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Vegetation Classification and Mapping Project Report, Fossil Butte National Monument

Natural Resource Technical Report NPS/NCPN/NRTR—2010/319

ON THE COVER
Fossil Butte, Fossil Butte National Monument (Photograph courtesy of Sarah Spratlen, e^2M)

Vegetation Classification and Mapping Project Report, Fossil Butte National Monument

Natural Resource Technical Report NPS/NCPN/NRTR—2010/319

Beverly Friesen, Steve Blauer, and Keith Landgraf
USGS Rocky Mountain Mapping Center
Lakewood, Colorado

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

Janet Coles
National Park Service
Moab, Utah

Keith Schulz
NatureServe
Boulder, Colorado

Amy Tendick, Aneth Wight and Gery Wakefield
National Park Service
Moab, Utah

Dr. Angela Evenden
National Park Service
Moab, Utah

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Acronyms and Abbreviations

AA	Accuracy Assessment
APFO	Aerial Photography Field Office (USDA)
BLM	United States Bureau of Land Management
BOR	United States Bureau of Reclamation
BPU	Biophysical Unit
CEGL	Community Element Code
CFS	Cubic Feet Per Second
CNHP	Colorado Natural Heritage Program
DBH	Diameter At Breast Height (4.5 feet)
DEM	Digital Elevation Model
DOQQ	Digital Orthophotograph Quarter Quadrangle
DRC	Diameter at Root Crown
e^2M	engineering-environmental Management, Incorperated
ES	Ecological System
ESRI	Environmental Systems Research Institute
FGDC	Federal Geographic Data Committee
FOBU	Fossil Butte National Monument
ft	Feet
GIS	Geographic Information System
GPS	Global Positioning System
I&M	Inventory and Monitoring Program
ITIS	Integrated Taxonomic Information System
km	Kilometer
LC/LU	Land Cover/Land Use
MMU	Minimum Mapping Unit
NAD	North American Datum
NBII	National Biological Information Infrastructure Program
NCPN	Northern Colorado Plateau Network
NPS	National Park Service
NPS FirePro	National Park Service Fire Program
NRCS	Natural Resource Conservation Service
NVC	National Vegetation Classification
NVCS	National Vegetation Classification Standard
QA/QC	Quality Assurance/Quality Control
RMGSC	USGS Rocky Mountain Geographic Science Center
RMMC	USGS Rocky Mountain Mapping Center
TNC	The Nature Conservancy
TSN	Taxonomic Serial Number
UNESCO	United Nations Education, Science, and Cultural Organization
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
WRCC	Western Region Climate Center

Summary

The Northern Colorado Plateau Inventory and Monitoring Network worked with the support of the U.S. Geological Survey - National Park Service Vegetation Mapping Program to describe and map vegetation at Fossil Butte National Monument (FOBU). This collaborative effort involved many project partners, particularly the FOBU superintendent and natural resources staff, the Rocky Mountain Mapping Center of the U.S. Geological Survey, the Western Region office of NatureServe, engineering-environmental Management, Inc., and their cooperators.

The mapping area is 6,217 ha (15,362 acres), encompassing the entire monument and an environs of adjacent public and private lands. Ecologists and photointerpreters cooperated to identify plant associations for FOBU and determine how best to map them using 1:12,000-scale, true color aerial photography and digital orthophotography. The team collected vegetation and environmental data from 158 vegetation classification plots and 97 observation points. Supplemental fuels data were collected in quaking aspen, Rocky Mountain juniper, limber pine, narrowleaf cottonwood, and Douglas-fir communities. Assessment of map accuracy entailed sampling 661 additional data points. Fieldwork and mapping were completed between 2005 and 2008.

A managed burn of approximately 95 acres occurred in sagebrush communities on the western side of the monument after the aerial photography was flown and before the accuracy assessment data was gathered.

Analysis of the plot data revealed 71 National Vegetation Classification plant associations, alliances, or park special vegetation types within the monument and environs. Four associations were documented from accuracy assessment data, the remainder from vegetation plots and observation points.

Vegetation and land use were interpreted to as detailed a level as possible from high-resolution, 9” x 9” stereo pairs of 1:12,000-scale true color aerial photography and 1m resolution true color orthoimagery. Polygons representing common vegetation or land use map classes were delineated using computer-assisted segmentation and classification techniques, supplemented by manual digitizing of rare types. The project used the program standard minimum mapping unit of 0.5 ha (1.24 ac) with few exceptions.

The FOBU vegetation mapping project area was divided into 1,709 polygons. A total of 1,687 map polygons represent 37 natural and semi-natural vegetation map classes. Two land use map classes describe 22 other polygons within the mapping area. Average polygon size across all map classes is 2.0 ha (5.0 acres). Natural and semi-natural vegetation classes cover 6,153 ha (15,205 acres; 98.7% of the project area). Land use polygons, including roads and NPS facilities, total 63.5 ha (156.9 acres; 1.3% of the project area). The most frequent vegetation mapping unit is the Low Sagebrush Shrubland (S-LOWS) with 646 polygons covering 2,161 ha (5,341 acres) or 35% of the project area.

Results from a thematic accuracy assessment of 15 vegetation map classes remaining after accuracy assessment analysis indicated an estimate of 89% overall map accuracy (Kappa statistic = 85.7%).

Products resulting from the FOBU vegetation mapping project include:

Available in this report:

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

Available elsewhere[1]:

- geodatabase containing map polygon attribute, land use, aerial photography flight lines, plot data and monument and project boundaries
- ground photography of vegetation plots, observation points, and accuracy assessment points in hard copy and digital formats
- all field data (plot, observation point, and accuracy assessment point) stored in a Microsoft Access database
- hard copy vegetation maps
- hard copy orthophotographs in DOQQ format and stereo aerial photograph prints
- metadata for all digital products

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

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

Acknowledgements

This project was completed through the effort and dedication of numerous individuals and organizations. Details of the role played by each person mentioned here are described in the Project Overview section. Angela Evenden (National Park Service), Mike Story and Tammy Cook (NPS), Karl Brown (USGS/NPS) and Mike Mulligan (USGS) provided project oversight and coordination. Funding for this project was provided through the USGS-NPS National Vegetation Mapping Program, NPS Fire Program, and the Northern Colorado Plateau Inventory and Monitoring Network.

Numerous individuals collected plot, observation point, and accuracy assessment field data. We appreciate the hard work of Janet Coles, Karin Edwards, Matt Smith, Margaret Foderero, Buddy Smith, Sarah Spratlen, and Jim Von Loh.

Karin Decker (Colorado Natural Heritage Program) completed the preliminary vegetation classification; final association names were assigned by Janet Coles, then of Natureserve. Bev Friesen, Steve Blauer and Keith Landgraf of the USGS Rocky Mountain Mapping Center (RMMC) developed the spatial database with assistance from Aneth Wight and Gery Wakefield of the NPS. Marion Reid of NatureServe developed the local association description template used in this report. Jim Von Loh (then of e^2M), Amy Tendick (NPS), and Karin Decker helped Janet Coles write and edit the final report.

Database management support and development were skillfully performed by Margaret Beer, Russ DenBleyker, and Helen Thomas (NPS) and Jack Doria (e^2M). Their preparation of a project MS Access database for plot, observation point, and accuracy assessment data simplified entry and analysis. Gery Wakefield and Aneth Wight (NPS) worked closely with RMMC to produce the final vegetation map coverage.

Special thanks to David McGinnis and Clay Kyte of Fossil Butte National Monument, who made us welcome whenever we arrived to check the map or collect field data, assisted with landowner contacts, and provided helpful advice as to the best way to access different parts of the monument.

For these and other contributors to the success of the project, we are grateful.

Introduction

Vegetation Classification and Mapping Project, Fossil Butte National Monument

The Fossil Butte National Monument (FOBU) Vegetation Mapping Project was organized and coordinated by the Northern Colorado Plateau Network (NCPN) Inventory and Monitoring (I&M) Program between 2005 and 2008, with assistance from several project cooperators. The purpose of this project was to describe and map existing plant associations on 6,217 hectares (15,362 acres) of FOBU and its environs, and to provide this information in written, tabular, digital, and spatial formats useful to monument resource managers, the NCPN I&M Program, and others. The basic project components consist of a classification and description of the monument's vegetation and a spatial database encompassing an interpretation of the vegetation from aerial imagery.

In 2001, the NCPN I&M Program launched a multi-year project to complete vegetation classifications and maps for network park units. Funding was provided by the U.S. Geological Survey (USGS) – National Park Service (NPS) Vegetation Mapping Program and the Northern Colorado Plateau Network. The FOBU Vegetation Classification and Mapping Project was initiated in 2004 by the NCPN, the U.S. Geological Survey Rocky Mountain Mapping Center (RMMC) and NatureServe. Project work was coordinated with the USGS-NPS Vegetation Mapping Program. Vegetation plot and observation point data collection occurred in 2005. Map accuracy assessment data were collected in 2006; analysis was completed in 2008.

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 FOBU mapping project area. Later sections document the methods and results for each of the major steps in the project: scoping, vegetation classification and description, vegetation mapping, and map accuracy assessment.

The USGS-NPS Vegetation Mapping Program

The National Vegetation Mapping Program is a cooperative project between the USGS and the NPS to inventory, classify, describe, and map vegetation in more than 270 national park units within the United States. Consistent vegetation classification, mapping, and accuracy assessment protocols and standards are applied across projects supported by this program. The National Vegetation Mapping Program is administered by the USGS Center for Biological Informatics in cooperation with the NPS I&M Program. Through implementation of the NPS Natural Resource Challenge (NPS 1999), significant funding became available for completing important natural resource baseline inventories in park units, including vegetation classification and mapping. This support provided the NPS with the opportunity to move forward with dozens of new park unit vegetation classification and mapping projects, including FOBU. 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 an inventory and long-term monitoring program for park natural resources over the last two decades of the twentieth century. This effort was enhanced by the NPS Natural Resource Challenge (NPS 1999); as a part of this initiative, the NCPN was formed in 2000 to develop an integrated inventory and monitoring program for 16 park units in Utah, Colorado, Arizona, and Wyoming.

A goal of the NPS I&M Program is to complete baseline inventories of biological and geophysical resources for each park unit. These inventories cover 12 basic data sets needed by park staff to guide resource management. Vegetation classification and mapping constitute one of these data sets. Early in the development of its I&M program, the NCPN made completing vegetation maps for each network park unit a priority. In addition to assisting park management, vegetation maps and classification information were identified as contributing significantly to NCPN long-term monitoring efforts. In 2001, the network began implementation of a strategy to complete vegetation mapping in all network park units. The FOBU vegetation mapping project is the eighth of the network-coordinated projects to be completed.

Vegetation Mapping Program Standards

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

Protocols

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

Standards

- National Vegetation Classification Standard (FGDC 1997)
- Spatial Data Transfer Standard (FGDC 1998b)
- Content Standard for Digital Geospatial Metadata (FGDC 1998a)
- United States National Map Accuracy Standards (USGS 1999)
- Integrated Taxonomic Information System
- Program-defined standards for map attribute accuracy and minimum mapping unit

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

National Vegetation Classification Standard

The National Vegetation Classification (NVC) is the system used in NCPN vegetation mapping projects (TNC and ESRI 1994a), and is based on the National Vegetation Classification Standard 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 structure of the NVC is based in part on an earlier international vegetation classification developed by the United Nations Educational, Cultural, and Scientific Organization (UNESCO 1973, Driscoll et al. 1984). Use of a standardized classification system helps to ensure data compatibility throughout the National Park Service and other agencies. The FGDC Vegetation Subcommittee works to keep this standard current and relevant. The substantial revisions to the upper levels of the NVC hierarchy adopted by the Vegetation Subcommittee as Version 2 (FGDC 2008) are not used in this project.

Vegetation classification systems attempt to recognize and describe repeating assemblages of plants in similar habitats. The 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 differences in floristic composition. The physiognomic units have a broad geographic perspective and the floristic units have utility in local and site-specific applications (Grossman et al. 1998). The physiognomic levels of the 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 form the base of the NVC hierarchy and are determined by the most abundant or diagnostic species comprising the various layers of a homogenous vegetation community. An association is here defined as a plant community type with a consistent species composition, uniform physiognomy, and similar habitat conditions (Flahault and Schroter 1910). Species composition differentiates associations (TNC and ESRI 1994a). An alliance is "a physiognomically uniform group of plant associations sharing one or more dominant or diagnostic species which, as a rule, are found in the uppermost strata of the vegetation." (Reid and Comer 1998). NatureServe coordinates plant association data for the NCPN vegetation mapping projects. Associations are added to the NVC and older concepts are refined as new data become available.

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

Level	Criteria Delineating Level	Example
Class	Structure (height, cover) of dominant vegetation strata	Forest
Subclass	Growth form characters including leaf type (evergreen, deciduous) for woody plants and persistence (perennial, annual) for herbaceous species	Deciduous forest
Group	Leaf morphology (broad leaf, microphyllous, xeromorphic), leaf phenology, and climatic conditions	Cold-deciduous forest
Subgroup	Relative degree of human disturbance	Natural/Semi-natural cold-deciduous forest

Level	Criteria Delineating Level	Example
Formation	Additional physiognomic characteristics, general environmental conditions, relative landscape position, and hydrologic regimes	Montane or boreal cold-deciduous forest
Alliance	Dominant or diagnostic species of uppermost or dominant stratum	*Populus tremuloides* Forest Alliance
Association	Other dominant or diagnostic species from any stratum	*Populus tremuloides / Shepherdia canadensis* Forest

Other Standards

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

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

Project Area Description

Location and Setting

FOBU is the northernmost of the NCPN park units, located in Lincoln County in southwestern Wyoming. It can be accessed from U.S. Highway 30 approximately 21 km (13 miles) west of Kemmerer (Figure 1). Kemmerer is the county seat with a population of 2,651. Lincoln County is rural in character, with a population density of four people per square mile.

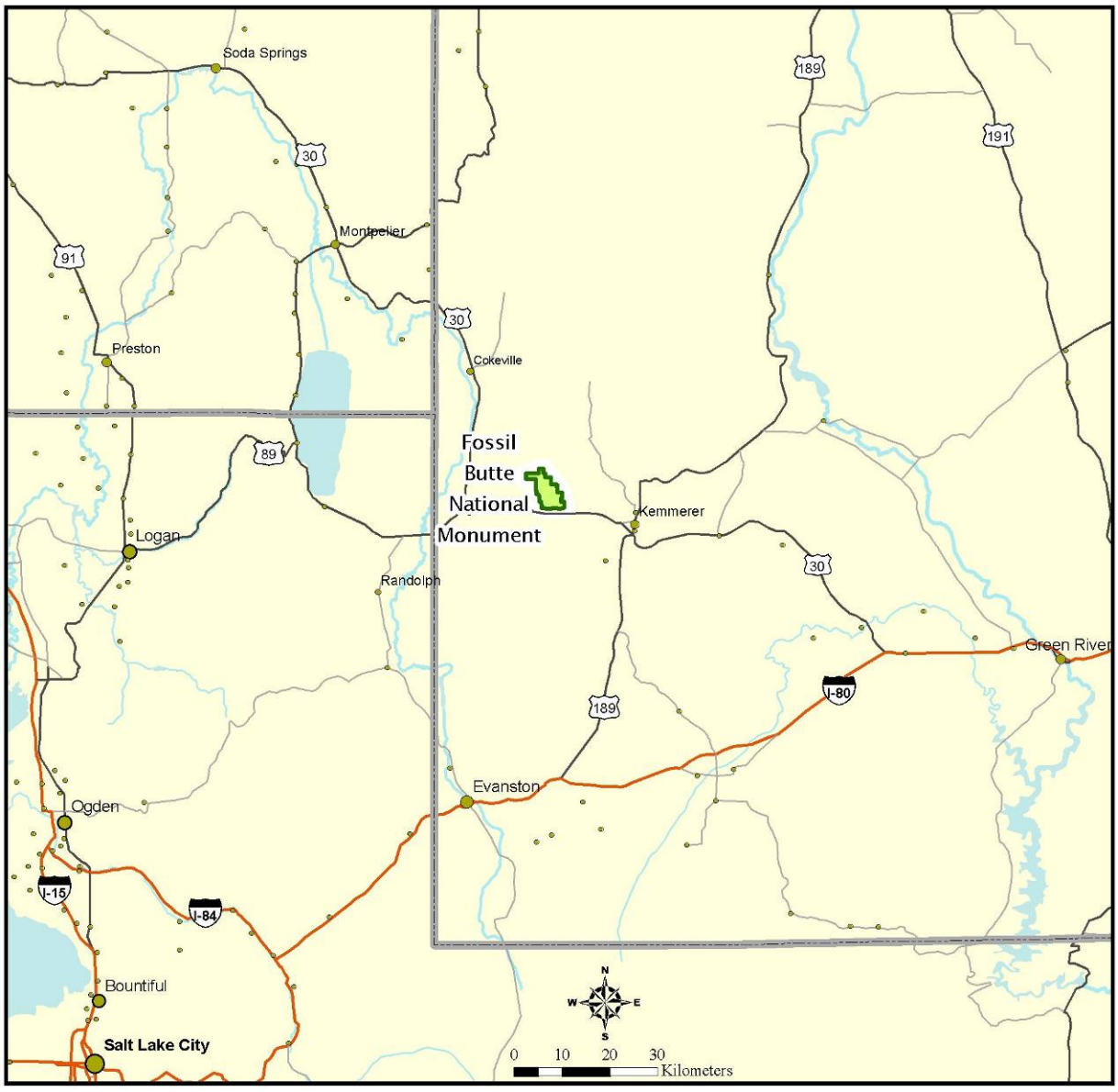


Figure 1. Location of FOBU in southwestern Wyoming.

The legislation creating Fossil Butte National Monument (FOBU) was signed in 1972 by President Richard M. Nixon (NPS 2008). FOBU was created to preserve and protect a unique assemblage of fossilized organisms that lived in or around Fossil Lake approximately 50 million

years ago. Rocks of the Wasatch and Green River formations within the monument also contain important clues to the environment of Fossil Lake and its environs. More than 80 specimens of fish and other biota that existed around 50 million years ago are on permanent display at the monument visitor center. An interpretive trail leads to a historic fossil quarry on the slopes of Fossil Butte. Recreational opportunities for monument visitors include viewing scenery and wildlife, hiking, and picnicking. Approximately 25,000 visitors travel to FOBU annually.

The monument boundary includes 3,351 ha (8,281 acres). The FOBU vegetation mapping area includes the entire monument and approximately 2,866 ha (7,077acres) of adjacent public and private lands (Figure 2) for a total of 6,217 ha (15,362 acres). The western FOBU boundary abuts private ranch land while the remainder is surrounded by BLM-managed grazing lands.

Topography

FOBU lies within the Bear Lake Section of the Middle Rocky Mountain physiographic province (McNab and Avers 1994). This section covers parts of southeastern Idaho, southwestern Wyoming and the northeastern corner of Utah. It is characterized by moderate, rolling terrain underlain by Tertiary sedimetary rocks. It lacks the steep mountains of other section in this province, and was not affected directly by Pleistocene glaciation.

The forces of water erosion and mass wasting combined to carve the sedimentary geological layers into their present topography. Landscapes within the monument are characterized by steep-sided buttes and ridges separated by small drainages and bordered by broad alluvial fans and shale badlands. Chicken Creek drains the central portion of the monument and Smallpox Creek drains the southwestern corner. Slumps and landslide deposits are evident throughout the monument. Named topographic features include Fossil Butte, Cundick Ridge, Murder Hill, Moosebones Canyon, The Bullpen, and Rubey Point. Elevations within FOBU range from 2,018 m (6,620 ft.) where Chicken Creek crosses the southern boundary to 2,464 m (8,084 ft.) at The Bullpen in the northern part of the monument.

