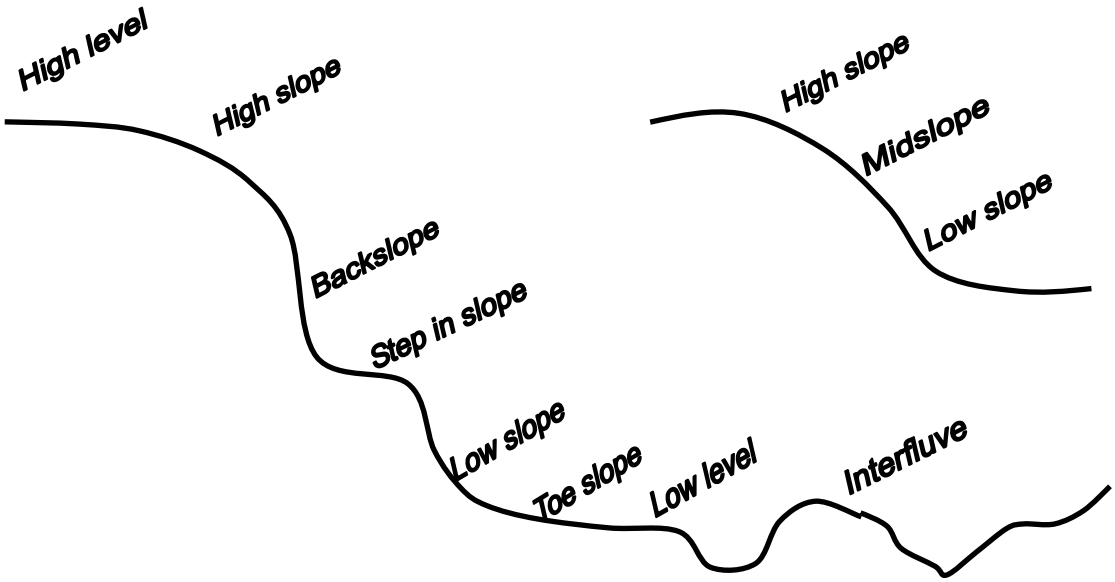
SURFICIAL GEOLOGY

Obscured by soil
Aeolian sands
Alluvial deposits
Artificial Fill
Older Alluvium (pre Holocene)
Talus / Colluvium / Landslides
Burro Canyon Formation
Chinle Formation
Colluvium
Dakota Formation
Entrada Sandstone
Entrada Sandstone – Board Beds Unit
Entrada Sandstone – Slickrock Member
Kayenta Formation
Lamprophyre dikes
Mancos Shale
Meta-igneous gneiss
Migmatitic meta-sedimentary rocks
Morrison Formation
Morrison Formation – Brushy Basin
Morrison Formation – Salt Wash Mem.
Morrison Formation – Tidwell Member
Older Alluvial Deposits
Older Landslide Deposits
Rockfall Deposits
Sheetwash Deposits
Terrace gravel deposits
Valley Fill
Wanakah Formation
Wingate Sandstone
Younger Landslide Deposits

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

TOPOGRAPHIC POSITION - CHEAT SHEET



CONSIDERATIONS FOR PLANNING

Planning for the day:

1. Safety and sustenance: Plenty of food, water, first-aid kit, raingear, sunscreen.
2. Field communications:
3. Develop a plan with other team(s) for radio check-in time.
4. 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?
5. Make sure you have the right maps and photos.
6. Check your GPS (Datum set to NAD83? WAAS on? Needs new batteries?).
7. Plan the day's mission before departing using a) USGS quads, b) aerial photos, c) BLM maps.
8. Considerations for mission planning:
   a. Plan travel based on topography, best access routes, density and complexity of vegetation
   b. Communicate with the other team member(s) to make sure you aren't duplicating effort.

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 receiver
- Extra AA batteries for walkie talkie
- Radio or walkie talkie and/or cell phone
- 35 mm camera & slide film (allow at least one exposure per AA point)
- Baggies for temporary storage of unknown plants, and masking tape for labeling
- Plant press & paper
- Plant Keys / Flora(s)
- Pencils / sharpies / spare pencil lead and erasers
- Forms: AA point and observation point
- Clipboard/forms holder
- Slate board, chalk, and chalkboard eraser or supply of clean rags
- Key to the plant associations of the park
- 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.)

ATTACHMENT A: Landform Glossary
(http://soils.usda.gov/technical/handbook/contents/part629glossary1.html)

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 U.S.. 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 m (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%. 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 m – 90 m) or *high hill* (90 m – 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 m – 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 floodplain 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 floodplain 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 U.S.; 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 m above surrounding lowlands, usually with a nominal summit area relative to bounding slopes and generally with steep sides (greater than 25% 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 floodplain 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 floodplain by floodwaters that cannot be contained within the stream channel.

overflow stream channel - A watercourse that is generally dry but conducts flood waters that have overflowed the banks of a river, commonly from large storms or annual meltwater.

oxbow - A closely looping stream meander having an extreme curvature such that only a neck of land is left between the two parts of the stream. (colloquial: northeastern A.) the land enclosed, or partly enclosed, within an oxbow. 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 U.S.) 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, U.S.) 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 mountainside 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-year 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 floodplain, floodplain steps, and, in some areas, low terrace surfaces. Compare - floodplain 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 U.S.) 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 m – 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 B.3. Example of a Vegetation Plot Data Form

NATIONAL PARK VEGETATION MAPPING PROGRAM: PLOT SURVEY FORM
IDENTIFIERS/LOCATORS

Plot Code: COLM 113 BPU Code NONE

Provisional Community Name MIXED MOUNTAIN SHRUB / HERBACEOUS

State CO Park Name COLORADO NM Park Site Name MONUMENT MESA

Quad Name COLORADO NATIONAL MONUMENT Quad Code _____ Quad Code _____ Aerial Photo # 1302-48

GPS file name CP 113 Field UTM X 698090 m E Field UTM Y 4325571 m N
DATUM NAD83 UTM Zone: (12) / 13 (circle one) Error +/- 5.0 m 3D Differential? Y / (N)
Comments/GPS device used:

Survey Date 5 16 03 Surveyors B. CONDIE S. TOPP

Directions to Plot ABOUT 2.2 KM FROM LIBERTY CAP TRAIL HEAD

Plot Permanent: NO

Plot length(m)_____ Azimuth _____ Plot Photos (y/n) __ Roll # BS 1 Frame # 35,36
Plot width(m)_____ Diameter if circle 22.6 Digital camera frame # 85

Photo Comments: Cryptogamic Soils Photos (y/n) __ Roll # _____ Frame # _____
Digital camera frame # _____

Plot representativeness (discuss plot placement and explain non-representativeness)
a. Representativeness of association compared with occurrences outside park (if known):

b. Representativeness of plot in stand: THIS SLOPE AND ASPECT OF THIS HILLSIDE ARE QUITE HOMOGENOUS. SCATTERED P.J. VARY A LITTLE IN DENSITY.

ENVIRONMENTAL DESCRIPTION 1945 m

Elevation: 6380 (ft) m (circle one) Slope: 28 deg. Aspect: 5 deg.
Topographic Position (see cheat sheet) MIDSLOPE
Landform (see cheat sheet) RAVINE
Surficial Geology (see cheat sheet/map) TIDWELL MEMBER OF THE MORRISON FORMATION

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

Environmental Comments (factors controlling community/plant distribution, seral stage, fire history etc):
THIS HILLSIDE IS STILL CREEPING, BUT MAYBE A LITTLE LESS THAN THE LAST PLOT. THANKS TO ABUNDANT GRASS HERE. PIÑON AND JUNIPER SEEDLINGS PRESENT.

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

25	Bare soil	4	Large rocks (>10 cm)
0	Bedrock	1	Lichen ON ROCK
0	Sand (0.1-2 mm) dune /alluvium	3	Wood (>1 cm)
0	Moss	27	Small rocks (0.2-10 cm)
	Other (describe):	0	Water
30	Litter / duff	0	~~Cryptogam~~ CYANO
	10 LIVE VEG BASAL		

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

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

VEGETATION DESCRIPTION 113

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic Class	Height Scale for Strata	Cover Scale for Strata
Trees and Shrubs __Evergreen X Cold-deciduous __Mixed evergreen-cold-deciduous Herbs __Annual __Perennial	X Broad-leaved __Needle-leaved __Microphyllous __Graminoid __Forb __Pteridophyte __Non-vascular __Mixed (describe)	__Forest __Woodland X Shrubland __Dwarf Shrubland __Shrub Herbaceous __Herbaceous __Nonvascular __Sparsely Vegetated	01 <0.5 m 02 0.5-1m 03 1-2 m 04 2-5 m 05 5-10 m 06 10-15 m 07 15-20 m 08 20-35 m 09 35 – 50 m 10 >50 m	T 0-1% P >1-5% 1 >5-15% 2 >15-25% 3 >25-35% 4 >35-45% 5 >45-55% 6 >55-65% 7 >65-75% 8 >75-85% 9 >85-95% 10 > 95%

	Height Class	Cover Class	Dominant Species (mark Diagnostic species with *)
T1 Emergent			
T2 Canopy	04	P	PIN EDU, JUN OST
T3 Sub-canopy			
S1 Tall shrub	03	2	CER MON, AME UTA
S2 Short Shrub	02	P	EPH VIR
S3 Dwarf-shrub	01	T	OPU FRA, SCL WHI
Ht Herbaceous		2	
H1 Graminoids	01	2	ELY SAL
H2 Forbs	01	T	ALE EAS
H3 Ferns			
H4 Tree seedlings	02	T	PIN EDU, JUN OST
N Non-vascular			
V Vine/liana			
E Epiphyte			

Animal Use Evidence (including scat, browse, burrows, bedding sites, etc)
GAME TRAIL THROUGH PLOT.

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 HILLSIDE SHOWS FEWER SIGNS OF CREEPING THAN THE LAST PLOT, POSSIBLY BECAUSE OF MORE VEG, BUT ITS STILL HAPPENING HERE A LITTLE. THE BIG SHRUBS HAVE A FEW DEAD STICKS IN THE - MAYBE BECAUSE OF PAST DROUGHT.

Other Comments/Continuation from previous sections. **Describe surrounding communities and how they relate to the plot.**
A GREAT SPOT FOR SIDE BY SIDE PLOTS! EVERYTHING ABOUT 112 AND 113 IS THE SAME EXCEPT ASPECT. WHAT A DIFFERENCE THIS HAS ON THE VEG. THE "LIVE VEG BASAL" PERCENTAGE ON GROUND COVER IS DRIVEN UP BY ALL THE BUNCH GRASSES. FLAT AREA BEHIND US (SOUTH) IS OPEN P.J. WOODLAND. SOME SNOWBERRY PLANTS NEAR RAVINE BOTTOM OUTSIDE OF PLOT

Plot Code: COLM. 113

Species/percent cover: Starting with the uppermost stratum, list all species with % cover for each species in the stratum. For each tree species estimate seedling, sapling, and total cover indicating stratum. **List species outside the plot at the end of the table and designate with a 0 in Cover Class column.**

Stratum	Species Name	Cover Class	Stratum	Species Name	Cover Class	Stratum	Species Name	Cover Class	TOTALS
T2	PINEDU	P	H1	ELYSAL	2				
↓	JUNOST	P	↓	POA ~~sec~~ fen	T				
S1	CERMON	1							T1=
↓	AMEUTA	P							T2=
									T3=
									S1=
									S2=
S2	EPHVIR	P							S3=
↓	YUC HAR	T							H1=
									H2=
									H3=
S3	SCL WHI	T							H4=
↓	OPU ERA	T							N=
									V=
									E=
H2	ALE EAS	T							
	DES PIN	T	H4	JUNOST	T				
	PHL LON	T	↓	PINEDU	T				
	PRABA Cp.	T							
	Arabis sp.	T							
	ERY ASP	T							
	CHOTEN !	T							
↓	ANTennaria sp.	T							

Cover Class Scale:
T = >0-1%
P = >1-5%
1 = >5-15%
2 = >15-25%
3 = >25-35%
4 = >35-45%
5 = >45-55%
6 = >55-65%
7 = >65-75%
8 = >75-85%
9 = >85-95%
10 = >95%

Strata:
T1 = Emergent
T2 = Canopy
T3 = Subcanopy
S1 = Tall Shrub
S2 = Short Shrub
S3 = Dwarf Shrub
H1 = Graminoid
H2 = Forb
H3 = Fern
H4 = Tree seedling
N = Nonvascular
V = Vine/liana
E = Epiphyte

Appendix B.4. Example of an Observation Point Data Form

NATIONAL PARK VEGETATION MAPPING PROGRAM: OBSERVATION POINT FORM

IDENTIFIERS/LOCATORS 326

Plot Code: COLM .9038 Polygon Code:

Provisional Community Name: Rabbitbrush Shrubland

State: CO Park Name: COLORADO NM Park Site Name: Monument Valley

Quad Name: CO National Monument Quad Code:

GPS File Name: COCM-0-038 Field UTM X: 698671 mE Field UTM Y: 4330434 mN

Please do not complete the following information when in the field: dop = 0.3 +/-50 m

Corrected UTM X: mE Corrected UTM Y: mN Zone: 12S

Observers: SB, JVL Date: 6/11/03 Photos: COCM 4-28

ENVIRONMENTAL DESCRIPTION

Elevation: 4770' Slope: 1 deg. Aspect: 135° deg.

Topographic Position: Low level

Landform: Valley Bottom Geology: Holocene alluvium

Cowardin Wetland Classification System

- X Upland
- ___ Estuarine
- ___ Riverine
- ___ Palustrine
- ___ Lacustrine

Hydrologic Regime - Non Tidal

- ___ Permanently Flooded
- ___ Semi-permanently Flooded
- ___ Seasonally/Temporarily Flooded
- ___ Saturated
- ___ Seasonally Flooded/Saturated
- ___ Intermittently Flooded

Environmental Comments: The rabbitbrush occupies the margin of the drainage, but the drainage bottom is barren, ~8 m wide. A few stalk juniper trees on the upper bank above the rabbit brush.

Unvegetated Surface (*please use cover scale below*)

01	Bedrock	01	Bare Soil
02	Rocks >10 cm	01	Litter/Duff
03	Rocks 0.2-10 cm	01	Wood
01	Sand	01	live wood
___	Other (describe)	01	wood

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic Class	Cover Scale for Strata and Unvegetated Surface
Trees and Shrubs	X Broad-leaved	___ Forest	01 = 0 - 10%
___ Evergreen	___ Needle-leaved	___ Woodland	02 = 10 - 25%
X Cold-deciduous	___ Microphyllous	X Shrubland	03 = 25 - 60%
___ Drought-deciduous	___ Graminoid	___ Dwarf shrubland	04 = 60 - 100%
___ Mixed evergreen/ cold-deciduous	___ Forb	___ Shrub Herbaceous	
	___ Pteridophyte	___ Herbaceous	
Herbs	___ Mixed (describe)	___ Nonvascular	
___ Annual		___ Sparsely vegetated	
___ Perennial			

NATIONAL PARK VEGETATION MAPPING PROGRAM: OBSERVATION POINT FORM

Stratum	Height	Cover Class	Dominant species (mark diagnostic spp with a *)	% cover
T1: Emergent				
T2: Canopy				
T3: Sub-canopy				
S1: Tall shrub				
S2: Short shrub	02	01	* ~~Chry~~ Ericameria nauseosa	8
			Artemisia tridentata tri	<1
			Ephedra viridis	<1
			Opuntia erinacea	<1
H: Herbaceous	01	01	~~St~~ Hesperostipa comata	<1
			Bromus tectorum	<1
			Bromus japonicus	<1
			Bromus (diandrus?)	1
			Pascopyrum smithii	<1
			Oenothera pallida	<1
N: Non-vascular				
V: Vine/liana				
E: Epiphyte				

Height Scale for strata:		Cover scale for strata and Unvegetated Surface:	
01 = <0.5 m	06 = 10-15m		
02 = 0.5-1m	07 = 15-20m	01 =	0 - 10%
03 = 1-2m	08 = 20-35m	02 =	10 - 25%
04 = 2-5m	09 = 35-50m	03 =	25 - 60%
05 = 5-10m	10 = >50m	04 =	60 - 100%

Appendix B.5. Example of an Accuracy Assessment Data Form

ACCURACY ASSESSMENT POINT FORM

IDENTIFIERS/LOCATORS

Field Point Code COLM. AA- 124 Database Point Code _____

State: CO Park Name: COLM Park Site Name UTE CANYON

Quad Name COL. NAT. MON. Quad Code _____

Primary Name Veg Assoc: SALIX EXIGUA / MESIC GRAMINOIDES SHRUBLAND

Secondary Name Veg Assoc: _____

Other Veg Assoc within 50 m: 1) _____ 2) _____

3) _____ Other Map Unit within 50m _____

Classification Comments: STAND IS UNIFORM ALONG CHANNEL WITH SCATTERED POPULUS FREMONTI OR ACER GLABRUM TREES. TWO ISOLATED ACER + ONE POPULUS TREE OCCUR IN THIS PLOT.

GPS file name _____ Field UTM X 6 9 8 3 3 4 m E Field UTM Y 4 3 2 3 7 6 8 m N

GPS Error 9 m m

Field Photo Notes: ABS 17 18

Please do not complete the following information when in the field

Corrected UTM X _____ m ECorrected UTM Y _____ m N

UTM Zone 12S

Survey Date 28.07.04 Surveyors BUECHLING

ENVIRONMENTAL DESCRIPTION

Elevation 1808 m Slope 2° Aspect 141°

Topographic Position LOW LEVEL

Landform CHANNEL (CANYON BOTTOM).

Environmental Comments (including hydrology):

THIS SITE IS SUPPORTED BY A HIGH WATER TABLE + IS INTERMITTENTLY FLOODED.

SOILS ARE MESIC + POORLY DRAINED.

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

0 Bedrock
02 Litter, duff
01 Wood (> 1 cm)
0 Large rocks (cobbles, boulders > 10 cm)
0 Small rocks (gravel, 0.2-10 cm)
0 Sand (0.1-2 mm)
01 Bare soil
0 Other: _____

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	HEIGHT (M) SCALE	COVER SCALE
Trees and Shrubs ___Evergreen ✓ Cold-deciduous ___Drought-deciduous ___Mixed evergreen - cold-deciduous ___Mixed everg. - drought-deciduous Herbs ___Annual ___Perennial	✓ Broad-leaved ___Needle-leaved ___Mixed broad-lvd/Needle-lvd ___Microphyllous ___Graminoid ___Forb ___Pteridophyte	___Forest ___Woodland ✓ Shrubland ___Dwarf-shrubland ___Herbaceous ___Nonvascular ___Sparsely Vegetated	01 -<0.5 02 - 0.5-1 03 - 1-2 04 - 2-5 05 - 5-10 06 - 10-15 07 - 15-20 08 - 20-35 09 - 35-50 10 ->50	T-<1% 01-1-5% 02-6-15% 03-16-25% 04-26-35% 05-36-45% 06-46-55% 07-56-65% 08-65-75% 09-76-85% 10-86-95% 11-96-100%

Strata	Height Class	Cover Class	Dominant species (mark any known diagnostic species with a *)	Cover Class
T1 Emergent				
T2 Canopy	06	03	ACER GLABRUM	8
			POPULUS ~~FREMONTII~~ deltoides ssp. wislizenii	2-3
T3 Sub-canopy				
S1 Tall shrub	04	07	* SALIX EXIGUA	65
S2 Short Shrub				
S3 Dwarf-shrub				
H Herbaceous	01	03	SPOROBOLUS AIROIDES	3-4
			* EQUISETUM LAEVIGATUM	8
			BROMUS TECTORUM	4
N Non-vascular				
V Vine/liana				
E Epiphyte				

Appendix C

Plots Database Documentation

Background

This database, designed for data resulting from fieldwork related to vegetation mapping projects, was developed by the Northern Colorado Plateau Network (NCPN). The Plots Database System, developed by The Nature Conservancy, was the starting point for this database. From this starting point, NCPN normalized the data structure, added fields and lookup tables, and developed an extensive user interface. Similar versions of this database, subsequently referred to as the COLM VegMapDB, have been used for all vegetation mapping projects conducted by NCPN. COLM VegMapDB contains plot, observation point, and accuracy assessment data collected during project field work.

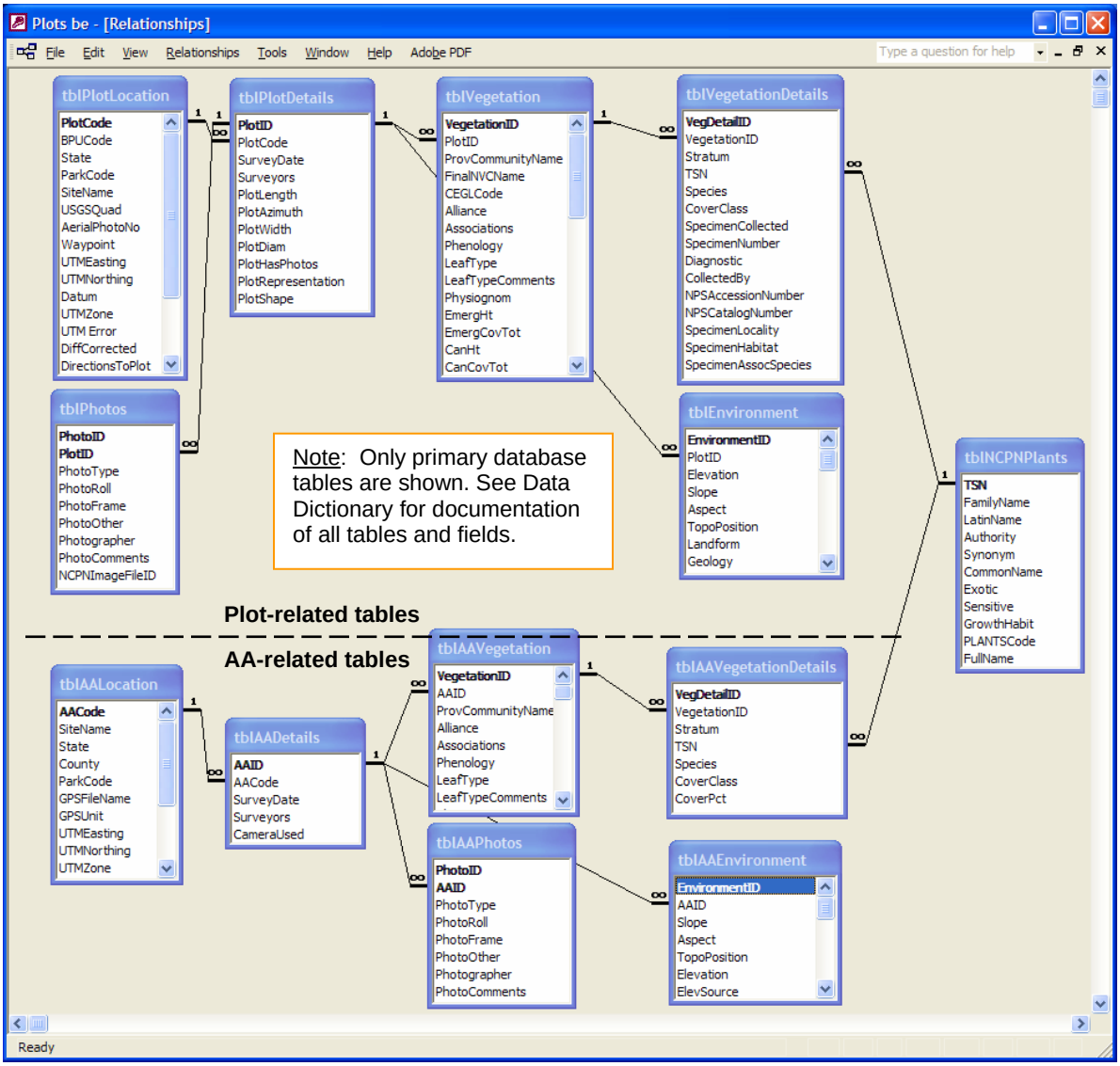
Two database files are required to use COLM VegMapDB:

- *COLM_PlotsAA_XP.mdb.* This "frontend" file contains all queries, forms, reports, associated modules and Visual Basic code.
- *COLM_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 back-end 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 (COLM_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.



0Figure 1. Entity Relationship Diagram for COLM 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: tblDataMgmtLog
Description: Table containing a log of data set manipulations or database object alterations (also used with accuracy assessment data).

Field Name	Field Description	Field Type	Field Width
ActionDate	The date on which the data set was massaged or manipulated.	dbDate	8

Field Name	Field Description	Field Type	Field Width
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, massaged, manipulated, etc. Include changes to data and changes to database objects or structures.	dbMemo	0
Who	The name of the person who performed the action with the data set.	dbText	50

Table Name: tbl_Final_Classification
Description: Final determination of plot vegetation association, as determined by NatureServe

Field Name	Field Description	Field Type	Field Width
ID	Unique record identifier	dbLong	4
PlotCode	Plot code	dbText	255
Final NVC Name	Name of plot vegetation association; assigned by NatureServe	dbText	255
CEGLCode	CEGL Code	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
Slope	Slope of plot measured in degrees	dbLong	4
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	50
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	dbText	3

Field Name	Field Description	Field Type	Field Width
	ground cover		
Litter	Estimate to the nearest percentage of litter ground cover	dbText	3
Rocks	Estimate to the nearest percentage of rocks >10cm wide ground cover	dbText	3
Lichen	Estimate to the nearest percentage of lichen ground cover	dbText	3
Wood	Estimate to the nearest percentage of wood >1cm ground cover	dbText	3
Gravel	Estimate to the nearest percentage of rocks <10cm wide ground cover	dbText	3
Water	Estimate to the nearest percentage of water ground cover	dbText	3
Cryptogam	Estimate to the nearest percentage of cryptogram ground cover	dbText	3
SoilTexture	Assessment of average soil texture from sample taken a few inches below the surface; values selected from tlkpSoilTexture	dbText	50
SoilDrainage	Soil drainage class based on actual moisture content and extent period; values selected from tlkpSoilDrainage	dbText	30
AnimalUseComments	Comments on evidence of use by non-domestic animals in plot area	dbMemo	0
DisturbanceComments	Comments on evidence of natural or anthropogenic disturbance in plot area, severity and effects on vegetation	dbMemo	0
OtherComments	Other general comments	dbMemo	0
LandscapeComments	Description of landscape context of plot, including any important landscape features influencing the community	dbMemo	0
SoilTaxonDesc	Field used for either identifying soils keyed, or to describe if large rocks or outcrops are present on the surface	dbText	255
LiveVegLitter	Estimate to the nearest percentage of live veg litter ground cover	dbDouble	8
LiveVegWood	Estimate to the nearest percentage of live veg wood ground cover	dbDouble	8
LichenRocks	Estimate to the nearest percentage of lichen covering rocks	dbDouble	8
LichenGround	Estimate to the nearest percentage of lichen ground cover (on the soil, associated with cryptogams)	dbDouble	8
MossPct	Estimate to the nearest percentage of moss ground cover	dbDouble	8
DarkCyanobacteria	Estimate to the nearest percentage of dark cyanobacteria ground cover	dbDouble	8
TotalPct	Calculated total percent ground cover.	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

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 COLM plots	dbText	3
PJPhotoGuide	n/a for COLM plots	dbText	3
SBPhotoGuide	n/a for COLM 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 COLM plots	dbText	3
LitterNorth	n/a for COLM plots	dbText	3
LitterEast	n/a for COLM plots	dbText	3
LitterSouth	n/a for COLM plots	dbText	3
LitterWest	n/a for COLM plots	dbText	3
DuffOrigin	n/a for COLM plots	dbText	3
DuffNorth	n/a for COLM plots	dbText	3
DuffEast	n/a for COLM plots	dbText	3
DuffSouth	n/a for COLM plots	dbText	3
DuffWest	n/a for COLM 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
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
WoodlandCrownWidth	n/a for COLM plots	dbDouble	8
WoodlandCrownHeight	n/a for COLM plots	dbDouble	8
ForestCrownBaseHeight	n/a for COLM plots	dbDouble	8
ForestCrownHeight	n/a for COLM plots	dbDouble	8
CrownRatio	n/a for COLM plots	dbText	12
StructureStage	n/a for COLM plots	dbText	12
Comments	n/a for COLM plots	dbText	255

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.	dbText	50
PhotoOther	Other unique identifier or reference number for digital photo or name of movie file.	dbText	25
Photographer	Name of photographer.	dbText	50
PhotoComments	Brief description of photo.	dbText	255
NCPNImageFileID	NCPN Photo Database file name	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	3
PlotAzimuth	Azimuth of plot; synonymous with aspect. One or the other, or both, can be used	dbText	3
PlotWidth	Width of plot, in meters	dbText	3
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

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	dbText	50
UTMNorthing	UTM northing of plot	dbText	7
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
DiffCorrected	Indicate if coordinates have been differentially corrected	dbText	3

Field Name	Field Description	Field Type	Field Width
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
FinalNVCName	Community name (final) assigned by NatureServe. Linked to tbl_Final_Classification	dbText	240
CEGLCode	CEGL Code	dbText	50
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. Field is blank for non-vascular plots	dbText	35
LeafType	Leaf form of the dominant stratum.	dbText	20
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 tllkPhysiogClass)	dbText	20
EmergHt	01<.5m 02=.5-1m 03=1-2m 04=2-5m 05=5-10m 06=10-15m 07=15-20m 08=20-35m 09=35-50m 10=>50m	dbText	2
EmergCovTot	Height class of emergent stratum (classes are in tlkpHeight)	dbText	2
CanHt	Height class of canopy stratum	dbText	2
CanCovTot	Cover class of canopy stratum	dbText	50
SubHt	Height class of subcanopy stratum	dbText	2
SubCovTot	Cover class of subcanopy stratum	dbText	2
TallShHt	Height class of tall shrub stratum	dbText	2
TallShCovTot	Cover class of tall shrub stratum	dbText	2
ShrubHt	Height class of short shrub stratum	dbText	2
ShrubCovTot	Cover class of short shrub stratum	dbText	2
DwarfHt	Height class of dwarf shrub stratum	dbText	2
DwarfCovTot	Cover class of dwarf shrub stratum	dbText	2
HerbHt	Height class of herbaceous stratum (all H layers)	dbText	2
HerbCovTot	Cover class of herbaceous stratum (all H layers)	dbText	2
GramHt	Height class of graminoid stratum	dbText	2
GramCovTot	Cover class of graminoid stratum	dbText	2
ForbHt	Height class of forb stratum	dbText	2
ForbCovTot	Cover class of forb stratum	dbText	2
FernHt	Height class of fern and fern ally stratum	dbText	2
FernCovTot	Cover class of fern and fern ally stratum	dbText	2
SeedlHt	Height class of seedling stratum	dbText	2
SeedlCovTot	Cover class of seedling stratum	dbText	2

Field Name	Field Description	Field Type	Field Width
NonvasHt	Height class of nonvascular stratum	dbText	2
NonvasCovTot	Cover class of nonvascular stratum	dbText	2
VineHt	Height class of vine stratum	dbText	2
VineTotCov	Cover class of vine stratum	dbText	2
EpiHt	Height class of epiphyte stratum	dbText	2
EpiTotCov	Cover class of epiphyte stratum	dbText	2

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 tllkStrata	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 tllkCover)	dbText	2
SpecimenCollected	Check yes if a specimen of the species was collected.	dbBoolean	1
SpecimenNumber	Enter the collector's reference number for the specimen collected.	dbText	50
Diagnostic	Check yes if the species is known to be diagnostic of the vegetation type.	dbBoolean	1
CollectedBy	Name of person collecting specimen	dbText	50
NPSAccessionNumber	NPS accession number assigned to specimen	dbText	50
NPSCatalogNumber	NPS catalog number assigned to specimen	dbText	50
SpecimenLocality	Brief description of location where specimen was collected, suitable for herbarium label	dbText	255
SpecimenHabitat	Brief description of habitat where specimen was collected, suitable for herbarium label	dbText	255
SpecimenAssocSpecies	Bried description of associated species where specimen was collected, suitable for herbarium label	dbText	255

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

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
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 ground cover	dbText	3
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

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
State	State where point is located	dbText	2
County	County where point 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 point is within park boundaries.	dbBoolean	1
GPSComments	Any brief comments on GPS data collection.	dbText	255

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	25
Photographer	Name of photographer.	dbText	50
PhotoComments	Brief description of photo.	dbText	255

Table Name: tblAAVegAssociation
Description: Vegetation association at AA location

Field Name	Field Description	Field Type	Field Width
VegAssocID	Unique record identifier	dbLong	4
AAID	Foreign key; provides link to tblAADetails	dbLong	4
VegAssocCode	Identification code of vegetation association; provided by NatureServe	dbText	25
VegAssocRank	Rank of vegetation association (primary, secondary, tertiary)	dbText	15

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
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 tllkPhysiogClass)	dbText	20
EmergHt	01<.5m 02=.5-1m 03=1-2m 04=2-5m 05=5-10m 06=10-15m 07=15-20m 08=20-35m 09=35-50m 10=>50m	dbText	2
EmergCovTot	Cover class of emergent stratum	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
HerbHt	Height class of herbaceous stratum	dbText	2
HerbCovTot	Cover class of herbaceous stratum	dbText	15
HerbCovPercent	[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
GramHt	Height class of graminoid stratum	dbText	2
GramCovTot	Cover class of graminoid stratum	dbText	15
GramCovPercent	[not used]	dbText	50

Field Name	Field Description	Field Type	Field Width
ForbHt	Height class of forb stratum	dbText	2
ForbCovTot	Cover class of forb stratum	dbText	15
ForbCovPercent	[not used]	dbText	50
FernHt	Height class of fern stratum	dbText	2
FernCovTot	Cover class of fern stratum	dbText	15
FernCovPercent	[not used]	dbText	50
SeedlHt	Height class of seedling stratum	dbText	2
SeedlCovTot	Cover class of seedling stratum	dbText	15
SeedCovPercent	[not used]	dbText	50
OutsidePlotHt	Height class of species occurring outside plot	dbText	50
OutsidePlotTotCov	Cover class of species occurring outside plot in plot (=0)	dbText	50
OutsidePlotTotPercent	[not used]	dbText	50
PlantSpeciesComments	Comments on plant species list	dbMemo	0
ClassificationComments	General comments on classification	dbMemo	0

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 tblVegetation	dbLong	4
Stratum	Strata class from tllkStrata	dbText	2
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS (Integrated Taxonomic Information System)	dbDouble	8
Species	Latin names of species, from tblNCPNPlants	dbText	100
CoverClass	Cover class to describe species and strata (from tllkCover)	dbText	5
CoverPct	[not used]	dbText	5

Lookup tables

Table Name: tblNCPNPlants
Description: Master look-up table for plant species names and taxonomic information. Derived from ITIS (USDA - 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: Look-up 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	for Plots: (t)= few, T =0-1%, P >1-5%, 1a >5-10%, 1b=10-15%, 02=15-25%, 03=25-35%, 04=35-45%, 05a=45-50%, 05b=50-55%, 06=55-65%, 07=65-75%, 08=75-85%, 09=85-95%, 10=>95% for Observation points: 01= 0-10%, 02=10-25%, 03=25-60%, 04=60-100%	dbText	50

Table Name: tlkpCowardin
Description: Look-up of Cowardin system catergories 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	50

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 07=15-20m 08=20-35m 09=35-50m 10=>50m	dbText	2

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/contents/part629glossary1.html).

Field Name	Field Description	Field Type	Field Width
Landform	Landforms from appendix 1 of field manual	dbText	50

Table Name: tlkpLeafPhen
Description: Look-up of phenology types to describe dominant stratum (from Veg Mapping 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 Veg Mapping 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 in the Northern Colorado Plateau network of I&M.

Field Name	Field Description	Field Type	Field Width
ParkCode	Four-letter abbreviation for park name	dbText	4
ParkName	Full name of park where data were collected	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: tlkpPlotShapes
Description: Look-up of shapes of plots.

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

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
StateName	Full name of each state in the USA	dbText	50

Table Name: tlkpStrata
Description: Look-up of strata classes in VegetationDetails (from Veg Mapping 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 names of data collection individuals for COLM 2003 field season.

Field Name	Field Description	Field Type	Field Width
SurveyorName	Full names of all surveyors who worked on data collection in COLM during the 2003 field season.	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	dbText	50

Field Name	Field Description	Field Type	Field Width
	point is located on its related landform.		

Table Name: tlkpUSGS_Quad
Description: Look-up of all 7.5 minute USGS quads for COLM.

Field Name	Field Description	Field Type	Field Width
USGSQuad	Names of all 7.5 minute USGS quads for COLM	dbText	50
USGSQuadCode	n/a for COLM	dbText	7

Table Name: tlkpUTMZone
Description: Look-up for UTM zone of COLM.

Field Name	Field Description	Field Type	Field Width
UTMZone	UTM zone where all COLM plots were collected	dbText	5

Background

The geodatabase was designed to consolidate all spatial and non-spatial (i.e., tabular) data from the COLM vegetation mapping project. In the geodatabase, feature classes were created for the spatial datasets, including plots, observation points, AA points, and polygons. These feature classes were then linked to the tables in the Plots database via relationship classes.

Entity Relationship Diagram

The primary tables and relationships for the geodatabase are illustrated below.

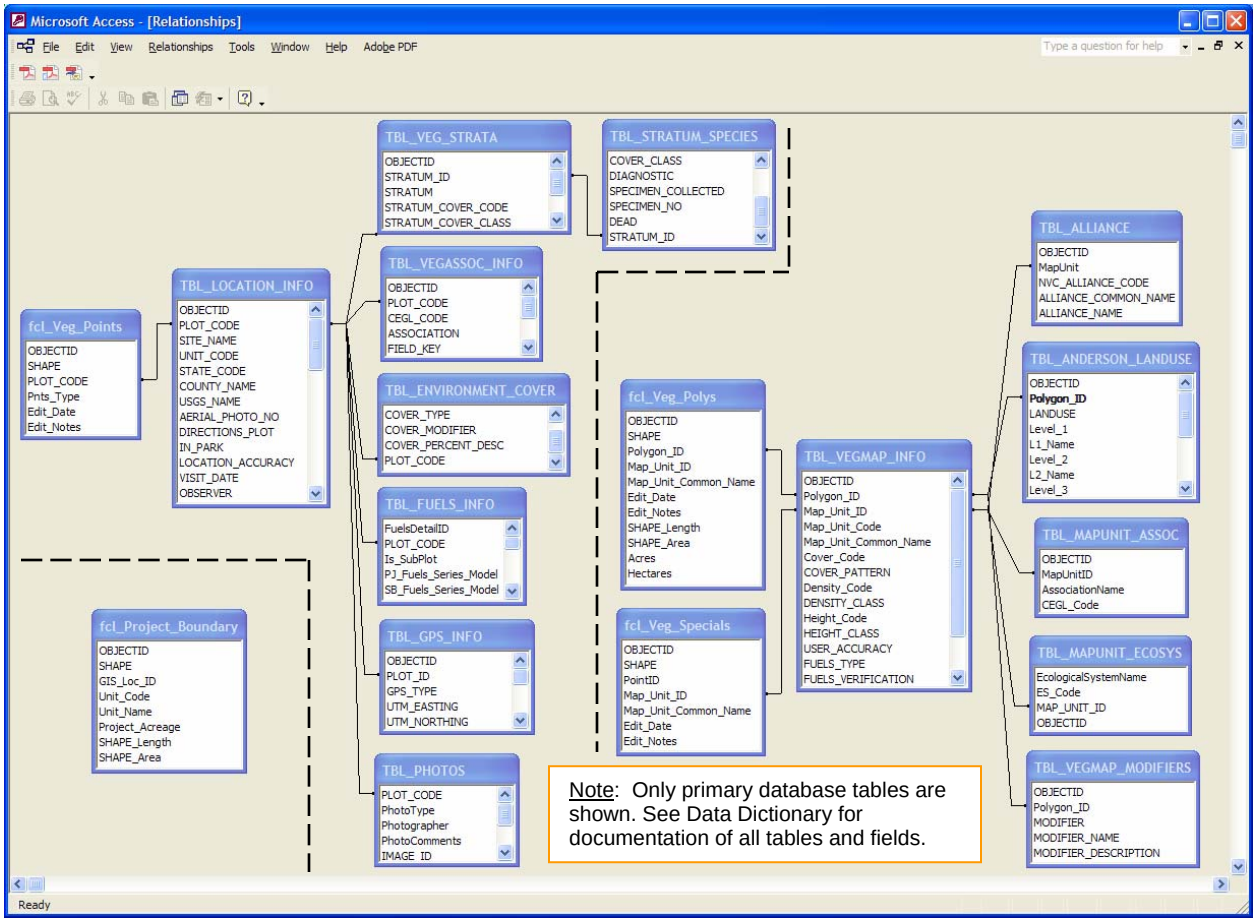


Figure 2. Entity Relationship Diagram for COLM Geodatabase

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 (COLM)	dbText	10
Unit_Name	Full name of national park (Colorado National Monument)	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
SHAPE_Length	ESRI generated	dbDouble	8
SHAPE_Area	ESRI generated	dbDouble	8
Acres	Acres per polygon, generated using ArcMap	dbDouble	8
Hectares	Hectares per polygon, generated using ArcMap	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

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 polygon or its attributes	dbText	20
Edit_Notes	Notes regarding any edits to the polygon 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)	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

Field Name	Field Description	Field Type	Field Width
COVER_TYPE	Ground cover type	dbText	30
COVER_MODIFIER	Estimate to the nearest percentage of ground cover type	dbText	10
COVER_PERCENT_DESC	Description of cover	dbText	255
PLOT_CODE	Unique Plot code, used for relating tables	dbText	12

Table Name: TBL_ENVIRONMENT_LANDFORM
Description: Contains landform data for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
LANDFORM	Landform on which plot is located, any landform could be entered by crew.	dbText	100
PLOT_CODE	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	20

Table Name: TBL_FUELS_INFO
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
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
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
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,	dbText	12

Field Name	Field Description	Field Type	Field Width
	seedling		
Comments	General comments regarding the fuels at a specific plot.	dbText	255

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 and model of GPS unit (e.g., Garmin Etrex)	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
SITE_NAME	General Site name given by field crew	dbText	255
UNIT_CODE	4 letter park code (COLM)	dbText	10
STATE_CODE	State (Colorado)	dbText	2
COUNTY_NAME	County where plot is located (Mesa County)	dbText	100
USGS_NAME	USGS 1:24k Topo Name	dbText	100
AERIAL_PHOTO_NO	9X9 photo name on which the point most directly falls	dbText	30
DIRECTIONS_PLOT	Directions to the location of the plot	dbText	255
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)	dbInteger	2
LOCATION_ACCURACY	Indicates general range of locational error of the point coordinates.	dbText	45
VISIT_DATE	Date the location was visited	dbText	8
OBSERVER	The names of the field crew member(s) observing the site.	dbText	50

Field Name	Field Description	Field Type	Field Width
PLOT_WIDTH	The width of the point	dbText	3
PLOT_LENGTH	The length of the point	dbText	3
PLOT_DIAMETER	The diameter of the point	dbText	5
PLOT_AZIMUTH	The azimuth of the point	dbText	5
PLOT_SHAPE	The shape of the area observed as a point	dbText	20
REPRESENTATIVENESS	The representativeness of the vegetation	dbText	255
ASPECT	Aspect of plot	dbText	50
ELEVATION	Elevation of plot in meters, created from 10 meter DEMs	dbDouble	8
SLOPE	Slope of plot measured in degrees	dbDouble	8
TOPO_POSITION	Topographic position of plot	dbText	50
SOIL_TEXTURE	Assessment of average soil texture from sample taken a few inches below the surface	dbText	50
COWARDIN_SYSTEM	If the plot is in a wetland system, select term that best describes its hydrology (Upland, Palustrine, Riverine, Lacustrine)	dbText	50
HYDROLOGY	Describes hydrology of plot	dbText	50
GEOLOGY	Geologic substrate influencing the plant community	dbText	50
SOIL_DRAINAGE	Soil drainage class based on actual moisture content and extent period	dbText	30
ENV_COMMENTS	Comments on environmental setting and its effect on the vegetation; also comments on any disturbance or reproduction factors	dbText	255
ANIMAL_USE_COMMENTS	Comments on evidence of use by non-domestic animals in plot area	dbText	255
DISTURBANCE_COMMENTS	Comments on evidence of natural or anthropogenic disturbance in plot area, severity and effects on vegetation	dbText	255
LANDSCAPE_COMMENTS	Description of landscape context of plot, including any important landscape features influencing the community	dbText	255
OTHER_COMMENTS	Other general comments	dbText	255
SOIL_TAXON_DESC	Field used for either identifying soils keyed, or to describe if large rocks or outcrops are present on the surface	dbText	255
ALLIANCE	Alliance corresponding to provisional community name	dbText	100
PROVISIONAL_COMM_NAME	Community name (provisional) assigned by field crews by following naming protocols as described in field manual and training (2004).	dbText	200
PHENOLOGY	Leaf phenology of the dominant stratum. Field is blank for non-vascular plots	dbText	200
LEAF_TYPE	Leaf form of the dominant stratum.	dbText	100
LEAF_TYPE_COMMENTS	If Leaf Type is "mixed," this field describes the multiple leaf types found in the dominant stratum.	dbText	255
PHYSIOGNOMIC_NAME	Physiognomic class of plot	dbText	100
PLANT_SPECIES_COMMENTS	Comments about the plant species observed.	dbText	200

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
AssociationName	The NVC Association name	dbText	250
CEGL_Code	NVC association code	dbText	30

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

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

Field Name	Field Description	Field Type	Field Width
PLOT_CODE	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	50
PhotoType	Type of photo being referenced (movie or jpeg).	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	Path to photos	dbText	200
OBJECTID	ESRI generated autonumber	dbLong	4

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.	dbBoolean	1
SPECIMEN_COLLECTED	"yes" if a specimen of the species was collected.	dbBoolean	1
SPECIMEN_NO	The collector's reference number for the specimen collected (n/a for COLM).	dbText	10
DEAD	n/a for COLM data	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	12

Table Name: TBL_VEGASSOC_INFO
Description: Contains association data for 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 (only AA points)	dbText	128
CEGL_CODE	CEGL (association) code	dbText	10
ASSOCIATION	Association corresponding to provisional community name	dbText	100
FIELD_KEY	n/a for COLM	dbBoolean	1
NEW_NAME	n/a for COLM	dbBoolean	1
POST_FIELD_NAME	n/a for COLM	dbBoolean	1
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 (X-XXXX)	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	dbText	100

Field Name	Field Description	Field Type	Field Width
	each polygon of forest/woodland and/or shrubland types		
USER_ACCURACY	User accuracy of the map unit (determined during AA meetings)	dbText	3
FUELS_TYPE	Fuels vegetation types	dbText	50
FUELS_VERIFICATION	Fuels verification	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:/COLM/Vegetation/ MapClassDescriptions/MU4.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	128
MODIFIER	Modifier code (one lower case letter)	dbText	12
MODIFIER_NAME	Name/type of modifier	dbText	50
MODIFIER_DESCRIPTION	Description of modifier	dbText	150

Appendix D

Plant Species List and Crosswalk

More than 300 plant species representing 67 families were noted during plot, observation point and accuracy assessment point data collection at Colorado National Monument (COLM). 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 Whittmann 2001 for Colorado parks, and Dorn and Lichvar 1984 for the single park in Wyoming; however, the COLM 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 COLM 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 negundo L.	*Acer negundo*	Box-elder	28749
Agavaceae	*Yucca angustissima* Engelm. ex Trel.	*Yucca angustissima*	Fineleaf Yucca	43131
	Yucca glauca Nutt.	*Yucca glauca*	Soapweed Yucca	43142
	Yucca harrimaniae Trel.	*Yucca harrimaniae*	Harriman's Yucca	43144
Anacardiaceae	*Rhus aromatica* Ait.	*Rhus aromatica*	Fragrant Sumac	28779
	Rhus aromatica var. *simplicifolia* (Greene) Cronq.	*Rhus trilobata var. simplicifolia*	Singleleaf Sumac	539585
	Rhus aromatica var. *trilobata* (Nutt.) Gray ex. S. Wats.	*Rhus trilobata*	Skunkbush	539586
	Toxicodendron rydbergii (Small ex Rydb.) Greene	*Toxicodendron rydbergii*	Western Poison-ivy	28822
Apiaceae	*Cymopterus acaulis* var. *fendleri* (Gray) Goodrich	*Cymopterus acaulis var. fendleri*	Plains Spring-parsley	527614
	Cymopterus bulbosus A. Nels.	*Cymopterus bulbosus*	Bulbous Spring-parsley	29631
	Cymopterus purpurascens (Gray) M.E. Jones	*Cymopterus purpurascens*	Wide-wing Spring-parsley	29653
	Cymopterus Raf.	*Cymopterus*	Spring-parsley	29625
	Lomatium eastwoodiae (Coult. & Rose) J.F. Macbr.	*Lomatium eastwoodiae*	Eastwood's Desert-parsley	29696
	Lomatium grayi (Coult. & Rose) Coult. & Rose	*Lomatium grayi*	Mountain Desert-parsley	29707
	Lomatium Raf.	*Lomatium*	Desert-parsley	29677
Apocynaceae	*Apocynum cannabinum* L.	*Apocynum cannabinum*	Indian-hemp	30157
	Apocynum L.	*Apocynum*	Dogbane, Indian-hemp	30155
Asclepiadaceae	*Asclepias cryptoceras* S. Wats.	*Asclepias cryptoceras*	Humboldt Mountain Milkweed	30257
	Asclepias L.	*Asclepias*	Milkweed	30240
	Asclepias speciosa Torr.	*Asclepias speciosa*	Showy Milkweed	30304
Asteraceae	*Agoseris* Raf.	*Agoseris*	Goat-chicory	36485
	Antennaria Gaertn.	*Antennaria*	Pussytoes	36716
	Artemisia bigelovii Gray	*Artemisia bigelovii*	Bigelow Sagebrush	35452
	Artemisia dracunculus L.	*Artemisia dracunculus*	Dragon Wormwood	35462
	Artemisia frigida Willd.	*Artemisia frigida*	Fringed Sagebrush	35465
	Artemisia L.	*Artemisia*	Sagebrush	35431

VASCULAR PLANTS				
Family	**Scientific Name (Welsh et al. 2003)**	**Scientific Name (Kartesz 1999)**	**Common Name (NatureServe)**	**TSN**
	Artemisia ludoviciana Nutt.	*Artemisia ludoviciana*	White Sagebrush	35474
	Artemisia nova A. Nels.	*Artemisia nova*	Black Sagebrush	500971
	Artemisia spinescens D.C. Eat.	*Picrothamnus desertorum*	Bud Sagebrush	35496
	Artemisia tridentata Nutt.	*Artemisia tridentata*	Basin 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 L.	*Aster*	Aster	35510
	Brickellia californica (Torr. & Gray) Gray	*Brickellia californica*	California Brickelbush	36866
	Brickellia Ell.	*Brickellia*	Brickellbush	36859
	Brickellia longifolia S. Wats.	*Brickellia longifolia*	Longleaf Brickellbush	36885
	Brickellia microphylla (Nutt.) Gray	*Brickellia microphylla*	Littleleaf Brickellbush	36886
	Chaenactis DC.	*Chaenactis*	Pincushion	36981
	Chaenactis douglasii (Hook.) Hook. & Arn.	*Chaenactis douglasii*	Dusty Maiden	36987
	Chaenactis stevioides Hook. & Arn.	*Chaenactis stevioides*	Broad-flower Pincushion	36998
	Chaetopappa ericoides (Torr.) Nesom	*Chaetopappa ericoides*	Rose-heath	501376
	Chrysopsis villosa (Pursh) Nutt. ex DC.	*Heterotheca villosa*	Hairy Goldenaster	510984
	Chrysothamnus depressus Nutt.	*Chrysothamnus depressus*	Long-flower Rabbitbrush	37051
	Chrysothamnus linifolius Greene	*Chrysothamnus linifolius*	Spearleaf Rabbitbrush	37054
	Chrysothamnus nauseosus (Pallas ex Pursh) Britt.	*Ericameria nauseosa*	Rubber Rabbitbrush	37055
	Chrysothamnus Nutt.	*Chrysothamnus*	Rabbitbrush	37048
	Chrysothamnus parryi (Gray) Greene	*Ericameria parryi*	Parry's Rabbitbrush	37071
	Chrysothamnus vaseyi (Gray) Greene	*Chrysothamnus vaseyi*	Vasey's Rabbitbrush	37089
	Chrysothamnus viscidiflorus (Hook.) Nutt.	*Chrysothamnus viscidiflorus*	Green Rabbitbrush	37090
	Cirsium calcareum (M.E. Jones) Woot. & Standl.	*Cirsium calcareum*	Cainville Thistle	36346
	Cirsium P. Mill.	*Cirsium*	Thistle	36334
	Cirsium undulatum (Nutt.) Spreng.	*Cirsium undulatum*	Wavyleaf Thistle	36423
	Crepis L.	*Crepis*	Hawk's-beard	37168

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Family	**Scientific Name (Welsh et al. 2003)**	**Scientific Name (Kartesz 1999)**	**Common Name (NatureServe)**	**TSN**
	Erigeron L.	*Erigeron*	Fleabane	35803
	Gaillardia pinnatifida Torr.	*Gaillardia pinnatifida*	Red-dome Blanket-flower	37409
	Grindelia squarrosa (Pursh) Dunal	*Grindelia squarrosa*	Curly-cup Gumweed	37472
	Grindelia Willd.	*Grindelia*	Gumweed	37439
	Gutierrezia Lag.	*Gutierrezia*	Snakeweed	37478
	Gutierrezia sarothrae (Pursh) Britt. & Rusby	*Gutierrezia sarothrae*	Snakeweed	37483
	Haplopappus acaulis (Nutt.) Gray	*Stenotus acaulis*	Stemless Mock Goldenweed	37499
	Haplopappus armerioides (Nutt.) Gray	*Stenotus armerioides*	Thrift Mock Goldenweed	37506
	Helianthus annuus L.	*Helianthus annuus*	Common Sunflower	36616
	Hymenopappus filifolius Hook.	*Hymenopappus filifolius*	Fineleaf Woollywhite	37766
	Hymenopappus L'Hér.	*Hymenopappus*	Woollywhite	37763
	Hymenoxys acaulis (Pursh) Parker	*Tetraneuris acaulis*	Stemless Four-nerve-daisy	514991
	Hymenoxys acaulis var. *ivesiana* (Greene) Parker	*Tetraneuris ivesiana*	Ives' Four-nerve-daisy	536278
	Hymenoxys Cass.	*Hymenoxys*	Rubberweed	37778
	Hymenoxys richardsonii (Hook.) Cockerell	*Hymenoxys richardsonii*	Colorado Rubberweed	37785
	Iva axillaris Pursh	*Iva axillaris*	Deer-root	36033
	Iva L.	*Iva*	Marsh-elder	36024
	Lactuca serriola L.	*Lactuca serriola*	Prickly Lettuce	36608
	Lactuca tatarica var. *pulchella* (Pursh) Breitung	*Lactuca tatarica var. pulchella*	Russian Blue Lettuce	528669
	Lygodesmia D. Don	*Lygodesmia*	Skeletonplant	500397
	Lygodesmia grandiflora (Nutt.) Torr. & Gray	*Lygodesmia grandiflora*	Rush-pink	503622
	Machaeranthera grindelioides (Nutt.) Shinners	*Machaeranthera grindelioides*	Rayless Tansy-aster	37992
	Machaeranthera grindelioides var. *grindelioides* (Nutt.) Shinners	*Machaeranthera grindelioides var. grindelioides*	Rayless Tansy-aster	529072
	Petradoria pumila (Nutt.) Greene	*Petradoria pumila*	Grassy Rock-goldenrod	38233
	Platyschkuhria integrifolia (Gray) Rydb.	*Platyschkuhria integrifolia*	Basin-daisy	38253
	Platyschkuhria integrifolia var. *oblongifolia* (Gray) W. Ellison	*Platyschkuhria integrifolia var. oblongifolia*	Basin-daisy	529723
	Senecio integerrimus Nutt.	*Senecio integerrimus*	Lamb-tongue Ragwort	36148

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	Senecio L.	*Senecio*	Groundsel	36084
	Senecio multicapitatus Greenm. ex Rydb.	*Senecio spartioides var. multicapitatus*	Many-head Groundsel	36160
	Senecio multilobatus Torr. & Gray ex Gray	*Packera multilobata*	Lobeleaf Groundsel	36161
	Senecio spartioides var. *multicapitatus* (Greenm. ex Rydb.) Welsh	*Senecio spartioides var. multicapitatus*	Many-head Groundsel	531525
	Solidago L.	*Solidago*	Goldenrod species	36223
	Solidago occidentalis (Nutt.) Torr. & Gray	*Euthamia occidentalis*	Western Goldenrod	521747
	Solidago velutina DC.	*Solidago velutina*	Three-nerve Goldenrod	505290
	Sonchus L.	*Sonchus*	Sowthistle	38420
	Stephanomeria Nutt.	*Stephanomeria*	Wire-lettuce	38442
	Stephanomeria pauciflora (Torr.) A. Nels.	*Stephanomeria pauciflora*	Brown-plume Wire-lettuce	38451
	Taraxacum officinale G.H. Weber ex Wiggers	*Taraxacum officinale*	Common Dandelion	36213
	Tetradymia canescens DC.	*Tetradymia canescens*	Gray Horsebrush	38494
	Tetradymia spinosa Hook. & Arn.	*Tetradymia spinosa*	Short-spine Horsebrush	38499
	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
	Tragopogon L.	*Tragopogon*	Goat's-beard, Salsify	38563
	Xanthium strumarium L.	*Xanthium strumarium*	Rough Cockleburr	38692
	Xylorhiza Nutt.	*Xylorhiza*	Woody-aster	38695
Berberidaceae	*Mahonia repens* (Lindl.) G. Don	*Mahonia repens*	Creeping Oregon-grape	195045
Betulaceae	*Betula occidentalis* Hook.	*Betula occidentalis*	Water Birch	19488
Boraginaceae	*Cryptantha fendleri* (Gray) Greene	*Cryptantha fendleri*	Sand-dune Cat's-eye	31807
	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 pterocarya (Torr.) Greene	*Cryptantha pterocarya*	Wingnut Cat's-eye	31856
	Lappula occidentalis (S. Wats.) Greene	*Lappula occidentalis*	Flat-spine Sheepburr	503329

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Brassicaceae	*Alyssum* L.	*Alyssum*	Allyssum	23029
	Alyssum minus (L.) Rothm.	*Alyssum minus*	Small Alyssum	508080
	Arabis demissa Greene	*Arabis demissa*	Nodding Rockcress	22686
	Arabis L.	*Arabis*	Rockcress	22671
	Arabis pulchra M.E. Jones ex S. Wats.	*Arabis pulchra*	Desert Rockcress	22725
	Camelina microcarpa DC.	*Camelina microcarpa*	Little-pod False Flax	22599
	Chorispora tenella (Pallas) DC.	*Chorispora tenella*	Musk-mustard	23099
	Descurainia pinnata (Walt.) Britt.	*Descurainia pinnata*	Western Tansy Mustard	22826
	Descurainia sophia (L.) Webb ex Prantl	*Descurainia sophia*	Herb Sophia	22843
	Descurainia Webb & Berth.	*Descurainia*	Tansy-mustard	22819
	Draba cuneifolia var. *cuneifolia* Nutt. ex Torr. & Gray	*Draba cuneifolia var. cuneifolia*	Wedgeleaf	527759
	Draba reptans (Lam.) Fern.	*Draba reptans*	Carolina Whitlow-grass	22908
	Erysimum asperum (Nutt.) DC.	*Erysimum capitatum*	Dwarf Draba	22931
	Lepidium densiflorum Schrad.	*Lepidium densiflorum*	Miner's Pepperwort	22960
	Lepidium L.	*Lepidium*	Pepperwort	22953
	Lepidium montanum Nutt.	*Lepidium montanum*	Mountain Pepperwort	503381
	Lesquerella S. Wats.	*Lesquerella*	Bladderpod	23162
	Malcolmia africana (L.) Ait. f.	*Malcolmia Africana*	African Mustard	23243
	Physaria (Nutt. ex Torr. & Gray) Gray	*Physaria*	Twinpod	23269
	Physaria acutifolia Rydb.	*Physaria acutifolia*	Sharpleaf Twinpod	23270
	Physaria rectipes (Woot. & Stan.) O'Kane & Al-Shehbaz	*Lesquerella rectipes*	Colorado bladderpod	-14
	Sisymbrium altissimum L.	*Sisymbrium altissimum*	Jim Hill Mustard	23312
	Stanleya pinnata (Pursh) Britt.	*Stanleya pinnata*	Golden Prince's-plume	23329
	Streptanthella longirostris (S. Wats.) Rydb.	*Streptanthella longirostris*	Little twistflower	23333
	Streptanthus cordatus Nutt.	*Streptanthus cordatus*	Heartleaf Jewelflower	23348
	Thelypodium integrifolium (Nutt.) Endl. ex Walp.	*Thelypodium integrifolium*	Entireleaf Thelypody	23398
	Thelypodium laxiflorum Al-Shehbaz	*Thelypodium laxiflorum*	Loose-flower Thelypody	23404

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Cactaceae	*Echinocereus triglochidiatus* Engelm.	*Echinocereus triglochidiatus*	King-cup Cactus	19815
	Opuntia erinacea Engelm. & Bigelow ex Engelm.	*Opuntia erinacea*	Oldman Cactus	19705
	Opuntia fragilis (Nutt.) Haw.	*Opuntia fragilis*	Opuntia fragilis	19707
	Opuntia P. Mill.	*Opuntia*	Prickly-pear species	19686
	Opuntia phaeacantha Engelm.	*Opuntia phaeacantha*	Tulip Prickly-pear	19724
	Opuntia polyacantha Haw.	*Opuntia polyacantha*	Panhandle Prickly-pear	19726
	Pediocactus simpsonii (Engelm.) Britt. & Rose	*Pediocactus simpsonii*	Snowball Cactus	19776
	Sclerocactus Britt. & Rose	*Sclerocactus*	Fishhook Cactus	19758
	Sclerocactus whipplei (Engelm. & Bigelow) Britt. & Rose	*Sclerocactus whipplei*	Whipple's Fishhook Cactus	19765
Caprifoliaceae	*Symphoricarpos longiflorus* Gray	*Symphoricarpos longiflorus*	Desert Snowberry	35334
	Symphoricarpos occidentalis Hook.	*Symphoricarpos occidentalis*	Western Snowberry	35336
Caryophyllaceae	*Arenaria fendleri* Gray	*Arenaria fendleri*	Fendler’s Sandwort	20245
	Arenaria hookeri Nutt.	*Arenaria hookeri*	Hooker’s Sandwort	20247
	Silene antirrhina L.	*Silene antirrhina*	Sleepy Catchfly	20045
	Silene L.	*Silene*	Catchfly	20040
	Stellaria L.	*Stellaria*	Chickweed, Starwort	20163
Celastraceae	*Pachystima 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 L.	*Atriplex*	Saltbush species	20505
	Atriplex obovata Moq.	*Atriplex obovata*	New Mexico Saltbush	20552
	Bassia scoparia (L.) Schrad.	*Bassia scoparia*	Mexican Fireweed	20696
	Chenopodium album L.	*Chenopodium album*	Lamb's-quarters	20592
	Chenopodium L.	*Chenopodium*	Goosefoot	20589
	Grayia spinosa (Hook.) Moq.	*Grayia spinosa*	Spiny Hop-sage	20690
	Halogeton glomeratus (Bieb.) C.A. Mey.	*Halogeton glomeratus*	Salt-lover	20692

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	Krascheninnikovia lanata (Pursh) A.D.J. Meeuse & Smit	*Krascheninnikovia lanata*	Winter-fat	503290
	Salsola tragus L.	*Salsola kali*	Russian-thistle	520950
	Sarcobatus vermiculatus (Hook.) Torr.	*Sarcobatus vermiculatus*	Black Greasewood	20707
	Suaeda calceoliformis (Hook.) Moq.	*Suaeda calceoliformis*	Sea-blite	505402
Crassulaceae	*Sedum lanceolatum* Torr.	*Sedum lanceolatum*	Lanceleaf Stonecrop	24126
Cupressaceae	*Juniperus communis* L.	*Juniperus communis*	Common Juniper	194820
	Juniperus osteosperma (Torr.) Little	*Juniperus osteosperma*	Utah Juniper	194859
Cyperaceae	*Carex* L.	*Carex*	Sedge	39369
	Carex rossii Boott	*Carex rossii*	Ross' Sedge	39786
	Eleocharis palustris (L.) Roemer & J.A. Schultes	*Eleocharis palustris*	Marsh Spikerush	40019
	Scirpus L.	*Scirpus*	Bulrush	40225
Elaeagnaceae	*Elaeagnus angustifolia* L.	*Elaeagnus angustifolia*	Russian-olive	27770
Ephedraceae	*Ephedra torreyana* S. Wats.	*Ephedra torreyana*	Torrey's Joint-fir	502318
	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 laevigatum A. Braun	*Equisetum laevigatum*	Smooth Scouringrush	17156
Ericaceae	*Arctostaphylos patula* Greene	*Arctostaphylos patula*	Greenleaf Manzanita	23513
Euphorbiaceae	*Chamaesyce fendleri* (Torr. & Gray) Small	*Chamaesyce fendleri*	Fendler's Sandmat	501419
	Chamaesyce glyptosperma (Engelm.) Small	*Chamaesyce glyptosperma*	Rib-Seed Sandmat	501422
	Euphorbia L.	*Euphorbia*	Spurge	28032
Fabaceae	*Astragalus* L.	*Astragalus*	Milk-vetch	25392
	Astragalus mollissimus Torr.	*Astragalus mollissimus*	Woolly Milk-vetch	25589
	Astragalus nuttallianus DC.	*Astragalus nuttallianus*	Turkey-peas	25607
	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

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	Hedysarum L.	*Hedysarum*	Sweet-vetch	26722
	Lupinus argenteus Pursh	*Lupinus argenteus*	Silver-stem Lupine	503575
	Medicago sativa L.	*Medicago sativa*	Alfalfa	183623
	Melilotus albus Medikus	*Melilotus albus*	White Sweet-clover	26149
	Melilotus officinalis (L.) Lam.	*Melilotus officinalis*	Yellow Sweet-clover	26150
	Melilotus P. Mill.	*Melilotus*	Sweet-clover species	26148
	Pediomelum megalanthum (Woot. & Standl.) Rydb.	*Pediomelum megalanthum*	Intermountain Indian-breadroot	504181
	Trifolium L.	*Trifolium*	Clover species	26204
	Vicia americana Muhl. ex Willd.	*Vicia americana*	American Purple Vetch	26331
Fagaceae	*Quercus gambelii* Nutt.	*Quercus gambelii*	Gambel Oak	19337
Geraniaceae	*Erodium cicutarium* (L.) L'Hér. ex Ait.	*Erodium cicutarium*	Red-Stem Stork's-bill	29147
Grossulariaceae	*Ribes inerme* Rydb.	*Ribes inerme*	White-stem Gooseberry	24473
Hydrangeaceae	*Fendlera rupicola* Gray	*Fendlera rupicola*	Fendlerbush	24331
Hydrophyllaceae	*Phacelia crenulata* Torr. ex S. Wats.	*Phacelia crenulata*	Notchleaf Scorpionweed	31478
	Phacelia crenulata var. *corrugata* (A. Nels.) Brand	*Phacelia crenulata var. corrugata*	Notchleaf Scorpionweed	529549
Juncaceae	*Juncus arcticus* Willd.	*Juncus balticus*	Baltic Rush	39222
Lamiaceae	*Dracocephalum parviflorum* Nutt.	*Dracocephalum parviflorum*	American Dragonhead	32490
	Mentha arvensis L.	*Mentha arvensis*	American Wild Mint	565302
Liliaceae	*Allium acuminatum* Hook.	*Allium acuminatum*	Taper-tip Onion	42707
	Allium L.	*Allium*	Garlic, Onion, Wild Leek	42634
	Allium textile A. Nels. & J.F. Macbr.	*Allium textile*	White Wild Onion	42670
	Asparagus officinalis L.	*Asparagus officinalis*	Garden Asparagus	42784
	Calochortus gunnisonii S. Wats.	*Calochortus gunnisonii*	Gunnison's Mariposa-lily	42849
	Calochortus nuttallii Torr. & Gray	*Calochortus nuttallii*	Sego-lily	42863
	Smilacina stellata (L.) Desf.	*Maianthemum stellatum*	Starflower False Solomon's-seal	43038
	Zigadenus venenosus S. Wats.	*Zigadenus venenosus*	Meadow Deathcamas	43168
Linaceae	*Linum perenne* L.	*Linum lewisii*	Prairie Flax	29217

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Loasaceae	*Mentzelia albicaulis* (Dougl. ex Hook.) Dougl. ex Torr. & Gray	*Mentzelia albicaulis*	White-Stem Blazingstar	503757
Malvaceae	*Sphaeralcea coccinea* (Nutt.) Rydb.	*Sphaeralcea coccinea*	Scarlet Globemallow	21920
	Sphaeralcea fendleri Gray	*Sphaeralcea fendleri*	Thicket Globemallow	21933
	Sphaeralcea parvifolia A. Nels.	*Sphaeralcea parvifolia*	Small-leaf Globemallow	21953
	Sphaeralcea St.-Hil.	*Sphaeralcea*	Globemallow	21909
Nyctaginaceae	*Abronia fragrans* Nutt. ex Hook.	*Abronia fragrans*	Heart's-delight	19557
	Mirabilis glandulosa (Standl.) W.A. Weber	*Mirabilis multiflora var. glandulosa*	Showy Four-o'clock	517251
	Mirabilis multiflora (Torr.) Gray	*Mirabilis multiflora*	Showy Four-o'clock	19654
	Mirabilis multiflora var. *glandulosa* (Standl.) J.F. Macbr.	*Mirabilis multiflora var. glandulosa*	Showy Four-o'clock	529219
Oleaceae	*Fraxinus anomala* Torr. ex S. Wats.	*Fraxinus anomala*	Singleleaf Ash	32937
Onagraceae	*Oenothera caespitosa* Nutt.	*Oenothera caespitosa*	Tufted Evening-primrose	565328
	Oenothera pallida Lindl.	*Oenothera pallida*	Pale Evening Primrose	27436
	Oenothera villosa Thunb.	*Oenothera villosa*	Hairy Evening-primrose	27421
Orchidaceae	*Habenaria hyperborea* (L.) R. Br. ex Ait. f.	*Platanthera hyperborean*	Northern Green Orchid	514368
	Habenaria Willd.	*Habenaria*	False Rein Orchid	43398
Pinaceae	*Picea pungens* Engelm.	*Picea pungens*	Blue Spruce	183307
	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 major* L.	*Plantago major*	Great Plantain	32887
	Plantago patagonica Jacq.	*Plantago patagonica*	Woolly Plantain	32907
Poaceae	*Agropyron cristatum* (L.) Gaertn.	*Agropyron cristatum*	Crested Wheatgrass	182478
	Agropyron Gaertn.	*Agropyron*	Wheatgrass	40353
	Agrostis L.	*Agrostis*	Bentgrass	40389
	Agrostis stolonifera L.	*Agrostis stolonifera*	Spreading Bentgrass	40400
	Aristida purpurea Nutt.	*Aristida purpurea*	Purple Three-awn	41429
	Bouteloua curtipendula (Michx.) Torr.	*Bouteloua curtipendula*	Sideoats Grama	41500

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	Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths	*Bouteloua gracilis*	Blue Grama	41493
	Bromus diandrus Roth	*Bromus diandrus*	Ripgut Brome	40498
	Bromus inermis Leyss.	*Bromus inermis*	Smooth Brome	40502
	Bromus japonicus Thunb. ex Murr.	*Bromus japonicus*	Japanese Brome	40479
	Bromus tectorum L.	*Bromus tectorum*	Cheatgrass	40524
	Dactylis glomerata L.	*Dactylis glomerata*	Orchard Grass	193446
	Distichlis spicata (L.) Greene	*Distichlis spicata*	Saltgrass	40662
	Elymus canadensis L.	*Elymus canadensis*	Nodding Wild Rye	40683
	Elymus elymoides (Raf.) Swezey	*Elymus elymoides*	Bottlebrush	502264
	Elymus hispidus (Opiz) Melderis	*Thinopyrum intermedium*	Intermediate Wheatgrass	512825
	Elymus repens (L.) Gould	*Elymus repens*	Creeping Wild Rye	512839
	Elymus salinus M.E. Jones	*Leymus salinus*	Salinas Lyme Grass	512841
	Elymus smithii (Rydb.) Gould	*Pascopyrum smithii*	Western Wheatgrass	512844
	Elymus spicatus (Pursh) Gould	*Pseudoroegneria spicata*	Bluebunch Wheatgrass	512845
	Elymus trachycaulus (Link) Gould ex Shinners	*Elymus trachycaulus*	Slender Wild Rye	502282
	Festuca L.	*Festuca*	Fescue	40792
	Festuca octoflora Walt.	*Vulpia octoflora*	Six-weeks Grass	513551
	Hilaria jamesii (Torr.) Benth.	*Pleuraphis jamesii*	James' Galleta	41768
	Hordeum brachyantherum Nevski	*Hordeum brachyantherum*	Meadow Barley	40875
	Hordeum jubatum L.	*Hordeum jubatum*	Foxtail Barley	40871
	Koeleria macrantha (Ledeb.) J.A. Schultes	*Koeleria micrantha*	Prairie Junegrass	503284
	Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi	*Muhlenbergia asperifolia*	Alkali Muhly	41899
	Muhlenbergia richardsonis (Trin.) Rydb.	*Muhlenbergia richardsonis*	Mat Muhly	41938
	Oryzopsis micrantha (Trin. & Rupr.) Thurb.	*Piptatherum micranthum*	Little-seed Mountain Ricegrass	41989
	Phragmites australis (Cav.) Trin. ex Steud.	*Phragmites australis*	Common Reed	41072
	Poa fendleriana (Steud.) Vasey	*Poa fendleriana*	Muttongrass	504467
	Poa L.	*Poa*	Bluegrass species	41074

VASCULAR PLANTS				
Family	**Scientific Name (Welsh et al. 2003)**	**Scientific Name (Kartesz 1999)**	**Common Name (NatureServe)**	**TSN**
	Poa pratensis L.	*Poa pratensis*	Kentucky Bluegrass	41088
	Poa secunda J. Presl	*Poa secunda*	Sandberg's Bluegrass	41103
	Polypogon monspeliensis (L.) Desf.	*Polypogon monspeliensis*	Annual Rabbit's-foot Grass	41171
	Sporobolus airoides (Torr.) Torr.	*Sporobolus airoides*	Alkali Sacaton	42128
	Sporobolus cryptandrus (Torr.) Gray	*Sporobolus cryptandrus*	Sand Dropseed	42132
	Sporobolus flexuosus (Thurb. ex Vasey) Rydb.	*Sporobolus flexuosus*	Mesa Dropseed	42137
	Stipa arida M.E. Jones	*Achnatherum aridum*	Mormon Needlegrass	42159
	Stipa comata Trin. & Rupr.	*Hesperostipa comata*	Needle-and-thread	42172
	Stipa hymenoides Roemer & J.A. Schultes	*Achnatherum hymenoides*	Indian Ricegrass	522063
	Stipa speciosa Trin. & Rupr.	*Achnatherum speciosum*	Desert Needlegrass	42194
	Tridens Roemer & J.A. Schultes	*Tridens*	Fluffgrass	42220
	Triticum aestivum L.	*Triticum aestivum*	Wheat	42237
Polemoniaceae	*Gilia inconspicua* (Sm.) Sweet	*Gilia inconspicua*	Shy Gily-flower	31127
	Gilia Ruiz & Pavón	*Gilia*	Gily-flower	31075
	Gilia stenothyrsa Gray	*Gilia stenothyrsa*	Unita Gily-flower	31178
	Ipomopsis aggregata (Pursh) V. Grant	*Ipomopsis aggregate*	Scarlet Skyrocket	31192
	Leptodactylon pungens (Torr.) Torr. ex Nutt.	*Leptodactylon pungens*	Granite Prickly-phlox	31233
	Phlox austromontana Coville	*Phlox austromontana*	Desert Mountain Phlox	30913
	Phlox pulvinata (Wherry) Cronquist	*Phlox caespitosa*	Cushion Phlox	30980
	Phlox hoodii Richards.	*Phlox hoodii*	Carpet Phlox	30948
	Phlox L.	*Phlox*	Phlox	30897
	Phlox longifolia Nutt.	*Phlox longifolia*	Longleaf Phlox	30956
Polygonaceae	*Eriogonum alatum* Torr.	*Eriogonum alatum*	Winged Wild Buckwheat	21057
	Eriogonum corymbosum Benth.	*Eriogonum corymbosum*	Crispleaf Wild Buckwheat	21103
	Eriogonum flavum Nutt.	*Eriogonum flavum*	Alpine Golden Wild Buckwheat	21134
	Eriogonum inflatum Torr. & Frém.	*Eriogonum inflatum*	Desert Trumpet	21163
	Eriogonum lonchophyllum Torr. & Gray	*Eriogonum lonchophyllum*	Spearleaf Wild Buckwheat	21185

VASCULAR PLANTS				
Family	**Scientific Name (Welsh et al. 2003)**	**Scientific Name (Kartesz 1999)**	**Common Name (NatureServe)**	**TSN**
	Eriogonum Michx.	*Eriogonum*	Wild Buckwheat	21054
	Eriogonum microthecum Nutt.	*Eriogonum microthecum*	Slender Wild Buckwheat	21192
	Eriogonum ovalifolium Nutt.	*Eriogonum ovalifolium*	Cushion Wild Buckwheat	21212
	Eriogonum umbellatum Torr.	*Eriogonum umbellatum*	Sulphur-flower Wild Buckwheat	21266
	Polygonum ramosissimum Michx.	*Polygonum ramosissimum*	Yellow-Flower Knotweed	20921
	Rumex crispus L.	*Rumex crispus*	Curly Dock	20937
	Rumex hymenosepalus Torr.	*Rumex hymenosepalus*	Sand Dock	20962
Portulacaceae	*Portulaca oleracea* L.	*Portulaca oleracea*	Little Hogweed	20422
Primulaceae	*Androsace septentrionalis* L.	*Androsace septentrionalis*	Pygmy-flower Rock-jasmine	23935
Ranunculaceae	*Aquilegia micrantha* Eastw.	*Aquilegia micrantha*	Mancos Columbine	18743
	Clematis ligusticifolia Nutt.	*Clematis ligusticifolia*	White Virgins-bower	18702
	Delphinium andersonii var. *scaposum* (Greene) Welsh	*Delphinium scaposum*	Bare-stem Larkspur	534315
	Delphinium nuttallianum Pritz. ex Walp.	*Delphinium nuttallianum*	Two-lobe Larkspur	18483
	Ranunculus cymbalaria Pursh	*Ranunculus cymbalaria*	Alkali Buttercup	18600
	Ranunculus testiculatus Crantz	*Ceratocephala testiculata*	Bur Buttercup	18649
Rosaceae	*Amelanchier alnifolia* (Nutt.) Nutt. ex M. Roemer	*Amelanchier alnifolia*	Saskatoon Servicberry	25109
	Amelanchier utahensis Koehne	*Amelanchier utahensis*	Utah Serviceberry	25121
	Cercocarpus intricatus S. Wats.	*Cercocarpus intricatus*	Littleleaf Mountain-mahogany	25133
	Cercocarpus montanus Raf.	*Cercocarpus montanus*	Mountain-mahogany	25136
	Holodiscus dumosus (Nutt. ex Hook.) Heller	*Holodiscus dumosus*	Glandular Oceanspray	25178
	Prunus virginiana L.	*Prunus virginiana*	Choke Cherry	24806
	Purshia mexicana (D. Don) Henrickson	*Purshia stansburiana*	Stansbury Cliff-rose	195899
	Purshia mexicana var. stansburiana (Torr.) Welsh	*Purshia stansburiana*	Stansbury Cliff-rose	195902
	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 alba* L.	*Populus alba*	White Poplar	22451

VASCULAR PLANTS				
Family	**Scientific Name (Welsh et al. 2003)**	**Scientific Name (Kartesz 1999)**	**Common Name (NatureServe)**	**TSN**
	Populus angustifolia James	*Populus angustifolia*	Narrowleaf Cottonwood	22452
	Populus deltoides ssp. *wislizeni* (S. Wats.) Eckenwalder	*Populus deltoides ssp. wislizeni*	Rio Grande Cottonwood	524563
	Populus tremuloides Michx.	*Populus tremuloides*	Quaking Aspen	195773
	Salix amygdaloides Anderss.	*Salix amygdaloides*	Peachleaf Willow	22499
	Salix exigua Nutt.	*Salix exigua*	Coyote Willow	22529
	Salix fragilis L.	*Salix fragilis*	Crack Willow	22535
	Salix lucida Muhl.	*Salix lucida*	Whiplash Willow	22554
	Salix monticola Bebb	*Salix monticola*	Mountain Willow	22558
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
Saxifragaceae	*Heuchera parviflora* Bartl.	*Heuchera parvifolia*	Littleleaf Alumroot	24365
Scrophulariaceae	*Castilleja* Mutis ex L. f.	*Castilleja*	Indian-paintbrush	33049
	Castilleja scabrida Eastw.	*Castilleja scabrida*	Rough Indian-paintbrush	33165
	Pedicularis L.	*Pedicularis*	Lousewort	33352
	Penstemon caespitosus Nutt. ex Gray	*Penstemon caespitosus*	Mat Penstemon	33839
	Penstemon comarrhenus Gray	*Penstemon comarrhenus*	Dusty Beardtongue	33854
	Penstemon Schmidel	*Penstemon*	Beardtongue	33665
	Verbascum thapsus L.	*Verbascum thapsus*	Great Mullein	33394
Selaginellaceae	*Selaginella* Beauv.	*Selaginella*	Spike-moss	17064
	Selaginella densa Rydb.	*Selaginella densa*	Dense Spike-moss	17076
Tamaricaceae	*Tamarix chinensis* Lour.	*Tamarix chinensis*	Chinese Tamarisk	22308
	Tamarix ramosissima Ledeb.	*Tamarix ramosissima*	Salt-cedar	22310
Typhaceae	*Typha domingensis* Pers.	*Typha domingensis*	Southern Cattail	42327
	Typha latifolia L.	*Typha latifolia*	Broadleaf Cattail	42326
Ulmaceae	*Celtis reticulata* Torr.	*Celtis laevigata var. reticulata*	Netleaf Hackberry	19045
	Ulmus pumila L.	*Ulmus pumila*	Siberian Elm	19057
Valerianaceae	*Valeriana edulis* Nutt. ex Torr. & Gray	*Valeriana edulis*	Tobacco-root	35359

NON-VASCULAR PLANTS				
Family	**Scientific Name (Welsh et al. 2002)**	**Scientific Name (Kartesz 1999)**	**Common Name (NatureServe)**	**TSN**
Bacidiaceae	*Squamarina* Poelt	*Squamarina*	Rim Lichen	190068
Bryaceae	*Anomobryum* Schimp.	*Anomobryum*	Anomobryum Moss	547437
	Bryum dichotomum Hedw.	*Bryum dichotomum*	Bryum Moss	547621
Collemataceae	*Collema coccophorum* Tuck.	*Collema coccophorum*	Jelly Lichen	191339
Ditrichaceae	*Saelania glaucescens* (Hedw.) Broth. in Bomanss. & Broth.	*Saelania glaucescens*	Blue Dew	16870
Hymeneliaceae	*Aspicilia reptans* (Looman) Wetmore	*Aspicilia reptans*	Rimmed Lichen	189747
Pottiaceae	*Pterygoneurum* Jur.	*Pterygoneurum*	Pterygoneurum Moss	16692
	Tortula caninervis (Mitt.) Broth.	*Tortula caninervis*	Tortula Moss	548145
Psoraceae	*Psora* Hoffm.	*Psora*	Scale Lichen	190026
Teloschistaceae	*Fulgensia bracteata* (Hoffm.) Rasanen	*Fulgensia bracteata*	Bracted Sulphur Lichen	191760

Appendix E

Field Plot Crosswalk to NVC Associations

Plots and observation points are assigned to National Vegetation Classification associations based on their composition and structure as they were recorded in the field. One association (*Artemisia frigida / Heterotheca villosa* Dwarf-shrubland) was documented only during accuracy assessment.

Plant Association Scientific Name	CEGL Code	No. of Plots	Plot/Observation Point/AA Point Assignments
Acer negundo / Disturbed Understory Woodland	CEGL002693	1	COLM.0010
Achnatherum hymenoides - Bromus tectorum Herbaceous Vegetation	PARK SPECIAL	15	COLM.0051, COLM.0056, COLM.0084, COLM.0094, COLM.0095, COLM.0113, COLM.0150, COLM.0154, COLM.0171, COLM.0176, COLM.0183, COLM.0439, COLM.0465, COLM.0466, COLM.0467
Agropyron cristatum Semi-natural Herbaceous Alliance	A.3563	1	COLM.00347
Amelanchier (*utahensis, alnifolia*) - *Cercocarpus montanus* Shrubland	CEGL001070	11	COLM.0051, COLM.0056, COLM.0084, COLM.0094, COLM.0095, COLM.0113, COLM.0150, COLM.0154, COLM.0171, COLM.0176, COLM.0183
Amelanchier utahensis Shrubland	CEGL001067	4	COLM.0009, COLM.0042, COLM.0296, COLM.0304
Aquilegia micrantha Herbaceous Vegetation	CEGL002762	2	COLM.0256, COLM.0303
Arctostaphylos patula Shrubland	CEGL002696	1	COLM.0017
Artemisia frigida / Heterotheca villosa Dwarf-shrubland	PARK SPECIAL	3	COLM_AA.009, COLM_AA.049
Artemisia nova / *Leymus salinus* Shrub Herbaceous Vegetation	CEGL001421	10	COLM.0071, COLM.0103, COLM.0165, COLM.0209, COLM.0322, COLM.0390, COLM.0391, COLM.0394, COLM.0404, COLM.0453
Artemisia nova Shrubland	CEGL001417	3	COLM.0147, COLM.0226, COLM.0231
Artemisia tridentata - (*Ericameria nauseosa*) / *Bromus tectorum* Semi-natural Shrubland	CEGL002699	7	COLM.0047, COLM.0118, COLM.0152, COLM.0156, COLM.0234, COLM.0371, COLM.0450
Artemisia tridentata ssp. *tridentata* / *Sporobolus airoides* Shrubland	CEGL002200	1	COLM.0243
Artemisia tridentata ssp. *wyomingensis - Atriplex confertifolia* Shrubland	CEGL001040	1	COLM.0015
Artemisia tridentata ssp. *wyomingensis* / (*Agropyron cristatum, Psathyrostachys juncea*) Seeded Grasses Semi-natural Shrubland	CEGL002185	11	COLM.0036, COLM.0037, COLM.0060, COLM.0061, COLM.0062, COLM.0063, COLM.0065, COLM.0066, COLM.0067, COLM.0077, COLM.0190
Artemisia tridentata ssp. wyomingensis / Disturbed Understory Semi-natural Shrubland	CEGL002083	9	COLM.0018, COLM.0030, COLM.0040, COLM.0090, COLM.0149, COLM.0162, COLM.0199, COLM.0213, COLM.0266
Artemisia tridentata ssp. *wyomingensis* / *Hesperostipa comata* Colorado Plateau Shrubland	CEGL002761	10	COLM.0132, COLM.0135, COLM.0140, COLM.0160, COLM.0197, COLM.0273, COLM.0346, COLM.0405, COLM.0408, COLM.0481
Artemisia tridentata ssp. *wyomingensis* / *Pleuraphis jamesii* Shrubland	CEGL002084	8	COLM.0006, COLM.0041, COLM.0057, COLM.0059, COLM.0289, COLM.0320, COLM.0373, COLM.0470
Artemisia tridentata ssp. *wyomingensis* / *Poa fendleriana* Shrubland	CEGL002775	2	COLM.0107, COLM.0109
Atriplex canescens - Ephedra viridis Talus Shrubland	CEGL001287	3	COLM.0179, COLM.0180, COLM.0294
Atriplex canescens Shrubland	CEGL001281	4	COLM.0026, COLM.0032, COLM.0269, COLM.0279, COLM.0217

Plant Association Scientific Name	CEGL Code	No. of Plots	Plot/Observation Point/AA Point Assignments
Atriplex confertifolia - Sarcobatus vermiculatus Shrubland	CEGL001313	2	COLM.0025, COLM.0097
Atriplex confertifolia / *Pleuraphis jamesii* Shrubland	CEGL001304	15	COLM.0021, COLM.0083, COLM.0178, COLM.0227, COLM.0230, COLM.0238, COLM.0241, COLM.0242, COLM.0247, COLM.0249, COLM.0263, COLM.0265, COLM.0286, COLM.0298, COLM.0352
Atriplex gardneri / *Pleuraphis jamesii* Dwarf-shrubland	CEGL001441	2	COLM.0052, COLM.0333
Betula occidentalis / *Maianthemum stellatum* Shrubland	CEGL001162	5	COLM.0099, COLM.0153, COLM.0158, COLM.0366, COLM.0395
Bromus tectorum Semi-natural Herbaceous Vegetation	CEGL003019	10	COLM.0001, COLM.0053, COLM.0096, COLM.0246, COLM.0274, COLM.0281, COLM.0399, COLM.0437, COLM.0440, COLM.0452
Cercocarpus intricatus Slickrock Sparse Vegetation	CEGL002977	9	COLM.0072, COLM.0073, COLM.0323, COLM.0324, COLM.0342, COLM.0343, COLM.0423, COLM.0424, COLM.0443
Equisetum laevigatum Herbaceous Vegetation	CEGL002241	2	COLM.0120, COLM.0240
Ericameria nauseosa Desert Wash Shrubland	CEGL002261	2	COLM.0031, COLM.0086
Eriogonum lonchophyllum Sparse Vegetation	PARK SPECIAL	1	COLM.0403
Fendlera rupicola Talus Shrubland	CEGL002765	4	COLM.0292, COLM.0328, COLM.0349, COLM.0523
Fraxinus anomala Woodland	CEGL002752	2	COLM.0193, COLM.0521
Hesperostipa comata Great Basin Herbaceous Vegetation	CEGL001705	2	COLM.0035, COLM.0215
Hordeum jubatum Herbaceous Vegetation	CEGL001798	1	COLM.0456
Juncus balticus Herbaceous Vegetation	CEGL001838	7	COLM.0003, COLM.0048, COLM.0085, COLM.0239, COLM.0291, COLM.0438, COLM.0509
Juniperus osteosperma / *Artemisia tridentata* ssp. *wyomingensis* Woodland	CEGL000730	3	COLM.0182, COLM.0184, COLM.0297
Juniperus osteosperma / *Cercocarpus montanus* Woodland	CEGL000735	1	COLM.0122
Juniperus osteosperma / *Hesperostipa comata* Woodland	CEGL002815	1	COLM.0008
Pinus edulis - Juniperus spp. / *Leymus salinus* Woodland	CEGL002340	7	COLM.104, COLM.0196, COLM.0201, COLM.0203, COLM.0204, COLM.0205, COLM.0248
Juniperus osteosperma / Mixed Shrubs Talus Woodland	CEGL002266	12	COLM.0005, COLM.0020, COLM.0024, COLM.0172, COLM.0185, COLM.0217, COLM.0219, COLM.0229, COLM.0260, COLM.0267, COLM.0275, COLM.0276
Krascheninnikovia lanata / *Pleuraphis jamesii* Dwarf-shrubland	CEGL001322	1	COLM.0270
Leymus salinus Shale Sparse Vegetation	CEGL002745	10	COLM.0023, COLM.0027, COLM.0028, COLM.0175, COLM.0200, COLM.0208, COLM.0334, COLM.0458, COLM.0464, COLM.0512
Mahonia repens Dwarf-shrubland	PARK SPECIAL	1	COLM.0045
Nonvascular Cover - Board Beds Unit, Entrada Sandstone Sparse Vegetation	PARK SPECIAL	1	COLM.0486
Opuntia polyacantha / *Pleuraphis jamesii* Shrubland	CEGL002299	7	COLM.0004, COLM.0034, COLM.0186, COLM.0233, COLM.0277, COLM.0278, COLM.0299
Pascopyrum smithii Herbaceous Vegetation	CEGL001577	2	COLM.0068, COLM.0455
Picea pungens - Pinus edulis - Juniperus osteosperma / *Quercus gambelii* Woodland	PARK SPECIAL	1	COLM.0487
Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / *Hesperostipa comata* Woodland	CEGL000797	1	COLM.0007

Plant Association Scientific Name	CEGL Code	No. of Plots	Plot/Observation Point/AA Point Assignments
Pinus edulis - Juniperus osteosperma / *Amelanchier utahensis* Woodland	CEGL002329	3	COLM.0401, COLM.0435, COLM.0519
Pinus edulis - Juniperus osteosperma / *Artemisia bigelovii* Woodland	CEGL002118	20	COLM.0016, COLM.0039, COLM.0043, COLM.0161, COLM.0173, COLM.0174, COLM.0235, COLM.0237, COLM.0244, COLM.0250, COLM.0251, COLM.0253, COLM.0378, COLM.0398, COLM.0414, COLM.0463, COLM.0483, COLM.0488, COLM.0489, COLM.0503
Pinus edulis - Juniperus osteosperma / *Artemisia nova* Woodland	CEGL002331	17	COLM.0101, COLM.0102, COLM.0105, COLM.0133, COLM.0138, COLM.0167, COLM.0168, COLM.0255, COLM.0386, COLM.0417, COLM.0420, COLM.0421, COLM.0422, COLM.0444, COLM.0445, COLM.0454, COLM.0499
Pinus edulis - Juniperus osteosperma / *Cercocarpus intricatus* Woodland	CEGL000779	5	COLM.0038, COLM.0163, COLM.0169, COLM.0252, COLM.0396
Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland	CEGL002328	10	COLM.0046, COLM.0055, COLM.0087, COLM.0123, COLM.0129, COLM.0143, COLM.0170, COLM.0177, COLM.0194, COLM.0262
Pinus edulis - Juniperus osteosperma / *Petradoria pumila* Woodland	CEGL002332	3	COLM.0093, COLM.0131, COLM.0225
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	CEGL002148	41	COLM.0013, COLM.0079, COLM.0080, COLM.0089, COLM.0092, COLM.0106, COLM.0110, COLM.0117, COLM.0124, COLM.0126, COLM.0128, COLM.0141, COLM.0146, COLM.0148, COLM.0159, COLM.0181, COLM.0187, COLM.0211, COLM.0214, COLM.0271, COLM.0272, COLM.0282, COLM.0287, COLM.0305, COLM.0339, COLM.0358, COLM.0359, COLM.0407, COLM.0410, COLM.0415, COLM.0425, COLM.0426, COLM.0428, COLM.0432, COLM.0434, COLM.0446, COLM.0448, COLM.0490, COLM.0495, COLM.0498, COLM.0500
Pinus edulis - Juniperus spp. / *Artemisia tridentata* (ssp. *wyomingensis,* ssp. *vaseyana*) Woodland	CEGL000776	30	COLM.0012, COLM.0044, COLM.0064, COLM.0076, COLM.0078, COLM.0091, COLM.0100, COLM.0111, COLM.0121, COLM.0127, COLM.0142, COLM.0191, COLM.0245, COLM.0306, COLM.0307, COLM.0311, COLM.0318, COLM.0369, COLM.0379, COLM.0381, COLM.0384, COLM.0449, COLM.0451, COLM.0469, COLM.0479, COLM.0480, COLM.0497, COLM.0508, COLM.0510, COLM.0522
Pinus edulis - Juniperus spp. / *Cercocarpus montanus* - Mixed Shrub Woodland	CEGL000780	78	COLM.0054, COLM.0074, COLM.0075, COLM.0081, COLM.0082, COLM.0088, COLM.0108, COLM.0112, COLM.0114, COLM.0115, COLM.0116, COLM.0119, COLM.0125, COLM.0130, COLM.0137, COLM.0139, COLM.0144, COLM.0145, COLM.0166, COLM.0188, COLM.0189, COLM.0192, COLM.0195, COLM.0207, COLM.0212, COLM.0221, COLM.0222, COLM.0223, COLM.0224, COLM.0228, COLM.0232, COLM.0254, COLM.0280, COLM.0283, COLM.0284, COLM.0285, COLM.0288, COLM.0310, COLM.0314, COLM.0315, COLM.0319, COLM.0335, COLM.0345, COLM.0350, COLM.0351, COLM.0356, COLM.0360, COLM.0361, COLM.0363, COLM.0380, COLM.0382, COLM.0385, COLM.0387, COLM.0388, COLM.0389, COLM.0393, COLM.0400, COLM.0402, COLM.0406, COLM.0409, COLM.0411, COLM.0419, COLM.0429, COLM.0447, COLM.0457, COLM.0468, COLM.0476, COLM.0477, COLM.0478, COLM.0482, COLM.0484, COLM.0485, COLM.0491, COLM.0492, COLM.0506, COLM.0507, COLM.0511, COLM.0514
Pleuraphis jamesii Herbaceous Vegetation	CEGL001777	10	COLM.0022, COLM.0033, COLM.0164, COLM.0202, COLM.0206, COLM.0268, COLM.0365, COLM.0459, COLM.0462, COLM.0504
Populus deltoides (ssp. *wislizeni,* ssp. *monilifera*) / *Salix exigua* Woodland	CEGL002685	10	COLM.0029, COLM.0049, COLM.0218, COLM.0220, COLM.0259,

Plant Association Scientific Name	CEGL Code	No. of Plots	Plot/Observation Point/AA Point Assignments
			COLM.0261, COLM.0309, COLM.0472, COLM.0501, COLM.0515
Populus tremuloides / *Betula occidentalis* Forest	CEGL002650	1	COLM.0157
Populus tremuloides / *Prunus virginiana* Forest	CEGL000596	2	COLM.0257, COLM.0368
Pseudotsuga menziesii / *Quercus gambelii* Forest	CEGL000452	1	COLM.0258
Quercus gambelii / *Rhus trilobata* Shrubland	CEGL002338	6	COLM.0151, COLM.0155, COLM.0210, COLM.0332, COLM.0473, COLM.0496
Rhus trilobata Intermittently Flooded Shrubland	CEGL001121	1	COLM.0198
Salix exigua / Mesic Graminoids Shrubland	CEGL001203	6	COLM.0050, COLM.0098, COLM.0216, COLM.0331, COLM.0370, COLM.0520
Sarcobatus vermiculatus / *Artemisia tridentata* Shrubland	CEGL001359	1	COLM.0014
Sarcobatus vermiculatus Disturbed Shrubland	CEGL001357	11	COLM.0002, COLM.0019, COLM.0069, COLM.0236, COLM.0264, COLM.0295, COLM.0301, COLM.0340, COLM.0348, COLM.0353, COLM.0513
Sporobolus airoides Southern Plains Herbaceous Vegetation	CEGL001685	1	COLM.0058

Appendix F

Plant Association Descriptions for Colorado National Monument

The Colorado National Monument (COLM) vegetation mapping project identified 67 National Vegetation Classification (NVC) plant associations representing 38 vegetation alliances. Detailed vegetation descriptions are essential for recognizing floristic vegetation types (association and alliance levels of the NVC) in the field. Local and global descriptions "*provide specific information on the geographical distribution, level of acceptable physiognomic and compositional variation, and the key ecological process and environmental/abiotic factors that are associated with a type*" (Grossman et al. 1998). The two levels of vegetation descriptions are valuable for comparing each association as it appears in the park with the global range of variation for that association.

The following report was prepared by NatureServe to provide local and global descriptions for each plant association found at COLM, with the exception of the *Agropyron cristatum* Semi-natural Herbaceous Alliance, which occurred primarily on private lands in the environs and was only poorly sampled during this project. These descriptions reflect NatureServe's accumulated data and analysis. Global descriptions of COLM associations that are NVC types are available on NatureServe's Explorer Web site (http://www.natureserve.org/explorer); local descriptions are not. Some vegetation types at COLM were not accepted by NatureServe for inclusion in the NVC because they appear to be unique to the monument. Only local descriptions are available for these types, which are termed "Park Specials." Because they are outside the NVC, they appear at the end of the document under the heading "HIERARCHY PLACEMENT UNDETERMINED."

In this appendix, NVC plant associations are arranged by physiognomic class (e.g., Forest, Woodland). Within each physiognomic class, associations are sorted into formations (e.g., Conical-crowned temperate), and alliances (e.g., *Juniperus osteosperma* Woodland Alliance).

I. Forests

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)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This forest association occurs on mountains and plateaus from Colorado to Trans-Pecos Texas, west into Arizona and Utah. Elevation ranges from 1,370 m–2,870 m (4,500-9,400 ft). Stands are found along drainages, lower and middle slopes, steep upper slopes and ridgetops. 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 sandy loams to clay. The vegetation is characterized by a relatively sparse to moderately dense evergreen tree canopy dominated by *Pseudotsuga menziesii* sometimes with scattered large *Pinus ponderosa, Pinus strobiformis, Pinus edulis*, or *Juniperus* spp. (especially on drier sites). *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 over 25%. At higher elevations, the *Quercus gambelii* are more tree-like 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 herbaceous layer is generally sparse and composed of mostly graminoids with scattered forbs, but can be moderately dense and diverse. Many other species are associated such as *Amelanchier* spp., *Holodiscus dumosus, Mahonia repens, Paxistima myrsinites, Robinia neomexicana, Rosa woodsii, Carex* spp., *Festuca arizonica, Muhlenbergia virescens, Poa fendleriana, Lathyrus lanszwertii var. leucanthus, Thalictrum fendleri*, and *Vicia americana*. The shrub layer has equal or greater cover than graminoids.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled in upper No Thoroughfare Canyon; it is the only Douglas-fir stand known in the monument. A single large Douglas-fir tree was observed on a ledge in Kodels Canyon in the northernmost portion of the monument. Trees in this canyon occur on both sides (east and west) and both near the floor to the base of the Wingate sandstone cliff walls.

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

Colorado National Monument

This forest association was observed only in the bottom of an arm of No Thoroughfare Canyon on the associated talus or rockfall slopes derived from Wingate sandstone. The site is steep (64% slope), occurs at 1,970 m elevation, and is oriented to an aspect of 300 degrees. The unvegetated surface has high cover of litter and moderate cover of large rocks and mosses and lichens. Litter and duff depth ranged from 0-4 cm and 0 cm–0.5 cm, respectively. Soils are rapidly drained and texturally are sandy loam. Site geology is that of rockfall slopes, with relatively large blocks present.

Globally

This forest association occurs on mountains and plateaus at elevation ranges from 1,370 m–2,870 m (4,500 ft–9,400 ft). Stands are found along drainages, gentle to moderate lower and middle slopes, steep upper slopes and ridgetops. 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 sandy loams to clay. The surface is generally largely covered with a thin layer of litter. Parent materials include fractured limestone, sandstone, basalt and andesite.

VEGETATION DESCRIPTION

Colorado National Monument

This Douglas-fir / Gambel oak forest association appeared as one stand in an arm of No Thoroughfare Canyon. A few individual Douglas-fir trees were observed in the park, the furthest north occurred in Kodels Canyon on a rock ledge. The total vegetation cover for this stand is 75%. This forest association is characterized by an open tree canopy, typically 20-35 m tall, of *Pseudotsuga menziesii* that ranged in cover from 25% to 35%. These trees are mature (39.0 cm to 91.5 cm diameter at breast height (dbh)). *Juniperus osteosperma* and *Pinus edulis* trees are also present as canopy trees at <5% cover each. The shrub layer consists of tall shrubs from 2 m–5 m tall that contribute moderate cover, predominantly by *Amelanchier utahensis* (15%–25%), while *Cercocarpus montanus, Fraxinus anomala,* and *Quercus gambelii* contribute from 1%–5% cover. The herbaceous layer is sparse and includes the graminoids *Achnatherum hymenoides, Bromus tectorum, Elymus elymoides,* and *Poa* sp., and the forbs *Cryptantha* sp., *Galium coloradoense, Gilia stenothyrsa, Lepidium montanum,* and *Physaria acutifolia*.

Globally

This association is characterized by a relatively sparse to moderately dense evergreen tree canopy dominated by *Pseudotsuga menziesii*, sometimes with scattered large *Pinus ponderosa, Pinus strobiformis, Pinus edulis*, or *Juniperus* spp. (especially on drier sites). *Abies concolor* is typically not present. *Quercus gambelii* dominates both the subcanopy (tree form, if present) and the 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 over 25%. At higher elevations, the *Quercus gambelii* are more tree-like, 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. Other common shrub species, depending on geographic location, may include *Acer glabrum, Arctostaphylos patula, Amelanchier* spp., *Cercocarpus montanus, Holodiscus dumosus, Mahonia repens, Paxistima myrsinites, Prunus virginiana, Ribes cereum, Robinia neomexicana,* and *Rosa woodsii*. The generally sparse herbaceous layer is composed of mostly graminoids with scattered forbs but ranges to moderately dense and diverse. Associated graminoids may include *Bromus* spp., *Carex rossii, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Muhlenbergia virescens,* and *Poa fendleriana*. Common forbs include *Achillea millefolium, Lathyrus lanszwertii var. leucanthus, Thalictrum fendleri,* and *Vicia americana*. The shrub layer has equal or greater cover than graminoids. This open conifer forest transitions to *Quercus gambelii* woodlands in drier sites and at lower elevations.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*
Tree subcanopy	*Juniperus osteosperma*, *Pinus edulis*
Tall shrub/sapling	*Fraxinus anomala*
Short shrub/sapling	*Quercus gambelii*

Globally

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

OTHER NOTEWORTHY SPECIES

Colorado National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Colorado National Monument

Data are not available.

Globally

Within the Habitat Type literature 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, Alexander et al. 1987, DeVelice et al. 1986, Fitzhugh et al. 1987, Johnston 1987, Larson and Moir 1987, Muldavin et al. 1996, Stuever and Hayden 1997b). There are 3 similar USNVC *Pseudotsuga menziesii* associations that use these phase species as the nominal species. These phases represent "intermediate" vegetation. Review of these associations is needed to clarify relationships between associations.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Colorado National Monument Inventory Notes: There are no other stands known for the vicinity.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot: COLM.0258).
Local Description Authors: J. Von Loh
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, Cogan et al. 2004, DeVelice et al. 1986, Diamond 1993, Fitzhugh et al. 1987, Freeman and Dick-Peddie 1970, Hess and Wasser 1982, Johnston 1987, Keammerer 1974b, Kittel et al. 1994, Kittel et al. 1999a, Kittel et al. 1999b, Komarkova et al. 1988a, Komarkova et al. 1988b, Larson and Moir 1987, Muldavin et al. 1996, Stuever and Hayden 1997b, Tiedemann and Terwilliger 1978, Western Ecology Working Group n.d., Youngblood and Mauk 1985

Populus tremuloides / Prunus virginiana Forest
Quaking Aspen / Choke Cherry Forest

CODE	CEGL000596
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	Montane or boreal cold-deciduous forest (I.B.2.N.b.)
ALLIANCE	POPULUS TREMULOIDES FOREST ALLIANCE (A.274) Quaking Aspen Forest Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Aspen Forest and Woodland (CES306.813)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This aspen forest type is found in the Rocky Mountains and Black Hills of the western United States. It occurs on slope crests and midslopes with sandy loam, loam, or clay loam soils from approximately 1,750 m to 2,715 m (5,750 ft–8,900 ft) in elevation. Aspects are highly variable, and slopes are primarily gentle (0%–20%) but may also be steep (50%–100%). *Populus tremuloides* dominates this association. Conifers are sparse when present and can include *Pseudotsuga menziesii, Pinus contorta, Pinus ponderosa*, and *Picea glauca* in the Black Hills. The shrub layer can be a rich multilayered mixture of medium- and low-height shrubs. *Prunus virginiana* is often dominant or codominant with *Amelanchier alnifolia*. Additional shrub associates can include *Acer grandidentatum, Ribes inerme, Ribes oxyacanthoides ssp. setosum (= Ribes setosum), Rosa woodsii, Cornus sericea, Paxistima myrsinites, Rubus parviflorus, Symphoricarpos occidentalis*, and *Symphoricarpos oreophilus*. Herbaceous species can have low cover due to the well-developed shrub layer but commonly include *Agastache urticifolia, Aralia nudicaulis, Bromus carinatus, Carex sprengelii, Calamagrostis rubescens, Carex geyeri, Elymus glaucus, Fragaria virginiana, Galium boreale, Geranium viscosissimum, Maianthemum stellatum, Osmorhiza depauperata, Osmorhiza berteroi (= Osmorhiza chilensis), Rudbeckia occidentalis, Senecio serra*, and *Thalictrum fendleri*. Diagnostic features of this association are *Populus tremuloides* dominant in the canopy and *Prunus virginiana* well-represented in the shrub layer.

DISTRIBUTION

Colorado National Monument

This association is rare in the monument and was observed and sampled at the head of one arm of No Thoroughfare Canyon where it received water via a large pour-off.

Globally

This aspen forest type is found in the Rocky Mountains and Black Hills of the western United States, ranging from South Dakota west to Wyoming and Montana, south to Colorado and Utah.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This forest association occurs on partially shaded slopes at the terminus of a box canyon. The site is steep (78% slope), occurs at 2011 m elevation, and is oriented to an aspect of 315 degrees. The unvegetated surface has high cover of litter and large rock. Downed wood in the form of old *Pseudotsuga* trunks, is common. Soils are rapidly drained are sandy loam, derived from sandstone. The site geology is rockfall deposits, and it consists of talus or colluvium derived from Wingate sandstone.

Globally

This aspen forest type occurs on slope crests and midslopes with sandy loam, loam, or clay loam soils from approximately 1,750 m to 2,700 m (5,750 ft–8,900 ft) in elevation. Aspects are highly variable, and slopes are primarily gentle (0%–20%) but may be steep (50%–100%). In the Black Hills, stands occur along mesic valley bottoms. The slopes an vary from steep (at the bottom of the hillslope) to gentle (along the valley bottom) (H. Marriott pers. comm. 1999). In the southern Rocky Mountains, a stand occurs on a steep, southeasterly midslope on granitic substrates, and on the Colorado Plateau a stand occurs at the end of a box canyon on a steep northwesterly slope on sandstone colluvium.

VEGETATION DESCRIPTION

Colorado National Monument

This quaking aspen / choke cherry forest association is very rare within the monument. The total vegetation cover is 115% in this densely vegetated stand. This forest association is characterized by an open tree canopy of 10- to 15-m tall *Populus tremuloides* that provides 25% cover. Canopy tree cover is also provided by *Pinus edulis* and *Pseudotsuga menziesii*, but it is sparse, e.g., 1% cover for each species. The shrub layer is limited in composition but has dense cover. The tall-shrub stratum is dense with up to 65% cover provided by *Amelanchier utahensis, Populus tremuloides*, and *Prunus virginiana*. A single dwarf-shrub, *Mahonia repens*, contributed 25% cover. Herbaceous species are uncommon and provide sparse cover. Graminoids include *Agropyron cristatum* and *Piptatherum micranthum*. Forbs include *Antennaria* sp., *Artemisia ludoviciana*, and *Heterotheca villosa*. Scattered tree seedlings and root sprouts of *Pinus edulis* and *Populus tremuloides* are present.

Globally

This association is dominated by *Populus tremuloides*. Conifers are sparse (<25% of the tree canopy) when present and can include *Pseudotsuga menziesii, Pinus contorta, Pinus ponderosa*, and *Picea glauca* in the Black Hills. The shrub layer can be a rich multilayered mixture of medium- and low-height shrubs. *Prunus virginiana* is often dominant or codominant with *Amelanchier alnifolia*. Additional shrub associates can include *Acer grandidentatum, Amelanchier utahensis, Cornus sericea, Mahonia repens, Ribes inerme, Ribes oxyacanthoides ssp. setosum (= Ribes setosum), Rosa woodsii, Paxistima myrsinites, Rubus parviflorus, Symphoricarpos occidentalis*, and *Symphoricarpos oreophilus*. Herbaceous species have low cover due to the well-developed shrub layer but commonly include *Agastache urticifolia, Aralia nudicaulis, Artemisia ludoviciana, Bromus carinatus, Carex sprengelii, Calamagrostis rubescens, Carex geyeri, Elymus glaucus, Fragaria virginiana, Galium boreale, Geranium viscosissimum, Maianthemum stellatum, Osmorhiza depauperata, Osmorhiza berteroi (= Osmorhiza chilensis), Piptatherum micranthum, Rudbeckia occidentalis, Senecio serra, Thermopsis divaricarpa*, and *Thalictrum fendleri*. Nonnative graminoids such as *Agropyron cristatum, Bromus tectorum, Phleum pratense*, and *Poa pratensis*, may dominate disturbed herbaceous layers. Diagnostic features of this association are *Populus tremuloides* dominant in the canopy and *Prunus virginiana* well-represented in the shrub layer.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tree canopy	*Populus tremuloides*
Tall shrub/sapling	*Amelanchier utahensis, Prunus virginiana*
Herb (field)	*Mahonia repens*
Herb (field)	*Artemisia ludoviciana, Heterotheca villosa*
Herb (field)	*Piptatherum micranthum*

Globally

Stratum	Species
Tree canopy	*Populus tremuloides*
Shrub/sapling (tall & short)	*Amelanchier alnifolia, Prunus virginiana*
Tall shrub/sapling	*Amelanchier utahensis*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Agropyron cristatum, Bonasa umbellus, Bromus tectorum, Phleum pratense, Poa pratensis

CONSERVATION STATUS RANK
Global Rank & Reasons: G3G4 (24-Oct-2002). This community has a relatively restricted range (which would not change even if combined with *Populus tremuloides / Prunus virginiana* Woodland (CEGL002130)). Stands are somewhat patchy on the landscape, with relatively small occurrences. They require a moderately specific set of abiotic factors, being found in drainage bottoms, with or without flowing streams. Few Element Occurrences have been documented. The restriction of this type to primarily riparian areas or moist drainages makes it susceptible to impacts caused by cattle grazing, especially at lower elevations.

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
This type appears to be most common in riparian areas (Marriott and Faber-Langendoen 2000). This type seems equivalent to *Populus tremuloides / Prunus virginiana* Woodland (CEGL002130).

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Data are not available.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot: COLM.0257 and one observation point: COLM.0368).
Local Description Authors: J. Von Loh, mod. K.A. Schulz
Global Description Authors: J. Drake, mod. S.L. Neid and K.A. Schulz

REFERENCES: Coenenberg and Depuit 1979, Driscoll et al. 1984, Johnston 1987, Kagan et al. 2004, Komarkova et al. 1988b, MTNHP 2002b, Marriott pers. comm., Midwestern Ecology Working Group n.d., Mueggler 1988, Mueggler and Campbell 1986, Youngblood and Mueggler 1981

Populus tremuloides / Betula occidentalis Forest
Quaking Aspen / Water Birch Forest

CODE	CEGL002650
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 TREMULOIDES TEMPORARILY FLOODED FOREST ALLIANCE (A.300) Quaking Aspen Temporarily Flooded Forest Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Subalpine-Montane Riparian Woodland (CES306.833)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This plant association of Colorado and eastern Nevada is a lush, deciduous, riparian woodland with a canopy of aspen and sometimes conifer and cottonwood trees. The understory has a high structural diversity of shrubs and an herbaceous undergrowth ranging from a thick carpet of grasses and forbs to a very sparse ground cover in heavily shaded areas. The streamside location and the presence of obligate riparian shrub species such as *Betula occidentalis, Salix exigua,* and *Cornus sericea* distinguish this association from upland *Populus tremuloides* communities.

DISTRIBUTION

Colorado National Monument

This association occurred only in upper No Thoroughfare Canyon.

Globally

This association is known to occur in eastern Nevada and middle elevation canyons throughout Colorado. It may occur in southeastern Utah in sheltered canyons with perennial water.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This woodland association was observed in a narrow, seasonally flooded canyon bottom that also contains a perennial seep and spring. The site is nearly level (2% slope), occurs at 1,873 m elevation, and is oriented to the aspect of 35 degrees. The unvegetated surface has high cover of litter and bare soil. Soils are poorly drained and texturally are sandy loam. Site geology is old alluvium that has deposited at the toe of rockfall slopes and beyond the splash zone of a pour-off.

Globally

This association occurs on seasonally flooded bottoms, terraces and benches of narrow canyons in the mountains of Nevada and Colorado and in sheltered canyons of western Colorado. Except during spring runoff, the water table is generally at least 1 m or more below the ground surface. Elevations range from 1,875 m–3,100 m (6,150 ft–10,400 ft) and slope gradients are gentle (3%–6%), except in a few tributary gulch sites which have steeper gradients. Soils are coarse sandy alluvium, often with buried cobble layers. Litter and bare soil account for most of the unvegetated ground surface cover.

VEGETATION DESCRIPTION

Colorado National Monument

This woodland association is extremely rare, occupying only one known site of cold-air drainage at the head of a canyon. The total vegetation cover is 65% in this linear and densely vegetated riparian stand. This woodland association is characterized by an open tree canopy of 10 m to 15 m tall *Populus tremuloides* trees, providing up to 25% cover, and scattered *Populus deltoides ssp. wislizeni* trees that contribute up to 5% cover. The subcanopy of 5 m to 10 m tall *Betula occidentalis* trees (or tall shrubs) provides up to 15% cover. The shrub layer is low in diversity and provides sparse to low cover. Tall and short shrubs present include *Cercocarpus montanus, Elaeagnus angustifolia, Salix exigua* and *Rosa woodsii*. The herbaceous layer contributes moderate cover but is not diverse. Common graminoids present include *Juncus balticus* and the nonnative *Poa pratensis*. The riparian vine *Clematis ligusticifolia* contributed sparse cover.

Globally

This structurally diverse forest association is characterized by a canopy 10 m–15 m tall of *Populus tremuloides,* sometimes with *Abies concolor, Pseudotsuga menziesii, Pinus ponderosa* or *Populus deltoides* present. Total canopy closure is 30% to more than 100%, with *Populus tremuloides* providing 20%–85% cover. *Betula occidentalis* forms a subcanopy or tall shrub layer with 15% to 80% cover. The short shrub layer is diverse, and can include *Cornus sericea, Amelanchier alnifolia, Acer glabrum, Rosa*

woodsii, Salix scouleriana, Salix bebbiana, Salix exigua and *Symphoricarpos oreophilus*. If *Alnus incana* is present, it has less than 5% cover. Because of light and soil moisture competition by the trees and shrubs, the herbaceous layer tends to be relatively sparse, rarely exceeding 10% cover. Common species include *Poa pratensis, Calamagrostis canadensis, Equisetum arvense, Maianthemum stellatum, Urtica dioica, Taraxacum officinale* and *Clematis ligusticifolia*.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tree canopy	*Populus deltoides* ssp. *wislizeni, Populus tremuloides*
Tree subcanopy	*Betula occidentalis*
Tall shrub/sapling	*Salix exigua*
Herb (field)	*Poa pratensis*

Globally

Tree canopy	*Populus tremuloides*
Tree subcanopy	*Betula occidentalis*
Tall shrub/sapling	*Cornus sericea, Salix exigua*
Herb (field)	*Calamagrostis canadensis, Equisetum arvense*
Herb (field)	*Maianthemum stellatum*

OTHER NOTEWORTHY SPECIES

Colorado National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (7-Apr-1998).

CLASSIFICATION COMMENTS

Colorado National Monument

Data are not available.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Colorado National Monument Inventory Notes: Stand occupies one site with permanent spring flow and intermittent run-off drainage.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot: COLM.0157).
Local Description Authors: J. Von Loh
Global Description Authors:

REFERENCES: Bourgeron and Engelking 1994, CONHP Ecology Team 2001, Kittel et al. 1997a, Kittel et al. 1999a, Manning and Padgett 1995, NVNHP 2003, Western Ecology Working Group n.d.

IIa. Coniferous Woodlands

Juniperus osteosperma / Artemisia tridentata ssp. *wyomingensis* Woodland
Utah Juniper / Wyoming Big Sagebrush Woodland

CODE	CEGL000730
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)
Rocky Mountain Foothill Limber Pine-Juniper Woodland (CES306.955)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This sparse woodland association has been reported from semi-arid foothills, plateaus and mountains throughout much of the western Rocky Mountains, Colorado Plateau, and Great Basin. Elevation ranges from 1,220 m to 2,260 m (4000–7400 ft). This community generally occurs on a variety of slopes and aspects, often at the break between foothill and basin. Soils are generally coarse-textured, calcareous alluvial or eolian deposits derived from sandstone and shale. Evidence of erosion such as gullies and rills is not uncommon. There are generally significant amounts of bare ground, litter, and desert pavement at the soil surface. Rock cover is variable. The vegetation is characterized by an open tree canopy dominated by *Juniperus osteosperma* with *Artemisia tridentata ssp. wyomingensis* dominating the sparse to moderately dense short-shrub layer. Tree canopy cover values are over 5%, but typically less than 20%, and canopy height is usually 2 m–10 m. Other shrubs, such as *Atriplex canescens, Atriplex confertifolia, Artemisia nova, Chrysothamnus viscidiflorus, Ephedra nevadensis, Ericameria nauseosa, Gutierrezia sarothrae, Opuntia* spp., or *Purshia* spp., may be present but generally with low cover. The sparse to moderately dense herbaceous layer is dominated by graminoids such as *Achnatherum hymenoides, Aristida* spp., *Bouteloua* spp., *Carex filifolia, Elymus elymoides, Hesperostipa comata, Pleuraphis jamesii (= Hilaria jamesii), Pascopyrum smithii, Poa secunda, Pseudoroegneria spicata, Sporobolus* spp., and introduced annual *Bromus* spp. Associated forbs may include *Artemisia frigida, Eriogonum* spp., *Gayophytum racemosum, Leptodactylon pungens, Phlox hoodii*, and *Plantago patagonica*.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled in Wedding Canyon, Monument Canyon, and Gold Star Canyon.

Globally

This sparse woodland association occurs throughout much of the western Rocky Mountains, Colorado Plateau, and Great Basin region.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This woodland association was observed on midslopes of canyons and on alluvial fans. Sites are gentle (8%–10% slope), occur between 1,482 m and 1,618 m elevation, and have northern aspects. The unvegetated surface has low to moderate cover of litter and high cover of small rocks. Parent materials are Precambrian gneiss and sandstones. Soils are rapidly drained and texturally are silty clay and sandy loam.

Site geology is migmatitic meta-sedimentary Precambrian rock (deposited as steep ridges in broad canyon bottoms and steep slopes at canyon mouths) and alluvial fans.

Globally
This sparse woodland association has been reported from semi-arid foothills, plateaus and mountains throughout much of the western Rocky Mountains, Colorado Plateau, and Great Basin. Elevation ranges from 1,220 m to 2,260 m (4,000–7,400 ft). This community occurs on a variety of slopes and aspects, often at the break between foothill and basin. Soils are generally coarse-textured, calcareous alluvial or eolian deposits derived from sandstone and shale. Evidence of erosion such as gullies and rills is not uncommon. There are generally significant amounts of bare ground, litter, and desert pavement at the soil surface. Rock cover is variable.

VEGETATION DESCRIPTION
Colorado National Monument
This Utah juniper / Wyoming big sagebrush woodland association is uncommon and results from tree invasion into stands of shrubs. The total vegetation cover ranged from 16% to 19% in these sparsely vegetated stands. This woodland association is characterized by an open tree canopy, typically 2 m–5 m tall, of *Juniperus osteosperma* trees that range in cover from 5% to 15% and sparse to moderate short-shrub cover of *Artemisia tridentata ssp. wyomingensis* that ranges from 1% to 20%. The shrub layer is variable in composition but provides sparse cover. Short and dwarf-shrubs include *Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra viridis, Opuntia erinacea, Sarcobatus vermiculatus, Gutierrezia sarothrae, Opuntia erinacea, Opuntia phaeacantha*, and *Opuntia polyacantha*. The herbaceous layer is typically sparse, usually less than 5% total cover and often less. Common graminoids include *Achnatherum hymenoides, Bromus tectorum, Elymus elymoides, Hesperostipa comata, Pleuraphis jamesii*, and *Vulpia octoflora*. Forbs commonly present are *Astragalus mollissimus, Astragalus nuttallianus, Calochortus gunnisonii, Descurainia pinnata, Lepidium densiflorum, Phacelia crenulata var. corrugata, Silene antirrhina*, and *Stanleya pinnata*.

Globally
The vegetation is characterized by an open tree canopy dominated by *Juniperus osteosperma* with *Artemisia tridentata. ssp. wyomingensis* dominating the sparse to moderately dense short-shrub layer. Tree canopy cover values are over 5%, but typically less than 20%, and the height of the tree canopy is 2 m–10 m. Other shrubs, such as *Atriplex canescens, Atriplex confertifolia, Artemisia nova, Chrysothamnus viscidiflorus, Ephedra nevadensis, Ericameria nauseosa, Gutierrezia sarothrae, Opuntia* spp., or *Purshia* spp., may be present but generally with low cover. The herbaceous layer tends to have sparse to low cover but can range to moderately dense cover in some stands. It is dominated by graminoids such as *Achnatherum hymenoides, Aristida* spp., *Bouteloua* spp., *Carex filifolia, Elymus elymoides, Hesperostipa comata, Pleuraphis jamesii (= Hilaria jamesii), Pascopyrum smithii, Poa secunda, Pseudoroegneria spicata, Sporobolus* spp., and introduced annual *Bromus* spp. Associated forbs may include *Artemisia frigida, Eriogonum* spp., *Gayophytum racemosum, Leptodactylon pungens, Phlox hoodii*, and *Plantago patagonica*.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Opuntia polyacantha*
Herb (field)	*Pleuraphis jamesii*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G5? (1-Feb-1996).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Association occupies dry, hot exposures of Precambrian slopes and alluvial fans.
Colorado National Monument Plots: The description is based on 2003 field data (2 plots: COLM.0182, COLM.0184 and 1 observation point: COLM.0297).
Local Description Authors: J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles

REFERENCES: Barney and Frischknecht 1974, Blackburn 1967, Blackburn et al. 1968a, Blackburn et al. 1968c, Blackburn et al. 1969a, Blackburn et al. 1969e, Blackburn et al. 1971, Bourgeron and Engelking 1994, Bradley 1964, Brotherson and Evenson 1983, Bunting 1987, CONHP unpubl. data 2003, Cogan et al. 2004, Dastrup 1963, DeVelice and Lesica 1993, Donart et al. 1978b, Driscoll et al. 1984, Everett 1987, Francis 1986, Isaacson 1967, Jameson et al. 1962, Johnson and Payne 1968, Johnston 1987, Jones 1992b, Larson and Moir 1987, MTNHP 2002b, Milton and Purdy 1983, Moir and Carleton 1987, NVNHP 2003, Stuever and Hayden 1997a, USFS 1983a, West et al. 1998, Western Ecology Working Group n.d., Wright et al. 1979

Juniperus osteosperma / Cercocarpus montanus Woodland
Utah Juniper / Mountain-mahogany Woodland

CODE	CEGL000735
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)
Rocky Mountain Foothill Limber Pine-Juniper Woodland (CES306.955)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This is a low, shrubby woodland type growing on shallow, rocky soils on hogbacks, ridges and colluvial slopes in south-central Wyoming and western Colorado. The sites on which this vegetation grows are sometimes classified as the shallow breaks range site (Warren n.d.). *Juniperus osteosperma* and *Cercocarpus montanus* occur together in either a wooded shrubland or woodland form, depending on the relative cover of the two dominant species. . Occasionally the junipers are stunted and grow no taller than the mountain mahogany. Sparse grasses dominate the understory, including *Pseudoroegneria spicata, Poa secunda, Pleuraphis jamesii* and *Hesperostipa comata.*

DISTRIBUTION

Colorado National Monument

This association was observed and sampled in Ute Canyon.

Globally

This is type occurs in south-central Wyoming and western Colorado.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This woodland association was observed on midslopes of canyons. The site is gentle (12% slope), occurs at 1,759 m elevation, and is oriented to 10 degrees. The unvegetated surface has low cover of litter and high cover of large rocks, small rocks, and bare soil. Cryptogamic cover up to 15% occurred. Parent materials are sandstone, including bedrock slabs. Soils are well-drained and texturally are sandy loam. Site geology is rockfall deposits that are comprised of large slabs of Kayenta sandstone that have fallen on the talus slope.

Globally

This association generally occurs on the rocky slopes of canyons, hills, hogbacks and ridges below 1,900 m (6,234 ft) in south central Wyoming and western Colorado. It also occurs on somewhat barren shale ridges of the Carmel Formation in Colorado. Slopes range from gentle to moderately steep and stands are often oriented to east or north aspects. Substrates include sandstone, talus and shale, and soils generally correspond to the substrate; sandy loams on sandstones and clay soils on shales. The unvegetated ground surface often has a high percentage of rock, exposed bedrock or bare ground, but in undisturbed examples on sandy substrates the cover of cryptobiotic crusts may be high.

VEGETATION DESCRIPTION

Colorado National Monument

This woodland association is uncommon in the monument with only one occurrence observed. The total vegetation cover is 17% in this sparsely vegetated stand. This woodland association is characterized by a sparse tree canopy, from 5 m–10 m tall, of *Juniperus osteosperma* trees that range in cover from 5% to 15%. The shrub layer is low in cover and in composition. Tall, short, and dwarf-shrubs present include *Fraxinus anomala, Cercocarpus montanus* (the indicator of this association), *Ephedra torreyana, Ephedra viridis, Fendlera rupicola, Eriogonum* sp., *Gutierrezia sarothrae*, and *Opuntia erinacea*. The herbaceous layer is sparse, less than 5% cover. The graminoids present include *Achnatherum hymenoides, Bromus tectorum, Hesperostipa comata, Pleuraphis jamesii, Poa fendleriana,* and *Vulpia octoflora*. Forbs present include *Descurainia pinnata, Heterotheca villosa, Lappula occidentalis, Lepidium montanum,* and *Selaginella* sp. Cryptogam cover is low, less than 5%.

Globally

This woodland association is characterized by an open to moderately closed canopy of *Juniperus osteosperma* with a mixed shrub understory dominated by *Cercocarpus montanus.* Other species generally present in the shrub layer include *Fraxinus anomala, Ephedra viridis, Artemisia tridentata* ssp. *wyomingensis* and *Gutierrezia sarothrae.* The herbaceous layer typically has less than 10% total cover of grasses and forbs. *Poa fendleriana, Pleuraphis jamesii, Achnatherum hymenoides,* and *Heterotheca villosa* are common herbaceous species. Nonvascular plants and cryptobiotic soil crusts are often present, but usually with very low cover.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Cercocarpus montanus, Fendlera rupicola*
Herb (field)	*Hesperostipa comata, Pleuraphis jamesii*

Globally

Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Cercocarpus montanus*

OTHER NOTEWORTHY SPECIES

Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G2Q (30-Nov-1998). The G2 portion of the rank reflects the limited area in which this vegetation type may occur. The "Q" portion of the rank reflects the serious uncertainty about the validity of this type as an association.

CLASSIFICATION COMMENTS

Colorado National Monument
Data are not available.

Globally
Evidence for this plant association in Wyoming is contained in a brief description of range sites in the BLM's Great Divide Resource Area of south-central Wyoming. Quantitative data on the composition and structure of the vegetation in Wyoming are lacking. *Juniperus osteosperma* and *Cercocarpus montanus* both occur in southwestern Wyoming as well, and this vegetation type might be found there, but information to that effect has not been found. The association has been documented by vegetation plots in both Black Canyon of the Gunnison NP and Dinosaur NM.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Colorado National Monument Inventory Notes: Large slabs of sandstone positioned on talus slope provides habitat.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot): Plot: COLM.0122).
Local Description Authors: J. Von Loh
Global Description Authors: G.P. Jones

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Warren n.d., 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)

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 southeastern Utah. Sites are on level to moderately sloping terrain that may be oriented to any aspect. Elevation of most stands ranges from 1,423 m to 1,880 m (4,670–6,165 ft) but may occur as high as 2,200 m (7,215 ft) 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 m 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

Colorado National Monument

This association is known from near the head of Kodels Canyon.

Globally

This association has been described from the Colorado Plateau, specifically from western Colorado and southeastern Utah. It is likely to occur on sandy soils at low to moderate elevations throughout the plateau.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This association is known from a single site at 1525 m elevation, on a gentle, northwest-facing slope. The substrate is a sandy loam derived from Wingate sandstone. Cryptogamic crusts contribute significant ground cover.

Globally
This woodland association occurs on slopes, hills, benches and alluvial terraces in the Colorado Plateau of western Colorado and southeastern Utah. Sites are on level to moderately sloping terrain that may be oriented to any aspect. Elevation of most stands ranges from 1,423 m to 1,880 m (4,670–6,165 ft) but may occur as high as 2,200 m (7,215 ft) 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.

VEGETATION DESCRIPTION
Colorado National Monument
This association is represented by an open canopy of *Juniperus osteosperma* and a grassy understory dominated by *Hesperostipa comata*. Shrubs contribute less than 1% cover. Other common but minor graminoids include *Poa fendleriana, Pleuraphis jamesii,* and *Achnatherum hymenoides*. Total graminoid cover may be as much as 10%. Forbs are diverse but contribute less than 5% cover. Typical species include *Hymenoxys richardsonii* and *Mirabilis multiflora*.

Globally
This woodland association has total vegetation cover that ranges from 24% to 60%. It is characterized by a savanna-like distribution of 2 m 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 *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. *Bromus tectorum* may be abundant in plots that have experienced chronic or severe disturbance.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Herb (field)	*Hesperostipa comata*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Herb (field)	*Hesperostipa comata*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (6-Jul-2005).

CLASSIFICATION COMMENTS
Colorado National Monument

Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This association was sampled at a single site. It may be found in woodlands on sandy substrates.
Colorado National Monument Plots: This association is described from 2003 field data (1 plot: COLM.0008).
Local Description Authors: J. Coles
Global Description Authors: J. Coles

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 only from Colorado National Monument, where it occurs on the midslopes of canyons, canyon bottoms, midslopes of ridges, and the talus or rockfall slopes of canyons. Sites are moderately steep to very steep (16%–84% slopes) and include all aspects. 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 range in cover from 1% to 40%. *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, Fraxinus anomala, Artemisia bigelovii, Artemisia tridentata ssp. tridentata, Atriplex canescens, Cercocarpus montanus, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum microthecum, Fendlera rupicola, Brickellia microphylla, Gutierrezia sarothrae*, 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.

DISTRIBUTION

Colorado National Monument
This association was observed and sampled near the head of Gold Star Canyon, Lizard Canyon, near the Liberty Cap trailhead and in the vicinity of the Liberty Cap Trail, north of Balanced Rock, near Independence Monument, in the vicinity of the Broadway Avenue access, in the vicinity of Red Canyon, and west of the Ribbon Trail.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Colorado National Monument
This woodland association was observed on the midslopes of canyons, canyon bottoms, midslopes of ridges, and the talus or rockfall slopes of canyons. Sites are moderately steep to very steep (16%–84% slopes), occur between 1,487 m and 1,853 m elevation, and include all aspects. The unvegetated surface has low to moderate cover of litter and bare soil and high cover of bedrock and large and small rocks. Downed wood can be present in low amounts. Parent materials are sandstones, shale, and Precambrian gneiss. Soils are rapidly drained and texturally are silt loam, sandy loam, loamy sand, clay loam, and silty clay. Site geology is Precambrian migmatitic meta-sedimentary rocks, Tidwell Member of the Morrison Formation, and Kayenta Formation.

Globally
Data are not available.

VEGETATION DESCRIPTION
Colorado National Monument
This Utah juniper / mixed shrub woodland is common within the canyons of the monument. The total vegetation cover ranged from 11% to 50% in these sparsely to moderately vegetated stands. This woodland association is characterized by an open tree canopy, typically 2 m to 5 m tall (the trees are often stunted on dry exposures) of *Juniperus osteosperma* that range in cover from 1% to 40%. Subcanopy *Juniperus osteosperma* trees are present in some stands and may provide up to 5% cover. One stand contained additional canopy trees of *Pinus edulis* and *Fraxinus anomala* that provided cover of <1% and 10%, respectively. The shrub layer is highly variable in cover and composition among stands. Tall, short, and dwarf-shrubs provided low to moderate cover and include *Amelanchier utahensis, Fraxinus anomala, Artemisia bigelovii, Artemisia tridentata ssp. tridentata, Atriplex canescens, Cercocarpus montanus, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum microthecum, Fendlera rupicola, Brickellia microphylla,* and *Gutierrezia sarothrae*, and the succulents *Echinocereus triglochidiatus, Opuntia erinacea, Opuntia fragilis, Opuntia phaeacantha, Opuntia polyacantha, Sclerocactus whipplei*, and *Yucca harrimaniae*. 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 provided the highest cover of the graminoid species, sometimes up to 15%. Forbs commonly present include *Astragalus nuttallianus, Chaenactis* spp., *Cryptantha flava, Descurainia pinnata, Draba reptans, Eriogonum inflatum, Erodium cicutarium, Heterotheca villosa, Lappula occidentalis, Lepidium densiflorum, Lepidium montanum, Physaria acutifolia, Silene antirrhina, Streptanthella longirostris, Streptanthus cordatus,* and *Tetraneuris acaulis*. The fern ally *Selaginella densa* was observed in one stand and provided up to 5% cover.

Globally
Data are not available.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Tree canopy	*Fraxinus anomala*
Herb (field)	*Hesperostipa comata, Pleuraphis jamesii*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (10-Jan-2005).

CLASSIFICATION COMMENTS
Colorado National Monument
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 Canyon Wall Mixed Vegetation (ARCH, CANY), *Artemisia bigelovii* Canyonside Mixed Shrubland (ARCH, CANY), *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
Colorado National Monument Inventory Notes: The stands are located on slopes that include Precambrian gravel and rockfall substrates that are too hot and dry for pinyon pine to establish.
Colorado National Monument Plots: The description is based on 2003 field data (12 plots): (Plots: COLM.0005, COLM.0020, COLM.0024, COLM.0172, COLM.0185, COLM.0217, COLM.0219, COLM.0229, COLM.0260, COLM.0267, COLM.0275, COLM.0276).
Local Description Authors: J. Von Loh
Global Description Authors: M.S. Reid and J. Coles

REFERENCES: 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

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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 southwestern Colorado and likely occurs into eastern Utah. Stands occur on a variety of sites from flat or gentle lower slopes, benches, mesa tops to moderately steep slopes on montane alluvial fans. Parent materials are frequently sandstone and shale. Aspects are often western or southern, but have been reported from the east-facing slopes. 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,* 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

Colorado National Monument

This association is rare in the monument. It was observed and sampled in Kodels Canyon.

Globally

This association is known from four counties (Montrose, San Miguel, Mesa, and Saguache) in the southwestern portion of Colorado. It may be more widespread (Isaacson 1967, P. Lyon pers. comm.)

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This woodland association was observed at a single site at 1,490 m on a moderately sloping upper canyon wall. The unvegetated surface has high cover by gravel and large rocks. Cryptogamic cover is well-developed but patchy. The soil parent material is Wingate sandstone, eroded and distributed as colluvium. Soils are rapidly drained sandy loams.

Globally

Data are not available.

VEGETATION DESCRIPTION

Colorado National Monument

This pinyon-juniper / needle-and-thread association is uncommon within the monument. The total vegetation cover is approximately 45% in these sparsely to moderately vegetated stands. This woodland association is characterized by an open canopy, typically 2 m–5 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees that each range in cover from 5% to 15%, and the bunchgrass *Hesperostipa comata*

that ranges in cover from 1% to 5%. Scattered shrubs are present but do not form a layer. *Ephedra viridis* is the only shrub species that occurs with more than trace cover. The herbaceous layer is diverse and provides up to 10% cover. *Achnatherum hymenoides* may be codominant with *Hesperostipa comata,* and *Pleuraphis jamesii* is often present with low cover. Forbs are more diverse but contribute little cover and include *Hymenoxys richardsonii* and *Mirabilis multiflora*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Achnatherum hymenoides, Hesperostipa comata*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Colorado National Monument
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 southwestern 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, nonnative species invasion, and possibly fire suppression.

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This association may be more common than a single sample would indicate, as sandy substrates favoring *Hesperostipa comata* and *Achnatherum hymenoides* are common.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot: COLM.0007).
Local Description Authors: J. Coles
Global Description Authors: D. Clark

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data, CONHP unpubl. data 2003, Driscoll et al. 1984, Isaacson 1967, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Amelanchier utahensis Woodland
Two-needle Pinyon - Utah Juniper / Utah Serviceberry Woodland

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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 western Colorado. Stands in northwestern Colorado are at lower elevations (1,528 to 1,950 m) and tend to occur on northerly aspects. Stands in central and southern Colorado occur at higher elevations (2,481 m to 2,510 m) and have southerly aspects. Stands throughout the range may be on gentle to steep slopes (7% to 160%). Soils are rapidly drained but texture and parent materials vary from clay to sandy loam and from marine shale to sandstone and granite. The unvegetated ground 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

Colorado National Monument

This association was observed and sampled near the south and west entrances of the park and near Alcove Trail.

Globally

This association is found in the Colorado Plateau and central Rocky Mountains of western Colorado.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This woodland association was observed on drainage margins in canyons and valleys and on the midslope of a hill. Sites are gentle to moderate (4% to 25% slopes), occur between 1,528 m and 1,950 m elevation, and are oriented to northeastern aspects. The unvegetated surface ranges from low to moderate for litter

and bare soil and is high for bedrock, large rocks, and small rocks. Parent materials are sandstones and shale, either as bedrock exposures or as particles eroded from the exposures. Soils are fine to coarse in texture. Site geology is Kayenta Formation and Wingate Formation sandstones and shale of the Tidwell Member of the Morrison Formation.

Globally
This association is characteristic of rocky slopes in western Colorado. Stands in northwestern Colorado are at lower elevations (1,528 m–1,950 m) and tend to occur on northerly aspects. Stands in central and southern Colorado occur at higher elevations (2,481 m–2,510 m) and have southerly aspects. Stands throughout the range may be on gentle to steep slopes (7% to 160%). Soils are rapidly drained, but texture and parent materials vary from clay to sandy loam and from marine shale to sandstone and granite. The unvegetated ground is composed primarily of exposed bedrock, rocks, gravel and bare ground.

VEGETATION DESCRIPTION
Colorado National Monument
This pinyon-juniper woodland association is rare, found along drainages and in alcoves within the monument. The total vegetation cover ranged from 26% to 43% in these moderately vegetated stands. This woodland association is characterized by an open tree canopy, typically 2 m to 10 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees that each range in cover from 1% to 20% and the tall-shrub stratum of *Amelanchier utahensis* that is 2 m – 10 m tall and ranges from <1% to 8% cover. The shrub layer is moderately variable in cover and composition. Common tall, short, and dwarf-shrubs that contribute low cover, typically less than 10%, include *Fraxinus anomala, Cercocarpus montanus, Chrysothamnus viscidiflorus, Ephedra viridis, Fendlera rupicola, Gutierrezia sarothrae, Rhus trilobata,* and *Yucca harrimaniae*. The herbaceous layer provides low cover, typically less than 5%. Common graminoids present include *Achnatherum hymenoides, Bromus tectorum, Leymus salinus,* and *Poa fendleriana*. Forbs commonly present include *Eriogonum ovalifolium, Lepidium montanum, Physaria acutifolia,* and *Streptanthella longirostris*.

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 m 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 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, Artemisia ludoviciana, Collinsia parviflora, Erigeron peregrinus, Eriogonum ovalifolium, Heterotheca villosa, Lathyrus lanszwertii, Lepidium montanum, Phlox austromontana,* and *Streptanthella longirostris*. Disturbed stands may contain *Bromus tectorum*.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*
Herb (field)	*Bromus tectorum, Leymus salinus*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*

Tall shrub/sapling *Amelanchier utahensis*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (11-Jan-2005).

CLASSIFICATION COMMENTS
Colorado National Monument
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
Colorado National Monument Inventory Notes: Sites are associated with more mesic areas.
Colorado National Monument Plots: The description is based on 2003 field data (3 observation points: COLM.0401, COLM.0435, COLM.0519).
Local Description Authors: J. Von Loh
Global Description Authors: J. Drake and J. Coles

REFERENCES: Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Artemisia bigelovii Woodland
Two-needle Pinyon - Utah Juniper / Bigelow Sagebrush Woodland

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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 1,476 m and 2,104 m (4,840–6,900 ft) 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 m – 5 m tall dominated by *Pinus edulis* and *Juniperus osteosperma* with 2% to 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% to 10% cover. Other typical shrubs are *Echinocereus triglochidiatus, 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

Colorado National Monument

This association was observed and sampled above Kodels Canyon, near the East Entrance, Historic Trails Overlook, north of the Monument Canyon trailhead, Monument Canyon Trail, the tilted rock formation between Wedding and Monument canyons, along Otto's Trail, on the mesa south of Ute Canyon, along Rimrock Drive, on the rim of Columbus Canyon, along Liberty Cap Trail, mesa along No Thoroughfare Canyon, and along Ribbon Trail on property managed by the U.S. Bureau of Land Management.

Globally

This association is found in western Colorado and southeastern Utah.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This woodland association was observed on tilted bedrock formations of mesa tops and canyon rims. Sites are gentle to steep (2%–70% slopes), occur between 1,476 m and 1,926 m elevation, and include all aspects. The unvegetated surface can have low to high cover of litter, bedrock, and bare soil. Large and small rocks may occur in low to moderate amounts of cover. Parent materials are sandstones. Soils are well-drained to rapidly drained (one site had somewhat poorly drained soils) and texturally are loamy sand, sandy loam, and silt loam. Site geology is Kayenta Formation and Wingate Formation sandstones.

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 1º and 35º) 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 1,476 m and 2,104 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.

VEGETATION DESCRIPTION

Colorado National Monument

This pinyon-juniper / flat sagebrush woodland association is common on mesa tops tilted to the north and east with mantles of thin soil over bedrock. The total vegetation cover ranges from 11% to 44% in these sparsely to moderately vegetated stands. This woodland association is characterized by an open tree canopy, typically 2 m to 5 m tall, of *Juniperus osteosperma* and *Pinus edulis* trees that range in cover from 3% to 20% and 2 to 10%, respectively, and the dwarf-shrub *Artemisia bigelovii* that ranges in cover from 2% to 10%. *Fraxinus anomala* occurs as a canopy tree in one stand providing 6% cover. The shrub layer is highly variable in composition and low in cover. Tall shrubs present and providing sparse cover include *Cercocarpus montanus, Fendlera rupicola, Fraxinus anomala, Juniperus osteosperma, Pinus edulis*, and *Purshia stansburiana*. Short shrubs commonly present provided low cover by *Artemisia*

tridentata ssp. wyomingensis, Atriplex canescens, Cercocarpus intricatus, Ephedra viridis, Eriogonum corymbosum, and *Grayia spinosa*. Other dwarf-shrubs contributed sparse cover, including *Brickellia microphylla, Chrysothamnus viscidiflorus,* and *Gutierrezia sarothrae, Petradoria pumila,* and the succulents *Echinocereus triglochidiatus, Opuntia erinacea, Opuntia phaeacantha, Opuntia polyacantha,* and *Yucca harrimaniae*. The herbaceous layer is typically sparse, usually less than 5% total cover and sometimes less. A diverse group of species can occur across stands, but any one stand will usually have low diversity. Common graminoids provide sparse to low cover and include *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Elymus elymoides, Vulpia octoflora, Hesperostipa comata, Pleuraphis jamesii,* and *Poa fendleriana*. Forbs commonly present include *Arenaria fendleri, Descurainia pinnata, Draba reptans, Erodium cicutarium, Heterotheca villosa, Tetraneuris acaulis, Lappula occidentalis, Lepidium montanum, Physaria acutifolia, Selaginella densa, Silene antirrhina,* and *Streptanthus cordatus*. Cryptogam cover is variable with some stands having very little, but occasionally cover can be as high as 50%.

Globally
This woodland association generally has sparse to moderate total vegetation cover. There is an open tree canopy 2 m to 5 m tall and dominated by *Pinus edulis* and *Juniperus osteosperma*. These tree species can vary in abundance from 2% to 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% to 10% cover. Other typical components of the shrub stratum include *Echinocereus triglochidiatus, Ephedra viridis, Eriogonum corymbosum, Fraxinus anomala* (which can be present in the tree canopy, as well), and *Gutierrezia sarothrae.* 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,* and *Tetraneuris acaulis*. Stands of this community sampled at higher elevation have northern aspects and more dense vegetation cover.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tree subcanopy	*Pinus edulis*
Herb (field)	*Yucca harrimaniae*
Herb (field)	*Heterotheca villosa*
Herb (field)	*Achnatherum hymenoides, Bromus tectorum, Hesperostipa comata, Pleuraphis jamesii*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Herb (field)	*Artemisia bigelovii*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (15-Dec-2004).

CLASSIFICATION COMMENTS

Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Stands grow on bedrock overlain by very thin soils or from exposed sandstone bedrock.
Colorado National Monument Plots: The description is based on 2003 field data (12 plots: COLM.0016, COLM.0039, COLM.0043, COLM.0161, COLM.0173, COLM.0174, COLM.0235, COLM.0237, COLM.0244, COLM.0250, COLM.0251, COLM.0253, and 8 observation points: COLM.0378, COLM.0398, COLM.0414, COLM.0463, COLM.0483, COLM.0488, COLM.0489, COLM.0503).
Local Description Authors: J. Von Loh
Global Description Authors: J. Drake, mod. J. Coles

REFERENCES: 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 association occurs in western Colorado and eastern Utah on the higher areas of local topographical features such as canyon rims, mesas, ridgetops, and upper slopes. Sites are nearly level to moderately steep and tend toward northern aspects, although other directions are possible. Elevation ranges from 1,772 m to 2,518 m (5,800–8,260 ft). Soils are fine-textured and rapidly drained. Parent materials are often sandstones or limestones. 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 has an open tree canopy dominated by short evergreen trees 2 m to 10 m tall. *Pinus edulis* and *Juniperus osteosperma* dominate the tree canopy and may form a sparse subcanopy 2 m to 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 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, 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, Carex spp., *Koeleria macrantha,* and *Poa fendleriana* and forbs *Arabis* spp., *Petradoria pumila, Phlox* spp., and many others.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled in upper Ute Canyon, along Glade Park Road, near Cold Shivers Point, on Monument Mesa, on the mesa south of Ute Canyon, on Black Ridge, and at the Coke Ovens Overlook.

Globally

This association is found in western Colorado and eastern Utah.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This woodland association was observed on ridgetops and slopes of ridges, and on mesa tops. Sites are gentle (2% to 10% slopes), occur between 1,772 m and 2,140 m elevation, and are oriented to northern aspects. One steep site (48% slope) occurs on Black Ridge. The unvegetated surface has low to high cover of litter and low to moderate cover by bare soil, large and small rocks, and bedrock. Cryptogamic cover can be as high as 75% on some stands. Downed wood is generally sparse but can be as high as 12% cover. Parent materials are sandstones and shale. Soils are moderately well-drained to rapidly drained and texturally are clay loam and sandy loam. Site geology is Dakota Formation and Kayenta Formation sandstone, Brushy Basin and Burro Canyon members of the Morrison Formation, and eolian deposits.

Globally

This association occurs on the higher areas of local topographical features such as canyon rims, mesas, ridgetops, and upper slopes. Sites are nearly level to moderately steep and tend toward northern aspects, although other directions are possible. Elevation ranges from 1,772 m to 2,518 m. Soils are loams or sandy clay and tend to be shallow and rapidly drained. Parent materials are often sandstones but can 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

Colorado National Monument

This pinyon pine - Utah juniper / black sagebrush woodland association is commonly distributed on the western and south-central portions of the monument. The total vegetation cover ranged from 15% to 68% in these low to moderately vegetated stands. This woodland association is characterized by an open tree canopy, typically 2 m to 10 m tall, of *Pinus edulis* and *Juniperus osteosperma* that each range in cover from 3% to 35%, and the dwarf-shrub *Artemisia nova* that ranges from 1% to 20% cover. A subcanopy, typically 2 m to 5 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees provided up to 3% cover. The shrub layer is highly variable in composition but is sparse to low in terms of cover. The tall, short, and dwarf-shrub strata include *Amelanchier utahensis, Artemisia tridentata ssp. wyomingensis, Cercocarpus montanus, Ephedra viridis, Fraxinus anomala, Grayia spinosa, Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Eriogonum microthecum, Gutierrezia sarothrae,* and *Leptodactylon pungens,* and the succulents *Opuntia erinacea, Opuntia fragilis, Opuntia polyacantha, Sclerocactus whipplei,* and *Yucca harrimaniae*. The herbaceous layer is typically sparse, usually less than 5% cover. A diverse group of species can occur across stands, but any one stand will usually have low diversity. Common graminoids include *Achnatherum hymenoides, Bromus tectorum, Elymus elymoides, Vulpia octoflora, Hesperostipa comata, Leymus salinus, Pleuraphis jamesii,* and *Poa fendleriana*. Forbs commonly present include *Allium textile, Arabis* spp., *Arenaria hookeri, Calochortus nuttallii, Cryptantha flavoculata, Cymopterus bulbosus, Delphinium nuttallianum, Descurainia pinnata, Heterotheca villosa, Tetraneuris acaulis, Lappula occidentalis, Lepidium montanum, Penstemon caespitosus, Petradoria pumila, Phlox longifolia, Physaria acutifolia, Senecio integerrimus, Silene*

antirrhina, and *Streptanthella longirostris*. Cryptogam cover is variable with some stands having very little, but occasionally cover can be as high as 75%.

Globally
This woodland association has an open tree canopy dominated by short evergreen trees 2 m to 10 m tall. *Pinus edulis* and *Juniperus osteosperma* dominate the tree canopy and may form a sparse subcanopy 2 m to 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, 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, Carex* spp., *Koeleria macrantha,* and *Poa fendleriana*. Forbs can include *Arabis* spp., *Petradoria pumila, Phlox* spp., and many others.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tree subcanopy	*Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Artemisia nova, Gutierrezia sarothrae, Leptodactylon pungens, Opuntia fragilis, Opuntia polyacantha, Yucca harrimaniae*
Herb (field)	*Heterotheca villosa, Petradoria pumila*
Herb (field)	*Achnatherum hymenoides, Leymus salinus, Pleuraphis jamesii*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Herb (field)	*Artemisia nova*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (11-Jan-2005).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This association is typical where it occurs on Morrison Formation shale exposures and there is little contact between black sagebrush and Wyoming big

sagebrush. Where contact between the sagebrush species occurs, there is hybridization, and the affected plants are more similar to *Artemisia nova* in morphology. Monument Mesa and the area around Cold Shivers Point contain the majority of what appear to be hybrid plants. For this study, hybrid plants are considered *Artemisia nova*.
Colorado National Monument Plots: The description is based on 2003 field data (8 plots: COLM.0101, COLM.0102, COLM.0105, COLM.0133, COLM.0138, COLM.0167, COLM.0168, COLM.0255, and 9 observation points: COLM.0386, COLM.0417, COLM.0420, COLM.0421, COLM.0422, COLM.0444, COLM.0445, COLM.0454, COLM.0499).
Local Description Authors: J. Von Loh
Global Description Authors: J. Drake, mod. J. Coles

REFERENCES: Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland
Two-needle Pinyon - Utah Juniper / Littleleaf Mountain-mahogany Woodland

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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, and colluvial slopes at moderate elevations of 1,585 m to 2,470 m (5,200–8,100 ft) 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 m–10 m), open tree canopy (10% to 25% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*, and by the dominance of *Cercocarpus intricatus* in the relatively sparse short-shrub layer (10% to 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
Colorado National Monument
This association was observed and sampled east of the northern tunnel on Rimrock Drive, on the mesa east of Cold Shivers Point, along Serpent's Trail, and near the Monument Canyon trailhead on the east side of the monument.

Globally
This plant association is found on the Colorado Plateau and in extreme northwestern Colorado, adjacent Utah, and possibly Wyoming.

ENVIRONMENTAL DESCRIPTION
Colorado National Monument
This woodland association was observed growing on rimrock and caprock in cracks along the edges of barren, tilted mesas on the eastern side of the monument. Sites are moderately steep to steep (6%–32% slopes), occur between 1,636 m and 1,876 m elevation, and are oriented to eastern aspects (the direction of the tilted sandstone slabs). The unvegetated surface has sparse to moderate cover of litter and moderate to high cover by bedrock and large and small rocks. Parent materials are sandstones, and plants are typically rooted in bedrock cracks. Soils are rapidly drained and texturally are loamy sand and sandy loam. Site geology is Kayenta Formation sandstone.

Globally
This woodland association occurs on dry, sandstone ridgetops, mesa edges, outcrops, and colluvial slopes at moderate elevations (1,585 m–2,470 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. Bare soil is common.

VEGETATION DESCRIPTION
Colorado National Monument
This pinyon-juniper / littleleaf mountain-mahogany woodland association is distributed along the eastern edge of the monument. The total vegetation cover ranged from 15% to 44% in these sparsely to moderately vegetated stands. This woodland association is characterized by a sparse tree canopy, typically 2 m to 10 m tall, of *Pinus edulis* and *Juniperus osteosperma* that each range in cover from 1 to 15%, and *Fraxinus anomala* that ranged in cover from 0% to 2%. A large portion of the association cover is provided by the short shrub *Cercocarpus intricatus*, ranging from 5 to 35% cover and rooting in bedrock cracks. Large open expanses of bedrock are present in the community. The remaining shrub layer is highly variable in composition, but the cover is typically low. Short and dwarf-shrubs present include *Ephedra viridis, Ericameria nauseosa, Rhus trilobata, Artemisia bigelovii*, and *Gutierrezia sarothrae*, and the succulents *Echinocereus triglochidiatus, Opuntia erinacea, Opuntia polyacantha, Sclerocactus whipplei*, and *Yucca harrimaniae*. The herbaceous layer is typically sparse, usually less than 5% cover. A diverse group of species typically occurs at each stand. Common graminoids, largely bunch grasses, include *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Elymus elymoides, Vulpia octoflora, Hesperostipa comata, Pleuraphis jamesii*, and *Poa fendleriana*. Forbs commonly present are *Chaenactis douglasii, Descurainia pinnata, Draba reptans, Erodium cicutarium, Gilia stenothyrsa, Heterotheca villosa, Lepidium montanum, Petradoria pumila, Silene antirrhina, Streptanthella longirostris*, and *Valeriana edulis*. Cryptogam cover is sparse because the stands have very little soil for establishment.

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 (10%–25% cover). The tree canopy may be between 2 m and 10 m tall, and *Pinus edulis* and *Juniperus osteosperma* vary in cover between 1% and 15%, with some stands having up to 25% cover of *Pinus edulis*. 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*, 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.*

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Fraxinus anomala*
Short shrub/sapling	*Cercocarpus intricatus*
Herb (field)	*Artemisia bigelovii, Yucca harrimaniae*
Herb (field)	*Achnatherum hymenoides, Aristida purpurea, Hesperostipa comata*

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

Colorado National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (30-Dec-2000). The plant association are 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

Colorado National Monument

Data are not available.

Globally

Compare this association with *Juniperus osteosperma / Cercocarpus intricatus* Woodland (CEGL000733) which is very similar, but lacks *Pinus edulis*.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Colorado National Monument Inventory Notes: This association is confined to exposed outcrops of Kayenta sandstone.
Colorado National Monument Plots: The description is based on 2003 field data (4 plots: COLM.0038, COLM.0163, COLM.0169, COLM.0252, and 1 observation point: COLM.0396).
Local Description Authors: 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, Cogan et al. 2004, Driscoll et al. 1984, Western Ecology Working Group n.d., Zimmerman 1978

Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland
Two-needle Pinyon - Utah Juniper / Mixed Shrubs Talus Woodland

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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 open woodland association is found in western Colorado generally on lower slopes where talus and rockfalls accumulate. Sites can be between 1,498 m and 2,291 m (4,900–7,500 ft) 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 sparse. The sparse to open tree canopy is 2 m to 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 tridentata ssp. vaseyana, Cercocarpus montanus, Echinocereus triglochidiatus, Ephedra viridis, Gutierrezia sarothrae,* and *Opuntia* spp. 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,* and *Streptanthus cordatus*. Cryptogams are rare or absent on these active slopes.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled in Ute Canyon, north of the Coke Ovens, 6 km east of the CCC trailhead on Rimrock Drive, on a mesa north of Red Canyon, in Fruita Canyon, on the uplands above Kodels Canyon, and at the east monument entrance.

Globally

This association is found in western Colorado.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This woodland association was observed midslope on ridges, on slopes in canyons, on rockfall or talus slopes, and on mesas. Sites are gentle to steep (7%–73% slopes), occur between 1,498 m and 2,013 m elevation, and include all aspects. The unvegetated surface is low to moderate for litter and low to high for bedrock, large and small rocks, and bare soil. Cryptogamic cover is absent from these active slopes. Parent materials are sandstones and shale that have deposited on slopes. Soils are rapidly drained and

texturally are loamy sand, loam, silty clay, and sandy loam. Site geology is rockfall (talus) deposits, older landslide deposits, Tidwell Member of the Morrison Formation, Chinle Formation, and Kayenta and Wingate sandstones.

Globally
This association is found on midslopes of ridges and in ravines and canyons on talus and rockfalls. Sites are found between 1,498 m and 2,291 m elevation. Slopes can be gentle to steep 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 rapidly drained clay loam, loam, sandy loam, and loamy sand. The parent material is talus rockfall.

VEGETATION DESCRIPTION
Colorado National Monument
This pinyon-juniper / mixed shrub woodland associated with talus slopes is common in all canyons within the monument. The total vegetation cover ranges from 4% to 61% in these sparsely to moderately vegetated stands but was predominantly sparse (<15% cover). This woodland association is characterized by a very open to scattered tree canopy, typically 2 m to 5 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees that range in cover from <1% to 15% and 1% to 45%, respectively. A few *Fraxinus anomala* canopy trees were present in some stands but provided less than 5% cover. The shrub layer is highly variable in composition but is typically sparse to low in cover. Tall shrubs, commonly present are 2 m to 5 m in height, provide sparse to low cover and include *Amelanchier utahensis, Fraxinus anomala, Juniperus osteosperma,* and *Pinus edulis*. Short and dwarf-shrubs also provide sparse to low cover; the common species present include *Cercocarpus montanus, Chrysothamnus viscidiflorus, Ephedra viridis, Eriogonum corymbosum, Fendlera rupicola, Rhus trilobata, Artemisia bigelovii, Artemisia ludoviciana, Brickellia microphylla, Gutierrezia sarothrae,* and *Leptodactylon pungens*, and the succulents *Echinocereus triglochidiatus, Opuntia erinacea, Opuntia phaeacantha, Opuntia polyacantha,* and *Yucca harrimaniae*. The herbaceous layer is typically sparse to low in terms of cover, usually less than 5% total cover. A diverse group of species can occur across stands, but any one stand will usually have low diversity. Common graminoids include *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Bromus tectorum, Elymus elymoides, Hesperostipa comata, Leymus salinus, Pleuraphis jamesii, Poa fendleriana, Pseudoroegneria spicata,* and *Vulpia octoflora*. Forbs commonly present include *Arenaria fendleri, Artemisia ludoviciana, Chamaesyce glyptosperma, Cryptantha* sp., *Descurainia pinnata, Draba reptans, Galium coloradoense, Heterotheca villosa, Lepidium montanum, Physaria acutifolia, Selaginella densa, Silene antirrhina, Streptanthella longirostris, Streptanthus cordatus,* and *Valeriana edulis*. Scattered tree seedlings of *Juniperus osteosperma* and *Pinus edulis* are present, providing up to 5% cover in some stands. Cryptogam cover is absent or sparse on these active slopes.

Globally
This woodland association can have sparse to moderate vegetation cover (4%–61%) but is most often <15%. The sparse to open tree canopy is 2 m to 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 tridentata ssp. vaseyana, Cercocarpus montanus, Echinocereus triglochidiatus, Ephedra viridis, Gutierrezia sarothrae,* and *Opuntia* spp. 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,* and *Streptanthus cordatus*. Cryptogams are rare or absent on these active slopes.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Fraxinus anomala*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Artemisia bigelovii, Brickellia microphylla, Opuntia erinacea*
Herb (field)	*Achnatherum hymenoides, Bouteloua gracilis, Bromus tectorum, Hesperostipa comata, Leymus salinus, Poa fendleriana*
Herb (field)	*Selaginella densa*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Opuntia fragilis*
Herb (field)	*Achnatherum hymenoides, Elymus elymoides, Poa fendleriana*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (11-Jan-2005).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Stands occupy slopes of mostly rockfall or talus that is of sandstone origin.
Colorado National Monument Plots: The description is based on 2003 field data (10 plots: COLM.0046, COLM.0055, COLM.0087, COLM.0123, COLM.0129, COLM.0143, COLM.0170, COLM.0177, COLM.0194, COLM.0262).
Local Description Authors: J. Von Loh
Global Description Authors: J. Drake

REFERENCES: Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Petradoria pumila Woodland
Two-needle Pinyon - Utah Juniper / Grassy Rock-goldenrod Woodland

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CODE	CEGL002332
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 eastern Utah and western Colorado on upper topographic positions between 1,841 m and 2,195 m (6,050–7,200 ft) elevation. It occurs on level to gently sloping sites on any aspect with thin soils over sandstone or shale bedrock. Litter, bedrock, and bare soil are the most common components of the ground cover. This woodland association has a short, open tree canopy dominated by evergreen tree species. Total vegetation cover is sparse to moderate. The dominant tree species are *Pinus edulis* and *Juniperus osteosperma*; either species can have cover between 1% and 25%. The shrub layer is absent to moderate and has low diversity. *Ephedra viridis, Gutierrezia sarothrae,* and succulents, such as *Echinocereus triglochidiatus, Opuntia erinacea, Opuntia fragilis,* and *Yucca harrimaniae*, are the most common species. The herbaceous layer has low cover, as well, but tends to have greater diversity. Common grasses, such as *Achnatherum hymenoides, Bromus tectorum, Elymus elymoides,* and *Poa fendleriana*, provide sparse cover. The forb *Petradoria pumila* is the most abundant herbaceous species and is characteristic of this association. Other forbs include *Arenaria fendleri, Descurainia pinnata, Eriogonum alatum, Heterotheca villosa, Streptanthus cordatus,* and *Tetraneuris acaulis*.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled on a mesa north of Red Canyon, on the rim of No Thoroughfare Canyon, and on BLM land south of the monument.

Globally

This association is found in western Colorado and eastern Utah.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This woodland association was observed growing on canyon rims and mesa tops where bedrock was mantled with only thin soil. Sites are gentle (2%–7% slopes), occur between 1,895 m and 2,098 m elevation, and include all aspects. The unvegetated surface has moderate to high cover of litter, bedrock, and bare soil. Downed wood can be relatively common, up to 8% cover. Parent materials are sandstones. Soils are somewhat poorly to rapidly drained and are texturally sandy loam. Site geology is Wingate, Kayenta, and Wanakah sandstones.

Globally

This association is found on canyon rims, mesatops, and interfluves between 1,841 m and 2,195 m elevation. It occurs on level to gently sloping sites and on any aspect. Soils are thin and usually well- to rapidly drained over sandstone or shale bedrock. Litter, bedrock, and bare soil are the most common components of the ground cover.

VEGETATION DESCRIPTION

Colorado National Monument

This pinyon-juniper woodland association is rarely encountered within the monument. The total vegetation cover ranged from 17% to 51% in these moderately vegetated stands. This woodland association is characterized by an open tree canopy, typically 2 m to 10 m tall, of *Pinus edulis* and *Juniperus osteosperma* that range in cover from 1% to 5% and 1% to 25%, respectively, and the forb

Petradoria pumila that ranges in cover from 1% to 15%. Sapling *Pinus edulis* trees can provide up to 5% cover in a stand. The shrub layer has low diversity and provides only sparse cover by *Ephedra viridis* and *Gutierrezia sarothrae*, and the succulents *Echinocereus triglochidiatus, Opuntia erinacea, Opuntia fragilis,* and *Yucca harrimaniae*. The herbaceous layer is typically low in cover but somewhat diverse. Additional forbs present include *Arenaria fendleri, Descurainia pinnata, Lepidium montanum, Silene antirrhina, Streptanthella longirostris, Streptanthus cordatus, Tetraneuris acaulis, Tetraneuris ivesiana,* and *Valeriana edulis*. Common graminoids provide sparse cover and include *Achnatherum hymenoides, Bromus tectorum, Elymus elymoides, Poa fendleriana,* and *Vulpia octoflora*. Cryptogam cover is sparse, typically less than 5%.

Globally
This woodland association has a short, open tree canopy dominated by evergreen tree species. Total vegetation cover is sparse to moderate. The dominant tree species are *Pinus edulis* and *Juniperus osteosperma* which range between 2 and 10 m tall, and either species can have cover between 1% and 25% in the tree canopy. The shrub layer is absent to moderate and has low diversity. *Ephedra viridis, Gutierrezia sarothrae,* and succulents, such as *Echinocereus triglochidiatus, Opuntia erinacea, Opuntia fragilis,* and *Yucca harrimaniae,* are the most common species. The herbaceous layer has low cover, as well, but tends to have greater diversity. Common grasses, such as *Achnatherum hymenoides, Bromus tectorum, Elymus elymoides,* and *Poa fendleriana,* provide sparse cover. The forb *Petradoria pumila* is the most abundant herbaceous species and is characteristic of this association. Other forbs that may be present include *Arenaria fendleri, Descurainia pinnata, Eriogonum alatum, Heterotheca villosa, Streptanthus cordatus,* and *Tetraneuris acaulis*.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Herb (field)	*Gutierrezia sarothrae, Opuntia fragilis*
Herb (field)	*Petradoria pumila*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Herb (field)	*Petradoria pumila*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (11-Jan-2005).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This association occurs predominantly on thin soils and exposed bedrock.
Colorado National Monument Plots: The description is based on 2003 field data (3 plots): (Plots: COLM.0093, COLM.0131, COLM.0225).
Local Description Authors: J. Von Loh
Global Description Authors: J. Drake

REFERENCES: Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland
Two-needle Pinyon - Utah Juniper / Sparse Understory Woodland

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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 southeastern Utah. It is found most commonly on mid- to upper slopes, though other topographic positions are possible. It has been sampled at elevations between 1,580 m and 2,389 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% to 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 can be found as sparsely to moderately vegetated stands with total vegetation cover ranging from 3% to 75%. The tree canopy is dominated by *Pinus edulis* and *Juniperus osteosperma*. Both typically range from 1% to 35% cover with some stands having canopy cover by one species up to 50%. The tree canopy is short, usually 2 m to 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
Colorado National Monument

This association was observed and sampled near the Campground, along Liberty Cap Trail, the Old Gordon Trail, in Ute Canyon, on the mesa south of Ute Canyon, in No Thoroughfare Canyon, the mesa above No Thoroughfare Canyon, near Black Ridge, in Monument Canyon, on Monument Mesa, in the mouth of Red Canyon, on a mesa north of Red Canyon, near the south entrance of the monument, and on BLM land (Ribbon Trail and southwest of the monument).

Globally
association is known to occur in western Colorado and southeastern Utah.

ENVIRONMENTAL DESCRIPTION
Colorado National Monument
This woodland association was observed on the mid- and upper slopes of mesas, midslopes of hills, mid- and upper slopes of ridges, steps-in-slope of benches, and in canyon bottoms. Sites are flat to moderately steep (0%–46% slope), occur between 1,583 m and 2,166 m elevation, and include all aspects. The unvegetated surface has low to high cover of litter and moderate to high cover of small and large rocks, bedrock, and bare soil. Downed wood is common and can have cover up to 15%. Cryptogamic cover is highly variable but can be as high as 65%. Parent materials are sandstones, shale, and Precambrian gneiss. Soils are rapidly drained to moderately well-drained and texturally are sandy loam, loamy sand, and silty clay. Site geology is diverse and includes Kayenta, Wingate, and Entrada (Board Beds unit) sandstones, Tidwell and Brushy Basin members of the Morrison Formation, Precambrian migmatitic meta-sedimentary rock and gravel, and eolian and valley fill deposits.

Globally
This woodland association is found most commonly on mid- to upper slopes, though other topographic positions are possible. It has been sampled at elevations between 1,580 m and 2,389 m and on all aspects. At higher elevations, such as in Black Canyon of the Gunnison National Recreation Area, it tends toward southwestern aspects. Sites range from flat to moderately steep (0º–25º). 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% to 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
Colorado National Monument
This pinyon-juniper woodland association is widely distributed throughout the monument. The total vegetation cover ranged from 8% to 47% in these sparsely to moderately vegetated stands. This woodland association is characterized by an open tree canopy, typically 2 m to 10 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees that each range in cover from 1% to 45%. *Fraxinus anomala* is rarely observed as a canopy tree and provides up to 5% cover. In the subcanopy, *Pinus edulis* and *Juniperus osteosperma* trees from 2 m to 5 m tall provide up to 2% cover. The shrub component is highly variable in composition but is usually sparse or low in cover. Tall shrubs commonly present include *Amelanchier utahensis* and *Fraxinus anomala*, in addition to sapling *Juniperus osteosperma* and *Pinus edulis* trees. Short and dwarf-shrubs provide sparse to low cover by *Artemisia tridentata ssp. tridentata, Artemisia tridentata ssp. wyomingensis, Cercocarpus montanus, Ephedra viridis, Ericameria nauseosa, Juniperus osteosperma, Pinus edulis, Chrysothamnus viscidiflorus, Eriogonum microthecum,* and *Gutierrezia sarothrae*, and the succulents *Echinocereus triglochidiatus, Opuntia erinacea, Opuntia fragilis, Opuntia phaeacantha, Opuntia polyacantha, Sclerocactus whipplei*, and *Yucca harrimaniae*. The herbaceous layer is very diverse but typically sparse, usually less than 5% total cover and often less. Common graminoids include *Achnatherum hymenoides, Bouteloua gracilis, Bromus tectorum, Elymus elymoides, Vulpia octoflora, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana,* and *Poa secunda*. Forbs commonly present include *Arenaria fendleri, Ceratocephala testiculata, Chenopodium album, Cirsium undulatum,*

Cryptantha spp., *Cymopterus purpureus, Descurainia pinnata, Draba reptans, Chamaesyce glyptosperma, Heterotheca villosa, Lappula occidentalis, Lepidium montanum, Oenothera pallida, Petradoria pumila, Phlox longifolia, Physaria acutifolia, Senecio integerrimus, Silene antirrhina, Sphaeralcea coccinea, Stenotus armerioides, Streptanthella longirostris,* and *Streptanthus cordatus*. Cryptogam cover is variable with many stands having very little, but occasionally cover can be as high as 65%.