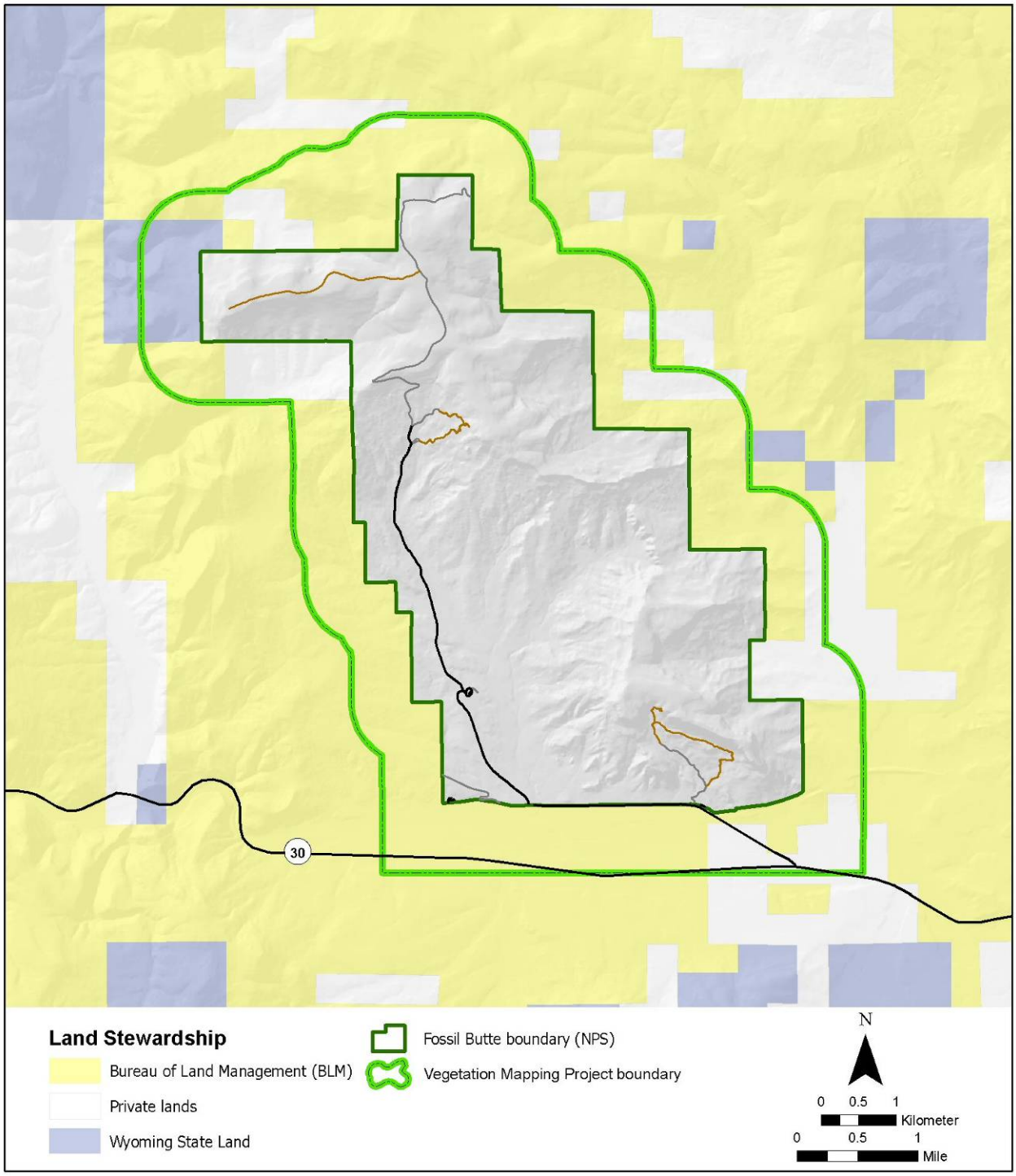


Figure 2. Map of the FOBU vegetation mapping project area boundary showing adjacent land ownership.

Climate

FOBU is characterized by a semiarid climate, averaging 27 cm (10.6 inches) of precipitation annually (Figure 3). Precipitation peaks in the late spring, with a smaller peak in the early autumn. Summers are relatively dry.

Records of climatic conditions have been maintained since 1990 at the monument visitor center (Western Regional Climate Center 2008). The driest year of record is 1999, in which only 3.4 cm (1.34 inches) of precipitation were recorded. The wettest year of record is 2005, with 37.7 cm (14.86 inches) of precipitation. Average annual snowfall is approximately 76 inches (193 cm) with December and January being the snowiest months. Snow can fall as early as September (report cover) and as late as June. Fossil Butte is quite windy, and during the winter there are frequent periods when the wind reaches 50 to 65 kph (30 to 40 mph) with gusts to 97 kph (60 mph). Winds are generally from the southwest (WRCC 2008).

Conditions within the monument can change significantly during a day and between seasons. The mean frost-free period is among the shortest of NCPN parks, averaging only 59 days. Summers are moderately warm with hot days averaging 84.0°F (28.9°C) and cool nights averaging 42.8 °F (6.0°C) in July. Hot days typically approach 90°F (32.2°C). The hottest day on record was 101°F (38.3°C) on July 31, 2000. Winters are cold with an average maximum temperature of 28.3°F (2.1°C) and an average minimum temperature of 5.1°F (-14.9°C) occurring in January. The coldest day on record was -45°F (-42.8°C) on December 1, 1995. Summer thunderstorms can arise seemingly out of nowhere and drench the unwary with heavy rain and high winds.

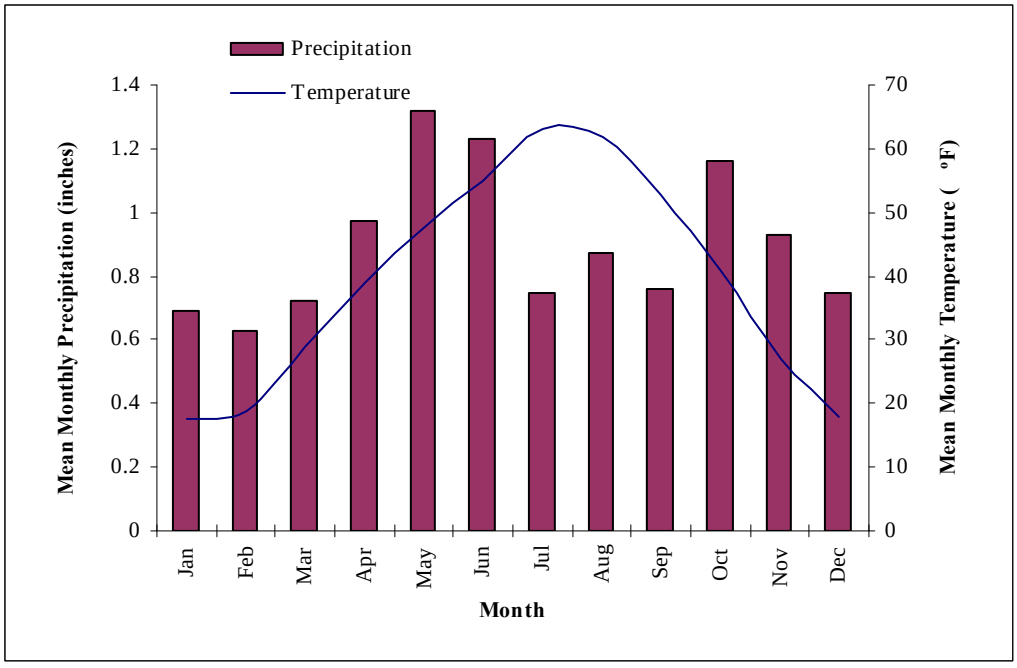


Figure 3. Climate data for FOBU (Western Regional Climate Center 2008).

Geology and Vegetation

FOBU was established to protect geologic exposures of the Green River and Wasatch formations containing a unique fossil assemblage (Figure 4). The paleo-ecosystems preserved in these lakebed and stream sediments at FOBU span approximately two million years of the Eocene Epoch (NPS 2008). Fossil Lake, which covered this region during the Eocene, has been described as a subtropical freshwater basin (M'Gonigle and Dover 1992). Fossils recovered from FOBU sediments include at least 25 species of fish (gar, paddlefish, bowfin, herring, perch, mooneye, stingray), insects (dragonflies), crayfish, reptiles (turtle, snake, crocodile), mammals (bat, horse), birds, and plants (palm, fig, cypress, willow, beech, oak, maple, sycamore, ferns, spruce, fir). The diversity, quality, and anatomical detail of the fossils is unique for sites of this period.

Fossil Lake sediments have been uplifted more than 1,830 m (6,000 ft.) since deposition, exposing rocks of the Green River and Wasatch formations. Erosion during the Pleistocene and Holocene deposited large areas of alluvium, colluvium, landslides, and terrace deposits. Landslides tend to occur where groundwater seeps and springs emerge at the contact between water-bearing layers and impermeable bedrock.

The following description of the geologic history of FOBU is derived from M'Gonigle and Dover (1992) and NPS (2008). All exposed rocks at FOBU are sedimentary, ranging in age from lower Eocene and possibly upper Paleocene (about 56 to 41 million years ago) to middle Eocene (about 41 to 34 million years ago). The uppermost strata of the Green River Formation, representing the largest extent of Fossil Lake, are exposed on Cundick Ridge and Fossil Butte. The Wasatch Formation interfingers with the Green River Formation throughout the monument (Figure 5); outcrops of its multi-colored shales and sandstones are best exposed in badlands around the visitor center. Recent surficial (unconsolidated) sediments are also evident in the form of alluvial fans, slumps, and stream terraces. Erosion has cut gullies into many of these soft deposits, exposing their structure and contributing to the instability of plant communities that have become established.

FOBU lies within the Intermountain Semidesert Province of the Temperate Desert Division (Bailey 2001) and supports vegetation broadly classified as high, cold desert. The monument contains vegetation typical of the rolling steppes of the Wyoming Basin; the arrangement of plant communities across the terrain is driven by elevation, substrate (geology and soils), aspect, hydrology, and fire history. Sagebrush-dominated shrublands cover most of the landscape, with woodland and forest stands occupying sheltered lee slopes and seeps; permanent grassland and forb communities are restricted to windswept ridgelines and hilltops, although herbaceous species will temporarily dominate sagebrush stands that have burned within the past 20 years. Actively eroding slopes may form sparsely vegetated badlands.

The remainder of this section is a summary of the general distribution of vegetation in relation to geology across the FOBU mapping area, organized stratigraphically from bottom to top as described in M'Gonigle and Dover (1992).

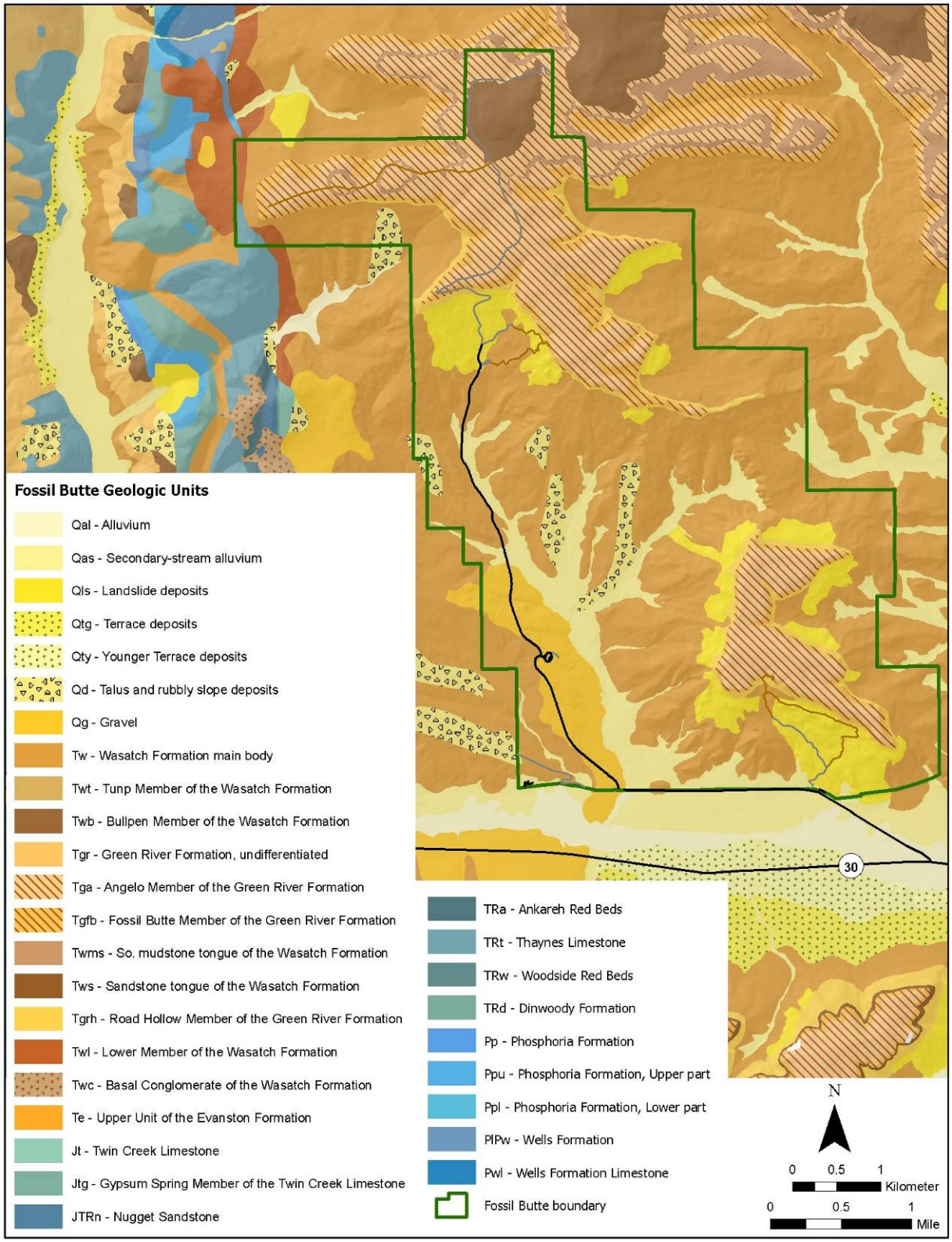


Figure 4. Bedrock geology map of FOBU and vicinity.

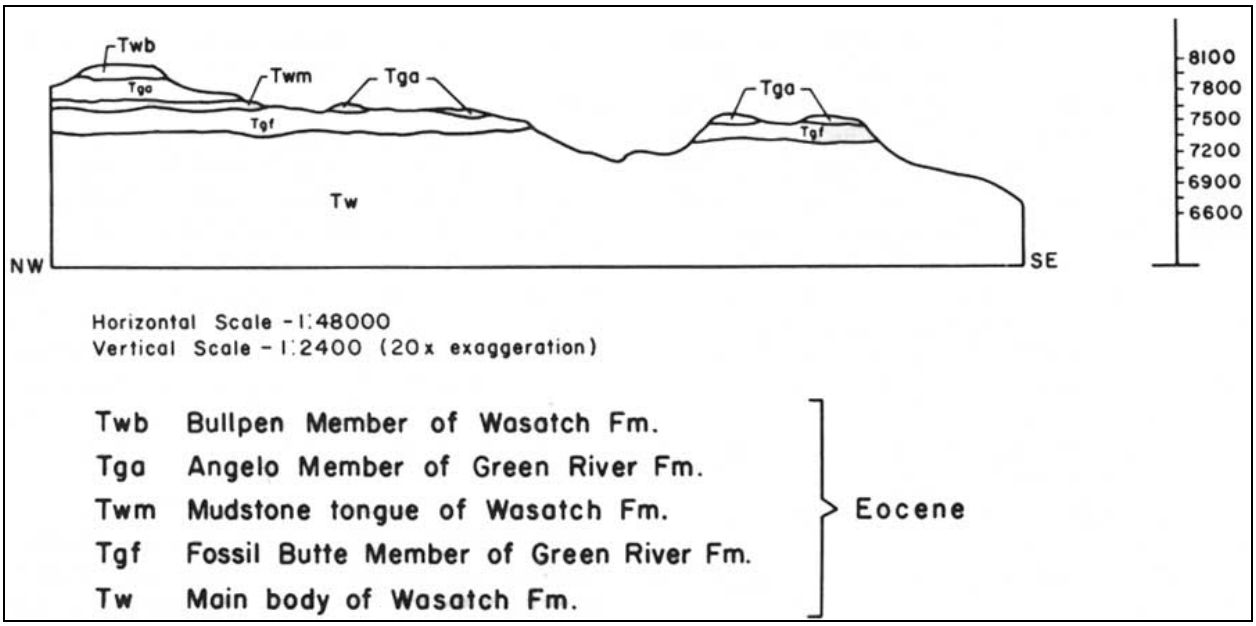


Figure 5. Generalized cross-section oriented from northwest to southeast through Fossil Butte National Monument. Diagram from McGrew and Casilliano (1975).

Wasatch Formation (Middle Eocene). The main body of the Wasatch Formation is the basal unit exposed at FOBU. It consists of predominantly red interbedded mudstones, fluvial sandstones, siltstones, claystones, conglomerates, and marlstones approximately 450 m (1,400 ft.) thick; only the uppermost layers of this formation are exposed at FOBU. This formation underlies most of the hills, ridges, slopes, valleys, and plains in the southern part of the monument. It forms colorful badlands on the northwest side of Fossil Butte. The vegetation of the Wasatch Formation is primarily sagebrush, including Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) on slopes, basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) in drainages, and low sagebrush (*Artemisia arbuscula* ssp. *longiloba*) on the thin soils of ridgelines. Stands of shadscale (*Atriplex confertifolia*), greasewood (*Sarcobatus vermiculatus*), and Gardner saltbush (*Atriplex gardneri*) occupy badlands and flats along the southern monument boundary (Figure 6). Common understory species include bluebunch wheatgrass (*Pseudoroegneria spicata*), thickspike wheatgrass (*Elymus lanceolatus*), western wheatgrass (*Pascopyrum smithii*), curly bluegrass (*Poa secunda*), muttongrass (*Poa fendleriana*), and basin wildrye (*Leymus cinereus*).

Photo credits: e²M

Figure 6. Characteristic plant communities of the main body of the Wasatch Formation.

Fossil Butte Member of the Green River Formation (Lower Eocene). This member consists of light-colored limestones, calcareous siltstones, marlstones, and shales 80 to 100 m (250 to 330 ft.) thick. Layers exposed on the upper slopes of Fossil Butte are rich in fossil fish, algae, gastropods, and ostracods, with lesser fossil concentrations on the tops and rims of Cundick Ridge and Ruby Point. Where slopes are steep and eroding, the vegetation consists of sparse patches of mountain mahogany (*Cercocarpus montanus*), Utah serviceberry (*Amelanchier utahensis*), antelope bitterbrush (*Purshia tridentata*), and snowberry (*Symphoricarpos oreophilus*) shrublands. Gentler slopes underlain by the Fossil Butte member support shrublands of mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) on deeper soils or low sagebrush on shallow soils. Less common communities include woodlands of quaking aspen (*Populus tremuloides*), Douglas-fir (*Pseudotsuga menziesii*), or limber pine (*Pinus flexilis*), and herbaceous communities of bluebunch wheatgrass and thickspike wheatgrass (Figure 7).

Photo credits: e²M

Figure 7. Characteristic plant communities of the Fossil Butte Member of the Green River Formation.

Mudstone Tongue of the Wasatch Formation (Middle Eocene). This member consists of distinctive green, red, brown, and reddish-brown mudstone and shale approximately 20 m (65 ft.) thick. The layer separates the Fossil Butte and Angelo Members of the Green River Formation. It is exposed in a narrow band on Ruby Point and at the northern monument boundary. The primary vegetation occurring on this exposed rim topography is a tundra-like sparse cushion plant community characterized by shortstem buckwheat (*Eriogonum brevicaule*), turpentine

wavewing (*Pteryxia terebinthina*), tufted milkvetch (*Astragalus spatulatus*), dwarf fleabane (*Erigeron nanus*), Hood's phlox (*Phlox hoodii*), stemless goldenweed (*Haplopappus acaulis*), Hooker's sandwort (*Arenaria hookeri*), fringed sagewort (*Artemisia frigida*), curly bluegrass and bluebunch wheatgrass (Figure 8).

Photo credits: e²M

Figure 8. Characteristic plant communities of the Mudstone Tongue of the Wasatch Formation.

Angelo Member of the Green River Formation (Lower Eocene). This member consists of light-colored limestone, shale, and siltstone up to 60 m (190 ft) thick and best exposed on top of Fossil Butte and Cundick Ridge. Characteristic vegetation includes mountain big sagebrush and low sagebrush shrublands. Less common are small stands with low cover of shadscale (*Atriplex confertifolia*) or black sagebrush (*Artemisia nova*). Associated grasses include bluebunch wheatgrass, curly bluegrass, and thickspike wheatgrass, in addition to the forb arrowleaf balsamroot (*Balsamorhiza sagittata*). Patches of leafybract aster (*Aster foliaceous*) may occur in the heads of draws where snow drifts collect to provide extra moisture (Figure 9).