Globally
This widespread association can be found as sparsely to moderately vegetated stands with total vegetation cover ranging from 3% to 75%. The tree canopy is dominated by *Pinus edulis* and *Juniperus osteosperma*. Both typically range from 1% to 35% cover with some stands having canopy cover by one species up to 50%. The tree canopy is short, usually 2 m to 10 m tall, and open to moderately closed. *Fraxinus anomala* has been observed in the canopy of some stands at COLM, 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., 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
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*, *Pinus edulis*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (15-Dec-2004).

CLASSIFICATION COMMENTS
Colorado National Monument
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.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Colorado National Monument Inventory Notes: This association occupies a variety of substrates from eolian deposits to exposed bedrock. The woodland may be stunted and have sparse to low cover or may be quite tall with moderate cover.

Colorado National Monument Plots: The description is based on 2003 field data (23 plots: COLM.0013, COLM.0079, COLM.0080, COLM.0089, COLM.0092, COLM.0106, COLM.0110, COLM.0117, COLM.0124, COLM.0126, COLM.0128, COLM.0141, COLM.0146, COLM.0148, COLM.0159, COLM.0181, COLM.0187, COLM.0211, COLM.0214, COLM.0271, COLM.0272, COLM.0282, COLM.0287, and 18 observation points: COLM.0305, COLM.0339, COLM.0358, COLM.0359, COLM.0407, COLM.0410, COLM.0415, COLM.0425, COLM.0426, COLM.0428, COLM.0432, COLM.0434, COLM.0446, COLM.0448, COLM.0490, COLM.0495, COLM.0498, COLM.0500).

Local Description Authors: J. Von Loh, mod. J. Coles

Global Description Authors: J. Drake, mod. J. Coles

REFERENCES: 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

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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 1,465 m to 2,500 m (4,800–8,200 ft). 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 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) dominates a 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, or species of *Yucca* and *Opuntia*. Herbaceous cover is variable but generally sparse and dominated by graminoids (<5% cover) with scattered forbs.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled on the mesa north of Red Canyon, in Ute Canyon, on the mesa south of Ute Canyon, on Monument Mesa, in No Thoroughfare Canyon, in the vicinity of the Old Gordon Trail, south of Rimrock Drive, north of CS Road, near the Monument Canyon trailhead, west of the Ribbon trailhead, near the mouth of Wedding Canyon, north of Monument Valley trailhead, in Fruita Canyon, and near the Liberty Cap Trail.

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

Colorado National Monument

This woodland association was observed growing on alluvial fans, tops of mesas, on canyon slopes, and midslopes of ridges. Sites are typically flat or gentle (0%–8% slopes) (one stand occurred on a moderately steep (26%) slope), occur between 1,459 m and 2,144 m elevation, and include all aspects. The unvegetated surface has low to high cover of litter and low to moderate cover of bedrock, large and small rocks, and bare soil. Cryptogamic cover can be up to 50% in some stands. Downed wood is uncommon to common. Parent materials are variable, including sandstones, shale, and Precambrian gneiss. Soils are rapidly drained to moderately well-drained and are texturally sand, loamy sand, and sandy loam. Site geology is primarily eolian and valley fill deposits, in addition to rockfall deposits, Tidwell Member of the Morrison Formation, Kayenta Formation, and Precambrian migmatitic meta-sedimentary rocks.

Globally

This broadly defined woodland association occurs on dry foothills and mesas across much of the Colorado Plateau and adjacent areas. Elevations range from 1,459 m to 2,502 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

Colorado National Monument

This pinyon-juniper / Wyoming big sagebrush woodland association is widely distributed on mesa tops and in canyon bottoms. The total vegetation cover ranged from 12% to 62% in these sparsely to moderately vegetated stands. This woodland association is characterized by an open tree canopy, typically 2 m to 5 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees that range in cover from 0% to 25% and 2% to 65%, respectively, and by the short shrub *Artemisia tridentata ssp. wyomingensis* that ranges in cover from 1% to 20%. *Juniperus osteosperma* and *Pinus edulis* are also present in the subcanopy in several stands, and each provides cover up to 5%. The shrub layer is somewhat variable in composition and typically provides low to moderate cover. The tall shrub *Fraxinus anomala* provided sparse cover in only a few stands. Short and dwarf- shrubs provide low cover, including *Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra viridis, Krascheninnikovia lanata, Artemisia bigelovii, Echinocereus triglochidiatus, Eriogonum microthecum*, and *Gutierrezia sarothrae*, and the succulents *Opuntia erinacea, Opuntia fragilis, Opuntia polyacantha, Sclerocactus whipplei*, and *Yucca harrimaniae*. The herbaceous layer is typically low in terms of cover, usually less than 5% total cover, but relatively

diverse. Common graminoids include *Achnatherum hymenoides, Agropyron cristatum, Bouteloua gracilis, Bromus tectorum, Elymus elymoides, Hesperostipa comata, Pleuraphis jamesii, Poa fendleriana, Sporobolus cryptandrus,* and *Vulpia octoflora*. Forbs commonly present include *Allium acuminatum, Astragalus mollissimus, Chaenactis douglasii, Chenopodium album, Cryptantha* spp., *Cymopterus acaulis var. fendleri, Descurainia pinnata, Draba reptans, Erysimum capitatum, Heterotheca villosa, Lappula occidentalis, Lepidium montanum, Oenothera pallida, Phlox longifolia, Senecio integerrimus, Silene antirrhina, Sphaeralcea coccinea, Streptanthella longirostris,* and *Townsendia incana*. Cryptogam cover is variable with some stands having little, but cover can be as high as 20%.

Globally
This woodland is characterized by a typically open tree canopy (10% to 30% cover but ranges to 50% cover) that ranges from 2 m to 10 m tall in most stands. The 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 from northwestern New Mexico, western Colorado, Arizona, and Utah. *Juniperus scopulorum* is more common in higher elevation stands. *Artemisia tridentata* dominates a 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,* 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
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Artemisia bigelovii, Artemisia tridentata* ssp. *wyomingensis, Ephedra viridis*
Herb (field)	*Gutierrezia sarothrae, Opuntia fragilis, Opuntia polyacantha, Yucca harrimaniae*
Herb (field)	*Descurainia pinnata*
Herb (field)	*Bromus tectorum, Hesperostipa comata*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma, Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION COMMENTS

Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This is predominantly a community of deep eolian deposits supporting stands of *Artemisia tridentata ssp. wyomingensis* that became invaded by *Pinus edulis* and *Juniperus osteosperma* trees. The cover of Wyoming big sagebrush is decreased under the tree canopies.
Colorado National Monument Plots: The description is based on 2003 field data (13 plots: COLM.0012, COLM.0044, COLM.0064, COLM.0076, COLM.0078, COLM.0091, COLM.0100, COLM.0111, COLM.0121, COLM.0127, COLM.0142, COLM.0191, COLM.0245, and 18 observation points: COLM.0306, COLM.0307, COLM.0311, COLM.0318, COLM.0369, COLM.0379, COLM.0381, COLM.0384, COLM.0449, COLM.0451, COLM.0469, COLM.0479, COLM.0480, COLM.0497, COLM.0508, COLM.0510, COLM.0522).
Local Description Authors: J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles

REFERENCES: Bourgeron and Engelking 1994, Bunting 1987, CONHP unpubl. data 2003, Cogan et al. 2004, 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, NVNHP 2003, Stuever and Hayden 1997a, Tiedemann 1978, USFS 1983a, USFS 1985a, USFS 1985e, Warren et al. 1982, Western Ecology Working Group n.d., Wright et al. 1979

Pinus edulis - Juniperus spp. / *Cercocarpus montanus* - Mixed Shrub Woodland
Two-needle Pinyon - Juniper species / Mountain-mahogany - Mixed Shrub 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 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 1,472 m to 2,480 m (4,830–8,135 ft). 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. The canopy averages 2 m to 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 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 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

Colorado National Monument

This association is widely distributed throughout the monument, except at the lowest elevations, and was observed and sampled along Monument Trail, west of Coke Ovens Trail, near the maintenance yard, near Artist's Point/Highlands View Overlook, Monument Overlook, along Rimrock Drive, along the Old Gordon Road, rim of No Thoroughfare Canyon, along Liberty Cap Trail, at Otto's Bathtub, on Monument Mesa, in Ute Canyon, on the mesa south of Ute Canyon, on the mesa north of Red Canyon, near the southwestern monument entrance, in Fruita Canyon, above Kodels Canyon on adjacent BLM land, along Ribbon Trail, on Black Ridge, along Black Ridge Trail, BLM property southwest and west of the monument, and BLM property in Echo Canyon.

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

Colorado National Monument

This woodland association was observed on the midslopes and upper slopes of mesas, mesa rims, canyon ledges and rims, middle and upper slopes of ridges, on benches, ravine slopes, talus slopes in canyons, broad canyon heads, and in alcoves. Sites are moderately steep to steep (6%–56% slopes), occur between 1,472 m and 2,155 m elevation, and include all aspects. The unvegetated surface often has low cover of litter and mosses or lichens. Bedrock, large and small rocks, and bare soil typically comprise much of the unvegetated surface but can be variable. Cryptogamic cover can be over 50% in some stands. Downed wood is uncommon. Parent materials are variable and include sandstones, shale, landslide or alluvial deposits. Soils are moderately well-drained to rapidly drained and texturally range from loamy sand to clay and silty clay, but are usually coarse. Site geology is Kayenta, Wingate, Wanakah, and Entrada sandstones, Tidwell and Burro Canyon members of the Morrison Formation, rockfall deposits, Chinle Formation rockfall, older landslide deposits, and eolian deposits.

Globally

This broadly defined woodland association is common on the Colorado Plateau, occurring on 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 1,472 m to 2,480 m (4,830–8,135 ft). Stands occur on gentle to steep (3º–35º) 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

Colorado National Monument

This pinyon-juniper / mountain-mahogany woodland association is the most widely distributed community within the monument. The total vegetation cover ranged from 10% to 45% in these sparsely to moderately vegetated stands. This woodland association is characterized by an open tree canopy, typically 2 m to 5 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees that each range in cover from 1% to 25%. One stand had a single emergent tree of *Pinus ponderosa* that, because of its size, had 40% cover. Scattered individuals of *Fraxinus anomala* occur in some stands as small trees of tall shrubs. *Pinus edulis* and *Juniperus osteosperma* also occur in most stands as shorter seedlings or saplings but usually with cover less than 5%. The shrub layer is highly variable in cover and composition. *Cercocarpus montanus* is present in all stands, ranging in cover from <1% to over 30%, and with heights varying from <0.5 m to 5 m. Other tall shrubs commonly present, but with <5% cover, include *Amelanchier utahensis, Purshia stansburiana,* and *Quercus gambelii*. Short and dwarf-shrubs can contribute moderate cover; species present in most stands include *Ephedra viridis, Chrysothamnus viscidiflorus, Opuntia* spp., and *Gutierrezia sarothrae*. Other common shrubs occurring with low cover include *Artemisia tridentata ssp. tridentata, Artemisia tridentata ssp. wyomingensis, Ericameria parryi, Eriogonum corymbosum, Holodiscus dumosus, Rhus trilobata, Artemisia bigelovii, Artemisia nova, Atriplex confertifolia, Brickellia microphylla, Mahonia repens*, and succulents such as *Echinocereus triglochidiatus, Sclerocactus whipplei,* and *Yucca harrimaniae*. The herbaceous layer is typically sparse, usually less than 10% total cover and often less. A diverse group of species can occur across stands, but any one stand will usually have low diversity. Common graminoids include *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Elymus elymoides, Vulpia octoflora, Hesperostipa comata, Leymus salinus, Pleuraphis jamesii, Poa fendleriana,* and *Pseudoroegneria spicata*. Forbs commonly present include *Arenaria* spp., *Calochortus gunnisonii, Cryptantha* spp., *Descurainia pinnata, Eriogonum alatum, Galium coloradoense, Heterotheca villosa, Lappula occidentalis, Lepidium montanum, Penstemon caespitosus, Petradoria pumila, Phlox longifolia, Senecio integerrimus, Silene antirrhina, Stanleya pinnata, Streptanthella longirostris,* and *Tetraneuris acaulis*. Cryptogam cover is variable with some stands having very little, but occasionally cover can be as high as 60%.

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 m to 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% to 35% cover. It typically occurs as a short shrub <2 m tall but can be a tall shrub (2 m–5 m) on some sites. Other shrubs may be present, including *Amelanchier* spp., *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. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Andropogon gerardii, Bouteloua curtipendula, Bouteloua gracilis, Bouteloua hirsuta, Carex rossii, Leymus salinus (= Elymus salinus), Hesperostipa comata, Koeleria macrantha, Muhlenbergia pauciflora, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana, Pseudoroegneria spicata*, and *Schizachyrium scoparium*. Common forbs include species of *Cryptantha, Eriogonum, Penstemon* and *Phlox*. 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.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tree subcanopy	*Pinus edulis*
Tall shrub/sapling	*Cercocarpus montanus, Purshia stansburiana*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Heterotheca villosa, Petradoria pumila, Tetraneuris acaulis*
Herb (field)	*Bromus tectorum*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma, Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Cercocarpus montanus*

OTHER NOTEWORTHY SPECIES

Colorado National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Colorado National Monument

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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Colorado National Monument Inventory Notes: This is a very widespread association that occurs over most substrates in the Monument and provides from sparse to dense cover.

Colorado National Monument Plots: The description is based on 2003 field data (37 plots: COLM.0054, COLM.0074, COLM.0075, COLM.0081, COLM.0082, COLM.0088, COLM.0108, COLM.0112, COLM.0114, COLM.0115, COLM.0116, COLM.0119, COLM.0125, COLM.0130, COLM.0137, COLM.0139, COLM.0144, COLM.0145, COLM.0166, COLM.0188, COLM.0189, COLM.0192, COLM.0195, COLM.0207, COLM.0212, COLM.0221, COLM.0222, COLM.0223, COLM.0224, COLM.0228, COLM.0232, COLM.0254, COLM.0280, COLM.0283, COLM.0284, COLM.0285,

COLM.0288, and 41 observation points: COLM.0310, COLM.0314, COLM.0315, COLM.0319, COLM.0335, COLM.0345, COLM.0350, COLM.0351, COLM.0356, COLM.0360, COLM.0361, COLM.0363, COLM.0380, COLM.0382, COLM.0385, COLM.0387, COLM.0388, COLM.0389, COLM.0393, COLM.0400, COLM.0402, COLM.0406, COLM.0409, COLM.0411, COLM.0419, COLM.0429, COLM.0447, COLM.0457, COLM.0468, COLM.0476, COLM.0477, COLM.0478, COLM.0482, COLM.0484, COLM.0485, COLM.0491, COLM.0492, COLM.0506, COLM.0507, COLM.0511, COLM.0514).
Local Description Authors: 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, Cogan et al. 2004, Driscoll et al. 1984, Erdman 1962, Erdman 1969, 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, Stuever and Hayden 1997a, USFS 1981a, USFS 1981b, USFS 1983a, USFS 1985d, USFS 1985e, USFS 1985g, Vories 1974, Western Ecology Working Group n.d., Wright et al. 1979

Pinus edulis - Juniperus spp. / *Leymus salinus* Woodland
Two-needle Pinyon - Juniper species / Salinas Lyme Grass 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 (47% to more than 100% slopes), although a minority of stands occur on gentle slopes with gradients not exceeding 10%. Elevations range between 1,483 m and 2,301 m (4,865–7,550 ft). 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

Colorado National Monument

This association was observed and sampled in Fruita Canyon, on the CCC Trail, on the Black Ridge Trail, and north of Liberty Cap trailhead.

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

Colorado National Monument

This woodland vegetation association was observed growing on the midslopes of canyons, and the toeslope, midslope, and upper slopes of ridges. Sites are gentle to moderately steep (5%–32% slope), occur between 1,483 m and 1,997 m elevation, and most are oriented to northern or eastern aspects. The unvegetated surface often has low to moderate cover of litter and moderate to high cover of large and small rocks and bare soil. Cryptogams may be absent or range up to 35% cover. Parent materials are shale, typically white to pink in color, derived from Morrison Formation outcrops. Soils are rapidly drained to moderately well-drained and texturally are silt loam, clay loam, and silty clay. Site geology is rockfall deposits (talus formed below Tidwell Member cliffs), older landslide deposits (containing large blocks of chert), and Tidwell Member of the Morrison Formation.

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. These sites range from moderately to steeply sloping (47% to more than 100% slopes), although a minority of stands occur on gentle slopes with gradients not exceeding 10%. Elevations range between 1,483 m and 2,301 m (4,865–7,550 ft), with most stands occurring above 1,700 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

Colorado National Monument

This pinyon-juniper / Salina wildrye woodland type occurs primarily adjacent to Black Ridge on the western portion of the monument and to the White Rocks area on the eastern monument boundary. The total vegetation cover ranges from 7% to 20% in these sparsely vegetated stands. The vegetation is characterized by an open canopy 2 m to 5 m tall of *Juniperus osteosperma* that ranges in cover from 1% to 25% and the tall bunchgrass *Leymus salinus ssp. salinus* that ranges in cover from 1% to 15%. *Pinus edulis* trees may also be present in the canopy. Scattered dwarf-shrubs typically provide sparse to low cover. Shrubs that commonly occur include *Ephedra viridis, Artemisia nova, Atriplex confertifolia, Chrysothamnus depressus, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Leptodactylon pungens, Opuntia erinacea, Opuntia polyacantha,* and *Petradoria pumila*. The herbaceous layer is also typically sparse to low in cover. Common graminoids in addition to *Leymus salinus* include *Achnatherum hymenoides, Pleuraphis jamesii, Poa fendleriana,* and *Vulpia octoflora*. Forbs commonly present include *Allium textile, Arabis pulchra, Arenaria fendleri, Calochortus gunnisonii, Cymopterus bulbosus, Descurainia pinnata, Lappula occidentalis, Lepidium montanum, Oenothera pallida, Phlox*

austromontana, Ceratocephala testiculata, Silene antirrhina, Sphaeralcea coccinea, 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%–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 *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*. *Bromus tectorum* is common in stands that have experienced disturbance from roads or grazing.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Herb (field)	*Atriplex confertifolia, Chrysothamnus viscidiflorus*
Herb (field)	*Leymus salinus*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Herb (field)	*Leymus salinus*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

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
Colorado National Monument
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

Colorado National Monument Inventory Notes: Utah juniper trees are invading the Salina wildrye bunchgrass communities in many of the plots.
Colorado National Monument Plots: The description is based on 2003 field data (7 plots): (Plots: COLM.0104, COLM.0196, COLM.0201, COLM.0203, COLM.0204, COLM.0205, COLM.0248).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: J. Coles

REFERENCES: Baker 1982b, Shute and West 1978, Western Ecology Working Group n.d.

IIb. Deciduous Woodlands

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 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 2,015 m (6,600 ft) 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 m to 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 ramosissima*, and (in the south) *Quercus gambelii*. Herbaceous cover and species composition are variable. The herbaceous stratum may be sparse or dominated by native and introduced species typically found in disturbed areas. *Bromus tectorum* is common. Other typical species are *Heterotheca villosa, Poa pratensis, Sisymbrium altissimum, Lepidium latifolium, Taraxacum officinale,* and *Verbascum thapsus*.

DISTRIBUTION
Colorado National Monument
This association, represented by one stand, was observed and sampled at the head of Kodels Canyon. Another small stand of *Acer negundo* trees was observed near the head of Ute Canyon but was part of a larger *Salix exigua* shrubland. Only scattered, typically individual *Acer negundo* trees were observed elsewhere in the monument.

Globally
This association has been sampled in the Colorado Plateau from northwestern Colorado to southwestern Utah and is likely widespread elsewhere in the southwestern U.S.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument
This woodland association was observed at the edge of a plunge pool in an alcove at the base of an ephemeral waterfall. The site is gentle (8% slope), located at 1,681 m elevation, and is oriented to 50º. The unvegetated surface consists predominantly of bedrock, large rocks, small rocks, and litter in addition to the bare soil of the plunge pool bottom. Parent materials are sandstone alluvium. Soils are moderately well-drained and texturally are silt loam. Site geology is Wingate Formation sandstone that is present as a vertical cliff face and alcove from which pour-off occurs.

Globally
This association is found on flat to gently sloping riparian sites near permanent or temporary streams below 2,015 m (6,600 ft) 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
Colorado National Monument
This box-elder woodland association is very rare in the monument. The total vegetation cover is 46% for this moderately vegetated stand. This woodland association is characterized by an open tree canopy, between 10 m to 15 m tall, of *Acer negundo* and *Acer glabrum* trees that each range in cover between 15% and 25%. The shrub layer is sparse, contributing <2% cover and includes *Fraxinus anomala* and *Ericameria nauseosa*. The herbaceous layer is sparse and depauperate in terms of diversity. Graminoids present at low cover include the nonnatives *Bromus tectorum* and *Poa pratensis*. Forbs present contributing sparse cover include *Descurainia pinnata, Maianthemum stellatum, Streptanthus cordatus,* and *Taraxacum officinale*. The liana *Clematis ligusticifolia* also contributed sparse cover.

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 m and 15 m tall and dominated by *Acer negundo*. *Acer negundo* is also present as seedlings and saplings. Other trees that can be present are *Acer glabrum, Juniperus osteosperma,* and *Juniperus scopulorum*. Shrub cover is sparse, though it can be more prominent when the tree canopy is open. The shrub stratum is usually less than 2 m tall and contains species such as *Artemisia tridentata ssp. tridentata, Ericameria nauseosa, Fraxinus anomala, Rhus trilobata, Ribes cereum, Tamarix ramosissima,* and (in the south) *Quercus gambelii*. Herbaceous cover and species composition are variable. The herbaceous stratum is dominated by native and introduced species typically found in disturbed areas. *Bromus tectorum* 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
Colorado National Monument

Stratum	Species
Tree canopy	*Acer glabrum, Acer negundo*
Short shrub/sapling	*Ericameria nauseosa*
Herb (field)	*Bromus tectorum*

Globally

Stratum	Species
Tree canopy	*Acer negundo*
Herb (field)	*Bromus tectorum*

OTHER NOTEWORTHY SPECIES

Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (14-Aug-2001).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This type could possibly occur in other shaded pour-offs located in the heads of major canyons or side canyons.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot: COLM.0010).
Local Description Authors: J. Von Loh
Global Description Authors: J. Drake, mod. J. Coles

REFERENCES: Cogan et al. 2004, 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 Riparian Woodland and Shrubland (CES306.821)
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 1,430 m and 2,043 m (4,700–6,700 ft) 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 m–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

Colorado National Monument

This woodland association was observed and sampled in Fruita Canyon and near the Broadway Street trail access, where it occupied narrow, cobble- and boulder-lined drainages.

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

Colorado National Monument

This woodland association was observed along intermittent drainages. Sites are narrow and relatively gentle (6%–10% slopes), occur at 1,471 m elevation, and are oriented to northeastern aspects. The unvegetated surface has high cover of large and small rocks and low cover of litter. Downed wood may be common if it is deposited by flood flows from the canyons. Parent materials are variable and include sandstones, shale, and Precambrian gneiss. Soils are well-drained to rapidly drained and texturally are sandy loam. Site geology is rockfall deposits, but the materials are constantly redistributed by flood flows and replenished by bank erosion.

Globally

This woodland association is found in deep canyons and mountains on the Colorado Plateau in southwestern Utah and western Colorado. Elevation ranges from 1,430 m to 2,043 m (4,700–6,700 ft). 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

Colorado National Monument

This singleleaf ash woodland association is uncommon along boulder-lined drainages on the east side of the monument. The total vegetation cover ranged from 13% to 20% in these linear, sparsely vegetated stands. This woodland association is characterized by the canopy and tall-shrub layer of *Fraxinus anomala* that ranged in cover up to 15%. Additional canopy trees that are from 2 m to 5 m tall include *Juniperus osteosperma* and *Pinus edulis* that range in cover from 1% to 5%. The shrub layer is variable in terms of cover and composition, largely due to the distribution pattern along the drainages. Tall shrubs contributed sparse cover by *Amelanchier utahensis* and the nonnative *Tamarix ramosissima*. Short and dwarf-shrubs are diverse but contribute low cover, including *Atriplex canescens, Brickellia* sp., *Ephedra viridis, Ericameria nauseosa, Fendlera rupicola, Rhus trilobata, Artemisia bigelovii, Echinocereus triglochidiatus, Eriogonum microthecum,* and *Gutierrezia sarothrae*. Graminoids are relatively diverse, with several nonnative species, but provide only sparse cover by *Achnatherum hymenoides, Bromus japonicus, Bromus tectorum, Dactylis glomerata, Elymus elymoides, Vulpia octoflora,* and *Hesperostipa comata*. Few forbs occurred and provided sparse cover, including *Artemisia ludoviciana* and *Lepidium montanum*.

Globally
This association is characterized by a moderately dense (30%–50%) cold-deciduous tall-shrub canopy that is typically 2 m to 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
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Tree canopy	*Fraxinus anomala*
Tall shrub/sapling	*Amelanchier utahensis*
Herb (field)	*Artemisia bigelovii*
Herb (field)	*Artemisia ludoviciana*
Herb (field)	*Achnatherum hymenoides, Bromus japonicus, Bromus tectorum, Hesperostipa comata*

Globally

Stratum	Species
Tall shrub/sapling	*Amelanchier alnifolia, Fraxinus anomala, Quercus gambelii*
Short shrub/sapling	*Ericameria nauseosa, Rhus trilobata*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GUQ (26-Jun-2001).

CLASSIFICATION COMMENTS
Colorado National Monument
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
Colorado National Monument Inventory Notes: This association is distributed in drainages on the eastern toeslopes of the monument. It also occurs in small patches on sparsely vegetated sandstone bedrock slabs. *Colorado National Monument* Plots: The description is based on 2003 field data (1 plot: COLM.0193 and 1 observation point: COLM.0521).

Local Description Authors: J. Von Loh
Global Description Authors: G. Kittel, mod. J. Drake and J. Coles

REFERENCES: CONHP Ecology Team 2001, Cogan et al. 2004, Kittel et al. 1999a, Welsh et al. 1987, Western Ecology Working Group n.d.

Populus deltoides (ssp. *wislizeni*, ssp. *monilifera*) / *Salix exigua* Woodland **(Rio Grande Cottonwood, Plains Cottonwood) / Coyote Willow Woodland**

CODE	CEGL002685
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 DELTOIDES TEMPORARILY FLOODED WOODLAND ALLIANCE (A.636) Eastern Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.821) Western Great Plains Floodplain (CES303.678)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This is a lowland riparian association known from the Rio Grande, Pecos and Canadian River drainages of central and eastern New Mexico and probably elsewhere in northern New Mexico. It also occurs in the Great Plains in Colorado, North Dakota, Nebraska, Oklahoma, South Dakota, and Texas, and in the Colorado Plateau of Utah and Colorado. This association occurs in wide river corridors that have low-gradient and primarily sandy/gravelly beds (becoming cobbly with increasing gradients). Elevations range from 1,380 m to 1,980 m (4,525–6,500 ft). The type is most often found proximal to perennial rivers on low sidebars and streambanks near streambank-full levels (discharge ratios close to one). Occasionally, it can be found within the active channel or nearby. Because of its low position, the type is flooded frequently (average recurrence interval is 5 years). Most soils are young and undeveloped Entisols, and soils within the active channel are classified as Riverwash. Soils tend to be well-drained sands with mixtures of cobbles and gravels throughout the profile. Most soils tend to be moist or wet within 1 m, at least during seasonal high water. In some soils, moisture indicators are found at greater depths. This association is dominated by relatively young stands of *Populus deltoides* that form open to moderately open overstories (25%–50 % cover) with thickets of *Salix exigua* in the understory. *Baccharis salicina* is often well-represented to abundant and may codominate. Herbaceous cover is abundant, particularly among graminoids, and numerous (23) native wetland indicators can be present such as *Schoenoplectus pungens (= Scirpus pungens), Scirpus microcarpus, Eleocharis palustris, Juncus balticus, Juncus longistylis, Juncus tenuis, Glyceria striata, Carex aquatilis, Carex oreocharis, Carex scoparia, Carex stipata, Equisetum arvense*, and *Equisetum laevigatum*. Overall, herbaceous diversity is high (90 species), and still predominantly native in composition (66 species, or 73%).

DISTRIBUTION

Colorado National Monument

This association was observed and sampled in lower and middle No Thoroughfare Canyon, upper and middle Ute Canyon, mouth of Columbus and Red Canyons, in lower and upper Red Canyon, in Columbus Canyon, in the mouth of Wedding Canyon, and at Sunken Curve near the east tunnel on Rimrock Drive.

Globally
This association is found in the Rio Grande, Pecos and Canadian River drainages of central and eastern New Mexico and probably elsewhere in northern New Mexico. It also occurs in the Great Plains in Colorado, North Dakota, Nebraska, Oklahoma, South Dakota, and Texas, as well as the Colorado Plateau of Colorado and Utah.

ENVIRONMENTAL DESCRIPTION
Colorado National Monument
This forest association was observed in drainages, canyon bottoms, and at the head of alcoves. Sites are gentle to moderately steep (2%–30% slopes), occur between 1,511 m and 1,833 m elevation, and are oriented to eastern and southeastern aspects. The unvegetated surface has high cover of litter and moderate cover of large and small rocks. Parent materials are sandstone, shale, and Precambrian gneiss. The soils are poorly drained to somewhat poorly drained and texturally are sand, sandy loam, and loamy sand. Site geology is variable and includes valley fill deposits, Holocene alluvium, meta-igneous gneiss, migmatitic meta-sedimentary rocks, and rockfall deposits.

Globally
This community type occurs in wide river corridors that have low-gradient and primarily sandy/gravelly beds (becoming cobbly with increasing gradients). Elevations range from 1,380 m to 1,980 m (4,525–6,500 ft). The type is most often found proximal to perennial rivers on low sidebars and streambanks near stream bankfull levels (discharge ratios close to 1). Occasionally, it can be found within the active channel or nearby, or at the base of pour-offs in slickrock canyons. Because of its low position, the type is flooded frequently (average recurrence interval five years). Most soils are young and undeveloped Entisols, and soils within the active channel are classified as riverwash. Soils tend to be well-drained sands with mixtures of cobbles and gravels throughout the profile. Most soils tend to be moist or wet within 1 m, at least during seasonal high water. In some soils, moisture indicators are found at greater depths.

VEGETATION DESCRIPTION
Colorado National Monument
This Rio Grande cottonwood / coyote willow woodland association is distributed in drainage bottoms and alcoves but is rare within the monument. The total vegetation cover ranges from 24% to 85% in these stands. This forest association is characterized by an open tree canopy, typically 10 m to 35 m tall, of *Populus deltoides ssp. wislizeni* that ranges in cover from 8% to 40%, and the tall shrub *Salix exigua* that ranges in cover from 0% to 50%. Scattered trees of *Celtis laevigata var. reticulata* and *Fraxinus anomala* sometimes occur in the subcanopy, but more often the open subcanopy (5 m–15 m) includes *Juniperus osteosperma, Populus angustifolia, Populus deltoides ssp. wislizeni,* and *Salix fragilis*. The tall-shrub layer is highly variable in cover and composition and typically includes *Elaeagnus angustifolia, Fraxinus anomala, Rhus trilobata, Salix lucida,* and *Tamarix ramosissima*. Short and dwarf-shrubs generally have sparse cover and may include *Artemisia tridentata ssp. tridentata, Brickellia microphylla,* and *Ericameria nauseosa*. The herbaceous layer provides sparse to low cover, often dependent on the amount of soil saturation. Common graminoids present include *Achnatherum hymenoides, Agrostis gigantea, Bromus japonicus, Bromus tectorum, Distichlis spicata, Equisetum* spp., *Pascopyrum smithii, Phragmites australis, Poa pratensis, Sporobolus airoides,* and *Typha latifolia*. Forbs commonly present are *Artemisia ludoviciana, Cirsium calcareum, Cirsium undulatum, Glycyrrhiza lepidota, Heterotheca villosa, Lepidium montanum, Maianthemum stellatum,* and *Vicia americana*. The liana *Clematis ligusticifolia* contributed up to 5% cover. Mosses can provide up to 5% cover within this association.

Globally
This type is dominated by relatively young stands of *Populus deltoides* that form open to moderately open overstories (10%–50% cover) with thickets of *Salix exigua* in the understory. Stands in the Colorado

Plateau may include *Populus* x *acuminata* in the canopy. *Baccharis salicina* is often well-represented to abundant and may codominate with *Salix* in some parts of the range. Herbaceous cover is abundant, particularly among graminoids, and numerous (23) native wetland indicators can be present, such as *Schoenoplectus pungens (= Scirpus pungens), Scirpus microcarpus, Eleocharis palustris, Juncus balticus, Juncus longistylis, Juncus tenuis, Glyceria striata, Carex aquatilis, Carex oreocharis, Carex scoparia, Carex stipata, Equisetum arvense,* and *Equisetum laevigatum*. Invasive nonnative species can also be prevalent such as *Agrostis gigantea, Agrostis stolonifera, Poa pratensis,* and *Melilotus officinalis*. Overall, herbaceous diversity is high (90 species) and still predominantly native in composition (66 species, or 73%).

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tree canopy	*Celtis laevigata* var. *reticulata, Populus deltoides* ssp. *wislizeni*
Tree subcanopy	*Juniperus osteosperma*
Tree subcanopy	*Populus angustifolia, Populus deltoides* ssp. *wislizeni, Salix fragilis*
Tall shrub/sapling	*Elaeagnus angustifolia, Fraxinus anomala, Rhus trilobata, Salix exigua, Salix lucida, Salix monticola, Tamarix ramosissima*
Short shrub/sapling	*Ericameria nauseosa*
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Clematis ligusticifolia*
Herb (field)	*Cirsium undulatum, Glycyrrhiza lepidota, Heterotheca villosa, Maianthemum stellatum, Melilotus officinalis*
Herb (field)	*Agrostis gigantea, Bromus japonicus, Bromus tectorum, Dactylis glomerata, Distichlis spicata, Juncus balticus, Phragmites australis, Poa pratensis, Sporobolus airoides, Typha latifolia*
Herb (field)	*Equisetum arvense, Equisetum laevigatum*

Globally

Tree canopy	*Populus deltoides* ssp. *monilifera, Populus deltoides* ssp. *wislizeni*
Tall shrub/sapling	*Salix exigua*

OTHER NOTEWORTHY SPECIES

Colorado National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (1-Dec-2000). This lowland riparian association is restricted to scattered stands along the Rio Grande and Pecos rivers (and their tributaries) in New Mexico, where plants, particularly trees and shrubs, have access to an active ground water table. The number of high-quality occurrences is not likely to exceed 25 in number, because as with many riparian zone communities in the Southwest, impacts over the past 150 years from livestock use, agricultural conversion, urbanization, recreational use, nonnative tree and shrub invasion, and the alteration of hydrological regimes have led to extensive fragmentation and loss of this community. Viable occurrences are mostly found along unregulated rivers where periodic flooding and sustained maintenance flows lead to successful reproduction and establishment of native riparian species. In the Southwest, such unregulated rivers are few, hence this community still is threatened, and declines continue, suggesting a rank of G3. Should declines continue the rank might need to be raised to G2.

CLASSIFICATION COMMENTS

Colorado National Monument
Data are not available.

Globally
Initially developing on exposed depositional sandbars, this mid-successional community type depends on periodic flooding for maintenance and growth, even when well-established. As sediments and debris become trapped among the woody stems, the bar becomes more stable. In this community type, the cottonwoods overtop the shrubby willows. Because the willows are limited to lower riverside bars or cutoff channels, the community type eventually changes as the trees develop into mature forests on higher terraces without the willow understory. Historically, when cottonwoods eventually died from old age or were removed in high-energy flood events, they were replaced by new, young trees. For this cycle to occur under regulated conditions, flows should mimic the natural flood regime as closely as possible.

Hink and Ohmart (1984) describe a cottonwood/coyote willow mapping unit with four structural sub-types for the middle Rio Grande. Dick-Peddie (1993) refers to a *Populus fremontii / Salix exigua* / Mesic Grass - Forb vegetation type as part of a Floodplains-Plains Riparian group that is probably inclusive of this type. This association is similar to *Populus deltoides - (Salix amygdaloides) / Salix (exigua, interior)* Woodland (CEGL000659) reported from the Great Plains states.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Restricted to narrow drainages with intermittent surface flows and groundwater seepage.
Colorado National Monument Plots: The description is based on 2003 field data (6 plots: COLM.0029, COLM.0049, COLM.0218, COLM.0220, COLM.0259, COLM.0261, and 4 observation points: COLM.0309, COLM.0472, COLM.0501, COLM.0515).
Local Description Authors: J. Von Loh
Global Description Authors: E. Muldavin et al.

REFERENCES: CONHP Ecology Team 2001, Dick-Peddie 1993, Hink and Ohmart 1984, Muldavin et al. 2000a, Western Ecology Working Group n.d.

III. Shrublands

Arctostaphylos patula Shrubland
Greenleaf Manzanita Shrubland

CODE	CEGL002696
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	ARCTOSTAPHYLOS PATULA SHRUBLAND ALLIANCE (A.788) Greenleaf Manzanita Shrubland Alliance

ECOLOGICAL SYSTEM(S): Great Basin Semi-Desert Chaparral (CES304.001)
Mogollon Chaparral (CES302.741)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

This association has been found mostly in southwestern Utah but observed in at least one stand in western Colorado. Most sites are on gentle to moderate slopes between 1,770 m and 2,655 m (5,800–8,700 ft) elevation. The short-shrub canopy can have low to high cover (5%–90%) but is consistently dominated by *Arctostaphylos patula*. Other shrubs may be found at low cover, including *Amelanchier utahensis, Artemisia tridentata, Ericameria nauseosa, Purshia tridentata, Quercus gambelii*, and *Tetradymia canescens*. The herbaceous stratum has sparse to low cover and is composed of species common to dry sites on the Colorado Plateau.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled on the only location known in the monument, approximately 1.5 km west of the eastern monument boundary near Liberty Cap Trail. An individual *Arctostaphylos patula* shrub occurred along the Old Gordon Trail, growing from a bedrock crack.

Globally

This association has been sampled extensively from Zion National Park in southwestern Utah with additional stands observed in Colorado and Dinosaur national monuments in western Colorado.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This shrubland association was observed midslope on a ridge, growing at the base of a large slab of sandstone, its only known occurrence in the monument. The site is steep (78% slope), occurs at 1,558 m elevation, and is oriented to a northeastern aspect. The unvegetated surface has high cover of litter. Parent materials are Kayenta sandstone. Soils are moderately well-drained and are texturally silt loam. The stand occurs at the base of a large, barren slab of Kayenta sandstone that contributes runoff and the rockfall.

Globally

This association usually occurs on mesatops and plateaus between 1,737 m and 2,377 m elevation. Slopes can have any aspect and are gentle to moderately sloping. One lower elevation site (1,558 m) was observed on a steep northeast slope. Soils are sands to sandy loams.

VEGETATION DESCRIPTION

Colorado National Monument

This green manzanita shrubland occurs as only one stand on the eastern side of the monument. The total vegetation cover is 98% for this dense stand. This shrubland association is characterized by a closed canopy of 1 m to 2 m tall *Arctostaphylos patula* shrubs that provided 89% cover and 2 m to 5 m tall *Amelanchier utahensis* shrubs that provided 7% cover. Other tall, short, and dwarf-shrubs present provide <1% cover and include *Cercocarpus montanus, Ephedra viridis, Artemisia bigelovii,* and *Chrysothamnus viscidiflorus*. The trees *Juniperus osteosperma* and *Pinus edulis* provided <1% cover each. The herbaceous layer is also sparse, with no individual species providing 1% cover. Graminoids and forbs present are *Achnatherum hymenoides, Poa fendleriana, Artemisia ludoviciana, Erysimum capitatum,* and *Lepidium montanum*.

Globally

This shrubland association can have variable cover but is dominated by *Arctostaphylos patula* with 5% to 90% cover. The shrub canopy is between 1 m to 2 m tall. Other shrubs contribute only limited cover. These associates include *Amelanchier utahensis, Artemisia tridentata, Ericameria nauseosa, Purshia tridentata, Quercus gambelii,* and *Tetradymia canescens*. Widely scattered trees may be found. The herbaceous stratum has sparse to low cover and is composed of species common to dry sites. These include the graminoids *Achnatherum hymenoides, Carex rossii, Hesperostipa comata, Poa fendleriana,* and *Sporobolus cryptandrus*.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Arctostaphylos patula*

Globally

Stratum	Species
Short shrub/sapling	*Arctostaphylos patula*

OTHER NOTEWORTHY SPECIES

Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Aug-2001).

CLASSIFICATION COMMENTS

Colorado National Monument
Data are not available.

Globally
Nearly all the plots for this association are from Zion National Park with one from Colorado National Monument and two from Dinosaur National Monument. The description may be skewed based on this.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES

Colorado National Monument Inventory Notes: The stand appears healthy, but is not expanding.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot): (Plot: COLM.017).
Local Description Authors: J. Von Loh
Global Description Authors: J. Drake

REFERENCES: CONHP unpubl. data 2003, Cogan et al. 2004, Western Ecology Working Group n.d.

Fendlera rupicola Talus Shrubland
Fendlerbush Talus Shrubland

CODE	CEGL002765
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	FENDLERA RUPICOLA SHRUBLAND ALLIANCE (A.2656) Fendlerbush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally
This tall-shrub association occurs in patches on cool colluvial slopes in Colorado Plateau canyons. Slopes are moderate to very steep and are often oriented to the north or east. Elevations range from 1,268 m to 1,638 m (4,160–5,375 ft). The high cover of rock on the ground surface acts both to concentrate runoff and as mulch to slow evaporation from the soil. Thus, relatively mesic species are able to persist on otherwise dry sites. Soils are sandy, skeletal, and derived from sandstones. Total vegetation cover ranges from 7% to 35% and is characterized by an open tall-shrub canopy of *Fendlera rupicola* that provides 1% to 12% cover. *Juniperus osteosperma* is usually present as scattered seedlings and saplings. Associated shrubs vary from site to site, depending on the underlying substrate, and may include *Atriplex* spp., *Chrysothamnus viscidiflorus, Ephedra* spp., *Ericameria nauseosa, Cercocarpus montanus, Fraxinus anomala, Rhus trilobata*, and several species of *Opuntia*. The herbaceous layer is sparse in cover and may include *Leymus salinus, Pleuraphis jamesii, Achnatherum hymenoides*, and *Hesperostipa comata*. Forbs provide sparse cover with no one species providing more than 1% cover. Cryptogam cover is also restricted, rarely covering more than 5% of the ground surface.

DISTRIBUTION
Colorado National Monument
This association was observed and sampled on areas of rockfall or talus slopes in the head of Kodels Canyon and in middle Monument Canyon and in lower Echo Canyon.

Globally
This association occurs on rocky canyon slopes in at least two areas of the northern Colorado Plateau of Colorado and Utah. It may also occur in northeastern Arizona.

ENVIRONMENTAL DESCRIPTION
Colorado National Monument
This shrubland association was observed as small patches growing on rockfall or talus slopes in canyons. Sites are steep (24%–54% slopes), occur between 1,492 m and 1,638 m elevation, and are oriented to northeastern to eastern aspects. The unvegetated surface has moderate cover of litter and high cover of large and small rocks. Cryptogams in the form of lichens growing on rock surfaces and cyanobacteria have low to moderate cover. Parent materials are Wingate and Kayenta sandstone. Soils drain rapidly and are coarse. Site geology is rockfall deposits.

Globally
This tall-shrub association occurs in patches on cool colluvial slopes in Colorado Plateau canyons. Slopes are moderate to very steep and are often oriented to the north or east. Elevations range from 1,268 m to 1,638 m (4,160–5,375 ft). Rocks and litter cover most of the unvegetated ground surface. The high cover of rock on the ground surface acts both to concentrate runoff and as mulch to slow evaporation from the soil. Thus, relatively mesic species are able to persist on otherwise dry sites. Soils are sandy, skeletal, and derived from sandstones. The combination of sandy rock and soils overlying a substrate that is usually a marine shale allows for both mesic and saline desert species to co-exist.

VEGETATION DESCRIPTION
Colorado National Monument
This fendlerbush talus shrubland association is rare, occurring as small patches or stands in canyons in the monument. The total vegetation cover ranges from 11% to 28% in these sparsely vegetated stands. This shrubland association is characterized by an open tall-shrub canopy of *Fendlera rupicola,* typically 1 m to 3 m tall, that provides 5% to 12% cover. The canopy tree *Juniperus osteosperma* is 2 m to 5m tall and contributes low cover (up to 10%) in some stands. The shrub layer is highly variable in composition but is typically sparse or low in cover. Commonly associated tall, short, and dwarf-shrubs include *Cercocarpus montanus, Fraxinus anomala, Atriplex canescens, Atriplex confertifolia, Ephedra viridis, Rhus trilobata,* and *Gutierrezia sarothrae,* and the succulents *Opuntia erinacea, Opuntia fragilis,* and *Opuntia*

phaeacantha. Herbaceous cover is sparse and is mostly provided by graminoids. Common graminoids are *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Vulpia octoflora, Hesperostipa comata,* and *Pleuraphis jamesii*. Forbs are uncommon and include *Descurainia pinnata, Lappula occidentalis, Lepidium montanum,* and *Silene antirrhina*. Cryptogam cover is sparse and can approach 5%.

Globally
This shrubland association is rare, occurring in small stands on colluvial canyon slopes. The total vegetation cover ranges from 7% to 35% and is characterized by an open tall-shrub canopy up to 3 m tall of *Fendlera rupicola* that provides 1% to 12% cover. *Juniperus osteosperma* is usually present as scattered seedlings and saplings. Associated shrubs vary from site to site, depending on the underlying substrate, and may include *Atriplex confertifolia, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Cercocarpus montanus, Fraxinus anomala, Rhus trilobata,* and several species of *Opuntia*. The herbaceous layer is moderate in terms of species composition but provides sparse cover. Common graminoids include *Leymus salinus, Pleuraphis jamesii, Achnatherum hymenoides,* and *Hesperostipa comata*. Forbs provide sparse cover with no one species providing more than 1% cover. Cryptogam cover is also restricted, rarely covering more than 5% of the ground surface.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Tall shrub/sapling	*Fraxinus anomala*
Tall shrub/sapling	*Cercocarpus montanus, Fendlera rupicola*
Short shrub/sapling	*Rhus trilobata*
Short shrub/sapling	*Atriplex canescens, Ephedra viridis*
Herb (field)	*Lappula occidentalis*
Herb (field)	*Bromus tectorum, Pleuraphis jamesii*

Globally

Stratum	Species
Tall shrub/sapling	*Fendlera rupicola*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Apr-2005).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Fendlera rupicola is an element, and sometimes codominant, of several shrub communities described from colluvial slopes, including *Amelanchier utahensis* Shrubland (CEGL001067). There is a great deal of uncertainty in the classification of these rocky slope shrublands in general, and assignments and concepts should be continually reviewed as new data become available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This association establishes around very large rock slabs and boulders, mostly on mesic exposures.
Colorado National Monument Plots: The description is based on 2003 field data (4 observation points: COLM.0292, COLM.0328, COLM.0349, COLM.0523).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: J. Coles

REFERENCES: Western Ecology Working Group n.d.

Artemisia nova Shrubland
Black Sagebrush Shrubland

CODE	CEGL001417
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 NOVA SHRUBLAND ALLIANCE (A.1105) Black Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Great Basin Xeric Mixed Sagebrush Shrubland (CES304.774)
Colorado Plateau Mixed Low Sagebrush Shrubland (CES304.762)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This broadly defined association is reported from eastern Wyoming and western Colorado to eastern California but may be found elsewhere in the interior western U.S. Stands occur at middle to upper elevations of 1,400 m to 2,730 m (4,590–8,960 ft) on mountain and hillslopes, ridges, mesa tops, alluvial fans and river bluffs. Sites are nearly level to steeply sloping; aspects are variable. Soils are shallow (often <30 cm deep), well-drained, and coarse-textured with high cover of gravel and cobble (desert pavement). Soil texture ranges from gravelly loam to sandy clay loam. The vegetation is characterized by an open to moderately dense (12%–40% cover) dwarf-shrub layer (<0.5 m tall) that is dominated by *Artemisia nova*. Other woody species present include *Picrothamnus desertorum (= Artemisia spinescens), Atriplex confertifolia, Artemisia tridentata, Chrysothamnus viscidiflorus, Ericameria nauseosa, Ephedra* spp., *Grayia spinosa, Krascheninnikovia lanata*, and *Opuntia erinacea*. Diagnostic of this community is a sparse herbaceous understory with only scattered grasses and forbs. Common grasses may include *Achnatherum hymenoides, Aristida purpurea, Hesperostipa comata, Pleuraphis jamesii, Pseudoroegneria spicata*, and *Poa secunda*. Forbs such as *Erysimum capitatum (= Erysimum asperum), Erigeron aphanacti, Stenotus acaulis*, and *Phlox* spp. may also be present. Scattered trees may be present, such as *Juniperus osteosperma, Pinus edulis, Pinus monophylla*, or *Yucca brevifolia*, depending on location. Introduced species are important in some stands and may include *Bromus tectorum, Salsola kali*, and *Halogeton glomeratus*.

DISTRIBUTION
Colorado National Monument
This association was observed and sampled in the monument at the western Liberty Cap trailhead, adjacent to the Liberty Cap Trail, and along Ribbon Trail on BLM land east of the monument.

Globally
This association occurs from eastern Wyoming south to west-central Colorado and west to eastern California.

ENVIRONMENTAL DESCRIPTION
Colorado National Monument
This shrubland association was observed on the midslopes of hills and ridges and on an erosion fan. Sites are relatively gentle (4%–18% slopes), occur between 1,641 m and 1,983 m elevation, and are oriented to all aspects. The unvegetated surface has low cover of litter and high cover of large and small rocks and bare soil. Cryptogam cover is variable but can be as high as 40%. Parent materials are shale derived from Morrison Formation deposits. Soils are poorly to rapidly drained and are texturally clay loam and silty clay. Site geology is the Tidwell Member of the Morrison Formation, typically white to pink in color.

Globally
Stands occur at middle to upper elevations (1,400 m–2,730 m) on mountain and hillslopes, ridges, mesatops, alluvial fans and river bluffs. Sites are nearly level to steeply sloping; aspects are variable, but stands are reported from northwestern slopes. Soils are often shallow (<30 cm deep), well-drained, calcareous and coarse-textured with high cover (35%–70% cover) of gravel and cobble (desert pavement). Soil texture ranges from gravelly loam to sandy clay loam. Adjacent vegetation includes *Juniperus osteosperma*-dominated woodlands. At Dinosaur National Monument, stands of *Artemisia nova* indicate limestone; at Mesa Verde National Park, stands occur in deep soils at the heads of drainages, as islands in a tall, mixed *Quercus - Amelanchier* shrubland.

VEGETATION DESCRIPTION
Colorado National Monument
This black sagebrush shrubland association is distributed where soils derived from shale have deposited and have not been invaded by pinyon-juniper. The total vegetation cover ranges from 15% to 24% in these sparsely to moderately vegetated stands. This dwarf-shrub association is characterized by an open canopy of *Artemisia nova* that provides from 10% to 15% cover. A diverse shrub layer is present with sparse to low cover that includes *Atriplex confertifolia, Chrysothamnus viscidiflorus, Ephedra torreyana, Ephedra viridis, Grayia spinosa, Gutierrezia sarothrae, Krascheninnikovia lanata,* and the succulents *Echinocereus triglochidiatus, Opuntia erinacea,* and *Opuntia polyacantha.* The herbaceous layer can be diverse but is usually sparse in terms of cover. Common graminoids include *Achnatherum hymenoides, Bromus tectorum, Vulpia octoflora, Hesperostipa comata, Pleuraphis jamesii, Poa fendleriana,* and *Poa secunda*. Forbs commonly present are *Arenaria fendleri, Calochortus gunnisonii, Descurainia pinnata, Draba reptans, Tetraneuris acaulis, Lappula occidentalis, Petradoria pumila,* and *Sphaeralcea coccinea*. Cryptogam cover is usually low but may be as high as 45% in some stands.

Globally
This association has an open to moderately dense (10%–40% cover) dwarf-shrub layer (<0.5 m tall) that is dominated by *Artemisia nova*. Other woody species present include *Picrothamnus desertorum (= Artemisia spinescens), Artemisia tridentata, Atriplex confertifolia, Chrysothamnus viscidiflorus, Ericameria nauseosa, Ephedra nevadensis, Ephedra torreyana, Ephedra viridis, Grayia spinosa, Krascheninnikovia lanata,* and *Opuntia erinacea*. Diagnostic of this community is a sparse herbaceous understory with only scattered grasses and forbs. Common grasses may include *Achnatherum hymenoides, Aristida purpurea, Hesperostipa comata, Pleuraphis jamesii,* and *Poa secunda*. Forbs such as *Erysimum capitatum (= Erysimum asperum), Erigeron aphanactis,* and *Phlox viridis* may be present. Scattered *Juniperus osteosperma, Pinus monophylla,* and *Yucca brevifolia* may be present in eastern Mojave stands such as Cottonwood Mountains in Death Valley National Park in California. *Juniperus osteosperma* and *Pinus edulis* have been noted in Colorado Plateau stands. Introduced species are important in some stands and may include *Bromus tectorum, Salsola kali,* and *Halogeton glomeratus*.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Short shrub/sapling	*Artemisia nova*
Herb (field)	*Lappula occidentalis, Sphaeralcea coccinea, Tetraneuris acaulis*
Herb (field)	*Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii, Poa fendleriana*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia nova*

OTHER NOTEWORTHY SPECIES

Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G5 (23-Feb-1994).

CLASSIFICATION COMMENTS

Colorado National Monument
Data are not available.

Globally
This wide-ranging and broadly defined association is distinguished from other *Artemisia nova* dwarf-shrublands by the lack of a significant graminoid layer and therefore is quite variable in species composition. Blackburn et al. (1968c) described an *Artemisia nova / Bromus tectorum* association that may be included here until a new *Artemisia nova / Bromus tectorum* Shrubland association is created in the USNVC.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Colorado National Monument Inventory Notes: This community is controlled by soil chemistry.
Colorado National Monument Plots: The description is based on 2003 field data (3 plots): (Plots: COLM.0147, COLM.0226, COLM.0231).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles

REFERENCES: Beatley 1976, Blackburn et al. 1968c, Bourgeron and Engelking 1994, Driscoll et al. 1984, Heinze et al. 1962, Leary and Peterson 1984, Milton and Purdy 1983, NVNHP 2003, Peterson 1984, Sawyer and Keeler-Wolf 1995, Western Ecology Working Group n.d.

Artemisia tridentata ssp. *tridentata / Sporobolus airoides* Shrubland
Basin Big Sagebrush / Alkali Sacaton Shrubland

CODE	CEGL002200
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)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association occurs on riparian terraces and drainage bottoms in western Colorado that rarely, if ever, flood. Elevations range from 1,521 m to 1,873 m (5,000–6,145 ft) and sites are level to gently sloping. Soils tend to be fine-textured silty clays derived from alluvium. The vegetation is characterized by a canopy of *Artemisia tridentata* ssp. *tridentata* between 1 and 3 meters tall with 30% and 45% cover, and a moderately dense understory dominated by *Sporobolus airoides* with 30% cover. Other shrubs associated with this community may include *Ericameria nauseosa, Rhus trilobata* and *Sarcobatus vermiculatus.* The herbaceous layer may include *Achnatherum hymenoides, Distichlis spicata, Pascopyrum smithii, Phragmites australis,* and *Glycyrrhiza lepidota.*

DISTRIBUTION

Colorado National Monument

This association was observed and sampled approximately 2.0 km north of the Monument Canyon trailhead, adjacent to the eastern boundary fence.

Globally

This association is known from western Colorado. It is to be expected throughout the Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This shrub association was observed in a narrow gully at the toeslope of a low ridge. The site is gently sloping (9%), occurs at 1,873 m elevation, and is oriented to the northeast. The unvegetated surface has high cover of litter and low cover of bare soil. Parent materials are variable and include sandstones, shale, and alluvial deposits. Soils are well-drained and texturally are silty clay. Site geology is old alluvium, and the site has an elevated moisture regime due to drainage flowing from canyons to the west.

Globally

This association occurs on high riparian terraces and drainage bottoms in western Colorado that rarely, if ever, flood. Elevations range from 1,521 m to 1,873 m (5,000–6,145 ft) and sites are level to gently sloping. The substrate is alluvium and soils tend to be fine-textured silty clays.

VEGETATION DESCRIPTION

Colorado National Monument

This basin big sagebrush - alkali sacaton shrubland association is rare, occupying one stand on a mesic site. The total vegetation cover is up to 90% in this densely vegetated stand. This shrubland association is characterized by the short shrub *Artemisia tridentata ssp. tridentata* and the large bunchgrass *Sporobolus airoides,* that provide cover ranging from 35% to 45%. The remaining shrub layer is diverse but provides low cover by *Ericameria nauseosa, Rhus trilobata, Sarcobatus vermiculatus, Atriplex confertifolia, Chrysothamnus viscidiflorus, Gutierrezia sarothrae,* and *Opuntia polyacantha*. Graminoids are diverse but provide low cover and include *Achnatherum hymenoides, Bromus tectorum, Distichlis spicata, Juncus balticus, Pascopyrum smithii, Phragmites australis*, and *Poa fendleriana*. Forbs contribute low cover and include *Comandra umbellata, Glycyrrhiza lepidota, Lappula occidentalis, Lepidium montanum,* and *Tragopogon dubius*.

Globally
This shrubland association is characterized by a canopy of *Artemisia tridentata* ssp. *tridentata* between 1 m and 3 m tall and between 30% and 45% cover. Other shrubs associated with this community may include *Ericameria nauseosa, Rhus trilobata* and *Sarcobatus vermiculatus*. The herbaceous layer is well developed and dominated by the bunchgrass *Sporobolus airoides* with approximately 30% cover. Other herbaceous species present vary, but may include *Achnatherum hymenoides, Distichlis spicata, Pascopyrum smithii, Phragmites australis,* and *Glycyrrhiza lepidota.* Some stands have at least rudimentary cryptobiological crusts.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Glycyrrhiza lepidota*
Herb (field)	*Bromus tectorum, Phragmites australis, Sporobolus airoides*

Globally

Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Glycyrrhiza lepidota*
Herb (field)	*Sporobolus airoides*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (6-Jan-2005).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Only one stand was observed in the monument, adjacent to the boundary fence. It is unlikely that other stands are present.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot: COLM.0243).
Local Description Authors: J. Von Loh
Global Description Authors:

REFERENCES: Western Ecology Working Group n.d.

Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Semi-natural Shrubland
Basin 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) Basin 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, occurring in small to moderate-sized patches on alluvial terraces, floodplains, and point bars. *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 nonnative 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

Colorado National Monument

This association was observed and sampled in upper and middle Ute Canyon, upper and lower No Thoroughfare Canyon, near the East Entrance, and in Fruita Canyon.

Globally

This association is widespread in southern Utah and western Colorado.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This shrubland association was observed on the first terraces along canyon bottom drainages, in the drainages, and on alluvial fans. Sites are gentle (0%–10% slopes), occur between 1,524 m and 1,926 m elevation, and are oriented to all aspects. The unvegetated surface often has high cover of litter and low to high cover of bare soil. Cryptogamic cover can be up to 10% in some stands. Parent materials are sandstones, shale, and Precambrian gneiss. Soils are somewhat poorly drained to rapidly drained and texturally are loamy sand, sandy loam, silt loam, and clay loam. Site geology is valley fill deposits and eolian deposits and sheetwash; these deposits can be many meters thick.

Globally

This association occurs on alluvial terraces, flats and fans or valley floors throughout the Colorado Plateau. Most stands occur below 2,000 m (6,560 ft) on level to gently sloping sites. Soils are variable and include sandy loams, silt loams, and clay loams, depending on the size of the stream and the geology of the watershed. Cryptobiotic soil crusts are often extensive.

VEGETATION DESCRIPTION

Colorado National Monument

This basin big sagebrush shrubland association is somewhat narrowly distributed along deeper drainage courses in canyon bottoms. The total vegetation cover ranges from 33% to 120% in these moderately to

densely vegetated stands. This shrubland association is characterized by an open to closed tall-shrub canopy, typically 1 m to 5 m tall, of *Artemisia tridentata ssp. tridentata* shrubs that range in cover from 30% to 55%. Another tall shrub present, but at <5% cover, is *Rhus trilobata*. A few *Juniperus osteosperma* and *Pinus edulis* trees, typically 2 m to 5 m tall, that provide cover up to 3%, are present in a few stands. Short and dwarf-shrubs can contribute sparse to low cover, including *Atriplex canescens, Ephedra viridis, Ericameria nauseosa, Artemisia frigida, Gutierrezia sarothrae, Opuntia erinacea*, and *Opuntia polyacantha*. The herbaceous layer is typically sparse but can have high cover of the nonnative annual grass *Bromus tectorum*. Common graminoids present include *Achnatherum hymenoides, Elymus elymoides, Vulpia octoflora, Hesperostipa comata, Hordeum jubatum, Poa fendleriana*, and *Sporobolus cryptandrus*. Forbs commonly present include *Allium acuminatum, Chenopodium* sp., *Descurainia pinnata, Descurainia sophia, Dracocephalum parviflorum, Erodium cicutarium, Ipomopsis aggregata, Lactuca serriola, Lappula occidentalis, Lepidium montanum, Plantago patagonica, Senecio integerrimus*, and *Sisymbrium altissimum*. Cryptogam cover is low and ranges from 3-10%.

Globally
This association is widespread on floodplains and terraces within the Colorado Plateau that have been subject to grazing. *Artemisia tridentata* ssp. *tridentata* is always present with cover ranging between 10% and 70% and up to 2 m in height. *Ericameria nauseosa* is not always present, but is likely to be present in the vicinity. Other shrubs that occur in this community consistently include *Atriplex canescens, Chrysothamnus viscidiflorus* and *Sarcobatus vermiculatus*. In some stands there may be scattered individuals of *Pinus edulis* or *Juniperus osteosperma*. The herbaceous layer reflects a long history of disturbance, and is dominated by nonnative annual species, especially *Bromus tectorum*. Other common herbaceous species include *Erodium cicutarium, Lappula occidentalis,* and *Sisymbrium altissimum.* Remnant native herbaceous vegetation may include scattered individuals or patches of *Achnatherum hymenoides* and *Oenothera cespitosa.*

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Tall shrub/sapling	*Rhus trilobata*
Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Short shrub/sapling	*Ericameria nauseosa*
Short shrub/sapling	*Atriplex canescens*
Herb (field)	*Bromus tectorum, Hesperostipa comata, Lappula occidentalis, Sporobolus cryptandrus*

Globally

Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Short shrub/sapling	*Ericameria nauseosa*
Herb (field)	*Bromus tectorum, Sporobolus cryptandrus*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (14-Aug-2001).

CLASSIFICATION COMMENTS
Colorado National Monument

Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Most stands are becoming decadent and would be eliminated during a fire.
Colorado National Monument Plots: The description is based on 2003 field data (5 plots: COLM.0047, COLM.0118, COLM.0152, COLM.0156, COLM.0234, and 2 observation points: COLM.0371, COLM.0450).
Local Description Authors: J. Von Loh
Global Description Authors:

REFERENCES: Cogan et al. 2004, Western Ecology Working Group n.d.

Artemisia tridentata ssp. *wyomingensis* - *Atriplex confertifolia* Shrubland
Wyoming Big Sagebrush - Shadscale Shrubland

CODE	CEGL001040
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)
Great Basin Xeric Mixed Sagebrush Shrubland (CES304.774)
Columbia Plateau Ash and Tuff Badland (CES304.081)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This type is found irregularly in xeric, alkaline sites in the Colorado Plateau and northwestern Great Plains of the United States. Slopes tend to be gentle to moderate, and alkaline substrates may be modified by a thin layer of alluvial or colluvial deposits. Stands are dominated by *Artemisia tridentata ssp. wyomingensis*, with *Atriplex confertifolia* as an associate. The understory tends to be sparse and inconsistent in its composition.

DISTRIBUTION
Colorado National Monument
This association was observed and sampled near the east entrance, adjacent to the boundary fence of the monument.

Globally
This type is found irregularly in the Great Basin and northwestern Great Plains of the United States, ranging from western North Dakota, southwest to Utah and California.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument
This shrubland association was observed on the midslope of a hill. The site is gentle (9% slope), occurs at 1,438 m elevation, and is oriented to an eastern aspect. The unvegetated surface is mostly bare soil and litter. Cryptogamic cover totaled nearly 50% on the sampled stand. Parent materials are Morrison Formation shale. Soils are rapidly drained and texturally are silty clay. Site geology is the Salt Wash Member of the Morrison Formation, an extremely alkaline exposure.

Globally
This short shrubland association occurs on slopes, ridgetops, and benches in dry habitats of the Colorado Plateau. Elevations range between 1,120 m and 1,634 m (3,680–5,360 ft), slopes range from level to gently sloping, and sites may be oriented to any aspect. Soil textures are variable, including clay loam, sandy loam and sandy clay, and generally are derived from alluvium, siltstone or shale. Soils of this association are more alkaline than those of adjacent sagebrush steppe associations (Knight et al. 1987) and similar in alkalinity to soils supporting saltbush associations. Cryptobiotic crusts may cover up to 50% of the unvegetated ground surface in undisturbed stands.

VEGETATION DESCRIPTION
Colorado National Monument
This Wyoming big sagebrush - shadscale shrubland association is present on one known site in the monument. The total vegetation cover is 36% in this moderately vegetated stand. This shrubland association is characterized by the short-shrub layer of *Artemisia tridentata ssp. wyomingensis* and *Atriplex confertifolia* that each range in cover from 5% to 15%. The associated shrubs are relatively diverse but provide low cover, including *Krascheninnikovia lanata* and *Tetradymia spinosa,* and the succulents *Echinocereus triglochidiatus, Opuntia erinacea*, and *Opuntia polyacantha*. Graminoids are uncommon and contributed low to moderate cover by *Pleuraphis jamesii* and *Bromus tectorum*. Forbs are diverse but sparse and include *Calochortus aureus, Cymopterus* sp., *Descurainia pinnata, Erodium cicutarium, Lappula occidentalis, Lepidium densiflorum, Lepidium montanum, Oenothera pallida,* and *Plantago patagonica*. Cryptogam cover is low for this association.

Globally
Stands of this somewhat sparsely vegetated association are dominated by *Artemisia tridentata ssp. wyomingensis*, with between 1% and 15% cover. *Atriplex confertifolia* is present and may be codominant. Other shrub species that may be present include *Krascheninnikovia lanata, Gutierrezia sarothrae*, and *Opuntia polyacantha*. The understory in most stands is relatively sparse, rarely exceeding 10% total cover. Herbaceous species may include small amounts of *Achnatherum hymenoides, Elymus elymoides, Pleuraphis jamesii, Lepidium montanum, Oenothera pallida, Sphaeralcea coccinea,* and *Hesperostipa comata*.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia, Tetradymia spinosa*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Bromus tectorum, Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*

OTHER NOTEWORTHY SPECIES
Colorado National Monument

Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK
Global Rank & Reasons: G3G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
This type needs further characterization. In the Great Plains, the type may be synonymous with *Artemisia tridentata - Atriplex confertifolia* Shrubland (CEGL000993). More information is needed as to how much *Atriplex confertifolia* cover is needed to classify a stand as this association. A number of the existing *Artemisia tridentata ssp. wyomingensis* associations list *Atriplex confertifolia* as an associate. Knight et al. (1987) indicate that in their stands, *Artemisia tridentata ssp. wyomingensis* averaged 7% cover, *Picrothamnus desertorum* averaged 1% cover, and *Atriplex confertifolia* averaged <1%. This closely resembles plots at Dinosaur National Monument that were assigned to other *Artemisia tridentata ssp. wyomingensis* associations.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This type is limited to one known stand; additional stands may exist where Morrison Formation outcrops occur, along the eastern and western edges of the monument.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot: COLM.0015).
Local Description Authors: J. Von Loh
Global Description Authors: D. Faber-Langendoen, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Kagan et al. 2000, Knight et al. 1987, MTNHP 2002b, NDNHI unpubl. data, Western Ecology Working Group n.d.

Artemisia tridentata ssp. *wyomingensis / (Agropyron cristatum, Psathyrostachys juncea)* Seeded Grasses Semi-natural Shrubland
Wyoming Big Sagebrush / (Crested Wheatgrass, Russian Wildrye) Seeded Grasses Semi-natural Shrubland

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CODE	CEGL002185
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 has been observed in western Colorado and eastern Utah, though it is very likely to be more widespread in the western U.S. It occurs on generally level topography that has been or is currently disturbed by land-management activities such as chaining or heavy grazing. Stands have been observed at mid-elevations, though more data are likely to expand this range. The unvegetated surfaces is generally dominated by litter and bare soil. Dead shrubs can be abundant due to past land-treatment activities. Soils are poorly drained to moderately well-drained sandy loams or loamy sands. Most observed sites have been on eolian deposits derived from sandstone. There is a short (1 m–2 m) open shrub canopy dominated by *Artemisia tridentata ssp. wyomingensis* with other shrubs contributing low cover. Common associates are *Artemisia dracunculus, Artemisia frigida, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae*, and *Opuntia* spp. Scattered short to medium-tall *Pinus edulis* and *Juniperus osteosperma* trees may be present. The herbaceous stratum has sparse to low cover and is characterized by seeded nonnative species, especially *Agropyron cristatum* or *Psathyrostachys juncea*. *Bromus tectorum* is another common nonnative species. Native species, which may have been seeded or migrated from nearby seed sources, include *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Elymus elymoides, Hesperostipa comata, Poa fendleriana, Sporobolus cryptandrus*, and *Vulpia octoflora*. Nonvascular component is usually poor due to the disturbance of these sites.

DISTRIBUTION
Colorado National Monument
This association was observed and sampled on the mesa south of No Thoroughfare Canyon to Little Park Road, on the west end of Old Gordon Road (Trail), along DS Road, and northwest of the Ribbon trailhead.

Globally
This association has been observed in western Colorado and eastern Utah, though it is very likely to occur elsewhere in the western U.S. *Psathyrostachys juncea* is particularly prevalent in northwestern Colorado, as a local seed-producer specialized in this species for revegetation of degraded rangelands.

ENVIRONMENTAL DESCRIPTION
Colorado National Monument
This disturbed shrubland association was observed growing on mesa tops west and south of No Thoroughfare Canyon. Sites are gentle (2%–10% slopes), occur between 2,024 m and 2,128 m elevation, and include all aspects. The unvegetated surface has moderate to high cover of litter and bare soil. Downed wood is low to moderate in cover, up to 35%, due to past land-treatment activities. Parent materials are sandstones. Soils are poorly drained to moderately well-drained and texturally are sandy loam and loamy sand. Site geology is eolian deposits.

Globally
This association is found on generally level topography such as mesatops, benches, and plateau. Sites can be flat to gently sloping on any aspect. Observed sites in western Colorado have been at mid-elevations (2,024 m–2,128 m), though a wider range is certain as more data are available. The unvegetated surfaces is generally dominated by litter and bare soil. Dead shrubs can be abundant due to past land-treatment activities. Soils are poorly drained to moderately well-drained sandy loams or loamy sands. Most observed sites have been on eolian deposits derived from sandstone.

VEGETATION DESCRIPTION
Colorado National Monument
This Wyoming big sagebrush / crested wheatgrass disturbed shrubland association is common on former BLM-managed land south of No Thoroughfare Canyon. The total vegetation cover ranges from 11% to 56% in these sparsely to moderately vegetated stands. This shrubland association is characterized by an open canopy of the short shrub *Artemisia tridentata ssp. wyomingensis* that ranges in cover from 4% to

40% and the graminoid *Agropyron cristatum* that ranges in cover from 1 to 25%. The canopy trees, typically 2 m to 5 m tall, of sapling *Juniperus osteosperma* and *Pinus edulis* provided up to 8% cover in some stands. The remaining short- and dwarf-shrub layer is sparse to low in diversity and cover, and other short and dwarf-shrubs present include *Chrysothamnus viscidiflorus, Ericameria nauseosa, Juniperus osteosperma, Pinus edulis, Artemisia dracunculus, Artemisia frigida, Gutierrezia sarothrae, Opuntia fragilis,* and *Opuntia polyacantha.* The herbaceous layer is also low in terms of diversity and provides sparse to low cover. Additional graminoids present include *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Bromus tectorum, Elymus elymoides, Vulpia octoflora, Hesperostipa comata, Poa fendleriana,* and *Sporobolus cryptandrus.* Forbs commonly present at sparse to low cover include *Chaenactis douglasii, Cirsium undulatum, Descurainia pinnata, Draba reptans, Heterotheca villosa, Lappula occidentalis, Lupinus argenteus, Melilotus* sp., *Oenothera pallida, Plantago patagonica, Senecio integerrimus,* and *Sphaeralcea coccinea*. Cryptogam cover is absent to low, not exceeding 5%.

Globally
This shrubland has sparse to moderate total vegetation cover with an open short-shrub canopy. The dominant species in the shrub stratum is *Artemisia tridentata ssp. wyomingensis* which may have between 4% and 50% cover. *Artemisia dracunculus, Artemisia frigida, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae,* and *Opuntia* spp. are common associates with low cover. Short to medium-tall trees, typically *Juniperus osteosperma* or *Pinus edulis,* may be scattered throughout stands of this association. The herbaceous stratum is dominated by nonnative species that have been seeded at some time in the past, most commonly *Agropyron cristatum* or *Psathyrostachys juncea* with 1% to 25% cover. *Bromus tectorum* is another common nonnative species. Native species, which may have been seeded or migrated from nearby seed sources, include *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Elymus elymoides, Hesperostipa comata, Poa fendleriana, Sporobolus cryptandrus,* and *Vulpia octoflora*. Nonvascular component is usually poor due to the disturbance of these sites.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Tall shrub/sapling	*Juniperus osteosperma*
Short shrub/sapling	*Ericameria nauseosa*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Opuntia fragilis*
Herb (field)	*Heterotheca villosa, Senecio integerrimus*
Herb (field)	*Achnatherum hymenoides, Agropyron cristatum, Bromus tectorum, Elymus elymoides, Sporobolus cryptandrus*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Agropyron cristatum*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (6-Jan-2005).

CLASSIFICATION COMMENTS

Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This association occurs on land formerly managed by the BLM and has been disturbed by chaining, roller-chopping, possibly herbicide application, and interseeding of nonnative species to support livestock grazing. Regrowth of pinyon-juniper is occurring, adding confusion to ground identification of this type with significant tree cover.
Colorado National Monument Plots: The description is based on 2003 field data (11 plots: COLM.0036, COLM.0037, COLM.0060, COLM.0061, COLM.0062, COLM.0063, COLM.0065, COLM.0066, COLM.0067, COLM.0077, COLM.0190).
Local Description Authors: J. Von Loh
Global Description Authors: J. Drake

REFERENCES: Western Ecology Working Group n.d.

Artemisia tridentata ssp. *wyomingensis* / Disturbed Understory Semi-natural Shrubland
Wyoming Big Sagebrush / Disturbed Understory Semi-natural Shrubland

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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 association has been found in western Colorado and eastern Utah but 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 1,455 m and 2,095 m (4,770–6,870 ft), 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 sandy loams. This shrubland association has moderate 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 short (2 m–5 m) *Pinus edulis* and *Juniperus osteosperma* trees may provide up to 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, nonnative and invasive species tend to dominate. Common graminoids include *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Vulpia octoflora*, and *Pleuraphis jamesii*. Forbs provide sparse to high cover and include *Astragalus nuttallianus, Descurainia pinnata, Erodium cicutarium, Lappula occidentalis*, and *Phacelia crenulata*.

DISTRIBUTION

Colorado National Monument

This alliance was observed and sampled east of Kissing Couple, near the mouth of Monument Valley; south of Devil's Kitchen Trail, near Liberty Cap Trail; near the Monument west boundary; east of the Cold Shivers turnout; near the head of Ute Canyon; near Rattlesnake Arch; and near the Liberty Cap trailhead.

Globally

This association has been observed in western Colorado and eastern Utah. It is very likely to occur in other parts of the western U.S.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This shrubland association was observed on the midslope of canyons, along washes, in swales, valleys, and canyons, on mesa tops and plains, and on drainage benches and terraces. Sites are gentle to moderately steep (0%–27% slopes), occur between 1,455 m and 2,095 m elevation, and include southern to northern aspects. The unvegetated surface often has low to high cover of litter and low to high cover of bare soil and large and small rocks. Cryptogamic cover can be up to 60% in some stands. Parent materials are sandstones, shale, and Precambrian gneiss. Soils are poorly to rapidly drained and are texturally loamy sand and sandy loam. Site geology is eolian deposits, Holocene alluvium, valley fill deposits, colluvium - undivided, Precambrian rocks (gneiss), and migmatitic meta-sedimentary rocks.

Globally

This association has been found on a variety of landscape features including mesatops, midslopes and low slopes of canyons, hills, and valleys, and on terraces. Sites can be flat to moderately steep (0º–15º) and have any aspect. Sampled sites have had elevations between 1,455 m and 2,095 m (4,770–6,870 ft). The unvegetated surface can be composed of variable amounts of litter and bare soil and large or small rocks. Soils are typically eolian, alluvial, or colluvial loamy sands to sandy loams.

VEGETATION DESCRIPTION

Colorado National Monument

This Wyoming big sagebrush / disturbed understory shrubland association is well-distributed throughout the monument. The total vegetation cover ranges from 34% to 62% in these moderately vegetated stands. This shrubland association is characterized by an open to closed short-shrub canopy of *Artemisia tridentata ssp. wyomingensis* that ranges in cover from 1% to 45%. *Artemisia tridentata ssp. wyomingensis* is present as a tall shrub in one stand and provides 55% cover. The canopy trees, typically 2 m to 5 m tall, of *Juniperus osteosperma* and *Pinus edulis* are occasionally present and provide up to 5% cover. The shrub layer is highly variable in cover and composition, with tall, short, and dwarf-shrubs present in all stands. Other tall, short, and dwarf-shrubs present in sparse to low cover include *Rhus trilobata, Sarcobatus vermiculatus, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Grayia spinosa, Artemisia nova, Gutierrezia sarothrae,* and *Krascheninnikovia lanata*, and the succulents *Echinocereus triglochidiatus, Opuntia erinacea, Opuntia fragilis, Opuntia phaeacantha, Pediocactus simpsonii,* and *Yucca harrimaniae*. The herbaceous layer typically provides low to moderate cover and is diverse. Common graminoids present include *Achnatherum hymenoides, Agropyron cristatum, Aristida purpurea, Bouteloua gracilis, Bromus tectorum, Elymus elymoides, Hesperostipa comata, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana,* and *Vulpia octoflora*. Forbs commonly present and providing sparse to low cover include *Astragalus nuttallianus, Comandra umbellata, Descurainia pinnata, Erodium cicutarium, Lactuca serriola, Lappula occidentalis, Lepidium densiflorum, Lepidium montanum, Oenothera pallida, Phlox longifolia, Plantago patagonica, Senecio integerrimus, Silene antirrhina, Sphaeralcea coccinea, Streptanthella longirostris,* and *Townsendia incana*. Cryptogam cover is present in most stands, but cover is variable from sparse to as high as 60%.

Globally
This shrubland association has moderate to dense vegetation cover (28%–89%) with an open to closed short-shrub layer. The dominant shrub, *Artemisia tridentata ssp. wyomingensis*, typically has 5% to 45% cover, though some stands may have more or less. Scattered short (2 m–5 m) *Pinus edulis* and *Juniperus osteosperma* trees may provide up to 5% to 10% cover. In addition to *Artemisia tridentata ssp. wyomingensis*, 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 and tends to be dominated by weedy and nonnative species. Common graminoids include *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Vulpia octoflora,* and *Pleuraphis jamesii*. Forbs provide sparse to high cover and include *Astragalus nuttallianus, Descurainia pinnata, Erodium cicutarium, Lappula occidentalis,* and *Phacelia crenulata*.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Achnatherum hymenoides, Bromus tectorum, Pleuraphis jamesii, Poa fendleriana*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNA (invasive) (14-Dec-2004).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Stands are historically disturbed by grazing; there are many nonnative species and increasers like prickly-pear. Pinyon-juniper trees are invading most stands, although recent drought has curtailed the advance.
Colorado National Monument Plots: The description is based on 2003 field data (9 plots: COLM.0018, COLM.0030, COLM.0040, COLM.0090, COLM.0149, COLM.0162, COLM.0199, COLM.0213, COLM.0266).
Local Description Authors: J. Von Loh
Global Description Authors: J. Drake, mod. J. Coles

REFERENCES: 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 1,450 m to 2,419 m (4,750–7,940 ft). Slopes are level to moderately steep (0%–50%). Substrates include eolian sands, loess and landslide deposits; most often soils are not residual but develop from these secondary sources. 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

Colorado National Monument

This association was observed and sampled on the mesa north of Red Canyon, west of Columbus Canyon, mesa south of Ute Canyon, along Glade Park Road, along Rimrock Drive, adjacent to Liberty Cap Trail, on the No Thoroughfare Canyon Mesa, and on U.S. Bureau of Land Management land southwest of the monument.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This shrubland association was observed growing on plains, mesatops, and ridgetops. Sites are gentle (2%–8% slopes), occur between 1,904 m and 2,147 m elevation, and include all aspects. The unvegetated surface has low to high cover of litter and low to high cover of cryptogams. Some sites also have low to high cover of bare soil. Parent materials are sandstones and shale. Soils are wind-deposited, somewhat

poorly drained to well-drained, and texturally are sandy loam and silt loam. Site geology is eolian deposits, several meters deep on some sites.

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 1,450 m to 2,419 m (4,750–7,940 ft). Slopes are level to moderately steep (0%–50%). Substrates include eolian sands, loess and landslide deposits; most often soils are not residual but develop from these secondary sources. In sparsely vegetated stands, there is usually an abundance of exposed soil on the ground surface, whereas in denser stands litter covers most of the ground.

VEGETATION DESCRIPTION
Colorado National Monument
This Wyoming big sagebrush / needle-and-thread shrubland association is common on mesatops and in broad canyon bottoms. The total vegetation cover ranges from 25% to 46% in these moderately vegetated stands. This shrub association is characterized by the short shrub *Artemisia tridentata ssp. wyomingensis* that ranges in cover from 1 to 45% and the associated graminoids *Hesperostipa comata* and *Poa fendleriana* that range in cover from 1% to 6% and from 0 to 1%, respectively. Sapling *Juniperus osteosperma* and *Pinus edulis* trees are present and provide low cover. Dwarf-shrubs provide sparse to low cover in each stand, including *Chrysothamnus viscidiflorus, Gutierrezia sarothrae,* and *Leptodactylon pungens,* and the succulents *Opuntia erinacea, Opuntia fragilis,* and *Opuntia polyacantha*. The herbaceous layer provides sparse to low cover and is diverse. Graminoids present in addition to the dominants are *Achnatherum hymenoides, Bouteloua gracilis, Bromus tectorum, Elymus elymoides, Vulpia octoflora, Koeleria macrantha,* and *Pleuraphis jamesii*. Forbs commonly present include *Arenaria fendleri, Calochortus gunnisonii, Comandra umbellata, Cryptantha* sp., *Descurainia pinnata, Draba reptans, Erigeron* sp., *Lappula occidentalis, Lepidium montanum, Linum lewisii, Plantago patagonica,* and *Sphaeralcea coccinea*. Cryptobiotic soil crusts are widespread in this type and can provide up to 85% cover.

Globally
This sagebrush association is widespread throughout the northern Colorado Plateau and is abundant in northwestern Colorado. Total vegetation cover ranges from 25% to 75%, 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*. *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.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Artemisia tridentata* ssp. *wyomingensis, Chrysothamnus viscidiflorus, Leptodactylon pungens, Opuntia erinacea, Opuntia fragilis, Opuntia polyacantha*

Herb (field)	*Sphaeralcea coccinea*
Herb (field)	*Achnatherum hymenoides*, *Bouteloua gracilis*, *Bromus tectorum*, *Elymus elymoides*, *Hesperostipa comata*, *Pleuraphis jamesii*, *Poa fendleriana*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Hesperostipa comata*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Apr-2005).

CLASSIFICATION COMMENTS
Colorado National Monument
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
Colorado National Monument Inventory Notes: Stands are being invaded by pinyon-juniper trees. The soils are deep and fine in texture.
Colorado National Monument Plots: The description is based on 2003 field data (6 plots: COLM.0132, COLM.0135, COLM.0140, COLM.0160, COLM.0197, COLM.0273, and 4 observation points: COLM.0346, COLM.0405, COLM.0408, COLM.0481).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: J. Coles

REFERENCES: Baker 1984a, Western Ecology Working Group n.d.

Artemisia tridentata ssp. *wyomingensis / Pleuraphis jamesii* Shrubland
Wyoming Big Sagebrush / James' Galleta Shrubland

CODE	CEGL002084
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 alluvial flats and terraces, as well as on upland slopes and mesas in the Colorado Plateau. Sites tend to have gentle to moderately steep slopes, and elevations range from 1,400 m to 1,939 m (4,600–6,360 ft). Known sites have an east or southeast aspect. Soils are derived from a wide variety of substrates; however, soil texture tends to be a sandy loam. Cryptobiotic crust cover is usually present. The vegetation is characterized by a moderately dense canopy of *Artemisia tridentata ssp. wyomingensis* with a sparse herbaceous understory dominated by *Pleuraphis jamesii*. Other shrubs present may include scattered individuals of *Atriplex confertifolia, Sarcobatus vermiculatus, Ericameria nauseosa, Gutierrezia sarothrae*, and *Opuntia* spp. *Achnatherum hymenoides, Hesperostipa comata, Pseudoroegneria spicata, Poa secunda*, and *Leymus salinus* may be present in addition to *Pleuraphis jamesii*. Forbs tend to be sparse and inconsistent among stands but may include *Calochortus* spp., *Astragalus nuttallianus, Oenothera pallida*, and *Sphaeralcea coccinea*.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled at the mouth of Lizard Canyon, east of Kissing Couple in Monument Canyon, upper Monument Canyon, near the West Entry Road, on the mesa north of Red Canyon, and on Rimrock Drive near the head of Ute Canyon.

Globally

This association is known from the northern Colorado Plateau of southeastern Utah and western Colorado.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This shrubland association was observed on alluvial fans and midslope in canyons and on ridges. Sites are gentle to moderately steep (2%–30% slope), occur between 1,439 m and 1,939 m elevation, and are oriented to eastern and southeastern aspects. The unvegetated surface may have high cover by litter, small rocks, and bare soil. Cryptogamic cover is sparse to low, typically less than 5%. Parent materials are sandstones, shale, and Precambrian gneiss. Soils are moderately well-drained to rapidly drained and texturally are sandy loam. Site geology is varied, including eolian sand and sheetwash deposits, eolian sand, valley fill, migmatitic meta-sedimentary rocks, and Tidwell Member of the Morrison Formation.

Globally

This shrubland association occurs on alluvial flats and terraces, as well as on ridges, slopes, benches and mesas throughout the Colorado Plateau. Sites tend to have gentle slopes, but some sites range up to 55% slope. Elevations range from 1,400 m to 1,939 m (4,600–6,360 ft), and sites may be oriented to any aspect, although most of the sampled stands have either an east or southeast aspect. Soils are derived from a wide variety of substrates, from alluvium, sandstone and eolian sands to limestone, metamorphic rocks and shales; however, soil texture tends to be a sandy loam. Cryptobiotic crust cover is usually present and ranges from sparse to nearly 30% cover.

VEGETATION DESCRIPTION

Colorado National Monument

This Wyoming big sagebrush / James' galleta shrubland association occurs occasionally in the monument. The total vegetation cover ranges from 37% to 53% in these moderately vegetated stands. This association is characterized by an open and homogenous shrub canopy of *Artemisia tridentata ssp. wyomingensis* that ranges in cover from 20% to 30% and low graminoid cover of *Pleuraphis jamesii* that ranges from 6 to 8% cover. Other short and dwarf-shrubs present, but with cover less than 5%, include *Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Ericameria nauseosa, Rhus trilobata, Echinocereus triglochidiatus, Grayia spinosa, Gutierrezia sarothrae,* and *Opuntia polyacantha*. The herbaceous layer provides sparse to low cover, usually less than 10% cover. Common graminoids include *Achnatherum aridum, Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Vulpia octoflora, Hesperostipa comata,* and *Leymus salinus*. Forbs commonly present include *Artemisia frigida, Astragalus mollissimus, Astragalus nuttallianus, Calochortus gunnisonii, Chaenactis douglasii, Descurainia pinnata, Draba reptans, Eriogonum ovalifolium, Heterotheca villosa, Lappula occidentalis, Lepidium densiflorum, Lupinus argenteus, Oenothera pallida, Phacelia crenulata, Plantago patagonica, Ceratocephala testiculata, Sphaeralcea coccinea, Stanleya pinnata,* and *Streptanthella longirostris*. Cryptogam cover is sparse to low, occasionally as high as 15%.

Globally
This shrubland association is characterized by a moderately dense canopy of *Artemisia tridentata ssp. wyomingensis,* with sparse to low cover of herbaceous species in the understory dominated by *Pleuraphis jamesii* (1%–10% cover). Total shrub cover ranges from 20% to 40% and may include scattered individuals of *Atriplex confertifolia, Sarcobatus vermiculatus, Ericameria nauseosa, Gutierrezia sarothrae,* and *Opuntia* spp. The herbaceous layer tends to be dominated in most years by perennial bunch grasses, with *Achnatherum hymenoides, Hesperostipa comata, Pseudoroegneria spicata, Poa secunda,* and *Leymus salinus* evident in addition to *Pleuraphis jamesii*. Forbs tend to be sparse and inconsistent among stands but may include *Calochortus* spp., *Astragalus nuttallianus, Oenothera pallida,* and *Sphaeralcea coccinea*.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Opuntia polyacantha*
Herb (field)	*Astragalus nuttallianus, Descurainia pinnata, Lappula occidentalis, Oenothera pallida*
Herb (field)	*Aristida purpurea, Bromus tectorum, Hesperostipa comata, Leymus salinus, Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Opuntia polyacantha*
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Dec-2004).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Some fire effects observed in stands in the monument.
Colorado National Monument Plots: The description is based on 2003 field data (4 plots: COLM.0006, COLM.0041, COLM.0057, COLM.0059, and 4 observation points: COLM.0289, COLM.0320, COLM.0373, COLM.0470).
Local Description Authors: J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Naumann pers. comm., Western Ecology Working Group n.d.

Artemisia tridentata ssp. *wyomingensis / Poa fendleriana* Shrubland
Wyoming Big Sagebrush / Muttongrass Shrubland

CODE	CEGL002775
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 sagebrush shrubland association is widespread throughout the northern Colorado Plateau, occurring on ridges, mesas and hills between 1,600 m and 2,400 m (5,250–7,875 ft) elevation. Stands may cover entire plateaus or less than an acre in small openings in pinyon-juniper woodlands. Slopes range from 3% to more than 50% and are oriented to all aspects. Soils are deep and often derived from eolian loess or sand, although some stands are on residual soils derived from the underlying sandstone or shale. Total vegetation cover ranges widely, from 10 to 80%. The shrub layer is sparse in hot, dry sites (around 10% cover) but may cover more than 50% in sheltered areas. Other shrubs are usually present and may include *Purshia tridentata, Atriplex confertifolia, Symphoricarpos oreophilus, Amelanchier utahensis*, and *Chrysothamnus viscidiflorus*. The herbaceous understory is generally well-developed and is dominated by *Poa fendleriana* with around 3% cover in sparse shrublands and up to 35% cover in denser shrublands. Associated herbaceous species vary but generally include a number of grass species, especially *Achnatherum hymenoides, Hesperostipa comata, Koeleria macrantha, Pseudoroegneria spicata, Bouteloua gracilis*, and *Achnatherum pinetorum*. Forbs are inconsistent and usually contribute 1% cover or less. Some stands will have scattered trees of *Pinus edulis* and *Juniperus osteosperma*.

DISTRIBUTION

Colorado National Monument

This association is known from the Liberty Cap Trail.

Globally

This association is widespread within the sagebrush shrublands of the Colorado Plateau. It has been documented from western Colorado and southeastern Utah.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This association occurs as openings within a matrix of pinyon-juniper woodlands on level to gently sloping hills and ridges. Elevations range between 1,950 m and 2,000 m. Sites tend to be oriented to the north. The soils are deep and sandy, as they are derived from eolian sands.

Globally

This sagebrush shrubland is widespread throughout the northern Colorado Plateau, occurring on ridges, mesas and hills between 1,600 m and 2,400 m (5,250–7,875 ft) elevation. Stands may cover hundreds of acres or less than an acre in small openings in pinyon-juniper woodlands. Slopes range from 3% to more than 50% and are oriented to all aspects. Soils are deep and often derived from eolian loess or sand, although some stands are on residual soils derived from the underlying sandstone or shale.

VEGETATION DESCRIPTION

Colorado National Monument

Artemisia tridentata ssp. wyomingensis strongly dominates this somewhat sparse shrubland association with between 25% and 35% cover. Associated shrubs include *Chrysothamnus viscidiflorus*. The herbaceous stratum is often relatively sparse but is dominated by the bunchgrass *Poa fendleriana* with between 1% and 5% cover. Other grasses present include *Achnatherum hymenoides*. Forb species are diverse but contribute little overall cover. Typical species include *Sphaeralcea coccinea, Townsendia incana, Delphinium nuttallianum,* and *Phlox longifolia*.

Globally

This type of Wyoming big sagebrush shrubland is common in the northern Colorado Plateau. The total vegetation cover ranges widely from 10% to 80%. The shrub layer ranges from sparse in hot, dry sites (around 10% cover) to more than 50% in sheltered sites. Other shrubs are usually present and may include *Purshia tridentata, Atriplex confertifolia, Symphoricarpos oreophilus, Amelanchier utahensis,* and *Chrysothamnus viscidiflorus*. The herbaceous understory is generally well-developed and is dominated by *Poa fendleriana* with around 3% cover in sparse shrublands and up to 35% cover in denser shrublands. Associated herbaceous species vary but generally include a number of grass species, especially *Achnatherum hymenoides, Hesperostipa comata, Koeleria macrantha, Pseudoroegneria spicata, Bouteloua gracilis,* and *Achnatherum pinetorum*. Forbs are inconsistent and usually contribute 1% cover or less. Some stands will have scattered trees of *Pinus edulis* and *Juniperus osteosperma*.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Achnatherum hymenoides, Poa fendleriana*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*

Herb (field) *Poa fendleriana*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (13-Apr-2005).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This association appears to be limited to deep, eolian sands on top of the plateau.
Colorado National Monument Plots: This description is based on 2003 field data (2 plots: COLM.0107, COLM.0109).
Local Description Authors: J. Coles
Global Description Authors: J. Coles

REFERENCES: 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 1,189 m and 2104 m (3,900–6,900 ft) 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%–30%). 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, Ephedra viridis*, and *Gutierrezia sarothrae*. The herbaceous stratum has sparse to moderate cover. The nonnative *Bromus tectorum* is often abundant. Other herbaceous species commonly found are *Achnatherum hymenoides, Elymus elymoides, Hesperostipa comata, Hordeum jubatum*, and *Pleuraphis jamesii*.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled along the lower reach of the intermittent drainage in No Thoroughfare Canyon and 300 m east of the mouth of Ute Canyon. It occupies intermittent drainage banks as small linear patches here and there along the eastern edge of the monument.

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

Colorado National Monument

This shrubland association was observed on the banks of drainages and in canyon bottoms. Sites are gentle (3%–4% slopes), occur between 1,520 m and 1,694 m elevation, and are oriented northerly and easterly to the direction of drainages. The unvegetated surface is predominantly bare soil and large and small rocks. There is little litter and occasional to heavy woody debris deposited by flood flows. Parent materials are variable and include sandstones, shale, and Precambrian gneiss. Soils are rapidly drained to well-drained and texturally are sand and sandy loam. Site geology is typically alluvium classified as valley fill deposits (old alluvium), but some stands occur on sediments deposited on Precambrian meta-igneous gneiss.

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 1,189 m and 2,104 m (3,900–6,900 ft) 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.

VEGETATION DESCRIPTION

Colorado National Monument

This rubber rabbitbrush shrubland association is rare and distributed on the margins of intermittent drainages from 5 m to 10 m wide and with a sandy or gravelly bottom. The total vegetation cover ranges from 20% to 30% in these sparsely vegetated stands. This shrub association is characterized by a linear (rows along each drainage bank) short-shrub canopy of *Ericameria nauseosa* that ranges in cover from 12% to 25%. The annual nonnative grass *Bromus tectorum* is always present and provides from 1% to 8% cover. Additional short-shrub species include *Artemisia tridentata ssp. tridentata* and *Artemisia tridentata ssp. wyomingensis*, which provide sparse cover. Herbaceous species are diverse and provide sparse to moderate cover. Common graminoids include *Achnatherum hymenoides, Agropyron cristatum, Bromus japonicus, Distichlis spicata, Hesperostipa comata, Hordeum jubatum, Muhlenbergia asperifolia, Pascopyrum smithii*, and *Pleuraphis jamesii*. Forbs commonly associated with intermittent drainages include *Astragalus nuttallianus, Comandra umbellata, Descurainia pinnata, Erodium cicutarium, Grindelia squarrosa, Heterotheca villosa, Lactuca serriola, Melilotus officinalis*, and *Sisymbrium altissimum*.

Globally
This shrubland association has sparse to moderate total vegetation cover (1%–30%). 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*, *Ephedra viridis*, and *Gutierrezia sarothrae*. The herbaceous stratum has sparse to moderate cover. The nonnative *Bromus tectorum* is often abundant. Other herbaceous species commonly found are *Achnatherum hymenoides*, *Elymus elymoides*, *Hesperostipa comata*, *Hordeum jubatum*, and *Pleuraphis jamesii*.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*
Herb (field)	*Bromus tectorum*, *Distichlis spicata*

Globally

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (10-Jan-2005).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Colorado National Monument Inventory Notes: *Tamarix ramosissima* had occupied one stand but had been removed by monument staff and volunteers.
Colorado National Monument Plots: The description is based on 2003 field data (2 plots: COLM.0031, COLM.0086).
Local Description Authors: J. Von Loh
Global Description Authors: J. Drake, mod. J. Coles

REFERENCES: Western Ecology Working Group 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)

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 (21%–86%), occur between 1,500 m and 1,875 m (4,920–6,150 ft) 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 nonnative 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

Colorado National Monument

This association was observed and sampled on rockfall or talus slopes in lower Monument Canyon and on a steep ridge off Liberty Cap Trail.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This sandstone talus shrubland association was observed on steep rockfall slopes below vertical cliffs and on a steep ridge. Sites are steep (21%–86% slopes), occur between 1,502 m and 1,563 m elevation, and are oriented to eastern to southern aspects. The unvegetated surface is usually large and small rocks and bare soil; there is little litter present. Parent materials are Wingate Formation and Kayenta Formation sandstones. Soils are rapidly drained and texturally are sandy loam. Site geology is rockfall deposits that consist of large sandstone boulders.

Globally

This sparse shrubland association occurs on warm talus slopes throughout the northern Colorado Plateau. Sites are on moderately steep to steep slopes (21%–86%), occur between 1,500 m and 1,875 m (4,920–6,150 ft) 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

Colorado National Monument

This fourwing saltbush association is rare within the monument. The total vegetation cover ranges from 6% to 22% in these sparse, steep stands. This short-shrub association is characterized by *Atriplex canescens* and *Ephedra viridis* that each range in cover from 1% to 4%. Other short and dwarf-shrubs and succulents present that provide sparse cover include *Artemisia bigelovii, Echinocereus triglochidiatus, Ephedra torreyana, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia erinacea, Opuntia phaeacantha,* and *Rhus trilobata*. *Juniperus osteosperma* was present as a canopy tree that is 2 m to 5 m tall and contributes sparse cover, typically less than 5% cover. Herbaceous species are uncommon and provide sparse cover. The common graminoids include *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Hesperostipa comata,* and *Pleuraphis jamesii*. Forbs commonly present include *Astragalus* sp., *Descurainia pinnata, Erigeron* sp., *Erodium cicutarium, Eriogonum inflatum, Lepidium densiflorum, Lepidium montanum, Sphaeralcea coccinea,* and *Streptanthella longirostris*.

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 nonnative 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
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Short shrub/sapling	*Atriplex canescens, Ephedra torreyana, Ephedra viridis*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex canescens, Ephedra viridis*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G4 (23-Feb-1994).

CLASSIFICATION COMMENTS
Colorado National Monument
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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Established on very steep sites and adjacent to large boulders.
Colorado National Monument Plots: The description is based on 2003 field data (2 plots: COLM.0179, COLM.0180, and 1 observation point: COLM.0294).
Local Description Authors: J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, 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. *Ephedra viridis* may be present but is not a codominant. 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 more dense than on undisturbed sites. Winter annual forb cover is variable depending on annual precipitation.

DISTRIBUTION
Colorado National Monument
This association was observed and sampled in Gold Star Canyon, near the East Entrance in lower No Thoroughfare Canyon, near the Broadway Street access on the east side of the park, and near the East Entrance to the south of Rimrock Drive. The type is found only on alluvial fans that were deposited along the eastern monument boundary.

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

Colorado National Monument

This shrubland association was observed on alluvial fans and on toeslopes of ridges with deep alluvium. Sites are gentle (6%–10% slopes), occur between 1,476 m and 1,530 m elevation, and are oriented to northeastern and eastern aspects. The unvegetated surface has moderate cover of litter and high cover of bare soil. Cryptogamic cover is usually low but can be up to 35% in some stands. Parent materials are variable and include sandstones, shale, and Precambrian gneiss. Soils are moderately well-drained to well-drained and texturally are sandy loam. Site geology is Holocene alluvium, valley fill deposits (old alluvium), and eolian and sheetwash deposits that have been laid down on the eastern monument boundary.

Globally

This shrubland association 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 (1,235 m–2,256 m [4,050–7,400 ft]) but will occur at lower elevations (down to 610 m [2,000 ft]) along alluvial benches where soils are often finer-textured and possibly saline/alkaline (Beatley 1976). 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

Colorado National Monument

This fourwing saltbush shrubland association is rare and distributed on the eastern monument boundary. The total vegetation cover ranges from 16% to 56% in these sparsely to moderately vegetated stands. This short-shrub association is characterized by an open canopy of *Atriplex canescens* that ranges in cover from 8% to 12%. Other short and dwarf-shrubs and succulents provide sparse cover and include *Artemisia tridentata ssp. wyomingensis, Ephedra viridis, Opuntia fragilis, Opuntia phaeacantha,* and *Opuntia polyacantha*. The herbaceous layer is diverse and may contribute moderate cover, up to 40% when *Bromus tectorum* is present in some stands. More typically, herbaceous cover is less than 15%. Common graminoids include *Achnatherum hymenoides, Agropyron cristatum, Aristida purpurea, Bromus tectorum, Vulpia octoflora, Hesperostipa comata, Pleuraphis jamesii,* and *Sporobolus cryptandrus*. Forbs common to this association include *Astragalus nuttallianus, Descurainia pinnata, Erodium cicutarium, Chamaesyce glyptosperma, Lepidium densiflorum, Oenothera pallida, Silene antirrhina, Sisymbrium altissimum,* and *Sphaeralcea coccinea*. Cryptogam cover is variable with some stands having very little, but cover can be as high as 30%.

Globally

This 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), Grayia spinosa, Gutierrezia sarothrae, Lycium pallidum, Psorothamnus fremontii,* or *Psorothamnus polydenius*. *Ephedra viridis* may be present but is not a codominant. The typically sparse herbaceous layer includes low cover of species 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*. Winter annual forb cover is variable depending on annual precipitation. Introduced species such as *Bromus tectorum, Bromus*

diandrus, and *Salsola kali* are common on disturbed sites and may form a moderately dense herbaceous stratum.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*, *Atriplex canescens*
Herb (field)	*Opuntia phaeacantha*, *Opuntia polyacantha*
Herb (field)	*Astragalus nuttallianus*, *Descurainia pinnata*, *Erodium cicutarium*
Herb (field)	*Hesperostipa comata*, *Pleuraphis jamesii*, *Sporobolus cryptandrus*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex canescens*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

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

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This association has been affected by past grazing and/or fire and is subject to nonnative species introductions.
Colorado National Monument Plots: The description is based on 2003 field data (4 plots: COLM.0026, COLM.0032, COLM.0269, COLM.0279, and 1 observation point: COLM.0217).
Local Description Authors: J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles

REFERENCES: Beatley 1976, Bourgeron and Engelking 1994, Cogan et al. 2004, Driscoll et al. 1984, NVNHP 2003, Ostler et al. 2000, Western Ecology Working Group n.d.

Atriplex confertifolia - Sarcobatus vermiculatus Shrubland
Shadscale - Black 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)

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. Elevations range from 1,350 m to 1,650 m, slopes range from level to moderately steep (1%– 50% slopes), and sites can be oriented to any aspect. Soils are fine-textured and poorly drained 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 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 herbaceous layer is variable but 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*. Nonvascular species are generally present on the soil surface and may have as much as 95% cover in undisturbed sites.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled in Gold Star Canyon and near the East Entrance, north of Rimrock Drive.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This shrubland association was observed on alluvial fans and shallow drainages. Sites are gentle (2%–12% slopes), occur at 1,483 m to 1,520 m elevation, and are oriented to northeastern to eastern aspects. The unvegetated surface often has high cover of cryptogams and moderate cover of litter. Bare soil cover is high at some sites. Parent materials are eolian and sheetwash deposits. Soils are somewhat poorly drained to well-drained and are texturally sandy loam. Site geology is Holocene alluvium and eolian sand and sheetwash deposits that lay in drainages or on alluvial fans.

Globally

This shrub association is found scattered in saline habitats across the Colorado Plateau. 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 and western Colorado indicate that the habitat for this association includes valley toeslopes and alluvial terraces, as well as low-lying areas on valley floors. Elevations range from 1,350 m to 1,650 m, slopes range from level to moderately steep (1%–50% slopes), and sites can be oriented to any aspect. Soils are fine-textured and poorly drained clays, clay loams and silt loams.

VEGETATION DESCRIPTION

Colorado National Monument

This shadscale - black greasewood shrubland association is rare on the lowest elevations within the monument. The total vegetation cover is 13% to 50% for these sparse to moderately vegetated stands.

This short-shrub association is characterized by an open canopy of *Sarcobatus vermiculatus* and *Atriplex confertifolia* shrubs that range in cover from 4 to 13% and 2% to 5%, respectively. Low cover of dwarf-shrubs, mostly succulents, in this association includes *Echinocereus triglochidiatus, Opuntia erinacea, Opuntia polyacantha,* and *Suaeda calceoliformis*. Herbaceous cover is sparse to low and is provided by graminoids, including *Bromus tectorum, Vulpia octoflora, Pleuraphis jamesii,* and *Sporobolus cryptandrus*. Forbs commonly present are annuals, including *Astragalus nuttallianus* and *Descurainia pinnata*. Cryptogam cover is variable, with some disturbed stands having very little, but can be as high as 95% on undisturbed sites.

Globally
This mixed shrubland association occurs in habitats that are significantly saline, either because of poor drainage or high levels of salts in the soil. 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. Upland sites tend to have sparser vegetation. The shrub stratum generally consists primarily of *Sarcobatus vermiculatus* shrubs not more than 1 m tall, 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 herbaceous layer is variable but 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, Sporobolus airoides,* and *Sphaeralcea parvifolia*. Mosses and ground lichens are generally present and may have as much as 95% cover in undisturbed sites.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia, Sarcobatus vermiculatus*
Herb (field)	*Opuntia polyacantha*
Herb (field)	*Bromus tectorum, Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia, Sarcobatus vermiculatus*
Herb (field)	*Bromus tectorum*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

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

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This is a rare association for the monument and occurs in relatively small patches.
Colorado National Monument Plots: The description is based on 2003 field data (2 plots: COLM.0025, COLM.0097).
Local Description Authors: J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Fenemore 1970, Kagan et al. 2004, Miller et al. 1977, NVNHP 2003, 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 shrubland association is reported from the southwestern Great Plains, Colorado Plateau, Great Basin, and Mojave Desert mountains. It 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 association is characterized by a sparse to open canopy (1%–25% cover) of short shrubs dominated by *Atriplex confertifolia* with a sparse to moderate graminoid layer dominated by *Pleuraphis jamesii*. Associated shrubs include *Ericameria nauseosa, Ephedra torreyana, Chrysothamnus viscidiflorus, Krascheninnikovia lanata, Gutierrezia sarothrae, Artemisia bigelovii, Picrothamnus desertorum, Grayia spinosa, Suaeda moquinii (= Suaeda fruticosa),* and *Opuntia polyacantha* depending on substrate, or *Amphipappus fremontii, Ambrosia dumosa,* and *Lycium pallidum* 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, Phacelia,* and *Chenopodium*. Introduced species such as *Bromus tectorum* and *Salsola kali* are common on some sites.

DISTRIBUTION
Colorado National Monument
This association was observed and sampled near the east entrance, along the east end of Liberty Cap Trail, above Kodels Canyon, along Black Ridge Trail, Ribbon Trail and Echo Canyon on U.S. Bureau of

Land Management property near Little Park Road, near the East Entrance, north of the Monument Valley trailhead (east side of monument), and north of the Liberty Cap trailhead.

Globally
This shrubland association is reported from the southwestern Great Plains, Colorado Plateau, Great Basin, and Mojave Desert mountains.

ENVIRONMENTAL DESCRIPTION
Colorado National Monument
This shrubland association was observed on the midslopes of hills, mesas and ridges, on ridge shoulders, alluvial fans, toeslopes or erosion fans, and on canyon slopes. Sites are moderately steep (4%–70% slopes), occur between 1,438 m and 1,924 m elevation, and include all aspects. The unvegetated surface often has high cover of bare soil or small rocks. Cover by litter is low to moderate, and cryptogamic cover can be over 80% in some stands. Parent materials are variable and include Morrison Formation shale and sandstones. Soils are somewhat poorly drained to rapidly drained and texturally are silty clay, clay loam, and sandy loam. Site geology includes the white-to-pink-colored soils of the Salt Wash and Tidwell members of the Morrison Formation and darker deposits of Kayenta Formation sandstone and eolian sand.

Globally
This association 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, mesa escarpments, mountain and hillslopes, ridges, and along toeslopes of river bluffs. Fine-textured soil sites include 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 cm–23 cm annually) or because of high internal plant moisture stress from soil alkalinity. The unvegetated surface is composed largely of bare soil, gravel, and large or small rocks. Cryptogamic crusts and mosses are important in some stands.

VEGETATION DESCRIPTION
Colorado National Monument
This shadscale / James' galleta association is common within the monument. The total vegetation cover ranged from 6% to 30% in these sparsely to moderately vegetated stands. This shrubland association is characterized by a very open short-shrub canopy of *Atriplex confertifolia* that ranges in cover from 2% to 12% and the sparse graminoid layer of *Pleuraphis jamesii* that ranges in cover from 1% to 18%. Canopy trees and tall shrubs are rarely recorded, provide sparse cover, and include *Juniperus osteosperma* and *Fraxinus anomala*. The shrub layer is highly variable in cover and composition. Shrub cover is typically sparse, and the short- and dwarf-shrub layers include *Artemisia tridentata ssp. wyomingensis, Ephedra torreyana, Ephedra viridis, Krascheninnikovia lanata, Sarcobatus vermiculatus, Picrothamnus desertorum, Chrysothamnus viscidiflorus, Eriogonum microthecum, Gutierrezia sarothrae, Suaeda calceoliformis, Tetradymia canescens,* and the succulents *Echinocereus triglochidiatus, Opuntia erinacea, Opuntia polyacantha, Sclerocactus whipplei,* and *Yucca harrimaniae*. The herbaceous layer is typically sparse, usually less than 10% total cover. A diverse group of species occurs across stands, but any one stand usually has low diversity. Common graminoids include *Achnatherum hymenoides, Bromus tectorum, Vulpia octoflora, Poa fendleriana, Poa secunda,* and *Sporobolus cryptandrus*. Forbs commonly present include *Astragalus nuttallianus, Calochortus gunnisonii, Cryptantha flavoculata, Descurainia pinnata, Eriogonum lonchophyllum, Erodium cicutarium, Lappula occidentalis, Lepidium densiflorum, Lepidium montanum, Oenothera pallida, Plantago patagonica, Platyschkuhria integrifolia var. oblongifolia, Pediomelum megalanthum, Senecio integerrimus, Silene antirrhina, Sisymbrium altissimum,*

and *Sphaeralcea coccinea*. Cryptogam cover is variable with some stands having very little, but cover can be as high as 80%.

Globally
This association is characterized by a sparse to open canopy (1%–25% cover) of short shrubs dominated by *Atriplex confertifolia* with a sparse to moderate graminoid layer dominated by *Pleuraphis jamesii*. Some stands can be even more sparsely vegetated, and total vegetation cover is widely variable (1%–70% in sampled stands). Associated shrubs include *Ericameria nauseosa, Ephedra torreyana, Chrysothamnus viscidiflorus, Krascheninnikovia lanata, Gutierrezia sarothrae, Artemisia bigelovii, Picrothamnus desertorum, Grayia spinosa, Suaeda moquinii (= Suaeda fruticosa),* and *Opuntia polyacantha* depending on substrate, or *Amphipappus fremontii, Ambrosia dumosa*, and *Lycium pallidum* 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, Phacelia*, and *Chenopodium*. Introduced species such as *Bromus tectorum* and *Salsola kali* are common on some sites.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*
Herb (field)	*Opuntia polyacantha, Picrothamnus desertorum*
Herb (field)	*Astragalus nuttallianus, Descurainia pinnata, Erodium cicutarium, Lappula occidentalis*
Herb (field)	*Bromus tectorum, Pleuraphis jamesii, Sporobolus cryptandrus*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*
Short shrub/sapling	*Gutierrezia sarothrae*
Herb (field)	*Bromus tectorum, Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G3G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Colorado National Monument
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.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This association is distributed around Black Ridge and along the eastern side of the monument at lower elevations.
Colorado National Monument Plots: The description is based on 2003 field data (13 plots: COLM.0021, COLM.0083, COLM.0178, COLM.0227, COLM.0230, COLM.0238, COLM.0241, COLM.0242, COLM.0247, COLM.0249, COLM.0263, COLM.265, COLM.0286, and 2 observation points: COLM.0298, COLM.0352).
Local Description Authors: 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, Dastrup 1963, Driscoll et al. 1984, Graham 1937, Harper and Jaynes 1986, Ibrahim et al. 1972, Lusby et al. 1963, NVNHP 2003, Potter et al. 1985, Singh and West 1971, Soil Conservation Service 1978, Tuhy and MacMahon 1988, U.S. Bureau of Reclamation 1976, Von Loh 2000, Welsh 1957, West and Ibrahim 1968, 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): 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 (5%–72%) slopes between 1,457 m and 1,628 m elevation (4,780–5,340 ft). Substrates include dark gravels derived from metamorphic rocks and eolian sands. 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, including *Atriplex confertifolia, Atriplex canescens, Chrysothamnus viscidiflorus, Gutierrezia sarothrae,* and *Grayia spinosa*. The herbaceous layer is dominated by grasses, with *Achnatherum hymenoides* and *Hesperostipa comata* 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
Colorado National Monument
This association was observed and sampled along the eastern edge of the monument in the mouth of Columbus Canyon, on BLM land at the eastern Liberty Cap trailhead, near the Broadway Street access on the east side, and in Gold Star Canyon.

Globally
This association occurs in the northern Colorado Plateau of Colorado.

ENVIRONMENTAL DESCRIPTION
Colorado National Monument
This dwarf-shrubland association was observed on plains or flats, on small ridges in canyons, on toeslopes, midslopes, and mid-level on ridge slopes. Sites are moderately steep to steep (4%–36%), occur between 1,457 m and 1,592 m elevation, and are oriented to eastern and southern aspects. 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%. Parent materials are variable and include sandstone, shale, Precambrian gneiss, and deposits of eolian, sheetwash, and rockfall material. Soils are somewhat poorly drained to rapidly drained and texturally are sandy loam, but range from fine to coarse. Geology of the sites included eolian deposits, Holocene rockfall deposits, sheetwash deposits, and Precambrian gneiss - migmatitic meta-sedimentary rocks.

Globally
This low succulent association occurs on xeric sites on benches, valley floors, and slopes in the northern Colorado Plateau. Stands occur on gentle to steep (5%–72%) slopes with east or south aspects between 1,457 m and 1,628 m elevation (4,780–5,340 ft). Substrates include dark gravels derived from metamorphic rocks and eolian sands. The unvegetated surface has moderate to high cover of bare soil, sometimes with high cover of biological soil crusts, while soils may be fine- or coarse-textured.

VEGETATION DESCRIPTION
Colorado National Monument
This panhandle prickly-pear / James' galleta dwarf-shrubland association is distributed in the eastern one-third of the monument. The total vegetation cover ranged from 13% to 29% in these sparsely to moderately vegetated stands. *Opuntia polyacantha* likely became widely distributed in response to intensive grazing by a herd of bison that were kept along the eastern border of the monument in its early years and by grazing cattle and sheep throughout the monument area. This dwarf-shrub association is characterized by large patches of *Opuntia polyacantha* and the bunchgrass *Pleuraphis jamesii* that range in cover from 2% to 20% and 2% to 7%, respectively. *Juniperus osteosperma* is rarely present as a canopy tree between 2 m to 5 m tall and contributing 1% to 5% cover. The shrub layer is diverse and typically sparse in cover, including the short and dwarf-shrubs *Artemisia tridentata ssp. wyomingensis, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra viridis, Eriogonum microthecum, Grayia spinosa, Krascheninnikovia lanata, Sarcobatus vermiculatus, Atriplex confertifolia, Chrysothamnus viscidiflorus, Gutierrezia sarothrae,* and *Opuntia phaeacantha*. The herbaceous layer is sparse or contributes low cover, usually less than 10% total cover. Common graminoids include *Achnatherum hymenoides, Bromus tectorum, Vulpia octoflora, Hesperostipa comata*, and *Sporobolus cryptandrus*. Forbs commonly present include *Astragalus nuttallianus, Lappula occidentalis, Lepidium densiflorum, Sphaeralcea coccinea*, and *Streptanthella longirostris*. Cryptogam cover is sparse to low but can be as high as 20%.

Globally
These dwarf-shrublands tend to be characteristic of rocky sites that are too dry for most vegetation. Total vegetation cover tends to be somewhat sparse, between 15% 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. *Juniperus osteosperma* trees are scattered through the community but do not form a stratum. Cryptogams are absent in gravelly sites but may have up to 25% cover in sandy sites. The shrub stratum may contain other shrubs, including *Atriplex confertifolia, Atriplex canescens, Chrysothamnus viscidiflorus, Gutierrezia sarothrae*, and *Grayia spinosa*, but none will have higher cover than *Opuntia polyacantha,* and usually have much less. Forbs are sparse and inconsistent in the herbaceous layer, but *Pleuraphis jamesii* is often

accompanied by other grasses with lesser cover, including *Achnatherum hymenoides* and *Hesperostipa comata*.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*, *Atriplex canescens*, *Ephedra viridis*
Herb (field)	*Atriplex confertifolia*, *Gutierrezia sarothrae*, *Opuntia polyacantha*
Herb (field)	*Astragalus nuttallianus*
Herb (field)	*Bromus tectorum*, *Pleuraphis jamesii*, *Vulpia octoflora*

Globally

Stratum	Species
Herb (field)	*Opuntia polyacantha*
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Colorado National Monument
Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (11-Jan-2005).

CLASSIFICATION COMMENTS

Colorado National Monument
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

Colorado National Monument Inventory Notes: Natural disturbance such as fire and rockfall or slope creep could perpetuate this community.
Colorado National Monument Plots: The description is based on 2003 field data (6 plots: COLM.0004, COLM.0034, COLM.0186, COLM.0233, COLM.0277, COLM.0278, and 1 observation point: COLM.0299).
Local Description Authors: J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Western Ecology Working Group n.d.

Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland
(Utah Serviceberry, Saskatoon Serviceberry) - Mountain-mahogany Shrubland

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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 Gambel Oak-Mixed Montane Shrubland (CES306.818)

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 1,586 m and 2,500 m (5,200–8,200 ft). 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, 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. *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, 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

Colorado National Monument

This association was observed and sampled in Fruita Canyon, Ute Canyon, above Kodels Canyon, Monument Canyon near Kissing Couple, on Monument Mesa, near the Highland View overlook on Rimrock Drive, near the Artist's Point overlook on Rimrock Drive, along Liberty Cap Trail, No Thoroughfare Canyon, and Wedding Canyon.

Globally

This association is documented from stands in western Colorado and southeastern 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.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This shrubland association was observed on talus or rockfall slopes in canyons, upper slopes in canyons, midslopes of ravines, midslopes of ridges, ridgetops, and in alcoves. Sites are gentle to steep (6%–60% slopes), occur between 1,586 m and 1,953 m elevation, and include all aspects. The unvegetated surface has low to moderate cover of litter and low to high cover of bedrock, large rocks, small rocks, and bare

soil. Parent materials include sandstones and shale. Soils are rapidly drained and texturally are sandy loam, silty clay, and clay loam. Site geology is rockfall deposits, Chinle Formation, Tidwell Member of the Morrison Formation, and Kayenta Formation and Wingate Formation sandstones.

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 1,586 m and 2,500 m (5,200–8,200 ft). 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 but are generally always rocky with a high cover of surface rock.

VEGETATION DESCRIPTION
Colorado National Monument
This Utah serviceberry - mountain-mahogany shrubland association is widely distributed throughout the monument. The total vegetation cover ranged from 10% to 50% in these sparsely to moderately vegetated stands. This shrubland association is characterized by an open tall-shrub canopy, typically 2 m–10 m tall, of *Amelanchier utahensis* that ranges in cover from 1% to 25% and *Cercocarpus montanus* that ranges in cover from 1% to 15%. A sparse canopy tree layer, typically 2 m–10 m tall, is often present and includes *Fraxinus anomala, Juniperus osteosperma*, and *Pinus edulis*. The associated shrub layer is highly variable in composition but is usually sparse or low in cover. Additional tall, short, and dwarf-shrubs present include *Artemisia tridentata ssp. tridentata, Artemisia bigelovii, Artemisia ludoviciana, Artemisia tridentata ssp. wyomingensis, Ephedra viridis, Ericameria nauseosa, Rhus trilobata, Brickellia microphylla, Chrysothamnus viscidiflorus, Eriogonum corymbosum*, and *Gutierrezia sarothrae*, and the succulents *Opuntia erinacea, Opuntia polyacantha, Sclerocactus whipplei*, and *Yucca harrimaniae*. The herbaceous layer is typically sparse, usually less than 5% cover, and is extremely diverse. Common graminoids include *Achnatherum hymenoides, Bromus tectorum, Elymus elymoides, Vulpia octoflora, Hesperostipa comata, Leymus salinus, Poa fendleriana*, and *Pseudoroegneria spicata*. Forbs commonly present include *Arenaria fendleri, Chaenactis douglasii, Chamaesyce glyptosperma, Cryptantha flava, Descurainia pinnata, Draba reptans, Galium coloradoense, Heterotheca villosa, Lepidium montanum, Petradoria pumila, Phlox longifolia, Physaria acutifolia, Senecio integerrimus, Silene antirrhina, Sphaeralcea coccinea, Stanleya pinnata*, and *Streptanthella longirostris*. Cryptogam cover is sparse, rarely as high as 5%.

Globally
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 shrub species include *Artemisia bigelovii, Artemisia tridentata, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, 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. *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, 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*.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tree canopy	*Fraxinus anomala*
Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Cercocarpus montanus*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis, Ephedra viridis*
Herb (field)	*Artemisia bigelovii*
Herb (field)	*Chaenactis douglasii, Galium coloradoense*
Herb (field)	*Achnatherum hymenoides, Bromus tectorum, Leymus salinus, Poa fendleriana, Pseudoroegneria spicata*

Globally

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Cercocarpus montanus*
Herb (field)	*Achnatherum hymenoides, Poa fendleriana*

OTHER NOTEWORTHY SPECIES

Colorado National Monument
Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK

Global Rank & Reasons: G2? (18 May 2001). This association is well-known only from a small area in Colorado, and very few occurrences have been documented. It also occurs in Utah and Nevada, but no information is available on its conservation status in those states. 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 Dinosaur and Colorado National Monuments.

CLASSIFICATION COMMENTS

Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Colorado National Monument Inventory Notes: Association of steep slopes, especially rockfall and talus; density increases with more mesic aspect and deeper soils.
Colorado National Monument Plots: The description is based on 2003 field data (11 plots: COLM.0051, COLM.0056, COLM.0084, COLM.0094, COLM.0095, COLM.0113, COLM.0150, COLM.0154, COLM.0171, COLM.0176, COLM.0183, and 4 observation points: COLM.0439, COLM.0465, COLM.0466, COLM.0467).
Local Description Authors: J. Von Loh
Global Description Authors: L. Tasker, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data, CONHP unpubl. data 2003, Driscoll et al. 1984, NVNHP 2003, Tiedemann 1978, 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)

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 at lower elevations and at 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
Colorado National Monument
This association was observed and sampled as sparse stands in Kodels, Gold Star, and No Thoroughfare canyons. It occupies difficult to access slopes and is more widespread than the sampling indicates.

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
Colorado National Monument
This tall-shrub association was observed on high slopes and midslopes in canyons, on areas of talus or rockfall. Sites are moderately steep to steep (16%–76% slopes), occur between 1,481 m and 2,028 m elevation, and include many aspects. The unvegetated surface has high cover of bedrock, large and small rocks, and bare soil. Parent materials include sandstone rockfall, sometimes atop slopes of Chinle Formation shale. Soils are rapidly drained and texturally are silt loam. Site geology is described as Wingate sandstone, rockfall deposits - sandstone, and migmatitic meta-sedimentary rocks.

Globally
This montane shrubland association occurs the foothills, mountains and mesas at elevations from 1,480 m to 2,440 m (4,855–8,000 ft). Stands occur on moderate to steep slopes (9-37 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 at lower elevations and more southern latitudes. Substrates are moderately deep, rocky loams and clays and are rapidly drained.

VEGETATION DESCRIPTION
Colorado National Monument
This Utah serviceberry shrubland association is distributed on difficult to access sites on rockfall or talus slopes and cliff bands in the monument. The total vegetation cover ranges from 17% to 27% in these sparsely to moderately vegetated stands. This shrubland association is characterized by an open, tall-shrub canopy, typically 2 m–5 m tall, of *Amelanchier utahensis* shrubs that range in cover from 5% to 15%. The canopy tree stratum is comprised of *Pinus edulis* and *Juniperus osteosperma*, each providing cover up to 6%. Another tall shrub, *Fraxinus anomala*, is often present but at very low cover. The shrub layer is variable in terms of species composition, but cover is sparse. Short shrubs that are often present include *Artemisia tridentata ssp. wyomingensis, Chrysothamnus viscidiflorus, Ephedra viridis,* and *Rhus trilobata* and the dwarf-shrubs *Artemisia ludoviciana, Gutierrezia sarothrae, Leptodactylon pungens,* and *Opuntia erinacea*. The herbaceous layer is typically sparse, usually less than 5% total cover. Common graminoids include *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Vulpia octoflora, Hesperostipa comata, Leymus salinus, Pleuraphis jamesii*, and *Poa fendleriana*. Forbs commonly present include *Asclepias cryptoceras, Castilleja scabrida, Cryptantha* spp., *Eriogonum umbellatum, Hymenopappus filifolius, Lepidium montanum, Mirabilis multiflora,* and *Physaria acutifolia*.

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, 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
Colorado National Monument

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Herb (field)	*Hymenopappus filifolius*
Herb (field)	*Achnatherum hymenoides, Bromus tectorum*

Globally

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Symphoricarpos oreophilus*

OTHER NOTEWORTHY SPECIES
Colorado National Monument

Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G4 (19-Sep-2000).

CLASSIFICATION COMMENTS
Colorado National Monument
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
Colorado National Monument Inventory Notes: Occupies steep, highly erosive slopes and is more widespread than sampling indicates.
Colorado National Monument Plots: The description is based on 2003 field data (2 plots: COLM.0009, COLM.0042, and 2 observation points: COLM.0296, COLM.0304).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: K.A. Schulz, mod. J. Drake

REFERENCES: Bourgeron and Engelking 1994, Carmichael et al. 1978, Cogan et al. 2004, Crane 1982, Driscoll et al. 1984, Eddleman and Jaindl 1994, NVNHP 2003, Western Ecology Working Group n.d., Yake and Brotherson 1979

Quercus gambelii / Rhus trilobata Shrubland
Gambel Oak / Skunkbush 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 (6%–38% slopes), occur between 1,685 m and 1,948 m elevation, and are oriented to north and east aspects. Total vegetation cover may range from 67% to well over 100%. *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,* and the vine *Clematis ligusticifolia*.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled at the head of Ute Canyon and its associated drainages on the mesatops and at the head of No Thoroughfare 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

Colorado National Monument

This woodland association was observed growing on the colluvial slope and associated terrace in canyons, at the base of sandstone formations adjacent to small canyons, in canyon bottoms, midslope in canyons, and on the upper slopes of canyons. Sites are moderately steep (6%–16% slopes), occur between 1,814 m and 1,948 m elevation, and are oriented to northeastern and eastern aspects. The unvegetated surface has high cover of litter in the form of oak mast. Parent materials are sandstone. Soils are somewhat poorly drained to moderately well-drained and texturally are sandy loam and loam. Site geology is rockfall deposits and eolian sand.

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 in canyon bottoms. Sites range from are moderately steep to steep (6%–38% slopes), occur between 1,685 m and 1,948 m elevation, and are oriented to north and east aspects. The unvegetated surface has high cover of leaf litter (greater than 90%). Parent materials are sandstone colluvium or eolian/alluvial sands, and soils are moderately well-drained sandy loams and loams.

VEGETATION DESCRIPTION

Colorado National Monument

This Gambel oak / skunkbush woodland association is rare on mesic sites in cool canyons. The total vegetation cover ranged from 67% to 106% in these densely vegetated stands. This woodland association is characterized by a closed tree canopy, typically 2 m to 10 m tall, of *Quercus gambelii* that ranges in cover from 35% to 95%. In one stand the canopy trees *Juniperus osteosperma* and *Pinus edulis* provided sparse cover. The shrub layer is diverse and provides low to moderate cover, with *Rhus trilobata* being a common associate. Other tall shrubs include *Amelanchier utahensis, Artemisia tridentata ssp. tridentata, Cercocarpus montanus, Ericameria nauseosa,* and *Prunus virginiana*. Short and dwarf-shrubs provide low cover and include *Artemisia tridentata ssp. wyomingensis, Ericameria nauseosa, Quercus gambelii, Symphoricarpos occidentalis, Mahonia repens,* and *Opuntia erinacea*. The herbaceous layer is sparse to moderately dense in cover and includes the common graminoids *Achnatherum hymenoides, Agropyron cristatum, Elymus trachycaulus, Bromus tectorum, Elymus elymoides, Piptatherum micranthum,* and *Poa fendleriana*. Forbs common to this association are *Artemisia dracunculus, Chenopodium album, Comandra umbellata, Descurainia pinnata, Heterotheca villosa, Heuchera parvifolia, Lepidium densiflorum, Lepidium montanum, Maianthemum stellatum, Silene antirrhina, Sisymbrium altissimum, Streptanthella longirostris,* and *Vicia americana*. The liana *Clematis ligusticifolia* contributed sparse cover in one stand.

Globally

This minor Gambel oak association may take the form of a woodland, with a canopy of *Quercus gambelii* clones between 5 m and 10 m tall providing 35% to 95% cover. *Rhus trilobata* shrubs between 1 m 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 and may include *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 graminoids include *Poa fendleriana* and *Piptatherum micranthum*, common forbs include *Maianthemum stellatum* and *Lepidium montanum*, and the vine *Clematis ligusticifolia* is nearly always present.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tree canopy	*Quercus gambelii*
Tall shrub/sapling	*Prunus virginiana, Quercus gambelii, Rhus trilobata*
Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Short shrub/sapling	*Rosa woodsii*
Herb (field)	*Mahonia repens*
Herb (field)	*Maianthemum stellatum*
Herb (field)	*Achnatherum hymenoides, Bromus tectorum, Elymus trachycaulus, Piptatherum micranthum, Poa fendleriana*

Globally

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis, Prunus virginiana, Quercus gambelii, Rhus trilobata*
Herb (field)	*Clematis ligusticifolia*
Herb (field)	*Maianthemum stellatum*
Herb (field)	*Poa fendleriana*

OTHER NOTEWORTHY SPECIES

Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (13-Jan-2005).

CLASSIFICATION COMMENTS

Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES

Colorado National Monument Inventory Notes: This association occurs as small stands and patches on mesic sites in cool canyons.
Colorado National Monument Plots: The description is based on 2003 field data (3 plots: COLM.0151, COLM.0155, COLM.0210, and 3 observation points: COLM.0332, COLM.0473, COLM.0496).
Local Description Authors: J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Western Ecology Working Group n.d.

Rhus trilobata Intermittently Flooded Shrubland
Skunkbush Intermittently Flooded Shrubland

CODE	CEGL001121
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	RHUS TRILOBATA INTERMITTENTLY FLOODED SHRUBLAND ALLIANCE (A.938) Skunkbush Intermittently Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This association is known from both mesic riparian and non-riparian situations in Utah, western Colorado, and the Snake River canyon and its tributaries of southern Idaho. Throughout its range, the association occurs at low to mid elevations (701 m–1,676 m (2,300–5,500 ft) in Idaho and 1,555 m to 2,000 m [5,100–6,560 ft] in Colorado), most often along mid-order to large rivers, but also in narrow canyons of small creeks and intermittent drainages. This association often forms linear bands above the high-water line on steep shorelines, along rocky toeslopes at cliff bases, on benches, and in intermittent arroyos, usually where there is minimal floodplain development. Stands also occur on rocky hillsides in association with springs and seeps emanating from canyon walls. In broad river bottoms, stands occur in the floodplain on second terraces between older *Populus* spp. forests on upper terraces and *Salix exigua* shrublands next to the river. In these large floodplains, habitats are in flux with stream meanders, channel downcutting, and sediment deposition; sites where this shrubland persists are generally too dry for the establishment of *Populus* and *Salix* spp. The association is found on well-drained, fine silty clay to sandy loam soils overlying coarse alluvium, bedrock or talus. *Rhus trilobata* often forms tall, dense, and nearly impenetrable thickets with 30%–98% cover. Associated shrubs can sometimes be codominant, but no single species has consistently high cover or constancy across the range of the association. Associated shrubs include *Celtis laevigata var. reticulata, Clematis ligusticifolia, Cornus sericea, Ericameria nauseosa, Ribes aureum, Rosa woodsii, Salix exigua, Salix lasiolepis, Salix lutea, Shepherdia argentea,* and *Toxicodendron rydbergii*. Saplings of *Populus fremontii, Populus angustifolia*, or *Salix amygdaloides* may be present. Total understory herbaceous cover and diversity are low, and herbaceous species are often confined to shrub canopy gaps. *Bromus tectorum* and *Galium aparine* are the most frequently occurring species, but native grasses such as *Elymus canadensis, Equisetum* spp., *Hordeum jubatum, Muhlenbergia asperifolia, Leymus cinereus, Pascopyrum smithii*, and *Phragmites australis* are sometimes also present. Forb associates include *Apocynum cannabinum* and *Artemisia ludoviciana*. Nonnative species are common in disturbed stands.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled in an alcove at the head of a canyon draining to Ute Canyon.

Globally

This association is known from western Colorado, Utah and southern Idaho. This minor shrubland association is known from the Yampa, San Miguel and Dolores river basins of the western slope of Colorado, along the Green River in northeastern Utah and Idaho, and the Colorado River in western Colorado and eastern Utah.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This shrubland association was observed on deep sediments deposited in an alcove at the head of a canyon. The site is gentle (10% slope), occurs at 1,961 m elevation, and is oriented to the east. The unvegetated surface is litter, predominantly. Parent materials are sandstones that eroded into fine sediment deposited as alluvium at the base of a pour-off. Soils are poorly drained and are alluvium deposited to 3 m deep. Texturally, the soils are sandy loam.

Globally

This minor association occurs in mesic, often riparian sites in western Colorado, eastern Utah and southwestern Idaho. Elevation ranges from 940 m to 2,000 m (3,085–6,560 ft). These small shrublands are reported from stream and river bottoms and terraces, and upland in mesic swales and on hillslopes below seeps and springs. Along the Yampa, San Miguel, and Dolores rivers stands often form linear bands on rocky, well-drained benches and toeslopes where it is often confined between the high-water mark of a river and adjacent cliff faces and has access to the high water table. Along the Green River stands occur in the floodplain on second terraces between older *Populus fremontii* forests on upper terraces and *Salix exigua* shrublands next to the river. In large floodplains, habitats are in flux with stream meanders, channel downcutting, and sediment deposition; sites where this shrubland persists are generally too dry for the establishment of *Populus* and *Salix* spp. Substrates are variable and range from shallow loamy sand to silt loam over coarse alluvium, boulders or bedrock, to fine silty clay with the depth to groundwater between 2 m to 4 m. Adjacent riparian vegetation includes communities dominated by *Schoenoplectus* spp., *Typha* spp., *Phragmites australis, Salix exigua, Alnus incana, Betula occidentalis, Populus angustifolia*, and *Populus fremontii*.

VEGETATION DESCRIPTION

Colorado National Monument

This skunkbush shrubland association is rare in the monument. The total vegetation cover is 102% in this densely vegetated stand. This shrubland is characterized by a closed canopy of *Rhus trilobata*, from 2 m to 3 m tall, that provided cover of 80%. The tall shrub *Amelanchier utahensis* and the short shrub *Artemisia tridentata ssp. wyomingensis* provided low cover. Graminoids are represented only by the nonnative annual *Bromus tectorum* that contributed moderate cover. The forb stratum includes sparse *Descurainia pinnata*.

Globally

This plant association is characterized by a dense short-shrub layer dominated by 30%–90% cover of *Rhus trilobata* sometimes forming near monocultures. However, the tall shrub *Salix exigua* is often present to codominant on mesic sites. Drier sites further from watercourses can have significant amounts of *Artemisia tridentata ssp. tridentata, Amelanchier utahensis*, or *Chrysothamnus linifolius*. Other associated shrubs include *Ericameria nauseosa, Ribes aureum, Salix lutea, Shepherdia argentea, Toxicodendron radicans*, and occasional sapling trees of *Populus fremontii, Populus angustifolia*, or *Salix amygdaloides*. In cooler, mesic sites *Cornus sericea, Salix ligulifolia (= Salix eriocephala var. ligulifolia), Berberis fendleri, Rosa woodsii*, and *Clematis ligusticifolia* may be present to abundant. The herbaceous layer is relatively sparse (<20% cover) and is composed primarily of graminoids such as *Elymus canadensis, Leymus cinereus (= Elymus cinereus), Equisetum* spp., *Hordeum jubatum, Muhlenbergia asperifolia, Pascopyrum smithii*. or *Phragmites australis*. Forb associates include *Apocynum cannabinum* and *Artemisia ludoviciana*. Nonnative species are common in disturbed stands and may include *Elaeagnus angustifolia, Tamarix ramosissima, Lepidium latifolium, Cirsium arvense,*

Thinopyrum intermedium, Poa pratensis, Agropyron cristatum, Melilotus officinalis, and *Helianthus annuus*.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis, Rhus trilobata*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*

Globally

Stratum	Species
Tall shrub/sapling	*Salix exigua*
Short shrub/sapling	*Rhus trilobata*

OTHER NOTEWORTHY SPECIES

Colorado National Monument

Data are not available.

Globally

Lepidium latifolium, Tamarix ramosissima

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (22-Oct-2002). Throughout its relatively broad range (i.e., western Colorado through Utah to southern Idaho), this association is restricted to hot and dry, low- to mid-elevation creeks and rivers. At least 35 plots have been sampled and 21 other stand observations documented, however, less than 20% of these occurrences are in good to excellent ecological condition. Further inventories throughout the range of the plant association will likely find more occurrences and possibly support classification of additional, distinct Rhus trilobata associations. This association often forms large, dense patches that are resistant to minor or occasional disturbance (e.g., fire, livestock damage). However, nonnative species, especially Bromus tectorum, frequently occur in the understory. In southern Idaho, most stands are protected from land development. Based on the moderate number of occurrences, broad range, and relative resilience of the Rhus trilobata association, it is best ranked as G3 rather than G2. Nevertheless, the association is definitely globally rare, being discontinuously distributed through an ecologically degraded landscape with on-going and growing threats, such as agricultural and housing development, livestock grazing, fires and conversion to nonnative species, and hydrologic alteration (e.g., irrigation diversions, hydroelectric development, and groundwater pumping).

CLASSIFICATION COMMENTS

Colorado National Monument

Data are not available.

Globally

This association has been quantitatively described from numerous locations: 28 plots and 12 stand observations from southern Idaho (Cole 1995, 1996, Jankovsky-Jones et al. 2001, Hansen and Hall 2002) and a number of plots from western Colorado (e.g., Kittel et al. 1999a). Several riparian communities dominated by, or with high cover of, *Rhus trilobata* have been documented along the Snake River by Cole (1995, 1996). Due to their degraded stand conditions (indicated by abundant *Bromus tectorum*) and to inconsistency in the cover and constancy of associated or codominant shrubs, these four communities are considered synonymous variants of this more broadly defined *Rhus trilobata* association. In addition, no diagnostic herbaceous species useful for differentiating between possible *Rhus trilobata* associations is apparent (Jankovsky-Jones et al. 2001, Hansen and Hall 2002). *Rhus trilobata - Salix exigua* has been proposed as a different association, but *Salix exigua* has only moderate constancy in otherwise similar stands sampled from Idaho and Colorado. Although this *Rhus trilobata* plant association occurs in two

distinct wetland settings (riverine and canyon-slope seeps or springs), no other distinct *Rhus trilobata* associations have been observed in these different settings. *Rhus trilobata* also occurs as a dominant species in xeric upland stands, especially east of the Continental Divide (Kittel et al. 1999a). These stands are separated by their clearly non-riparian settings and species.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This type may occur in similar locations at the heads of alcoves or around the base of bedrock exposures.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot: COLM.0198).
Local Description Authors: J. Von Loh
Global Description Authors: K.A. Schulz, mod. C. Murphy, J. Drake, J. Coles

REFERENCES: Bourgeron and Engelking 1994, CONHP Ecology Team 2001, Cole 1995, Cole 1996, Driscoll et al. 1984, Goodrich and Neese 1986, Hall and Hansen 1997, Hansen and Hall 2002, IDCDC 2005, IDCDC unpubl. data 2002, Jankovsky-Jones et al. 2001, Kittel and Lederer 1993, Kittel et al. 1999a, Padgett et al. 1989, Welsh et al. 1987, Western Ecology Working Group n.d.

Betula occidentalis / Maianthemum stellatum Shrubland
Water Birch / Starflower False Solomon's-seal Shrubland

CODE	CEGL001162
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 plant association occurs within the Intermountain West states from Colorado north and west into the Pacific Northwest. It typically forms a tall band of shrubs (1.5 m–2.5 m; 5–8 ft) lining the channel of first- and second-order streams in the elevational range of 2,000 m to 2,700 m (6,400–88,00 ft). At higher elevations, conifer trees on the upper slopes intermix with *Betula occidentalis* at the streambank. At lower elevations along sunny valley bottoms, well-developed, large occurrences occupy relatively flat stream benches and often extend away from the channel edge. While dominated by birch, other shrub species are commonly present, including *Alnus incana, Cornus sericea,* and one or two *Salix* species, depending on geographic location. In Colorado and Nevada, other shrubs that may be present include *Amelanchier utahensis, Loniceria involucrata,* and *Prunus virginiana.* In northeastern Oregon other shrubs include, *Ribes hudsonianum, Acer glabrum, Philedelphus lewisii, Symphoricarpos albus,* and *Crataegus douglasii.* The undergrowth can be a sparse or thick carpet of grasses and forbs. In undisturbed stands, forb species richness can be high, with over 30 species in one stand and may include species such as *Maianthemum stellatum* with up to 40% cover, *Heracleum maximum, Thalictrum fendleri,* and *Rudbeckia laciniata*. Graminoid cover is usually low but can include *Poa pratensis, Equisetum arvense, Carex utriculata,* and

others. An abundance of nonnative grass species is considered an indication of past or current heavy grazing.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled in the upper fingers of No Thoroughfare Canyon where cold-air drainage modifies the habitat and permanent seeps supply water.

Globally

This plant association occurs in many western states, but is restricted to the banks and floodplains of relatively small streams. It is rare on the Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This shrubland association was observed growing in drainage bottoms confined by deep sediment deposits. Sites are gentle to moderately steep (2%–16% slopes), occur between 1,857 m and 2,028 m elevation, and are oriented to northern aspects. The unvegetated surface has high cover of litter and can have moderate cover of bare soil. Parent materials are sandstones. Soils are somewhat poorly drained to moderately well-drained and texturally are sandy loam and silt loam. Site geology is valley fill deposits delivered from mesa tops and cliffs of Kayenta sandstone and cliffs of Wingate sandstone.

Globally

This plant association occurs within the Intermountain West states from Colorado north and west into the Pacific Northwest. It typically forms a tall band of shrubs (1.5 m–5 m; 5–18 ft tall) lining the channel of first- and second-order streams between 1,850 m to 2,700 m elevation (6,070–8,800 ft). At higher elevations, conifer trees intermix with *Betula occidentalis* on the stream bank. At lower elevations along sunny valley bottoms, well-developed, large occurrences occupy relatively flat stream benches and often extend away from the channel edge. In the canyons of the Colorado Plateau, stands are generally linear and may be isolated several meters above the downcuttting stream channel. Soils are often coarse-textured and bouldery.

VEGETATION DESCRIPTION

Colorado National Monument

This water birch / starflower false Solomon's-seal tall shrubland is rare within the monument occurring only in upper No Thoroughfare Canyon. The total vegetation cover ranged from 72% to 116% in these densely vegetated stands. This shrubland association is characterized by a closed tall-shrub canopy of *Betula occidentalis* that is up to 5.5 m (18 ft) tall and ranges in cover from 30% to 55%, and the understory forb *Maianthemum stellatum* that ranges in cover from 3% to 40%. The trees *Juniperus osteosperma* and *Populus tremuloides* provided low cover in some stands. The shrub layer is highly variable in cover and is diverse. Tall, short, and dwarf-shrubs provide low to moderate cover, up to 50%, and include *Amelanchier utahensis, Salix exigua, Salix lucida, Salix monticola, Ericameria nauseosa, Paxistima myrsinites, Prunus virginiana, Rhus trilobata, Rosa woodsii, Quercus gambelii,* and *Ribes inerme*. The herbaceous layer is typically sparse, usually less than 5% total cover. Common graminoids include *Dactylis glomerata, Equisetum laevigatum, Juncus balticus*, and *Poa pratensis*. Forbs present include *Agoseris* sp., *Artemisia dracunculus, Chenopodium album, Cirsium* sp., *Platanthera hyperborea, Heterotheca villosa, Melilotus officinalis, Penstemon comarrhenus, Ranunculus cymbalaria, Packera multilobata,* and *Taraxacum officinale*. The liana or vine *Clematis ligusticifolia* is present but sparse in terms of cover. Moss contributed up to 6% cover in one stand, present in water flowing over bedrock.

Globally

The tall shrub canopy in this association is dominated by *Betula occidentalis* up to 5 m (18 ft) tall and with up to 98% cover. While dominated by birch, other shrub species are commonly present, including

Alnus incana, Cornus sericea, and one or two *Salix* species, depending geographic location. In Colorado and Nevada, other shrubs that may be present include *Amelanchier utahensis, Loniceria involucrata,* and *Prunus virginiana.* In northeastern Oregon, other shrubs include, *Ribes hudsonianum, Acer glabrum, Philedelphus lewisii, Symphoricarpos albus,* and *Crataegus douglasii*. The undergrowth can be a sparse or thick carpet of grasses and forbs. In undisturbed stands, forb species richness can be high, with over 30 species in one stand and may include species such as *Maianthemum stellatum* up to 40% cover, *Heracleum maximum, Thalictrum fendleri,* and *Rudbeckia laciniata*. Graminoid cover is usually low but can include *Poa pratensis*, *Equisetum arvense*, *Carex utriculata*, and others. Stands with a very dense canopy and somewhat dry conditions may have a sparse understory not exceeding 5% cover. Total vegetation cover often exceeds 100%.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Tree canopy	*Populus tremuloides*
Tall shrub/sapling	*Betula occidentalis, Salix exigua, Salix monticola*
Short shrub/sapling	*Rosa woodsii*
Herb (field)	*Clematis ligusticifolia*
Herb (field)	*Maianthemum stellatum, Ranunculus cymbalaria*
Herb (field)	*Juncus balticus*
Herb (field)	*Equisetum laevigatum*

Globally

Tall shrub/sapling	*Betula occidentalis, Cornus sericea, Lonicera involucrata, Salix exigua, Salix lutea*
Herb (field)	*Heracleum maximum, Maianthemum stellatum, Rudbeckia laciniata, Thalictrum fendleri*

OTHER NOTEWORTHY SPECIES

Colorado National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G4? (26-Jun-2001). Throughout the association's range, fewer than thirty stands are documented. While more occurrences are known, good condition occurrences are difficult to find at the lower elevational habitats where this community typically is found. This association is highly threatened by abuse from over grazing, development, road building, recreation, stream modifications, and other similar human impacts. It appears to be relatively common in Nevada, so the Global rank is lower than might otherwise be indicated but the threats. Future inventory and ranking of occurrences may result in a raising of the rank.

CLASSIFICATION COMMENTS

Colorado National Monument

Data are not available.

Globally

Classification for this association is based on seven stands in Nevada, five stands in Utah and southeastern Idaho, three stands in southwestern Idaho, and 15 stands in Colorado. Closely related communities include *Betula occidentalis / Cornus sericea* Shrubland (CEGL001161), the *Betula*

occidentalis community type which includes degraded stands with abundant nonnative grasses in the undergrowth, *Alnus incana - Betula occidentalis* Shrubland (CEGL001142), and *Alnus incana - Betula fontinalis / Salix* spp. plant association (not in USNVC). *Betula fontinalis* is a synonym for *Betula occidentalis*.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Association is confined to mesic drainage bottoms and upper canyon fingers, mostly where flowing water is present for at least a portion of the year.
Colorado National Monument Plots: The description is based on 2003 field data (3 plots: COLM.0099, COLM.0153, COLM.0158, and 2 observation points: COLM.0366, COLM.0395).
Local Description Authors: J. Von Loh
Global Description Authors: J. Thompson and J. Stevens

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Cooper and Cottrell 1990, Crowe and Clausnitzer 1997, Driscoll et al. 1984, Kittel et al. 1994, Kittel et al. 1995, Kittel et al. 1996, Kittel et al. 1999a, Manning and Padgett 1995, NVNHP 2003, Nachlinger and Reese 1996, Padgett et al. 1989, 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 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

Colorado National Monument

This association was observed and sampled in upper Ute Canyon, upper No Thoroughfare Canyon, and Red and Columbus canyons.

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

Colorado National Monument

This shrubland association was observed in mesic canyon bottoms and within a stock pond. Sites are gentle (0%–6% slopes) (an exception being one canyon site with a 44% slope), occur between 1,530 m and 2,007 m elevation, and are oriented to northeastern, eastern, and southeastern aspects. The unvegetated surface has high cover of litter. Parent materials are variable but mostly consist of sandstones. Soils are somewhat poorly drained to poorly drained and texturally are sandy loam. Site geology is valley fill deposits, rockfall deposits, and Kayenta sandstone.

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 m to 2,700 m (3,075–9,100 ft). 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 cm–30 cm) often have 25%–30% organic matter (Kittel et al. 1999a), and organic litter covers most of the unvegetated ground surface.

VEGETATION DESCRIPTION

Colorado National Monument

This coyote (sandbar) willow shrubland association is rare within the monument. The total vegetation cover ranges from 61% to 74% in these densely vegetated stands. This shrubland association is characterized by a closed tall-shrub canopy of *Salix exigua* that ranges in cover from 50% to 65%. Additional tall shrubs provide sparse to low cover and include *Acer negundo, Amelanchier utahensis, Fraxinus anomala, Prunus virginiana, Quercus gambelii, Salix lucida,* and *Tamarix ramosissima*. Canopy trees from 5 m to 15 m tall are often present, provide low cover, and include *Acer negundo* and *Populus deltoides ssp. wislizeni*. Short and dwarf-shrubs provide sparse cover and include *Artemisia tridentata, Ericameria nauseosa, Ericameria parryi, Rosa woodsii, Artemisia ludoviciana,* and *Gutierrezia sarothrae*. The herbaceous layer provides moderate cover, from 5% to 20%, and is diverse. Common graminoids include *Achnatherum hymenoides, Bromus japonicus, Bromus tectorum, Dactylis glomerata, Distichlis spicata, Eleocharis palustris, Elymus elymoides, Equisetum laevigatum, Vulpia octoflora, Hordeum jubatum, Juncus balticus, Poa pratensis, Polypogon monspeliensis, Sporobolus airoides,* and *Typha latifolia*. Forbs are less common and include *Chenopodium album, Cirsium undulatum, Erodium cicutarium, Heterotheca villosa, Lepidium densiflorum, Lepidium montanum,*

Maianthemum stellatum, Melilotus officinalis, Mentha arvensis, Rumex crispus, Sisymbrium altissimum, Taraxacum officinale, and *Tragopogon dubius*. The liana *Clematis ligusticifolia* contributed sparse cover in some stands.

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
Colorado National Monument

Stratum	Species
Tall shrub/sapling	*Prunus virginiana, Quercus gambelii, Salix exigua*
Short shrub/sapling	*Ericameria parryi, Rosa woodsii*
Herb (field)	*Clematis ligusticifolia*
Herb (field)	*Melilotus officinalis*
Herb (field)	*Bromus japonicus, Bromus tectorum, Distichlis spicata, Juncus balticus, Poa pratensis, Typha latifolia*
Herb (field)	*Equisetum laevigatum*

Globally

Stratum	Species
Tall shrub/sapling	*Salix exigua*
Herb (field)	*Pascopyrum smithii, Poa pratensis, Schoenoplectus americanus, Sorghastrum nutans*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (7-Apr-1998).

CLASSIFICATION COMMENTS
Colorado National Monument
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
Colorado National Monument Inventory Notes: The association is found in very confined drainage bottoms and subject to flash flood effects.
Colorado National Monument Plots: The description is based on 2003 field data (3 plots: COLM.0050, COLM.0098, COLM.0216, and 3 observation points: COLM.0331, COLM.0370, COLM.0520).
Local Description Authors: 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, Cogan et al. 2004, 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, Steinauer and Rolfsmeier 2000, Walford et al. 2001, Western Ecology Working Group n.d.

Sarcobatus vermiculatus / Artemisia tridentata Shrubland
Black Greasewood / Basin Big Sagebrush Shrubland

CODE	CEGL001359
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 (III.B.3.N.b.)	Intermittently flooded extremely xeromorphic deciduous subdesert shrubland
ALLIANCE	SARCOBATUS VERMICULATUS INTERMITTENTLY FLOODED SHRUBLAND ALLIANCE (A.1046) Black Greasewood Intermittently Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Greasewood Flat (CES304.780)
Inter-Mountain Basins Playa (CES304.786)
Northwestern Great Plains Shrubland (CES303.662)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This mixed bottomland shrubland is characteristic of terraces and floodplains of the Intermountain West. The presence of other shrubs in the canopy indicates less saline conditions than found in *Sarcobatus vermiculatus* Shrubland (CEGL001357). Soils are deep and generally sandy, but a few sites are on well-drained silt loams. The sagebrush element may be either *Artemisia tridentata ssp. tridentata* or *Artemisia tridentata ssp. wyomingensis*, and either the sagebrush or *Sarcobatus vermiculatus* may have

the greater cover. *Atriplex canescens, Ericameria nauseosa,* and *Chrysothamnus viscidiflorus* are other common minor elements of the shrub canopy. Total shrub cover is between 5% and 30%. The understory is variable; cover by herbaceous species may be sparse to dense, or nonnative species may dominate the field layer.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled west of the west entry gate for the monument. It may also occur in the bottom of Ute Canyon.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This shrubland association was observed on an alluvial fan. The site is gently sloping (9% slope), occurs at 1,442 m elevation, and is oriented to an eastern aspect. The unvegetated surface has moderate cover of bare soil and litter. Cryptogamic cover is up to 35%. Parent materials are mostly sandstones and shale deposited by wind and water. Soils are somewhat poorly drained and texturally are sandy loam. Site geology is eolian and sheetwash deposits.

Globally

This minor shrub association occurs on terraces, alluvial fans, floodplains, toeslopes and valley floors. Elevations range from 1,300 m to 1,950 m. Slopes are generally gentle, and the upper soil layers are somewhat saline. Bare soil and litter cover most of the ground surface. Soils are deep and generally sandy, but a few sites are on well-drained silt loams.

VEGETATION DESCRIPTION

Colorado National Monument

This shrubland association is limited to one sampled stand and possibly wider distribution in Ute Canyon. The total vegetation cover is 51% for this moderately vegetated site. This shrubland association is characterized by the short shrubs *Sarcobatus vermiculatus* and *Artemisia tridentata ssp. wyomingensis* that each range in cover from 5% to 25%. The dwarf-shrub *Chrysothamnus viscidiflorus* also provided low cover. The herbaceous layer is relatively diverse but sparse. Graminoids include *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Elymus elymoides, Vulpia octoflora, Hesperostipa comata,* and *Triticum aestivum*. Forbs are relatively diverse and include *Astragalus nuttallianus, Descurainia pinnata, Lappula occidentalis, Lepidium densiflorum, Oenothera pallida, Plantago patagonica,* and *Streptanthella longirostris*. Cryptogam cover is moderate, up to 35% cover.

Globally

This mixed bottomland shrubland is characteristic of terraces and floodplains of the Intermountain West. The sagebrush element may be either *Artemisia tridentata ssp. tridentata* or *Artemisia tridentata ssp. wyomingensis,* and either the sagebrush or *Sarcobatus vermiculatus* may have the greater cover. *Atriplex canescens, Ericameria nauseosa,* and *Chrysothamnus viscidiflorus* are other common minor elements of the shrub canopy. Total shrub cover is between 5% and 30%. The understory is variable; cover by herbaceous species may be sparse to dense, or nonnative species may dominate the field layer.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus*
Herb (field)	*Chrysothamnus viscidiflorus*

Globally

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus*
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*, *Artemisia tridentata* ssp. *wyomingensis*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G4 (1-Feb-1996).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This association has very limited distribution, on alkaline/saline soils, in the monument.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot: COLM.0014).
Local Description Authors: J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Lesica and DeVelice 1992, MTNHP 2002b, Western Ecology Working Group n.d.

Sarcobatus vermiculatus Disturbed Shrubland
Black 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 (III.B.3.N.b.)	Intermittently flooded extremely xeromorphic deciduous subdesert shrubland
ALLIANCE	SARCOBATUS VERMICULATUS INTERMITTENTLY FLOODED SHRUBLAND ALLIANCE (A.1046) Black 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 shrubland association occurs on saline soils of terraces, swales, alluvial fans, valley floors, toeslopes and ridges throughout the Colorado Plateau and Great Basin. 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), 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 nonnative; *Vulpia octoflora, Bromus tectorum, Descurainia pinnata, Salsola tragus, Alyssum desertorum,* and *Halogeton glomeratus* are typical understory species.

DISTRIBUTION
Colorado National Monument
This association was observed and sampled along the Liberty Cap Trail, near the eastern Liberty Cap trailhead, near the North Entrance, near the East Entrance, in lower No Thoroughfare Canyon, on the Old Gordon Trail, in Ute Canyon, and north of the Monument Canyon trailhead.

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 Uinta Basin (eastern Utah), Great Basin (central Utah, central Nevada, eastern California), northwestern New Mexico (Francis 1986) and Colorado Plateau (western Colorado).

ENVIRONMENTAL DESCRIPTION
Colorado National Monument
This shrubland association was observed on alluvial fans, swales, in drainages, in canyons, on toeslopes, and midslope on ridges. Sites are gentle to moderately steep (2%–16% slopes), occur between 1,420 m and 1,700 m elevation, and are oriented to all aspects. The unvegetated surface has low to moderate cover of litter and often has moderate to high cover of bare soil. Cryptogamic cover is variable and often low, but approaches 80% on one site. Parent materials are sandstones, shale, and Precambrian gneiss. Soils are somewhat poorly drained to well-drained and texturally are sandy loam, clay loam, and silty clay. Site geology is Holocene alluvium, eolian and sheetwash deposits, and valley fill deposits that are mostly located along the eastern monument boundary.

Globally
This widespread but patchy shrubland association occurs on terraces, swales, coppice dunes, alluvial fans, valley floors, toeslopes and ridges throughout the Colorado Plateau and Great Basin. Elevations range between 1,200 m and 2,073 m (3,940–6,800 ft), and slopes tend to be gentle. 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. Soil textures range from sandy loam to silty clay and tend to be alkaline, often with a white salt crust on the soil surface.

VEGETATION DESCRIPTION
Colorado National Monument
This shrubland association is rare and distributed as small stands in the monument. The total vegetation cover ranged from 9% to 47% in these sparsely to moderately vegetated stands. This shrubland association is characterized by an open tall- and short-shrub canopy of *Sarcobatus vermiculatus* that ranged in cover between 12% and 20%. Associated short and dwarf-shrubs are diverse, providing sparse

to low cover by *Artemisia tridentata ssp. tridentata, Artemisia tridentata ssp. wyomingensis, Ericameria nauseosa, Tetradymia spinosa, Atriplex confertifolia, Ephedra viridis, Gutierrezia sarothrae,* and the succulents *Echinocereus triglochidiatus, Opuntia phaeacantha, Opuntia polyacantha*, and *Sclerocactus whipplei*. Herbaceous species are diverse but generally contribute sparse cover, an exception being low to moderate cover in some stands by annual nonnative species. Common graminoids include *Achnatherum hymenoides, Bromus tectorum, Elymus elymoides, Vulpia octoflora, Pleuraphis jamesii, Poa secunda, Sporobolus airoides,* and *Sporobolus cryptandrus*. Forbs commonly present include *Astragalus nuttallianus, Chaenactis stevioides, Cryptantha fendleri, Descurainia pinnata, Erodium cicutarium, Lappula occidentalis, Lepidium densiflorum, Lepidium montanum, Plantago patagonica, Rumex hymenosepalus, Sisymbrium altissimum, Sphaeralcea coccinea,* and *Streptanthella longirostris*. Cryptogam cover is variable with some stands having little, but cover can be as high as 80%.

Globally
This shrubland association 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 include *Atriplex gardneri, Ericameria nauseosa, Grayia spinosa, Suaeda moquinii (= Suaeda torreyana), Atriplex canescens,* and *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 nonnative; *Vulpia octoflora, Bromus tectorum, Descurainia pinnata, Salsola tragus, Alyssum desertorum,* and *Halogeton glomeratus* are typical understory dominants.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Tall shrub/sapling	*Sarcobatus vermiculatus*
Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Short shrub/sapling	*Sarcobatus vermiculatus, Tetradymia spinosa*
Herb (field)	*Atriplex confertifolia, Gutierrezia sarothrae, Opuntia phaeacantha, Opuntia polyacantha*
Herb (field)	*Astragalus nuttallianus, Descurainia pinnata, Erodium cicutarium, Lappula occidentalis*
Herb (field)	*Achnatherum hymenoides, Pleuraphis jamesii, Sporobolus cryptandrus*

Globally

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus*
Herb (field)	*Bromus tectorum*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

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

CLASSIFICATION COMMENTS
Colorado National Monument
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 nonnative herbaceous species.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Stands occupy saline/alkaline soils.
Colorado National Monument Plots: The description is based on 2003 field data (5 plots: COLM.0002, COLM.0019, COLM.0069, COLM.0236, COLM.0264, and 6 observation points: COLM.0295, COLM.0301, COLM.0340, COLM.0348, COLM.0353, COLM.0513).
Local Description Authors: J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Bourgeron and Engelking 1994, Brotherson et al. 1986, Dastrup 1963, Donovan et al. 1996, Driscoll et al. 1984, Francis 1986, Ganskopp 1986, Graham 1937, Groeneveld and Crowley 1988, NVNHP 2003, Shantz and Piemeisel 1940, Western Ecology Working Group n.d., Young et al. 1986

Krascheninnikovia lanata / Pleuraphis jamesii Dwarf-shrubland
Winter-fat / 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) Winter-fat Dwarf-shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)

USFWS WETLAND SYSTEM: Palustrine

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, and 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 co-dominated 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, Machaeranthera pinnatifida,* and *Sphaeralcea coccinea*. Nonnative annuals may include *Bromus tectorum, Salsola kali,* and *Sisymbrium altissimum.*

DISTRIBUTION
Colorado National Monument

This association was observed and sampled in the project environs on land managed by the U.S. Bureau of Land Management, adjacent to the southwestern boundary of the monument north of CS Road.

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
Colorado National Monument
This dwarf-shrubland association was observed growing on the lower slope of a low ridge. The site is gentle (6% slope), occurs at 2,048 m elevation, and is oriented to an aspect of 155 degrees. The unvegetated surface has high cover of bare soil and moderate cover of litter. Parent materials are sandstones and shale that have decomposed and blown to this site. Soils are well-drained and texturally are sandy loam. Site geology is eolian and sheetwash deposits.

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 cm to 30 cm with most occurring during the growing season, often as short-duration, convectional thunderstorms. 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, and 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 DESCRIPTION
Colorado National Monument
This winter-fat / James' galleta dwarf-shrubland stand is rare and occurs on BLM land adjacent to the monument. The total vegetation cover is sparse (17%) for this stand that occupies an historically and possibly annually disturbed site. This dwarf-shrubland is characterized by *Krascheninnikovia lanata* and the perennial bunchgrass *Pleuraphis jamesii* that each range in cover from 1% to 5%. The shrub layer is sparse in terms of cover and includes *Artemisia tridentata ssp. wyomingensis* and *Opuntia fragilis*. Graminoids contributed most of the vegetative cover, and additional species include *Bouteloua gracilis, Bromus tectorum, Pascopyrum smithii,* and *Sporobolus cryptandrus*. Forbs provided sparse cover and included *Cryptantha* sp., *Erigeron* sp., *Portulaca oleracea,* and *Sphaeralcea coccinea*.

Globally
This association is characterized by a sparse to moderately dense dwarf-shrub layer dominated by *Krascheninnikovia lanata* and sometimes co-dominated by *Gutierrezia sarothrae,* and a sparse to moderately dense herbaceous layer dominated by the perennial graminoid *Pleuraphis jamesii (= Hilaria jamesii)*. Scattered *Artemisia tridentata, Artemisia bigelovii, Atriplex canescens, 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, Machaeranthera pinnatifida,* and *Sphaeralcea coccinea*. Nonnative annuals may include *Bromus tectorum, Salsola kali,* and *Sisymbrium altissimum.*

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Short shrub/sapling	*Krascheninnikovia lanata*
Herb (field)	*Bouteloua gracilis, Bromus tectorum, Pleuraphis jamesii, Sporobolus cryptandrus*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex canescens*
Short shrub/sapling	*Gutierrezia sarothrae, Krascheninnikovia lanata*
Herb (field)	*Bromus tectorum, Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G4 (23-Feb-1994).

CLASSIFICATION COMMENTS

Colorado National Monument
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

Colorado National Monument Inventory Notes: Stand occupies a site that may be disturbed historically/annually by yarding livestock prior to loading into trucks.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot): (Plot: COLM.0270).
Local Description Authors: J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Francis 1986, Von Loh 2000, 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 but consists of an open canopy of dwarf-shrubs consisting primarily or entirely of *Atriplex gardneri* and an herbaceous stratum in which *Pleuraphis jamesii* is conspicuous. The substrate is derived from shale, but there is often a layer of gravel or small rocks on the ground surface.

DISTRIBUTION

Colorado National Monument

This association was observed as three small patches along the Black Ridge Trail, northwest of its intersection with the CCC Trail and adjacent to the western monument boundary. The lands to the west of the monument boundary are managed by the U.S. Bureau of Land Management.

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

Colorado National Monument

This dwarf-shrubland association was observed on the midslope of low ridges. Sites are gentle (6% slope), occur between 1,961 m and 1,972 m elevation, and are oriented to aspects of 150 and 260 degrees. The unvegetated surface has high cover of bare soil and large and small rocks. Parent materials are clay and shale derived from the Morrison Formation. Soils are rapidly drained and texturally are clay loam, but they are overlain with a gravel veneer. Site geology is that of older landslide deposits derived from the Brushy Basin Member of the Morrison Formation and younger strata.

Globally

This association occurs on slopes of ridges, hills, eroded pediment slopes and badlands of the Colorado Plateau in eastern Utah and western Colorado. Elevations range between 1,225 m and 1,975 m (4,020–6,480 ft) and slopes from gentle to moderately steep (10%–65%). The substrate is often a silt loam or clay loam derived from shale, including the Morrison Formation, Chinle shale, Mancos shale, or Moenkopi Formation. The soil surface often has a coating of gravel or small rocks.

VEGETATION DESCRIPTION

Colorado National Monument

This dwarf-shrubland association is very rare and occurs only on the monument's western boundary. The total vegetation cover is 19% for this sparsely vegetated stand. This dwarf-shrubland association is characterized by sparse cover, up to 8%, of the mat-forming *Atriplex gardneri*. Additional dwarf-shrubs and succulents provide sparse cover and include *Artemisia nova, Echinocereus triglochidiatus, Opuntia polyacantha*, sapling *Juniperus osteosperma*, and *Sarcobatus vermiculatus*. The herbaceous layer is typically sparse or provides low cover, usually less than 5% total cover. Graminoids are relatively diverse, provide low cover, and include *Bromus tectorum, Elymus elymoides, Hordeum brachyantherum, Leymus salinus, Pleuraphis jamesii,* and *Poa secunda*. Forbs commonly present include *Agoseris* sp., *Allium* sp.,

Calochortus gunnisonii, Camelina microcarpa, Lappula occidentalis, Lepidium densiflorum, Malcolmia africana, Plantago patagonica, Platyschkuhria integrifolia, and *Sphaeralcea coccinea*.

Globally
This association occurs on shale badlands, often where the soil surface is modified by a layer of gravel or small rocks. Total vegetation is generally sparse, rarely exceeding 20%. The sparse dwarf-shrub layer (1%–10% cover) is dominated by *Atriplex gardneri*, although other low shrubs are also often present, including *Picrothamnus desertorum, Atriplex confertifolia, Krascheninnikovia lanata,* or *Artemisia nova*. Herbaceous species form a sparse layer (up to 8% cover), where *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 *Achnatherum hymenoides, Eriogonum inflatum, Xylorhiza venusta, Platyschkuhria integrifolia,* and *Sphaeralcea coccinea*.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Short shrub/sapling	*Artemisia nova*
Herb (field)	*Atriplex gardneri, Opuntia polyacantha*
Herb (field)	*Lappula occidentalis, Platyschkuhria integrifolia*
Herb (field)	*Bromus tectorum, Pleuraphis jamesii, Poa secunda*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex gardneri*
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Ceratocephala testiculata, Malcolmia africana

CONSERVATION STATUS RANK
Global Rank & Reasons: G3G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This type is limited to small patches on the monument boundary. Additional stands may occur on BLM land to the west.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot: COLM.0052 and 1 observation point: COLM.0333).
Local Description Authors: J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Ibrahim et al. 1972, Singh and West 1971, U.S. Bureau of Reclamation 1976, Utah Environmental and Agricultural Consultants 1973, West and Ibrahim 1968, Western Ecology Working Group n.d.