Photo credits: e²M

Figure 9. Characteristic plant communities of the Angelo Member of the Green River Formation

Bullpen Member of the Wasatch Formation (Middle Eocene). This member consists of variegated red, gray, and green mudstones and light-colored sandstones up to 120 m (370 ft) thick. The deposit contains thin interbeds of granule conglomerate, gray and tan limestone, and light-gray shale forming the hill known as The Bullpen. The hill slopes support shrublands of mountain big sagebrush and low sagebrush, as well as patches of mountain mahogany and Utah

serviceberry. Seeps and springs at the base of the hill support small stands of yellow willow (*Salix lutea*), basin wildrye, and Baltic rush (*Juncus balticus*) (Figure 10). The summit of The Bullpen supports the sparse cushion plant community described above.

Photo credits: e^2M

Figure 10. Characteristic plant communities of the Bullpen Member of the Wasatch Formation.

Surficial Deposits (Pleistocene and Holocene). Surficial deposits at FOBU are the result of erosion of the bedrock members described above, as well as deposition from sources outside the monument. At FOBU, most of these deposits take the form of alluvium, colluvium, and slumps or landslides. There is an element of wind-deposition as well over much of FOBU, which is difficult to detect because it generally takes the form of deeper soils on slopes and valley bottoms.

A thin veneer or pavement of older Holocene gravels overlies benches and low ridges between the Smallpox Creek and Chicken Creek drainages. These sites tend to support shrublands characterized by winterfat (*Krascheninnikovia lanata*), low sagebrush, and Wyoming big sagebrush, with a relatively sparse, grass-dominated understory of curly bluegrass, Indian ricegrass (*Achnatherum hymenoides*), squirreltail (*Elymus elymoides*), and bluebunch wheatgrass (Figure 11).

Some of the steep slopes of the higher ridges and buttes are covered by deposits of coarse colluvial material weathered from limestone, marlstone and sandstone outcrops (Figure 11). Drier, steeper, more active slopes support dense montane shrublands characterized by true mountain mahogany and Utah serviceberry. Slopes with some groundwater seepage may support surprising mesic communities, including grasslands of basin wildrye, chokecherry (*Prunus virginianus*) tall shrublands, or narrowleaf cottonwood (*Populus angustifolia*) woodlands. Landslide and slump deposits are evident throughout the monument, most spectacularly where a large slump in the mid-1980s forced realignment of the Union Pacific railroad line paralleling the southern monument boundary.

Alluvium occurs as deposits of clay, silt, sand, and gravel in fans and terraces within the Chicken Creek drainage. Communities occurring in these sites include emergent wetlands characterized by Nebraska sedge (*Carex nebrascensis*), common spikerush (*Eleocharis palustris*), Baltic rush, and meadow barley (*Hordeum brachyantherum*). Communities on better-drained alluvial sites

include shrublands characterized by silver sagebrush (*Artemisia cana*), shrubby cinquefoil (*Dasiphora fruticosa* ssp. *floribunda*), basin big sagebrush, or greasewood (Figure 11).

Photo credits: e^2M

Figure 11. Characteristic plant communities of unconsolidated geologic strata: landslide (top left), gravel (top right), colluvial (middle), and alluvial (bottom).

Soils

In areas of similar climate and topography, differences in the kind and amount of vegetation are often closely related to soils. Glenn (1974) produced a map of soil types occurring in FOBU (Figure 12). All soil units described by Glenn are suitable for rangeland, recreation, and wildlife habitat, although the erosion hazard is moderate to severe for all units. The most common soil map units at FOBU are complexes of several soil associations:

- Redmanson-Swift Creek (24.9% of the area). This complex occurs as an irregular band around the sides of buttes, including Fossil Butte. The unit contains small inclusions of Fossilon soils, Prow soils, and wet soils caused by snowmelt and springs. Runoff is medium to rapid, and the erosion hazard is moderate to severe.
- Wiscow-Ulrich (14.2% of the area). This complex occupies rolling to very steep landslide deposits derived from the Wasatch Formation. The soils are highly intermingled on the landscape. Wiscow and Moyerson soils are on hot south- and west-facing slopes, Ulric soils are on cooler lee slopes, and Gunsone soils are in depositional areas. Small inclusions of Redmanson and Swift Creek soils and shale outcrops are present. Runoff is rapid and erosion hazard is severe.
- Fossilon-Prow (20.2% of the area). This complex occupies level to moderately steep ridges and hillsides of the Green River Formation. The soils are intermingled on the landscape. Small inclusions of Redmanson-like soils, Swift Creek soils, and deep clay soils occur throughout this unit. Runoff is medium to rapid and erosion hazard is moderate to severe.

The most common soil association, Moyerson-Wiscow, occurs on 19.3% of the monument. This association occupies rolling to very steep ridges and hillsides of the Wasatch Formation. Moyerson and Wiscow soils are on hotter south- and west-facing ridges and slopes; Ulric soils are on protected leeward slopes. Small areas of Gunsone soils are included in depositional areas and shale (Wasatch) outcrops. Runoff is rapid and erosion hazard is severe.

Hydrology and Water Resources

Although most of the monument consists of uplands, it also contains surface water resources in the form of seeps, springs, and intermittent drainages. These resources, although rare and of limited extent, are important for wildlife, amphibians, and downstream water quality.

FOBU is drained by a number of ephemeral creeks: Chicken and Smallpox creeks drain directly into Twin Creek south of the monument. The other drainages originating within FOBU drain to Twin Creek tributaries Rock Creek or the North Fork of Twin Creek. Twin Creek feeds into the Bear River system that originates in the High Uinta Mountains and drains into Bear Lake northeast of Ogden, Utah.

All drainages within FOBU are ephemeral, with surface flows occurring only during snowmelt and following significant rainstorms. Kyte (2001) stated that although the clay soils of the monument have high runoff values, they are also capable of absorbing a large amount of water when they are dry. Desiccation cracks in the creek beds can be up to 1 meter (3 ft) deep and are capable of allowing the infiltration of large amounts of runoff. Construction of the Union Pacific railroad just south of the monument boundary lowered the stream's base level, causing channel incision in the lower reaches of the Chicken Creek / Smallpox Creek watershed.

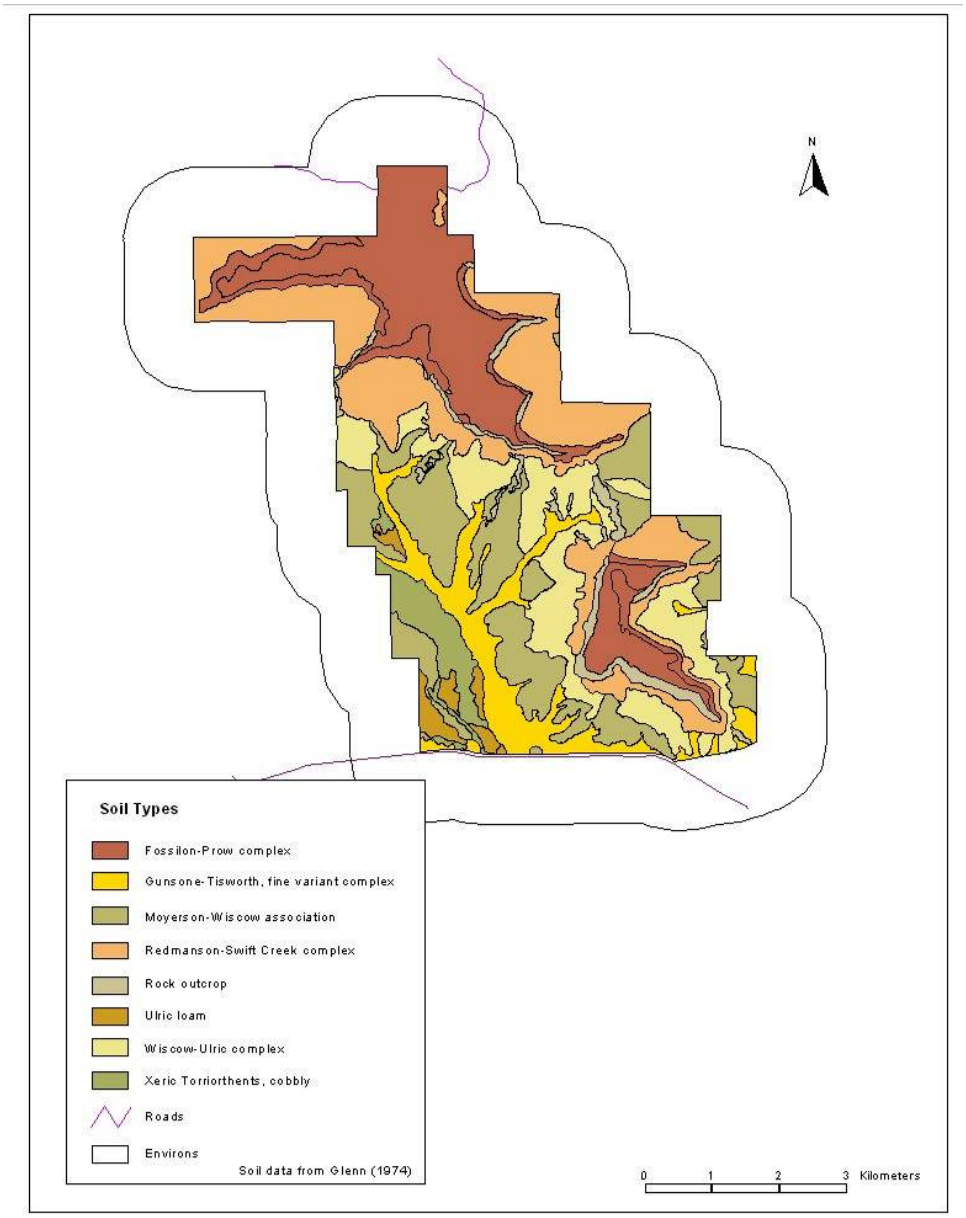


Figure 12. Soil type distribution within FOBU (diagram from Kyte 2001, data from Glenn 1974).

Numerous seeps and springs emerge within the monument, mostly in the contact zone where permeable members of the Green River Formation overlie the less permeable rocks of the Wasatch Formation (Figure 5). Small springs also emerge from the base of the Bullpen Member of the Wasatch Formation. Where there is sufficient quaking aspen and willow, water from the seeps and springs is captured by dam-building beavers. Surface water and near-to-surface ground water occur in the headwaters of Chicken Creek and Smallpox Creek and in the upper portions of Moosebones, Murder Hill, Middle, and Millet canyons. Seepage on the steeper slopes of Rubey Point, Fossil Butte and Cundick Ridge tends to cause slumping; small ephemeral slump ponds

are associated with these landforms. Most are dry by mid-summer, and support only emergent vegetation such as cattails (*Typha* spp.).

The seeps, springs, and ponds of FOBU support small patches of wetland and riparian vegetation. Most stands are herbaceous and shrubland vegetation types, with a few woodlands dominated by deciduous trees. Plant species commonly associated with FOBU seeps and springs include narrowleaf cottonwood, quaking aspen, yellow willow, silver sagebrush, shrubby cinquefoil, chokecherry, black greasewood, basin big sagebrush, western wheatgrass, basin wildrye, tufted hairgrass (*Deschampsia caespitosa*), meadow barley, Kentucky bluegrass (P*oa pratensis*), Baltic rush, spike rush, and several species of sedge (*Carex* spp).

Land Use and Settlement History

Prehistoric land use

Prehistoric archaeological sites occurring along Chicken Creek and elsewhere in the monument have been interpreted as temporary camps established by nomadic aboriginal peoples gathering and processing food (Kyte 2001). Local plants of importance to Native Amercans included camas lily (*Camassia quamash*), turkey peas (*Orogenia linearifolia*), biscuitroot (*Lomatium* spp.), and western gromwell (*Lithospermum ruderale*). Also of value were elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), bison (*Bison bison*), brown and black bears (*Ursus arctos* and *U. americanus*), gray wolf (*Canis lupus*), and coyote (*Canis latrans*), as well as other wildlife species useful for food, fur, and feathers.

Exploration and early settlement

Anglo-American exploration and settlement began in the 1840s and intensified during the 1870s; the Oregon Shortline Railroad was completed through the area in 1881. Early settlers to the area arrived in the late 1800s and established homesteads and ranches, introducing some of the first non-native plants to the area for livestock forage and food. The town of Fossil (now abandoned) was established at this time and ranching and mining began, supported by the towns of Kemmerer, Frontier, Oakley, and Diamondville.

A homestead was established within the monument about 1905 at the confluence of the west fork and main stem of Chicken Creek (Kyte 2001). The homestead included a house and other structures, a small irrigation ditch (near the FOBU picnic area), and unimproved roads. Many non-native plant species have become established on this site.

Mining and Logging

In 1959, an exploratory oil well was drilled in FOBU near the Wasatch Saddle in the upper end of the East Fork of Chicken Creek (Kyte 2001). The drill pad was leveled and a metal casing still protrudes from the ground at this site, which was abandoned after drilling. The site was never formally reclaimed.

Timber was harvested on FOBU in historic times and stumps of felled trees are still evident. The trees harvested were large enough for railroad ties or coal mine timbers. The stumps are relatively tall, suggesting that logging occurred in the winter and the logs skidded out on top of the snow. A stand of conifers, probably limber pine, is visible in an 1899 photograph of the talus slopes below Fossil Butte. The trees were apparently cut for railroad timbers and a stand of

narrow-leaved cottonwood trees became established on the seeps and slump pools in the area. Although the cottonwoods persist to this day, this site could revert to a limber pine woodland as it is drying out and limber pine seedlings are present in the cottonwood understory.

Grazing

Grazing of cattle, sheep, and horses in the vicinity of FOBU began in the late 1800s. By 1899 it was noted that the whole region around Fossil had been closely cropped or "sheeped" (Kyte 2001). Between 1972, when the monument was established, and 1989, when grazing was eliminated from the monument, the approximate permitted number of animal unit months included 2,480 sheep and 642 cows plus their calves; the exact number is unknown. In dry years FOBU was used more heavily by grazing livestock due to the presence of reliable springs. A herd of approximately 20 feral horses also grazed the monument continuously until they were removed by the BLM in the early 1980s.

The legislation creating FOBU in 1972 stipulated that grazing within the monument could continue for ten years, but not more than twenty years, providing, "the Secretary finds that such uses will not conflict with public use, interpretation, or administration of the monument." (Appendix C in NPS 1980). Because of this stipulation, Beetle and Marlow initiated a study (1974) of grazing within the monument. Their report documented effects on the monument's vegetation of grazing practices that including grazing both cattle and sheep in the late spring and early summer and placing mineral blocks near water sources. Documented effects included declines in the cover of cool-season grasses and significant damage to vegetation around springs.

As of 2010, the only permitted livestock use of FOBU is as a stock driveway; sheep and cattle are trailed through the monument in spring and fall to reach pastures east and north of the boundary (Figure 13). Several trespass cattle were observed in FOBU during the plot data collection and accuracy assessment sampling and the northern boundary fence is subject to breakage by toppled trees and broken branches.

Fossil quarrying

Scientific and commercial quarrying for fossil fish began in the late 1800s and continued until FOBU was established as a monument in 1972. Quarries were established on the slopes of Fossil Butte and Cundick Ridge. In the early decades of collecting, fossils were dug by hand, but with the increased availability of explosives following World War II, dynamiting became a common excavation tool (Aase et al. 2002). Waste rock was dumped downslope of the quarries, and the area around the quarries was marred by roads, campsites, structures, and trash middens.

Effects of land use on the vegetation

Human activities on the FOBU landscape over the past century have resulted in changes in the distribution and abundance of native vegetation and have contributed to invasions of native and nonnative plant species. In particular, livestock grazing and fire suppression have increased the frequency of big sagebrush and rabbitbrush species and decreased the abundance of native grasses.

Pollen analyses conducted in Wyoming sedimentary basins indicated that sagebrush steppe has dominated the vicinity of Fossil Butte for the past 7,000 to 10,000 years. French explorers passing through the area in 1843 noted that Native Americans in this region did not burn the

sagebrush the way that other tribes burned prairies to the east. Natural burns were probably common in any case. Pre-settlement, lightning-ignited fires were estimated to return to this portion of the northern Colorado Plateau at 10 to 70 year intervals in big sagebrush / mixed grassland types similar to FOBU (Petersburg 2004). Widespread fire suppression by Anglo settlers would have occurred only after 1945 (Kyte 2001).

The combination of fire suppression and repeated spring and early summer grazing pressure contributed to the current dominance of decadent sagebrush stands depauperate in grasses (Petersburg 2004). Fire suppression has also allowed limber pine and Rocky Mountain juniper to encroach into mixed mountain brush and big sagebrush stands. Current fire management practices are designed to restore a more natural fire regime through use of prescribed fire and associated fire effects monitoring. A managed burn was ignited on the west side of FOBU in the late fall of 2005.

Other effects of recent human uses include the establishment of non-native plant species associated with the development and use of roads, campgrounds, trails, picnic areas, and visitor facilities. Railroad construction in the late 19th century lowered the base level of Chicken Creek which drains almost half of the monument, triggering significant stream incision and erosion throughout the lower reaches of the drainage.

Figure 13. Domestic sheep being driven through FOBU in 2005.

Previous Vegetation Studies

Vegetation studies

The existing data for FOBU included several previous attempts at classifying and mapping the monument's vegetation, described below (Beetle and Marlow 1974, Dorn et al. 1984, and Kyte 2001). We evaluated the quality of these studies and their potential utility for this project using procedures developed by TNC (1996). The procedures included a hierarchical analysis of the sampling methodology, the data format and completeness, the accuracy of species identifications, inclusion of environmental data, the degree to which the monument's vegetation might have changed, and locational accuracy. The results of the analysis follow the description of the three studies.

In the summer of 1973, Dr. Alan Beetle of the University of Wyoming and an undergraduate assistant surveyed the vegetation of FOBU (Beetle and Marlow 1974) in order to create a map of the vegetation and a baseline study of range conditions. They described twelve major vegetation types for FOBU:

1. mixed timber and shrub complex
2. aspen complex
3. alkali sagebrush and grass complex
4. mountain big sagebrush and shrub complex
5. basin big sagebrush complex
6. shadscale saltbrush and shrub complex
7. shadscale saltbrush and alkali sagebrush complex
8. serviceberry complex
9. mountain mahogany and serviceberry complex
10. mountain mahogany complex
11. mixed shrub complex
12. chokecherry and antelope bitterbrush complex.

In 1984, Dr. Robert Dorn and coworkers were hired to update the vegetation map and range condition inventory. They mapped and categorized the monument's vegetation into fourteen types:

1. Alkali Sagebrush
2. Aquatic (rooted in water)
3. Aspen
4. Barren
5. Basin Big Sagebrush
6. Cottonwood
7. Disturbed
8. Grass/Forb
9. Mixed Timber
10. Mountain Big Sagebrush
11. Mountain Shrub
12. Saline
13. Wet Meadow
14. Willow

Dorn attributed the distribution of FOBU vegetation types primarily to the depth, clay content, and moisture content of the soil, but some, such as the Barren type that occurs on ridgetops, are controlled at least in part by exposure to wind (Dorn et al. 1984). Dorn mapped the vegetation on unrectified stereo aerial photographs. The vegetation patterns were transferred manually to

1:24,000-scale USGS topographic quadrangles. This vegetation map was ground-truthed in 1993 by George Jones, staff ecologist with the Wyoming Natural Diversity Database. Jones made minor changes to the map and this version was subsequently digitized (Figure 14).

In 2001, FOBU staff biologist Clayton Kyte updated the Dorn et al. (1984) data and prepared a draft Vegetation Management Plan for the monument (Kyte 2001). This document describes the monument's vegetation resources and presents historical data describing the plant communities and species, as well as discussions of past grazing and disturbance patterns, soils, and exotic plant species management.

Legacy studies were important in providing a starting point and general guidance for the present vegetation classification and mapping project, but each data set had significant limitations. The 1974 Beetle and Marlow inventory provided a list of species occurring in the monument, but did not describe their relative abundance within each of the 12 vegetation types. The National Vegetation Classification Standard adopted by the NVMP requires quantitative estimates of species abundance to distinguish alliances and associations. In addition, the data collection methodology was inadequately described and so its rigor could not be evaluated. The utility of the Dorn et al. (1984) data was limited by incomplete descriptions of the 14 vegetation types. The Dorn map was compromised by errors transferred from the unrectified aerial photography, which included distortion caused by camera angle and variations in elevation. When laid over orthorectified aerial imagery, siginificant errors in map polygon locations and boundaries are evident.

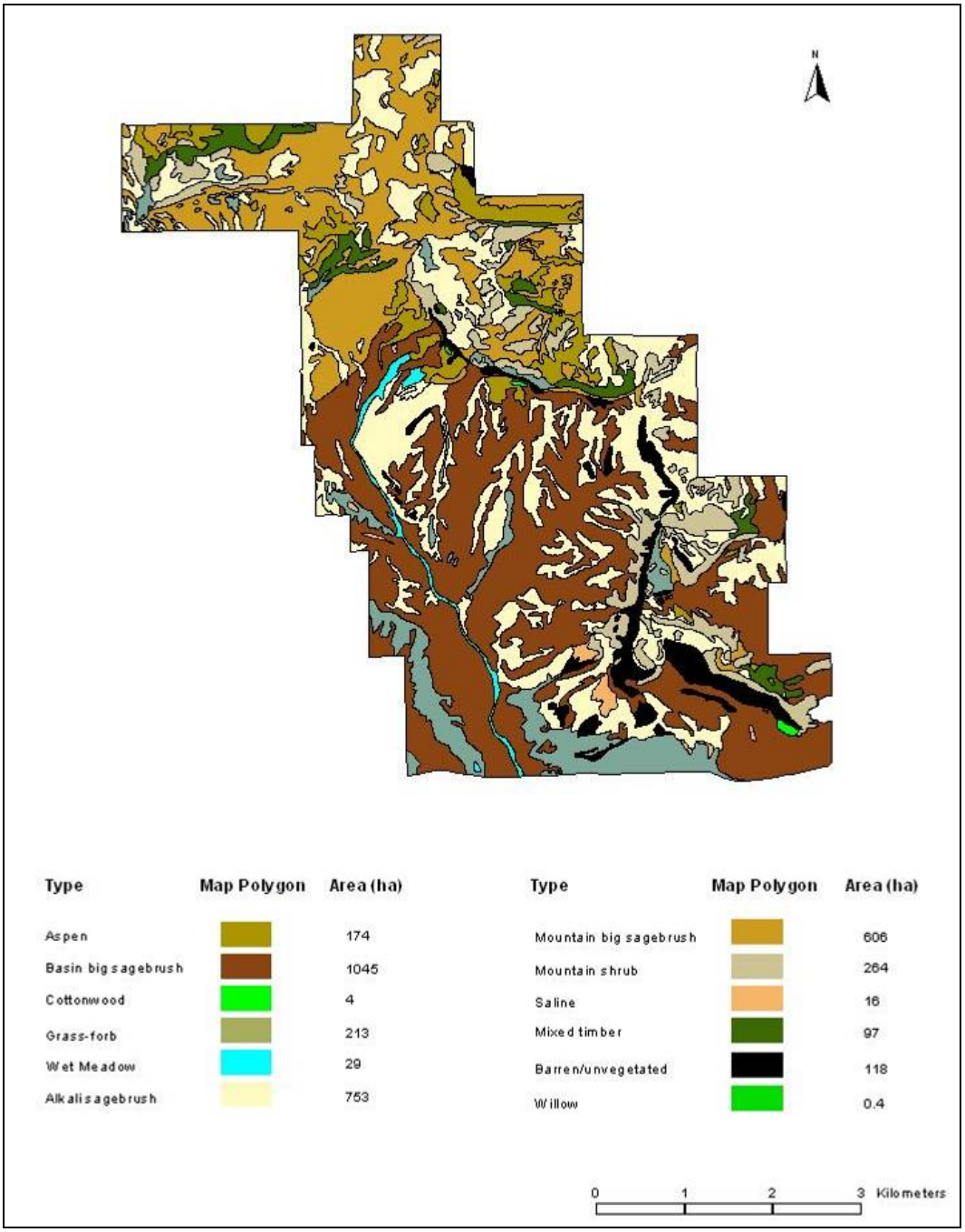


Figure 14. Vegetation classes mapped by Dorn et al. (1984) and ground-truthed by Jones in 1993.

Floristic studies

Fertig and Kyte (2009) include a thorough review of floristic studies for FOBU; this section is a abbreviated version of their summary. The earliest documented plant collection from the vicinity of FOBU was by George Letterman, who collected *Lepidium integrifolium* (thick-leaf pepperwort, a rare plant) near the Fossil Station train stop in 1885.

Formal floristic studies began shortly after the establishment of the monument in 1972. The Beetle and Marlow vegetation mapping and baseline range condition study (1974) contributed 72 taxa to the monument's checklist. In 1977, William Litzinger collected nearly 200 voucher specimens documenting 132 new species for the purpose of developing the monument's herbarium (FOBU). The Dorn et al. vegetation mapping project increased the monument plant checklist to 347 vascular species, of which all but 28 have since been supported by voucher specimens. Since 1984, Clayton Kyte (FOBU staff biologist) and various researchers added more than 100 previously uncollected taxa to the monument herbarium and floristic list.

FOBU supports several plant species of special concern. Thick-leaf pepperwort (*Lepidium integrifolium* var. *integrifolium*) is critically imperiled across its range. Tufted twinpod (*Physaria condensata*) is considered imperiled across its range (Fertig et al. 1994). Sodaville milkvetch (*Astragalus lentiginosus* var. *salinus*), ternate desert-parsley (*Lomatium triternatum* var. *anomalum*), western dodder (*Cuscuta occidentalis*), and Utah mountain lilac (*Ceanothus martinii*) are considered critically imperiled in Wyoming, but otherwise secure across their global range. Dorn's twinpod (*Physaria dornii),* considered critically imperiled in Wyoming and globally, is known to occur immediately west of FOBU, but it has not been observed in FOBU to date.

Non-native plants are a management concern, with 72 exotic species confirmed or reported from FOBU (Fertig and Kyte 2009). Introduced plants account for 13% of the monument's flora. Some species were introduced accidentally by railroad and road construction, livestock, other maintenance and construction activities, and visitors. Others were intentionally introduced for food, livestock forage, or soil stabilization. Ten exotic species are designated by the state of Wyoming as "noxious weeds" that must be controlled by landowners. Since the early 1990s FOBU has had an active control program for Canada thistle (*Cirsium arvense*), bull thistle (*C. vulgare*), musk thistle (*Carduus nutans*), woolly mullein (*Verbascum thapsus*), common burdock (*Arctium minus*), spotted knapweed (*Centaurea maculosa*), perennial sowthistle (*Sonchus uliginosus*), houndstongue (*Cynoglossum officinale*), white sweetclover (*Melilotus alba*), yellow sweetclover (*M. officinalis*), black henbane (*Hyoscyamus niger*), and any other non-native species encountered while spraying herbicides. Weed control efforts have resulted in the eradication of diffuse knapweed and tamarisk (Evenden et al. 2002). FOBU manages its exotic species because of their potential to alter the function and compostion of upland, riparian, and wetland plant communities, wildlife habitats, neighboring ranches, and farms.

Project Overview

General Approach and Timeline

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

The NCPN vegetation classification and mapping program was launched in July 2001 at a scoping meeting among network park staff, NCPN staff, and potential project cooperators. Following this meeting, NCPN prepared a multi-year, multi-park project proposal to the USGS/NPS Vegetation Mapping Program to cost-share network I&M funding with the National Vegetation Mapping Program funding to complete vegetation maps for all network parks (Evenden 2001). Meetings to determine the FOBU project boundary, biophysical model parameters, supplemental fuels data, and park specials were held in March 2005. Table 2 is a timeline for the completion of major project components.

NCPN negotiated interagency agreements with the USDA Aerial Photo Field Office to acquire aerial photography for each park, including FOBU. Stereo aerial photography for FOBU was flown in July 2004.

Table 2. Timeline for FOBU vegetation mapping project tasks.

TASK DESCRIPTION	2004	2005	2006	2007	2008	2009
Planning and Scoping	▬	▬				
Acquire Aerial Imagery	X					
Field Data Collection		▬				
Photo Interpretation			▬	▬		▬
Vegetation Classification			▬			
Local & Global Descriptions			▬	▬	▬	
Spatial Database			▬	▬		▬
Field Key to Plant Associations			▬	▬		
Accuracy Assessment				▬		
Final Report and Products						▬

Vegetation plot and observation point data were collected in the summer of 2005. Field data were entered into the project database and analyzed during the fall and winter of 2005. The intial analysis indicated that no additional sampling would be necessary.

NatureServe and e^2M ecologists completed the vegetation classification in 2006. e^2M ecologists prepared draft descriptions of the monument's plant associations immediately thereafter; final local descriptions were prepared by NatureServe in 2006. Global plant association descriptions for FOBU were completed by NatureServe ecologists in 2008.

USGS cartographers completed a draft vegetation map and initial set of map class concepts between fall 2005 and early summer 2006. A guide to the map classes was drafted in 2006 and revised in 2007. An illustrated field key to FOBU plant associations was developed prior to map accuracy assessment. Accuracy assessment (AA) data collection was completed by e^2M staff late in the 2006 field season. AA field data were entered into the FOBU project database and analyzed, with results tabulated into a contingency matrix by the end of 2006. A meeting to discuss the AA analysis and decide on final map classes was held in the spring of 2008. Final revisions were made to the vegetation classification, field keys, map class concepts, and spatial database in 2008 and early 2009.

Primary Partners and Project Roles

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

engineering-environmental Management, Inc.

- *Jim Von Loh, Senior Biologist* – Prepared project work plan, helped prepare agendas and compile minutes for project meetings, collected plot, observation point, and AA field data, created and field tested association key, prepared association local descriptions, wrote parts of final report
- *Matt Smith, Staff Biologist* – Collected classification plot and observation point data, field tested association key, collected and entered AA data, attended preliminary AA meeting
- *Jack Doria, Database Programmer* – developed the plots (MS Access) database
- *Travis Belote &Arne Buechling, Staff Ecologists* – Assisted with work plan development
- *Sarah Spratlen, Staff Ecologist* – collected plot and observation point data
- *Karin Edwards, Consulting Botanist* – collected plot and observation point data
- *Buddy Smith, Consulting Botanist* – collected plot and observation point data
- *Margaret Foderaro, Staff Ecologist* – collected and entered AA data
- *Wanda Lafferty, Technical Editor* – Prepared the draft and final workplan, provided technical editing, and contracted the printing
- *Nancy Jepsen*, Assistant Editor – Formatted the Key to Plant Associations and provided technical editing
- *Karin Decker, Ecologist, Colorado Natural Heritage Program* – Prepared the draft vegetation classification; Technical editor of the final report

National Park Service, Northern Colorado Plateau Network

- *Angie Evenden, Ph.D., Vegetation Program Manager* – overall project coordination and management, set NCPN project standards, organized project meetings, managed budgets, agreements and contracts
- *Janet Coles, Vegetation Ecologist* – Technical editor and co-author of the final report; coordinated creation of final products, coordinated AA review and analysis, collected plot and observation point data
- *Amy Tendick, BioTechnician* – Wrote and edited sections of the final report
- *Margaret Beer, Data Manager* – project database development
- *Helen Thomas* – project database support, photo database development
- *Russ Den Bleyker* – project database support and QC

Gery Wakefield, GIS Team Leader – prepared maps to support the AA, assisted with final GIS production
Aneth Wight, GIS Technician – produced final geodatabase; plots database support, project metadata

National Park Service, Fossil Butte National Monument
Dave McGinnis, Superintendent – provided Monument-level project oversight
Clayton Kyt, Biologist – Provided on-site logistical support, provided NPS documents to support development of work plan and final report, attended accuracy assessment decision meeting

U.S. Department of Agriculture Aerial Photo Field Office
Cindy Sessions, Contracting Officer – Procured aerial photography (9" x 9" stereo coverage)
Mark Cox, Photography Specialist – Provided QA/QC of photography, developed photo index

USDI Bureau of Reclamation Remote Sensing and Geographic Information Group
Alan Bell, Photography Specialist – Provided aerial photo contract specifications, subcontracted with Horizons, Inc. for aerial photography and production of color DOQQs for project area, provided QA/QC of orthoimagery

U.S. Geological Survey – Rocky Mountain Geographic Science Center
Beverly Friesen,ImageInterpreter/GIS Specialist – Oversaw image processing, participated in PI field reconnaissance and review, analyzed AA data and attended AA meeting, produced spatial database
Steve Blauer, Image Interpreter – Created the FOBU spatial database, participated in PI field reconnaissance and review
Keith Landgraf, Image Ingerpreter – Participated in PI field reconnaissance and review

U.S. Geological Survey – Mid-Continent Geographic Science Center
Dave Shaver– participated in PI field reconnaissance

NatureServe
Marion Reid, Senior Regional Ecologist – project manager, reviewed classification and final report
Janet Coles, Regional Ecologist – Reviewed field key, reviewed draft local descriptions, trained field crews, collected plot and observation point data
Keith Schulz, Regional Ecologist – prepared global association descriptions, reviewed classification, reviewed AA data and attended AA meeting, and reviewed final report
Mary Russo, Ecology Data Manager – Entered FOBU local and global descriptions into NatureServe's Biotics database, formatted descriptions, completed plant species crosswalk
Kristin Snow, Assistant Ecologist/Ecological Information Manager – Developed format for NCPN plant association local and global descriptions

U.S. Geological Survey – National Park Service National Vegetation Mapping Program
Karl Brown, PhD., NPS Program Leader – Provided national level program oversight
Mike Mulligan, USGS Program Leader – Provided national level program oversight
Tammy Cook, Vegetation Mapping Program Biologist – Facilitated generation of final products
Theresa Singh, USGS Website Manager – Coordinated posting of final products on the Internet

Aerial Photography

High-quality aerial photography of an appropriate scale is an important part of all USGS-NPS National Vegetation Mapping Program projects. Stereo photographs acquired vertically from the air, with adequate overlap, allow three-dimensional, high-resolution photointerpretation when

viewed under a stereoscope (Avery 1978). In order to maximize vegetative expression, the goal was to fly 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 cast by cliffs, although false color infrared photography probably would have allowed better distinction of the deciduous vegetation within FOBU.

Orthophotography provides a base image for mapping vegetation in a digital format and is the basis for interpreting vegetation patterns. During the planning and scoping phase of the project, the decision was reached to have USGS construct orthoimagery from new stereo pair aerial photography flown at a 1:12,000 scale for FOBU.

Stereoscopic Aerial Photo Coverage

NCPN contracted with the USDA - Farm Services Agency Aerial Photo Field Office (APFO) to acquire new 23 cm x 23 cm (9 in x 9 in) true color aerial photographs for FOBU. The imagery was acquired on July 21, 2004 by Valley Air Photos, LLC of Caldwell, Idaho. 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 15.3 cm (6 in) lens was used with Kodak Aerocolor negative film. The target scale for this photography was 1:12,000 (1 in = 1,000 ft). The mission was designed with approximately 30% sidelap between flight lines and 60% overlap between photos. The project encompassed 22 linear km (13.7 miles) divided among 6 flight lines and 57 individual photos (Figure 15). Figure 16 is an example of the 23 cm x 23 cm aerial stereo photographs for FOBU. These photographs were used for photo interpretation during the mapping phase of the project, as well as by field crews during plot data collection.

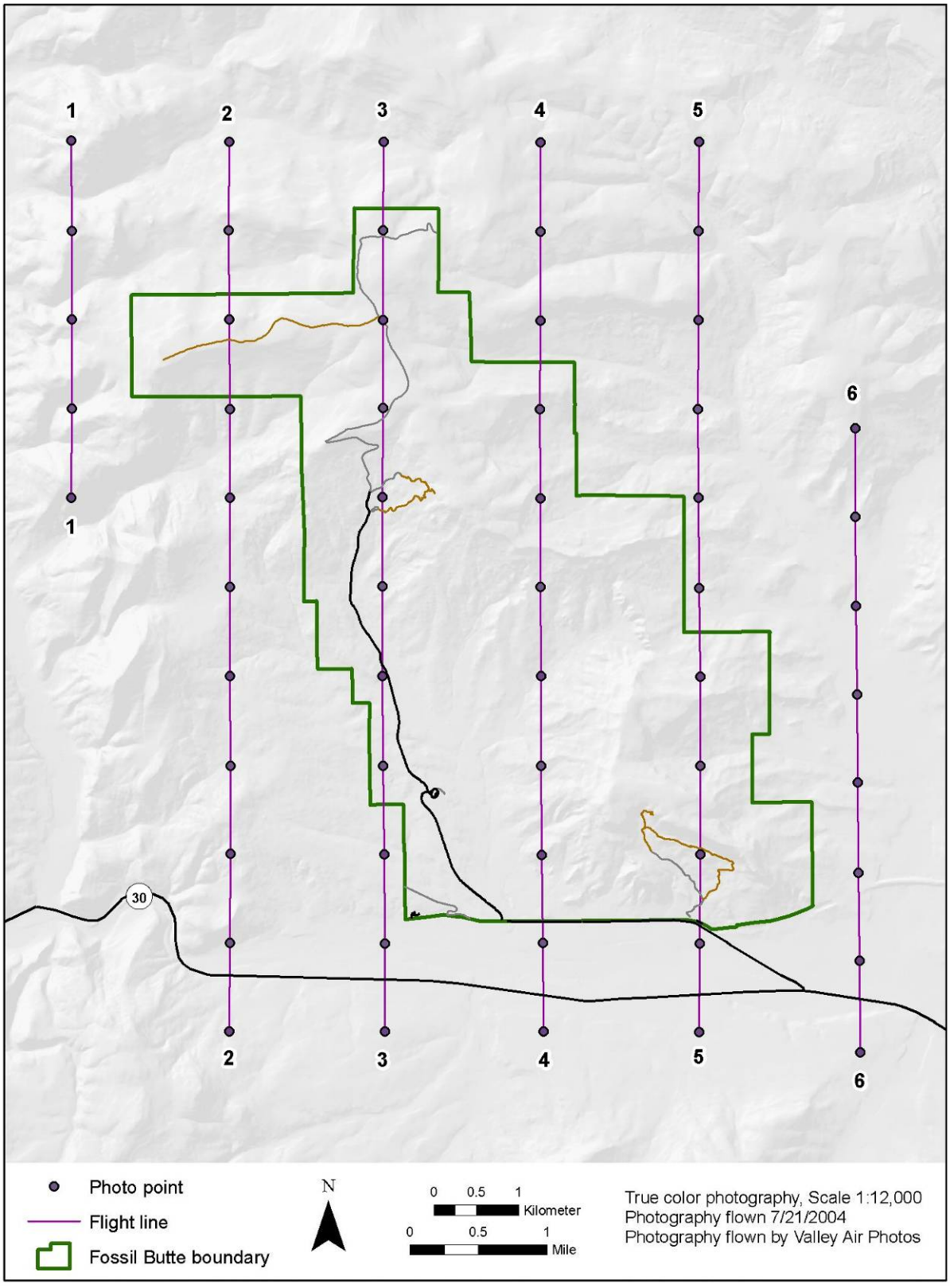


Figure 15. Flight lines for 2004 stereo aerial photograph coverage of FOBU.

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 FOBU and the other is retained at the NCPN offices in Moab, Utah.