IV. Herbaceous Communities

Pascopyrum smithii Herbaceous Vegetation
Western Wheatgrass Herbaceous Vegetation

CODE	CEGL001577
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 sod temperate or subpolar grassland (V.A.5.N.c.)
ALLIANCE	PASCOPYRUM SMITHII HERBACEOUS ALLIANCE (A.1232) Western Wheatgrass Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Central Mixedgrass Prairie (CES303.659)
Northwestern Great Plains Mixedgrass Prairie (CES303.674)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This midgrass prairie type is found in the northern and western Great Plains, Rocky Mountains, the interior western United States and possibly Canada. Stands occur on level to gently sloping terrain. They are found on alluvial fans, swales, river terraces, floodplains, valley floors and basins. The soils are clay, clay loam, and silt loam. *Pascopyrum smithii* strongly dominates the moderate to dense (40%–100% cover) mixedgrass herbaceous canopy that grows 0.5 m–1.0 m tall. Other graminoids that co-occur and may achieve local dominance are *Koeleria macrantha, Eleocharis palustris*, and *Poa* spp. Many other species common in midgrass prairies are also found in this community. These include *Artemisia ludoviciana, Eriogonum* spp., *Bouteloua gracilis, Nassella viridula*, and *Hesperostipa comata (= Stipa comata)*. Shrubs and dwarf-shrubs are rare in this community, but occasional woody plants such as *Artemisia tridentata, Symphoricarpos* spp., *Ericameria nauseosa*, or *Krascheninnikovia lanata* may be present. Introduced species, such as *Bromus tectorum, Bromus inermis, Poa pratensis, Melilotus* spp. or *Cirsium arvense*, are common in some stands, especially where disturbed.

DISTRIBUTION

Colorado National Monument

This association is rare and was observed in a drainage near the junction of Glade Park Road and Rimrock Drive and in a stock pond on U.S. Bureau of Land Management property on the western edge of the monument.

Globally

This midgrass prairie type is found in the northern and western Great Plains, Rocky Mountains, intermountain western United States and possibly Canada, ranging from North Dakota and possibly Saskatchewan, south to Nebraska and Colorado, west to northern Arizona, Utah and Idaho.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This herbaceous association was observed in a drainage bottom and in an old stock pond, both located in small valleys. Sites were gentle (2% slope), occurred at elevations of 1,940 m and 1,968 m, and were oriented to the aspects of 220 and 250 degrees. The unvegetated surface is mostly litter. Parent materials

are sandstones, shales, and Precambrian rocks that have eroded and are deposited as alluvium. Soils are moderately well-drained and texturally are silty clay. The geology in the vicinity of this association included slopes of Tidwell Formation shales, Kayenta Formation sandstones, and Precambrian bedrock.

Globally
This grassland association is widespread in the northern and western Great Plains, Rocky Mountains, the intermountain western United States and possibly Canada. Elevation ranges from 600 m to 3,000 m. Stands occur on level to gently sloping terrain. They are found on alluvial fans, swales, river terraces, floodplains, valley bottoms and basins. The soils are deep (40 cm–100 cm) and well-developed with clay, clay loam, and silt loam textures. Some stands occur on perched water tables

VEGETATION DESCRIPTION
Colorado National Monument
This western wheatgrass herbaceous association is rare and distributed only as two vegetation patches occupying mesic, low-lying sites. The total vegetation cover ranged from 28%–36% in these moderately vegetated stands. This herbaceous association is characterized by *Pascopyrum smithii* that contributed 15% foliar cover. Nonnative graminoids contribute low to moderate cover and include *Agropyron cristatum, Bromus japonicus, Bromus tectorum,* and *Poa pratensis*. It is possible that *Pascopyrum smithii* was introduced to this area as part of range seeding programs, historically. Forbs are weedy and contribute <5% cover by *Iva axillaris, Solidago* sp., and *Tragopogon dubius*. Short shrubs are uncommon and contribute 1% or less cover, including *Artemisia tridentata ssp. tridentata* and *Ericameria nauseosa*.

Globally
This association is characterized by a moderate to dense (40%–100% cover) mixedgrass herbaceous canopy that grows 0.5 m to 1.0 m tall and is strongly dominated by *Pascopyrum smithii*. Other graminoids that co-occur and may achieve local dominance are *Koeleria macrantha, Eleocharis palustris,* and *Poa* spp. Many other species common in midgrass prairies are also found in this community. These include *Artemisia frigida, Artemisia ludoviciana, Achillea* sp., *Carex* spp., *Eriogonum* spp., *Bouteloua gracilis, Nassella viridula,* and *Hesperostipa comata (= Stipa comata)*. Shrubs and dwarf-shrubs are rare in this community, but occasional woody plants such as *Symphoricarpos* spp., *Ericameria nauseosa,* or *Krascheninnikovia lanata* may be present. Introduced species, such as *Bromus tectorum, Bromus inermis, Poa pratensis, Melilotus* spp., *Cirsium arvense, Taraxacum officinale,* or *Salsola kali,* are common in some stands, especially where disturbed.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Herb (field)	*Agropyron cristatum, Bromus tectorum, Pascopyrum smithii, Poa pratensis*

Globally

Stratum	Species
Herb (field)	*Pascopyrum smithii*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G3G5Q (1-Feb-1996).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
This community is similar to several others that are dominated or codominated by *Pascopyrum smithii*. As currently defined, it represents a western Great Plains and foothills version of the western wheatgrass types in the central Great Plains. Further work needs to be done to refine the differences in composition and environmental characteristics. See recent descriptions by Thilenius et al. (1995) (*Pascopyrum smithii* sodgrass steppe, a more playa-like wheatgrass type) and by Steinauer and Rolfsmeier (2000). In Nebraska, Steinauer and Rolfsmeier (2000) suggest that their stands may resemble *Pascopyrum smithii - Nassella viridula* Herbaceous Vegetation (CEGL001583).

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This association occurs in small patches on mesic sites.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot: COLM.0068, and 3 observation points: COLM.0455).
Local Description Authors: J. Von Loh
Global Description Authors: J. Drake, mod. K.A. Schulz

REFERENCES: Aldous and Shantz 1924, Baker 1983c, Baker 1984a, Baker and Kennedy 1985, Bourgeron and Engelking 1994, Bunin 1985, CONHP unpubl. data 2003, Christensen and Welsh 1963, Driscoll et al. 1984, Godfread 1994, Hall and Hansen 1997, Hansen et al. 1991, Hansen et al. 1995, Hansen et al. 2004c, IDCDC 2005, Jones and Walford 1995, MTNHP 2002b, Marr and Buckner 1974, Ramaley 1916b, Ramaley 1919b, Ramaley 1942, Shanks 1977, Soil Conservation Service 1978, Steinauer and Rolfsmeier 2000, Thilenius et al. 1995, Von Loh 2000, 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 grassland occurs on the Colorado Plateau and Great Basin. Stands are found on plains, gentle hillslopes, knolls and bluffs, mesa tops, and plateau parks. Substrates are variable and include sand, cobbles, clay loams and silty clay. This association is characterized by a relatively sparse to moderate herbaceous layer (10%–40% cover) that is strongly dominated by the cool-season bunchgrass *Hesperostipa comata*. Low cover of other grasses, such as *Achnatherum hymenoides, Achnatherum lettermanii, Aristida purpurea, Elymus elymoides, 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 species may be diverse and include species of *Artemisia, Balsamorhiza, Cirsium, Gilia, Hymenopappus, Lappula, Machaeranthera,* and *Vicia*. Scattered shrubs and dwarf-shrubs may be present with less than 5% total cover. The widespread introduced annual grass *Bromus tectorum* often contributes significant cover in disturbed stands. Some stands have high cover of cryptogams on the soil.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled on a ridge of Precambrian rocks and on eolian deposits at the mouth of Columbus Canyon.

Globally

This grassland is found in the Colorado Plateau and Great Basin in Colorado and Utah and will probably occur in adjacent states.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This herbaceous association was observed on a Precambrian gravel ridge and on a ridgetop of eolian origin. Sites are gentle to steep (7%–53% slopes), occur between 1,531 m and 1,574 m elevation, and are oriented to aspects of 60 and 130 degrees. The unvegetated surface has moderate to high cover of bare soil and small and large rocks. Parent materials are sandstones of several formations that have been eroded and redistributed in alluvial and eolian deposits. Soils are moderately well-drained to rapidly drained and are texturally sandy loam.

Globally

This grassland occurs in the Colorado Plateau and Great Basin. Elevation ranges from 1,250 m to 2,320 m. Stands are found on plains, gentle hillslopes, knolls and bluffs, mesa tops, and plateau parks. Substrates are variable and include sand, alluvium, cobbles, clay loams and silty clay. Fires may be important in maintaining these grasslands by reducing woody cover, but burning during the growing season could also damage the *Hesperostipa comata* plants.

VEGETATION DESCRIPTION

Colorado National Monument

This needle-and-thread herbaceous association is rare within the monument. Total vegetation cover ranged from 28% to 29% in these relatively sparsely vegetated grasslands. This herbaceous association is characterized by the graminoids *Hesperostipa comata* and *Pleuraphis jamesii* that each range in cover from 1% to 15%. Additional graminoids are present in low cover and include *Achnatherum hymenoides, Bromus tectorum, Poa fendleriana,* and *Vulpia octoflora*. Forbs are uncommon and include *Astragalus nuttallianus, Descurainia pinnata, Erigeron* sp., *Gilia* sp., and *Streptanthella longirostris*. The shrub layer is sparse but relatively diverse, including *Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Eriogonum microthecum, Gutierrezia sarothrae,* and *Opuntia polyacantha* in the dwarf-shrub layer and the short shrubs *Artemisia tridentata ssp. wyomingensis, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra viridis,* and *Grayia spinosa*.

Globally

This association is characterized by a relatively sparse to moderate herbaceous layer (10%–40% cover) that is strongly dominated by the cool-season bunchgrass *Hesperostipa comata*. Low cover of other grasses, such as *Achnatherum hymenoides, Achnatherum lettermanii, Aristida purpurea, Elymus elymoides, 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 species include *Artemisia campestris, Artemisia dracunculus, Artemisia ludoviciana,*

Balsamorhiza sagittata, Cirsium arizonicum, Hymenopappus filifolius, Machaeranthera canescens, Vicia americana, and species of *Antennaria, Eriogonum, Gilia,* and *Lappula*. Scattered shrubs and dwarf-shrubs may present with less than 5% total cover. *Artemisia tridentata ssp. vaseyana, Chrysothamnus viscidiflorus, Ericameria nauseosa, Opuntia polyacantha, Gutierrezia sarothrae,* 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 nonnative species like *Salsola kali, Bassia scoparia (= Kochia scoparia), Poa pratensis,* and *Sisymbrium altissimum* may be present to abundant. 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

Colorado National Monument

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Opuntia polyacantha*
Herb (field)	*Astragalus nuttallianus*
Herb (field)	*Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii*

Globally

Stratum	Species
Herb (field)	*Hesperostipa comata*

OTHER NOTEWORTHY SPECIES

Colorado National Monument

Data are not available.

Globally

Cirsium arizonicum

CONSERVATION STATUS RANK

Global Rank & Reasons: G2G4 (23-Feb-1994).

CLASSIFICATION COMMENTS

Colorado National Monument

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 lack of codominance by other grass species or a shrub layer.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Colorado National Monument Inventory Notes: Stands are small when they occur.
Colorado National Monument Plots: The description is based on 2003 field data (2 plots: COLM.0035, COLM.0215).
Local Description Authors: J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Cogan et al. 2004, Daubenmire 1970, Driscoll et al. 1984, FEIS 1998, Kleiner 1968, Kleiner 1983, Kleiner and Harper 1977, Thilenius et al. 1995, Western Ecology Working Group n.d.

Sporobolus airoides Southern Plains Herbaceous Vegetation
Alkali Sacaton Southern Plains Herbaceous Vegetation

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): Inter-Mountain Basins Greasewood Flat (CES304.780)
Chihuahuan-Sonoran Desert Bottomland and Swale Grassland (CES302.746)
Western Great Plains Floodplain (CES303.678)
Western Great Plains Saline Depression Wetland (CES303.669)
Western Great Plains Shortgrass Prairie (CES303.672)

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 sheet flow runoff are important to many 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

Colorado National Monument

This association was observed and sampled in the bottom of the Monument Canyon drainage below the Kissing Couple formation. *Sporobolus airoides* was only otherwise observed as an understory species in an *Artemisia tridentata ssp. tridentata* shrubland stand (Plot: COLM.0243) on the monument eastern boundary.

Globally

This alkali sacaton mesic grassland community is found in the southwestern Great Plains 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

Colorado National Monument

This herbaceous association was observed in a drainage bottom where sufficient sediment deposition over Precambrian bedrock had occurred to support adequate rooting depths. The site is nearly flat (2% slope), occurs at 1,584 m elevation, and is oriented to 250 degrees. The unvegetated surface has high cover of large rocks and small rocks and moderate cover of litter. Parent materials are sediments formed from sandstones that have deposited in and over bedrock depressions and around boulders. Soils are moderately well-drained and are texturally loamy sand. Site geology is migmatitic meta-sedimentary rocks exposed in canyon bottoms throughout the monument.

Globally
This grassland community occurs on alluvial toe slopes and flats, terraces, floodplain depressions, and sandy streambanks and washes in bottomlands throughout the southern Great Plains and Colorado Plateau. Elevations range from below 1,000 m (3,050 ft) to over 2,000 m (6,100 ft). Sites are typically flat to gently sloping but may be as steep as 30% slope. Soils are shallow to moderately deep, moderately well- to poorly drained, alkaline, and often saline with sandy, silty, or clay soils (Francis 1986, Johnston 1987, Kittel et al. 1999a, Lauver et al. 1999, Von Loh et al. 2002). Other parent materials include lava flow, cinders, relic Pleistocene river cobbles, and sandstone.

VEGETATION DESCRIPTION
Colorado National Monument
This alkali sacaton association is rare and was observed and sampled in only one location. The total vegetation cover is 50%. This herbaceous association is characterized by the graminoids *Sporobolus airoides* and *Juncus balticus* that contribute between 1%–15% cover. Additional graminoids, mostly exotics, contribute moderate cover from <1% to 5% and include *Bromus diandrus, Bromus japonicus, Bromus tectorum, Hordeum jubatum, Muhlenbergia asperifolia, Pascopyrum smithii*, and *Polypogon monspeliensis*. Forbs are diverse, but many are nonnatives, contribute low cover, and include *Artemisia ludoviciana, Erodium cicutarium, Lactuca serriola, Melilotus officinalis, Silene antirrhina, Solidago* sp., *Taraxacum officinale*, and *Tragopogon dubius*. Short shrubs from 1 m to 2 m tall contribute low cover from <1% to 5% and include *Juniperus osteosperma* and *Tamarix ramosissima*. An active eradication program for *Tamarix ramosissima* is in place, and this stand was reported to monument natural resource staff.

Globally
This association is characterized by a sparse to moderately dense (20%–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. shrubs may be present. Forb cover is minor.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Short shrub/sapling	*Tamarix ramosissima*
Herb (field)	*Bromus diandrus, Bromus japonicus, Juncus balticus, Muhlenbergia asperifolia, Pascopyrum smithii, Sporobolus airoides*

Globally

Stratum	Species
Herb (field)	*Sporobolus airoides*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

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 Colorado (S3), Kansas (SP), New Mexico (S2), Texas (S?), and Mexico (S?) and may occur in California (SP). The community is found on slightly to moderately saline, nearly level bottomland and terraces with alluvial silty clay soils.

CLASSIFICATION COMMENTS
Colorado National Monument
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
Colorado National Monument Inventory Notes: It is unlikely that any significant stands of this type occur elsewhere in the monument.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot): (Plot: COLM.0058).
Local Description Authors: J. Von Loh
Global Description Authors: J. Drake, mod. K. Schulz

REFERENCES: Aldous and Shantz 1924, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Francis 1986, Hansen et al. 2004b, Johnston 1987, Kittel and Lederer 1993, Kittel et al. 1999a, Lauver et al. 1999, Lindauer 1970, Soil Conservation Service 1978, Steward 1982, Von Loh et al. 2002, 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 mesa tops 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

Colorado National Monument

This association was observed and sampled northwest of the Liberty Cap trailhead on the east side of the monument, at Liberty Cap Trail on the west side of the monument, at Black Ridge Trail near the western monument boundary, at No Thoroughfare Canyon near the East Entrance, and south of the Broadway Street access on the east side of the monument.

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

Colorado National Monument

This herbaceous association was observed on the upper slopes of ridges, hilltops, midslopes of hills, and alluvial fans. Sites are nearly level to moderately steep (5%–25% slopes), occur between 1,469 m and 1,955 m elevation, and are oriented to aspects between 5 and 210 degrees. The unvegetated surface often has high cover of bare soil and small and large rocks, and occasionally moderate cover of litter. Parent materials are variable and include alluvium, eolian deposits, shale, and Precambrian gneiss gravel. Soils are rapidly drained, well-drained, and moderately well-drained and texturally range from sandy loam, silt loam, silty clay, and clay loam. Site geology consists of Holocene alluvium, eolian sand and sheetwash deposits, valley fill deposits, migmatitic meta-sedimentary rocks, and the Tidwell Member of the Morrison Formation.

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. Elevation ranges from 1,220 m to 1,900 m, with a few sites on the western edge of the southern Rocky Mountains extending to 2400 m. Landforms vary from mesa tops and slopes to basin floors. Stands may be small woodland parks or more extensive on the plains. Soils are variable. In bottomland stands soils tend to be fine-textured; however, stands also occur on sandy loams derived from sandstone, remnant lava flow, basaltic cobbles, black or red cinders, or alluvium derived from relic Pleistocene river cobbles, sandstone, sand, or clay soils.

VEGETATION DESCRIPTION

Colorado National Monument

This James' galleta grassland association is distributed at low to middle elevations in the monument. The total vegetation cover ranged from 6% to 60% in these sparsely to moderately vegetated stands. This herbaceous association is characterized by the perennial grass *Pleuraphis jamesii* that ranges in cover from 1% to 35%. Other grasses contributed low cover in the stands and included *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Hesperostipa comata, Poa fendleriana*, and *Sporobolus cryptandrus*. Forbs are diverse and contribute low to moderate cover by *Arenaria fendleri, Asclepias cryptoceras, Astragalus nuttallianus, Chamaesyce glyptosperma, Descurainia pinnata, Eriogonum lonchophyllum, Erodium cicutarium, Gaillardia pinnatifida, Lappula occidentalis, Lepidium densiflorum, Oenothera pallida, Plantago patagonica, Platyschkuhria integrifolia var. oblongifolia, Rumex hymenosepalus, Sphaeralcea coccinea*, and *Tragopogon porrifolius*. The shrub layer is variable in

cover and composition. Dwarf-shrubs are uncommon and include *Atriplex confertifolia, Echinocereus triglochidiatus, Leptodactylon pungens, Opuntia erinacea, Opuntia polyacantha*, and *Suaeda calceoliformis*. Short shrubs are common but contribute low cover by *Atriplex canescens, Atriplex confertifolia, Ephedra viridis*, and *Krascheninnikovia lanata*. Canopy *Juniperus osteosperma* and *Pinus edulis* trees are rarely present in these short grasslands at up to 5% cover each. Cryptogam cover is variable with some stands having little.

Globally
This association is characterized by a relatively sparse to moderately dense perennial herbaceous layer (10%–60% cover) that is strongly dominated by the warm-season bunchgrass *Pleuraphis jamesii*. Low cover of other grasses such as *Aristida* spp., *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, 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 filifolia, Atriplex canescens, Atriplex confertifolia, Brickellia oblongifolia, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Fallugia paradoxa, Gutierrezia* spp., *Tetradymia* spp., and occasional *Juniperus monosperma* trees. The widespread introduced annual grass *Bromus tectorum* and several other nonnative species like *Salsola kali, Bassia scoparia (= Kochia scoparia), 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
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Herb (field)	*Atriplex confertifolia, Opuntia erinacea, Opuntia polyacantha*
Herb (field)	*Astragalus nuttallianus, Erodium cicutarium, Lappula occidentalis, Sphaeralcea coccinea*
Herb (field)	*Aristida purpurea, Bromus tectorum, Hesperostipa comata, Pleuraphis jamesii*

Globally

Stratum	Species
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G2G4 (23-Feb-1994).

CLASSIFICATION COMMENTS
Colorado National Monument
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
Colorado National Monument Inventory Notes: Grassland stands are subject to erosion by wind and water and invasion by shrubs.
Colorado National Monument Plots: The description is based on 2003 field data (6 plots: COLM.0022, COLM.0033, COLM.0164, COLM.0202, COLM.0206, COLM.0268, and 4 observation points: COLM.0365, COLM.0459, COLM.0462, COLM.0504).
Local Description Authors: J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Cannon 1960, Cogan et al. 2004, 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, NVNHP 2003, Nichol 1937, Stewart et al. 1940, USFS 1937, Utah Environmental and Agricultural Consultants 1973, Von Loh et al. 2002, Weaver and Albertson 1956, West et al. 1972, Western Ecology Working Group n.d.

Hordeum jubatum Herbaceous Vegetation
Foxtail Barley Herbaceous Vegetation

CODE	CEGL001798
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	Temporarily flooded temperate or subpolar grassland (V.A.5.N.j.)
ALLIANCE	HORDEUM JUBATUM TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1358) Foxtail Barley Temporarily Flooded Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Playa (CES304.786)
Western Great Plains Closed Depression Wetland (CES303.666)
Western Great Plains Saline Depression Wetland (CES303.669)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This foxtail barley community type is found in the northern and central Great Plains of the United States and Canada, Utah and may occur elsewhere in the interior western U.S. Stands are found in lowlands with moderately to strongly saline soils. The topography is flat to slightly concave and the soils are often flooded or saturated in the spring. The vegetation is dominated by short and medium tall graminoids with a total vegetation cover of nearly 100%. Shrubs are usually absent. *Hordeum jubatum* dominates the community. Other common species in this community are *Elymus trachycaulus, Distichlis spicata, Pascopyrum smithii, Poa arida, Poa compressa,* and *Rumex crispus*.

DISTRIBUTION
Colorado National Monument
This association was observed and sampled adjacent to a stock pond, including the dam face, on the Black Ridge Trail where it exits the monument and crosses adjacent U.S. Bureau of Land Management property.

Globally

This foxtail barley community type is found in the northern and central Great Plains of the United States and Canada, ranging from Colorado to Saskatchewan. It is also described from Utah and may occur elsewhere in the interior West.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This herbaceous association was observed growing around a small stock pond and in its associated inlet channel. The stock pond dam was constructed midslope on a ridge on U.S. Bureau of Land Management property. The site is gentle, occurs at 1,925 m elevation, and is oriented to the northeast. The unvegetated surface consisted mostly of caked and cracked mud. Parent materials are shales of the Morrison Formation that erode fine-grained sediment into the pond. The soils are poorly drained and are texturally silty clay. Site geology was described as artificial fill deposits within larger exposures of the Tidwell Formation.

Globally

This association has been reported from lowlands across the northern Great Plains, in intermountain parks in Colorado and northeastern Utah. The climate is semi-arid continental with mean annual precipitation of 25 cm to 48 cm. Elevation generally ranges from 750 m to 1,950 m, and up to 2,600 m in South Park, Colorado. Stands are located in lowlands with moderately to strongly saline soils (Barnes and Tieszen 1978). The topography is flat, and the soils are often flooded or saturated in the spring (Redmann 1972). *Hordeum jubatum* is often found dominating disturbed areas such as roadsides, stock ponds, and over-grazed bottomland.

VEGETATION DESCRIPTION

Colorado National Monument

This foxtail barley herbaceous association is rare and occupied a stock pond site. The total vegetation cover is 13% in this sparsely vegetated stand. This herbaceous association is characterized by sparse graminoids, including *Hordeum jubatum, Polypogon monspeliensis, Scirpus* sp., and *Typha latifolia*. Forbs also contribute sparse foliar cover and include the nonnatives *Polygonum ramosissimum* and *Xanthium strumarium*. Shrubs are represented only by the nonnative *Tamarix ramosissima* that is 1-3 m tall and contributes up to 2% cover.

Globally

The typically dense vegetation is dominated by short and medium-tall graminoids with a total vegetation cover of nearly 100%, but may occur in sparser stands (15%–30% cover) (Barnes and Tieszen 1978, Von Loh 2000). Shrubs are usually absent. *Hordeum jubatum* dominates the community. Other common species in this community are *Elymus trachycaulus, Distichlis spicata, Pascopyrum smithii, Poa arida, Poa compressa, Rumex crispus, Ambrosia tomentosa*, and *Malvella leprosa*. Introduced species may be common in some stands including *Bassia scoparia (= Kochia scoparia), Sonchus arvensis,* and *Lepidium latifolium.*

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tall shrub/sapling	*Tamarix ramosissima*
Herb (field)	*Polygonum ramosissimum*
Herb (field)	*Hordeum jubatum*

Globally

Stratum	Species
Herb (field)	*Hordeum jubatum*

OTHER NOTEWORTHY SPECIES

Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G4 (1-Feb-1996).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Although this is a common community type in the interior West, it is poorly sampled and defined. This abstract is based on two descriptions of *Hordeum jubatum*-dominated stands which are assumed to be examples of this community, and plot data from a single national park (COLM). These stands may be variants of *Distichlis spicata - Hordeum jubatum - Puccinellia nuttalliana - Suaeda calceoliformis* Herbaceous Vegetation (CEGL002273) and *Pascopyrum smithii - Hordeum jubatum* Herbaceous Vegetation (CEGL001582). The relationship between *Hordeum jubatum* Herbaceous Vegetation (CEGL001798) and these types is unclear. Both communities usually contain *Hordeum jubatum* and *Distichlis spicata* or *Pascopyrum smithii* in varying amounts. The presence of *Puccinellia nuttalliana* or *Suaeda calceoliformis* may be distinguishing factors. They appear to be more characteristic of strongly saline areas while *Hordeum jubatum* can dominate on less saline sites (Redmann 1972). Classification problems may arise on intermediate sites when *Hordeum jubatum* is the dominant species and *Distichlis spicata, Pascopyrum smithii, Puccinellia nuttalliana*, and *Suaeda calceoliformis* are present in more than minor amounts.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Colorado National Monument Inventory Notes: The stand is limited to the stock pond margin, including the dam face.
Colorado National Monument Plots: The description is based on 2003 field data (1 observation point: COLM.0456).
Local Description Authors: J. Von Loh
Global Description Authors: J. Drake, mod. K. Schulz

REFERENCES: Baker 1984a, Barnes and Tieszen 1978, Bourgeron and Engelking 1994, Bunin 1985, CONHP Ecology Team 2001, Driscoll et al. 1984, Hansen et al. 1991, Hansen et al. 1995, IDCDC 2005, Jones and Walford 1995, MTNHP 2002b, NDNHI unpubl. data, Redmann 1972, Reid 1974, Ungar 1967, Vestal 1914, Von Loh 2000, Western Ecology Working Group n.d.

Juncus balticus Herbaceous Vegetation
Baltic Rush Herbaceous Vegetation

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)
Western Great Plains Open Freshwater Depression Wetland (CES303.675)
Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)
Northern Columbia Plateau Basalt Pothole Ponds (CES304.058)
Temperate Pacific Subalpine-Montane Wet Meadow (CES200.998)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This Baltic rush wet meadow community is found widely throughout the western United States. This wet meadow vegetation occurs as small, open to typically dense patches on flat stream benches, along overflow channels, and near springs. 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 a dense sward of *Juncus balticus* and often minor cover of *Carex* species, including *Carex aquatilis, Carex praegracilis, Carex nebrascensis,* or *Carex utriculata*. 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.

DISTRIBUTION

Colorado National Monument

This association is rare to uncommon in the monument and was observed in canyon bottom drainages and drainages exiting the monument on the east side, where water is present via seepage and intermittent surface flows. In addition, sufficient sediment must be deposited in the canyon bottoms to support rooting of this perennial herbaceous type. The type most commonly occurs as patches in Ute, No Thoroughfare, and Monument canyons with lesser stands growing in Kodels and Fruita canyons.

Globally

This Baltic rush wet meadow community is found widely throughout the western United States, ranging from South Dakota and Montana west to Washington, south to possibly California, and east to New Mexico.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This herbaceous association was observed in perennially moist drainages with adequate deposition of sediments and alluvium and on seeps. Sites are gentle (2%–10% slopes), occur between 1,424 m and 1,821 m elevation, and include many aspects. The unvegetated surface is predominantly litter. Parent materials are predominantly sandstone and shale rocks that have eroded and deposited as sediments and alluvium. Soils are somewhat poorly drained to poorly drained and texturally range from sandy clays, clay loams, and silty clays and are usually fine. Some of these wetland soils exhibited gleying and contained reddish-brown mottles.

Globally

This widespread herbaceous wetland community is found throughout western North America. Elevation ranges from 1,420 m to 3,500 m (4,655–11,475 ft). 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 deeply entrenched to very sinuous (Kittel et al. 1999b). Soils are also variable and range from sandy and well-drained to poorly drained silty clay loam or silty clay alluvium to organic; however, soils tend to be finer-textured, alkaline and may be saline (Brotherson and Barnes 1984, Padgett et al. 1989, Kittel et al. 1999b). 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

Colorado National Monument

This Baltic rush association is limited to perennially wet sites and is limited in distribution in the monument. The total vegetation cover ranged from 6% to 80% in these sparse to densely vegetated stands. Dense stands occupied deeper sediment deposits with perennial water supplies, and sparse stands occupied less deep soils over Precambrian bedrock with a high scour potential. This herbaceous association is characterized by the graminoid *Juncus balticus* that contributed 2% to 65% cover. Other common graminoids contributed low to moderately high cover and included *Agrostis gigantea, Bromus japonicus, Bromus tectorum, Distichlis spicata, Equisetum laevigatum, Hordeum jubatum, Muhlenbergia asperifolia, Pascopyrum smithii, Poa pratensis,* and *Poa* sp. Forbs are relatively diverse but contribute low to moderate cover by *Artemisia ludoviciana, Aster* sp., *Astragalus nuttallianus, Cirsium* sp., *Descurainia pinnata, Erodium cicutarium, Iva axillaris, Lactuca serriola, Lepidium densiflorum, Plantago major, Sisymbrium altissimum, Solidago* sp., *Taraxacum officinale, Tragopogon dubius,* and *Xanthium strumarium*. The shrub layer is occasionally present along stand margins at low cover and includes *Artemisia tridentata ssp. tridentata, Ericameria nauseosa, Populus deltoides ssp. wislizeni, Salix exigua, Sarcobatus vermiculatus,* and *Tamarix ramosissima*. The canopy tree stratum was present adjacent to these stands, and tree crowns of *Juniperus osteosperma, Pinus edulis,* and *Populus deltoides ssp. wislizeni* sometimes hung over the herbaceous stands.

Globally

This association is characterized by a low (<50 cm), open to typically dense graminoid layer dominated by the rhizomatous perennial *Juncus balticus*. 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 jubatum, Muhlenbergia asperifolia, Pascopyrum smithii, Poa nemoralis ssp. interior, Phleum alpinum,* and *Sporobolus airoides*. Forb cover is generally low but may include *Caltha leptosepala, Glaux maritima, Maianthemum stellatum, Rumex aquaticus, Cirsium scariosum (= Cirsium tioganum), Achillea millefolium, Artemisia ludoviciana, Potentilla plattensis, Polygonum bistortoides, Dodecatheon pulchellum,* and *Iris missouriensis*. Shrubs and dwarf-shrubs are not common; however, *Artemisia frigida* cover may be significant in some stands, and occasional *Artemisia tridentata ssp. tridentata, Ericameria nauseosa, Dasiphora fruticosa ssp. floribunda, Populus spp., Salix* spp, or *Sarcobatus vermiculatus* shrubs may occur. Some stands may be co-dominated by the introduced perennial sod grasses *Poa pratensis* or *Agrostis stolonifera*. Other introduced species, such as *Cirsium arvense, Erodium cicutarium, Iva axillaris, Lactuca serriola, Phleum pratense, Taraxacum officinale, Thinopyrum intermedium, Trifolium* spp., *Tragopogon dubius,* and *Xanthium strumarium,* may occur in disturbed stands.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tree canopy	*Populus deltoides* ssp. *wislizeni*
Short shrub/sapling	*Sarcobatus vermiculatus*
Herb (field)	*Iva axillaris*
Herb (field)	*Agrostis gigantea, Bromus japonicus, Bromus tectorum, Hordeum jubatum, Juncus balticus, Muhlenbergia asperifolia, Pascopyrum smithii, Poa pratensis*

Globally

Stratum	Species
Herb (field)	*Juncus balticus*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
This association is often considered to be a grazing-induced community since it increases with grazing disturbance.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Colorado National Monument Inventory Notes: One stand is drying because a reservoir providing seepage has been abandoned. Other stands are affected by flood events.
Colorado National Monument Plots: The description is based on 2003 field data (4 plots: COLM.0003, COLM.0048, COLM.0085, COLM.0239 and 3 observation points: COLM.0291, COLM.0438, COLM.0509).
Local Description Authors: J. Von Loh
Global Description Authors: J. Drake, mod. D. Faber-Langendoen, mod. K.A. Schulz

REFERENCES: Baker 1984a, 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, Cogan et al. 2004, Cowardin et al. 1979, Crowe and Clausnitzer 1997, Driscoll et al. 1984, Faber-Langendoen 2001, Flowers 1962, Hall and Hansen 1997, Hansen et al. 1995, Hess 1981, IDCDC 2005, Jankovsky-Jones et al. 2001, Johnston 1987, Jones 1992b, Jones and Walford 1995, Kagan et al. 2000, Kartesz 1994a, Kittel and Lederer 1993, Kittel et al. 1999a, Kittel et al. 1999b, Komarkova 1986, Kovalchik 1987, MTNHP 2002b, Manning 1988, Muldavin et al. 2000a, Mutel 1973, Mutz and Graham 1982, NVNHP 2003, Olson and Gerhart 1982, Padgett 1981, Padgett 1982, Padgett et al. 1989, Rector 1979, Richard et al. 1996, Shupe et al. 1986, Stewart 1940, Titus and Christy 1996a, Tuhy and Jensen 1982, WANHP unpubl. data, Wasser and Hess 1982, Western Ecology Working Group n.d., Youngblood et al. 1985a

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Artemisia nova / Leymus salinus Shrub Herbaceous Vegetation
Black Sagebrush / Salinas Lyme Grass Shrub Herbaceous Vegetation

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CODE	CEGL001421
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland with a sparse shrub layer (V.A.7.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland with a sparse shrub layer (V.A.7.N.)

FORMATION	Medium-tall temperate or subpolar grassland with a sparse needle-leaved or microphyllous evergreen shrub layer (V.A.7.N.e.)
ALLIANCE	ARTEMISA NOVA SHRUBLAND ALLIANCE (A.1105) Black Sagebrush Shrub Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This plant association is reported from widely separated sites in the Lemhi Range in Idaho and in the Colorado Plateau of western Colorado. In Idaho, the association occurs on gentle lower slopes composed of volcanic tuffs, at approximately 1,680 m to 1,890 m (5,500–6,200 ft) elevation. Constant downslope soil movement and a high shrink-swell ratio create a highly unstable substrate. In Colorado, this association is known from ridges of Morrison Formation shales. The dwarf-shrub vegetation is dominated by *Artemisia nova*. Vegetation cover and composition information is available for Colorado stands only. The community is relatively open and sparse appearing, with total vegetation rarely exceeding 30%. Other shrubs are often present in Colorado stands, including *Atriplex confertifolia* and *Krascheninnikovia lanata*. The herbaceous layer is clearly dominated by *Leymus salinus* with 3%–15% cover. The herbaceous layer is usually diverse and may include *Achnatherum hymenoides, Bouteloua gracilis, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana, Poa secunda, Calochortus gunnisonii, Sphaeralcea coccinea, Stanleya pinnata, Streptanthella longirostris,* and *Townsendia incana*.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled along the Black Ridge Trail, Liberty Cap Trail, on Black Ridge, on Monument Mesa, and on Glade Park Road at its junction with Rimrock Drive.

Globally

This plant association occurs within the southwestern region of the Bitterroot Mountains ecoregional section, within east-central Idaho, as well as in Colorado National Monument in western Colorado. It is likely to be found elsewhere in the northern Colorado Plateau where Morrison Formation shales outcrop at around 2,000 m elevation.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This shrub herbaceous association was observed on the step-in-slope of a plateau, in valleys, midslope and top of ridges, and low slopes in swales. Sites are gentle to moderately steep (0%–16% slopes), occur between 1,960 m and 2,089 m elevation, and are oriented to many aspects. The unvegetated surface often has high cover of large and small rocks and bare soil. Moderate cover by litter to 15% is typical. Cryptogam cover is highly variable but can be as high as 60%. Parent materials are Morrison Formation shales. Soils are somewhat poorly drained to rapidly drained and texturally are clay loam and silty clay, but are usually fine. Site geology includes older landslide deposits and Tidwell and Brushy Basin members of the Morrison Formation.

Globally

This plant association is reported from widely separated sites in the southern end of the Lemhi Range in Idaho and in the Colorado Plateau of western Colorado. In Idaho, the association occurs on gentle lower slopes composed of volcanic tuffs, at approximately 1,680 m to 1,890 m (5,500–6,200 ft) elevation. Constant downslope soil movement and a high shrink-swell ratio create a highly unstable substrate. In Colorado, this association is known from gentle to moderate slopes on somewhat barren ridges, benches and hills of Morrison Formation shales between 1960 and 2089 m (6,430–6,854 ft). Bare soil and gravel cover much of the unvegetated ground surface.

In Idaho, the region where the association occurs is to the east of a major mountain mass which strongly affects the climate of the region. The high mountains to the west create a rainshadow, allowing only occasional incursions of moisture-laden winter storms from the Pacific. Average annual precipitation is low, ranging from 17.8 cm (7 in) in the valleys, such as along the Salmon River, to roughly 1,14.3 cm (45 in) at the highest elevations. There is a peak during May and June, when convective showers are common, but winters are relatively dry. Summers are cool and winters cold. The region is mountainous with high, massive ranges, dissected by deep valleys. The bedrock is a heterogeneous formation of volcanic and sedimentary rock, with only minor amounts of granitics, known as Challis Volcanics. At lower elevations along the Salmon River the most common rock types of this formation are tuffs and andesites. A flora endemic to the Lemhi region, known collectively as Challis Endemics, occurs on these substrates and is joined by a flora of species disjunct from drier regions of the Great Basin. Much of the Challis endemic region roughly coincides with an area receiving less than 20.3 cm (8 in) of precipitation annually, combined with low-elevation occurrences of andesites and tuffs of the Challis Volcanics.

VEGETATION DESCRIPTION

Colorado National Monument

This black sagebrush / Salinas lyme grass association is narrowly distributed where appropriate soils occur. The total vegetation cover ranged from 20% to 28% in these sparsely to moderately vegetated stands. This shrub herbaceous association is characterized by the dwarf-shrub *Artemisia nova* and the tall bunchgrass *Leymus salinus* that each range in cover from 3% to 15%. The shrub layer is relatively diverse but contributes sparse to low cover, including *Atriplex confertifolia, Atriplex gardneri, Chrysothamnus depressus, Echinocereus triglochidiatus, Gutierrezia sarothrae, Leptodactylon pungens, Krascheninnikovia lanata, Opuntia erinacea, Opuntia polyacantha, Sarcobatus vermiculatus,* and *Sclerocactus whipplei*. The herbaceous layer is sparse to low in cover but is very diverse. Common graminoids include *Achnatherum hymenoides, Bouteloua gracilis, Bromus tectorum, Elymus elymoides, Vulpia octoflora, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana,* and *Poa secunda*. Forbs commonly present include *Calochortus gunnisonii* (0%–<1%), *Descurainia pinnata, Erigeron* sp., *Lappula occidentalis, Sphaeralcea coccinea, Stanleya pinnata, Streptanthella longirostris*, and *Townsendia incana*. The canopy trees *Juniperus osteosperma* and *Pinus edulis*, that are 2 m to 5 m tall, are sometimes present with sparse cover up to 3%. Cryptogam cover is variable with some stands having little, but cover can be as high as 60%.

Globally

The dwarf-shrub vegetation is dominated by *Artemisia nova*. Vegetation cover and composition information is available for Colorado stands only. The community is relatively open and sparse appearing, with total vegetation rarely exceeding 30%. Other shrubs are often present in Colorado stands, including *Atriplex confertifolia* and *Krascheninnikovia lanata*. The herbaceous layer is clearly dominated by *Leymus salinus* with 3% to 15% cover. The herbaceous layer is usually diverse and may include *Achnatherum hymenoides, Bouteloua gracilis, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana, Poa secunda, Calochortus gunnisonii, Sphaeralcea coccinea, Stanleya pinnata, Streptanthella longirostris,* and *Townsendia incana*.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Short shrub/sapling	*Artemisia nova, Krascheninnikovia lanata*
Herb (field)	*Leymus salinus, Poa fendleriana*

Globally

Stratum	Species
Shrub/sapling (tall & short)	*Artemisia nova*

Herb (field) *Leymus salinus*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G1G2Q (29 Oct 1997). This naturally rare plant association occurs over a relatively narrow geographic range, in the southwestern region of the Bitterroot Mountains ecoregional section, within east-central Idaho. It is found on gentle lower slopes composed of volcanic tuffs, at approximately 1,680 m to 1,890 m (5,500–6,200 ft) elevation. The volcanic tuff substrate is typically unstable, with constant downslope movement of soil surface layers and a high shrink-swell ratio. The association is protected in proposed and established conservation sites. However, information is not available to confirm the representative quality of these occurrences. Appropriate inventory and monitoring work has not been completed to provide information necessary to adequately understand and describe current condition, trend or threat. Quantitative stand composition and environmental data are not available to verify that the association is a discrete classification unit, thus a "Q" is added to the global rank. However, now that the concept of the association has been expanded to include other subspecies of Leymus salinus, the global rank should probably be revisited. While it is unlikely that this is a common type, it is no longer a narrowly restricted endemic association.

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
In Idaho, this association includes *Leymus salinus ssp. salmonis*, a subspecies endemic to the Challis Volcanics. In the Colorado Plateau, the subspecies is *Leymus salinus ssp. salinus*. The two are combined in this description.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Subject to invasion by *Pinus edulis* and *Juniperus osteosperma*.
Colorado National Monument Plots: The description is based on 2003 field data (4 plots: COLM.0071, COLM.0103, COLM.0165, COLM.0209, and 6 observation points: COLM.0322, COLM.0390, COLM.0391, COLM.0394, COLM.0404, COLM.0453).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: M.S. Reid, mod. S.K. Rust and J. Coles

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Caicco and Wellner 1983g, Driscoll et al. 1984, Moseley 1987b, Western Ecology Working Group n.d.

Equisetum laevigatum Herbaceous Vegetation
Smooth Horsetail Herbaceous Vegetation

CODE	CEGL002241
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	Semipermanently flooded temperate perennial forb vegetation (V.B.2.N.e.)
ALLIANCE	EQUISETUM LAEVIGATUM SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.2648) Smooth Horsetail Semipermanently Flooded Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.821)

Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This rare association occurs on the narrow valley floors and low alluvial terraces of small perennial streams of the Colorado Plateau that are subject to periodic scouring from flooding. Elevations range from 1,603 m to 1,785 m (5,260–5,855 ft), and slopes do not exceed 8%. The alluvial soils vary in texture from clay or silt to sand, and the soil surface may be bare if flooding has occurred recently, or covered by a mat of older *Equisetum* stems. Total vegetation cover in this association may exceed 100%, but it is dominated by the fern ally *Equisetum laevigatum* with between 20% and 75% cover. Graminoids may provide up to 25% cover and include *Agrostis gigantea*, *Juncus balticus*, or *Muhlenbergia asperifolia*. Forbs are generally also present and are variable, but usually indicate disturbance. Riparian trees and shrubs, such as *Tamarix ramosissima, Populus* spp., and *Salix* spp., may occur at the margins of the association. Deep rhizome growth allows *Equisetum* plants to survive environmental disturbances such as burial, flooding, fire and drought. As riparian terraces become isolated from flooding and the water table, *Equisetum laevigatum* will persist thanks to its system of rhizomes, but other herbaceous and woody species will tend to become dominant.

DISTRIBUTION

Colorado National Monument

This association was observed and sampled as nearly pure stands in the bottom of Ute Canyon; however, *Equisetum laevigatum* is an associate of palustrine and riparian types in their limited distribution in canyon bottoms throughout the monument.

Globally

This type is restricted to small streams in the Colorado Plateau that are subject to flooding and scouring from flooding.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This herbaceous association was observed on alluvial deposits in drainage bottoms in canyons and forms nearly pure stands in Ute Canyon. Sites are gentle (2%–4% slopes), occurred between 1,769 m and 1,785 m elevation, and are oriented to aspects of 5 to 10 degrees. The unvegetated surface has high cover of litter. Parent materials are sandstone cliffs that decompose to silt, sand, and fine gravel deposited as alluvium or valley fill deposits, in pockets over Precambrian meta-igneous gneiss. Soils are poorly drained and texturally are silty clay.

Globally

This association occurs on the narrow valley floors and low alluvial terraces of small perennial streams of the Colorado Plateau that are subject to periodic scouring from flooding. Elevations range from 1,603 m to 1,785 m (5,260–5,855 ft), slopes do not exceed 8%, and aspect varies. Soils are alluvium derived from shales, sandstones or igneous rocks. The soil surface may be bare if flooding has occurred recently, or covered by a mat of older *Equisetum* stems.

VEGETATION DESCRIPTION

Colorado National Monument

This herbaceous association is rare in the monument, occurring only in canyons with permanent seeps and springs. The total vegetation cover ranged from 49% to 80% in these moderately to densely vegetated stands. This herbaceous association is characterized by nearly pure stands of the fern ally *Equisetum laevigatum* that range in cover from 35% to 75% and occurs in the narrow canyon bottoms from a few meters up to 15 m wide. Additional graminoids in the herbaceous layer include *Agrostis gigantea, Bromus japonicus, Bromus tectorum, Distichlis spicata, Elymus repens, Hordeum jubatum, Juncus balticus, Muhlenbergia asperifolia, Poa pratensis,* and *Typha latifolia*. Forbs are uncommon, nonnatives, and include *Medicago sativa, Plantago lanceolata,* and *Tragopogon dubius*. The shrub layer is low in cover but is not diverse, including *Artemisia tridentata ssp. tridentata, Ericameria nauseosa, Salix exigua,* and *Tamarix ramosissima*. An aggressive program to eradicate *Tamarix ramosissima* is in place monument-wide, and it is common to observe many cut stumps and branch piles in this habitat. Sapling trees invade the margins of this association and include *Juniperus osteosperma, Pinus edulis,* and *Populus deltoides ssp. wislizeni*. Canopy trees that are 10-15 m tall are present with low cover along stand margins and include *Juniperus osteosperma, Populus deltoides ssp. wislizeni*, and *Salix fragilis*. Seedling *Populus deltoides ssp. wislizeni* trees are present with low cover, establishing on exposed silt and sand along the drainage channel that bisects this association.

Globally

This herbaceous association is dominated by the fern ally *Equisetum laevigatum* with between 20% and 75% cover. Graminoids may provide up to 25% cover and include *Agrostis gigantea, Juncus balticus,* or *Muhlenbergia asperifolia*. Forbs are generally also present and are variable, but usually indicate disturbance and include *Cirsium arvense, Tragopogon dubius,* and *Plantago lanceolata*. Riparian trees and shrubs, such as *Tamarix ramosissima, Populus* spp., and *Salix* spp., may occur at the margins of the association.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Tree canopy	*Populus deltoides* ssp. *wislizeni*
Tall shrub/sapling	*Populus deltoides* ssp. *wislizeni*
Herb (field)	*Agrostis gigantea, Distichlis spicata, Juncus balticus*
Herb (field)	*Equisetum laevigatum*

Globally

Stratum	Species
Herb (field)	*Equisetum laevigatum, Muhlenbergia asperifolia*

OTHER NOTEWORTHY SPECIES

Colorado National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (10-Jan-2005).

CLASSIFICATION COMMENTS

Colorado National Monument

Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Colorado National Monument Inventory Notes: The stands observed appear healthy but are subject to scour. Small stands of this association are likely to occur in No Thoroughfare Canyon, which also has extensive permanent seeps.
Colorado National Monument Plots: The description is based on 2003 field data (2 plots): (Plots: COLM.0120, COLM.0240).
Local Description Authors: J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Hauke 1993, Page 1977, 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: Not applicable

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
Colorado National Monument

Only two alcoves with hanging gardens were observed, occupying either side of Rimrock Drive near the opening for the eastern tunnel. These are hydrologically linked sites, with the water seeping into the upper alcove, emerging above the road grade, then seeping below the road grade to re-emerge further down-canyon. Other seeps occur along the base of the Wingate sandstone and support small, linear stands of mesic forbs in Fruita, Monument, and No Thoroughfare canyons.

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
Colorado National Monument
This forb association was observed growing in two alcoves that are hydrologically linked, and elements of the type were observed on other minor seeps at the base of sandstone formations. Sites are nearly level to steep (3%–40% slope), occur at 1,716 m and 1,786 m elevation, and are oriented to aspects of 50 and 90 degrees. The unvegetated surface has high cover of litter and moderate cover of bedrock, large rocks, and small rocks. Parent materials are sandstone, and soils are poorly drained. Soils are texturally loamy sand. The sites are formed at the base of Wingate sandstone cliffs where erosion from seepage has resulted in alcove formation. A continuous-flowing seep feeds this habitat and leaves a noticeable white encrustation of salts where evaporation occurs.

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.

VEGETATION DESCRIPTION
Colorado National Monument
This columbine association grows in alcoves or caverns having a dominant forb cover of *Aquilegia micrantha* distributed along active seeps. The alcoves are connected hydrologically, and both have plunge pools below the seeps, where water flows over cliff faces during precipitation events. The total vegetation cover in two stands in two separate alcoves ranges from 45% to 95% in these moderately to densely vegetated stands. This herbaceous vegetation association is characterized by the forb *Aquilegia micrantha* that contributes 3% to 35% foliar cover. A scattering of trees 2 m to 10 m tall includes *Juniperus osteosperma, Pinus edulis,* and *Populus deltoides ssp. wislizeni* trees contributes <1% to 15% cover. The tall-shrub stratum is likewise sparse, is between 2 m to 10 m tall, and is represented by *Amelanchier utahensis, Cercocarpus intricatus,* and *Fraxinus anomala*. Short and dwarf-shrubs are also present with low cover and include *Brickellia longifolia, Ephedra viridis, Ericameria nauseosa, Fendlera rupicola, Holodiscus dumosus,* and *Opuntia polyacantha*. Graminoids have become established on the seep face and also in the plunge pool area below the seep, contribute low cover, and include the nonnative *Dactylis glomerata* and natives *Muhlenbergia richardsonis,* and *Poa pratensis*. Forbs are diverse, contribute moderate to dense cover along the alcove seeps, and include *Apocynum* sp., *Aquilegia micrantha, Artemisia ludoviciana, Castilleja scabrida, Cirsium calcareum, Galium coloradoense, Lepidium montanum, Solidago simplex, Stephanomeria pauciflora, Toxicodendron rydbergii,* and *Trifolium* sp. The liana *Clematis ligusticifolia* is growing on vegetation and on the waterfall area of the upper alcove lip, contributing up to 15% cover.

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

Colorado National Monument

Stratum	Species
Tree canopy	*Pinus edulis*
Tall shrub/sapling	*Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis, Fraxinus anomala*
Tall shrub/sapling	*Cercocarpus intricatus*
Short shrub/sapling	*Brickellia longifolia, Holodiscus dumosus*
Short shrub/sapling	*Fendlera rupicola*
Herb (field)	*Clematis ligusticifolia*
Herb (field)	*Aquilegia micrantha, Cirsium calcareum, Galium coloradoense, Stephanomeria pauciflora*
Herb (field)	*Poa pratensis*

Globally

Stratum	Species
Herb (field)	*Aquilegia micrantha*

OTHER NOTEWORTHY SPECIES

Colorado National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (12-Apr-2005).

CLASSIFICATION COMMENTS

Colorado National Monument

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: 3 - Weak

ELEMENT SOURCES

Colorado National Monument Inventory Notes: Other than some nonnative plant species invasion, the stands appear healthy. Neither *Carex scopulorum* nor *Mimulus eastwoodiae* are present.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot: COLM.0256 and 1 observation point: COLM.0303).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: J. Coles

REFERENCES: Spence pers. comm., Western Ecology Working Group n.d.

Bromus tectorum Semi-natural Herbaceous Vegetation
Cheatgrass Semi-natural Herbaceous Vegetation

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 (V.D.2.N.)	Natural/Semi-natural temperate or subpolar annual grasslands or forb vegetation
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 alliance-level herbaceous vegetation type is found throughout much of western North America from the western Great Plains to 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 nonnative, 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 alliance 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
Colorado National Monument
This association was observed and sampled in historically and/or intermittently disturbed sites near the North Entrance and SH 340, across from Lizard Canyon near SH 340, near the Broadway Street access, near the western boundary off the Black Ridge Trail on former U.S. Bureau of Land Management managed land, in a narrow drainage in Wedding Canyon, near the Visitor Center, in a narrow drainage next to Glade Park Road at its intersection with Rimrock Drive, near the East Entrance station, and on U.S. Bureau of Land Management property southwest of the monument.

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
Colorado National Monument

This herbaceous association was observed on disturbed sites on alluvial fans, ridge slopes, ridgetops, in drainages, and in a valley. One stand near the East Entrance and occupying adjacent private land supported prairie dog burrowing activity. Sites were gentle (2%–6% slope), occurred between 1,335 m and 1,992 m elevation, and were oriented to all aspects. The unvegetated surface has high cover of bare soil or litter. Parent materials are variable and include sandstone, shales, landslide, eolian, and alluvial deposits. Soils are moderately well-drained to well-drained and are texturally sandy loam and silty clay. Site geology is highly variable and includes Holocene eolian sand and sheetwash deposits; older landslide deposits - Brushy Basin Member of the Morrison Formation and younger strata; alluvium - older alluvial slope deposits; migmatitic meta-sedimentary rocks - Precambrian rock; and Tidwell Member of the Morrison Formation.

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. Elevation ranges from sea level to 2,200 m. Stands occur after disturbance of a natural shrub- or grass-dominated community resulting in the replacement of the natural vegetation by nonnative, 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 nonnative 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 has 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
Colorado National Monument
This cheatgrass association occupied disturbed sites that were oriented to several aspects within the monument. The total vegetation cover ranged from 7% to 56% in these sparsely to moderately vegetated stands. This herbaceous association is characterized by dense graminoid cover of *Bromus tectorum*, from 3% to 55%. Other graminoid species present are diverse but have low cover and include *Achnatherum hymenoides, Agropyron cristatum, Aristida purpurea, Bromus inermis, Distichlis spicata, Elymus elymoides, Equisetum laevigatum, Hesperostipa comata, Juncus balticus, Pascopyrum smithii, Pleuraphis jamesii, Poa pratensis, Poa secunda, Sporobolus cryptandrus,* and *Triticum aestivum*. Forbs are typically weedy and are present in low cover; the most common are *Astragalus nuttallianus, Calochortus gunnisonii, Camelina microcarpa, Cryptantha* sp., *Descurainia pinnata, Erodium cicutarium, Grindelia squarrosa, Heterotheca villosa, Lappula occidentalis, Lepidium densiflorum, Ceratocephala testiculata, Salsola kali, Sisymbrium altissimum, Sphaeralcea coccinea, Sphaeralcea* sp., and *Tragopogon dubius*. The shrub layer is sparse but somewhat diverse and includes the dwarf-shrubs *Gutierrezia sarothrae, Krascheninnikovia lanata,* and *Opuntia polyacantha* and short shrubs *Artemisia tridentata ssp. wyomingensis, Atriplex canescens, Chrysothamnus viscidiflorus, Ericameria nauseosa, Juniperus osteosperma, Sarcobatus vermiculatus,* and *Tamarix ramosissima*. Low cover by cryptogams is present on some sites.

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 nonnative annual forbs may also have significant cover in some stands. At Wind Cave National Park in South Dakota, this weedy nonnative graminoid vegetation is usually dominated by several perennial and annual brome grasses, including *Bromus inermis, Bromus japonicus,* and cheatgrass *Bromus tectorum*.

Cover is variable (H. Marriott pers. comm. 1999), and in drought years *Bromus tectorum* may be sparse or absent.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa, Sarcobatus vermiculatus*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Krascheninnikovia lanata*
Herb (field)	*Descurainia pinnata, Erodium cicutarium, Salsola kali, Sisymbrium altissimum, Sphaeralcea coccinea*
Herb (field)	*Aristida purpurea, Bromus tectorum, Hesperostipa comata, Pleuraphis jamesii, Poa secunda*

Globally

Stratum	Species
Herb (field)	*Bromus hordeaceus, Bromus japonicus, Bromus madritensis, Bromus rigidus, Bromus rubens, Bromus tectorum*

OTHER NOTEWORTHY SPECIES

Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (1-Dec-1997).

CLASSIFICATION COMMENTS

Colorado National Monument
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

Colorado National Monument Inventory Notes: Site disturbances included fire, substrate compaction by heavy vehicles, livestock corrals, prairie dog burrowing and grazing, and livestock or bison grazing.
Colorado National Monument Plots: The description is based on 2003 field data (6 plots: COLM.0001, COLM.0053, COLM.0096, COLM.0246, COLM.0274, COLM.0281, and 4 observation points: COLM.0399, COLM.0437, COLM.0440, COLM.0452).
Local Description Authors: J. Von Loh
Global Description Authors: D. Faber-Langendoen, mod. K. Schulz

REFERENCES: Beatley 1976, Cogan et al. 2004, Daubenmire 1975, Evans et al. 2001, FEIS 2001, Karl et al. 1999, Marriott pers. comm., Sawyer and Keeler-Wolf 1995, 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 1,412 m and 2,348 m (4,630–7,700 ft), 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 m–1.5 m tall) of *Pinus edulis* of *Juniperus osteosperma* may occur.

DISTRIBUTION

Colorado National Monument

This association is narrowly distributed and was observed and sampled on exposures of Kayenta sandstone near the East Entrance, near the east tunnel, and near the Historic Trails overlook.

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

Colorado National Monument

This sparse shrubland association was observed on exposed bedrock of Kayenta Formation and Wingate Formation sandstone. The sandstone outcrops formed mildly to steeply inclined habitat that ranged from 4 to 28% slopes, occurred between 1,599 m and 1,821 m elevation, and was oriented to northeastern aspects. The unvegetated surface cover is mostly bedrock with low cover of large and small rocks and litter. Soils are rapidly drained and texturally are loamy sand. Site geology is large slabs and continuous exposures of Kayenta Formation and Wingate Formation sandstone, with vegetation rooted in bedrock cracks.

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 1,412 m and 2,348 m (4,630–7,700 ft), 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

Colorado National Monument

This littleleaf mountain-mahogany sparse shrub association is limited in distribution to the eastern fringe of the monument, confined to tilted bedrock slabs and mesas. The total vegetation cover ranged from 8 to 20% in these sparsely vegetated stands. This sparse shrub association is characterized by the short shrub *Cercocarpus intricatus* that ranged in cover from 3% to 12%. The short- and tall-shrub layer is typically depauperate, with *Ephedra viridis* and *Fraxinus anomala* recorded at sparse cover. Dwarf-shrubs are diverse but contribute sparse cover, including *Artemisia bigelovii, Artemisia ludoviciana, Artemisia nova, Echinocereus triglochidiatus, Gutierrezia sarothrae, Opuntia erinacea, Opuntia phaeacantha, Sclerocactus whipplei*, and *Yucca harrimaniae*. The canopy trees, typically 2 m to 5 m tall, of *Fraxinus anomala, Juniperus osteosperma*, and *Pinus edulis* are present between 0% to 6% cover. Graminoids are consistently present, with sparse cover provided by *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Elymus elymoides, Vulpia octoflora, Hesperostipa comata, Pleuraphis jamesii*, and *Poa fendleriana*. Forbs are also diverse but sparse in terms of cover and include *Castilleja* sp., *Chaenactis douglasii, Descurainia pinnata, Erodium cicutarium, Gilia* sp., *Heterotheca villosa, Lepidium densiflorum, Lepidium montanum, Mirabilis multiflora, Plantago patagonica, Silene antirrhina, Streptanthella longirostris*, and *Streptanthus cordatus*. Cryptogam cover is low and ranges between 1% and 20% in this association.

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 15% and often is 5% or less. *Cercocarpus intricatus* is dominant or codominant, with between 1% and 10% 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 1.0 m–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

Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Fraxinus anomala*
Short shrub/sapling	*Cercocarpus intricatus*
Herb (field)	*Artemisia bigelovii, Opuntia erinacea, Opuntia polyacantha*
Herb (field)	*Chaenactis douglasii*
Herb (field)	*Achnatherum hymenoides, Bromus tectorum, Poa fendleriana*

Globally

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Tall shrub/sapling	*Amelanchier utahensis, Fraxinus anomala*
Short shrub/sapling	*Cercocarpus intricatus, Ephedra viridis*
Herb (field)	*Artemisia bigelovii*
Herb (field)	*Achnatherum hymenoides, Poa fendleriana*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (22-Jan-2002).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Stands were well-represented in sampling due to the limited distribution of this type.
Colorado National Monument Plots: The description is based on 2003 field data (2 plots: COLM.0072, COLM.0073, and 7 observation points: COLM.0323, COLM.0324, COLM.0342, COLM.0343, COLM.0423, COLM.0424, COLM.0443).
Local Description Authors: J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Cogan et al. 2004, Western Ecology Working Group n.d.

Leymus salinus Shale Sparse Vegetation
Salinas Lyme Grass Shale Sparse Vegetation

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) Salinas Lyme Grass 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 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 1,341 m and 1,971 m (4,400–6,465 ft), and slopes tend to be north- to east-facing and moderately steep to steep (38%–71% slope). The physical appearance of the community is characterized by a moderate cover of colluvial rocks and blocks fallen from sandstone ledges above the stand. Total vegetation cover 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

Colorado National Monument

This association is common where steep shale soils occur and was observed and sampled along Liberty Cap Trail, in Gold Star Canyon, near Black Ridge Trail, near Monument Valley trailhead, and along Rimrock Drive in the monument, and above Kodels Canyon on BLM-managed land.

Globally

This sparse herbaceous association occurs throughout the northern Colorado Plateau in its characteristic habitat of steep, northerly shale slopes.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This sparse association is observed on the midslope and upper slopes of ridges and hills. Sites are gentle to steep (6%–48%), occur between 1,475 m and 1,971 m elevation, and are oriented to many aspects. Small and large rocks and bare soil comprise much of the unvegetated surface. Cryptogamic cover can be up to 70% in some stands. Parent materials are sandstones and shales of Morrison age. Soils are somewhat poorly drained to rapidly drained, typically white in color, and are texturally silty clay and clay loam. Geology includes the Tidwell and Salt Wash members of the Morrison Formation and older landslide deposits - Brushy Basin Member of the Morrison Formation and younger.

Globally

This association typically occurs on sparsely vegetated shale slopes in the Colorado Plateau of southeastern Utah and western Colorado between 1,341 m and 1,971 m (4,400–6,465 ft). Slopes tend to be moderately steep to steep (38%–71%) and are generally north- to east-facing. The soil surface usually has moderate cover of colluvial rocks and blocks from sandstone ledges above the stand. Soil textures range from clays to clay loams, and the effects of shrink-swell action and sheet erosion in these soils is evident in the high percentage of bare ground.

VEGETATION DESCRIPTION

Colorado National Monument

This Salina wildrye association is relatively common and is distributed below outcrops of the Morrison Formation. The total vegetation cover ranged from 4% to 25% in these sparsely to moderately vegetated stands. This sparse vegetation association is characterized by the tall bunchgrass *Leymus salinus ssp. salinus* that contributes between 2% to 20% cover. Other grass species present in sparse amounts include *Achnatherum hymenoides, Bromus tectorum, Hesperostipa comata, Pleuraphis jamesii, Poa fendleriana,* and *Poa secunda*. Forbs are diverse but contribute sparse cover, including *Allium textile, Asclepias cryptoceras, Calochortus gunnisonii, Comandra umbellata, Cymopterus* sp., *Descurainia pinnata, Erigeron* sp., *Eriogonum ovalifolium, Lappula occidentalis, Lepidium montanum, Lomatium grayi, Penstemon* sp. *Physaria acutifolia, Platyschkuhria integrifolia, Pediomelum megalanthum, Ceratocephala testiculata, Silene antirrhina, Stanleya pinnata,* and *Streptanthella longirostris*. The shrub layer is diverse in terms of composition but contributes sparse cover. Dwarf-shrubs commonly present include *Atriplex confertifolia, Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Gutierrezia sarothrae, Opuntia erinacea, Opuntia polyacantha, Suaeda calceoliformis, Tetradymia spinosa,* and *Yucca harrimaniae*. Short shrubs include *Cercocarpus montanus, Ephedra viridis, Ericameria nauseosa,* and *Sarcobatus vermiculatus*. The canopy tree layer is uncommon, with *Juniperus osteosperma* and *Pinus edulis* contributing <5% cover. Cryptogam cover is typically sparse; however, one plot had high cover (68%).

Globally
This sparse herbaceous association occurs throughout the northern Colorado Plateau in its characteristic habitat of steep, northerly shale slopes. Total vegetation cover ranges widely, from 3% to 55% 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
Colorado National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Herb (field)	*Atriplex confertifolia, Leptodactylon pungens, Tetradymia spinosa*
Herb (field)	*Ceratocephala testiculata, Platyschkuhria integrifolia*
Herb (field)	*Hesperostipa comata, Leymus salinus* ssp. *salinus, Pleuraphis jamesii*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia, Chrysothamnus viscidiflorus* var. *stenophyllus, Ephedra torreyana, Ephedra viridis*
Herb (field)	*Leymus salinus, Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (26-Jun-2001).

CLASSIFICATION COMMENTS
Colorado National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This association is found on steep, highly erosive, shale slopes.
Colorado National Monument Plots: The description is based on 2003 field data (6 plots: COLM.0023, COLM.0027, COLM.0028, COLM.0175, COLM.0200, COLM.0208, and 4 observation points: COLM.0334, COLM.0458, COLM.0464, COLM.0512).
Local Description Authors: J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Comer pers. comm., Western Ecology Working Group n.d.

V. Park Specials – Not included in NVC Hierarchy

Achnatherum hymenoides – Bromus tectorum Herbaceous Vegetation [Park Special]
Indian Ricegrass - Cheatgrass Herbaceous Vegetation [Park Special]

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 Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Colorado National Monument
This association was observed on historically disturbed sites consisting mainly of roadway fill, gravel pits, campsites, and some heavily grazed areas. Sites disturbed by fire tended to revegetate mostly to cheatgrass and are described under *Bromus tectorum* Semi-natural Herbaceous Vegetation (CEGL003019). The large fill slope for Rimrock Drive at the northern tunnels in Fruita Canyon, sand and gravel pits west of Red and Columbus canyons, camping area near Liberty Cap Trail, near the sewage ponds, and gravel pits or asphalt/chip-seal batching areas adjacent to the Black Ridge Trail were sampled.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Colorado National Monument
This herbaceous association was observed on historically disturbed areas that occurred on a steep fill slope, mesa tops, low bench, plain, and on ridgetops. Sites were flat to extremely steep (0%–68% slopes), occurred between 1,492 m and 2,024 m elevation, and were oriented to aspects between 20 and 360 degrees. The unvegetated surface can contain moderately high amounts of large rocks, litter, and cryptobiotic crust and moderately low amounts of small rocks and bare soil. Parent materials have been removed or covered over, and the exposed soils and fill are texturally loamy sand, silt loam, and sandy loam. The associated geology is variable and includes artificial fill, eolian sand, migmatitic meta-sedimentary rocks, and the Tidwell Member of the Morrison Formation. One area of artificial fill on Rimrock Drive is comprised of river cobble, hauled in during road construction to stabilize the roadbed and slope, and it covers approximately the minimum mapping unit of 1.5 ha

Globally
Data are not available.

VEGETATION DESCRIPTION
Colorado National Monument

This Indian ricegrass - cheatgrass association is distributed on previously disturbed land that has been scraped, compacted, and/or covered with fill. The total vegetation cover ranged from 2% to 22% in these sparsely vegetated stands. One stand in Kodels Canyon was moderately dense and attained vegetative cover of 59%. This herbaceous association is characterized by *Achnatherum hymenoides* or *Bromus tectorum* that range in cover from 1% to 25%. A diverse group of herbaceous species occurs across stands, but one stand will usually have low diversity. Additional graminoids include *Agropyron cristatum, Aristida purpurea, Elymus elymoides, Leymus salinus, Vulpia octoflora, Hesperostipa comata, Pleuraphis jamesii,* and *Poa fendleriana*. Forbs are relatively diverse but contribute sparse cover; the more common include *Astragalus nuttallianus, Heterotheca villosa,* and *Lepidium montanum*. A canopy of *Juniperus osteosperma* and *Pinus edulis* trees are present on some sites, contributing up to 3% cover. The shrub layer is moderately variable in composition but low in cover. Shrubs commonly present include *Artemisia tridentata ssp. wyomingensis, Atriplex confertifolia, Ericameria nauseosa, Gutierrezia sarothrae,* and *Krascheninnikovia lanata*. Cryptogam cover is variable with some stands having none, but cover can be as high as 69%.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Short Shrub	*Artemisia tridentata ssp. wyomingensis, Ericameria nauseosa, Juniperus osteosperma, Pinus edulis*
Dwarf-shrub	*Gutierrezia sarothrae, Opuntia erinacea*
Graminoid	*Achnatherum hymenoides, Agropyron cristatum, Bromus tectorum, Elymus elymoides, Hesperostipa comata, Leymus salinus*
Forb	*Grindelia squarrosa, Heterotheca villosa, Lepidium montanum*

Globally

Stratum	Species

Data are not available.

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Data are not available.

CLASSIFICATION COMMENTS
Colorado National Monument
This association is found on previously disturbed land that is undergoing revegetation. Most sites were used as sources for sand and gravel extraction, and one large site is a highway fill slope. Over time each site will revegetate to reflect the surrounding plant community, typically *Artemisia tridentata ssp. wyomingensis* shrubland or *Pinus edulis - Juniperus osteosperma* woodland.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Lack of topsoil hinders full and rapid recovery of these sites..
Colorado National Monument Plots: The description is based on 2003 field data (4 plots: COLM.0011; COLM.0070; COLM.0134; COLM.0136, and 6 observation points: COLM.0341; COLM.0347; COLM.0392; COLM.0412; COLM.0413; COLM.0427).
Local Description Authors: J. Von Loh
Global Description Authors: Data are not available.

REFERENCES: Data are not available.

Artemisia frigida / Heterotheca villosa Dwarf-shrubland [Park Special]
Fringed Sagebrush / Hairy Goldenaster Dwarf-shrubland [Park Special]

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
Data are not available.

DISTRIBUTION
Colorado National Monument
This association was observed as one stand occupying a former BLM pasture on the COLM boundary near the rim of No Thoroughfare Canyon and south of C Road. The lands to the west of the Monument boundary were private or were public lands managed by the BLM

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Colorado National Monument
This dwarf-shrubland association was observed on a mesa top. Sites are gentle (1^{o} slope), occur between 2,014 m and 2,075 m, and were oriented to aspects of 131^{o} and 174^{o}. The unvegetated surface had high exposure of bare soil and low cover of litter. Cryptobiotic crust provided sparse cover. Parent materials were eroded from sandstones and shale and deposited as eolian sand and silt. Soils were rapidly drained and texturally were loamy sand. Site geology was eolian deposits.

Globally

Data are not available.

VEGETATION DESCRIPTION

Colorado National Monument

This dwarf-shrubland association was very rare and occurred only on the Monument western boundary. The total vegetation cover ranged from 26% to 37% for this moderately vegetated stand. This association was characterized by the dwarf-shrub *Artemisa frigida* that contributed from 14% to 18% cover and the forb *Heterotheca villosa* that contributed from 5% to 6% cover. Seedling *Pinus edulis* trees provided sparse cover. The shrub layer was low in terms of species composition and provided sparse cover. Short shrubs included *Artemisia tridentata* ssp. *wyomingensis* and *Ericameria nauseosa*. An additional dwarf-shrub was *Gutierrezia sarothrae*. The remaining herbaceous layer was low in terms of species diversity and provided sparse cover. Graminoids included the short bunchgrasses *Elymus elymoides* and *Agropyron cristatum,* a perennial nonnative, and the nonnative annual *Bromus tectorum*. Additional forbs included *Lupinus argenteus* and *Packera multilobata*.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Short Shrub	*Artemisia tridentata* ssp. *wyomingensis*
Dwarf-shrub	*Artemisia frigida*
Graminoid	*Agropyron cristatum, Bromus tectorum*
Forb	*Heterotheca villosa*

Globally

Stratum	Species

Data are not available.

OTHER NOTEWORTHY SPECIES

Colorado National Monument

Agropyron cristatum, Bromus tectorum

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: Data are not available.

CLASSIFICATION COMMENTS

Colorado National Monument

This association occupied a small area within a stand of Wyoming big sagebrush that had been previously treated to increase livestock forage production by reducing shrub cover then interseeding with crested wheatgrass. Prairie dogs had colonized the site and their burrowing and grazing activities had further reduced short shrub cover and supported establishment of native dwarf-shrub and forb species tolerant of this disturbance. The prairie dog colony was inactive, possibly as a result of migration elsewhere, sylvatic plague, or poisoning. Over time this site would be expected to support a Wyoming big sagebrush / crested wheatgrass shrubland.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Colorado National Monument Inventory Notes: Site was occupied by prairie dogs, the burrows remain, and the ground is quite disturbed. Flat area with deep soils beginning to be re-invaded by Wyoming big sagebrush and two-needle pinyon.
Colorado National Monument Plots: The description is based on 2004 field data (2 accuracy assessment points): (Point: COLM_AA.009; COLM_AA.049).
Local Description Authors: J. Von Loh
Global Description Authors: Data are not available.

REFERENCES: Data are not available.

Eriogonum lonchophyllum Sparse Vegetation [Park Special]
Spearleaf Wild Buckwheat Sparse Vegetation [Park Special]

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 Mixed Bedrock Canyon and Tableland (CES304.765)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Colorado National Monument
This association was observed on a ridgetop and upper slope in the mesas west of Red Canyon. Small remnants of the Tidwell Formation shales are eroding from their position on top of Entrada sandstone deposits.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Colorado National Monument
This forb association was observed on exposed ridgetops and upper ridge shoulders. Sites were relatively gentle (12% slope), occurred at 2,001 m elevation, and were oriented to 260 degrees. The unvegetated surface consists of gravelly and rocky substrate. Parent materials include sandstones and shales of the Morrison Formation. Soils are rapidly drained and texturally are silty clay. This association occurs on the Tidwell Member of the Morrison Formation, on white-colored exposures.

Globally

Data are not available.

VEGETATION DESCRIPTION

Colorado National Monument

This forb association is highly restricted to the Black Ridge area of the monument, where Tidwell Formation shales are exposed. The total vegetation cover is <4% in these sparsely vegetated stands. This herbaceous association is characterized by a sparse forb stratum of *Eriogonum lonchophyllum* and *Platyschkuhria integrifolia var. oblongifolia* that contribute approximately 1% cover per species. Additional forbs present include *Asclepias cryptoceras* and *Cryptantha* sp. The dwarf-shrubs are predictable and include *Ephedra torreyana, Gutierrezia sarothrae,* and *Yucca harrimaniae* at <1% cover. Graminoids are also sparse and include *Achnatherum hymenoides* and *Pleuraphis jamesii*. Scattered trees of *Juniperus osteosperma* that are 2-5 m tall are present along the ridgetops.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Dwarf-shrub	*Ephedra torreyana*
Forb	*Eriogonum lonchophyllum, Platyschkuhria integrifolia var. oblongifolia*

Globally

Stratum	Species

Data are not available.

OTHER NOTEWORTHY SPECIES

Colorado National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: Data are not available.

CLASSIFICATION COMMENTS

Colorado National Monument

This geologic exposure is constantly eroding due to wind and water action. Coupled with its landscape position on ridges, this small and harsh habitat will only support sparse vegetation.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Colorado National Monument Inventory Notes: This type will occupy similar small habitats on Black Ridge and along Liberty Cap Trail where it is exposed.

Colorado National Monument Plots: The description is based on 2003 field data (1 observation point: COLM.0403).

Local Description Authors: J. Von Loh

Global Description Authors: Data are not available.

REFERENCES: Data are not available.

Mahonia repens Dwarf-shrubland [Park Special]
Creeping Oregon-grape Dwarf-shrubland [Park Special]

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 Mixed Bedrock Canyon and Tableland (CES304.765)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Colorado National Monument
One stand of *Mahonia repens* occurs behind Fallen Rock in Ute Canyon. The stand occupies the area from the cliff face to the face of Fallen Rock and extends almost the length of Fallen Rock. Only minor patches of *Mahonia repens* were observed in stands of Gambel oak and in some alcoves and drainages elsewhere in the monument.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Colorado National Monument
This shrubland was observed on rockfall or talus behind the large sandstone block known as Fallen Rock in Ute Canyon. The site is moderately steep (12% slope), occurs at 1,829 m elevation, and is oriented to the southwestern aspect of 227 degrees. The unvegetated surface has high cover of litter, mosses and lichens. Bedrock and large and small rocks comprise about half the unvegetated surface. Downed wood is uncommon and consists mostly of old quaking aspen trunks and branches. Parent materials are sandstone rocks and boulders broken off the Wingate and Kayenta formations. Soils are rapidly drained and are texturally loamy sand.

Globally
Data are not available.

VEGETATION DESCRIPTION
Colorado National Monument
The Oregon-grape dwarf-shrubland occurs as a stand only behind Fallen Rock in Ute Canyon. The vegetation cover is 89% in this densely vegetated stand. This dwarf-shrub association is characterized by a closed canopy of *Mahonia repens* that provides 85% cover. Another dwarf-shrub, *Yucca harrimaniae*, is

present in the stand but provides <1% cover. The shrub layer is sparse in terms of diversity and cover. The tall shrubs, from 2 m to 5 m tall, contribute <1% cover and include *Fraxinus anomala* and *Juniperus osteosperma*. Short shrubs provide sparse cover and include *Juniperus osteosperma*, *Pinus edulis*, and *Rhus trilobata*. The herbaceous layer is sparse and contains few species. Graminoids present provide diversity and include *Piptatherum micranthum* and *Poa fendleriana*. The forbs present provide sparse cover and include an unknown Lamiaceae, *Taraxacum officinale*, and *Tragopogon dubius*. The liana *Clematis ligusticifolia* is present and provides 1% to 5% cover. It is evident that *Populus tremuloides* trees were once present as a canopy tree, because fallen trunks were present on the northern stand portion.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species
Dwarf-shrub	*Mahonia repens*

Globally

Stratum	Species

Data are not available.

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Data are not available.

CLASSIFICATION COMMENTS
Colorado National Monument
This association occupies a mesic site protected behind a huge sandstone slab broken away from the adjacent cliff. Additional rockfall could bury this stand. Future movement of Fallen Rock could eliminate this stand by exposing it to sun and wind desiccation. At one time, *Populus tremuloides* trees also grew in this habitat; however, only the dead trunks remain.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Colorado National Monument Inventory Notes: This is the only known occurrence of an Oregon-grape stand in the monument; it otherwise occurs as scattered understory shrubs or in very small patches.
Colorado National Monument Plots: The description is based on 2003 field data (1 plot): (Plot: COLM.045).
Local Description Authors: J. Von Loh
Global Description Authors: Data are not available.

REFERENCES: Data are not available.

Nonvascular Cover – Board Beds Units, Entrada Sandstone Sparse Vegetation [Park Special]

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 Mixed Bedrock Canyon and Tableland (CES304.765)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

Data are not available.

DISTRIBUTION

Colorado National Monument

This association was observed on exposures of the Board Beds unit of Entrada sandstone on and adjacent to Ribbon Trail above Echo Canyon.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument

This community was observed on the surface of exposures of the Board Beds unit of Entrada sandstone. Sites have a moderately steep, 16% slope, occur at 1,829 m elevation, and are oriented to a northeastern aspect. The unvegetated surface cover is a small amount of exposed bedrock, with most consisting of lichen and moss species.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Nonvascular	Crustose lichens, Foliose lichens, Mosses

Globally

Data are not available.

VEGETATION DESCRIPTION

Colorado National Monument

This nonvascular community occupies exposed bedrock. The total cover is 95% on these bedrock surfaces. Cover may be further divided into mosses (5%), foliose lichens (8%), and crustose lichens (82%).

Globally

Data are not available.

MOST ABUNDANT SPECIES
Colorado National Monument

Stratum	Species

Globally

Stratum	Species

Data are not available.

OTHER NOTEWORTHY SPECIES
Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Data are not available.

CLASSIFICATION COMMENTS
Colorado National Monument
The Ribbon Trail, used by hikers and mountain bikers, crosses an exposure of Entrada sandstone, resulting in the elimination of lichens and mosses on the trail across the outcrop.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Colorado National Monument Inventory Notes: .
Colorado National Monument Plots: The description is based on 2003 field data (1 observation point: COLM.0486).
Local Description Authors: J. Von Loh
Global Description Authors: Data are not available.

REFERENCES: Data are not available.

Picea pungens - Pinus edulis - Juniperus osteosperma / Quercus gambelii Woodland [Park Special]
Blue Spruce - Two-needle Pinyon - Utah Juniper / Gambel Oak Woodland [Park Special]

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)
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally
Data are not available.

DISTRIBUTION

Colorado National Monument
This woodland was observed and recorded near the Ribbon Trail in Echo Canyon. It grows on talus derived from the Board Beds unit of Entrada sandstone.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION

Colorado National Monument
This woodland consisted of a small stand of 4 to 6 trees and was observed in the waterfall or pour-off zone, rooted in talus at the head of an alcove. The site is gently sloped (8% slope), occurs at 1,794 m elevation, and is oriented to an aspect of 30 degrees. The unvegetated surface had high cover of litter and downed wood. The parent material is Entrada sandstone. Soils are well-drained and coarse.

Globally
Data are not available.

VEGETATION DESCRIPTION

Colorado National Monument
This Colorado blue spruce stand occurred in a single alcove near Echo Canyon; the species is also present as an individual sapling on talus in Red Canyon. The total vegetation cover is 59% in this moderately vegetated stand. This woodland is characterized by an open, mixed tree canopy, 5 m to 15 m tall, of *Picea pungens, Pinus edulis,* and *Juniperus osteosperma* trees that range in cover from 1% to 5% for each species. The shrub layer is mostly tall, from 2 m to 5 m, and includes *Amelanchier utahensis, Quercus gambelii, Rhus trilobata,* and *Cercocarpus montanus* that contribute from 3% to 25% cover for each species. Graminoid and forb composition and cover could not be determined because the access was 15 m above the stand at the top of a vertical rock wall.

Globally
Data are not available.

MOST ABUNDANT SPECIES

Colorado National Monument

Stratum	Species
Canopy Tree	*Picea pungens, Pinus edulis, Juniperus osteosperma*
Tall Shrub	*Quercus gambelii, Amelanchier utahensis, Rhus trilobata*

Globally

Stratum	Species

Data are not available.

OTHER NOTEWORTHY SPECIES

Colorado National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Data are not available.

CLASSIFICATION COMMENTS
Colorado National Monument
There is no known disturbance affecting this stand. It could be buried by a large rockfall or landslide event. Adequate moisture is available from runoff across exposed bedrock to the pour-off area of this site.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Colorado National Monument Inventory Notes: The trees appear healthy and include mature and sapling individuals. Another sapling Colorado blue spruce was observed growing from talus in Red Canyon.
Colorado National Monument Plots: The description is based on 2003 field data (1 observation point: COLM.0487).
Local Description Authors: J. Von Loh
Global Description Authors: Data are not available.

REFERENCES: Data are not available.

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Appendix G

Illustrated Keys to the Plant Associations of Colorado National Monument

A diversity of vegetation types was observed, sampled and described during the summer of 2003 under the U.S. Geological Survey and National Park Service Vegetation Mapping Program. This dichotomous key, illustrated with images taken during the vegetation sampling effort, has been prepared to assist in the field identification of 67 plant associations described for Colorado National Monument. The key is designed to allow identification of plant associations using one or a combination of dominant species. Because of natural variation within plant associations and observer bias, observers may key to vegetation associations using more than one of the physiognomic keys. Within ecotones (areas where dominant species intermix between plant associations), it may be difficult to determine a definitive association name.

This illustrated key also allows the user to crosswalk plant associations directly to the Colorado National Monument vegetation map so that all research can have a common focal point relative to the baseline year of aerial photography (2002) and field data (2003). Map unit codes are in square brackets [] following each association name. A map unit may contain more than one plant association. "[Map Unit = point]" indicates vegetation types that were difficult to map; following the analysis of the accuracy assessment data, the map units and polygons containing these types were combined into other map units to raise the overall map accuracy; known locations (i.e., classification plots, observation plots, or accuracy assessment plots) classified to these types were retained as point data.

This version of the key represents an update of the original key, done after the accuracy assessment stage of the vegetation mapping project. One association (*Artemisia frigida – Heterotheca villosa* Dwarf-Shrubland) was added to the key and the couplets were re-written and rearranged in response to comments and corrections made by accuracy assessment field crews. This version of the key does not represent the document used during photo interpretation or accuracy assessment.

How to Use the Key

The key approaches plant association identification at two levels. The first level (Key I) is physiognomic, allowing the user to determine which major group is being evaluated, e.g., forest/woodland, shrubland, or herbaceous. The second level (Keys II – IV) allows identification to plant association based on dominant species foliar cover. As an aid to observers in the field, representative photographs demonstrating variation within associations are shown below association names.

It is possible that in using this key, you will have difficulty getting to an association that describes your community. There are several possible reasons for this, and each has a solution:

1. You have 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 10% (tree layer) or 5% (shrub or herbaceous layers), it is ignored. The exception is in very sparse communities (see #4 below).

2. If you have a community dominated by *Fraxinus anomala* or *Quercus gambelii*, try running it through the woodland key. Although these two species often occur in shrub form, at Colorado National Monument they are sometimes considered to be small trees, equivalent to *Pinus edulis* and *Juniperus osteosperma*.

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 – very likely you have an association that was not found during the sampling phase of the project. In this case, simply record "Unclassified pinyon-juniper (or whatever type of vegetation you have) association". Be sure to note the dominant species in each stratum.

4. Communities with relatively sparse vegetation (i.e., < 15% total vascular plant cover) should be run through multiple keys. Even though they contain trees or shrubs, they may not fall cleanly into a “woodland” or “shrubland” category.