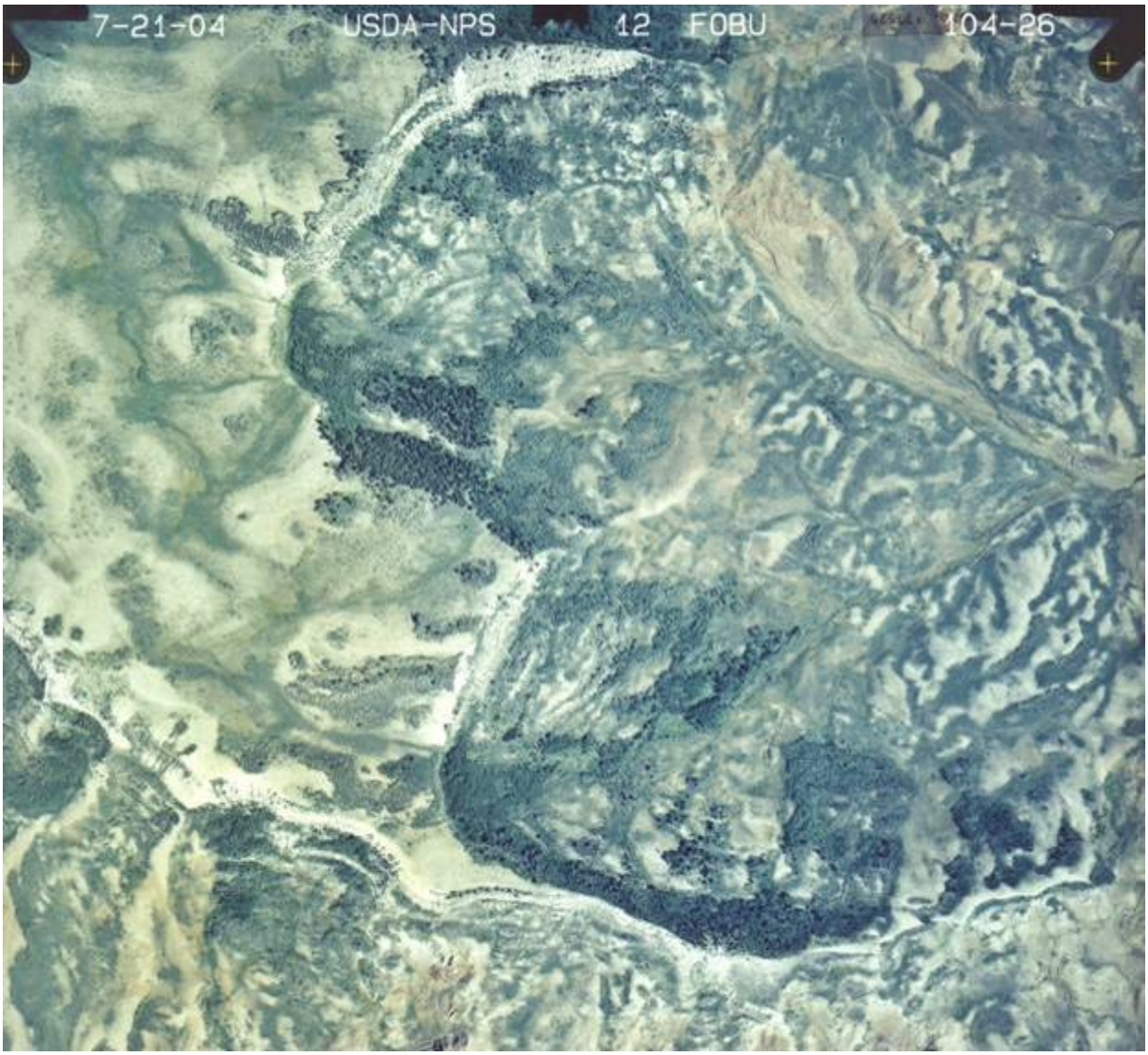


Figure 16. Example of a 9" x 9" stereo aerial photograph taken for the FOBU vegetation classification and mapping project.

Orthoimagery

The 1:12,000-scale hardcopy prints of the natural color stereo imagery acquired for FOBU in 2004 were scanned at 1000 dots per inch by USGS and mosaicked into a seamless one-meter digital image. USDA-FSA AFPO National Agricultural Imagery Program (NAIP) imagery was also obtained as an ancillary dataset for the project area. This imagery was one-meter color-infrared data flown during 2006.

Project Boundary and Map Extent

A variable project boundary of approximately 0.8 km (0.5 mile) environs around the edge of the monument was chosen by network and FOBU staff with project cooperators at the 2005 scoping meeting (Figure 2). The total project mapping area is 6,217 hectares (15,362 acres). Of this area, 3,351 ha (8,281 acres) are within the FOBU boundary and 2,866 ha (7,077 acres) are in the environs. The environs were delineated to provide supporting information for coordinated management projects between FOBU and its public and private neighbors.

Minimum Mapping Unit

A standard 0.5 ha (1.24 acres) minimum mapping unit (MMU) was employed in the FOBU vegetation mapping project. The major exception was that project photointerpreters attempted to delineate all wetland vegetation, regardless of stand or patch size.

Ecological System Classification

The NCPN selected 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 that tend to co-exist in a given landscape due to similar ecologic processes, substrates, and/or environmental gradients. The ES classification was developed to provide larger scale classification units for application to resource management, mapping, and conservation. Current estimates are that Wyoming contains 79 ecological systems (NatureServe Explorer 2008). This approach compliments the NVC; the finer-scale associations provide a basis for interpreting larger-scale ES patterns and concepts. A description of each ecological system identified in FOBU appears in Appendix A.

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

- Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)
- Inter-Mountain Basins Greasewood Flat (CES304.780)
- Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785)
- Inter-Mountain Basins Semi-Desert Grassland (CES304.787)
- Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)
- Inter-Mountain Basins Shale Badland (CES304.789)
- Inter-Mountain Basins Wash (CES304.781)
- North American Arid West Emergent Marsh (CES300.729)
- Rocky Mountain Alpine - Montane Wet Meadow (CES306.812)
- Rocky Mountain Aspen Forest and Woodland (CES306.813)
- Rocky Mountain Foothill Limber Pine Woodland (CES306.955)
- Rocky Mountain Lower Montane – Foothill Riparian Woodland and Shrubland (CES306.821)
- Rocky Mountain Lower Montane – Foothill Shrubland (CES306.822)
- Rocky Mountain Subalpine- Montane Mesic Meadow (CES306.829)

- Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)
- Southern Rocky Mountain Montane –Subalpine Grassland (CES306.824)
- Wyoming Basins Dwarf Sagebrush Shrubland and Steppe (CES304.794)

Vegetation Classification and Description

Pre-Field Methods

Preliminary Classification List

e^2M ecologists compiled a preliminary list of vegetation associations and alliances for FOBU in 2004. This list was developed by intersecting existing NVC associations and alliances with the FOBU species list. Previous vegetation classification work, floristic information for FOBU (e.g., Von Loh et al. 2004), and expert local knowledge were used to refine the list. This process resulted in a preliminary list of 212 plant associations potentially occurring in the vegetation mapping project area (Von Loh et al. 2004). This association list was a useful gauge for estimating and planning field work and for assigning provisional association names to vegetation plots and observation points.

Legacy Data Review

Existing vegetation data for FOBU were reviewed for possible use in the classification. Two previous vegetation mapping projects (Beetle and Marlow 1974 and Dorn et al. 1984) were reviewed. The plot data included lists of species by community type; however foliar cover estimates by species were lacking. The data were therefore deemed to be useful for reference by ecologists responsible for the final vegetation classification, but could not be used to supplement the new data. The vegetation classification presented in this report was derived from new field data collected specifically for the FOBU vegetation mapping project.

Field Methods

The primary purpose of classification plot data was to document the composition and structure of FOBU vegetation and associated environmental conditions. These data became the basis for classifying the vegetation at the monument. Field methods used in this project followed national program standards (e.g., TNC and ESRI 1994a, 1994b). Data gathered during this project contributed to understanding vegetation relationships across broader landscapes beyond the boundaries of the monument. The plot dataset was enhanced by collecting observation point data, whose primary purpose was to support photo interpretation.

In addition to the basic vegetation data collected at each plot, the NCPN and monument staff defined fuels and summary data fields for a subset of community types to meet needs of network managers. Plot forms and individual data field descriptions appear in Appendix B.

Field Sampling Approach

The sampling area included the entire monument and BLM lands in the environs. Private lands in the environs were not visited for this project. Because the project area is relatively small in size and moderate in terms of vegetation complexity, the areas sampled were selected systematically so that nearly the entire monument was visited. Draft vegetation polygons derived from photo-signatures were used to delineate potential sample areas and sampling was designed to ensure that all major environmental settings were visited and a good spatial dispersion of sample plots was achieved.

Sampling began at the lower elevations on the southern edge of the monument, working north to the higher elevations as the season progressed. This method resulted in the maximum number of

plant species being in the proper phenologic stage for identification early in the sampling effort. Most sampling occurred in shrub communities, which make up the majority of FOBU vegetation types.

To achieve maximum productivity and to prevent duplication of effort, each ecologist on the field sampling team was assigned a discrete area to explore and sample. Copies of the aerial photographs with preliminary vegetation types delineated on Mylar overlays helped to guide plot placement and were also used to record field notes. Monument staff provided an orientation to the monument and its vegetation at the beginning of the field season.

The field sampling team consisted of six ecologists with experience sampling plant communities in national parks and other landscapes. The list of 212 potential plant associations provided a starting point for naming communities sampled in the field. The sampling goal was to collect between three and five plots in every vegetation association within the FOBU project area. However, some common associations were sampled more often and some rare types were sampled less often. An effort was made to capture the full range of variation of each association. The data collection was conducted during June 2005.

Plot Data Collection

Field crews located classification plots subjectively within vegetation stands in order to best represent the association being sampled. Ecotones (areas where two or more plant communities intermix) were avoided. Highly disturbed areas were also avoided unless they covered several hectares. Plots were generally located in stands exceeding the minimum mapping unit (MMU) of 0.5 hectares. A few plots were sampled in smaller patches of distinctive vegetation. Plot size and shape requirements were consistent with national program guidelines (TNC and ESRI 1994a). Plot size was determined by the physiognomy of the community being sampled (Table 3). Plot shape was adjusted as needed to sample linear bands of vegetation in drainage bottoms. Plot size and shape were recorded for all plots.

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

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

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

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

Location and Plot Identifiers. FOBU staff requested that the vegetation plot locations not be permanently marked. The bounds of each plot were marked temporarily using measuring tapes. The Universal Transverse Mercator (UTM) coordinates at the center of each plot were recorded (Zone 12, NAD83) on Trimble or Garmin hand-held GPS receivers. Other data fields documenting the location of each plot are listed in Table 4 and are described in detail in Appendix C. Locations were recorded on topographic maps during each field trip to avoid duplication of effort and to ensure good spatial distribution of sampling points within the monument.

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
Other Information	Narrative description of the setting of the plot; describes adjacent communities, note unusual ecological processes, continue descriptions from other narrative fields

Environmental Description. The physical characteristics of each plot were documented in both categorical and narrative fields (Table 4; Appendix B). These characteristics included physical site features (elevation, slope, aspect, topography), hydrology, geology, and soils. Description of the ground surface included an estimate of the cover of rocks, sand, litter, bare soil, biological soil crust, moss, and lichen. A narrative field was provided for a general description of the plot setting and the influence of disturbance and environmental factors on the vegetation.

Vegetation Description. Every vascular plant species in each plot was assigned to one of 14 physiognomic strata (Appendix B). Within each stratum, the investigator recorded average height and percent canopy cover for all species using the scales in Table 5. Consistent and repeatable cover estimates were obtained by training field crews to relate 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.

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

vegetation and features of each plot were recorded in two or more 35 mm color slide photographs.

Table 5. Vegetation cover and height classes used in the FOBU 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%				

Data Processing and Analysis

One-hundred fifty-eight vegetation plots were sampled within the mapping project area during the 2005 field season (Figure 17). Plot data were manually entered into the FOBU 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 NCPN database offers greater flexibility in overall data management than does the NatureServe PLOTS database, and is designed to accommodate all project field data recorded in plots, observation points, and accuracy assessment points. Data standards were established by NCPN for all network vegetation mapping projects, allowing compatibility of data across network park units. Fields associated with the FOBU plots database are described in Appendix C.

Each 35 mm slide associated with the project was scanned into digital format. The 3,254 digital images of plots, observation points, accuracy assessment points and the general landscape were stored in a photograph database. A unique identifier allows each photograph to be linked with the plots and spatial databases.

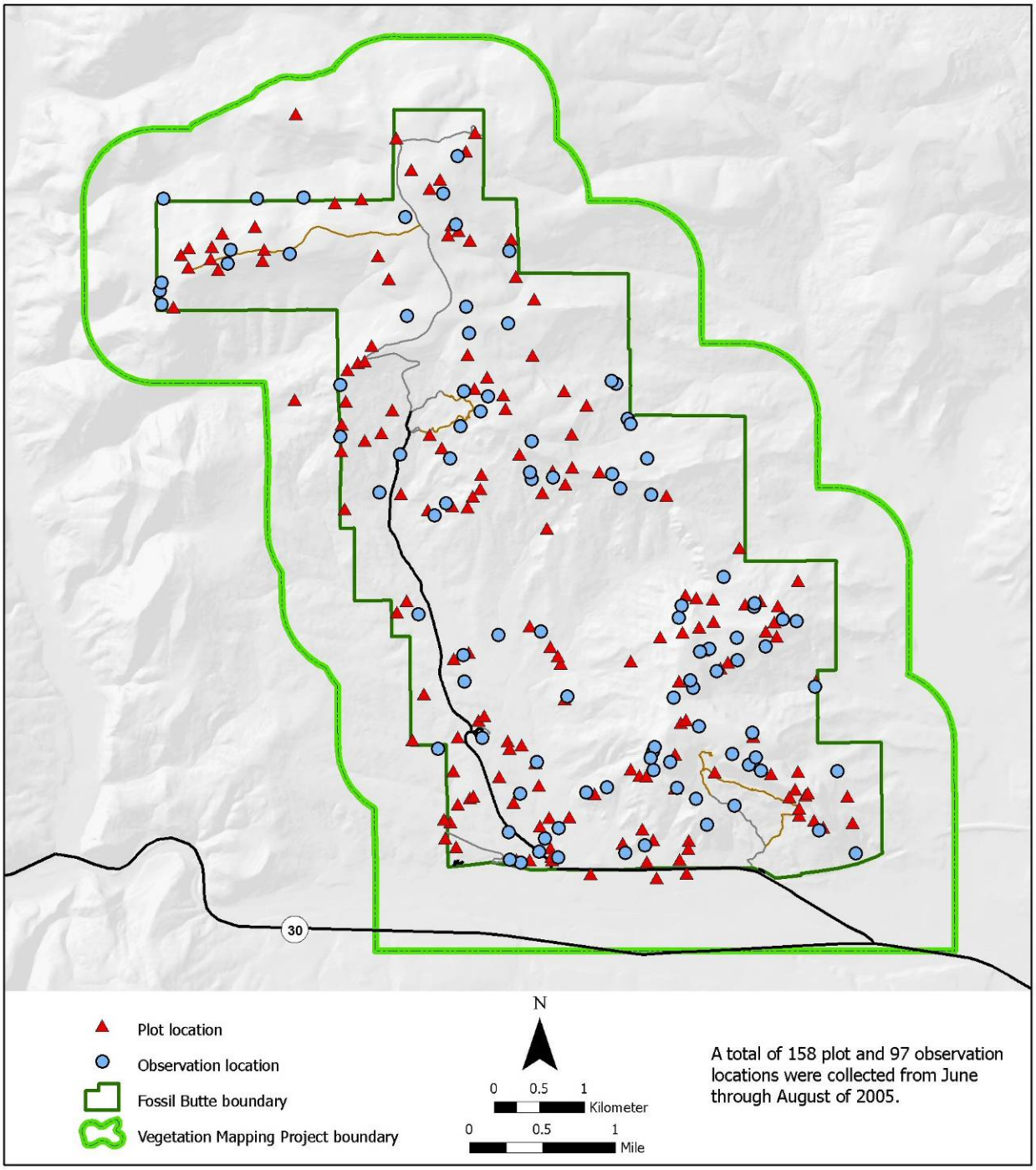


Figure 17. Vegetation plot and observation point locations in the FOBU mapping project area.

Observation Points

In addition to classification plots, field crews collected vegetation and environmental data at 97 observation points (Figure 17). Data collected at observation points reflected the vegetation of a loosely undefined area around the point (the "stand") rather than a measured plot, and were less detailed (Appendix B). Overall conditions at each observation point were documented by one or more 35mm color slide photographs. These data were intended primarily to support modeling

and 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 classification plot when:

- they were sampling the environs outside the monument boundary
- the vegetation was highly disturbed, ecotonal, or otherwise anomalous and therefore unlikely to be classified under the NVC
- project photointerpreters requested documentation of a specific photo signature or area
- they wished to document special features as requested by monument staff such as chokecherry patches and stands and prairie dog colonies
- they wanted to document a vegetation type that consistently occurred in stands smaller than 0.5 ha (1.24 acres).

A thorough quality assessment and 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 original field data sheets in hand. Additional checks used 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 FOBU vegetation mapping project is the Checklist with Recent Synonymy of the Vascular Plants of Wyoming of Nelson and Hartman (1997). 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 (1999), whereas nomenclature in the project database follows Nelson and Hartman (1997). Differences between the two nomenclatural authorities are reconciled in a crosswalk table (Appendix D).

Following completion of QA/QC procedures, the database was made available to e^2M and NatureServe ecologists for vegetation classification analysis as described in the next section. Slide labels were printed from the database. A GIS data layer (point data) was developed to document classification plot locations.

Classification Data Analysis

Vegetation classification was accomplished through multivariate analysis of vegetation plot data augmented by observation point data. Similar analyses were performed on the vegetation plots dataset and on a dataset that included both plots and observation points. In each case, species cover data were exported in list format from the plots database, then imported into PC-Ord (McCune and Mefford, 1999). Midpoints of canopy cover classes were used in all data analysis procedures, and different strata of a single species within a plot were combined. Due to the frequency and possible importance of many species with habitually low cover, all species were retained for the initial analyses. The plot data set contained 158 samples and 280 species, and the combined plot and observation point data set contained 255 samples and 315 species.

A variety of exploratory data analyses, including summary statistics, outlier analysis, Bray-Curtis (polar) ordination, cluster analysis, Indicator Species Analysis (ISA), and tabular summaries were used to characterize the data and identify groups appropriate for classification under the NVC.

Outlier analysis revealed three plots in the dataset with average distance greater than two standard deviations, and the combined plot and observation point dataset included seven outliers (two were the same as for the plot-only dataset). Because these outliers appeared to represent valid vegetation types (often riparian or weedy) that are uncommon and hence, under-sampled, they were retained for subsequent analyses.

Ordination results were difficult to interpret, not improved by data transformations, and consequently not very useful as a data reduction method. Cluster analysis (Sorensen Distance, flexible clustering linkage method, $\beta = -0.25$) was used to identify potential associations. Groups resulting from cluster analysis were described by using Indicator Species Analysis (ISA) and tabular summaries of plots within groups. When groups could not clearly be parsed further with these methods, individual plots were inspected and assigned to appropriate NVC associations or alliances, based on species composition and cover, and environmental factors. On inspection it was clear that the inclusion of observation points greatly facilitated interpretation of the association groupings provided by cluster analysis; therefore, the combined vegetation plot – observation point dataset was used for the final classification.

The cluster analysis results were examined for appropriate cutoff levels. The minimum average indicator p-value method of McCune and Grace (2002) suggested that a pruning level somewhere in the range of 8-15 groups would be the most informative. In the combined plot and observation point data set, 15 groups were interpreted (Figure 18). This level of clustering represented a local minimum in the average significance level of species indicator values, and provided a pruning point where most clusters had at least one significant indicator.

To explore whether these groups represented real ecological units, we compared the indicator species for each group and the summary tables of species composition and percent cover within a group. Indicator Species Analysis scores species within groups according to how faithful a taxon is to that group as well as how exclusive it is to that group. A good indicator species occurs with high relative abundance and high frequency in its own group, but does not occur in other groups. Following the technique of Dufrêne and Legendre (1997), species with an indicator value ≥ 25 and an estimated significance of $p \leq 0.05$ were used to characterize cluster levels. These indicators were compared with summary table results listing which species were present in the largest number of plots and had the greatest contribution to vegetation cover. The two methods were in close agreement.

Groups and subgroups in the dendrogram were labeled with indicator species and other characteristics derived from the tabular analysis. Using the provisional association name given by the field crew as a starting point, each terminal branch of the dendrogram was assigned to an NVC or new association. Association assignments were revised by comparing plot composition with existing NVC association descriptions, taking into account the position of the plot within the dendrogram and the shared characteristics within its branch. The preliminary classification was submitted to NatureServe, whose ecologists reviewed each plot association assignment and made adjustments to ensure consistency with NVC concepts. NatureServe ecologists were also responsible for deciding whether to add new associations to the NVC or assign unusual types to a “Park Special” category. After several revisions and refinements, the final classification was

issued by NatureServe in 2008. This version included additional associations identified from accuracy assessment plots.

Classification Results

FOBU is an area where Wyoming Basin, Great Basin, and Rocky Mountain floristic elements converge to form a rich diversity of native plant communities. The vegetation of the FOBU mapping project area is classified into 71 community types (Table 6). Of these, 58 are described at the plant association level, one is described at the alliance level, and 12 are described as a 'park specials' because they are found only in small stands and appear to be unique to the monument. Park specials are not assigned to NVC associations or alliances. One plot was unclassifiable. Four associations are documented exclusively from data gathered during accuracy assessment. The vegetation of the mapping project area is moderately diverse, including 33 NVC alliances and 17 ecological systems. More than half of the communities are shrubland types, including 40 upland shrubland associations and three riparian shrubland types. Shrublands characterized by sagebrush species are most common and widespread.

Twenty-three of the vegetation types are represented by a single plot. These may have been rare vegetation types in the monument, or were simply under-sampled as a result of difficult access or other limitations of the original field sampling design. The remaining 48 types are represented by two to eighteen samples (Appendix E).

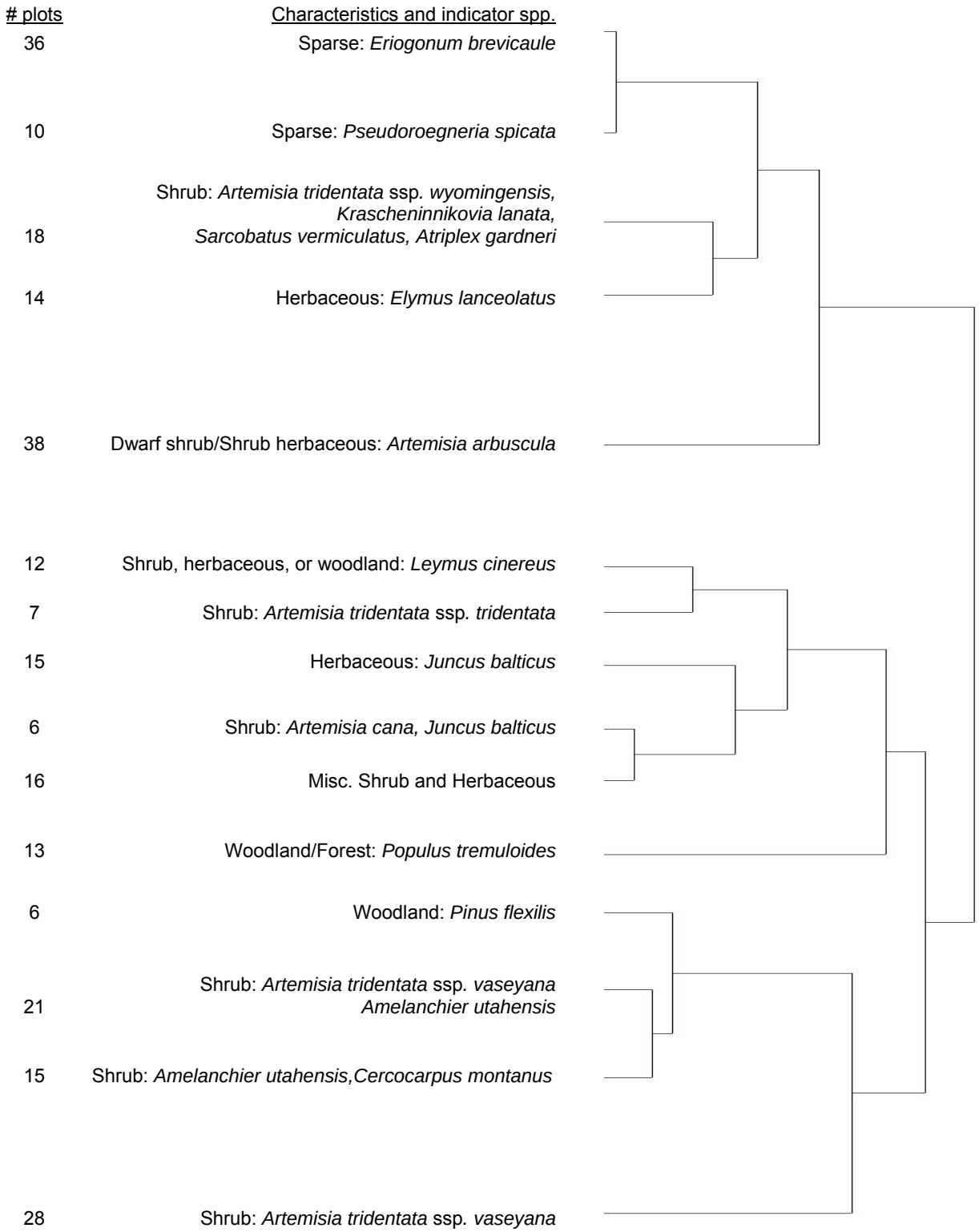


Figure 18. Cluster analysis dendrogram of FOBU plot data showing fifteen upper-level clusters defined using the Sorensen Distance Measure and Flexible Beta group linkage method.

Table 6. Classified plant associations for the FOBU vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVC Association	Common Name	Element Code†
UPLAND ASSOCIATIONS		
FORESTS AND WOODLANDS		
Rocky Mountain Aspen Forest and Woodland (CES306.813)‡		
Populus tremuloides / Amelanchier alnifolia - Symphoricarpos oreophilus / Mixed Graminoid Forest	Quaking Aspen / Saskatoon Serviceberry - Mountain Snowberry / Mixed Graminoid Forest	CEGL002816
Populus tremuloides / Apocynum androsaemifolium Forest	Quaking Aspen / Spreading Dogbane Forest	Park Special
Populus tremuloides / Cornus sericea Forest	Quaking Aspen / Red-osier Dogwood Forest	CEGL000582
Populus tremuloides / Invasive Perennial Grasses Forest	Quaking Aspen / Invasive Perennial Grasses Forest	CEGL003748
Populus tremuloides / Prunus virginiana Woodland	Quaking Aspen / Chokecherry Woodland	CEGL002130
Populus tremuloides / Shepherdia canadensis Forest	Quaking Aspen / Russet Buffaloberry Forest	CEGL000606
Populus tremuloides / Tall Forbs Forest	Quaking Aspen / Tall Forbs Forest	CEGL000618
Populus tremuloides Woodland Alliance	Quaking Aspen Woodland Alliance	A.610
Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)		
Pseudotsuga menziesii / Symphoricarpos oreophilus Forest	Douglas-fir / Mountain Snowberry Forest	CEGL000462
Rocky Mountain Foothill Limber Pine-Juniper Woodland (CES306.955)		
Juniperus scopulorum / Artemisia tridentata Woodland	Rocky Mountain Juniper / Basin Big Sagebrush Woodland	CEGL000743
Pinus flexilis / Cercocarpus montanus - Amelanchier utahensis Woodland	Limber Pine / Alderleaf Mountain-mahogany - Utah Serviceberry Woodland	CEGL005320
Pinus flexilis / Symphoricarpos oreophilus Woodland	Limber Pine / Mountain Snowberry Woodland	CEGL005321
SHRUBLANDS AND SHRUB-HERBACEOUS VEGETATION		
Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)		
Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland	(Utah Serviceberry, Saskatoon Serviceberry) - Alderleaf Mountain-mahogany Shrubland	CEGL001070

Table 6. Classified plant associations for the FOBU vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVC Association	Common Name	Element Code†
Amelanchier utahensis Shrubland	Utah Serviceberry Shrubland	CEGL001067
Ceanothus martinii Shrubland	Martin's Ceanothus Shrubland	Park Special
Prunus virginiana - (Prunus americana) Shrubland	Chokecherry - (American Plum) Shrubland	CEGL001108
Purshia tridentata / Pteryxia terebinthina Shrubland	Bitterbrush / Turpentine Wavewing Shrubland	Park Special
Symphoricarpos oreophilus Shrubland	Mountain Snowberry Shrubland	CEGL002951
Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785)		
Artemisia tridentata (ssp. vaseyana, ssp. wyomingensis) - Amelanchier utahensis Shrubland	(Mountain Big Sagebrush, Wyoming Big Sagebrush) - Utah Serviceberry Shrubland	CEGL002820
Artemisia tridentata ssp. vaseyana / Achnatherum lettermanii Shrubland	Mountain Big Sagebrush / Letterman's Needlegrass Shrubland	CEGL002811
Artemisia tridentata ssp. vaseyana / Balsamorhiza sagittata Shrubland	Mountain Big Sagebrush / Arrowleaf Balsamroot Shrubland	CEGL001020
Artemisia tridentata ssp. vaseyana / Elymus lanceolatus Shrubland	Mountain Big Sagebrush / Streambank Wheatgrass Shrubland	CEGL005318
Artemisia tridentata ssp. vaseyana / Leucopoa kingii Shrubland	Mountain Big Sagebrush / Spike Fescue Shrubland	CEGL001025
Artemisia tridentata ssp. vaseyana / Leymus cinereus Shrubland	Mountain Big Sagebrush / Great Basin Lyme Grass Shrubland	CEGL001027
Artemisia tridentata ssp. vaseyana / Pascopyrum smithii Shrubland	Mountain Big Sagebrush / Western Wheatgrass Shrubland	CEGL001028
Artemisia tridentata ssp. vaseyana / Poa fendleriana Shrubland	Mountain Big Sagebrush / Muttongrass Shrubland	CEGL002812
Artemisia tridentata ssp. vaseyana / Poa pratensis Sagebrush Shrubland	Mountain Big Sagebrush / Kentucky Bluegrass Sagebrush Shrubland	CEGL002528
Artemisia tridentata ssp. vaseyana / Poa secunda Shrubland	Mountain Big Sagebrush / Curly Bluegrass Shrubland	CEGL001029
Artemisia tridentata ssp. vaseyana / Pseudoroegneria spicata Shrubland	Mountain Big Sagebrush / Bluebunch Wheatgrass Shrubland	CEGL001030
Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)		
Krascheninnikovia lanata / Achnatherum hymenoides Dwarf-shrubland	Winterfat / Indian Ricegrass Dwarf-shrubland	CEGL001323
Krascheninnikovia lanata / Poa secunda Dwarf-shrubland	Winterfat / Curly Bluegrass Dwarf-shrubland	CEGL001326
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)		

Table 6. Classified plant associations for the FOBU vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVC Association	Common Name	Element Code†
Artemisia tridentata / Elymus lanceolatus Shrubland	Big Sagebrush / Streambank Wheatgrass Shrubland	Park Special
Artemisia tridentata ssp. tridentata / Leymus cinereus Shrubland	Mountain Big Sagebrush / Great Basin Lyme Grass Shrubland	CEGL001016
Artemisia tridentata ssp. tridentata / Poa secunda Shrubland	Basin Big Sagebrush / Curly Bluegrass Shrubland	CEGL001008
Artemisia tridentata ssp. wyomingensis / Disturbed Understory Semi-natural Shrubland	Wyoming Big Sagebrush / Disturbed Understory Semi-natural Shrubland	CEGL002083
Artemisia tridentata ssp. wyomingensis / Leymus cinereus Shrubland	Wyoming Big Sagebrush / Great Basin Lyme Grass Shrubland	Park Special
Artemisia tridentata ssp. wyomingensis / Poa secunda Shrubland	Wyoming Big Sagebrush / Curly Bluegrass Shrubland	CEGL001049
Artemisia tridentata ssp. wyomingensis / Pseudoroegneria spicata Shrubland	Wyoming Big Sagebrush / Bluebunch Wheatgrass Shrubland	CEGL001009
Wyoming Basins Dwarf Sagebrush Shrubland and Steppe (CES304.794)		
Artemisia arbuscula ssp. longiloba / Cushion Plants Shrubland	Alkali Sagebrush / Cushion Plants Shrubland	CEGL005996
Artemisia arbuscula ssp. longiloba / Elymus lanceolatus Shrubland	Alkali Sagebrush / Streambank Wheatgrass Herbaceous Vegetation	CEGL002585
Artemisia arbuscula ssp. longiloba / Poa fendleriana Shrubland	Alkali Sagebrush / Muttongrass Shrubland	CEGL005997
Artemisia arbuscula ssp. longiloba / Poa secunda Shrub Herbaceous Vegetation	Alkali Sagebrush / Curly Bluegrass Shrub Herbaceous Vegetation	CEGL001523
Artemisia arbuscula ssp. longiloba / Pseudoroegneria spicata Shrub Herbaceous Vegetation	Alkali Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation	CEGL001416
Artemisia arbuscula ssp. longiloba Shrubland	Alkali Sagebrush Shrubland	CEGL001414
Artemisia nova / Pseudoroegneria spicata Shrubland	Black Sagebrush / Bluebunch Wheatgrass Shrubland	CEGL001424
Inter-Mountain Basins Shale Badland (CES304.789)		
Atriplex confertifolia - Sarcobatus vermiculatus Shrubland	Shadscale – Black Greasewood Shrubland	CEGL001313
Atriplex confertifolia Wyoming Basins Shrubland	Shadscale Wyoming Basins Shrubland	CEGL001293
Atriplex gardneri - Artemisia arbuscula ssp. longiloba Dwarf Shrubland	Gardner's Saltbush - Alkali Sagebrush Dwarf-shrubland	Park Special

Table 6. Classified plant associations for the FOBU vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVC Association	Common Name	Element Code†
Atriplex gardneri Dwarf-shrubland	Gardner's Saltbush Dwarf-shrubland	CEGL001438
Cushion Plants Sparse Shale Vegetation	Cushion Plants Sparse Shale Vegetation	Park Special
Eriogonum brevicaule - Cushion Plants Sparse Vegetation	Shortstem Wild Buckwheat - Cushion Plants Sparse Vegetation	CEGL005319
Lepidium virginicum Sparse Herbaceous Vegetation	Poor-man's Peppergrass Sparse Herbaceous Vegetation	Park Special
Pseudoroegneria spicata - Cushion Plants Herbaceous Vegetation	Bluebunch Wheatgrass - Cushion Plants Herbaceous Vegetation	CEGL001666
Pteryxia terebinthina Herbaceous Vegetation	Turpentine Wavewing Herbaceous Vegetation	Park Special
Sarcobatus vermiculatus / Atriplex gardneri Shrubland	Black Greasewood / Gardner's Saltbush Shrubland	CEGL001360
Inter-Mountain Basins Greasewood Flat (CES304.780)		
Sarcobatus vermiculatus / Artemisia tridentata Shrubland	Black Greasewood / Basin Big Sagebrush Shrubland	CEGL001359
GRASSLANDS AND FORB-DOMINATED VEGETATION		
Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)		
Leymus cinereus Herbaceous Vegetation	Great Basin Lyme Grass Herbaceous Vegetation	CEGL001479
Pascopyrum smithii Herbaceous Vegetation	Western Wheatgrass Herbaceous Vegetation	CEGL001577
Poa pratensis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation	Kentucky Bluegrass - (Western Wheatgrass) Semi-natural Herbaceous Vegetation	CEGL005265
Pseudoroegneria spicata Herbaceous Vegetation	Bluebunch Wheatgrass Herbaceous Vegetation	CEGL001660
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)		
Elymus lanceolatus Herbaceous Vegetation	Streambank Wheatgrass Herbaceous Vegetation	CEGL002588
RIPARIAN, WETLAND AND MESIC ASSOCIATIONS		
Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.821)		
Artemisia cana / Juncus balticus Shrubland	Silver Sagebrush / Baltic Rush Shrubland	CEGL005998
Populus angustifolia / Leymus cinereus Woodland	Narrowleaf Cottonwood / Great Basin Lyme Grass Woodland	Park Special

Table 6. Classified plant associations for the FOBU vegetation mapping project area, arranged by ecological system within each physiognomic group*.

NVC Association	Common Name	Element Code†
Salix lutea / Leymus cinereus Shrubland	Yellow Willow / Great Basin Lyme Grass Shrubland	CEGL005322
Salix scouleriana Shrubland	Scouler's Willow Shrubland	Park Special
Rocky Mountain Subalpine-Montane Mesic Mesic Meadow (CES306.829)		
Dasiphora fruticosa ssp. floribunda Shrubland	Shrubby-cinquefoil Shrubland	CEGL001105
Symphyotrichum foliaceum Snow Glade Herbaceous Vegetation	Alpine Leafybract Aster Snow Glade Herbaceous Vegetation	Park Special
Inter-Mountain Basins Wash (CES304.781)		
Hordeum brachyantherum Herbaceous Vegetation	Meadow Barley Herbaceous Vegetation	CEGL003430
North American Arid West Emergent Marsh (CES300.729)		
Juncus balticus Herbaceous Vegetation	Baltic Rush Herbaceous Vegetation	CEGL001838
Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)		
Carex nebrascensis Herbaceous Vegetation	Nebraska Sedge Herbaceous Vegetation	CEGL001813
Eleocharis palustris Herbaceous Vegetation	Common Spikerush Herbaceous Vegetation	CEGL001833

* Plant associations as determined from the vegetation plot, observation point and accuracy assessment point data. Associations are ordered by physiognomy and grouped by ES. Identification codes are provided for plant associations and ecological systems. Because ES units are not constrained by physiognomy, they may appear more than once in the table.

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

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

Plant Community Descriptions

This section provides a summary of FOBU vegetation organized by physiognomic group. Appendix F provides detailed local and global descriptions of the 71 plant associations, alliances and park special vegetation types 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 range and are based primarily on published and unpublished literature.

Most of the vegetation types at FOBU fit into existing NVC association concepts, or were considered significant enough to create new NVC associations. Twelve associations were considered unique to the monument; NatureServe designated these as Park Specials. Only local descriptions were written for Park Specials, which lack global information.

Upland Forest and Woodland Associations

Tree-dominated vegetation types are uncommon and distributed mostly on north-facing slopes within FOBU. They occupy mesic sites from riparian corridors and seeps to rocky talus slopes and toeslopes. All stands are subject to fire; those on steep slopes are vulnerable to downslope soil movement or rock fall. Canopy density is controlled by stand age and the availability of soil moisture. Some examples at FOBU do not have the closed tree canopy that usually characterizes forest (as opposed to more open woodland) associations. The upland forest and woodland associations at FOBU include:

- Juniperus scopulorum / Artemisia tridentata Woodland
- Pinus flexilis / Cercocarpus montanus – Amelanchier utahensis Woodland
- Pinus flexilis / Symphoricarpos oreophilus Woodland
- Populus tremuloides / Amelanchier utahensis - Symphoricarpos oreophilus / Mixed Graminoid Woodland
- Populus tremuloides / Apocynum androsaemifolium Forest
- Populus tremuloides / Cornus sericea Forest
- Populus tremuloides / Invasive Perennial Grasses Forest
- Populus tremuloides / Prunus virginiana Woodland
- Populus tremuloides / Shepherdia canadensis Forest
- Pseudotsuga menziesii / Symphoricarpos oreophilus Forest

Douglas-fir forests are the most common tree-dominated community within the mapping area. They occupy north-facing slopes of Fossil Butte, Cundick Ridge, and Ruby Point and are hevily used by American elk (*Cervus elaphus*) for cover. Quaking aspen stands are generally limited to mesic sites and lee slopes where snow collects; these include the upper drainage of Chicken Creek, slopes of Cundick Ridge and slopes of Ruby Point. Limber pine may be mixed into the canopy of quaking aspen and Douglas-fir stands; it also forms open woodlands, often with a mixed mountain shrub understory, on rocky rims and slopes. An isolated, open stand of Rocky Mountain juniper occurs on a slump near the center of the monument.

Upland Shrubland Associations

Shrublands are the most diverse and widespread communities within the mapping area. They occupy butte and ridgetops, slopes, hills, alluvial fans, drainages, and flats. The upland shrubland associations of FOBU include:

- Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland

- Amelanchier utahensis Shrubland
- Artemisia arbuscula ssp. longiloba / Cushion Plants Shrubland
- Artemisia arbuscula ssp. longiloba / Elymus lanceolatus Shrubland
- Artemisia arbuscula ssp. longiloba / Poa fendleriana Shrubland
- Artemisia arbuscula ssp. longiloba / Poa secunda Shrub Herbaceous Vegetation
- Artemisia arbuscula ssp. longiloba / Pseudoroegneria spicata Shrub Herbaceous Vegetation
- Artemisia arbuscula ssp. longiloba Shrubland
- Artemisia nova / Pseudoroegneria spicata Shrubland
- Artemisia tridentata (ssp. vaseyana, ssp. wyomingensis) - Amelanchier utahensis Shrubland
- Artemisia tridentata / Elymus lanceolatus Shrubland
- Artemisia tridentata ssp. tridentata / Leymus cinereus Shrubland
- Artemisia tridentata ssp. tridentata / Poa secunda Shrubland
- Artemisia tridentata spp. tridentata / Achnatherum lettermanii Shrubland
- Artemisia tridentata ssp. vaseyana / Balsamorhiza sagittata Shrubland
- Artemisia tridentata ssp. vaseyana / Elymus lanceolatus Shrubland
- Artemisia tridentata ssp. vaseyana / Leucopoa kingii Shrubland
- Artemisia tridentata ssp. vaseyana / Leymus cinereus Shrubland
- Artemisia tridentata ssp. vaseyana / Pascopyrum smithii Shrubland
- Artemisia tridentata ssp. vaseyana / Poa fendleriana Shrubland
- Artemisia tridentata ssp. vaseyana / Poa pratensis Sagebrush Shrubland
- Artemisia tridentata ssp. vaseyana / Poa secunda Shrubland
- Artemisia tridentata ssp. vaseyana / Pseudoroegneria spicata Shrubland
- Artemisia tridentata ssp. wyomingensis / Disturbed Understory Semi-natural Shrubland
- Artemisia tridentata ssp. wyomingensis / Leymus cinereus Shrubland
- Artemisia tridentata ssp. wyomingensis / Poa secunda Shrubland
- Artemisia tridentata ssp. wyomingensis / Pseudoroegneria spicata Shrubland
- Atriplex confertifolia – Sarcobatus vermiculatus Shrubland
- Atriplex confertifolia / Wyoming Basins Shrubland
- Atriplex gardneri – Artemisia arbuscula ssp. longiloba Dwarf-shrubland
- Atriplex gardneri Dwarf-shrubland
- Ceanothus martinii Shrubland
- Krascheninnikovia lanata / Achnatherum hymenoides Dwarf-shrubland
- Krascheninnikovia lanata / Poa secunda Dwarf-shrubland
- Prunus virginiana - (Prunus americana) Shrubland
- Purshia tridentata / Pteryxia terebinthina Shrubland
- Sarcobatus vermiculatus / Artemisia tridentata Shrubland
- Sarcobatus vermiculatus / Atriplex gardneri Shrubland
- Symphoricarpos oreophilus Shrubland

Mountain and Wyoming big sagebrush shrublands dominate deep, loamy, soils in the middle and higher elevations within the monument. Low sagebrush shrublands are the most widespread communities within FOBU, occupying alkaline soils, badlands, and bottomlands. The harshest sites support sparse scrub communities of shadscale, winterfat, and other cool desert shrubs. Black sagebrush is rare on limestone substrates. Cool, rocky slopes are the main habitat for mountain shrublands of serviceberry, mountain mahogany, and Martin's buckbrush. Black greasewood and basin big sagebrush dominated terraces along drainage bottoms.