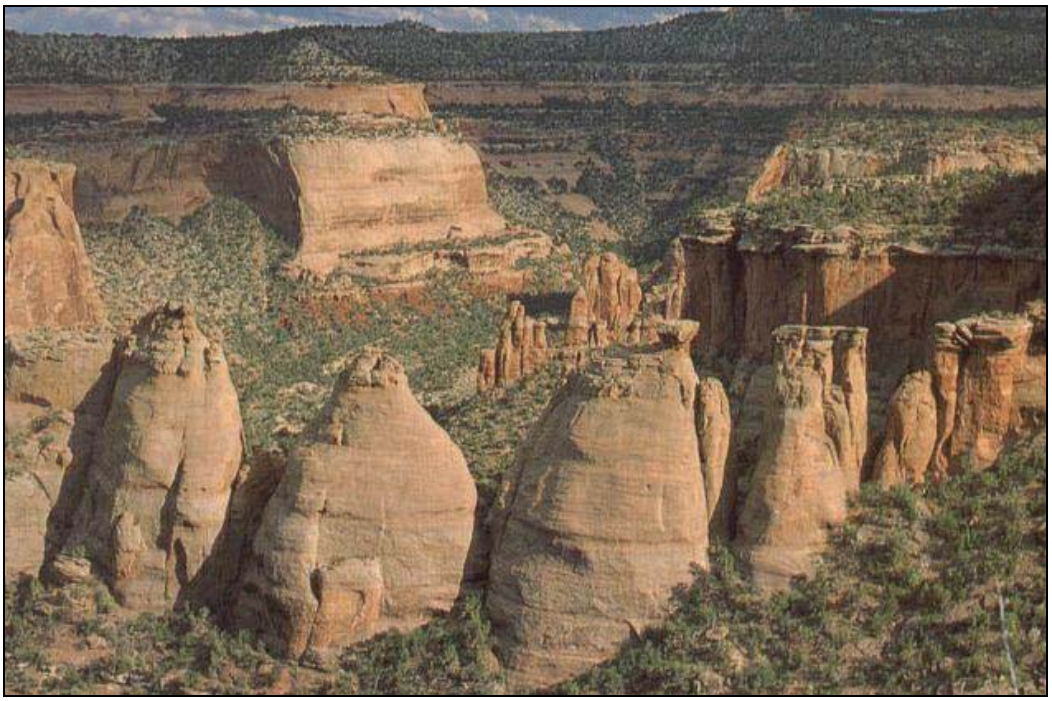


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KEY I
A KEY TO THE MAJOR PHYSIOGNOMIC GROUPS OF COLORADO NATIONAL MONUMENT

1a) Vegetation woody or appearing woody, with a canopy composed predominantly of trees, shrubs, or subshrubs; total vegetation cover may be sparse to dense (2)

1b) Vegetation predominantly composed of herbaceous species, either grasses, graminoids, fern allies or forbs; some woody species may be present with less than 5% cover. Total vegetation cover ranges from sparse to dense - **Key IV,** Page 36







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2a) Forest or woodland vegetation, with interlocking tree canopies (forest) or non - interlocking tree canopies (woodland). Characteristic genera include *Pinus, Juniperus, Pseudotsuga, Picea, Populus, Acer, Fraxinus, Quercus* - **Key II,** Page 6





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2b) Tall, short or dwarf-shrub vegetation; canopies may interlock but are commonly less dense. Some trees may be present with low relative cover. Characteristic genera include *Amelanchier, Arctostaphylos, Artemisia, Atriplex, Betula, Cercocarpus, Chrysothamnus, Ericameria, Krascheninnikovia, Mahonia, Opuntia, Quercus, Rhus, Salix, Sarcobatus* - **Key III,** Page 20



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KEY II

A KEY TO THE FOREST AND WOODLAND ASSOCIATIONS OF COLORADO NATIONAL MONUMENT

Please note that although the generally accepted minimum tree canopy cover for woodlands is 10%, there are many situations in Colorado Plateau woodlands where tree canopy cover is less than this value. In most cases the entire community is relatively sparse (less than 15 or 20% total vegetation cover) and the tree stratum is still dominant in terms of relative cover. In these sparse woodlands, the cover of diagnostic shrub species may also be low, sometimes 5% or less.

1a) Forest or woodland associations in moist or cold-air drainages with canopies dominated by deciduous trees or tall shrubs (*Populus, Acer, Quercus, Fraxinus*), sometimes with interlocking canopies. The understory is variable but may contain mesic or wetland species (2)

1b) Woodlands or forests with canopies dominated by evergreen trees (*Pinus, Juniperus, Picea, Pseudotsuga*), generally with less than 60% canopy closure and often with scattered young trees, forbs, grasses or shrubs present in openings between tree crowns (7)

2a) Woodlands or forests of deciduous trees growing in mesic to wet sites adjacent to springs and seeps in the heads of canyons, along perennial streams, or adjacent to plunge pools. The canopy is characterized by *Populus* or *Acer* with a variety of mesic shrubs or a disturbed surface in the understory (3)

2b) Woodland associations of deciduous trees or tall shrubs occurring on talus/rock fall slopes, in alcoves, or in intermittent drainages. Dominant species include *Quercus gambelii* or *Fraxinus anomala* (6)

3a) Woodlands or forests of *Populus tremuloides* with a tall shrub understory of mesic species such as *Prunus* or *Rhus* (4)

3b) Woodlands or forests of *Populus deltoides* ssp. *wislizeni* or *Acer negundo* with various species in the understory (5)

4a) Vegetation of *Populus tremuloides* with an understory dominated by *Betula occidentalis* — ***Populus tremuloides / Betula occidentalis Forest*** **(Quaking Aspen / Water Birch Forest)** [Map Unit # 14]



Photo credit: e²M

4b) Vegetation of *Populus tremuloides* with a mixed, shrub understory dominated by *Prunus virginiana*— ***Populus tremuloides* / *Prunus virginiana* Forest (Quaking Aspen / Chokecherry Forest)** [Map Unit # 14]



Photo credit: e²M

5a) Forests or woodlands of *Populus deltoides* ssp. *wislizeni* with an understory dominated by *Salix exigua* — ***Populus deltoides* (ssp. *wislizeni*, ssp. *monilifera*) / *Salix exigua* Forest (Cottonwood / Coyote Willow Forest)** [Map Unit # 29]





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5b) Woodlands or forests of *Acer negundo* and *Acer glabrum* trees with little in the understory other than annual weeds such as *Bromus tectorum* or *Descurainia pinnata. Fraxinus anomala* and *Ericameria nauseosa* may be present but contribute little cover — ***Acer negundo* / Disturbed Understory Woodland (Box-elder / Disturbed Understory Woodland)** [Map Unit = point]



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6a) Dense woodlands growing on talus slopes, valley fill deposits, or in alcoves, dominated by *Quercus gambelii*. Other shrubs commonly present include *Amelanchier utahensis, Artemisia tridentata ssp. tridentata, Cercocarpus montanus, Ericameria nauseosa,* and *Prunus virginiana* — ***Quercus gambelii* / *Rhus trilobata* Shrubland (Gambel Oak / Skunkbush Shrubland)** [Map Unit # 30]

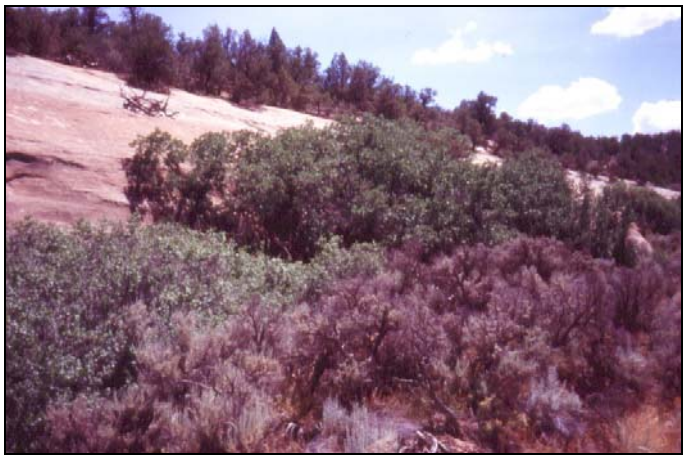




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6b) Open, sometimes sparse woodlands occurring in rocky, intermittent drainages dominated by *Fraxinus anomala* tall shrubs (sometimes with cover <5%), often with *Juniperus osteosperma* and *Pinus edulis* present with lesser cover — ***Fraxinus anomala* Woodland (Single-leaf Ash Woodland)** [Map Unit = point]

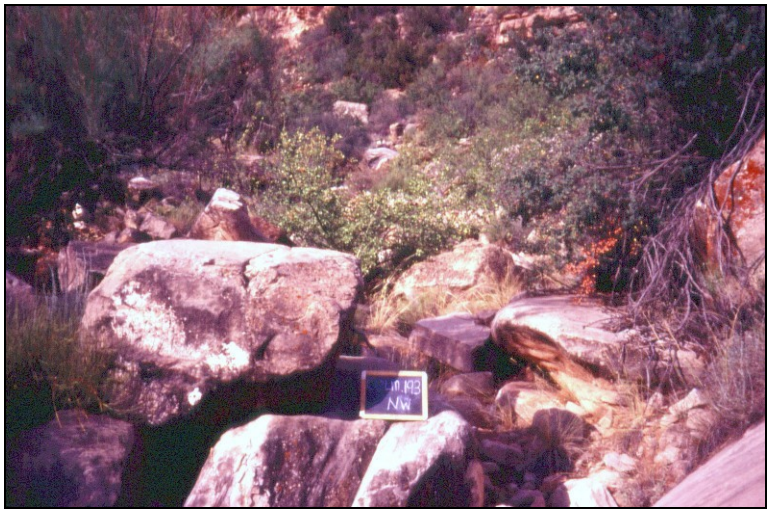


Photo credit: e²M

7a) Forest or woodlands dominated by *Pseudotsuga menziesii* or *Picea pungens* (8)

7b) Woodlands or tall shrublands dominated by *Juniperus osteosperma,* often with *Pinus edulis* (9)

8a) Woodlands or forests on canyon walls with a canopy dominated by *Pseudotsuga menziesii* and an understory canopy of mixed shrubs, including *Amelanchier utahensis* and *Quercus gambelii* —

***Pseudotsuga menziesii* / *Quercus gambelii* Forest (Douglas-fir / Gambel Oak Forest)** [Map Unit = point]



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8b) Forests or woodlands in canyon alcoves with a canopy dominated by *Picea pungens* trees and *Juniperus osteosperma* and *Pinus edulis* trees contributing significant subcanopy cover. The understory consists of mixed shrubs, including *Amelanchier utahensis* and *Quercus gambelii* – ***Picea pungens* - *Pinus edulis* - *Juniperus osteosperma* / *Quercus gambelii* Woodland (Colorado Blue Spruce - Two-needle Pinyon - Utah Juniper / Gambel Oak Woodland)** [Map Unit = point]





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9a) Woodlands, sometimes sparse, with a canopy dominated by *Juniperus osteosperma* and/or *Pinus edulis*, and an understory dominated by woody shrubs totaling at least 5% cover (10)

9b) Woodlands with a canopy dominated by *Juniperus osteosperma* and/or *Pinus edulis* and an understory that is either sparse (<5% total cover) or dominated by herbaceous species (grasses or forbs). Shrubs may be present if they have significantly less cover than the herbaceous species, and usually less than 5% cover (19)

10a) Woodlands that tend to be on relatively level surfaces with deep alluvial or eolian soils, with an understory dominated by *Artemisia tridentata* ssp. *wyomingensis* (11)

10b) Woodlands with understories dominated by other shrubs, including *Cercocarpus, Amelanchier, Ericameria* and other species of *Artemisia* (12)

11a) Woodlands whose canopy is dominated by *Juniperus osteosperma* trees and an understory composed predominantly of *Artemisia tridentata* ssp. *wyomingensis*. *Pinus edulis* is absent or is a very minor part of the tree canopy or seedling layer —***Juniperus osteosperma* / *Artemisia tridentata* ssp. *wyomingensis* Woodland (Utah Juniper / Wyoming Big Sagebrush Woodland)** [Map Unit # 19]





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11b) Woodlands with a mixed canopy of *Pinus edulis* and *Juniperus osteosperma* trees and with an understory (sometimes sparse) dominated by *Artemisia tridentata* ssp. *wyomingensis* — ***Pinus edulis* - *Juniperus* spp. / *Artemisia tridentata* (ssp. *wyomingensis*, ssp. *vaseyana*) Woodland (Two-needle Pinyon - Juniper / Wyoming, Mountain Big Sagebrush Woodland)** [Map Unit # 19]





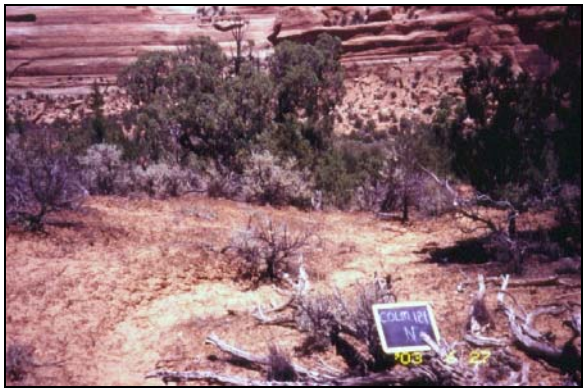



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12a) Woodlands with canopies of *Pinus edulis* and *Juniperus osteosperma* trees with an understory dominated by *Artemisia bigelovii* or *Artemisia nova* (13)

12b) Woodlands of *Pinus edulis* and *Juniperus osteosperma* trees with an understory that may include *Artemisia nova* or *Artemisia bigelovii,* but which is dominated by other species of shrubs or a mix of shrubs (14)

13a) Woodlands of *Pinus edulis* and *Juniperus osteosperma* trees on shallow soils over slickrock with an understory dominated by the dwarf-shrub *Artemisia bigelovii* — ***Pinus edulis - Juniperus osteosperma / Artemisia bigelovii*** **Woodland (Two-needle Pinyon - Utah Juniper / Bigelow (Flat) Sagebrush Woodland)** [Map Unit # 20]






13b) Woodlands of *Pinus edulis* and *Juniperus osteosperma* trees on deeper, often calcareous soils with the understory dominated by the dwarf-shrub *Artemisia nova* — ***Pinus edulis - Juniperus osteosperma* / *Artemisia nova* Woodland (Two-needle Pinyon - Utah Juniper / Black Sagebrush Woodland)** [Map Unit # 25]





Photo credits: e²M

14a) Open woodlands of *Juniperus osteosperma,* sometimes mixed with *Pinus edulis,* occurring on moderate to steep slopes covered with colluvium of sandstone or migmatitic gneiss. The shrub layer may have as much cover as the tree overstory. and consists of a combination of *Amelanchier utahensis, Artemisia bigelovii, Atriplex canescens, Brickellia microphylla, Cercocarpus montanus, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Fendlera rupicola, Fraxinus anomala,* and *Rhus trilobata,* with no clear dominant shrub evident when considered across a large area (15)

14b) Open to moderately closed woodlands of *Juniperus osteosperma* with or without *Pinus edulis,* occurring on a variety of substrates, but not on slopes heavily covered by talus (16)

15a) Substrate predominantly talus or rock fall derived from sandstone cliffs and mesa tops, or substrate predominantly gravel, rocks, and/or boulders derived from Precambrian gneiss. Trees are dwarfed in stature – ***Juniperus osteosperma* / Mixed Shrubs Talus Woodland (Utah Juniper Mixed Shrubs Talus Woodland)** [Map Unit # 22]









Photo credits: e²M

15b) Woodlands with low cover of *Pinus edulis* and *Juniperus osteosperma* trees on sandstone cap rock or steep, colluvium-covered slopes with shallow soils. The sparse understory may contain several shrub or bunchgrass species in trace amounts — ***Pinus edulis* - *Juniperus osteosperma* / Mixed Shrubs Talus Woodland (Two-needle Pinyon - Utah Juniper Mixed Shrubs Talus Woodland)** [Map Unit # 20]









Photo credits: e²M

16a) Woodlands, sometimes sparse, of *Juniperus osteosperma* with or without *Pinus edulis*, characterized by a short shrub understory that may be mixed, but is dominated by *Cercocarpus montanus* (17)

16b) Woodlands with a mixed canopy of *Juniperus osteosperma* and *Pinus edulis* with an understory dominated by *Amelanchier utahensis* or *Cercocarpus intricatus* (18)

17a) Woodlands of *Juniperus osteosperma* trees with an understory composed predominantly of the shrub *Cercocarpus montanus* — ***Juniperus osteosperma* / *Cercocarpus montanus* Woodland (Utah Juniper / Mountain-mahogany Woodland)** [Map Unit # 20]



Photo credit: e²M

17b) Woodlands of *Pinus edulis* and *Juniperus osteosperma* trees growing on a variety of substrates characterized by an understory of the short shrub *Cercocarpus montanus; Amelanchier alnifolia* is often present. This association varies widely in terms of total cover, depending on substrate, slope, and exposure — ***Pinus edulis* - *Juniperus* spp. / *Cercocarpus montanus* –Mixed Shrub Woodland (Two-needle Pinyon - Juniper / Mountain-mahogany Mixed Shrub Woodland)** [Map Unit # 20]








Photo credits: e²M

18a) Woodlands of *Pinus edulis* and *Juniperus osteosperma* trees with an understory (sometimes sparse) dominated by the tall shrub *Amelanchier utahensis* — ***Pinus edulis - Juniperus osteosperma / Amelanchier utahensis*** **Woodland (Two-needle Pinyon - Utah Juniper / Utah Serviceberry Woodland)** [Map Unit # 20]




Photo credits: e²M

18b) Open woodlands of *Pinus edulis* and *Juniperus osteosperma* trees growing on sandstone cap rock and with an understory dominated by the short shrub *Cercocarpus intricatus* — ***Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus*** **Woodland (Two-needle Pinyon - Utah Juniper / Little-leaf Mountain-mahogany Woodland)** [Map Unit # 20]




19a) Woodlands with an herbaceous understory dominated by the bunchgrass *Hesperostipa comata* (20)

19b) Woodlands with other grasses or forbs dominating the understory, or with an understory that is sparse (<5% cover by shrubs or herbaceous species) (21)

20a) Woodlands of mixed *Pinus edulis* and *Juniperus osteosperma* trees with several bunchgrasses in the understory, among which *Hesperostipa comata* is at least co-dominant, and usually is dominant. The grasses have at least 5% cover, and shrubs have less than 5% cover — ***Pinus edulis – Juniperus (monosperma, osteosperma) / Hesperostipa comata*** **Woodland (Two-needle Pinyon – Juniper / Needle-and-Thread Grass Woodland)** [Map Unit # 20]

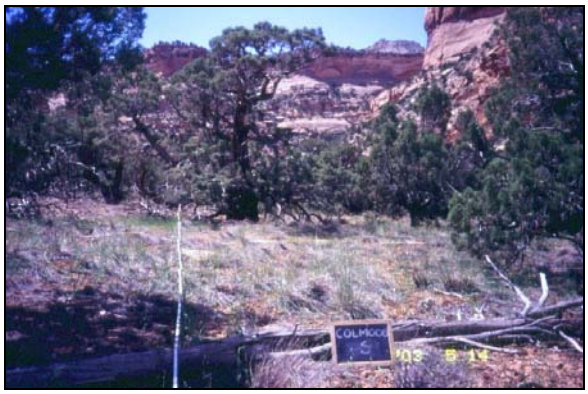




Photo credits: e²M

20b) Woodlands with a canopy consisting solely of *Juniperus osteosperma* and an herbaceous understory dominated by *Hesperostipa comata* — ***Juniperus osteosperma / Hesperostipa comata*** **Woodland (Utah Juniper / Needle-and-Thread Grass Woodland)** [Map Unit # 22]



Photo credit: e²M

21a) Woodlands with moderate to low cover of *Pinus edulis* and *Juniperus osteosperma* trees on gentle slopes with deep soils and less than 5% cover of herbaceous and shrub species in the understory;

non-vascular ground cover may be very high in some stands — ***Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland (Two-needle Pinyon - Utah Juniper / Sparse Understory Woodland)** [Map Unit # 28]



Photo credits: e²M

21b) Woodlands with an herbaceous understory dominated by *Leymus salinus* or *Petradoria pumila* (22)

22a) Woodlands, sometimes with a sparse canopy (at least 5% cover), of *Juniperus osteosperma* trees and an understory stratum dominated by the tall bunchgrass *Leymus salinus* — ***Pinus edulis - Juniperus* spp. / *Leymus salinus* Woodland (Two-needle Pinyon - Juniper / Salinas Lyme Grass Woodland)** [Map Unit # 4]






Photo credits: e²M

22b) Woodlands of *Juniperus osteosperma* and/or *Pinus edulis* trees with evenly dispersed clumps of *Petradoria pumila* (minimum 3% cover) in the understory — ***Pinus edulis - Juniperus osteosperma / Petradoria pumila* Woodland (Two-needle Pinyon - Utah Juniper / Grassy Rock goldenrod Woodland)** [Map Unit = point]




Photo credits: e²M

KEY III
A KEY TO THE SHRUBLAND ASSOCIATIONS OF COLORADO NATIONAL MONUMENT

Please note that while shrublands usually have a minimum cover by shrubs of 15%, in cases where the total vegetation cover is sparse or dominated by weedy herbaceous annual species, cover by the diagnostic shrub species may be as low as 5%.

1a) Plant associations of mat or dwarf-shrubs, mostly less than 0.5 m tall, typically occupying dry sites. Characteristic genera include *Artemisia*, *Atriplex (gardneri)*, *Krascheninnikovia*, *Mahonia*, and *Opuntia* (2)

1b) Plant associations of shrubs mostly greater than 0.5 m tall, occupying a variety of sites and exposures. Characteristic genera include *Amelanchier*, *Arctostaphylos*, *Artemisia*, *Atriplex (confertifolia, canescens)*, *Betula*, *Cercocarpus*, *Ericameria*, *Fendlera*, *Quercus*, *Rhus*, *Salix*, and *Sarcobatus* (8)

2a) Dwarf-shrublands dominated by the succulent *Opuntia polyacantha* with low to moderate cover of *Pleuraphis jamesii*. *Atriplex* spp. may be present, but *Opuntia* is the dominant shrub.— ***Opuntia polyacantha* / *Pleuraphis jamesii* Shrubland (Panhandle Prickly - Pear / James' Galleta Shrubland)** [Map Unit # 4]

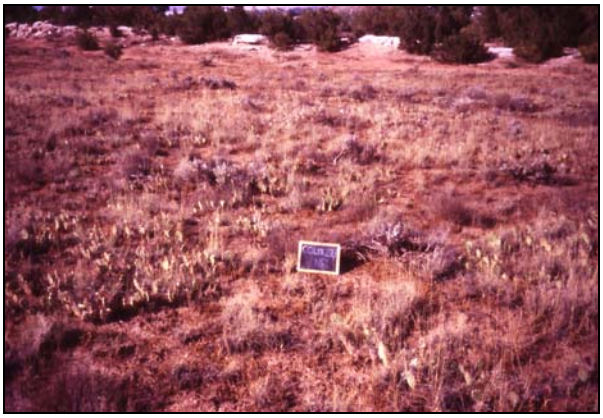



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2b) Dwarf-shrublands dominated by woody dwarf- or mat-forming shrubs of the genera *Artemisia*, *Atriplex*, *Krascheninnikovia*, or *Mahonia* (3)

3a) Uncommon low shrub association with high cover of *Mahonia repens* (creeping, evergreens with holly-like leaves) — ***Mahonia repens* Shrubland (Creeping Oregon-grape Shrubland)** [Map Unit = point]



Photo credit: e²M

3b) Uncommon to common dwarf-shrublands with sparse to moderate cover of woody or mat-forming shrubs (but not creeping or rhizomatous) (4)

4a) Uncommon dwarf-shrublands on shale substrates characterized by sparse cover of the mat-forming dwarf shrub *Atriplex gardneri* and the graminoid *Pleuraphis jamesii* — ***Atriplex gardneri* / *Pleuraphis jamesii* Dwarf-shrubland (Gardner's Saltbush / James' Galleta Dwarf-shrubland)** [Map Unit # 13]



Photo credit: e²M

4b) Uncommon to common dwarf-shrublands on a variety of substrates characterized by sparse to moderate cover of upright plants in the genera *Artemisia* and *Krascheninnikovia* (5)

5a) Dwarf-shrublands dominated by *Artemisia nova* or *Artemisia frigida* (6)

5b) Uncommon dwarf-shrublands exhibiting sparse cover (<10%) of *Krascheninnikovia lanata*, usually with the grasses *Pleuraphis jamesii* and *Sporobolus cryptandrus* present — ***Krascheninnikovia lanata* / *Pleuraphis jamesii* Dwarf-shrubland (Winter-fat / James' Galleta Dwarf-shrubland)** [Map Unit # 23]



Photo credit: e²M

6a) Sites on deep upland soils disturbed by prairie dogs, in which the dominant species are *Artemisia frigida* and *Heterotheca villosa.* Other species commonly present include *Artemisia tridentata* ssp. *wyomingensis, Ericameria nauseosa* and *Lupinus argenteus* - ***Artemisia frigida / Heterotheca villosa*** **Dwarf-shrubland (Prairie Sagebrush / Hairy False Golden-aster Dwarf-shrubland)** [Map Unit = point]


Photo credit: e²M

6b) Common dwarf-shrublands characterized by sparse to moderate cover of *Artemisia nova*; may have significant cover contributed by *Leymus salinus* (7)

7a) Dwarf-shrublands dominated by *Artemisia* nova with a variety of sparse co-occurring species; *Leymus salinus* may be present but is never very abundant — ***Artemisia nova*** **Shrubland (Black Sagebrush Shrubland)** [Map Unit # 4]




Photo credits: e²M

7b) Sparsely vegetated dwarf-shrublands dominated by *Artemisia nova* with *Leymus salinus* being the most abundant species in the herbaceous layer — ***Artemisia nova* / *Leymus salinus* Shrub Herbaceous Vegetation (Black Sagebrush / Salinas Lyme Grass Shrub Herbaceous Vegetation)** [Map Unit # 4]




Photo credits: e²M

8a) Shrublands typically of short to moderate stature (0.5 - 1.5 m tall); plants growing predominantly on drier sites in talus/rock fall deposits, bedrock cracks, eolian sand, alluvial fans, valley fill deposits or washes draining alluvial fans; total cover ranges from sparse to dense for species of Arctostaphylos, Artemisia, Atriplex, Cercocarpus, Ericameria, Fendlera, and Sarcobatus (9)

8b) Shrublands typically of moderate to tall stature (1.0 - 5.0 m tall); plants growing predominantly in mesic sites in talus/rock fall deposits, rock outcrops, and ledges, alcoves, valley fill deposits, and washes draining alluvial fans; total cover ranges from sparse to dense for species of *Amelanchier*, *Artemisia*, *Betula*, *Cercocarpus*, *Quercus*, *Rhus*, and *Salix* (25)

9a) Shrublands growing mostly on sandy soils derived from eolian deposits, alluvium, sheet wash deposits or in moderate to large washes, dominated by the genera *Artemisia* or *Ericameria* (10)

9b) Shrublands growing predominantly on talus or rock fall slopes, bedrock exposures, alluvial fans or valley fill, characterized by the genera *Arctostaphylos*, *Artemisia*, *Atriplex*, *Cercocarpus*, *Fendlera*, and *Sarcobatus* (17)

10a) Sparse, patchy shrublands dominated by *Ericameria nauseosa*, typically growing in the channels or on the banks and point bars of moderate to large washes. Other shrubs may be present in low cover, and grasses can be relatively diverse. — ***Ericameria nauseosa* Desert Wash Shrubland (Rubber Rabbitbrush Desert Wash Shrubland)** [Map Unit # 17]




Photo credits: e²M

10b) Shrublands dominated by species of *Artemisia* on eolian sands, alluvial terraces or sheet wash deposits (11)

11a) Shrublands of sparse to dense *Artemisia tridentata* (ssp. *tridentata* or ssp. *wyomingensis*) with understory dominated by exotic graminoids and weedy annual forbs, particularly grasses of the genera *Agropyron* or *Bromus* (12)

11b) Shrublands of sparse to dense *Artemisia tridentata* ssp. *wyomingensis* co - dominated by *Atriplex confertifolia* or with understory dominated by the native graminoid genera *Hesperostipa*, *Pleuraphis*, or *Poa* (14)

12a) Shrublands of moderate to dense *Artemisia tridentata* ssp. *tridentata* disturbed by fire or grazing, with an understory dominated by the exotic annual *Bromus tectorum* — ***Artemisia tridentata* ssp. *tridentata* - (*Ericameria nauseosa*) / *Bromus tectorum* Semi-natural Shrubland (Basin Big Sagebrush - Rubber Rabbitbrush / Cheatgrass Semi-natural Shrubland)** [Map Unit # 5]




Photo credits: e²M

12b) Shrublands of sparse to dense *Artemisia tridentata* ssp. *wyomingensis* disturbed by chaining and/or interseeding of exotic grasses (13)

13a) Shrublands of sparse to dense *Artemisia tridentata* ssp. *wyomingensis* disturbed by chaining or interseeding and grazing with an understory dominated by the exotic perennial bunchgrass *Agropyron cristatum* — ***Artemisia tridentata* ssp. *wyomingensis* / (*Agropyron cristatum, Elymus junceus*) Seeded Grasses Semi-natural Shrubland (Wyoming Big Sagebrush / Crested Wheatgrass, Russian Wild Rye Seeded Grasses Semi-natural Shrubland)** [Map Unit # 7]

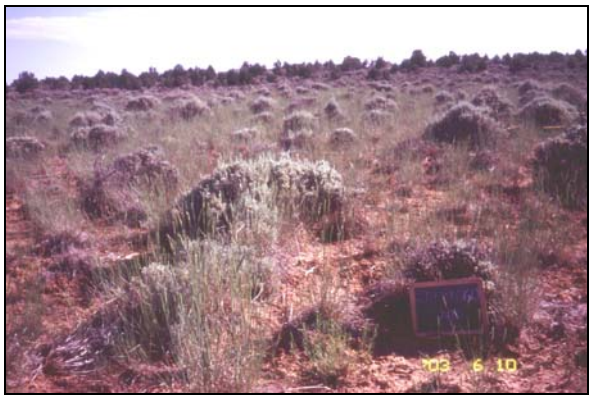



Photo credits: e²M

13b) Shrublands of sparse to dense *Artemisia tridentata* ssp. *wyomingensis* with a disturbed understory, mostly of weedy annual species, including *Bromus*. *Agropyron cristatum* may be present but is not dominant, and native grasses have <10% cover — ***Artemisia tridentata* ssp. *wyomingensis* / Disturbed Understory Semi-natural Shrubland (Wyoming Big Sagebrush / Disturbed Understory Semi-natural Shrubland)** [Map Unit # 8]




Photo credits: e²M

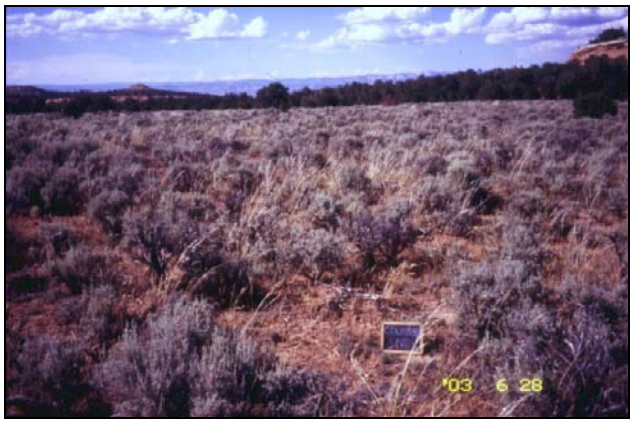
14a) Uncommon shrublands co-dominated by *Artemisia tridentata* ssp. *wyomingensis* and *Atriplex confertifolia* — ***Artemisia tridentata* ssp. *wyomingensis* – *Atriplex confertifolia* Shrubland (Wyoming Big Sagebrush – Shadscale Shrubland)** [Map Unit # 8]



Photo credit: e²M

14b) Shrublands of *Artemisia tridentata* ssp. *wyomingensis* with an understory dominated by native grasses of the genera *Hesperostipa*, *Poa*, and/or *Pleuraphis* (15)

15a) Shrublands of *Artemisia tridentata* ssp. *wyomingensis* with understory containing by at least 3% cover of the native bunchgrasses *Hesperostipa comata. Poa fendleriana* is often present to co-dominant. If present, *Pleuraphis jamesii* or *Bromus tectorum* have less cover than the first two. — ***Artemisia tridentata* ssp. *wyomingensis* / *Hesperostipa comata* Colorado Plateau Shubland (Wyoming Big Sagebrush / Needle-and-thread Colorado Plateau Shrubland)** [Map Unit # 8]



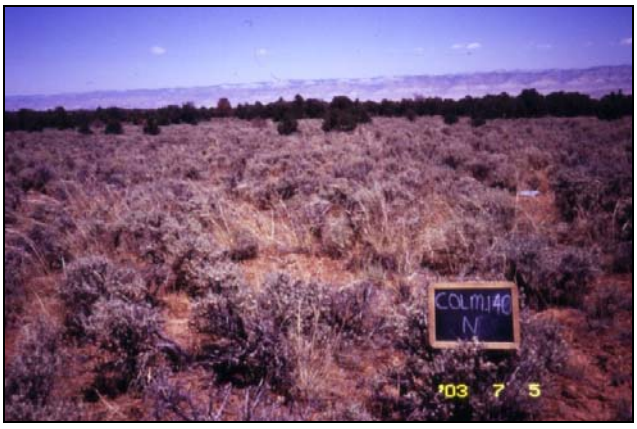


Photo credits: e²M

15b) Shrublands of *Artemisia tridentata* ssp. *wyomingensis* with an understory dominated by native species of *Poa*, and/or *Pleuraphis* (16)

16a) *Artemisia tridentata* ssp. *wyomingensis* shrublands with at least 10% cover of the native grass *Pleuraphis jamesii*. Other grasses, if present, have much less cover — ***Artemisia tridentata* ssp. *wyomingensis* / *Pleuraphis jamesii* Shrubland (Wyoming Big Sagebrush / James' Galleta Shrubland)** [Map Unit # 8]

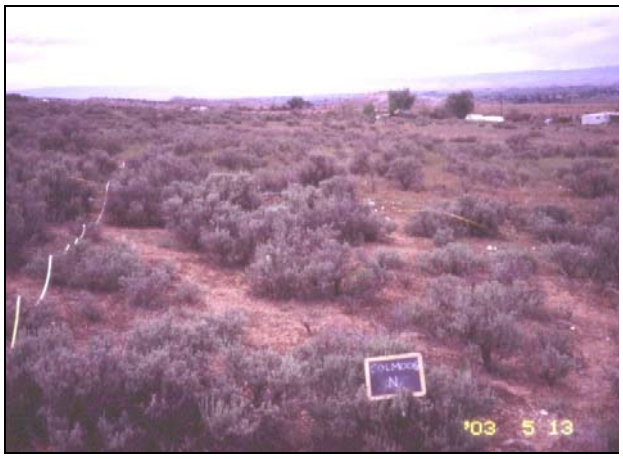




Photo creditse²M

16b) *Artemisia tridentata* ssp. *wyomingensis* shrublands with a sparse herbaceous understory which is dominated by the native grass *Poa fendleriana* — ***Artemisia tridentata* ssp. *wyomingensis* / *Poa fendleriana* Shrubland (Wyoming Big Sagebrush / Muttongrass Shrubland)** [Map Unit # 8]


Photo credit: e²M

17a) Shrublands growing on talus or rock fall slopes or on bedrock exposures, dominated by the genera *Arctostaphylos*, *Atriplex*, *Cercocarpus*, or *Fendlera* (18)

17b) Shrublands growing on alluvial fans or valley fill deposits and dominated by the genera *Atriplex* or *Sarcobatus*. *Artemisia* may be a co-dominant (21)

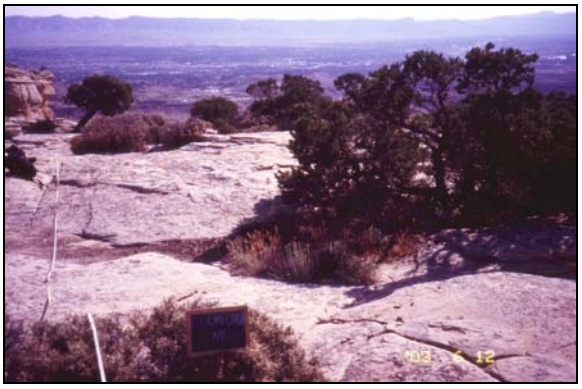
18a) Uncommon shrubland with dense (greater than 80%) cover by *Arctostaphylos patula*, growing on talus slopes with drainage from a bedrock slab — ***Arctostaphylos patula* Shrubland (Greenleaf Manzanita Shrubland)** [Map Unit # 3]



Photo credit: e²M

18b) Shrublands with sparse to moderate cover often growing on exposed slickrock or on shale slopes covered by sandstone talus, dominated by the genera *Atriplex*, *Cercocarpus*, or *Fendlera* (19)

19a) Shrublands with a sparse to moderate shrub canopy, characterized by *Cercocarpus intricatus* growing on exposed Kayenta Formation bedrock. If present, trees such as *Pinus edulis* and *Juniperus osteosperma* have <5% cover. Many other shrubs can be present but with low cover — ***Cercocarpus intricatus* Slickrock Sparse Vegetation (Littleleaf Mountain-mahogany Slickrock Sparse Vegetation)** [Map Unit # 16]



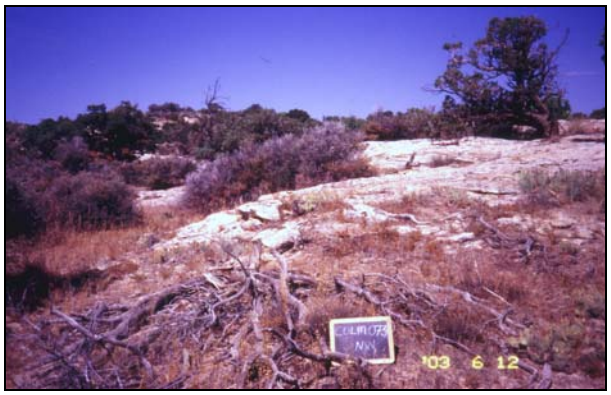


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19b) Shrublands with sparse cover, growing on talus or rock fall slopes, in which *Fendlera rupicola* or *Atriplex canescens* are conspicuous (20)

20a) Sparse shrublands growing on shale slopes mostly covered by sandstone talus and dominated by *Atriplex canescens* with species of *Ephedra* — ***Atriplex canescens* - *Ephedra viridis* Talus Shrubland (Fourwing Saltbush - Mormon Tea Talus Shrubland)** [Map Unit # 9]



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20b) Sparse shrublands on cool talus slopes dominated by *Fendlera rupicola* — ***Fendlera rupicola* Talus Shrubland (Fendlerbush Talus Shrub)** [Map Unit = point]

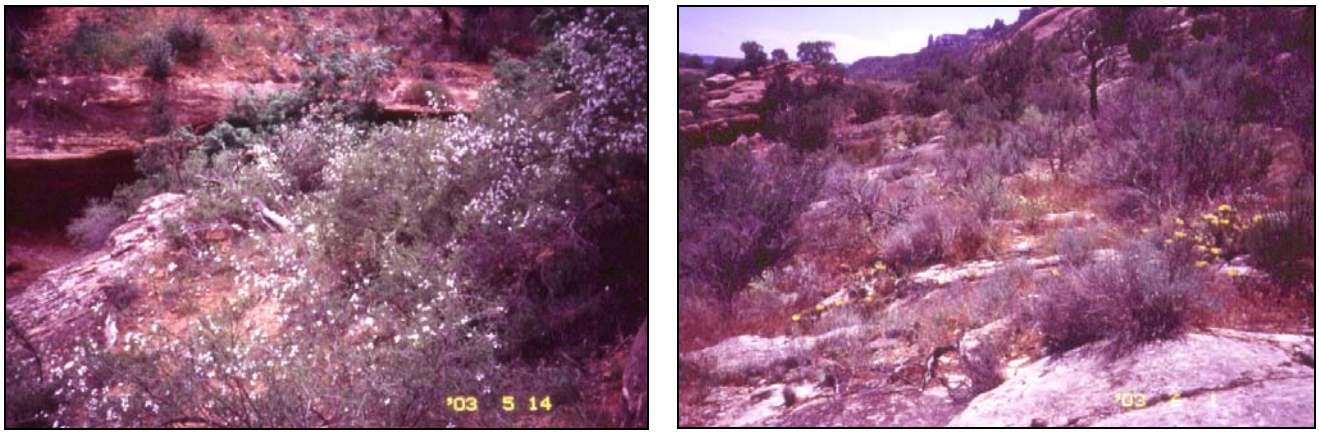


Photo credits: e²M

21a) Shrublands dominated by the low, rounded shrub *Atriplex confertifolia*, sometimes with sparse *Sarcobatus vermiculatus;* a native grass understory may or may not be present (22)

21b) Sparse shrublands dominated by *Atriplex canescens* and/or *Sarcobatus vermiculatus* (23)

22a) Shrublands of *Atriplex confertifolia* co-dominated by *Sarcobatus vermiculatus;* cacti in the genus *Opuntia* are common in the understory — ***Atriplex confertifolia – Sarcobatus vermiculatus* Shrubland (Shadscale – Black Greasewood Shrubland)** [Map Unit # 12]





Photo credits: e²M

22b) Shrublands, sometimes sparse (<5%), of *Atriplex confertifolia* with an understory dominated by the perennial grass *Pleuraphis jamesii* — ***Atriplex confertifolia* / *Pleuraphis jamesii* Shrubland (Shadscale / James' Galleta Shrubland)** [Map Unit # 4]





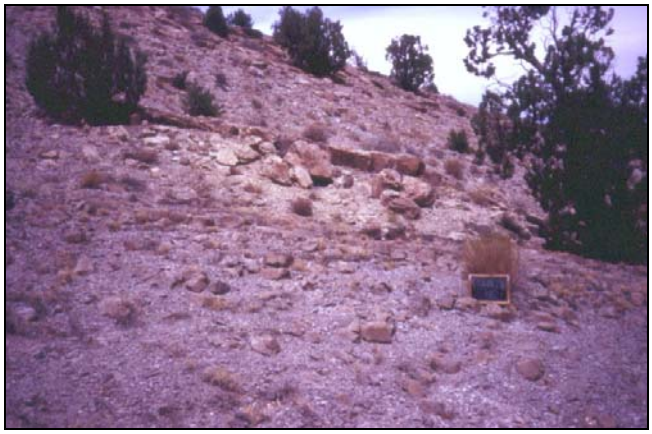



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23a) Sparse shrublands on valley bottoms of *Atriplex canescens* and the grasses *Bromus tectorum*, *Pleuraphis jamesii*, and *Sporobolus cryptandrus.* Overall understory composition is weedy and disturbed — ***Atriplex canescens*** **Shrubland (Fourwing Saltbush Shrubland)** [Map Unit # 10]



Photo creditse²M

23b) Shrublands on valley floors with sparse to moderate cover, dominated by *Sarcobatus vermiculatus*, sometimes in association with subspecies of *Artemisia tridentata* (24)

24a) Uncommon shrublands growing on eolian sand, sheet wash deposits or valley fill, co-dominated by *Sarcobatus vermiculatus* and *Artemisia tridentata* ssp. *wyomingensis* — ***Sarcobatus vermiculatus – Artemisia tridentata*** **Shrubland (Black Greasewood – Big Sagebrush Shrubland)** [Map Unit = point]



Photo credit: e²M

24b) Shrublands growing on alluvial fans, characterized by *Sarcobatus vermiculatus* shrubs of low stature. *Artemisia tridentata* ssp. *wyomingensis* is absent or has very low cover. Species of *Opuntia* can be co-dominant — ***Sarcobatus vermiculatus*** **Disturbed Shrubland (Black Greasewood Disturbed Shrubland)** [Map Unit # 12]



Photo credit: e²M

25a) Tall shrublands associated with seeps, springs, or moist drainages. Characteristic species are the tall shrubs Salix or Betula (26)

25b) Tall shrublands growing in or adjacent to washes, or on rock outcrops or talus/rock fall slopes, in alcoves and on dry to mesic valley fill deposits. Characteristic species are *Quercus gambelii, Artemisia tridentata* ssp. *tridentata, Amelanchier utahensis, Cercocarpus montanus,* or *Rhus trilobata* (27)

26a) Tall shrublands dominated by tree-like shrubs of *Betula occidentalis* — ***Betula occidentalis* / *Maianthemum stellatum* Shrubland (Water Birch / Starflower False Solomon's – seal Shrubland)** [Map Unit # 14]



Photo credit: e²M

26b) Tall shrublands dominated by slender shrubs of *Salix exigua.* If *Populus* spp. or *Juniperus osteosperma* are present, their cover is <10%. — ***Salix exigua* / Mesic Graminoids Shrubland (Coyote Willow / Mesic Graminoids Shrubland)** [Map Unit # 37]



Photo credit: e²M

27a) Tall shrublands of valley floors or intermittent washes, dominated by *Artemisia tridentata* ssp. *tridentata* with an understory of the native perennial bunchgrass *Sporobolus airoides*— ***Artemisia tridentata* ssp. *tridentata* / *Sporobolus airoides* Shrubland (Basin Big Sagebrush / Alkali Sacaton Shrubland)** [Map Unit = point]



Photo credits: e²M

27b) Tall shrublands growing on rock outcrops and talus/rock fall slopes, in alcoves, and on mesic valley fill deposits, dominated by *Amelanchier utahensis*, *Cercocarpus montanus*, *Quercus gambelii*, or *Rhus trilobata* (28)

28a) Tall shrublands predominantly growing on rock outcrops, ledges talus/rock fall slopes, or shale soils, dominated by Amelanchier utahensis or Cercocarpus montanus (29)

28b) Tall shrublands growing predominantly in alcoves and on mesic valley fill deposits, dominated by *Quercus gambelii* or *Rhus trilobata* (30)

29a) Tall shrublands with sparse to dense cover, growing on ledges, talus/rock fall slopes, and exposed Chinle shale, characterized by *Amelanchier utahensis. Cercocarpus montanus* is not present) — ***Amelanchier utahensis* Shrubland (Utah Serviceberry Shrubland)** [Map Unit # 2]



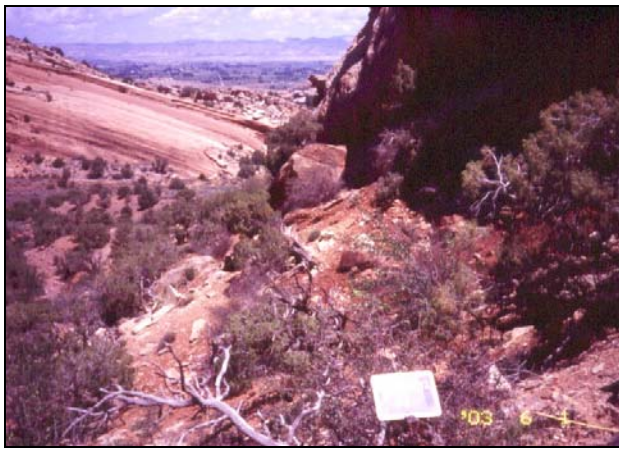


Photo credits: e²M

29b) Tall shrublands with sparse to dense cover, growing on talus or rock fall slopes, with *Amelanchier utahensis* and *Cercocarpus montanus* present or co-dominant in the stand. Most stands have low cover of *Pinus edulis* and/or *Juniperus osteosperma* — ***Amelanchier (utahensis, alnifolia) – Cercocarpus montanus* Shrubland (Utah, Alderleaf Serviceberry – Mountain-mahogany Shrubland)** [Map Unit # 2]





Photo credits: e²M

30a) Tall shrublands with dense cover, typically resembling a woodland in stature, growing on talus/rock fall slopes, valley fill deposits, or in alcoves, dominated by *Quercus gambelii* with occasional *Rhus trilobata* shrubs in the understory — ***Quercus gambelii* / *Rhus trilobata* Shrubland (Gambel Oak / Skunkbush Shrubland)** [Map Unit # 30]

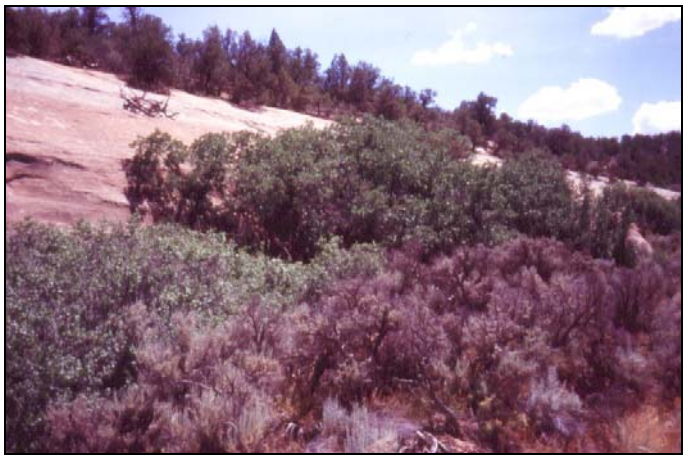




Photo credits: e²M

30b) Tall shrublands with dense cover, growing in alcoves or the margins of floodplains, and characterized by *Rhus trilobata. Quercus gambelii* is absent — ***Rhus trilobata*** **Intermittently Flooded Shrubland (Skunkbush Intermittently Flooded Shrubland)** [Map Unit = point]



Photo credit: e²M

KEY IV
A KEY TO THE HERBACEOUS AND SPARSELY VEGETATED ASSOCIATIONS OF COLM

Please note that herbaceous-dominated associations may have up to 5% cover by woody trees or shrubs.

1a) Herbaceous associations of perennially or intermittently moist soils, found within drainages or in alcoves on canyon walls, usually densely vegetated. Dominants include *Juncus balticus, Aquilegia micrantha, Equisetum laevigatum, Pascopyrum smithii, Sporobolus airoides,* or *Hordeum jubatum* (2)

1b) Herbaceous and non-vascular associations, sometimes sparsely vegetated, of upland habitats, dominated by *Achnatherum hymenoides, Agropyron cristatum, Bromus tectorum, Hesperostipa comata, Leymus salinus, Pascopyrum smithii, Pleuraphis jamesii,* or *Eriogonum lonchophyllum* (7)

2a) Mesic graminoid or fern-ally associations of valley floors, floodplains and drainage bottoms; dominant species include *Juncus balticus, Equisetum laevigatum, Pascopyrum smithii, Sporobolus airoides,* or *Hordeum jubatum* (3)

2b) Mesic herbaceous communities of wet, seepy alcoves in cliffs or canyon walls, in which *Aquilegia micrantha* is a conspicuous member. Shrubs and pinyon and juniper trees often occur around the margins of the seep community - ***Aquilegia micrantha*** **Herbaceous Vegetation (Mancos Columbine Herbaceous Vegetation)** [Map Unit = point]

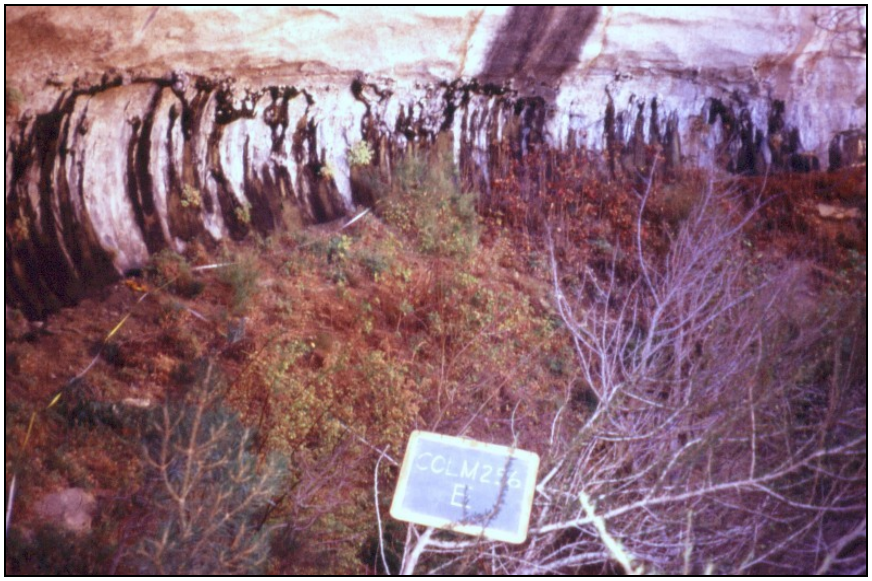


Photo credit: e²M

3a) Vegetation dominated by the rush *Juncus balticus.* Other grasses present may include *Poa pratensis, Bromus tectorum,* or *Distichlis spicata*. — ***Juncus balticus*** **Herbaceous Vegetation (Baltic Rush Herbaceous Vegetation)** [Map Unit # 18]



Photo creditse²M

3b) Mesic graminoid or fern-ally associations of valley floors, floodplains and drainage bottoms; dominant species include *Equisetum laevigatum, Pascopyrum smithii, Sporobolus airoides*, or *Hordeum jubatum* (4)

4a) Vegetation of drainages and wash terraces dominated by *Sporobolus airoides.* Annual bromes, *Hordeum jubatum, Juncus balticus* and *Muhlenbergia asperifolia* may be present but typically have less cover than the *Sporobolus*. — ***Sporobolus airoides*** **Southern Plains Herbaceous Vegetation (Alkali Sacaton Southern Plains Herbaceous Vegetation)** [Map Unit = point]


Photo credit: e²M

4b) Mesic graminoid or fern-ally associations of valley floors, floodplains and drainage bottoms; dominant species include *Equisetum laevigatum, Pascopyrum smithii*, or *Hordeum jubatum* (5)

5a) Vegetation typically growing in palustrine zones, around stock ponds, ditches, or canals and dominated by *Hordeum jubatum* — ***Hordeum jubatum*** **Herbaceous Vegetation (Foxtail Barley Herbaceous Vegetation)** [Map Unit = point]



Photo credit: e²M

5b) Mesic graminoid or fern-ally associations of valley floors, floodplains and drainage bottoms; dominant species include *Equisetum laevigatum* or *Pascopyrum smithii* (6)

6a) Vegetation of natural drainages dominated by *Pascopyrum smithii.* Annual bromes or *Poa pratensis* can also be present. — ***Pascopyrum smithii*** **Herbaceous Vegetation (Western Wheatgrass Herbaceous Vegetation)** [Map Unit = point]



6b) Vegetation of mesic areas in drainages dominated by the fern ally *Equisetum laevigatum.* Scattered seedling or small sapling of shrubs (*Salix, Tamarix, Ericameria*) or trees (*Populus, Juniperus*) may be present with <10% total cover — ***Equisetum laevigatum*** **Herbaceous Vegetation (Smooth Horsetail Herbaceous Vegetation)** [Map Unit = point]




Photo credits: e²M

7a) Upland herbaceous associations dominated by the exotic grass species *Bromus tectorum* or *Agropyron cristatum* (8)

7b) Upland herbaceous associations dominated native grass species (including *Achnatherum hymenoides, Hesperostipa comata, Leymus salinus,* or *Pleuraphis jamesii*) with sparse to moderate cover; exotic grass species may be present (10)

8a) Site dominated by exotic annual *Bromus tectorum* with moderate to high cover, sometimes in association with scattered plants of the native bunch grass *Achnatherum hymenoides* (9)

8b) Site dominated by the exotic perennial bunchgrass *Agropyron cristatum* with moderate to high cover and usually in association with sparse (<5% cover) *Artemisia* shrubs and/or regenerating *Pinus edulis* and *Juniperus osteosperma* trees with less than 5% cover. Nearly pure stands of *Agropyron cristatum*, without shrub cover, occur on private lands in the environs adjacent to the monument — ***Agropyron cristatum*** **Semi-natural Herbaceous Alliance (Crested Wheatgrass Semi-natural Herbaceous Alliance)** [Map Unit # 31]

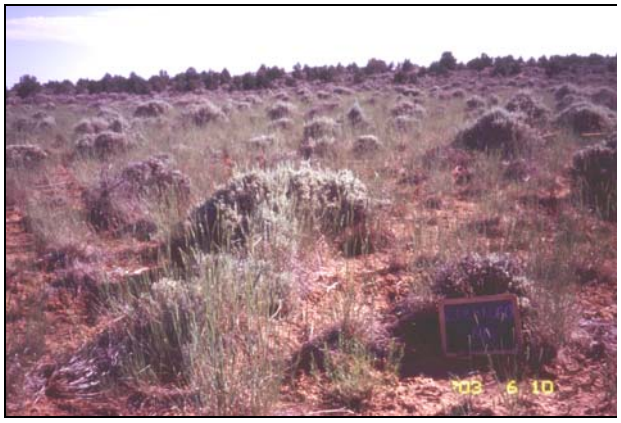



Photo credits: e²M

9a) Sites with sparse to moderate cover of *Achnatherum hymenoides;* in most years the highest cover is by *Bromus tectorum*. Sites typically have been severely disturbed and include artificial fill, severely grazed areas, and roadsides — ***Achnatherum hymenoides - Bromus tectorum*** **Herbaceous Vegetation (Indian Ricegrass – Cheatgrass Herbaceous Vegetation)** [Map Unit = point]




Photo credits: e²M

9b) Sites essentially a monoculture of *Bromus tectorum*; shrubs typically have <5% cover — ***Bromus tectorum*** **Semi-natural Herbaceous Vegetation (Cheatgrass Semi-natural Herbaceous Vegetation)** [Map Unit # 15]




Photo credits: e²M

10a) Associations, sometimes sparsely vegetated, dominated by the low forb *Eriogonum lonchophyllum* or consisting of non-vascular plants (lichens and mosses) growing directly on slickrock (11)

10b) Upland grasslands dominated by *Achnatherum hymenoides, Hesperostipa comata, Leymus salinus,* or *Pleuraphis jamesii* (12)

11a) Sites on exposed bedrock (Board Beds Unit of the Entrada Sandstone Formation), dominated by non-vascular species, including mosses and lichens. Vascular species absent or extremely sparse — **Non-vascular Cover - Board Beds Unit, Entrada Sandstone** [Map Unit # 34]



Photo credit: e²M

11b) Vegetation sparse but dominated by *Eriogonum lonchophyllum* growing on ridges with a gravelly or rocky substrate — ***Eriogonum lonchophyllum* Sparse Herbaceous Vegetation (Spearleaf Buckwheat Sparse Herbaceous Vegetation)** [Map Unit = point]



Photo credit: e²M

12a) North-facing slopes of Morrison Formation shales supporting a sparse grassland visually dominated by the bunchgrass *Leymus salinus*, usually with sparse shrub cover (<10% cover of shrubs or juniper) — ***Leymus salinus* Shale Sparse Vegetation (Salinas Lyme Grass Shale Sparse Vegetation)** [Map Unit # 4]






Photo credits: e²M

12b) Upland grasslands on a variety of substrates and aspects, dominated by *Hesperostipa comata* and/or *Pleuraphis jamesii* (13)

13a) Upland grasslands dominated by *Pleuraphis jamesii*, sometimes with up to 5% cover by shrubs such as *Atriplex confertifolia, Echinocereus triglochidiatus, Leptodactylon pungens, Opuntia* spp., *Suaeda calceoliformis, Atriplex canescens, Atriplex confertifolia, Ephedra viridis,* or *Krascheninnikovia lanata* — ***Pleuraphis jamesii*** **Herbaceous Vegetation (James' Galleta Herbaceous Vegetation)** [Map Unit # 4]




13b) Vegetation of dry uplands or wash terraces dominated by *Hesperostipa comata.* Shrubs are present in most stands with up to 10% cover; *Pleuraphis jamesii* is always present or even co-dominant, but *Hesperostipa* is the indicator of this association. — ***Hesperostipa comata* Great Basin Herbaceous Vegetation (Needle-and-Thread Great Basin Herbaceous Vegetation)** [Map Unit = point]





Photo credit: e²M

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Pinus edulis – Juniperus (monosperma, osteosperma) / Hesperostipa comata Woodland 425
Pinus edulis - Juniperus osteosperma / *Amelanchier utahensis* Woodland 424
Pinus edulis - Juniperus osteosperma / *Artemisia bigelovii* Woodland 420
Pinus edulis - Juniperus osteosperma / *Artemisia nova* Woodland 421
Pinus edulis - Juniperus osteosperma / *Cercocarpus intricatus* Woodland 424
Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland 422
Pinus edulis - Juniperus osteosperma / *Petradoria pumila* Woodland 427
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland 426
Pinus edulis - Juniperus spp. / *Artemisia tridentata* (ssp. *wyomingensis*, ssp. *vaseyana*) Woodland 419
Pinus edulis - Juniperus spp. / *Cercocarpus montanus* –Mixed Shrub Woodland 423
Pinus edulis - Juniperus spp. / *Leymus salinus* Woodland 426
Pleuraphis jamesii Herbaceous Vegetation 450
Populus deltoides (ssp. *wislizeni*, ssp. *monilifera*) / *Salix exigua* Forest 415
Populus tremuloides / Betula occidentalis Forest 414
Populus tremuloides / *Prunus virginiana* Forest 415
Prairie Sagebrush / Hairy False Golden-aster Dwarf-shrubland 430
Pseudotsuga menziesii / *Quercus gambelii* Forest 418
Quaking Aspen / Chokecherry Forest 415
Quaking Aspen / Water Birch Forest 414
Quercus gambelii / *Rhus trilobata* Shrubland 417, 442
Rhus trilobata Intermittently Flooded Shrubland 443

Rubber Rabbitbrush Desert Wash Shrubland 432
Salinas Lyme Grass Shale Sparse Vegetation 449
Salix exigua / Mesic Graminoids Shrubland 440
Sarcobatus vermiculatus – Artemisia tridentata Shrubland 439
Sarcobatus vermiculatus Shrubland 439
Shadscale – Black Greasewood Shrubland 437
Shadscale / James' Galleta Shrubland 438
Single-leaf Ash Woodland 417
Smooth Horsetail Herbaceous Vegetation 447
Spearleaf Buckwheat Sparse Herbaceous Vegetation 449
Sporobolus airoides Southern Plains Herbaceous Vegetation 445
Two-needle Pinyon - Juniper / Mountain-mahogany Mixed Shrub Woodland 423
Two-needle pinyon – Juniper / Needle-and-Thread Grass Woodland 425
Two-needle Pinyon - Juniper / Salinas Lyme Grass Woodland 426
Two-needle Pinyon - Juniper / Wyoming, Mountain Big Sagebrush Woodland 419
Two-needle Pinyon - Utah Juniper / Bigelow (Flat) Sagebrush Woodland 420
Two-needle Pinyon - Utah Juniper / Black Sagebrush Woodland 421
Two-needle Pinyon - Utah Juniper / Grassy Rock goldenrod Woodland 427
Two-needle Pinyon - Utah Juniper / Little-leaf Mountain-mahogany Woodland 424
Two-needle Pinyon - Utah Juniper / Sparse Understory Woodland 426
Two-needle Pinyon - Utah Juniper / Utah Serviceberry Woodland 424
Two-needle Pinyon - Utah Juniper Mixed Shrubs Talus Woodland 422
Utah Juniper / Mountain-mahogany Woodland 423
Utah Juniper / Needle-and-Thread Grass Woodland 425
Utah Juniper / Wyoming Big Sagebrush Woodland 419
Utah Juniper Mixed Shrubs Talus Woodland 421
Utah Serviceberry Shrubland 442
Utah, Alderleaf Serviceberry – Mountain-mahogany Shrubland 442
Water Birch / Starflower False Solomon's – seal Shrubland 440
Western Wheatgrass Herbaceous Vegetation 446
Winter-fat / James' Galleta Dwarf-shrubland 429
Wyoming Big Sagebrush – Shadscale Shrubland 433
Wyoming Big Sagebrush / Crested Wheatgrass, Russian Wild Rye Seeded Grasses Semi-natural Shrubland 433
Wyoming Big Sagebrush / Disturbed Understory Semi-natural Shrubland 433
Wyoming Big Sagebrush / James' Galleta Shrubland 434
Wyoming Big Sagebrush / Muttongrass Shrubland 435
Wyoming Big Sagebrush / Needle-and-thread Colorado Plateau Shrubland 434

Appendix H

Modified Anderson Land Use-Land Cover Classification

This classification was used to attribute polygons in the environs mapped around Colorado National Monument.

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				
	3.4 Flats				
	3.5 Disposal				

Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
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	4.22211 Rice Fields
			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)

1.15 Bay/estuary - the inlets or arms of the sea that extend inland

1.16 Sea/ocean - an area of the great body of salt water that covers much of the earth

1.2 Perennial Ice/Snow - areas covered year-round with snow and ice

1.21 Snowfield - permanent snow not underlain by a glacier

1.22 Glacier - a body of ice and snow, showing evidence of past or present flow

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.

2.221 Petro-chemical Refinery - structures and all associated equipment and grounds used for processing petro-chemicals. Include associated waste ponds.

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.

2.261 Airport - Includes the maintained active and overrun areas of the runways, landing strips, and taxiways, with the intervening land; along with the plane tie-down areas, terminals, hangers, related fuel storage facilities, service buildings, parking lots, navigation aids, and airport offices. Rental car lots integrated with the airport should be included with the airport.

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 loose 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, creosote, 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

4.132 Citrus - trees or shrubs cultivated in orchards or groves that bear edible fruit such as orange, lemon, lime, grapefruit, and pineapple.

4.133 Non-managed Citrus - orchards or groves containing fruit bearing trees or shrubs that are no longer maintained or harvested by humans. Evidence of non-managed citrus includes the growth of non-citrus shrubs, trees, and grasses within a orchard or grove.

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.

4.2221 Irrigated Small Grains - areas used for the production of small grain crops where a visible irrigation system is in place to supply water including the flooding of entire fields.

4.22211 Rice Fields - a cereal grass cultivated extensively in warm climates and used as a staple food. Rice is grown on submerged land in coastal plains, tidal deltas, and river basins of tropical, semi-tropical, semi-tropical, and temperate regions of Louisiana, Texas, California, Missouri, Arkansas, and Mississippi. The fields are characterized by a slope of less than .5% and have many dikes that meander parallel to the contours of the land surface. The dikes, that are the most significant characteristic of the rice fields, may be small in height and are used to hold water. At times, the rice fields may be covered in water.

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

4.2232 Sugar Cane - a very tall tropical grass up to 15 feet high with thick tough stems that is cultivated as the main source of sugar. It can be found in tropical and sub-tropical areas of the United States such as Louisiana, Florida, Hawaii, and Texas.

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 open bogs.

Appendix I

Criteria for Map Classes Delineated by GIS Modeling Techniques

The table below shows the matrix created for the 17 map classes that were modeled using GIS.

Map Class Code and Abbreviation	Elevation Zone	Geology[1]	Slope	Aspect	Physiognomic Class[2]	*Comments*
WOODLAND MAP CLASSES						
19 - pj_artrw	lowlands	Jms, Jk, Qse	all	all	3,4,10,11	
	canyons	Qvf, Xm, Qc	all	all	3,4,10,11	Only in Monument Canyon, lower No Thoroughfare Canyon, and lower and middle Ute Canyon
	canyons	Jms, Qe, Qse	all	all	3,4,10,11	
	above rim	Qe, Qse	all	all	3,4,10,11	
20 - pj_multi	canyons	Jk, Jeb, Jes	all	all	3,4,10,11	
	canyons	Qr, Qlso, TRc, Jmt, Jwg	0-48%	North	3,4,10,11	
	canyons and above rim	Qr, Qlso, Jmt, TRc, Jwg	16-100%	North (355-360 and 0-18 deg)	3,4	
	above rim	Jmt, Jmb, Kb, Kd	15-100%	all	3,4,10,11	Only in south and northwest parts of the project area
	above rim	Jw, Jeb	all	North	3,4,7,10,11	
	above rim	Jk	15-100%	North	3,4,7,10,11	All areas, except on the northwest extension of Monument Mesa, west of Gold Star Canyon
	above rim	Jms, Qc, Jes	15-100%	all	3,4,7,10,11	
	above rim	Jes, Jk	all	all	3,4,7,10,11	Above 1950 meters
	above rim	Jeb	all	North	3,4,7,10,11	Above 1950 meters
	above rim	Jk	all	South	3,4,7,10,11	Below 1950 meters
	above rim	Jk	all	North	3,4,7,10,11	Between 1425-2000 meters, and within 150 meters of the canyon rim
	above rim	all	all	all	3,4,10,11	Only within an area in eastern part of the project area near the East Entrance, delineated with the aid of the ecologists

Map Class Code and Abbreviation	Elevation Zone	Geology[1]	Slope	Aspect	Physiognomic Class[2]	*Comments*
	above rim	Jk	0-5%	North and East (338-360 and 0-158 deg)	all	Between 1600-1705 meters and within 100 meters of the canyon rim
22 - junost_breaks	canyons	Jk, Jes, Qr, Jmt,, Jwg, Jw, Rc,Jeb	all	East, South, West (68-293 deg)	all, except 6 and 8 (bare rock) for Jes, Jwg, Jeb, Jw	
	canyons	Xm, Xi, Qc	all	all	all, except 6 and 8 (bare rock) for Jes, Jwg, Jeb, Jw	All areas, except in Monument Canyon, lower and middle Ute Canyon, and lower No Thoroughfare Canyon
25 - pj_artnov	above rim	Kb, Kd	0-35%	East, South, West (68-293 deg)	3,4,10,11	
	above rim	Jk	0-10%	North and East (293-360 and 0-113 deg)	3,4,10,11	All areas except: 1) northwest part of Black Ridge, 2) southwest and southeast parts of the project area above 2000 meters
	above rim	Qlso	all	all	3,4,10,11	All areas except: 1) northwest part of Black Ridge, 2) southwest and southeast parts of the project area above 2000 meters
	above rim	Jk	all	all	3,4,10,11	Only on the northwest extension of Monument Mesa, west of Gold Star Canyon
	above rim	Jmt	0-10%	all	3,4,10,11	All areas except: 1) northwest part of Black Ridge, 2) southwest and southeast parts of the project area above 2000 meters
28 pj_sparse	above rim	Jms, Jes, Qc	0-15%	all	3,4,10,11	
	above rim	Jmt	0-15%	all	3,4,10,11	Only on the northwest part of Black Ridge
	above rim	Jw, Jeb	all	South	3,4,10,11	
	above rim	Jmb	0-15%	all	3,4,10,11	
	above rim	Jk	all	North and East (300-360 and 0-113 deg)	3,4,10,11	

Map Class Code and Abbreviation	Elevation Zone	Geology[1]	Slope	Aspect	Physiognomic Class[2]	*Comments*
SHRUBLAND MAP CLASSES						
2 - ameuta	canyons and above rim	Jwg	48-100%	North (293-360 and 0-68 deg)	3,4,5,7,10,11	
	canyons and above rim	Qr, TRc	48-100%	North (293-360 and 0-68 deg)	3,4,5,6,7,8,10, 11	
5 - arttri_brotec	canyons	Qvf	all	all	7,10,11	Only in upper No Thoroughfare Canyon and upper and middle Ute Canyon
8 - artrw_multi	lowlands	Jeb, Jes, Jk, Jmb, Jms, Jmt, Jw, Jwg, Kb, Qse, af	all	all	3,4,7,10,11	Sreas that are <u>not</u> 12-atrcon_sarver (see 12-atrcon_sarver for criteria)
	canyons	Qvf, Qse, Qlso, Qc, Qe, Xm	all	all	5,6,7,8	0nly in lower No Thoroughfare Canyon, lower and middle Ute Canyon, Monument Canyon and Wedding Canyon
	above rim	Qc, Qe, Qse, Qal, Jk	all	all	5,6,7,8	0nly <u>outside</u> outlined areas which appeared to have been cleared at one time ("managed areas") per photo interpretation. These managed areas are mostly in the southwestern part of the project area.
9 - atrcan_ephvir	lowlands and canyons	Qr, Jk, TRc, Jwg	37-100%	South (113-248 deg)	5,6,7,8	Above 1563 meters
12 - atrcon_sarver	lowlands	Jes, Qal, Qse, Qvf, Qaso	0-31%	North and East (338-360 and 0-158 deg)	7	
16 - cerint	above rim	all	all	all	5,6,8	Only within an area in eastern part of the project area near the East Entrance, delineated with the aid of the ecologists
SHRUBLAND-GRAMINOID MAP CLASSES						
4 - artnov_leysal_plejam	lowlands	Jmb, Qse	all	all	5,6,7,8	
	lowlands	Jmt	all	all	5,6,7,8,10,11	

Map Class Code and Abbreviation	Elevation Zone	Geology[1]	Slope	Aspect	Physiognomic Class[2]	*Comments*
	canyons	Qvf	all	South	5,6,8	Only in lower No Thoroughfare Canyon between 1500-1600 meters
	above rim	Jms, Jmt, Jmb, Kb, Kd, Qlso	0-30%	all	5,6,7,8	All areas except: 1) northwest part of Black Ridge, 2) southwest and southeast parts of the project area above 2000 meters
	above rim	Jeb, Jw	0-30%	all	5,7	All areas except: 1) northwest part of Black Ridge, 2) southwest and southeast parts of the project area above 2000 meters
	above rim	Jk	all	all	5,6,7,8	Only on the northwest extension of Monument Mesa, west of Gold Star Canyon
	above rim	Qc, Jmb	all	all	5,6,8	
	above rim	Jmt, Jw, Jmb	all	all	5,6,8	Only on the northwest part of Black Ridge
NON-VASCULAR MAP CLASSES						
34 - barerock_jeb	above rim	Jeb	all	all	6,8	Only in southeast parts of the project area
OTHER MAP CLASSES						
32 - barerock_jes	all	Jes	all	all	5,6,8	
33 - barerock_jwg	all	Jwg	all	all	6,8	
36 - unveg_jmb	all	Jmb	all	all	6,8	All areas except the northwest part of Black Ridge
41 - barerock_jk	all	Jk	all	all	6,8	

[1]**Geologic** spatial data from NPS COLM.

Af	Artificial fill
Qal	Alluvium
Qvf	Valley-fill deposits
Qaso	Older alluvial-slope deposits
Qlg	Local gravel deposits
Qc	Colluvium
Qr	Rock-fall deposits
Qlso	Old landslide deposits
Qe	Eolian deposits
Qse	Eolian and sheetwash deposits
Qcg	Cienaga deposits
Kd	Dakota Formation

Kb	Burro Canyon Formation
Jmb	Brushy Basin Member of the Morrison Formation
Jms	Salt Wash Member of the Morrison Formation
Jmt	Tidwell Member of the Morrison Formation
Jw	Wanakah Formation
Jeb	"Board beds" unit of the Entrada sandstone
Jes	Slickrock Member of the Entrada sandstone
Jk	Kayenta Formation
Jwg	Wingate sandstone
TRc	Chinle Formation
Xi	Meta-igneous gneiss
Xm	Migmatic meta-sedimentary rocks

[2]Physiognomic Class

1. Shadow Areas (Deep shadows)
2. N/A (This category discarded during analysis)
3. 25–50% Trees (25 – 60% tree coverage density)
4. 60-100% Trees (60 – 100% tree coverage density)
5. Shrubs/Grasses (Mix of shrubs and grasses, with neither as the dominant type. Less than10% trees)
6. Shrubs/Grasses/Sparse (Overall high reflectance areas and less than 10% trees)
7. Shrubs (Areas of predominantly shrubs and not high reflectance areas)
8. Grasses (Areas of predominantly grasses and not high reflectance areas)
9. “Green” (Areas of high green reflectance)
10. 10-25% Trees/Shrubs (10 – 25% tree coverage density with shrub understory)
11. 10-25% Trees/Shrubs/Grasses (10 – 25% tree coverage density with a mixed understory)

Appendix J

Map Class Descriptions for Colorado National Monument

Introduction

This document provides a visual guide and description of the map classes for the Colorado National Monument Vegetation Mapping Project. Twenty-six vegetation, four geology, and 21 land use map classes were delineated and defined as part of the mapping project. One map class (SS,1) is associated with point data documenting springs and seeps and is not included in this guide. The following information is provided for each of the 26 vegetation map classes associated with this project:

- ground photo images for each map class
- link to National Vegetation Classification (NVC) types and ecological system type
- common associated plant species
- visual examples of each map class with aerial photographs and delineated overlays
- descriptions of 'interpretation' for the visual examples
- ecological description
- area report (polygon number, size, area and proportion)
- provide accuracy assessment results for each map class

This key 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 a feel for the imagery and an understanding of the relationships between classification and mapping.

This key presents descriptions and illustrations for most map classes used in the Colorado National Monument Vegetation Mapping Project. Some map classes used only for polygons smaller than the 0.5-hectare minimum mapping unit have been omitted. Each map class description includes the map class name and representative ground photos of the map class. A paragraph describes the link between the map class and the vegetation association(s) within the NVC. A general description is given of the vegetation association(s) represented by the map class.

One or more aerial images illustrate the typical signature(s) of each map class. The images are the natural color orthophotos used in the vegetation mapping, and each image shows the photo interpreter's polygon outlines and the map code of the referenced map class. An accompanying map shows the example's approximate location. Each image is accompanied by a short description of the distinctive photographic signature of the map class. This description includes color(s) and texture(s), and when applicable, the coverage density, pattern, and height of the vegetation. Other information about the map class or the polygon is also presented if it adds to better understanding or recognition of that map class.

Each map class description has an area report and results of the accuracy assessment. The area report includes the number of polygons, hectares, acres, and the average polygon size. Accuracy assessment results for producer's and user's accuracy and the associated confidence intervals are also given.

At the end of the detailed vegetation map class descriptions in this document are general descriptions of geology and land use map classes. Two tiers of land use map classes were used in this project: (1) land use map classes within the primary project mapping area, and (2) land use map classes used only within the environs along northeastern Monument boundary (Figure 19 in main report). Brief descriptions and (in most cases) a ground photo are provided for each geology and land use map class.

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Map Class 19
Two-needle Pinyon Pine – Utah Juniper / Wyoming Big Sagebrush Woodland (W-PJWS)



Photo credit: e²M



Photo credit: e²M

The Two-needle Pinyon Pine – Utah Juniper / Wyoming Big Sagebrush Woodland (W-PJWS, Map Class 19) represents a combination of the *Juniperus osteosperma / Artemisia tridentata* ssp. *wyomingensis* Woodland and the *Pinus edulis* - *Juniperus* spp. */ Artemisia tridentata* (ssp. *wyomingensis,* ssp. *vaseyana*) Woodland

W-PJWS Map Class Specifics:

Frequency	Total Project Polygons = 681
	435 polygons in COLM
	246 polygons in environs
Area	Total Project Area = 1821.4 hectares / 4500.7 acres
	1112.7 hectares / 2749.6 acres in COLM
	708.6 hectares / 1751.1 acres in environs
Average Size	Total Project Polygons = 2.6 hectares / 6.6 acres
	2.5 hectares / 6.3 acres in COLM
	2.9 hectares / 7.1 acres in environs
Proportion	14.4% of total project mapping area
	13.5% of COLM portion of mapping area
	16.0% of environs portion of mapping area
Accuracy (COLM only)	Producer - 69% (confidence interval 55-83%)
	User - 68% (confidence interval 54-82%)

Ecological System:
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

Associations:
Juniperus osteosperma / Artemisia tridentata ssp. *wyomingensis* Woodland [CEGL000730]
Pinus edulis – Juniperus spp. */ Artemisia tridentata* (ssp. *wyomingensis*, ssp. *vaseyana*) Woodland [CEGL000776]

Common species:

Juniperus osteosperma	*Pinus edulis*
Artemisia tridentata ssp. wyomingensis	*Ephedra viridis*
Opuntia polyacantha	*Pleuraphis jamesii*

Distribution/Ecology/Composition:
The Utah juniper dominated phase of this community is an uncommon association that occurs on alluvial fans along the eastern portion of the Monument and within the major canyons on colluvial slopes and Precambrian gravel ridges. Utah juniper trees are encroaching into Wyoming big sagebrush stands on the

deep, sandy alluvial fans, resulting in a broad ecotone that represents an association. The pinyon and Utah juniper dominated phase of this community is common in the Monument typically becoming established on eolian deposits, alluvial fans, and on Precambrian gravel. This association mostly occurs on flat to gradually sloping mesas, and ridges and is the result of tree invasion into established Wyoming big sagebrush shrublands, possibly because of wetter climatic conditions over two to three decades. Wyoming big sagebrush typically provides from 3-8% shrub cover in the understory of this woodland type, but may provide up to 15% cover. As the canopy cover increases the understory shrub cover decreases. As the stands mature, these associations would likely become Two-needle Pinyon Pine - Utah juniper / Sparse Understory Woodland stands.

Interpretation:
The trees of the W-PJWS Map Class appear as medium dark green dots of varying diameters with a coarse texture. They are 2–15 m tall, have a canopy of 12-60% closed, and form a random pattern of unevenly dispersed dots. The stands are denser on north-facing slopes. The shrubs appear as a lighter gray-green with a smooth-to-slightly rough texture. They have a more even distribution. The exposed substrates tend to be medium in tone.

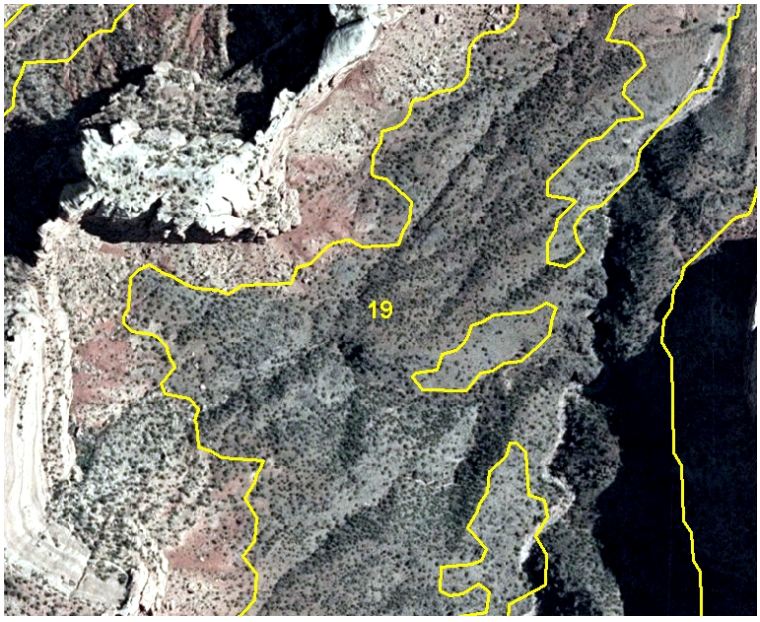
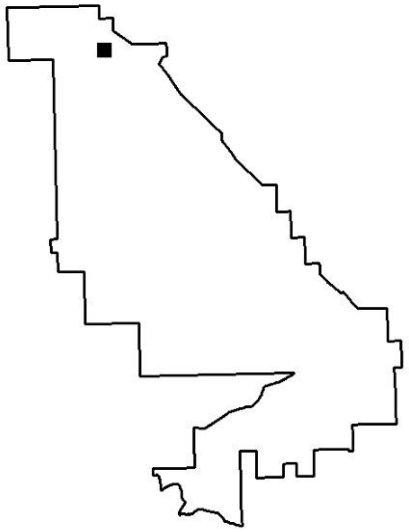


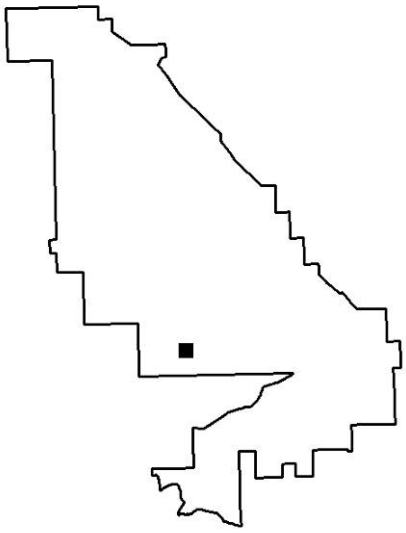
Photo W-PJWS-1



Location of **W-PJWS-1** within National Monument



Photo W-PJWS-2



Location of **W-PJWS-2** within COLM

Map Class 20
Two-needle Pinyon Pine – Utah Juniper / Multiple Shrub Woodland (W-PJSH)



Photo credit: e²M



Photo credit: e²M

The Two-needle Pinyon Pine – Utah Juniper / Multiple Shrub Woodland (W-PJSH, Map Class 20) represents a combination of the *Juniperus osteosperma / Cercocarpus montanus* (Utah Juniper / Mountain Mahogany)Woodland, the *Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* (Two-needle Pinyon Pine – Utah Juniper / Mountain Mahogany) – Mixed Shrubs Woodland, the *Pinus edulis - Juniperus osteosperma* / *Amelanchier utahensis* (Two-needle Pinyon Pine / Utah Serviceberry) Woodland, the *Pinus edulis - Juniperus osteosperma* / *Artemisia bigelovii* (Two-needle Pinyon Pine – Utah Juniper / Bigelow Sagebrush)Woodland, and the *Pinus edulis* – (*Juniperus monosperma, Juniperus osteosperma*) / Hesperostipa comata (Two-needle Pinyon Pine – Juniper / Needle-and-Thread) / Woodland.

W-PJSH Map Class Specifics:

Frequency	Total Project Polygons = 1337
	928 polygons in COLM
	409 polygons in environs
Area	Total Project Area = 3515.3 hectares / 8686.4 acres
	2475.2 hectares / 6116.5 acres in COLM
	1039.9 hectares / 2569.8 acres in environs
Average Size	Total Project Polygons = 2.6 hectares / 6.4 acres
	2.6 hectares / 6.6 acres in COLM
	2.5 hectares / 6.3 acres in environs
Proportion	27.7% of total project mapping area
	30.0% of COLM portion of mapping area
	23.5% of environs portion of mapping area
Accuracy (COLM only)	Producer -54% (confidence interval 47-60%)
	User - 83% (confidence interval 76-90%)

Ecological System:
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

Associations:
Juniperus osteosperma / Cercocarpus montanus Woodland [CEGL000735]
Pinus edulis - Juniperus spp. / Cercocarpus montanus –Mixed Shrubs Woodland [CEGL000780]
Pinus edulis - Juniperus osteosperma / Amelanchier utahensis Woodland [CEGL002329]
Pinus edulis - Juniperus osteosperma / Artemisia bigelovii Woodland [CEGL002118]
Pinus edulis – (*Juniperus monosperma, Juniperus osteosperma*) / *Hesperostipa comata* Woodland [CEGL000797]

Pinus edulis - *Juniperus* osteosperma / Mixed Shrubs Talus Woodland [CEGL002328]
Pinus edulis - *Juniperus osteosperma / Cercocarpus intricatus* Woodland [CEGL000779]

Common species:

Pinus edulis	*Juniperus osteosperma*
Cercocarpus montanus	*Cercocarpus intricatus*
Amelanchier utahensis	*Artemisia bigelovii*
Ephedra viridis	*Hesperostipa comata*
Achnatherum hymenoides	*Pleuraphis jamesii*

Distribution/Ecology/Composition:
This complex of pinyon – Utah juniper woodland associations with various shrub understories covers much of the Monument's upland habitats. Utah juniper very rarely forms an association with mountain mahogany on talus or rockfall slopes in the major canyons. Two-needle Pinyon Pine and Utah juniper form an association with mountain mahogany that is the most common and widely distributed vegetation type in the Monument. Except for deep eolian and alluvial deposits, this association occupies most upland habitats with shale, rocky, and bedrock substrates. Species composition is diverse across the stands and includes a variety of tall, short, and dwarf-shrubs, as well as graminoids and forbs. Two-needle Pinyon Pine and Utah juniper in association with Utah serviceberry is rare and occurs in small patches in mesic sites at the heads of alcoves below pour-offs, on ledging bedrock drainages, and on north-facing shale slopes. At mesa edges and ridge tops where thin soils are deposited over Kayenta sandstone, pinyon and Utah juniper provide the canopy over sparse Bigelow sagebrush shrubs. These mesa tops are moderately to strongly tilted to the east and northeast and typically have a thin cover of soil but they may be barren with vegetation rooting from cracks. Mixed bunchgrasses that typically include needle-and-thread, Indian ricegrass, and James' galleta form sparse to moderate cover under pinyon and Utah juniper on a few sites. The association is uncommon and occurs on a number of substrates including bedrock, mixed rock exposures with deeper soils, and eolian and alluvial deposits that occur on upper slopes of mesas or ridges. An association of pinyon and Utah juniper often becomes established in sparse stands on talus and Precambrian gravel slopes with a mixture of shrubs that tend to be sparse in terms of cover, but are always present in the understory, e.g., green Mormon-tea, shadscale, panhandle prickly-pear, etc. It is relatively common within the Monument, occupying slopes, ridges, and hills within canyons or hillslopes and mesa cliff faces, in addition to talus, colluvium, and rock slab substrates. The association of typically stunted pinyon and Utah juniper trees distributed with littleleaf mountain mahogany is uncommon and occurs when sufficient tree cover (typically greater than 10%) is present to classify stands from Little-leaf Mountain Mahogany Shrublands. The association is found within the distribution of the Littleleaf Mountain Mahogany Shrubland, where it occupies the exposed Kayenta sandstone bedrock on the edges of steeply tilted mesas along the eastern side of the Monument.