Upland Herbaceous Associations

Grass and forb-dominated associations are uncommon and patchy within the mapping area, tending to occur where soils are thin and windswept or where fire has removed the woody vegetation. The upland herbaceous associations of FOBU include:

- Cushion Plants Sparse Shale Vegetation
- Elymus lanceolatus Herbaceous Vegetation
- Eriogonum brevicaule – Cushion Plants Herbaceous Vegetation
- Lepidium virginicum Sparse Herbaceous Vegetation
- Leymus cinereus Herbaceous Vegetation
- Pascopyrum smithii Herbaceous Vegetation
- Pseudoroegneria spicata - Cushion Plants Herbaceous Vegetation
- Pseudoroegneria spicata Herbaceous Vegetation
- Pteryxia terebinthina Herbaceous Vegetation
- Symphyotrichum foliaceum Snow Glade Herbaceous Vegetation

Streamside wildrye or thickspike wheatgrass occur on a few windswept knolls and ridges and has also become established on the roadbed fill of the monument access road. Persistent bluebunch wheatgrass and curly bluegrass grasslands are uncommon, occurring only on windswept ridgelines in a mosaic with low sagebrush shrublands. Cushion-type forbs like buckwheat, milkvetch, and phlox are common in these sites, and occasionally form a cushion plant community. Relict stands of Great Basin wildrye are rare in draws and near seeps and springs.

Riparian and Wetland Forest and Woodland Associations

Riparian woodlands are rare, restricted in their distribution to seeps on the southwestern face of Fossil Butte. They are dominated by narrowleaf cottonwood trees with herbaceous and scattered shrub species in the understory. Riparian forest and woodland associations of FOBU include:

- Populus angustifolia / Leymus cinereus Woodland

Riparian and Wetland Shrubland Associations

Mesic and wetland shrub communities are very limited in their extent and distribution within the monument. All are restricted to areas with high water tables, including stream banks, stock pond margins, springs, and seeps. Riparian and wetland shrubland associations of FOBU include:

- Artemisia cana / Juncus balticus Shrubland
- Dasiphora fruticosa ssp. floribunda Shrubland
- Salix lutea / Leymus cinereus Shrubland
- Salix scouleriana Shrubland

Yellow willow shrublands are rare on springs and seeps emerging at bedrock contact zones. Silver sagebrush occurs on the banks of Chicken Creek, primarily and on the upper reach of Smallpox Creek.

Riparian and Wetland Herbaceous Associations

Riparian and wetland herbaceous associations are uncommon and limited in their distribution within the mapping area. All are restricted to areas with water at or near the surface for some or all of the growing season, including seeps, springs, ponds, Chicken Creek and Smallpox Creek. Diversity is low to moderate, but most occur in patches smaller than the minimum mapping unit. Riparian and wetland herbaceous associations of FOBU include:

- Carex nebrascensis Herbaceous Vegetation
- Eleocharis palustris Herbaceous Vegetation
- Hordeum brachyantherum Herbaceous Vegetation

- Juncus balticus Herbaceous Vegetation
- Leymus cinereus Herbaceous Vegetation
- Poa pratensis – (Pascopyrum smithii) Semi-natural Herbaceous Vegetation

Because it is resistant to grazing, tolerant of variable water tables, and alkaline conditions, Baltic rush is very common in draws, sometimes forming nearly pure stands, or co-dominating with silver sagebrush in drier sites. Meadow barley is likewise typical of grazed wetlands. Great Basin wildrye was probably more extensive and common historically; it is now most often replaced by Kentucky bluegrass (introduced) and western wheatgrass.

Field Key Preparation

An illustrated dichotomous field key to plant associations of the FOBU 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 level is defined by the physiognomy of the vegetation, i.e., forest, woodland, shrubland, or herbaceous. The second level focuses on the dominant species within each community. Brief environmental descriptions are included to assist in identifying plant associations. To increase the utility of the key, individual plant associations are cross-referenced to the final map classes.

The association field key was constructed from data collected during the classification phase of the mapping project and revised following accuracy assessment of the map. Because the key is based on a sample of the vegetation, it probably does not account for all 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 FOBU 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 is the final version containing revisions based on these suggestions. It also contains important associations discovered during the accuracy assessment phase of the project.

Assessment of Global Rarity

NatureServe and its network of state natural heritage programs indicate the rarity and degree of imperilment of plant communities by assigning state and global conservation status ranks to each. The rank scale ranges from 1 to 5; a rank of 1 indicates critical imperilment due to rarity, endemism, and/or threats, while a rank of 5 indicates little or no risk of extirpation of the plant community. No plant associations within FOBU are considered critically imperiled (G1). Five associations are considered imperiled (G2, Figure 19). Thirty-two associations are ranked vulnerable to secure (G3, G4, and G5) and the remaining associations are not yet ranked or are new to the NVC.

All vegetation communities within FOBU are subject to change over time; drought and fire are the most likely agents of change. Grazing and browsing pressure by a large herd of American elk

has influenced some quaking aspen and other vegetation stands and resulted in heavy trailing under Douglas-fir canopies.

Photo credit: NCPN

Figure 19. The globally imperiled *Pseudoroegneria spicata* vegetation association at FOBU.

Fuels Data Collection

Natural and prescribed fires are an established element of the FOBU ecosystem. Most FOBU vegetation types are adapted to periodic fires. Historically, moderate and low severity fires were usually limited in extent and confined to the herbaceous and shrub layers. These fires created and maintained a mosaic of communities of different ages, structure, and fuel loadings (NPS 2005). Stand-replacing fires were probably rare, occurring primarily under unusual climatic conditions.

It is the policy of the National Park Service to allow natural processes to occur to the extent practical while meeting management objectives. Under the current fire management plan (NPS 2005), wildland fire in FOBU is managed to enhance resource protection, diminish the risks and consequences of severe wildland fires, and to the extent possible, increase the health of naturally occurring plant communities and watersheds. Prescribed fires are used to reduce fuel accumulations and meet the management objectives described above, while all wildfires are suppressed. The proximity of private land and ranching operations adjacent to the monument boundary increases the concern associated with any fire.

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 FOBU. These data were entered in the FOBU plots database. Fuels data were not analyzed as part of this project.

A prescribed burn initiated by Monument staff in 2005 occurred after the classification plot sampling but before map accuracy assessment. Thirty-nine plots sampled in the area of the prescribed burn were kept aside to act as accuracy assessment points, since data collected after the burn would be unlikely to match the mapping that was done from pre-burn aerial imagery. The data in these plots were not made available to the mappers in order to maintain objectivity.

Fuels Data

Field forms, protocols, and definitions for collecting fuels data appear in Appendix B1 and Appendix B3. Quantitative fuels data collected in the vegetation plots at FOBU included measurements of each stem of forest tree species (limber pine, Douglas-fir, quaking aspen, Rocky Mountain juniper, and narrow-leaved cottonwood) exceeding 5 cm (2 in) in diameter:

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

Two 35 mm color slides were taken of each plot and one of each observation point to assist in assessing fuel conditions.

Vegetation Mapping

Methods

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

1. Digital Image Base
2. Field reconnaissance
3. Map class and polygon attribute development
4. Mapping
5. Spatial database development
6. Field verification

Each step was contingent on completion of the previous one. Field reconnaissance was intended to familiarize USGS Rocky Mountain Geographic Science Center (RMGSC) cartographers with the monument, its patterns of vegetation distribution, and environmental factors useful for developing mapping models. Map class development followed field reconnaissance and was based on intensive review of the aerial imagery in concert with data from the first year of vegetation plot sampling. The mapping phase applied the map class concepts in order to draw consistent, homogenous polygons on the base orthoimagery. The draft polygon set was digitized and assigned additional attributes (spatial database development). A final field visit was taken to verify the database and make any necessary corrections.

Digital Image Base

Natural color imagery was acquired for FOBU on July 21, 2004 and processed into 1:12,000-scale hardcopy prints. The 9-x 9-inch photographs were sent to the USGS, scanned at 1000 dots per inch, and mosaicked into a seamless one-meter digital image orthorectified using a 10 m digital elevation model. NAIP imagery was also obtained as an ancillary dataset for the project area. This imagery was one-meter color-infrared data flown during 2006.

Field Reconnaissance

RMGSC cartographers joined the lead project ecologist and FOBU resource management specialist during a field reconnaissance visit in August 2005. The goals of the reconnaissance were to

- 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

Notes were written directly on the hardcopy plots of the project aerial imagery and later converted to an annotation layer for use in a GIS. Photosignatures in diverse vegetation types across the monument and environs were also documented by taking digital photographs at GPS receiver waypoints. Observation points were sampled during field reconnaissance to provide supplemental documentation of the vegetation. Plant cover values at these observation points were checked against the original plot and observation data sampled earlier in the field season. Each association and its location, soils, and other environmental variables were discussed with

the project ecologist. All the different forms of field reconnaissance data were used to guide subsequent vegetation modeling and mapping.

The raster file was then converted to an Arc/Info coverage using Imagine raster-to-vector tools. Small unclassified areas were identified and manually coded. A 7- x 7-pixel majority neighborhood process was used to smooth edges, and remove extraneous linear features. Islands that were created from converting raster to vector output were identified with a roving 3- x 3-pixel neighborhood window. A clump process created unique polygons. Those that were smaller than 0.25 hectares were removed using an eliminate command. The few remaining unattributed polygons were manually recoded to the appropriate neighbor values. Other small but meaningful values that were lost in the eliminate command were then added back into the file. Linework questions, such as how the size of the computer-segmented polygons matched what was found on the ground were discussed with the project ecologist.

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 within the FOBU vegetation mapping project area. Map classes specific to this project were developed to characterize vegetation types within the monument and the environs. Standard land-use map classes (Anderson et al. 2002) were used to map developed parts in the entire mapping area, such as park facilities and roads.

The FOBU vegetation map was initiated using the original standard for the USGS-NPS Vegetation Mapping Program projects (i.e., mapping to the association level of the NVC). The level of detail possible in a vegetation map is limited, however, by the imagery, the skill and experience of the cartographer, and the availability of supporting information. Because of the plethora of good ground data collected by the field crews and project ecologist, a decision was made to adhere to the original project standard and attempt to map to the plant association level in the FOBU project area.

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 association name (e.g., Sagebrush – Serviceberry Shrubland) was used. If the map classes represented multiple associations or non-vegetated features, names incorporating vegetation and landscape features were used; e.g., Windswept Ridge Complex. Multiple-association map classes were sometimes created following the accuracy assessment when associations were combined to increase map accuracy. Cartographers initially assigned an arbitrary number to represent each map class and facilitate data processing. All of the polygon and map class naming history is retained in the final geodatabase. In addition to the map class, polygons were assigned physiognomic attributes to characterize vegetation structure (Table 7).

Table 7. Physiognomic attributes assigned to FOBU polygons during mapping. When appropriate, these attributes were assigned to individual polygons. Otherwise they were assigned to an entire map class.

Category	Attribute	Description
Vegetation Canopy Density (Applied to forest, woodland, and shrub-dominated map classes)	A	Closed Tree Canopy/Continuous (> 60% cover)
	B	Open Tree Canopy/Discontinuous (25- 60% cover)
	C	Dispersed – Sparse Tree Canopy (10-25% cover)
	D	Dense Shrub Canopy (≥ 25% cover)
	E	Light Shrub Canopy (10 – 24% cover)
	F	Sparse Shrub Canopy (<10% cover)

Natural Resource Features of Special Interest

In the scoping phase of the project, monument staff suggested that field crews take note of natural resource features of interest that might otherwise not have been identified. These features were photographed and noted by field workers as encountered, but were not sampled or mapped. Instances were reported directly to monument staff:

- prairie dog colonies
- recent elk antler casts if observed (only two decomposing casts were observed)
- stands of cheatgrass
- trespass livestock (three calves were observed inside the boundary)
- breaks in perimeter fencing (four instances were observed, mostly in quaking aspen stands along the northern side of the ridge supporting Rubey Point)
- occurrences of plains cottonwood (*Populus deltoides* ssp. *wislizeni*) (none were observed)
- plant species not currently listed on the monument species list, collect if good specimens were availabe
- non-native plant species populations or patches

Monument staff also requested that the following specific vegetation types be sampled and mapped:

- silver sagebrush populations
- sedge and rush meadows
- chokecherry patches and stands
- willow and sedge fens
- open water
- soil erosion if observed in plots.

Information describing the condition and location of park special features that were not mapped was provided directly to monument staff and is not otherwise included in this report. These features are commonly referred to as “park specials”, but should not be confused with the “park special” designation given by NatureServe to associations that could not be included in the NVC.

Mapping

A combination of methods was used to delineate and interpret vegetation polygons for the mapping component of the FOBU project area. RMGSC cartographers acquired or created a number of ancillary spatial datasets, including the Dorn et al. (1984) vegetation map, as well as

layers for FOBU soils, geology, fire perimeters, weeds, disturbed areas, monument and project boundaries, and Wasatch Outcrop geologic data. Digital elevation model (DEM) data were downloaded from the USGS Seamless Data Server (http://seamless.usgs.gov) and processed into a 10-meter Imagine file. Slope and aspect information were derived from the DEM coverage. Provisional NVC plant associations assigned by e^2M and NatureServe to plots and observation points during the initial stage of vegetation classification were used to help guide the interpretation. The map units were adjusted several times as new information became available.

Physiognomic Class Image Analysis

A spatial layer of vegetation physiognomy was developed through image analysis using ERDAS Imagine software. The analysis was intended to generate logical boundaries between visually distinctive features but not to determine what the features represented.

A principal component (PCA) layer was created from the 2001 1-m resolution infrared orthoimagery. Photointerpreters analyzed the PCA band 1 for observable spectral thresholds that were consistent with distinctive features visible on the imagery. Vegetation was initially placed into nine broad physiognomic categories. A sieving process eliminated groups of pixels that did not meet the minimum mapping unit (MMU) threshold and recoded them to adjacent vegetation categories. This resulted in a spatial dataset of vegetation classified to physiognomic type (Table 8).

Table 8. The nine broad physiognomic classes developed for biophysical modeling.

#	Category	Description
2	Large shrub bushy	Category of predominantly large shrubs
3	Medium shrub sagebrush	Category of predominantly medium shrubs
4	Small shrub little sagebrush	Category of predominantly small shrubs
5	Other shrub, not sagebrush	Category of non-sagebrush shrub types
6	Grass	Area of predominantly grasses and not high reflectance
7	Cushion plants	Areas of predominantly cushion plants with high reflectance
8	Wetland	Areas of wetland species
9	Other	Categories that were not classified
10	Tree	All tree densities with mixed understory

ArcGIS Procedures

Rare vegetation classes and land-use units were delineated through on-screen digitizing and attributed manually. This method was used if the map class appeared in few locations and all occurrences were easily identified by project ecologists, could readily be interpreted from the stereo photographs, or represented a land-use type (e.g., roads). A trained photointerpreter drew polygons in ArcGIS using the base imagery at a computer workstation. In order to see finer detail, the interpreter also examined the 9- x 9-inch 1:12,000-scale aerial photographs in stereo in conjunction with the electronic version of the orthophotos.

Definiens Procedures

Definiens Pro software (at the time called eCognition) was used to segment the imagery into homogeneous objects. Three data layers were used as the input to define the resulting image objects: the three-band color image, the physiognomic layer, and linear features buffered to eight meters. A shapefile of the resulting image objects was exported and converted to an Imagine file format.

Imagine Procedures

A digital layer of field data (plot and observation points) was used as a guide within ERDAS Imagine software for adding attribute data to the polygons delineated by eCognition. Field reconnaissance notes and the 9- x 9-in stereo photographs were also used to interpret patterns of color, texture, and landscape position as map classes for the vegetation database. A digital file of GPSed black sagebrush polygons was provided by FOBU. A prescribed fire boundary was obtained from the Kemmerer Office of the BLM. All these data layers were intersected into the database and manually edited, where necessary. All polygons were given a final manual check to attribute finer levels and make necessary corrections.

Field Verification

The draft vegetation map database was taken into the field in June, 2006 to validate the polygons and attributes. An Xplore tablet PC with an integrated GPS was used to automate the process of updating the Imagine files.

Spatial Database Development

As a final step in developing the draft map, each polygon was assigned a map class number, alpha code and name, Anderson land use class, and vegetation density attributes. In order to improve the utility of the map and related data, the spatial database was moved into a geodatabase format, the general structure of which is illustrated in Figure 20. This format allows text and image information to be incorporated and linked to spatial coordinates. A detailed description of the geodatabase is provided in Appendix C.

Map Classes

The original set of 95 map classes was ultimately reduced to a final set of 37 vegetation and two land-use map classes following accuracy assessment analysis (Table 9). Final map classes were derived from the original set by grouping them into ecologically and / or physiognomically similar mosaics or complexes (see Appendix J for more information). For example, seven *Artemisia arbuscula* map classes in the original set were grouped into a single map class in the final analysis (Low Sagebrush Shrubland). Ten of the 37 vegetation map classes are complexes or mosaics of multiple associations; the remaining 27 represent single plant associations.

The spatial database was revised to reflect post-accuracy assessment changes to the map classes. An Imagine process was run on the polygons in the Low Sagebrush Shrubland map unit to threshold it into three groupings of low, medium, and medium-to-high densities and assign the corresponding density attribute (Table 7). Modifiers were used to retain information about assocations that were mapped separately but were combined in the final accuracy analysis

(including the Aspen Complex and Low Sagebrush Shrublands). The original linework was retained in cases where there was a modifier difference between polygons of the same map class.

Of the 37 vegetation map classes, three consistently occurred in stands too small to map as polygons (Table 15). All plot, observation and AA points keyed to these types were retained as points only; otherwise the original polygons were merged with surrounding polygons as appropriate. This solution provided information on the known occurrences of these associations with the knowledge that there could be other occurrences of these types on the landscape within other map classes. An additional nineteen vegetation map classes were retained as polygons only where ground data or field observations confirmed their presence (Table 14). These 22 map classes all had 100% accuracy and were thus excluded from the final accuracy assessment analysis as well as the contingency table (Table 11).

Ecological systems (Comer et al. 2003) were used to organize the vegetation map classes (Table 9; see also Project Overview and Appendix A). They were developed by NatureServe to complement the NVC by creating mappable classification units representing groups of associations 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.

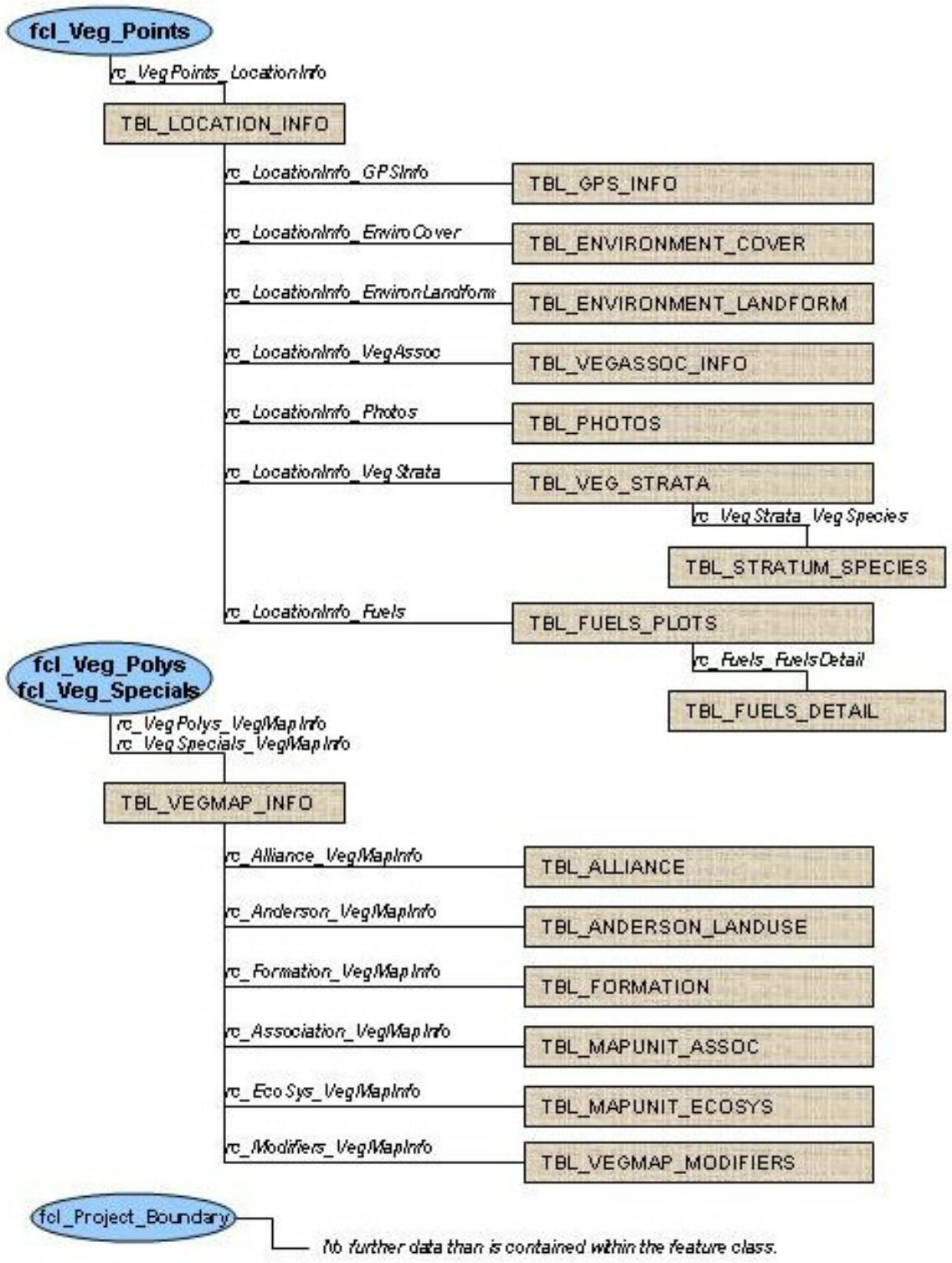


Figure 20. General structure of the FOBU geodatabase.

Results

Table 9 shows the relationship of vegetation map classes to ecological systems. Appendix A provides summary descriptions of each ecological system. The geologic and Anderson land use map classes could not be placed within the ecological system classification.

Table 9. Map classes used in the final (post-AA) FOBU vegetation map, with map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations. FOBU vegetation map classes are arranged using the NatureServe ecological systems classification (shaded boxes).

Map Class #	Code	Map Class Name	Associations Assigned to Map Class	Relation
Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)				
68	F-PSME	Douglas-fir Forest	Pseudotsuga menziesii / Symphoricarpos oreophilus Forest	1 : 1
Rocky Mountain Foothill Limber Pine-Juniper Woodland (CES306.955)				
44	W-JUSC	Rocky Mountain Juniper Woodland	Juniperus scopulorum / Artemisia tridentata Woodland	1 : 1
51	W-PIFL	Limber Pine Woodlands	Pinus flexilis / Cercocarpus montanus - Amelanchier utahensis Woodland Pinus flexilis / Symphoricarpos oreophilus Woodland	1 : many
Rocky Mountain Aspen Forest and Woodland (CES306.813)				
55	F-POTR	Aspen Complex	Populus tremuloides / Tall Forbs Forest Populus tremuloides Woodland Alliance Populus tremuloides / Amelanchier alnifolia - Symphoricarpos oreophilus / Mixed Graminoid Forest	1 : many
57	W-PTCS	Aspen / Red-osier Dogwood Woodland	Populus tremuloides / Cornus sericea Forest	1 : 1
59	W-PTPV	Aspen / Chokecherry Woodland	Populus tremuloides / Prunus virginiana Woodland	1 : 1
60	W-PTSC	Aspen / Buffaloberry – Invasive Grass Woodland	Populus tremuloides / Shepherdia canadensis Forest Populus tremuloides / Invasive Perennial Grasses Forest Populus tremuloides / Apocynum androsaemifolium Forest	1 : many
Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)				
1	S-MXDM	Mixed Mountain Shrubland	Amelanchier utahensis Shrubland Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland	1 : many
33	S-CEMA	Martin's Buckbrush Shrubland	Ceanothus martinii Shrubland [Park Special]	1 : 1

Table 9. Map classes used in the final (post-AA) FOBU vegetation map, with map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations. FOBU vegetation map classes are arranged using the NatureServe ecological systems classification (shaded boxes).

Map Class #	Code	Map Class Name	Associations Assigned to Map Class	Relation
63	S-PRVI	Chokecherry Shrubland	Prunus virginiana - (Prunus americana) Shrubland	1 : 1
69	S-PUTR	Bitterbrush Shrubland	Purshia tridentata / Pteryxia terebinthina Shrubland	1 : 1
74	S-SYOR	Mountain Snowberry Shrubland	Symphoricarpos oreophilus Shrubland	1 : 1
Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785)				
11	S-SASE	Sagebrush - Serviceberry Shrubland	Artemisia tridentata (ssp. vaseyana, ssp. wyomingensis) - Amelanchier utahensis Shrubland	1: 1
16	S-MOSA	Mountain Big Sagebrush Shrublands	Artemisia tridentata ssp. vaseyana / Achnatherum lettermanii Shrubland Artemisia tridentata ssp. vaseyana / Balsamorhiza sagittata Shrubland Artemisia tridentata ssp. vaseyana / Elymus lanceolatus Shrubland Artemisia tridentata ssp. vaseyana / Leucopoa kingii Shrubland Artemisia tridentata ssp. vaseyana / Leymus cinereus Shrubland Artemisia tridentata ssp. vaseyana / Pascopyrum smithii Shrubland Artemisia tridentata ssp. vaseyana / Poa fendleriana Shrubland Artemisia tridentata ssp. vaseyana / Poa pratensis Sagebrush Shrubland Artemisia tridentata ssp. vaseyana / Poa secunda Shrubland Artemisia tridentata ssp. vaseyana / Pseudoroegneria spicata Shrubland	1 : many
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)				
13	S-BBGB	Basin Big Sagebrush / Great Basin Wildrye Shrubland	Artemisia tridentata ssp. tridentata / Leymus cinereus Shrubland	1 : 1
15	S-BBSA	Basin Big Sagebrush / Bluegrass Shrubland	Artemisia tridentata ssp. tridentata / Poa secunda Shrubland	1 : 1

Table 9. Map classes used in the final (post-AA) FOBU vegetation map, with map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations. FOBU vegetation map classes are arranged using the NatureServe ecological systems classification (shaded boxes).

Map Class #	Code	Map Class Name	Associations Assigned to Map Class	Relation
23	S-WYSA	Wyoming Big Sagebrush Shrublands	Artemisia tridentata / Elymus lanceolatus Shrubland Artemisia tridentata ssp. wyomingensis / Disturbed Understory Semi-natural Shrubland Artemisia tridentata ssp. wyomingensis / Leymus cinereus Shrubland Artemisia tridentata ssp. wyomingensis / Poa secunda Shrubland Artemisia tridentata ssp. wyomingensis / Pseudoroegneria spicata Shrubland	1 : many
Wyoming Basins Dwarf Sagebrush Shrubland and Steppe (CES304.794)				
4	S-ARAR	Low Sagebrush Shrublands	Artemisia arbuscula ssp. longiloba / Cushion Plants Dwarf-shrubland Artemisia arbuscula ssp. longiloba / Elymus lanceolatus Shrubland Artemisia arbuscula ssp. longiloba / Poa fendleriana Shrubland Artemisia arbuscula ssp. longiloba / Poa secunda Shrub Herbaceous Vegetation Artemisia arbuscula ssp. longiloba / Pseudoroegneria spicata Shrub Herbaceous Vegetation Artemisia arbuscula ssp. longiloba Shrubland Atriplex gardneri Dwarf-shrubland Atriplex gardneri - Artemisia arbuscula ssp. longiloba Dwarf-shrubland	1 : many
10	S-ARNO	Black Sagebrush Shrubland	Artemisia nova / Pseudoroegneria spicata Shrubland	1 : 1
Multiple Ecological Systems: **Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)** **Inter-Mountain Basins Shale Badland (CES304.789)** **Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)**				
36	C-WIND	Windswept Ridge Complex	Cushion Plants Sparse Shale Vegetation Eriogonum brevicaule - Cushion Plants Sparse Vegetation Krascheninnikovia lanata / Achnatherum hymenoides Dwarf-shrubland Krascheninnikovia lanata / Poa secunda Dwarf-shrubland Pseudoroegneria spicata - Cushion Plants Herbaceous Vegetation Pseudoroegneria spicata Herbaceous Vegetation	1 : many
Inter-Mountain Basins Greasewood Flat (CES304.780)				
28	S-SASG	Saline Flat Shrublands	Atriplex confertifolia – Sarcobatus vermiculatus Shrubland Sarcobatus vermiculatus / Artemisia tridentata Shrubland Sarcobatus vermiculatus / Atriplex gardneri Shrubland	1 : many

Table 9. Map classes used in the final (post-AA) FOBU vegetation map, with map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations. FOBU vegetation map classes are arranged using the NatureServe ecological systems classification (shaded boxes).

Map Class #	Code	Map Class Name	Associations Assigned to Map Class	Relation
Inter-Mountain Basins Shale Badland (CES304.789)				
29	S-SHCL	Shadscale Cliff Sparse Shrubland	Atriplex confertifolia Wyoming Basins Shrubland	1 : 1
37	H-PTTE	Rockloving Wavewing Meadow	Pteryxia terebinthina Herbaceous Vegetation	1 : 1
48	H-LEVI	Virginia Pepperweed Sparse Vegetation	Lepidium virginicum Sparse Herbaceous Vegetation	1 : 1
Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)				
49	H-LECI	Great Basin Wildrye Grassland	Leymus cinereus Herbaceous Vegetation	1 : 1
50	H-PASM	Western Wheatgrass Grassland	Pascopyrum smithii Herbaceous Vegetation	1 : 1
53	H-POPR	Kentucky Bluegrass Meadow	Poa pratensis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation	1 : 1
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)				
40	H-ELLA	Streamside Wildrye Grassland	Elymus lanceolatus Herbaceous Vegetation	1 : 1
Inter-Mountain Basins Wash (CES304.781)				
42	H-HOBR	Meadow Barley Grassland	Hordeum brachyantherum Herbaceous Vegetation	1 : 1
Rocky Mountain Subalpine-Montane Mesic Mesic Meadow (CES306.829)				
38	S-DAFR	Shrubby Cinquefoil Shrubland	Dasiphora fruticosa ssp. floribunda Shrubland	1 : 1
27	H-SNOW	Snow Glade	Symphyotrichum foliaceum Snow Glade Herbaceous Vegetation	1 : 1
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)				

Table 9. Map classes used in the final (post-AA) FOBU vegetation map, with map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations. FOBU vegetation map classes are arranged using the NatureServe ecological systems classification (shaded boxes).

Map Class #	Code	Map Class Name	Associations Assigned to Map Class	Relation
54	W-POAN	Narrowleaf Cottonwood Woodland	Populus angustifolia / Leymus cinereus	1 : 1
9	S-ARCA	Silver Sagebrush Wet Meadow	Artemisia cana / Juncus balticus Shrubland	1 : 1
70	S-SALU	Yellow Willow Shrubland	Salix lutea / Leymus cinereus Shrubland	1 : 1
71	S-SASC	Scouler Willow Shrubland	Salix scouleriana Shrubland	1 : 1
Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)				
39	H-ELPA	Marsh Spikerush Wetland	Eleocharis palustris Herbaceous Vegetation	1 : 1
Multiple Ecological Systems: North American Arid West Emergent Marsh (CES300.729) Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)				
32	H-JUBA	Wet Meadow Herbaceous	Carex nebrascensis Herbaceous Vegetation Juncus balticus Herbaceous Vegetation	1 : many
Unvegetated Land Use Map Classes				
75	L-FACI	Park Infrastructure	NPS buildings, parking lots, and other infrastructure	N/A
76	L-ROAD	Roads	N/A	N/A

Map Class Descriptions

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

- a summary of the ecological concept of the map class. Reference is made to the ecology, abundance and distribution 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 (if available)
- statistics and accuracy assessment results

Map Polygons

The FOBU vegetation map consists of 1,709 polygons totaling 6,217 hectares (15,362 acres). Average polygon size is 2.0 ha (5.0 acres). Lands within the monument make up 3,351 ha (8,281 acres) or 53.9% of the total project area. Of the total, 1,687 polygons (99%) represent natural or semi-natural vegetation map classes covering 99% of the mapping project area. Map classes representing non-vegetated roads and facilities account for the remaining 22 polygons (<2% of polygons and area).

The polygon totals include adjacent polygons that have the same map code but different density or pattern attributes. The most common map class is Low Sagebrush Shrubland (S-ARAR) with 646 polygons covering 34.8% of the mapping area. The largest average polygon size belongs to Saline Flat Shrubland (S-SASG) at 6.1 ha (15.2 acres) per polygon.

Figure 21 is an example of a map of the vegetation of FOBU created from the spatial database. Because we used a geodatabase to store and organize mapping information, there is far more data in the spatial database than can be conveyed in a two-dimensional map. Maps can be produced with vegetation polygons labeled in many different ways at different levels of resolution. Table 10 provides summary statistics for FOBU vegetation map polygons.

Table 10. Summary statistics for polygons of each map class developed for the FOBU vegetation mapping project.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Monument	Environs	Total Area*	Monument	Environs	Total Area
Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)							
F-PSME	Douglas-fir Forest	9	0	9	19.1	0	19.1
	Subtotal	*9*	*0*	*9*	*19.1*	*0*	*19.1*
Rocky Mountain Foothill Limber Pine-Juniper Woodland (CES306.955)							
W-JUSC	Rocky Mountain Juniper Woodland	1	0	1	0.6	0	0.6
W-PIFL	Limber Pine Woodlands	39	5	44	76.7	41.9	118.6
	Subtotal	*40*	*5*	*45*	*77.3*	*41.9*	*119.2*
Rocky Mountain Aspen Forest and Woodland (CES306.813)							
F-POTR	Aspen Complex	32	34	66	123.6	108.7	232.3
W-PTCS	Aspen / Red-osier Dogwood Woodland	1	0	1	1.8	0	1.8
W-PTPV	Aspen / Chokecherry Woodland	2	1	3	4.0	1.3	5.3
W-PTSC	Aspen / Buffaloberry Woodland	5	6	11	26.6	0.9	27.6
	Subtotal	*40*	*41*	*81*	*156.1*	*110.9*	*267.0*
Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)							
S-MXDM	Mixed Mountain Shrubland	40	16	56	104.4	61.7	166.1
S-CEMA	Martin's Buckbrush Shrubland	N/A	N/A	N/A	N/A	N/A	N/A
S-PRVI	Chokecherry Shrubland	3	0	3	1.6	0	1.6
S-PUTR	Bitterbrush Shrubland	1	0	1	1.1	0	1.1
S-SYOR	Mountain Snowberry Shrubland	1	0	1	0.7	0	0.7
	Subtotal	*45*	*16*	*61*	*107.7*	*61.7*	*169.5*
Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785)							
S-SASE	Sagebrush - Serviceberry Shrubland	94	44	138	204.0	83.2	287.1

Table 10. Summary statistics for polygons of each map class developed for the FOBU vegetation mapping project.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Monument	Environs	Total Area*	Monument	Environs	Total Area
S-MOSA	Mountain Big Sagebrush Shrublands	171	145	316	995.5	857.8	1853.3
	Subtotal	*265*	*189*	*454*	*1199.5*	*941.0*	*2140.5*
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)							
S-BBGB	Basin Big Sagebrush / Great Basin Wildrye Shrubland	11	2	13	9.6	0.9	10.5
S-BBSA	Basin Big Sagebrush / Bluegrass Shrubland	22	29	51	46.1	194.5	240.7
S-WYSA	Wyoming Big Sagebrush Shrublands	20	45	65	133.2	144.9	278.1
	Subtotal	*53*	*76*	*129*	*189.0*	*340.3*	*529.3*
Wyoming Basins Dwarf Sagebrush Shrubland and Steppe (CES304.794)							
S-ARAR	Low Sagebrush Shrublands	401	245	646	1160.7	1000.7	2161.4
S-ARNO	Black Sagebrush Shrubland	2	0	2	3.1	0	3.1
	Subtotal	*403*	*245*	*648*	*1163.8*	*1000.7*	*2164.5*
Multiple Ecological Systems: Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788) Inter-Mountain Basins Shale Badland (CES304.789) Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)							
C-WIND	Windswept Ridge Complex	65	15	80	124.0	6.6	130.6
	Subtotal	*65*	*15*	*80*	*124.0*	*6.6*	*130.6*
Inter-Mountain Basins Shale Badland (CES304.789)							
S-SHCL	Shadscale Cliff Sparse Shrubland	8	1	9	34.9	5.1	40.1
H-PTTE	Rockloving Wavewing Meadow	N/A	N/A	N/A	N/A	N/A	N/A
H-LEVI	Virginia Pepperweed Sparse Vegetation	1	0	1	2.0	0	2.0
	Subtotal	*9*	*1*	*10*	*36.9*	*5.1*	*42.0*
Inter-Mountain Basins Greasewood Flat (CES304.780)							

Table 10. Summary statistics for polygons of each map class developed for the FOBU vegetation mapping project.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Monument	Environs	Total Area*	Monument	Environs	Total Area
S-SASG	Saline Flat Shrubland	26	27	53	117.5	207.7	325.2
	Subtotal	*26*	*27*	*53*	*117.5*	*207.7*	*325.2*
Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)							
H-LECI	Great Basin Wildrye Grassland	4	1	5	3.6	0.1	3.7
H-PASM	Western Wheatgrass Grassland	4	1	5	1.4	0.6	2.0
H-POPR	Kentucky Bluegrass Meadow	2	0	2	1.1	0	1.1
	Subtotal	*10*	*2*	*12*	*6.1*	*0.7*	*6.8*
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)							
H-ELLA	Streamside Wildrye Grassland	12	1	13	35.8	0.7	36.5
	Subtotal	*12*	*1*	*13*	*35.8*	*0.7*	*36.5*
Inter-Mountain Basins Wash (CES304.781)							
H-HOBR	Meadow Barley Grassland	N/A	N/A	N/A	N/A	N/A	N/A
	Subtotal						
Rocky Mountain Subalpine-Montane Mesic Mesic Meadow (CES306.829)							
S-DAFR	Shrubby Cinquefoil Shrubland	1	0	1	0.2	0	0.2
H-SNOW	Snow Glade	3	0	3	3.7	0	3.7
	Subtotal	*4*	*0*	*4*	*3.9*	*0*	*3.9*
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)							
W-POAN	Narrowleaf Cottonwood Woodland	1	0	1	1.2	0	1.2
S-ARCA	Silver Sagebrush Wet Meadow	8	2	10	7.8	0.2	7.9
S-SALU	Yellow Willow Shrubland	1	0	1	0.2	0	0.2
S-SASC	Scouler Willow Shrubland	1	0	1	0.1	0	0.1

Table 10. Summary statistics for polygons of each map class developed for the FOBU vegetation mapping project.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Monument	Environs	Total Area*	Monument	Environs	Total Area
	Subtotal	*11*	*2*	*13*	*9.3*	*0.2*	*9.5*
Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)							
H-ELPA	Marsh Spikerush Wetland	0	1	1	0	0.4	0.4
	Subtotal	*0*	*1*	*1*	*0*	*0.4*	*0.4*
Multiple Ecological Systems: North American Arid West Emergent Marsh (CES300.729) Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)							
H-JUBA	Wet Meadow Herbaceous	32	42	74	84.7	104.4	189.2
	Subtotal	*32*	*42*	*74*	*84.7*	*104.4*	*189.2*
Unvegetated Land Use Map Classes