Interpretation:
The trees of the W-PJSH appear as medium dark green dots of varying diameters with a coarse texture. They are 2-5 m tall, have a canopy of 1-25% closed, and form a random pattern of unevenly dispersed dots. The stands are denser on north-facing slopes. The shrubs appear as smaller medium dark green dots in a random pattern of unevenly dispersed dots between the trees. The exposed substrates tend to be medium to light in tone.

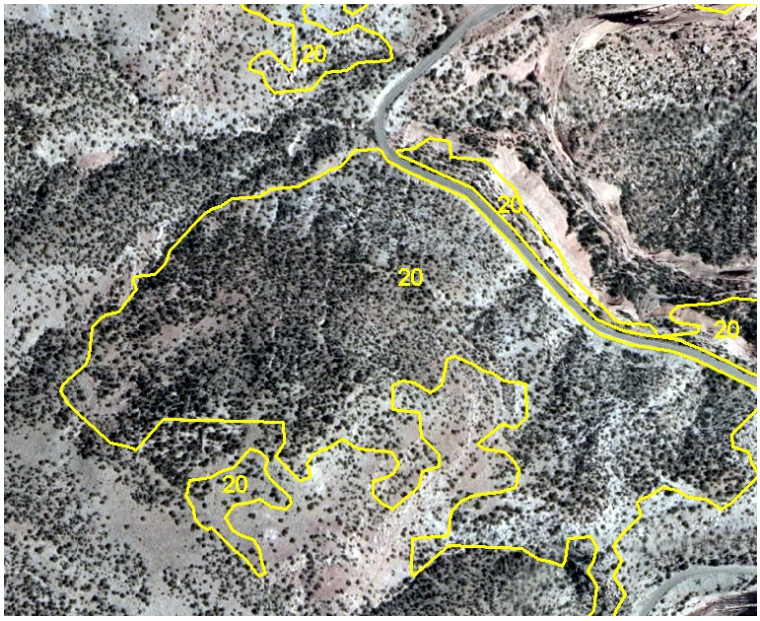
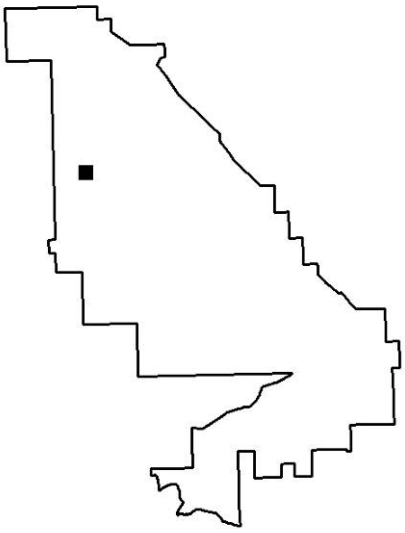


Photo W-PJSH-1



Location of **W-PJSH-1** within National Monument

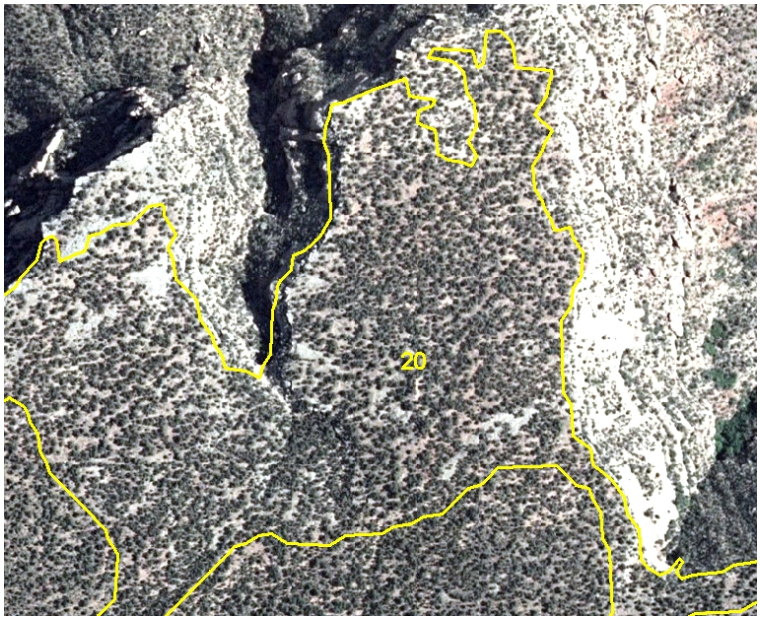
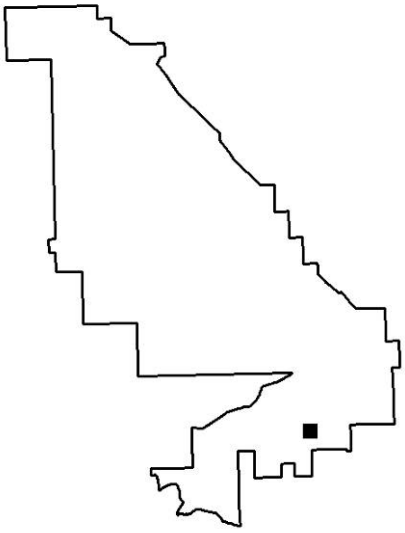


Photo W-PJSH-2



Location of **W-PJSH-2** within National Monument

Map Class 22
Utah Juniper / Mixed Shrubs Talus Woodland
(W-JUTA)



Photo credit: e²M



Photo credit: e²M

The Juniper / Talus Mixed Shrubs Woodland (W-JUTA, Map Class 22) represents a combination of the *Juniperus osteosperma* / Mixed Shrubs Talus Woodland and the *Juniperus osteosperma* / *Hesperostipa comata* Woodland.

W-JUTA Map Class Specifics:

Frequency	Total Project Polygons = 265
	255 polygons in COLM
	10 polygons in environs
Area	Total Project Area = 1464.5 hectares / 3618.8 acres
	1439.1 hectares / 3556.0 acres in COLM
	25.4 hectares / 62.8 acres in environs
Average Size	Total Project Polygons = 5.5 hectares / 13.6 acres
	5.6 hectares / 13.9 acres in COLM
	2.5 hectares / 6.2 acres in environs
Proportion	11.5% of total project mapping area
	17.4% of COLM portion of mapping area
	0.6% of environs portion of mapping area
Accuracy (COLM only)	Producer - 65% (confidence interval 51-79%)
	User - 62% (confidence interval 47-76%)

Ecological System:
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

Associations:
Juniperus osteosperma / *Hesperostipa comata* [CEGL002815]
Juniperus osteosperma / Mixed Shrubs Talus Woodland [CEGL002266]

Common species:

Juniperus osteosperma	*Pinus edulis*
Ephedra viridis	*Hesperostipa comata*
Achnatherum hymenoides	*Pleuraphis jamesii*

Distribution/Ecology/Composition:
Utah juniper-dominated woodland associations are common, occupying talus slopes, Precambrian gravel and cobble ridges and slopes, and sandstone bedrock exposures related to the canyon systems and slopes in the eastern and central portions of the Monument. When pinyon comprises a significant portion of the canopy cover, this more uncommon association occurs on bedrock, mixed rock exposures and deeper

soils, and eolian and alluvial deposits that occur on upper slopes of mesas or ridges. A variety of shrubs can occur among stands contributing sparse cover, and include green Mormon-tea, Wyoming big sagebrush, Bigelow sagebrush, mountain mahogany, and shadscale. The herbaceous understory is sparse and may include James' galleta and/or cheatgrass and cryptobiotic crust can provide moderate cover.

Interpretation:
The trees of the W-JUTA Map Class appear as medium dark green dots of varying diameters with a coarse texture. They are 2-5 m tall, have a canopy of 1-40% closed, and form a random pattern of unevenly dispersed dots. The stands are slightly denser on north-facing slopes. The exposed substrates tend to be medium to dark in tone.

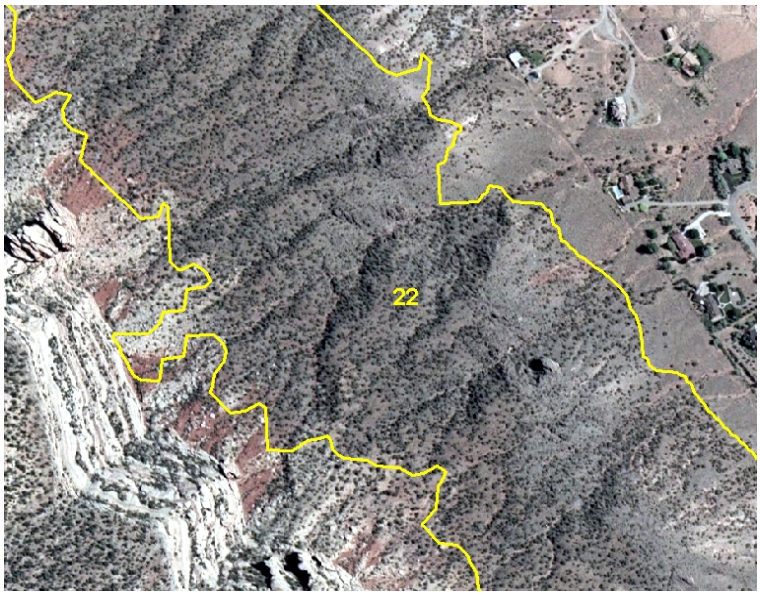
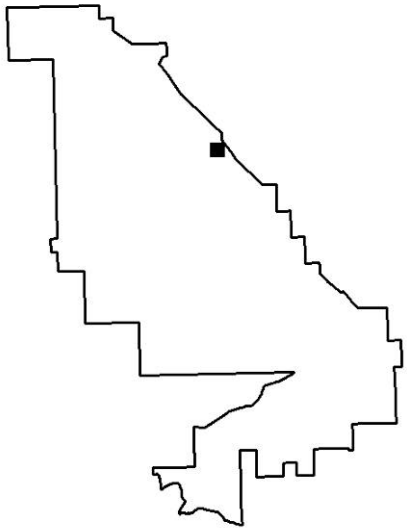


Photo W-JUTA-1



Location of **W-JUTA-1** within National Monument

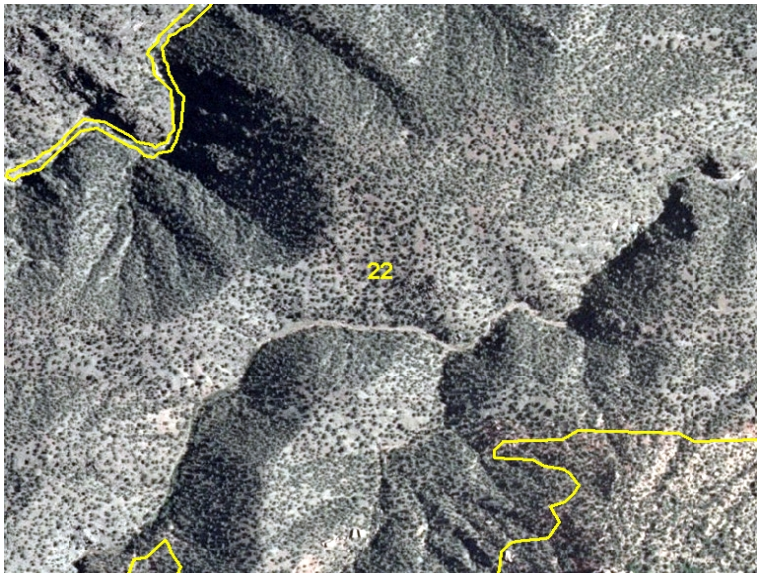
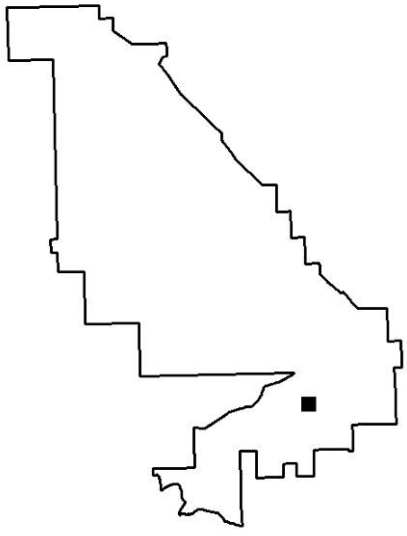


Photo W-JUTA-2



Location of **W-JUTA-2** within National Monument

Map Class 25
Two-needle Pinyon Pine – Utah Juniper / Black Sagebrush Woodland (W-PJBS)



Photo credit: e²M



Photo credit: e²M

The Two-needle Pinyon Pine-Juniper / Black Sagebrush Woodland (W-PJBS, Map Class 25) represents the *Pinus edulis – Juniperus osteosperma / Artemisia nova* (Two-needle Pinyon Pine – Utah Juniper / Black Sagebrush) Woodland

W-PJBS Map Class Specifics:

Frequency	Total Project Polygons = 384
	271 polygons in COLM
	113 polygons in environs
Area	Total Project Area = 857.3 hectares / 2118.3 acres
	674.7 hectares / 1667.2 acres in COLM
	182.6 hectares / 451.3 acres in environs
Average Size	Total Project Polygons = 2.2 hectares / 5.5 acres
	2.5 hectares / 6.1 acres in COLM
	1.6 hectares / 4.0 acres in environs
Proportion	6.8% of total project mapping area
	8.2% of COLM portion of mapping area
	4.1% of environs portion of mapping area
Accuracy (COLM only)	Producer - 75% (confidence interval 60-90%)
	User - 57% (confidence interval 42-72%)

Ecological System:
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

Association:
Pinus edulis - Juniperus osteosperma / Artemisia nova Woodland [CEGL002331]

Common species:

Pinus edulis	*Juniperus osteosperma*
Artemisia nova	*Opuntia polyacantha*
Pleuraphis jamesii	

Distribution/Ecology/Composition:
The Two-needle Pinyon Pine – Utah Juniper / Black Sagebrush Woodland association is uncommon to locally common within the Monument and occurs on rocky, thin, shale soils derived from Morrison Formation exposures typically associated with the Black Ridge, western Liberty Cap Trail, and the area between Cold Shivers Point and the rim of No Thoroughfare Canyon. An unusual occurrence of this

association is present on Monument Mesa, where black sagebrush and Wyoming big sagebrush have apparently hybridized and the resulting shrubs have the appearance of black sagebrush but are growing on deep eolian deposits. Stands with denser canopy cover support a sparser shrub and herbaceous layer. The community usually has shadscale, green Mormon-tea, and panhandle prickly-pear in the shrub layer and James' galleta in the herbaceous layer.

Interpretation:
The trees of the W-PJBS Map Class appear as medium dark green dots of varying diameters with a coarse texture. They are 2-10 m tall, have a canopy of 3-35% closed, and form a random pattern of unevenly dispersed dots. The stands are denser on north-facing slopes. The shrubs appear as a medium tone with a medium to coarse texture between the trees. The exposed substrates tend to be medium to light in tone.

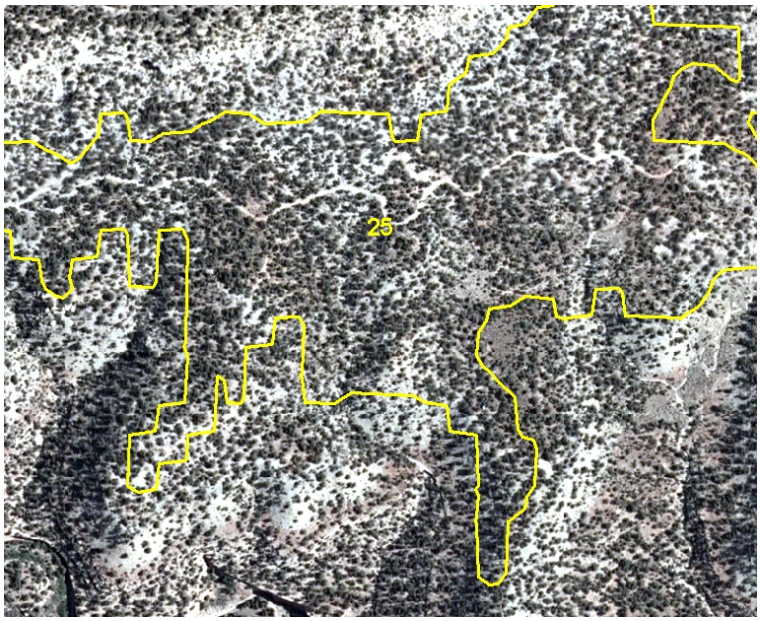
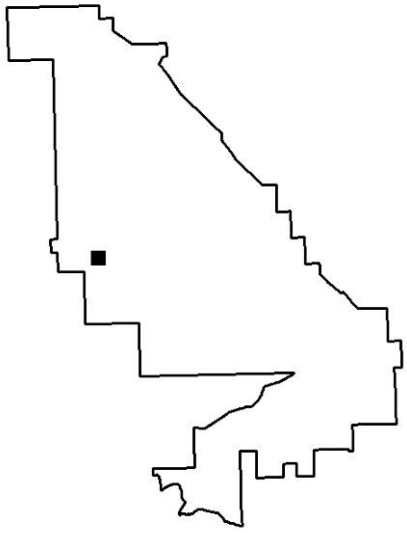


Photo W-PJBS-1



Location of **W-PJBS-1** within National Monument

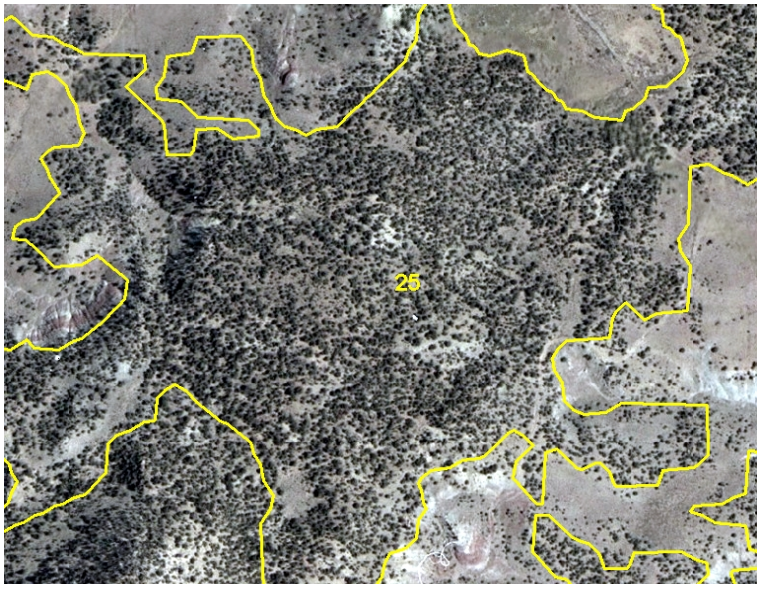
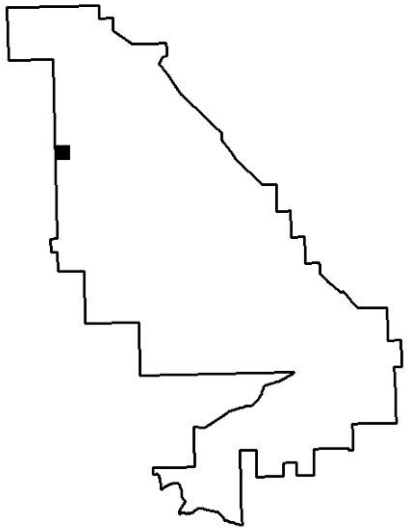


Photo W-PJBS-2



Location of **W-PJBS-2** within National Monument

Map Class 28
Two-needle Pinyon Pine – Utah Juniper / Sparse Understory Woodland (W-PJSP)



Photo credit: e²M



Photo credit: e²M

The Two-needle Pinyon Pine – Utah Juniper / Sparse Understory Woodland (W-PJSP, Map Class 28) represents the *Pinus edulis – Juniperus osteosperma* (Two-needle Pinyon Pine – Utah Juniper) / Sparse Understory Woodland.

W-PJSP Map Class Specifics:

Frequency	Total Project Polygons = 516
	281 polygons in COLM
	235 polygons in environs
Area	Total Project Area = 976.3 hectares / 2412.5 acres
	468.5 hectares / 1157.8 acres in COLM
	507.7 hectares / 1254.6 acres in environs
Average Size	Total Project Polygons = 1.9 hectares / 4.7 acres
	1.6 hectares / 4.1 acres in COLM
	2.1 hectares / 5.3 acres in environs
Proportion	7.7% of total project mapping area
	5.7% of COLM portion of mapping area
	11.5% of environs portion of mapping area
Accuracy (COLM only)	Producer - 51% (confidence interval 36-66%)
	User - 49% (confidence interval 34-63%)

Ecological System:
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

Association:
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland [CEGL002148]

Common species:

Pinus edulis	*Juniperus osteosperma*
Cercocarpus montanus	*Ephedra viridis*
Opuntia polyacantha	

Distribution/Ecology/Composition:
The Two-needle Pinyon Pine – Utah Juniper / Sparse Understory Woodland association is relatively common and is widespread within the distribution of woodlands in the Monument. It occurs on a variety of substrates including exposed bedrock, shale, eolian and alluvial deposits, and Precambrian gneiss and gravel and on all topographic positions. This woodland occurs on many landscape positions from mesa

tops with deep soil to slopes of exposed bedrock. The community usually has sparse cover by green Mormon-tea and mountain mahogany shrubs and can have a well-developed cryptobiotic soil crust. These stands often represent mature or older woodlands and higher cover of downed wood is present than typically occurs in other two-needle pine and Utah juniper woodlands.

Interpretation:
The trees of the W-PJSP appear as medium dark green dots with a coarse texture. They are 2-10 m tall, have a canopy of 1-45% closed, and form a random pattern of unevenly dispersed dots. The stands are denser on north-facing slopes. The exposed substrates tend to be medium to light in tone.

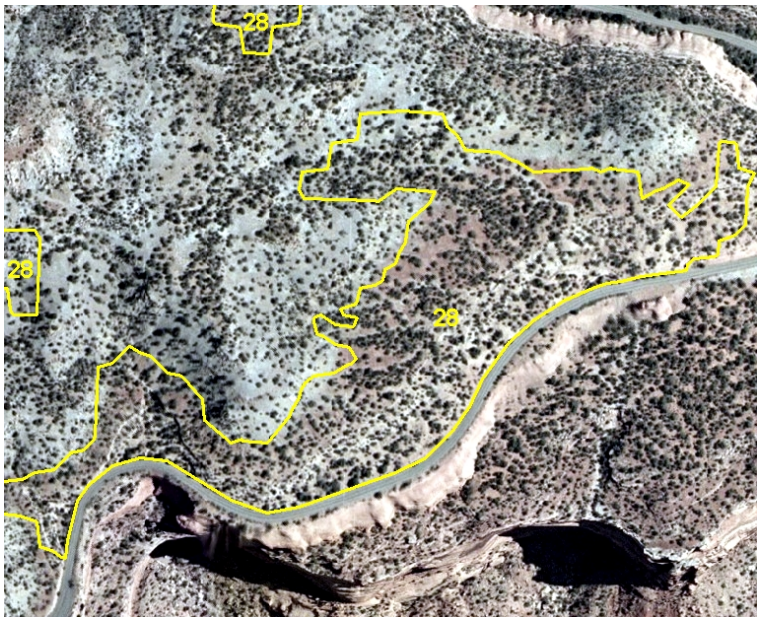
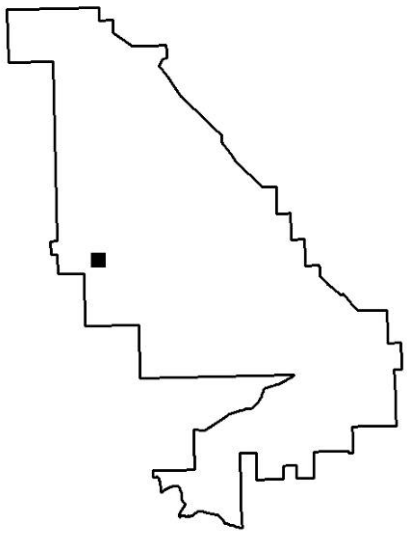


Photo W-PJSP-1



Location of **W-PJSP-1** within National Monument

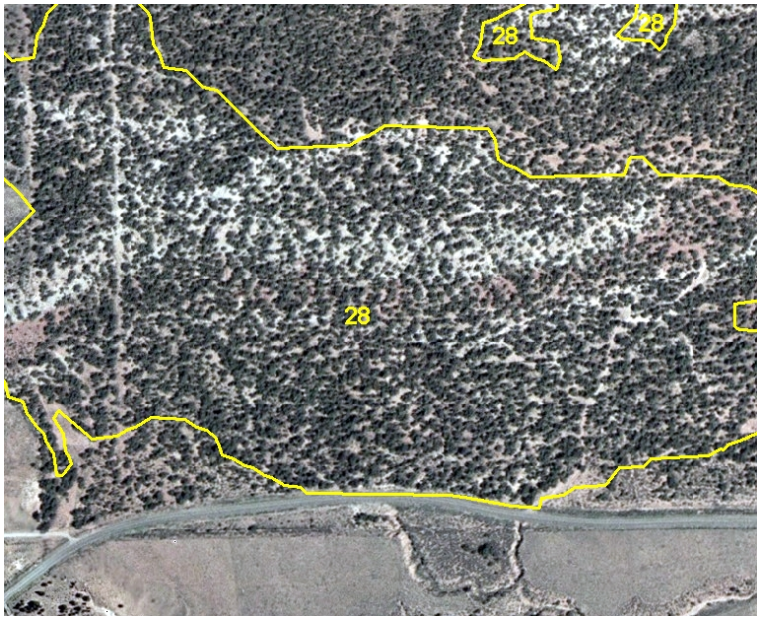
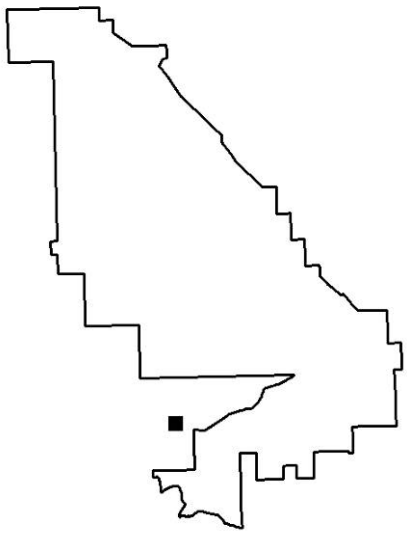


Photo W-PJSP-2



Location of **W-PJSP-2** within National Monument

Map Class 30
Gambel Oak / Skunkbush Shrubland
(S-OAKG)



Photo credit: e²M



Photo credit: e²M

The Gambel Oak / Skunkbush Shrubland (S-OAKG, Map Class 30) represents the *Quercus gambelii / Rhus trilobata* (Gambel Oak / Skunkbush) Woodland.

S-OAKG Map Class Specifics:

Frequency	Total Project Polygons = 21
	19 polygons in COLM
	2 polygons in environs
Area	Total Project Area = 22.1 hectares / 54.6 acres
	20.8 hectares / 51.3 acres in COLM
	1.3 hectares / 3.2 acres in environs
Average Size	Total Project Polygons = 1.1 hectares / 2.6 acres
	1.1 hectares / 2.7 acres in COLM
	0.7 hectares / 1.6 acres in environs
Proportion	0.2% of total project mapping area
	0.3% of COLM portion of mapping area
	<0.1% of environs portion of mapping area
Accuracy (COLM only)	Producer - 57% (confidence interval 19-95%)
	User -80% (confidence interval 41-119%)

Ecological System:
Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)

Association:
Quercus gambelii / Rhus trilobata Woodland [CEGL002338]

Common species:
Quercus gambelii *Rhus trilobata*

Distribution/Ecology/Composition:
The Gambel Oak / Skunkbush Shrubland is a rare to uncommon tall shrubland or short-stature woodland within the Monument and occurs on mesic sites in upper No Thoroughfare Canyon and in upper Ute Canyon. The woodland stands have become established on deep valley fill alluvium and the tall shrublands on colluvium that both receive additional moisture from near-to-surface groundwater, snow

deposition and melt, and the sites tend to be shaded for a larger part of the day. Canopy cover is high, as is litter or mast deposition, and there is little understory vegetation. There is no evidence of fire in this community, which would likely allow it to expand by root sprouts and seeds, because basin big sagebrush competition would be eliminated. As these stands become decadent, they would be replaced by Basin Big Sagebrush Shrubland on the valley fill sites and by Two-needle Pinyon Pine – Utah Juniper / Talus or Mixed Shrub Woodland on slopes and colluvial deposits.

Interpretation:
The S-OAKG Map Class appears as medium dark green with a mottled texture. The trees are 2-10 m tall and have a canopy of 35%-95%. Stands tend to have a rounded or oblong shape and are relatively small.

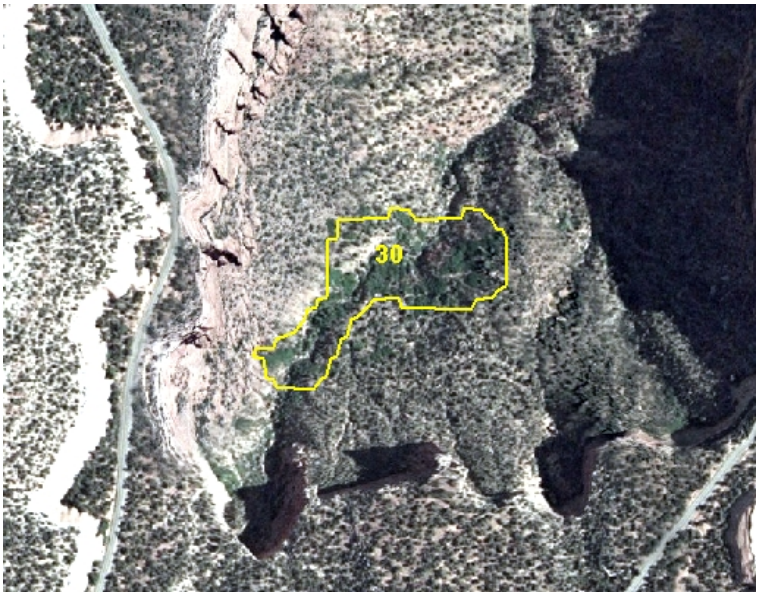
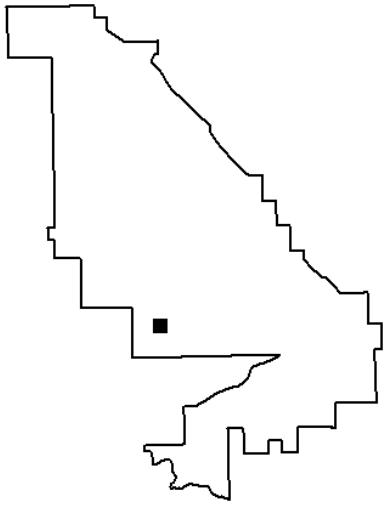


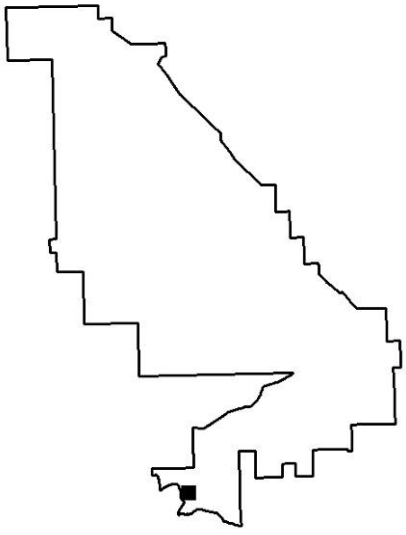
Photo S-OAKG-1



Location of **S-OAKG-1** within National Monument



Photo S-OAKG-2



Location of **S-OAKG-2** within National Monument

Map Class 2
Utah Serviceberry Shrubland
(S-UTSE)

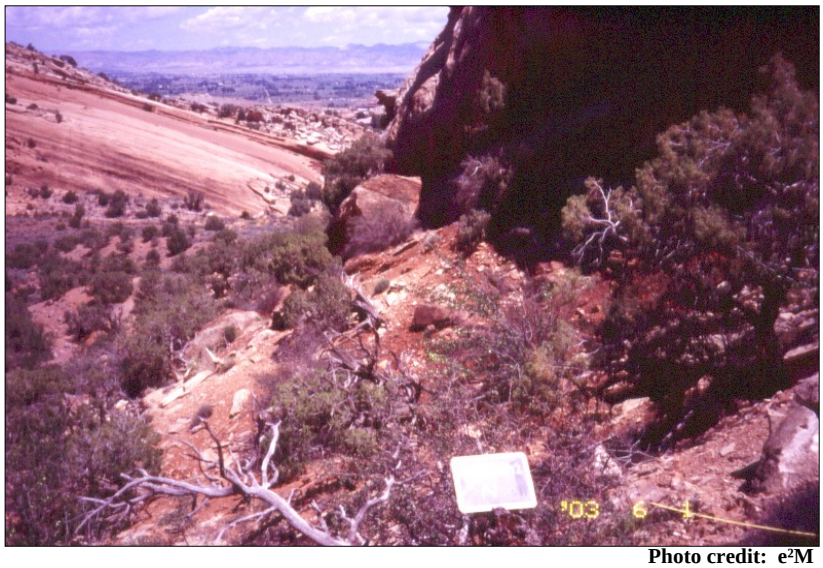


Photo credit: e²M

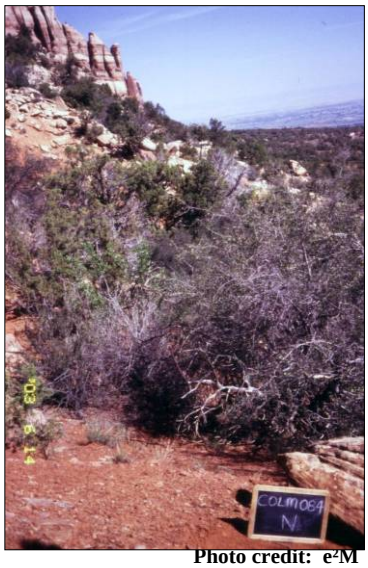


Photo credit: e²M

The Utah Serviceberry Shrubland (S-UTSE, Map Class 2) represents a combination of the *Amelanchier utahensis* (Utah Serviceberry) Shrubland and the *Amelanchier* (*utahensis, alnifolia*) – *Cercocarpus montanus* (Serviceberry – Mountain Mahogany) Shrubland.

S-UTSE Map Class Specifics:

Frequency	Total Project Polygons = 87
	84 polygons in COLM
	3 polygons in environs
Area	Total Project Area = 520.4 hectares / 1286.4 acres
	520.4 hectares / 1285.9 acres in COLM
	0.2 hectares / 0.4 acres in environs
Average Size	Total Project Polygons = 5.9 hectares / 14.7 acres
	6.2 hectares / 15.3 acres in COLM
	0.1 hectares / 0.1 acres in environs
Proportion	4.1% of total project mapping area
	6.3% of COLM portion of mapping area
	<1% of environs portion of mapping area
Accuracy (COLM only)	Producer - 89% (confidence interval 66-112%)
	User - 20% (confidence interval 8-32%)

Ecological System:
Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)

Associations:
Amelanchier utahensis Shrubland [CEGL001067]
Amelanchier (*utahensis, alnifolia*) – *Cercocarpus montanus* Shrubland [CEGL001070]

Common species:
Amelanchier utahensis *Ephedra viridis*
Cercocarpus montanus

Distribution/Ecology/Composition:
Small patches to large stands of Utah serviceberry and Utah serviceberry with mountain mahogany are present within all canyon systems and on steep slopes above the canyons within the Monument. This association forms sparse tall shrub stands on moderately steep-to-steep talus slopes derived from Chinle Formation shale and is relatively common occupying steep talus and rockfall slopes and ledges along the upper canyon margins, just below the rims, a habitat made up predominantly of Kayenta sandstone rockfall and occasional rocks of Wingate sandstone. Utah serviceberry is the dominant shrub on the Chinle Formation but shares dominance with mountain mahogany on talus and rockfall slopes. Mountain mahogany tends to dominate slopes eroding from Morrison Formation exposures. Stands can be sparse on shale soils and on southern exposures and dense on mesic sites of northern exposures.

Interpretation:
The shrubs of the S-UTSE Map Class appear as small dark green dots or clumps of varying diameters with a coarse texture. They are 2-10 m tall, have a canopy of 5-25% closed, and form a random pattern of unevenly dispersed dots, frequently forming linear clumped patterns where the vegetation follows a rock shelf. The stands are denser on north-facing slopes. The exposed substrates tend to be medium to light in tone. This Map Class often falls in shadowed areas along the steep canyon walls.

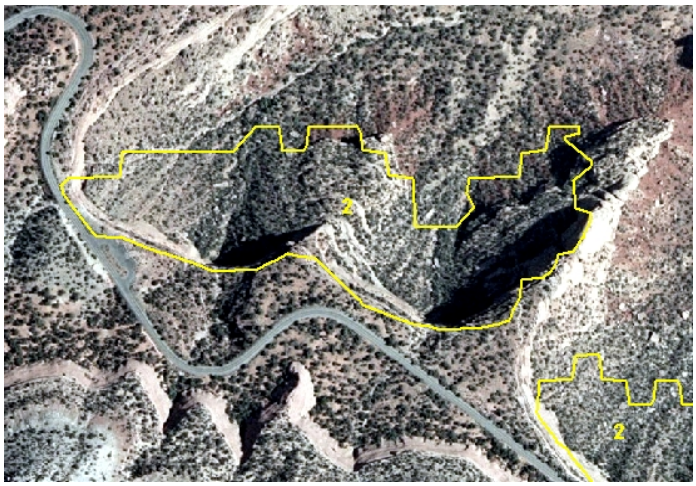
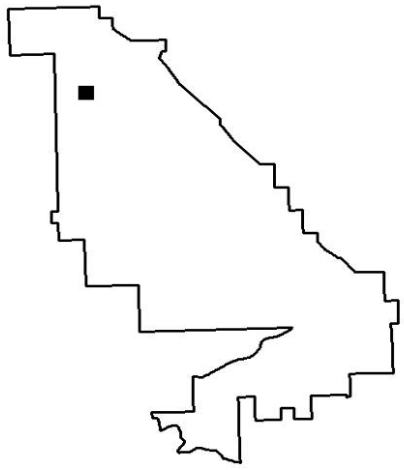


Photo S-UTSE-1



Location of **S-UTSE-1** within National Monument

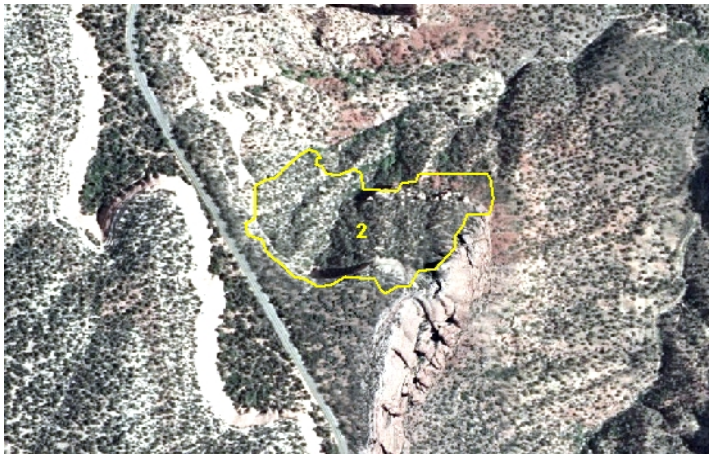
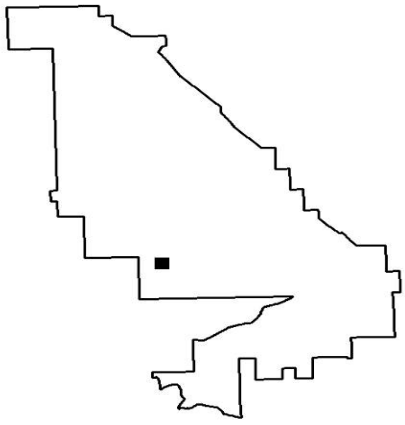


Photo S-UTSE-2



Location of **S-UTSE-2** within National Monument

Map Class 3
Greenleaf Manzanita Shrubland
(S-MANZ)



Photo credit: e²M

The Greenleaf Manzanita Shrubland (S-MANZ, Map Class 3) represents the *Arctostaphylos patula* (Greenleaf Manzanita) Shrubland.

S-MANZ Map Class Specifics:

Frequency	Total Project Polygons = 1
	1 polygons in COLM
	0 polygons in environs
Area	Total Project Area = 0.2 hectares / 0.5 acres
	0.2 hectares / 0.5 acres in COLM
	0 hectares / 0 acres in environs
Average Size	Total Project Polygons = 0.2 hectares / 0.5 acres
	0.2 hectares / 0.5 acres in COLM
	0 hectares / 0 acres in environs
Proportion	<1% of total project mapping area
	<1% of COLM portion of mapping area
	0% of environs portion of mapping area
Accuracy (COLM only)	Producer – 100%
	User – 100%

Ecological System:
Great Basin Semi-Desert Chaparral (CES304.001)

Association:
Arctostaphylos patula Shrubland [CEGL002696]

Common Species:
Arctostaphylos patula

Distribution/Ecology/Composition:
This association is present as one small, relict stand or patch at the base of a Kayenta sandstone slab near the Liberty Cap Trail and an individual shrub observed along the Old Gordon Trail, where it had become

established in a bedrock crack in Kayenta sandstone. The location at the base of the sandstone slab insures protection from the afternoon sun and also additional runoff from the slab surface. Both sites are on the east side of the Monument.

Interpretation:
The shrubs of the S-MANZ Map Class appear as a dark green clump with a mottled texture. They are 1-2 m tall and have a canopy of 98% closed. The stand is located at the base of a rock slab which has a very light tone.

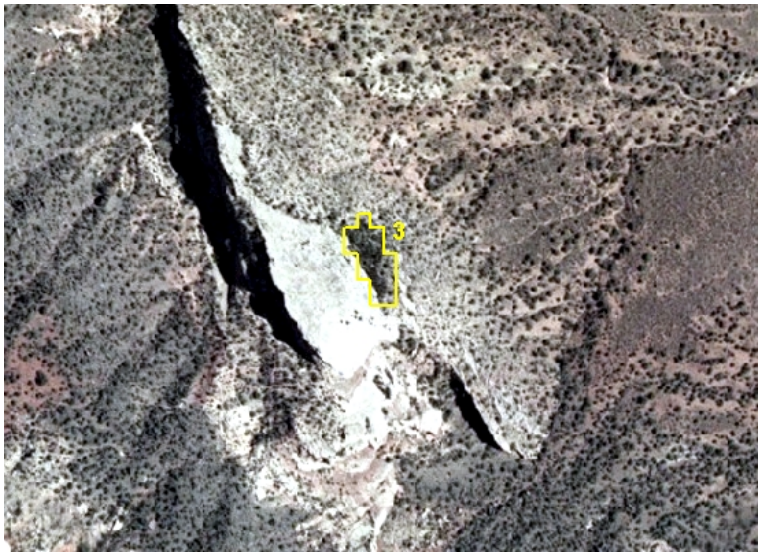
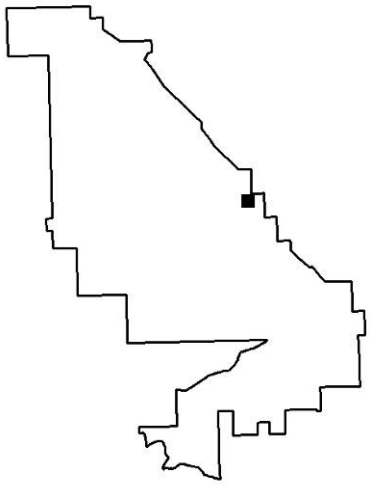


Photo S-MANZ-1



Location of **S-MANZ-1** within National Monument

Map Class 5
Basin Big Sagebrush / Cheatgrass Semi-natural Shrubland (S-BASA)



Photo credit: e²M



Photo credit: e²M

Artemisia tridentata ssp. *tridentata* – (*Ericameria nauseosa*) / *Bromus tectorum* (Basin Big Sagebrush / Cheatgrass) Semi-natural Shrubland.

S-BASA Map Class Specifics:

Frequency	Total Project Polygons = 21
	15 polygons in COLM
	6 polygons in environs
Area	Total Project Area = 100.5 hectares / 248.3 acres
	84.7 hectares / 209.4 acres in COLM
	15.8 hectares / 38.9 acres in environs
Average Size	Total Project Polygons = 4.8 hectares / 11.8 acres
	5.6 hectares / 13.9 acres in COLM
	2.6 hectares / 6.5 acres in environs
Proportion	0.8% of total project mapping area
	1.0% of COLM portion of mapping area
	0.4% of environs portion of mapping area
Accuracy (COLM only)	Producer - 94% (confidence interval 81-107%)
	User - 65% (confidence interval 47-84%)

Ecological System:
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

Association:
Artemisia tridentata ssp. *tridentata* - (*Ericameria nauseosa*) / *Bromus tectorum* Semi-natural Shrubland [CEGL002699]

Common species:
Artemisia tridentata ssp. *tridentata* *Bromus tectorum*

Distribution/Ecology/Composition:
This is a rare to uncommon intermittent drainage type within the mapping area. It occurs as decadent and disturbed stands of Basin big sagebrush with an understory of cheatgrass that occupy drainages in upper to middle Ute, lower No Thoroughfare, and middle Fruita Canyons. One stand had become established on alluvium along a minor drainage near the mouth of Red Canyon and adjacent to the eastern boundary fence. The community usually has no other shrubs in the canopy layer. These stands typically occupy terraces of fine sediments that have been elevated from 2 to 3 m by stream incision. As stands age they

are generally replaced by Utah juniper and pinyon trees (Two-needle Pinyon Pine – Utah Juniper / Sparse Understory Woodland), Utah juniper is the first tree species to become established.

Interpretation:
The S-BASA Map Class appears as gray-green areas with a fine to medium texture. They are 1-5 m tall and have a 30-55% foliar cover. The terraces they occupy are occasionally dissected by side drainages.

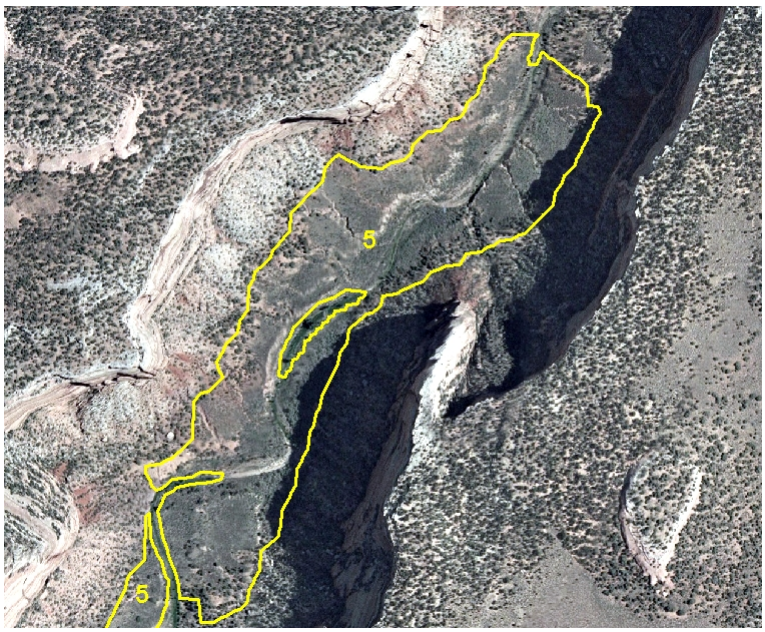
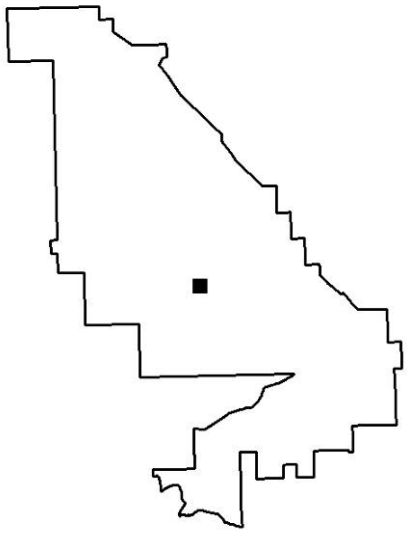


Photo S_BASA-1



Location of **S_BASA-1** within National Monument

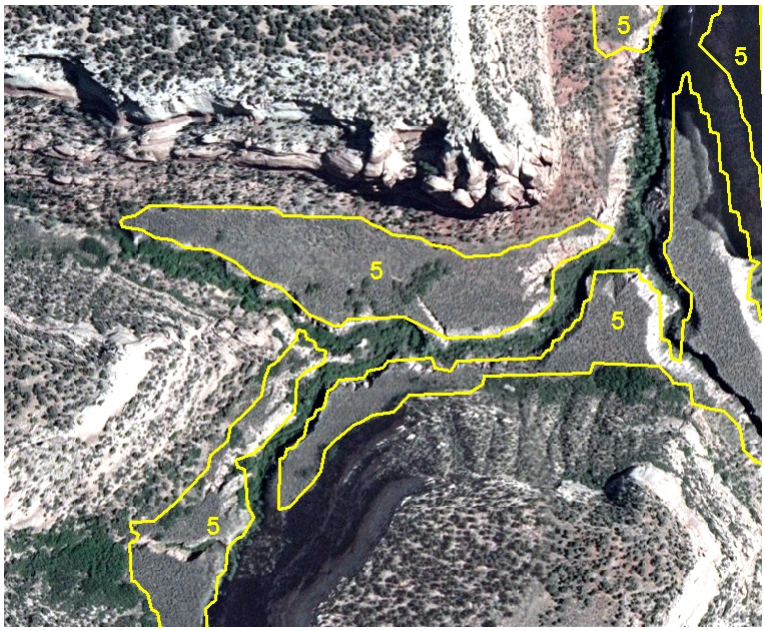
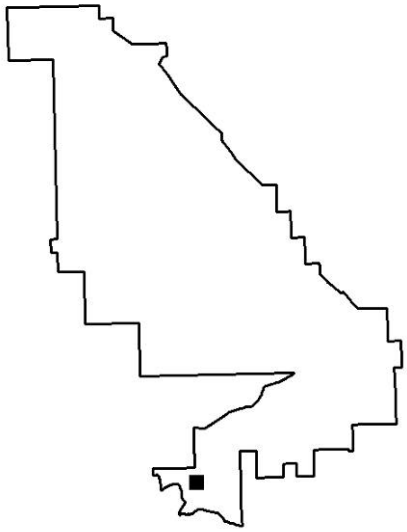


Photo S-BASA-2



Location of **S-BASA-2** within National Monument

Map Class 7
Wyoming Big Sagebrush / Seeded Grasses Semi-natural Shrubland (S-WSGR)



Photo credit: e²M



Photo credit: e²M

The Wyoming Big Sagebrush / Seeded Grasses Shrubland (S-WSGR, Map Class 7) represents the *Artemisia tridentata* ssp. *wyomingensis* / (*Agropyron cristatum, Psathyrostachys juncea*) (Wyoming Big Sagebrush / Crested Wheatgrass, Russian Wildrye) Seeded Grass Semi-natural Shrubland.

S-WSGR Map Class Specifics:

Frequency	Total Project Polygons = 75
	22 polygons in COLM
	53 polygons in environs
Area	Total Project Area = 536.7 hectares / 1326.1 acres
	139.6 hectares / 345.0 acres in COLM
	397.1 hectares / 981.2 acres in environs
Average Size	Total Project Polygons = 7.1 hectares / 17.7 acres
	6.3 hectares / 15.7 acres in COLM
	7.5 hectares / 18.5 acres in environs
Proportion	4.2% of total project mapping area
	1.7% of COLM portion of mapping area
	9.0% of environs portion of mapping area
Accuracy (COLM only)	Producer - 96% (confidence interval 87-105%)
	User - 88% (confidence interval 76-101%)

Ecological System:
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

Association:
Artemisia tridentata ssp. *wyomingensis / (Agropyron cristatum, Psathyrostachys juncea)* Seeded Grasses Semi-natural Shrubland [CEGL002185]

Common species:
Artemsia tridentata ssp. *wyomingensis*
Agropyron cristatum
Senecio multilobatus

Distribution/Ecology/Composition:
Stands of this altered association occupy relatively flat and deep eolian soils mostly on the mesa between No Thoroughfare Canyon and Little Park Road. The Wyoming big sagebrush cover was reduced by mechanical or chemical means historically and stands were seeded with crested wheatgrass to increase forage for livestock. Many shrubs are on small pedestals, the result of sheetwash and wind action. In some

stands, pinyon and Utah juniper trees are replacing the shrubland, eventually resulting in a Two-needle Pinyon Pine – Utah Juniper / Wyoming Big Sagebrush Woodland stand.

Interpretation:
The S-WSGR Map Class appears as light gray-tan areas with a fine texture for the seeded grasses interspersed with medium gray-green speckles for the Wyoming big sagebrush. The invading pinyon and Utah juniper trees appear as medium dark green dots of varying diameters with a coarse texture. The Wyoming big sagebrush shrubs are 0.5-1 m tall and have a 4-40% crown cover.

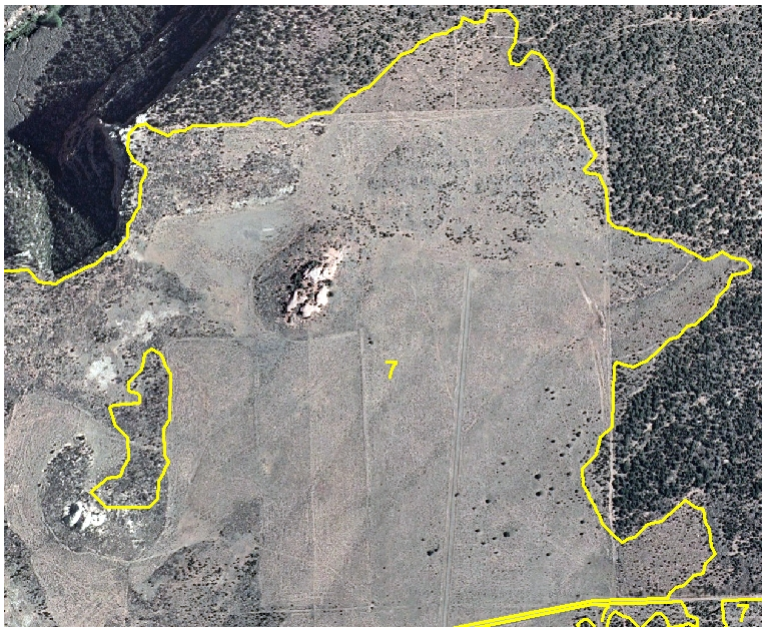
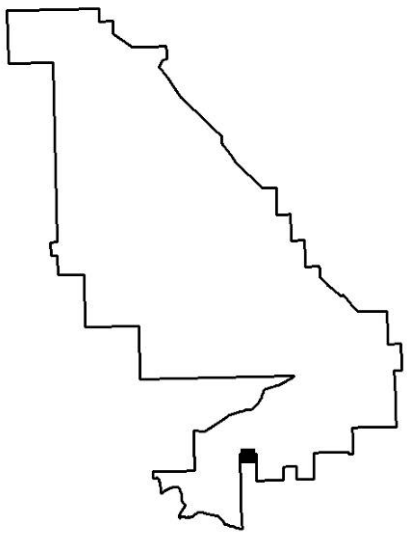


Photo S-WSGR-1



Location of **S-WSGR-1** within National Monument

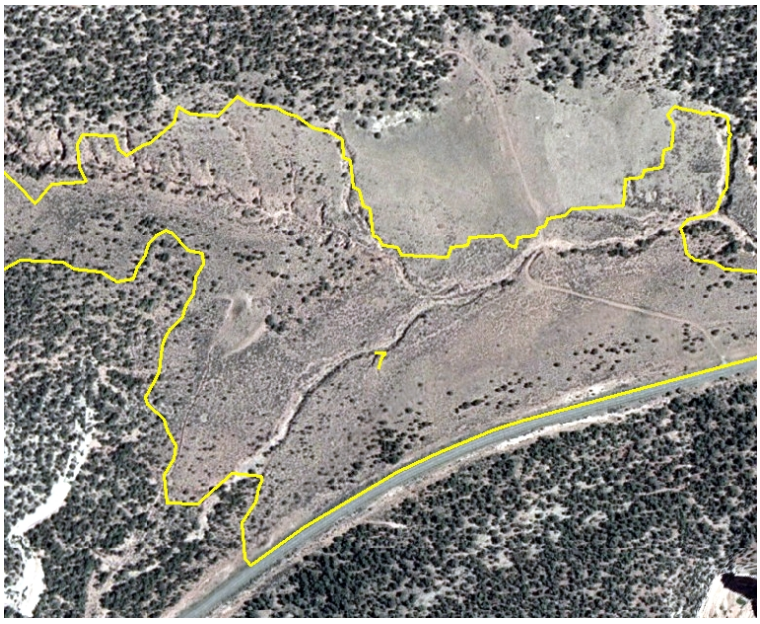
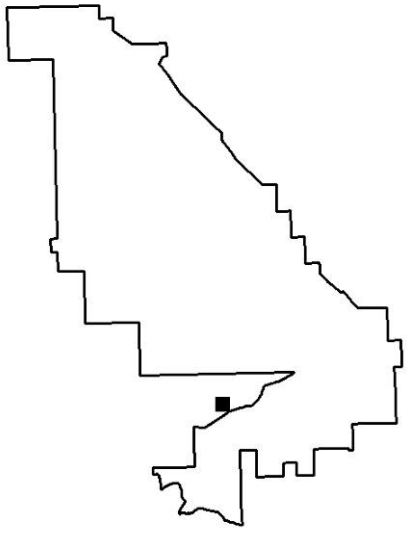


Photo S-WSGR-2



Location of **S-WSGR-2** within National Monument

Map Class 8
Wyoming Big Sagebrush Shrubland
(S-WYSA)



Photo credit: e²M



Photo credit: e²M

The Wyoming Big Sagebrush Shrubland (S-WYSA, Map Class 8) represents a combination of the *Artemisia tridentata* ssp. *wyomingensis – Atriplex confertifolia* (Wyoming Big Sagebrush – Shadscale) Shrubland, the *Artemisia tridentata* ssp. *wyomingensis* / *Pleuraphis jamesii* (Wyoming Big Sagebrush / James' Galleta) Shrubland, the *Artemisia tridentata* ssp. *wyomingensis* / *Hesperostipa comata* (Wyoming Big Sagebrush / Needle-and-thread) Colorado Plateau Shrubland, the *Artemisia tridentata* ssp. *wyomingensis / Poa fendleriana* (Wyoming Big Sagebrush / Muttongrass) Shrubland, and the *Artemisia tridentata* ssp. *wyomingensis* / Disturbed Understory (Wyoming Big Sagebrush / Disturbed Understory) Semi-natural Shrubland.

S-WYSA Map Class Specifics:

Frequency	Total Project Polygons = 143
	108 polygons in COLM
	35 polygons in environs
Area	Total Project Area = 392.2 hectares / 969.2 acres
	323.7 hectares / 799.8 acres in COLM
	68.5 hectares / 169.4 acres in environs
Average Size	Total Project Polygons = 2.7 hectares / 6.8 acres
	3.0 hectares / 7.4 acres in COLM
	1.9 hectares / 4.8 acres in environs
Proportion	3.1% of total project mapping area
	3.9% of COLM portion of mapping area
	1.5% of environs portion of mapping area
Accuracy (COLM only)	Producer - 83% (confidence interval 71-95%)
	User - 78% (confidence interval 66-91%)

Ecological System:
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

Associations:
Artemisia tridentata ssp. wyomingensis – Atriplex confertifolia Shrubland [CEGL001040]
Artemisia tridentata ssp. wyomingensis / Pleuraphis jamesii Shrubland [CEGL002084]
Artemisia tridentata ssp. wyomingensis / Poa fendleriana Shrubland [CEGL002775]
Artemisia tridentata ssp. wyomingensis / Disturbed Understory Semi-natural Shrubland [CEGL002083]
Artemisia tridentata ssp. *wyomingensis* / *Hesperostipa comata* Colorado Plateau Shrubland [CEGL002761]

Common Species:

Artemisia tridentata ssp. *wyomingensis*	*Atriplex confertifolia*
Pleuraphis jamesii	*Hesperostipa comata*
Poa fendleriana	*Bromus tectorum*

Distribution/Ecology/Composition:

Stands of Wyoming big sagebrush represent the most abundant upland shrubland within the Monument. They are located on alluvial fans, terraces, slopes, ridges, and mesas, occupying deep fine soils (alluvium and eolian deposits) and Precambrian gravels from the lowest to highest elevations. Undisturbed Wyoming big sagebrush stands are relatively common on mesa tops in and adjacent to the Monument and they have understories of needle-and-thread and/or muttongrass. The soils of this association are typically deep and eolian in origin. Where soils are more alkaline on the alluvial fans and drainages along the eastern edge of the Monument, shadscale and James' galleta are common in the understory. On Precambrian gravel ridges and slopes exposed in the major valleys, James' galleta and panhandle prickly-pear are common associates. The latter species was spread extensively by grazing cattle, American bison, and sheep. Recently burned stands are replaced by dense cover of the annual, nonnative Cheatgrass Semi-natural Herbaceous Vegetation, which is slowly replaced by Four-wing Saltbush Shrubland, and then by Wyoming Big Sagebrush Shrubland and its various associations. Established Wyoming big sagebrush stands are replaced by Utah juniper trees on drier sites forming the Utah Juniper / Wyoming Big Sagebrush Woodland type and by pinyon and Utah juniper on more mesic sites, forming the Two-needle Pinyon Pine – Utah Juniper / Wyoming Big Sagebrush Woodland.

Interpretation:

The S-WYSA Map Class appears as medium gray-green areas with a medium texture for the Wyoming big sagebrush, light gray-tan for the grass understories, and light tones for any exposed substrates. Occasional pinyon and Utah juniper trees appear as medium dark green dots of varying diameters with a coarse texture. The Wyoming big sagebrush shrubs are 0.5-1 m tall and have a 1-45% canopy cover.

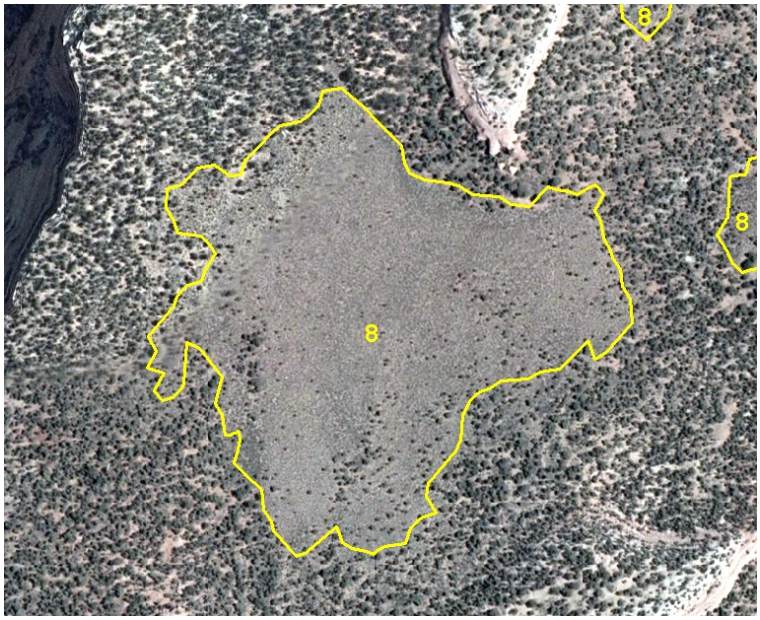
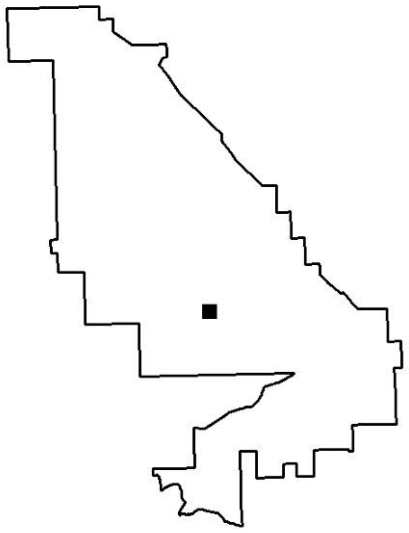


Photo S-WYSA-1



Location of **S-WYSA-1** within National Monument

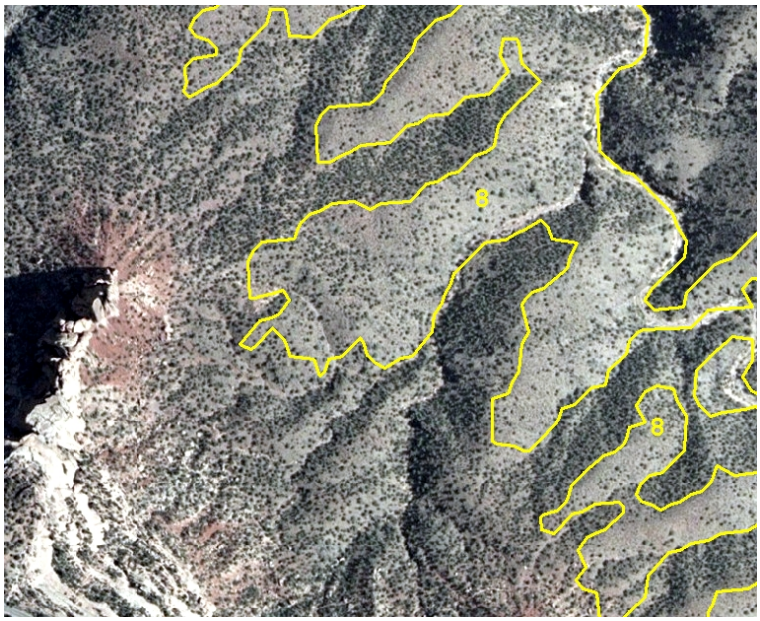
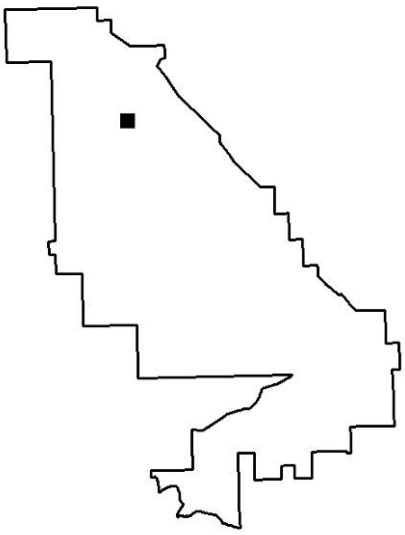


Photo S-WYSA-2



Location of **S-WYSA-2** within National Monument

Map Class 9
Fourwing Saltbush – Mormon Tea Talus Shrubland
(S-FWMT)

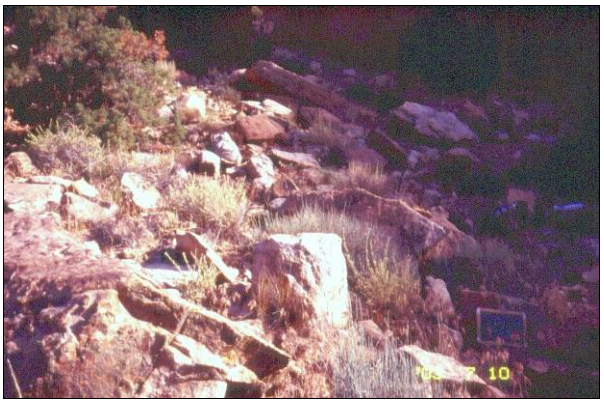


Photo credit: e²M

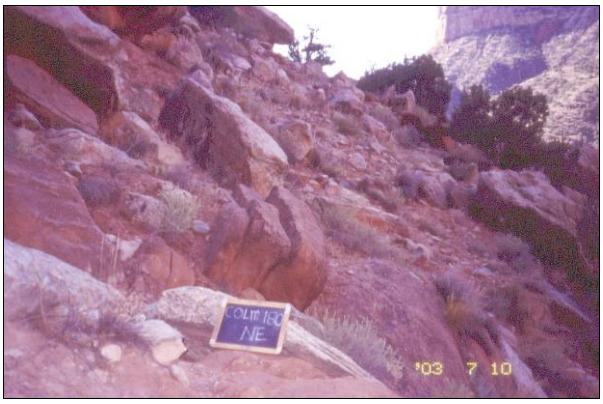


Photo credit: e²M

The Four-wing Saltbush – Mormon Tea Talus Shrubland (S-FWMT, Map Class 9) represents the *Atriplex canescens – Ephedra viridis* (Four-wing Saltbush – Green Mormon-tea) Talus Shrubland.

S-FWMT Map Class Specifics:

Frequency	Total Project Polygons = 8
	7 polygons in COLM
	1 polygon in environs
Area	Total Project Area = 15.5 hectares / 38.3 acres
	14.4 hectares / 35.5 acres in COLM
	1.2 hectares / 2.9 acres in environs
Average Size	Total Project Polygons = 1.91 hectares / 4.8 acres
	2.1 hectares / 5.0 acres in COLM
	1.2 hectares / 2.9 acres in environs
Proportion	0.1% of total project mapping area
	0.2% of COLM portion of mapping area
	<1% of environs portion of mapping area
Accuracy (COLM only)	Producer – 100% (confidence interval 83-117%)
	User - 43% (confidence interval 5-81%)

Ecological System:
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)

Association:
Atriplex canescens - Ephedra viridis Talus Shrubland [CEGL 001287]

Common species:

Atriplex canescens	*Ephedra torreyana*
Ephedra viridis	*Juniperus osteosperma*

Distribution/Ecology/Composition:
Sparse stands of four-wing saltbush occupy steep rockfall or talus slopes in the deeper canyons of the Monument and form an association with species of Mormon-tea. Typical habitat is present in the mouth of Monument Canyon and is characterized by large boulders and blocks of Wingate sandstone that have fallen on steep slopes of Chinle Formation talus at the base of massive cliffs. The slope exposure is to the south, as such cover is sparse typically less than 10%, and usually includes sparse Utah juniper trees. As the slopes stabilize at a lesser angle of repose, stands are replaced by Two-needle Pinyon Pine - Utah

Juniper / Talus Mixed Shrubs “Breaks” Woodland, associated with a variety of understory shrubs and herbaceous species.

Interpretation:
The shrubs of the S-FWMT Map Class appear as small gray-green dots in a random pattern of unevenly dispersed dots surrounded by medium- to light-toned areas representing the sparse grass understory and exposed substrate. Occasional Utah juniper trees appear as medium dark green dots of varying diameters with a coarse texture. Large boulders that have fallen from adjacent cliffs have light tones and cast small dark shadows.

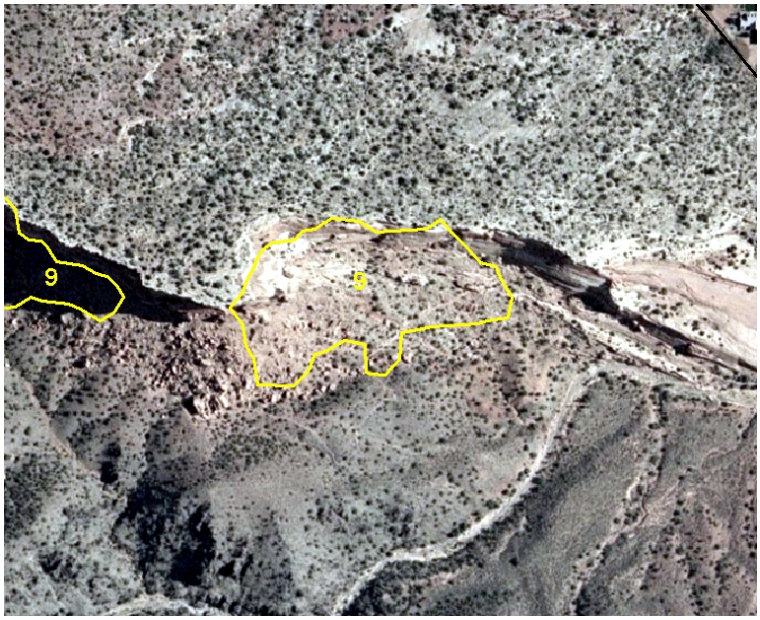
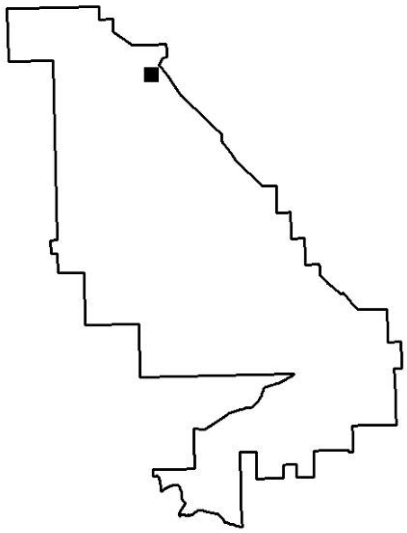


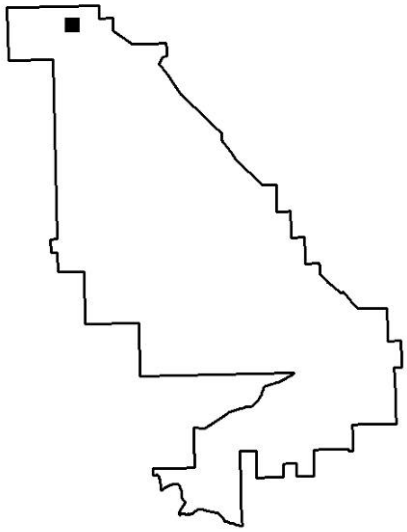
Photo S-FWMT -1



Location of **S-FWMT-1** within National Monument



Photo S-FWMT-2



Location of **S-FWMT-2** within National Monument

Map Class 10
Fourwing Saltbush Shrubland
(S-FWSH)



Photo credit: e²M

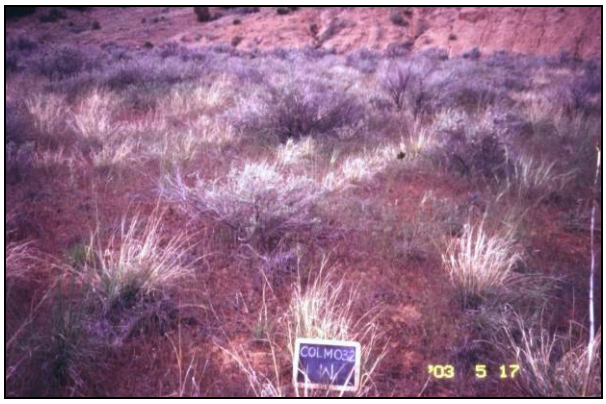


Photo credit: e²M

The Four-wing Saltbush (S-FWSH, Map Class 10) represents the *Atriplex canescens* (Four-wing Saltbush) Shrubland.

S-FWSH Map Class Specifics:

Frequency	Total Project Polygons = 15
	6 polygons in COLM
	9 polygons in environs
Area	Total Project Area = 62.6 hectares / 154.6 acres
	15.3 hectares / 37.8 acres in COLM
	47.3 hectares / 116.8 acres in environs
Average Size	Total Project Polygons = 4.2 hectares / 10.3 acres
	2.5 hectares / 6.3 acres in COLM
	5.2 hectares / 12.9 acres in environs
Proportion	0.5% of total project mapping area
	0.2% of COLM portion of mapping area
	1.1% of environs portion of mapping area
Accuracy (COLM only)	Producer - 80% (confidence interval 41-119%)
	User - 57% (confidence interval 19-95%)

Ecological System:
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)

Association:
Atriplex canescens Shrubland [CEGL001281]

Common species:

Atriplex canescens	*Sarcobatus vermiculatus*
Bromus tectorum	*Sporobolus cryptandrus*

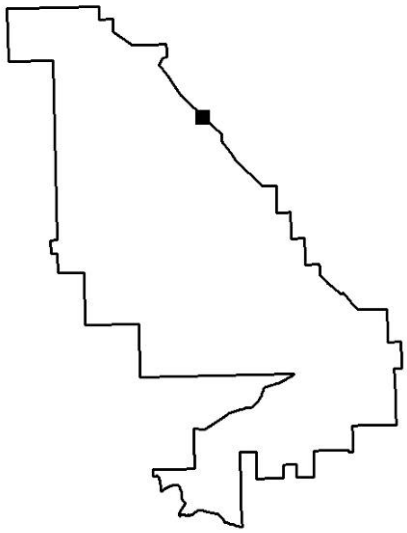
Distribution/Ecology/Composition:
This four-wing saltbush association is rare and has become established on fine soils of alluvial fans at canyon mouths, as in No Thoroughfare Canyon, and along the eastern side of the Monument extending to the eastern boundary fence. These sites were grazed historically by livestock and American bison and continue to be disturbed by burrowing small mammals. Stands occupy hot exposures on deep, fine soils amid extensive stands of Wyoming big sagebrush. The first shrubs to grow within burned Wyoming big sagebrush stands are four-wing saltbush therefore these stands may represent a seral stage that will be

replaced by the Wyoming Big Sagebrush Shrubland and its various associations as conducive environmental conditions occur.

Interpretation:
The S-FWSH Map Class appears as gray-green areas with a medium to fine texture. Lighter areas are more exposed substrate. Occasional pinyon and Utah juniper trees appear as medium dark green dots of varying diameters with a coarse texture.



Photo S-FWSH-1



Location of **S-FWSH-1** within National Monument

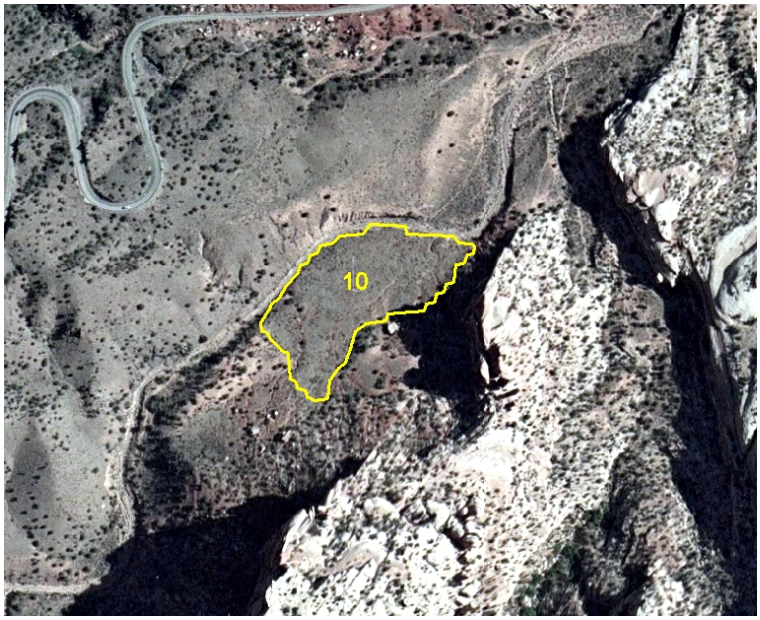
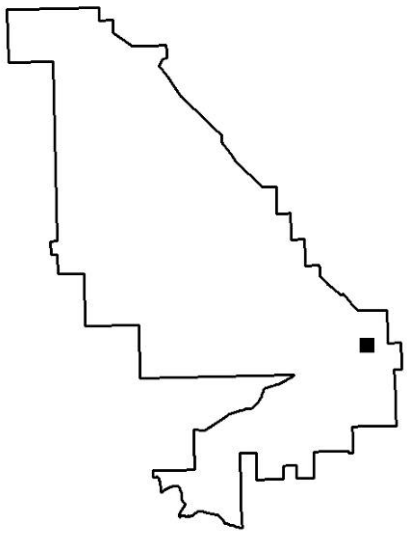


Photo S-FWSH-2



Location of **S-FWSH-2** within National Monument

Map Class 13
Gardner's Saltbush / James' Galleta Dwarf-shrubland (S-GSJG)



Photo credit: e²M

The Gardner Saltbush Shrubland (S-GSJG, Map Class 13) represents the *Atriplex gardneri / Pleuraphis jamesii* (Gardner Saltbush / James' Galleta) Dwarf-shrubland.

S-GSJG Map Class Specifics:

Frequency	Total Project Polygons = 2
	2 polygons in COLM
	0 polygons in environs
Area	Total Project Area = 5.3 hectares / 13.0 acres
	5.3 hectares / 13.0 acres in COLM
	0 hectares / 0 acres in environs
Average Size	Total Project Polygons = 2.6 hectares / 6.5 acres
	2.6 hectares / 6.5 acres in COLM
	0 hectares / 0 acres in environs
Proportion	<0.1% of total project mapping area
	0.1% of COLM portion of mapping area
	0% of environs portion of mapping area
Accuracy (COLM only)	Producer – 100% (confidence interval= 75-125%)
	User – 100% (confidence interval= 75-125%)

Ecological System:
Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783)

Association:
Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland [CEGL001441]

Common species:
Atriplex gardneri *Artemisia nova*
Pleuraphis jamesii

Distribution/Ecology/Composition:

A very rare occurrence of this association exists on patches of gravel exposed/deposited at the base of small hills on BLM-managed land adjacent to the Black Ridge Trail west of the Monument boundary. This sparse, dwarf-shrubland occupies graveled sites that are surrounded by black sagebrush shrublands and intermixes with black sagebrush on the stand margins. As sediments are trapped over these exposed gravels, the Black Sagebrush Shrubland association is likely to invade and become the stand dominant.

Interpretation:
The S-GSJG Map Class appears as light gray-green areas with a fine texture. Slightly darker areas occur along drain courses.

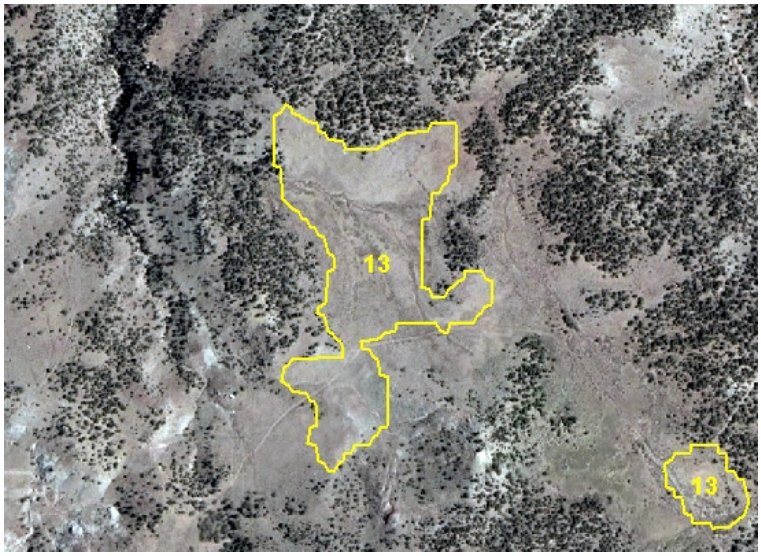
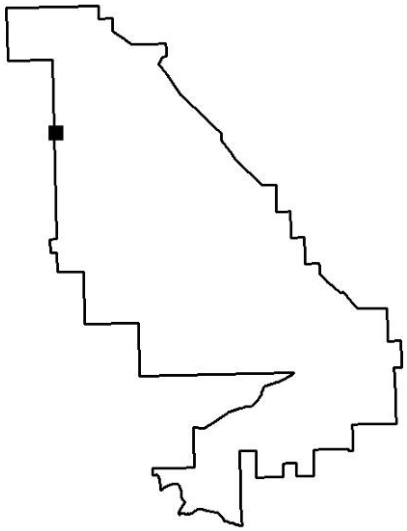


Photo S-GSJG-1



Location of **S-GSJG-1** within National Monument

Map Class 23
Winter-fat / James' Galleta Dwarf-shrubland (S-WFSH)



Photo credit: e²M

The Winter-fat James' Galleta Dwarf-shrubland (S-WFSH, Map Class 23) represents the *Krascheninnikovia lanata / Pleuraphis jamesii* (Winter-fat / James' Galleta) Dwarf-shrubland.

S-WFSH Map Class Specifics:

Frequency	Total Project Polygons = 1
	0 polygons in COLM
	1 polygons in environs
Area	Total Project Area = 4.2 hectares / 10.3 acres
	0 hectares / 0 acres in COLM
	4.2 hectares / 10.3 acres in environs
Average Size	Total Project Polygons = 4.2 hectares / 10.3 acres
	0 hectares / 0 acres in COLM
	4.2 hectares / 10.3 acres in environs
Proportion	<0.1% of total project mapping area
	0% of COLM portion of mapping area
	0.1% of environs portion of mapping area

Ecological System:
Inter-Mountain Semi-Desert Shrub-Steppe (CES304.788)

Association:
Krascheninnikovia lanata / Pleuraphis jamesii Dwarf-shrubland [CEGL001322]

Common species:

Krascheninnikovia lanata	*Opuntia polyacantha*
Pleuraphis jamesii	*Sporobolus cryptandrus*

Distribution/Ecology/Composition:
This rare winterfat / James' galleta association became established in an area outside the southwestern Monument boundary on BLM-managed land. This habitat of eolian and sheetwash deposits appears to have been used historically to yard livestock, as many droppings are present. It is probable that other

treatments have occurred on this land to control or minimize Wyoming big sagebrush cover and increase production of grasses as livestock forage. As the stand ages, it would be replaced by Wyoming Big Sagebrush Shrublands from the south and west sides and by Two-needle Pinyon Pine – Utah Juniper / Wyoming Big Sagebrush Woodlands from the north and east sides.

Interpretation:
The S-WFSH Map Class appears as light gray-tan areas with a fine texture for the dwarf shrubs and graminoids. The invading Wyoming big sagebrush appear as small gray-green speckles with a medium texture, and the invading pinyon and Utah juniper trees appear as medium dark green dots of varying diameters with a coarse texture.

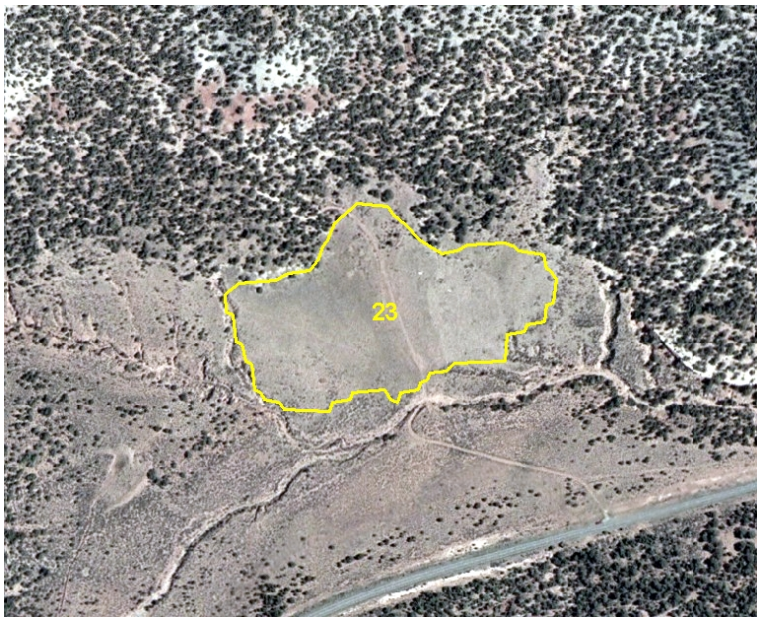
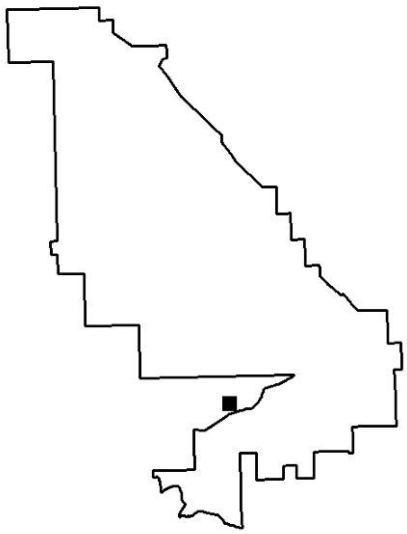


Photo S-WFSH-1



Location of **S-WFSH-1** within National Monument

Map Class 15
Cheatgrass Semi-natural Herbaceous Vegetation
(H-CGHB)

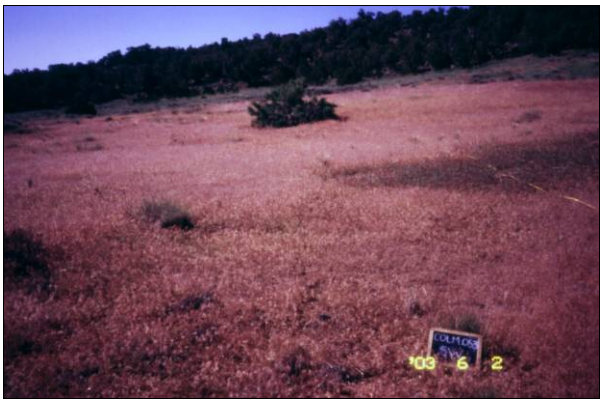


Photo credit: e²M



Photo credit: e²M

The Cheatgrass Semi-natural Herbaceous Vegetation (H-CGHB, Map Class 15) represents the *Bromus tectorum* (Cheatgrass) Semi-natural Herbaceous Vegetation.

H-CGHB Map Class Specifics:

Frequency	Total Project Polygons = 10
	7 polygons in COLM
	3 polygons in environs
Area	Total Project Area = 24.8 hectares / 61.4 acres
	13.1 hectares / 32.3 acres in COLM
	11.8 hectares / 29.1 acres in environs
Average Size	Total Project Polygons = 2.5 hectares / 6.1 acres
	1.9 hectares / 4.6 acres in COLM
	3.9 hectares / 9.7 acres in environs
Proportion	0.2% of total project mapping area
	0.2% of COLM portion of mapping area
	0.3% of environs portion of mapping area
Accuracy	Producer - 86% (confidence interval 57-115%)
(COLM only)	User - 86% (confidence interval 57-115%)

Ecological System:
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

Associations:
Bromus tectorum Semi-natural Herbaceous Vegetation [CEGL003019]

Common Species:
Bromus tectorum

Distribution/Ecology/Composition:
Small to moderate-sized patches of annual grasslands adjoin the eastern mapping area fenceline, have burned in the past two decades, and have been invaded by dense growth of the nonnative cheatgrass. This association often replaced stands of Wyoming Big Sagebrush Shrubland that had burned and were completely removed. One stand of cheatgrass located near the western Monument boundary established on former BLM-managed land that was used as a livestock corral or holding/loading area. Cheatgrass is the overwhelmingly dominant species on all sites, whether the cover is dense or sparse. A few relict native grasses or shrubs may persist, but they contribute less than 5% cover. One stand located at the eastern Monument fenceline was maintained by prairie dog grazing activity. Over time this annual

herbaceous community likely will be replaced by the Four-wing Saltbush Shrubland community, then the Wyoming Big Sagebrush community.

Interpretation

The H-CGHB Map Class occurs in small to large, mostly regular polygons typically located on the eastern edge of the Monument on alluvial fans. The signature varies from light to medium gray-green with a fine texture. The sparse, invading shrubs appear as small gray-green speckles with a medium texture, and the exposed substrates tend to be medium to light in tone.

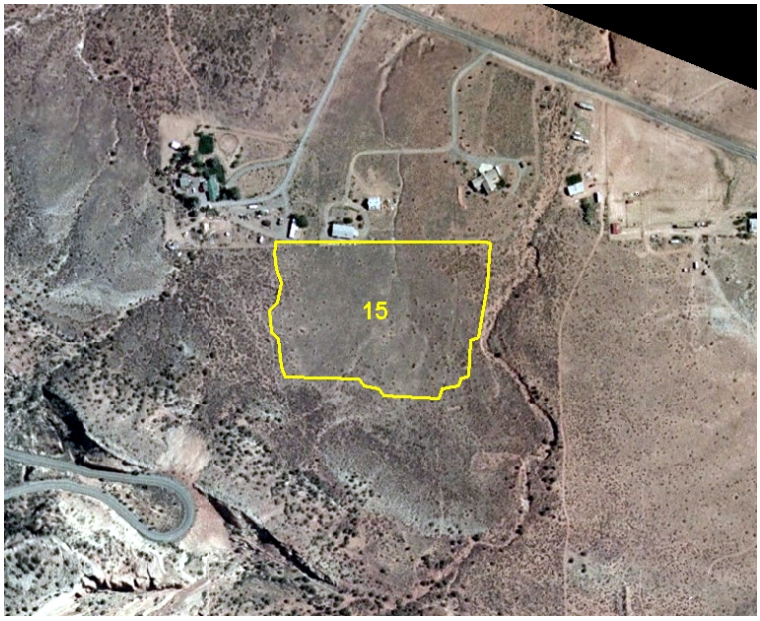
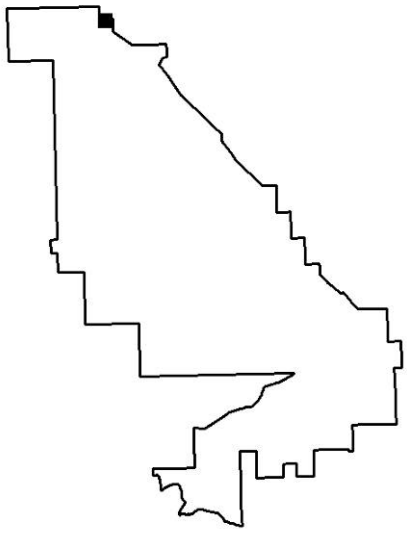


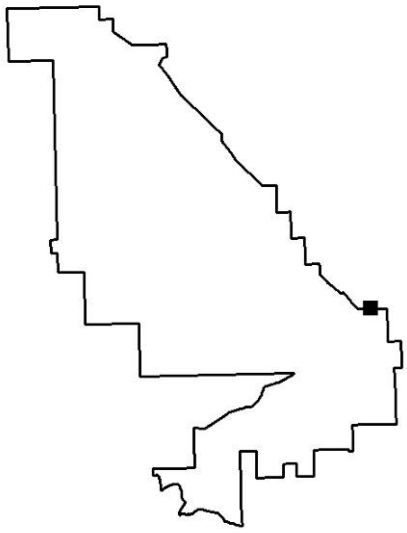
Photo H-CGHB-1



Location of **H-CGHB-1** within National Monument



Photo H-CGHB-2



Location of **H-CGHB-2** within National Monument

Map Class 16
Littleleaf Mountain Mahogany / Slickrock Sparse Vegetation (S-LLMM)



Photo credit: e²M



Photo credit: e²M

The Littleleaf Mountain Mahogany / Slickrock Sparse Vegetation (S-LLMM, Map Class 16) represents the *Cercocarpus intricatus* (Littleleaf Mountain Mahogany) / Slickrock Sparse Shrubland.

S-LLMM Map Class Specifics:

Frequency	Total Project Polygons = 16
	16 polygons in COLM
	0 polygons in environs
Area	Total Project Area = 37.7 hectares / 93.2 acres
	37.7 hectares / 93.2 acres in COLM
	0 hectares / 0 acres in environs
Average Size	Total Project Polygons = 2.3 hectares / 5.8 acres
	2.3 hectares / 5.8 acres in COLM
	0 hectares / 0 acres in environs
Proportion	0.3% of total project mapping area
	0.5% of COLM portion of mapping area
	0% of environs portion of mapping area
Accuracy (COLM only)	Producer - 100% (confidence interval 75-125%)
	User - 29% (confidence interval -7-64%)

Ecological System:
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

Association:
Cercocarpus intricatus / Slickrock Sparse Vegetation [CEGL002977]

Common Species:

Cercocarpus intricatus	*Artemisia bigelovii*
Ephedra viridis	*Juniperus osteosperma*
Pinus edulis	

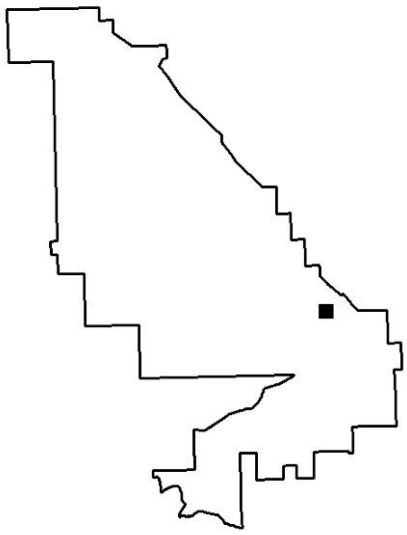
Distribution/Ecology/Composition:
The littleleaf mountain mahogany community is uncommon and occurs on the eastern edge of the Monument where Kayenta sandstone bedrock cracks and ledges provide sites for shrubs and a few small trees to root. Stands are present on the edges of mesas tilted to the northeast and east, including Lizard Mesa, Fruita Mesa, the mesa on which Serpent's Trail is constructed, and the canyon rims near Cold Shivers Point and eastern No Thoroughfare Canyon. Cover is open to sparse and littleleaf mountain mahogany is clearly dominant. Other shrubs include green Mormon-tea and Bigelow sagebrush and are

typically present, as are stunted trees of pinyon and Utah juniper. Depressions within the sandstone bedrock fill with shallow soils that support moderate to dense biological soil crust communities.

Interpretation:
The shrubs of the S-LLMM Map Class appear as small dark green dots in a random pattern of unevenly dispersed dots surrounded by lighter areas of exposed substrate. The shrubs often distribute linearly in cracks in the rock. Scattered pinyon and Utah juniper trees appear as medium dark green dots of varying diameters with a coarse texture.



Photo S-LLMM-1



Location of **S-LLMM-1** within National Monument

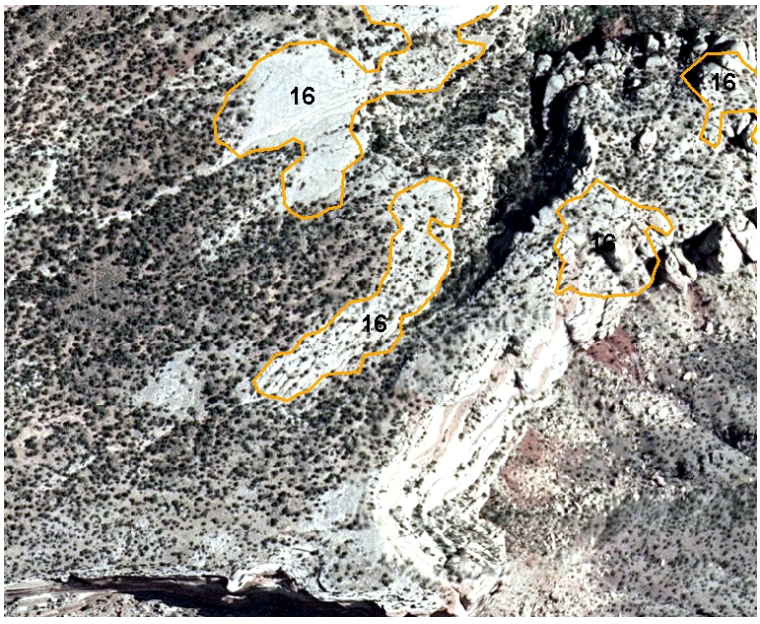
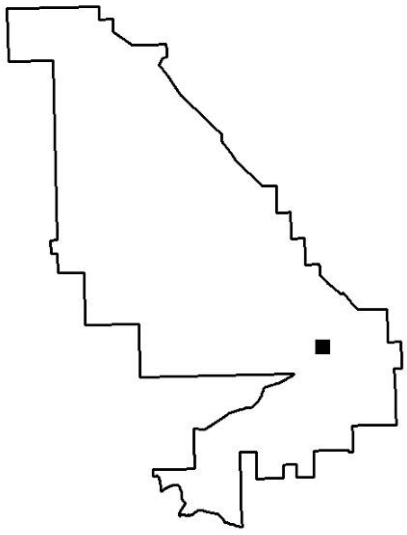


Photo S-LLMM-2



Location of **S-LLMM-2** within National Monument

Map Class 34
Nonvascular Cover - Board Beds Unit of the Entrada Sandstone (N-BIOC)



The Nonvascular Cover - Board Beds Unit of the Entrada sandstone (N-BIOC, Map Class 34) represents the moss and lichen growth of the Non-vascular Cover – Board Beds Unit, Entrada sandstone.

N-BIOC Map Class Specifics:

Frequency	Total Project Polygons = 14
	6 polygons in COLM
	8 polygons in environs
Area	Total Project Area = 22.9 hectares / 56.6 acres
	6.9 hectares / 17.0 acres in COLM
	16.0 hectares / 39.6 acres in environs
Average Size	Total Project Polygons = 1.6 hectares / 4.0 acres
	1.1 hectares / 2.8 acres in COLM
	2.0 hectares / 4.9 acres in environs
Proportion	0.2% of total project mapping area
	0.1% of COLM portion of mapping area
	0.4% of environs portion of mapping area

Ecological System:
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

Association:
Nonvascular Cover - Board Beds Unit, Entrada Sandstone [Park Special]

Common Species:
Crustose Lichens Foliose Lichens
Mosses

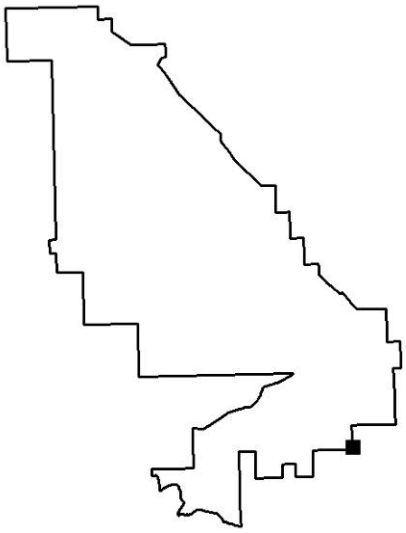
Distribution/Ecology/Composition:
Non-vascular Cover – Board Beds Unit, Entrada sandstone consists of the surface of this geologic exposure which is highly conducive to the growth of species of lichens and mosses. These are tan-to-

white-colored sandstone outcrops that are prominent along Ribbon Trail in the southeastern portion of the Monument. These large, tilted, east-facing sandstone exposures are devoid of vascular vegetation, but support a dense non-vascular community of crustose and foliose lichens and moss species. The nonvascular cover can approach 80% with plants attached to the roughened surface, along small crevices and cracks, and on minor elevations of this relatively smooth surfaced rock.

Interpretation:
Photo Signatures
The N-BIOC Map Class is very light colored with a fine to medium texture. The small cracks and channels in the rock surface appear as slightly darker gray lines. Inclusions of trees or shrubs appear as dark dots of varying sizes.



Photo N-BIOC-1



Location of **N-BIOC-1** within National Monument

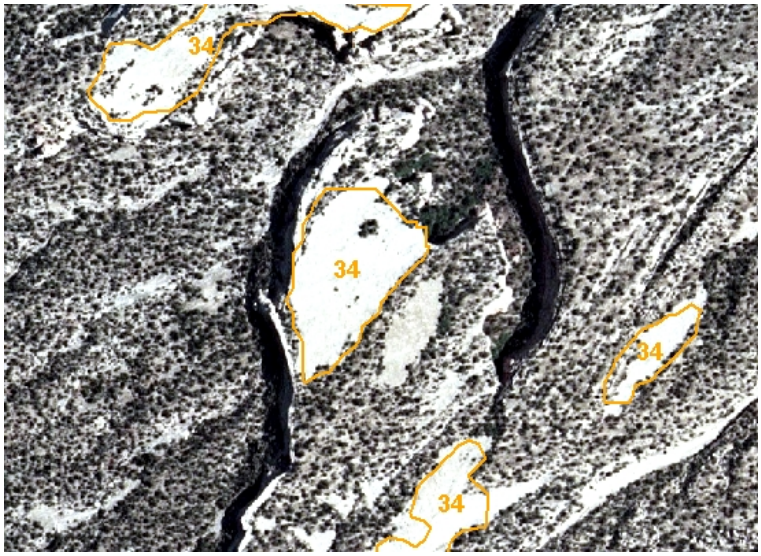
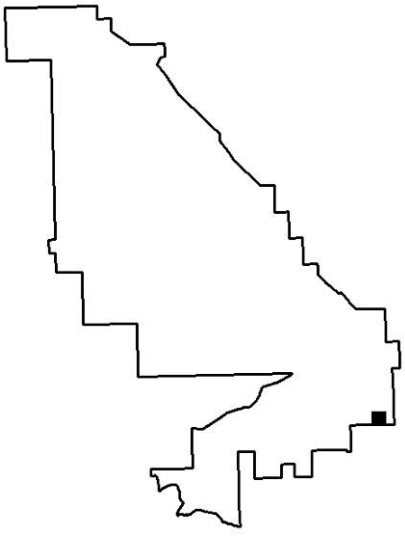


Photo N-BIOC-2



Location of **N-BIOC-2** within National Monument

Map Class 14
Quaking Aspen - Water Birch Forest-Shrubland
(F-ASWB)



Photo credit: e²M



Photo credit: e²M

The Quaking Aspen - Water Birch Forest-Shrubland (F-ASWB, Map Class 14) represents a combination of the *Populus tremuloides / Betula occidentalis* (Quaking Aspen / Water Birch) Forest and the *Betula occidentalis / Maianthemum stellatum* (Water Birch / Starflower False Solomon's-seal) Shrubland.

F-ASWB Map Class Specifics:

Frequency	Total Project Polygons = 2
	2 polygons in COLM
	0 polygons in environs
Area	Total Project Area = 6.5 hectares / 16.0 acres
	6.5 hectares / 16.0 acres in COLM
	0 hectares / 0 acres in environs
Average Size	Total Project Polygons = 3.2 hectares / 8.0 acres
	3.2 hectares / 8.0 acres in COLM
	0 hectares / 0 acres in environs
Proportion	0.1% of total project mapping area
	0.1% of COLM portion of mapping area
	0% of environs portion of mapping area
Accuracy (COLM only)	Producer – 100% (confidence interval= 83-117%)
	User – 100% (confidence interval= 83-117%)

Ecological System:
Rocky Mountain Subalpine-Montane Riparian Woodland (CES306.833)

Associations:
Populus tremuloides / Betula occidentalis Forest [CEGL002650]
Betula occidentalis / Maianthemum stellatum Shrubland [CEGL001162]

Common species:

Betula occidentalis	*Populus tremuloides*
Salix exigua	*Maianthemum stellatum*

Distribution/Ecology/Composition:

These are rare associations of the water birch tall shrubland or woodland type. They only occur in No Thoroughfare Canyon where there is cold air flow down the canyon and perennial flow or saturated soils in the stream. One stand occupied saturated soils of the drainage banks below a permanent spring at the head of No Thoroughfare Canyon and the other occurred on the drainage banks and in the channel in upper No Thoroughfare Canyon in the highest elevations of the monument. Quaking aspen saplings were present at the uppermost site, which was more mesic, shadier, and cooler than the other stands. The stands are subject to flooding when precipitation events occur and the channels have incised up to one-meter deep within the stands. A dense understory of forbs and graminoids becomes established where sediments remain undisturbed by flooding. As they age, these stands could be replaced by the Fremont, Rio Grande Cottonwood / Coyote Willow Forest or dense stands of the Coyote Willow / Mesic Graminoids Shrubland communities.

Interpretation:
The F-ASWB Map Class appears as medium dark green with a mottled texture. The trees are 5-20 m tall and have a canopy of up to 72% closed. The stands tend to have an oblong or linear shape, and follow the incised drainage course in the canyon bottom.

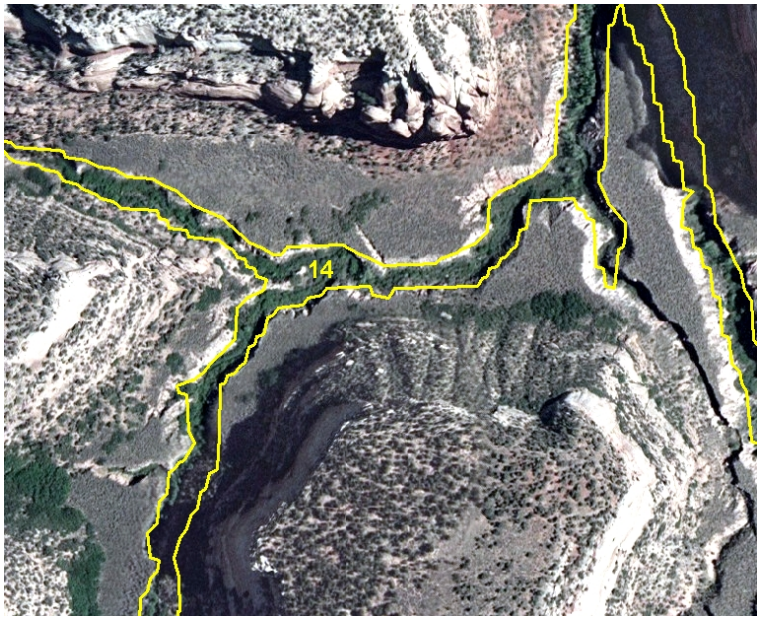
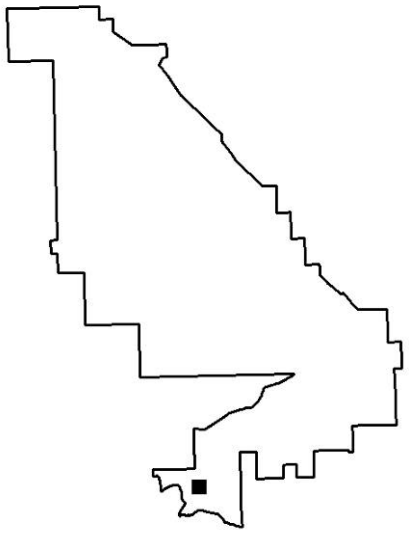


Photo F-ASWB-1



Location of **F-ASWB-1** within National Monument

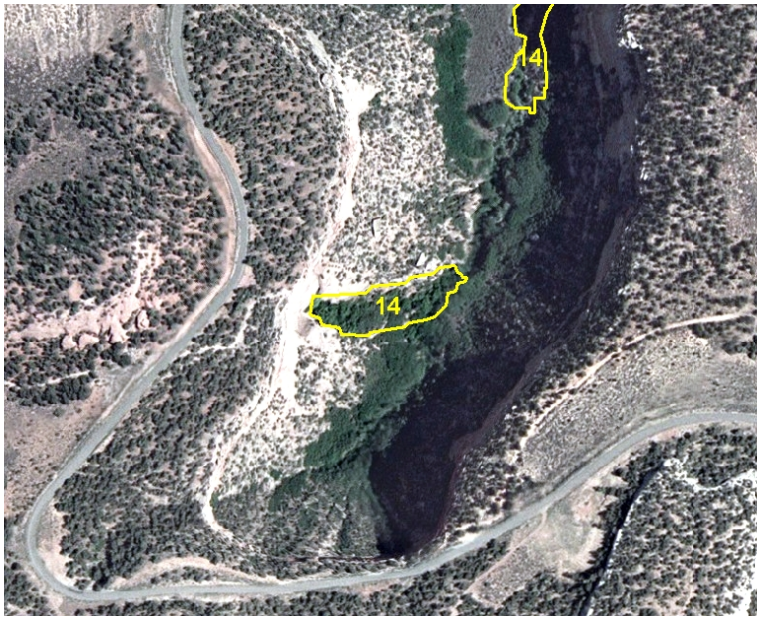
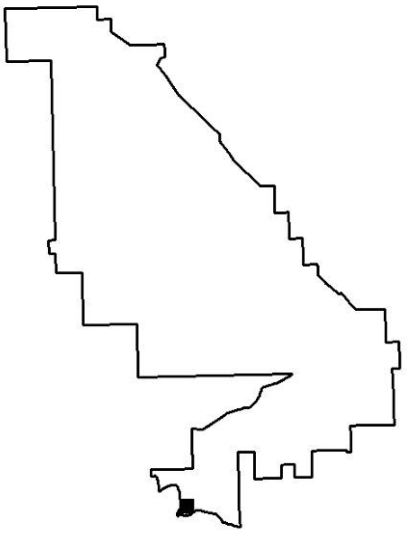


Photo F-ASWB-2



Location of **F-ASWB-2** within COLM

Map Class 29
Cottonwood / Coyote Willow Woodland
(W-COTW)



Photo credit: e²M

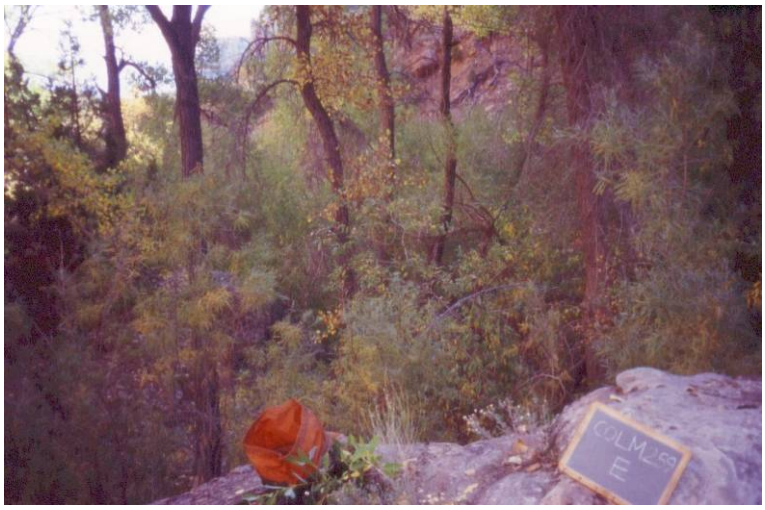


Photo credit: e²M

The Cottonwood / Coyote Willow Woodland (W-COTW, Map Class 29) represents the *Populus deltoides* (ssp. *wislizeni*, ssp. *monilifera*) */ Salix exigua* (Cottonwood / Coyote Willow) Woodland.

W-COTW Map Class Specifics:

Frequency	Total Project Polygons = 8
	6 polygons in COLM
	2 polygons in environs
Area	Total Project Area = 21.7 hectares / 53.5 acres
	10.6 hectares / 26.3 acres in COLM
	11.0 hectares / 27.2 acres in environs
Average Size	Total Project Polygons = 2.7 hectares / 6.7 acres
	1.8 hectares / 4.4 acres in COLM
	5.5 hectares / 13.6 acres in environs
Proportion	0.2% of total project mapping area
	0.1% of COLM portion of mapping area
	0.2% of environs portion of mapping area
Accuracy (COLM only)	Producer - 70% (confidence interval 41-99%)
	User – 100% (confidence interval 93-107%)

Ecological System:
Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.821)

Association:
Populus deltoides (ssp. *wislizeni*, ssp. *monilifera*) */ Salix exigua* Woodland [CEGL002685]

Common species:

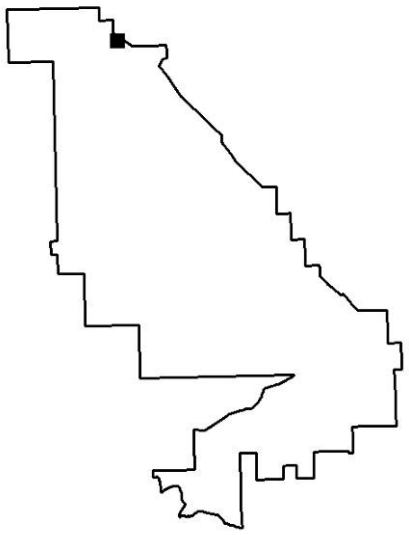
Populus deltoides ssp. *wislizenii*	*Celtis reticulata*
Fraxinus anomala	*Salix exigua*
Tamarix chinensis	*Maianthemum stellatum*

Distribution/Ecology/Composition:
The Rio Grande Cottonwood / Coyote Willow Forest is the most common riparian forest type within the Monument however it contributes a very small amount of the total vegetation cover. It is very patchy in distribution, occupying mesic canyon bottoms, intermittent drainage banks or terraces, and alcoves exclusively. The most extensive stands occupy the streambanks of upper No Thoroughfare Canyon where there is perennial flow from runoff, seeps, and springs. Smaller stands and clumps have become established on the floors of Ute, Red, and Columbus Canyons, all which have saturated soils or perennial stream flow in normal years. Narrow stands occur along drier intermittent drainages beyond the canyon mouths to the eastern boundary fenceline. The tree canopy is up to 35 m tall and is composed of Rio Grande cottonwood predominantly, but also occasional trees of western hackberry and single-leaf ash. Tamarisk, a nonnative tall shrub, often invades the shrub layer. These stands are subject to periodic flooding that can topple trees and scour the understory. However, the tree and shrub roots also trap and build sediments thus sustaining the stands. Where these stands become too dry, Utah juniper and pinyon trees replace the more mesic species forming an unclassifiable stand.

Interpretation:
The W-COTW appears as dark green with a coarse mottled texture for the cottonwood trees, and a lighter green with a smooth texture for the willow understory. The dark shadows of the individual cottonwood trees are distinctive. The tree canopy is 8-40%, but generally individual trees are visible. The tree heights are 10-35 meters.



Photo W-COTW-1



Location of **W-COTW-1** within National Monument

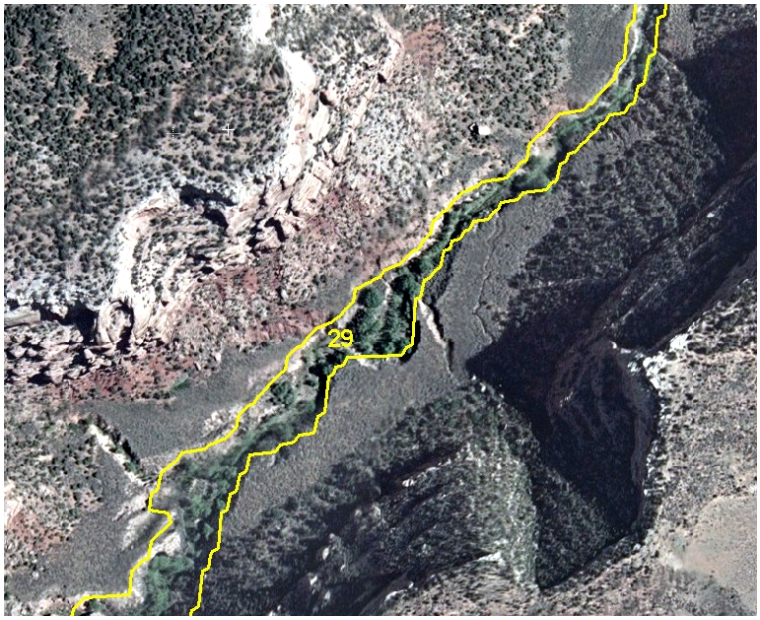
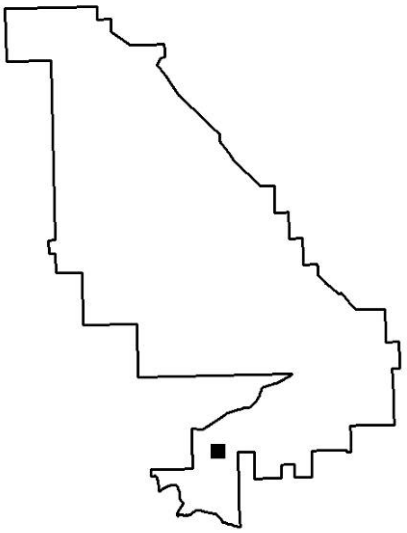


Photo W-COTW-2



Location of **W-COTW-2** within National Monument

Map Class 37
Coyote Willow / Mesic Graminoids Shrubland
(S-COWI)



Photo credit: e²M

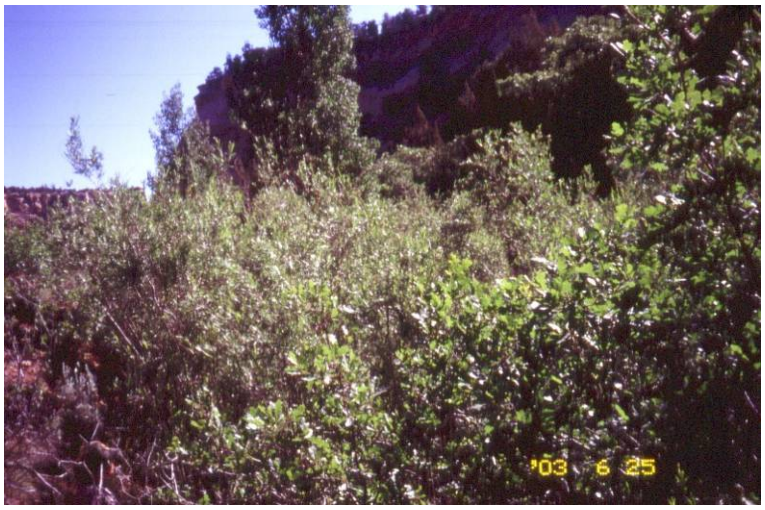


Photo credit: e²M

The Coyote Willow / Mesic Graminoids Shrubland (S-COWI, Map Class 37) represents the *Salix exigua* (Coyote Willow) / Mesic Graminoids Shrubland.

S-COWI Map Class Specifics:

Frequency	Total Project Polygons = 14
	19 polygons in COLM
	2 polygons in environs
Area	Total Project Area = 9.9 hectares / 24.4 acres
	9.2 hectares / 22.8 acres in COLM
	0.6 hectares / 1.6 acres in environs
Average Size	Total Project Polygons = 0.7 hectares / 1.7 acres
	0.8 hectares / 1.9 acres in COLM
	0.3 hectares / .8 acres in environs
Proportion	0.1% of total project mapping area
	0.1% of COLM portion of mapping area
	<0.1% of environs portion of mapping area
Accuracy (COLM only)	Producer - 83% (confidence interval 50-117%)
	User - 83% (confidence interval 50-117%)

Ecological System:
Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.821)

Association:
Salix exigua / Mesic Graminoids Shrubland [CEGL001203]

Common species:
Salix exigua *Juncus balticus*
Equisetum laevigatum

Distribution/Ecology/Composition:
The Coyote Willow / Mesic Graminoids Shrubland association is rare in the Monument, confined primarily to the streambanks in upper No Thoroughfare, Ute, and Red Canyons. A stand is also present in a small stock pond constructed on Kayenta sandstone bedrock on the south rim of No Thoroughfare

Canyon. This association occupied saturated, deep alluvium adjacent to the streambeds and also occurred in the stream channel of some reaches. It is subject to scour and streambed meandering during flood or high flow events. The community often has tamarisk and chokecherry shrubs and occasionally Rio Grande cottonwood trees. The herbaceous layer is typically low to moderate in cover and is often composed of the graminoids Baltic rush and smooth scouring-rush and the forb false Solomon's-seal. As these stands mature, they are generally replaced by Rio Grande Cottonwood / Coyote Willow Forest communities.

Interpretation:

The S-COWI Map Class appears as medium to dark green with a medium texture. The shrubs are 2-10 m tall and have a canopy of up to 65% closed. The stands have a linear shape, and follow the drainage course in the canyon bottoms.

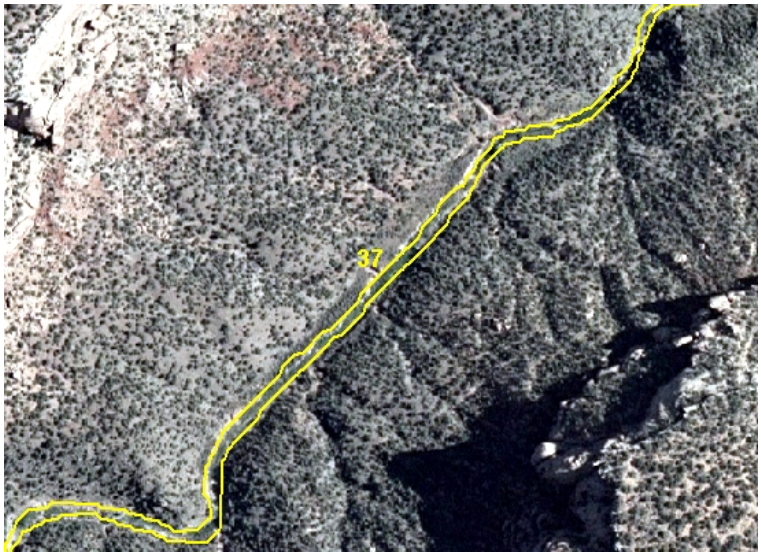
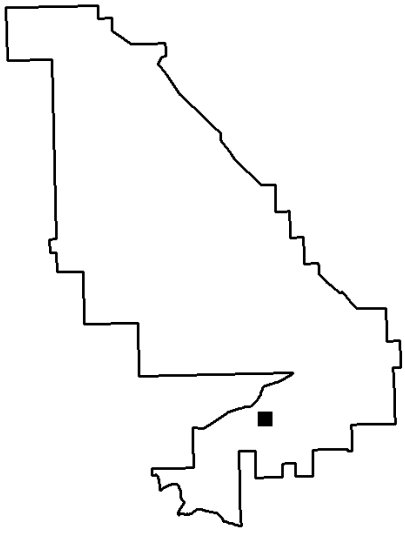


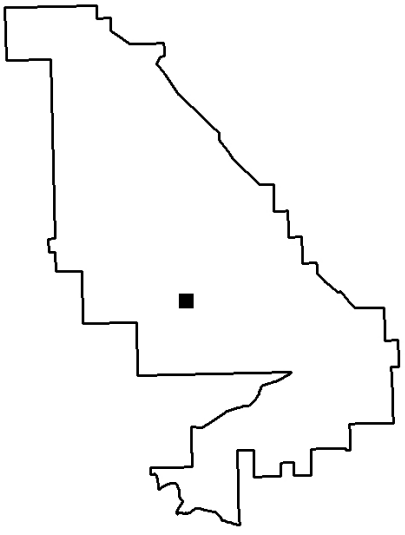
Photo S-COWI-1



Location of **S-COWI-1** within National Monument



Photo S-COWI-2



Location of **S-COWI-2** within National Monument

Map Class 17
Rubber Rabbitbrush Desert Wash Shrubland
(S-RURB)



Photo credit: e²M

The Rubber Rabbitbrush Desert Wash Shrubland (S-RURB, Map Class 17) represents the *Ericameria nauseosa* Desert Wash Shrubland.

S-RUBR Map Class Specifics:

Frequency	Total Project Polygons = 4
	4 polygons in COLM
	0 polygons in environs
Area	Total Project Area = 3.0 hectares / 7.4 acres
	3.0 hectares / 7.4 acres in COLM
	0 hectares / 0 acres in environs
Average Size	Total Project Polygons = 0.7 hectares / 1.8 acres
	0.8 hectares / 1.8 acres in COLM
	0 hectares / 0 acres in environs
Proportion	<0.1% of total project mapping area
	<0.1% of COLM portion of mapping area
	0% of environs portion of mapping area
Accuracy (COLM only)	Producer - 67% (confidence interval 27-107%)
	User – 100% (confidence interval 27-113%)

Ecological System:
Inter-Mountain Basins Wash (CES304.781)

Association:
Ericameria nauseosa Desert Wash Shrubland [CEGL002261]

Common species:
Ericameria nauseosa

Distribution/Ecology/Composition:
Rubber rabbitbrush lines the banks of sand and gravel-bottomed drainages in canyon bottoms where the drainages widen near the monument's eastern boundary. As such they are subject to intense floods, scouring, and burial during runoff from precipitation events. Drainages with these characteristics include

those in Echo, No Thoroughfare, Monument, and Fruita canyons. This rare to uncommon association typically consists of a band of vegetation approximately 2-5 m wide on the first terrace of both banks and an unvegetated gravel or cobble streambed in-between. The shrubs capture both water-borne sediments and eolian particles, building up small mounds of soil that support a variety of forbs and grasses, including nonnatives such as yellow sweet clover, cocklebur, and cheatgrass. Stands are often invaded by tamarisk, but monument staff and volunteers control these nonnative, invasive shrubs using an aggressive eradication program.

Interpretation:
The shrubs of the S-RURB Map Class are not easily interpreted. This Map Class is identified by the light tone, fine texture, and linear shape of the gravel and cobble streambed, and by its landscape location (where the drainages widen near the eastern boundary). There is a sharp contrast between the light tone of the streambed and the darker tones of the vegetation growing on the first terraces.

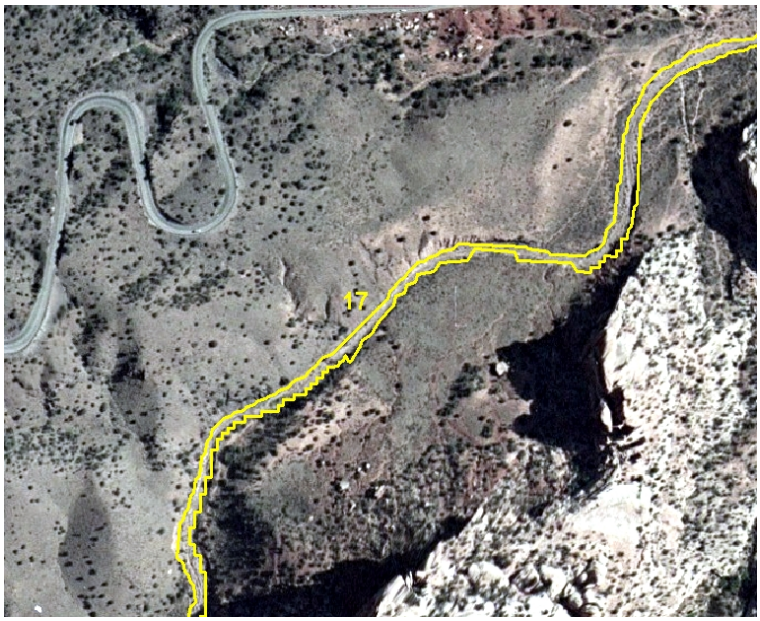
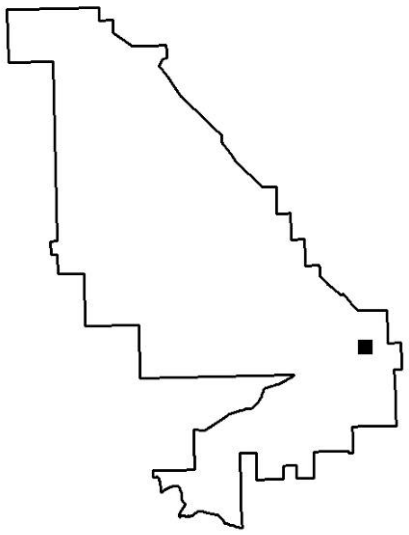


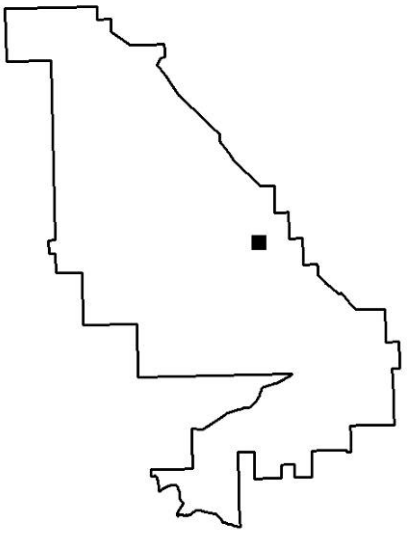
Photo S-RURB-1



Location of **S-RURB-1** within National Monument



Photo S-RURB-2



Location of **S-RURB-2** within National Monument

Map Class 18
Baltic Rush Herbaceous Vegetation
(H-BRHB)



Photo credit: e²M



Photo credit: e²M

The Baltic Rush Herbaceous Vegetation (H-BRHB, Map Class 18) represents the *Juncus balticus* (Baltic Rush) Herbaceous Vegetation.

H-BRHB Map Class Specifics:

Frequency	Total Project Polygons = 3
	3 polygons in COLM
	0 polygons in environs
Area	Total Project Area = 1.6 hectares / 3.8 acres
	1.6 hectares / 3.8 acres in COLM
	0 hectares / 0 acres in environs
Average Size	Total Project Polygons = 0.5 hectares / 1.3 acres
	0.5 hectares / 1.3 acres in COLM
	0 hectares / 0 acres in environs
Proportion	<0.1% of total project mapping area
	<0.1% of COLM portion of mapping area
	0% of environs portion of mapping area
Accuracy (COLM only)	Producer – 100% (confidence interval 88-113%)
	User – 100% (confidence interval 88-113%)

Ecological System:
North American Arid West Emergent Marsh (CES300.729)

Association:
Juncus balticus Herbaceous Vegetation [CEGL001838]

Common species:

Juncus balticus	*Equisetum laevigatum*
Hordeum jubatum	*Distichlis spicata*

Distribution/Ecology/Composition:
Baltic rush occupies saturated soils of canyon bottoms and alluvial fan drainages. In general Baltic rush stands are less than 10 m wide and have become established on saturated fine alluvium deposited in the drainage bottoms over Precambrian bedrock. Stands are therefore subject to scouring and/or burial by sediments and debris during runoff episodes. The most prominent stands occur in the bottom of Ute, Monument, and No Thoroughfare canyons where runoff water is supplemented by seepage from springs. One stand at the mouth of Fruita Canyon formed due to seepage from a small water storage reservoir that

was recently abandoned; this stand may disappear over time. When they dry due to drainage down-cutting or loss of hydrology by other means, stands are replaced by Black Greasewood Shrublands on alkaline soils or Basin Big Sagebrush Shrubland on neutral soils and drainages.

Interpretation:
The H-BRHB Map Class appears as medium to dark green in color with a fine texture. The herbaceous vegetation has up to 65% cover. The stands have a linear shape, and occupy the drainage course in the canyon bottom.

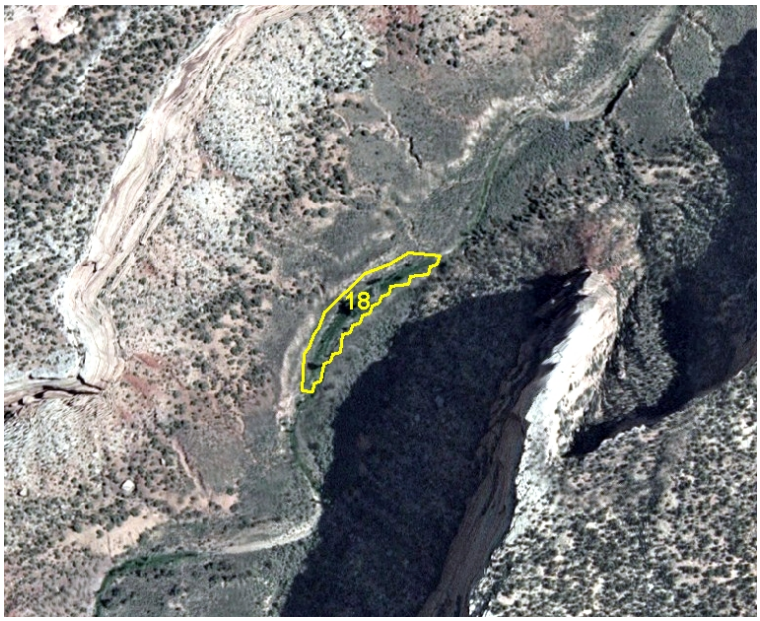
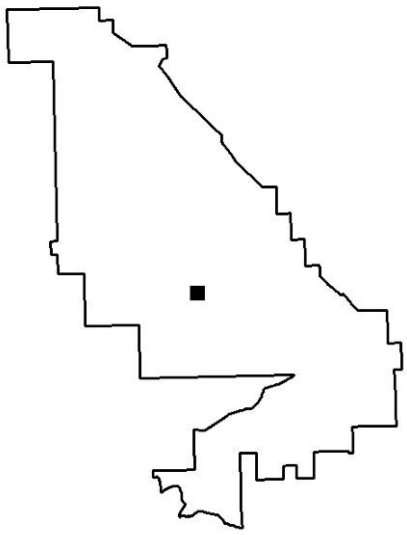


Photo H-BRHB-1



Location of **H-BRHB-1** within National Monument

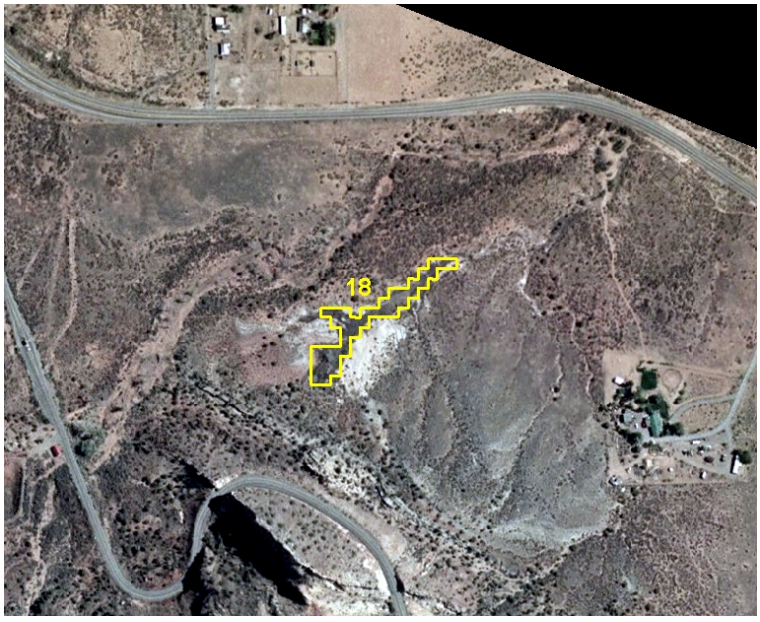
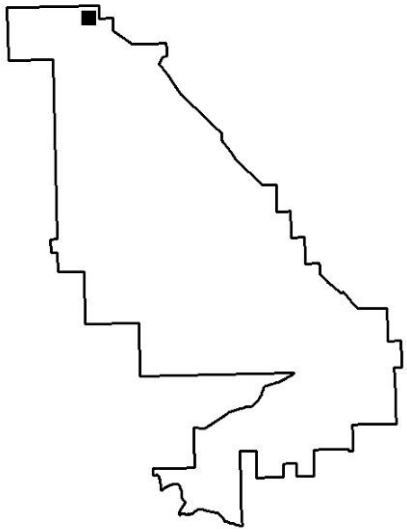


Photo H-BRHB-2



Location of **H-BRHB-2** within National Monument

Map Class 12
Shadscale – Black Greasewood Shrubland
(S-SSGR)



Photo credit: e²M



Photo credit: e²M

The Shadscale – Black Greasewood Shrubland (S-SSGR, Map Class 12) represents a combination of the *Atriplex confertifolia – Sarcobatus vermiculatus* (Shadscale – Black Greasewood) Shrubland and the *Sarcobatus vermiculatus* (Black Greasewood) Disturbed Shrubland.

S-SSGR Map Class Specifics:

Frequency	Total Project Polygons = 30
	10 polygons in COLM
	20 polygons in environs
Area	Total Project Area = 137.0 hectares / 338.4 acres
	31.2 hectares / 77.2 acres in COLM
	105.7 hectares / 261.3 acres in environs
Average Size	Total Project Polygons = 4.6 hectares / 11.3 acres
	3.1 hectares / 7.7 acres in COLM
	5.3 hectares / 13.1 acres in environs
Proportion	1.1% of total project mapping area
	0.4% of COLM portion of mapping area
	2.4% of environs portion of mapping area
Accuracy	Producer - 33% (confidence interval 10-57%)
(COLM only)	User - 71% (confidence interval 36-107%)

Ecological Systems:
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
Inter-Mountain Basins Greasewood Flat (CES304.780)

Associations:
Atriplex confertifolia - Sarcobatus vermiculatus Shrubland [CEGL001313]
Sarcobatus vermiculatus Disturbed Shrubland [CEGL001357]

Common species:

Atriplex confertifolia	*Sarcobatus vermiculatus*
Pleuraphis jamesii	*Bromus tectorum*

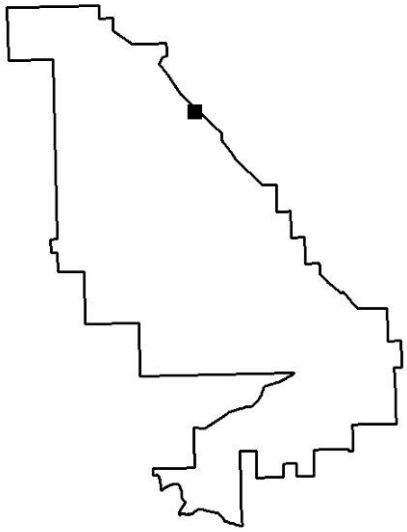
Distribution/Ecology/Composition:
These are rare to uncommon associations that have become established on alluvial fans and shallow drainages mostly on small slopes and ridges in canyon bottoms. Black greasewood dominated shrublands typically have sparse-to-low cover and occur on the alluvial fans and associated drainages along the eastern side of the Monument. The largest stand observed occurs south of the East Entrance Station in a

broad drainage along the Monument boundary fence. The soils of these stands are high in alkalinity, with shadscale more common where there is little deposition. The black greasewood tends to capture eolian particles and they form mounds of soil around these taller shrubs. Replacement of these stands following fire would result in Cheatgrass Semi-natural Herbaceous Vegetation dominance. As eolian deposits build and there is rooting space above the alkaline soils, the stands are likely to be replaced by the Utah Juniper / Wyoming Big Sagebrush Woodland.

Interpretation:
The S-SSGR Map Class appears as gray-green areas with a medium to fine texture. Lighter areas are more exposed substrate. Occasional pinyon and Utah juniper trees appear as medium dark green dots of varying diameters with a coarse texture.



Photo S-SSGR-1



Location of **S-SSGR-1** within National Monument

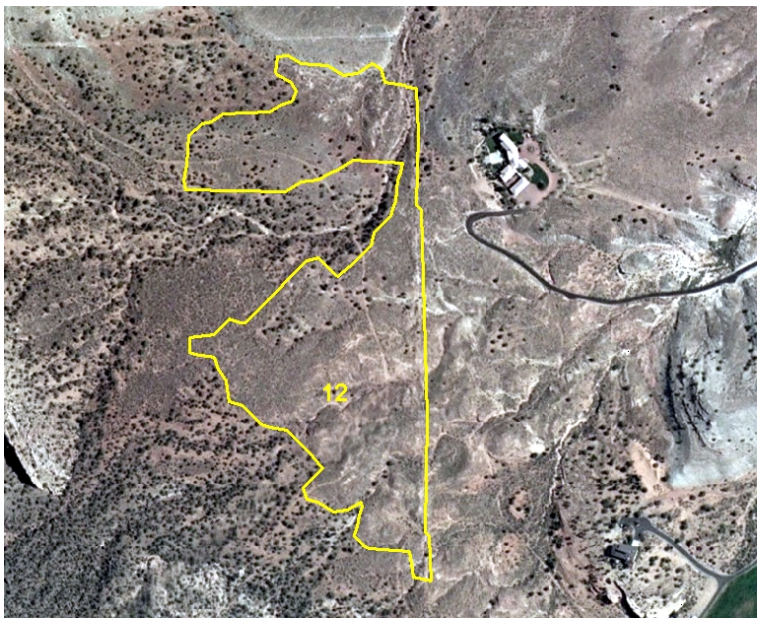
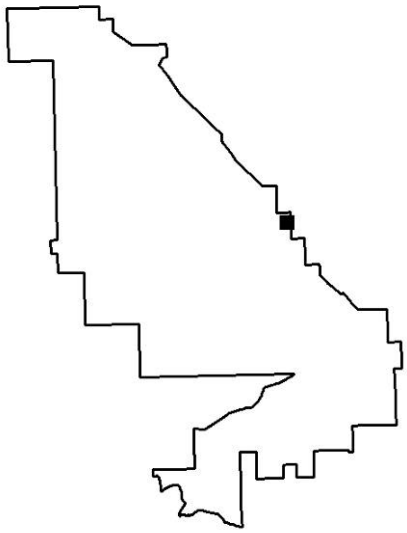


Photo S-SSGR-2



Location of **S-SSGR-2** within National Monument

Map Class 4
Black Sagebrush and Grasses Shrubland – Graminoids (S-BSGR)



Photo credit: e²M



Photo credit: e²M

The Black Sagebrush and Grasses Shrubland - Graminoids (S-BSGR, Map Class 4) represents a combination of the *Artemisia nova* / *Leymus salinus* (Black Sagebrush / Salinas Lyme Grass) Shrub Herbaceous Vegetation, the *Artemisia nova* (Black Sagebrush) Shrubland, the *Atriplex confertifolia* / *Pleuraphis jamesii* (Shadscale / James' Galleta) Shrubland, the *Opuntia polyacantha* / *Pleuraphis jamesii* (Panhandle Prickly-pear / James' Galleta) Dwarf-shrubland, the *Pleuraphis jamesii* (James' Galleta) Herbaceous Vegetation, the *Juniperus osteosperma* / *Leymus salinus* (Utah Juniper / Salinas Lyme Grass) Woodland, and the *Leymus salinus* (Salinas Lyme Grass) Shale Sparse Vegetation.

S-BSGR Map Class Specifics:

Frequency	Total Project Polygons = 154
	83 polygons in COLM
	71 polygons in environs
Area	Total Project Area = 612.2 hectares / 1512.8 acres
	267.1 hectares / 660.1 acres in COLM
	345.1 hectares / 852.7 acres in environs
Average Size	Total Project Polygons = 4.0 hectares / 9.8 acres
	3.2 hectares / 8.0 acres in COLM
	4.9 hectares / 12.0 acres in environs
Proportion	4.8% of total project mapping area
	3.2% of COLM portion of mapping area
	7.8% of environs portion of mapping area
Accuracy (COLM only)	Producer - 88% (confidence interval 77-99%)
	User - 81% (confidence interval 68-93%

Ecological Systems:
Colorado Plateau Mixed Low Sagebrush Shrubland (CES304.762)
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Inter-Mountain Basins Shale Badland (CES304.789)

Associations:
Artemisia nova / Leymus salinus Shrub Herbaceous Vegetation [CEGL001421]
Artemisia nova Shrubland [CEGL001417]
Atriplex confertifolia / Pleuraphis jamesii Shrubland [CEGL001304]
Opuntia polyacantha / Pleuraphis jamesii Shrubland [CEGL002299]

Pleuraphis jamesii Herbaceous Vegetation [CEGL001777]
Pinus edulis – Juniperus spp. / *Leymus salinus* Woodland [CEGL002340]
Leymus salinus Shale Sparse Vegetation [CEGL002745]

Common Species:

Artemisia nova	*Leymus salinus*
Pleuraphis jamesii	*Atriplex confertifolia*
Opuntia polyacantha	*Juniperus osteosperma*

Distribution/Ecology/Composition:
This unit occurs on soils derived from Morrison Formation and Precambrian bedrock on ridges, hills, slopes, and alluvial fans. It occurs at all elevations and occupies all aspects within the Monument, but stands are typically denser on north-facing aspects. Soils derived from Morrison Formation shale are white to pink in color while Precambrian bedrock gravels and sands are brown and reddish to gray-black and range from fine (silt) to coarse (gravel and cobble) in texture. The associations representing this unit occur on Black Ridge, Echo Canyon, Monument Mesa, and White Rocks and on Precambrian exposures in all valley bottoms. Scattered individuals or small clumps of pinyon and/or Utah juniper trees are typically present. Black sagebrush occupies rocky, thin soils on gentle to moderately steep slopes. Stands often have some cover by shadscale. Utah juniper and Wyoming big sagebrush commonly invade and provide sparse to low cover in stands that have become established on Precambrian gravel ridges and slopes. James' galleta has become established as the most common grassland type in the Monument on a variety of substrates including alluvium, shale, and Precambrian gravel. Panhandle prickly-pear is uncommon to locally common and is found in areas that were heavily grazed by bison, sheep, and cattle historically. The most stable soils often have a well-developed biological soil crust.

Interpretation:
The S-BSGR Map Class varies from very light tan to a medium red or gray with a fine texture for the dwarf-shrubs and graminoids. The invading shrubs appear as small gray-green speckles with a medium texture, and the invading pinyon and Utah juniper trees appear as medium dark green dots of varying diameters with a coarse texture. The exposed substrates tend to be medium to light in tone.

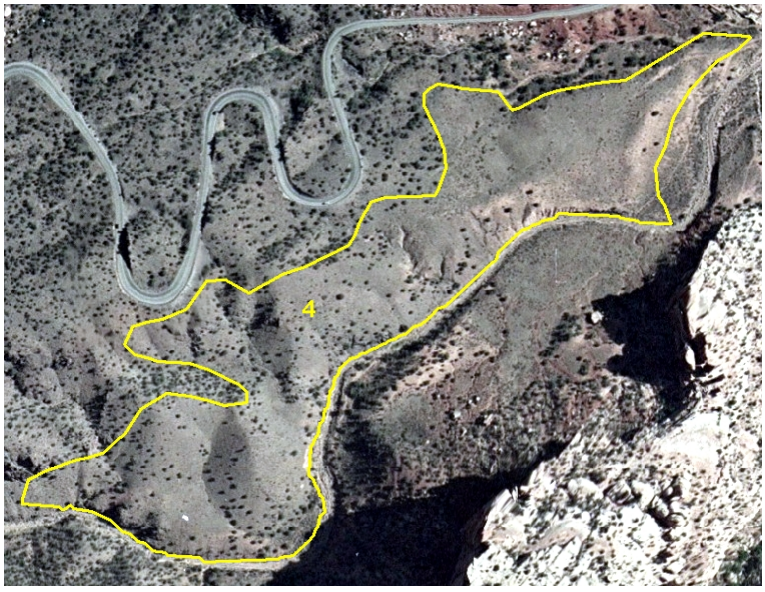
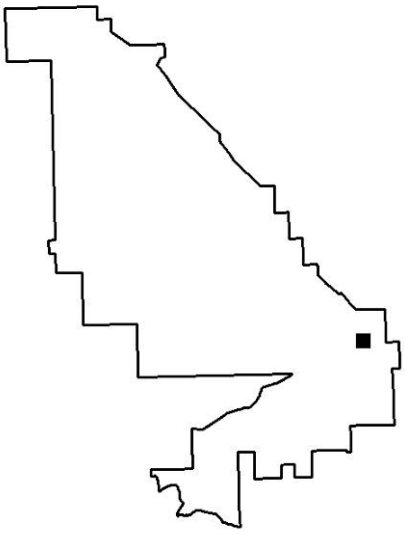


Photo S-BSGR-1



Location of **S-BSGR-1** within National Monument

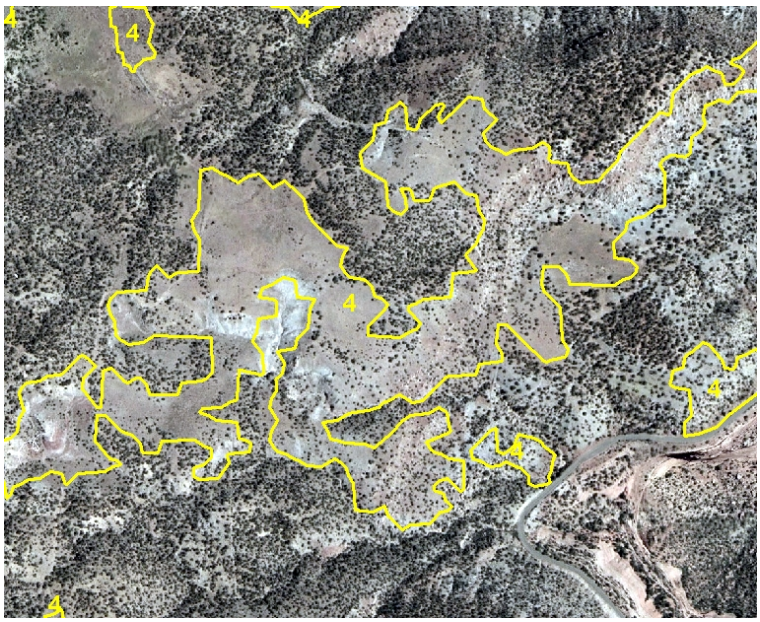
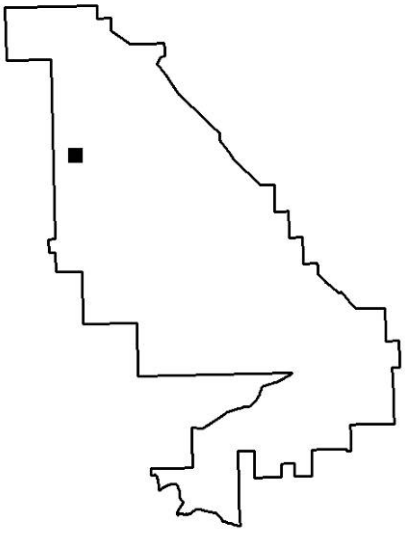


Photo S-BSGR-2



Location of **S-BSGR-2** within National Monument

Map Class 31
Crested Wheatgrass Semi-natural Herbaceous Vegetation (H-CWHB)



Photo credit: e²M



Photo credit: e²M

The Crested Wheatgrass Semi-natural Herbaceous Vegetation (H-CWHB, Map Class 31) represents the *Agropyron cristatum* (Crested Wheatgrass) Semi-natural Herbaceous Alliance.

H-CWHB Map Class Specifics:

Frequency	Total Project Polygons = 23
	2 polygons in COLM
	21 polygons in environs
Area	Total Project Area = 124.8 hectares / 308.4 acres
	3.5 hectares / 8.6 acres in COLM
	121.4 hectares / 300.0 acres in environs
Average Size	Total Project Polygons = 5.4 hectares / 13.4 acres
	1.7 hectares / 4.3 acres in COLM
	5.8 hectares / 14.3 acres in environs
Proportion	1.0% of total project mapping area
	<0.1% of COLM portion of mapping area
	2.7% of environs portion of mapping area

Ecological Systems:
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
Inter-Mountain Basins Greasewood Flat (CES304.780)
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

Association:
Agropyron cristatum Semi-natural Herbaceous Alliance [A3563]

Common species:
Agropyron cristatum

Distribution/Ecology/Composition:
Crested wheatgrass was introduced on private property adjacent to the Monument in the area of Little Park Road, south and west of upper No Thoroughfare Canyon, principally to support grazing livestock and possibly to reduce fire hazard to dwellings and outbuildings. The land formerly supported Two-needle Pinyon Pine - Utah Juniper / Wyoming Big Sagebrush Woodland stands and Wyoming Big Sagebrush Shrublands prior to alteration by physical and mechanical means, e.g., fire, chaining, disking, planting, etc. No additional data were collected for this vegetation type because it only occurs on private

property adjacent to the park. Should maintenance of crested wheatgrass stands be discontinued, they would be rapidly invaded by Wyoming big sagebrush shrubs and pinyon and Utah juniper trees.

Interpretation:
The H-CWHB Map Class varies from light to medium tan with a very fine texture. Due to the human manipulation, it has a very homogeneous signature. Two-needle Pinyon Pine and Utah juniper trees retained when the land was cleared appear as medium dark green dots of varying diameters with a coarse texture, and invading Wyoming big sagebrush and rubber rabbitbrush shrubs appear as small gray-green speckles with a medium texture

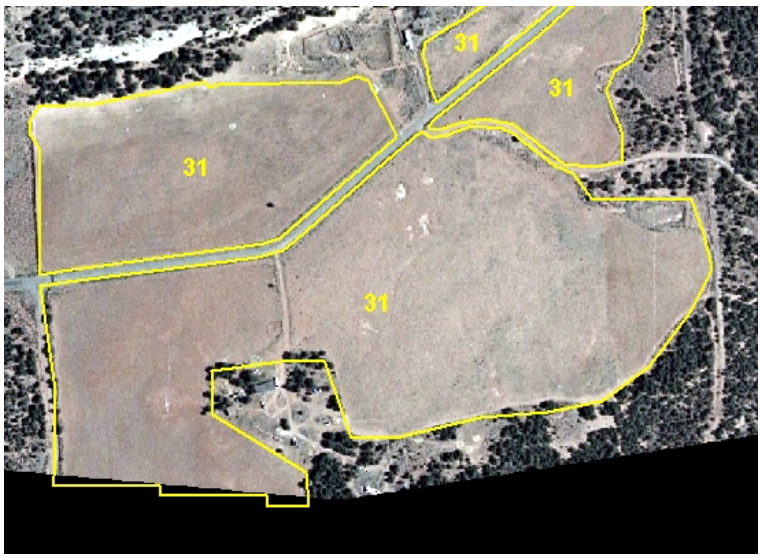
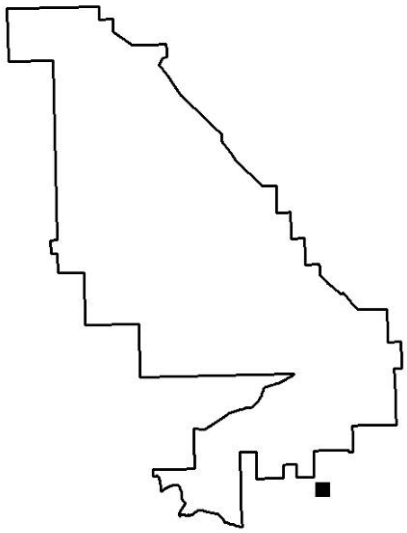


Photo H-CWHB-1



Location of **H-CWHB-1** within National Monument

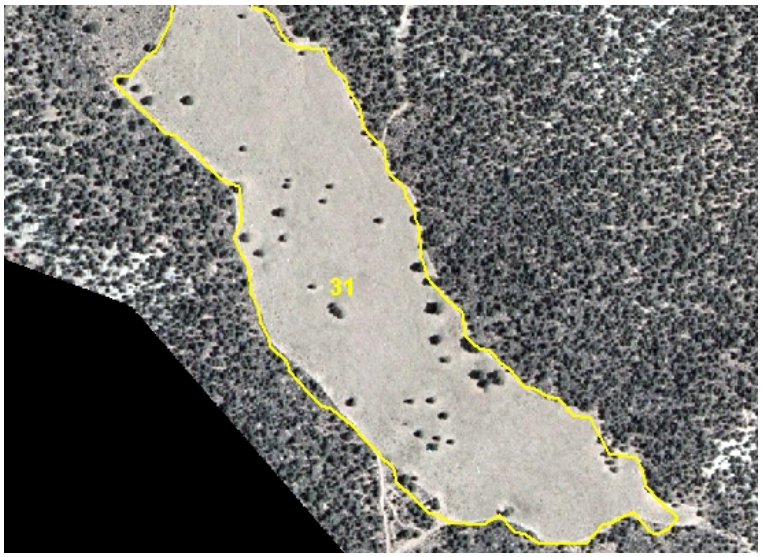
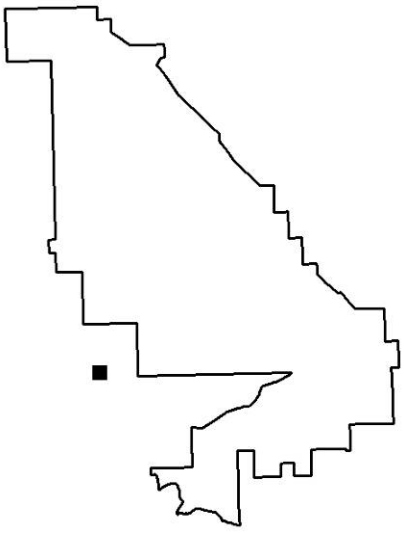


Photo H-CWHB-2



Location of **H-CWHB-2** within National Monument

GEOLOGY MAP CLASS WITHIN PRIMARY PROJECT MAPPING AREA

Map Class 32
Slickrock Member of the Entrada Sandstone
(G-ENTR)



Photo credit: NPS

Description:
Forms a pale-orange, ribbon-like cliff or rounded bench that is almost totally free of vegetation below the white cap of the 'board beds' unit. This unit weathers to form smooth, rounded benches or cliffs.

G-ENTR Map Class Specifics:

Frequency	Total Project Polygons = 130
	75 polygons in COLM
	55 polygons in environs
Area	Total Project Area = 264.6 hectares / 653.8 acres
	195.3 hectares / 482.6 acres in COLM
	69.3 hectares / 191.3 acres in environs
Average Size	Total Project Polygons = 2.0 hectares / 5.0 acres
	2.6 hectares / 6.4 acres in COLM
	1.2 hectares / 3.1 acres in environs
Proportion	2.1% of total project mapping area
	2.4% of COLM portion of mapping area
	1.6% of environs portion of mapping area

GEOLOGY MAP CLASS WITHIN PRIMARY PROJECT MAPPING AREA

Map Class 33
Wingate Sandstone
(G-WING)



Photo credit: NPS

Description:

This unit is predominantly cross-bedded orange-pink to reddish-orange sandstone and minor mudrock tha form the major cliffs within canyons that may be 600’ tall. Named monuments are generally of this sandstone, often capped by Kayenta sandstone.

G-WING Map Class Specifics:

Frequency	Total Project Polygons = 119
	118 polygons in COLM
	1 polygon in environs
Area	Total Project Area = 262.0hectares / 647.5 acres
	260.8 hectares / 644.6 acres in COLM
	1.2 hectares / 2.9 acres in environs
Average Size	Total Project Polygons = 2.2 hectares / 5.4 acres
	2.2 hectares / 5.4 acres in COLM
	1.2 hectares / 2.9 acres in environs
Proportion	2.1% of total project mapping area
	3.2% of COLM portion of mapping area
	<0.1% of environs portion of mapping area

GEOLOGY MAP CLASS WITHIN PRIMARY PROJECT MAPPING AREA

Map Class 36
Brushy Basin Member of the Morrison Formation
(G-MORR)



Photo credit: NPS

Description:
This unit is commonly involved in landslides, but consolidated cliffs and gentle rounded slopes of multicolored mudstone are also present.

G-MORR Map Class Specifics:

Frequency	Total Project Polygons = 19
	5 polygons in COLM
	14 polygons in environs
Area	Total Project Area = 29.3 hectares / 72.4 acres
	11.0 hectares / 27.3 acres in COLM
	18.2 hectares / 45.1 acres in environs
Average Size	Total Project Polygons = 1.5 hectares / 3.8 acres
	2.2 hectares / 5.5 acres in COLM
	1.3 hectares / 3.2 acres in environs
Proportion	0.2% of total project mapping area
	0.1% of COLM portion of mapping area
	0.4% of environs portion of mapping area

GEOLOGY MAP CLASS WITHIN PRIMARY PROJECT MAPPING AREA

Map Class 41
Kayenta Formation
(G-KAYN)



Photo credit: NPS

Description:
This reddish-orange sandstone bleaches nearly white and is comprised of sandstone, conglomerate, and mudstone. It forms resistant caps and ledges above the cliff-forming Wingate sandstone and also forms cliffs in several areas.

G-KAYN Map Class Specifics:

Frequency	Total Project Polygons = 4
	4 polygons in COLM
	0 polygons in environs
Area	Total Project Area = 33.6 hectares / 83.1 acres
	33.6 hectares / 83.1 acres in COLM
	0 hectares / 0 acres in environs
Average Size	Total Project Polygons = 8.4 hectares / 20.8 acres
	8.4 hectares / 20.8 acres in COLM
	0 hectares / 0 acres in environs
Proportion	0.3% of total project mapping area
	0.4% of COLM portion of mapping area
	0% of environs portion of mapping area

LAND USE MAP CLASS WITHIN PRIMARY PROJECT MAPPING AREA

Map Classes 42, 43 and 44
Roads
(L-ROAD, L-MROA, L-SERP)



Paved Road in Monument **Photo credit: NPS**



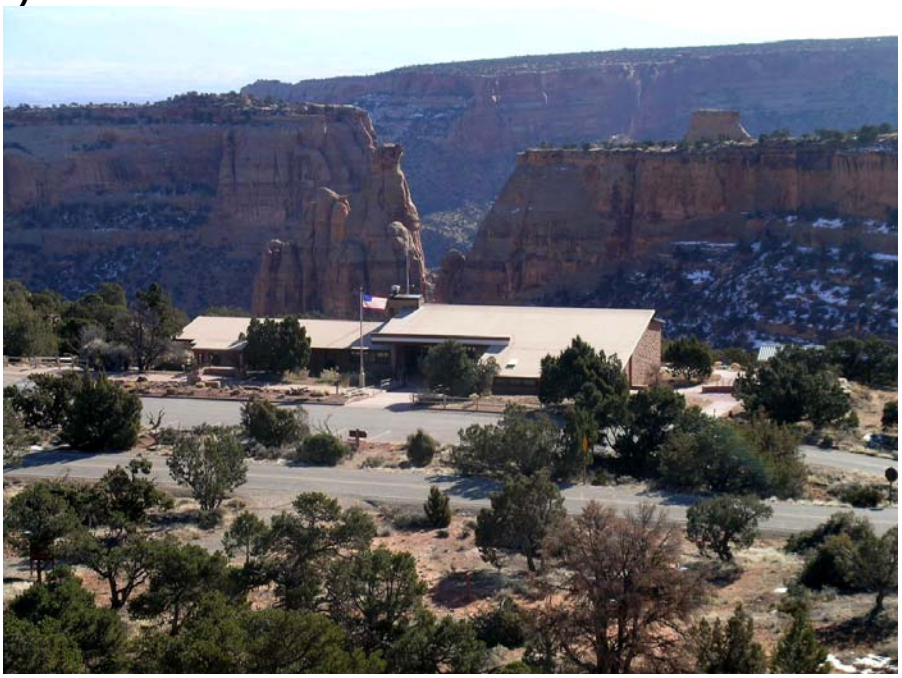
Serpent's Trail (dirt road converted to trail) **Photo credit: NPS**



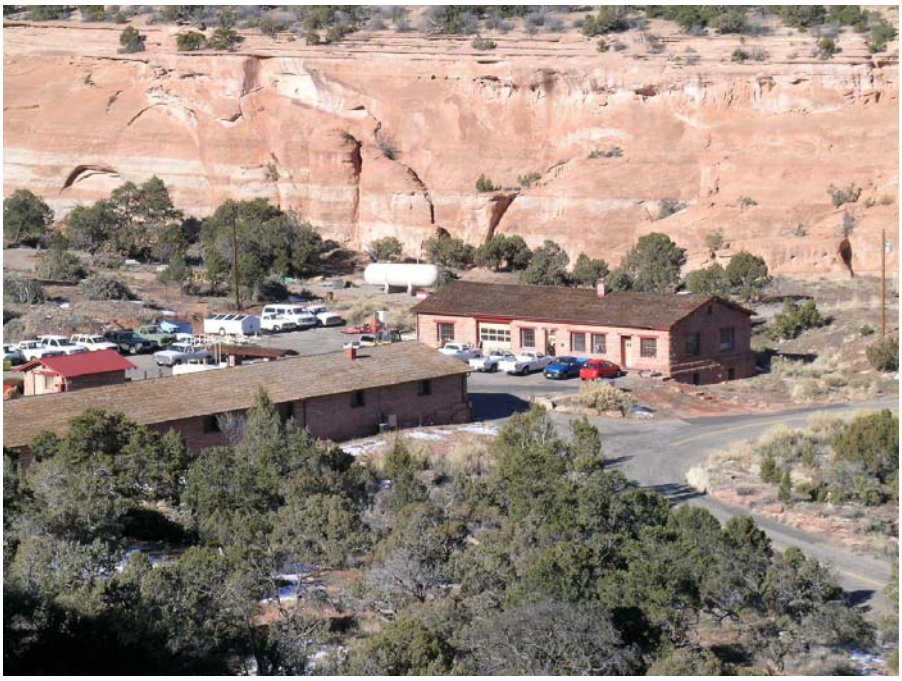
Gravel Road in Monnument **Photo credit: NPS**

Description:
All types of roads including paved, dirt, gravel and the Serpent's Trail (an historic road now used as a trail).

Map Class 46
Monument Buildings and Grounds
(L-MBLD)



Monument Visitor Center **Photo credit: NPS**



Residential and Office Area **Photo credit: NPS**

Description:
Building with associated driveways, parking areas and immediate developed and undeveloped land.

Map Class 47
Viewpoint Parking Area
(L-TOUT)



Red Canyon Overlook Parking Area **Photo credit: NPS**

Description:
Widened portions of major roads used for parking at viewpoints.

LAND USE MAP CLASS WITHIN PRIMARY PROJECT MAPPING AREA

Map Class 48
Unpaved Runway
(L-RNWY)

Photo Not Available

Description:
A runway for aircraft that is not paved.

Map Class 49
Picnic Area
(L-PICN)



Devil's Kitchen Picnic Area **Photo credit: NPS**

Description**:**
A developed area of the Monument for picknicking.

Map Class 50
Sewage Pond
(L-SEWG)



Photo credit: NPS

Description**:**
Artificial body of water in a human-constructed basin for the treatment of sewage.

Map Class 51
Road Fill Slope
(L-RFIL)



Photo credit: NPS

Description**:**
Embankment supporting the bed of a road.

LAND USE MAP CLASS WITHIN PRIMARY PROJECT MAPPING AREA

Map Class 52
Old Borrow Pit
(L-BPIT)



Photo credit: NPS

Description**:**
Area where gravel and/or soil was excavated in the past.

Map Class 53
Reservoir
(L-RESV)

Photo Not Available

Description**:**
Artificial body of water.

Map Classes 54 and 55
Residential Development
(L-RESD, L-RESM)



Photo credit: NPS

Description**:**
Lands containing structures for human habitation. This map class is further attributed as single-family or multi-family residential in the spatial database.

Map Classes 56 and 57
Non-Residential Development
(L-NONR, L-INST)



Photo credit: NPS

Description**:**
Developed areas used for purposes other than habitation. This map class is attributed as offices and institutions in the spatial database.

Map Class 58
Transportation
(L-TRAN)

Description:
Roads, railroads, airports and their associated lands in the urban-interface portion of the project area environs.



Photo credit: NPS

Map Class 59
Golf Course
(L-GOLF)

Description:
Structures and associated grounds, and interspersed natural areas used for golf.



Photo credit: NPS

Map Classes 60 and 61
Bare
(L-BARE, L-BROC)

Description:
Undeveloped areas of earth with less than 5% vegetative cover.

Photo Not Available

Map Class 63
Deciduous Forest Vegetation
(L-DFOR)

Description:
Stands of native and nonnative deciduous trees that are generally in excess of 60% crown closure. Typical species include Rio Grande cottonwood, weeping willow, globe willow, Chinese elm, and Russian-olive.

Photo Not Available

Map Class 64
Shrubland Vegetation
(L-SHRU)

Description:
Stands of native and nonnative shrubs that have moderate to dense crown closure. Typical species include black greasewood, rubber rabbitbrush, fourwing saltbush, Wyoming big sagebrush, basin big sagebrush, horizontal juniper, and tamarisk.

Photo Not Available

Map Class 66
Mixed Forest and Shrubland Vegetation
(L-MIXD)

Description:
Stands of mixed evergreen and deciduous native and nonnative trees and shrubs that together provide moderate to dense cover. Typical species include Utah juniper, pinyon, Rio Grande cottonwood, Russian-olive, black greasewood, fourwing saltbush, and tamarisk.



Photo credit: NPS

Map Class 67
Natural Herbaceous Vegetation
(L-HERB)

Description:
Stands of short- to medium-tall grasses that occupy alluvial deposits and drainages, including James' galleta, Indian ricegrass, needle-and-thread, sand dropseed, and blue grama.

Photo Not Available

Map Class 65
Orchards and Vineyards
(L-ORCH)

Description**:**
Areas containing plants of evenly spaced trees, shrubs, or other cultivated climbing plants. Also includes orchards, groves and vineyards.



Photo credit: NPS

Map Classes 68, 69, 70 and 71
Agricultural Field
(L-AGRI, L-IROW, L-PHAY, L-IPHA)

Description**:**
Areas of herbaceous vegetation planted and/or cultivated for agronomic purposes. This map class is further attributed in the spatial database by the following types of fields: fallow/bare, irrigated row crops, pasture/hay, and irrigated pasture/hay.



Photo credit: NPS

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov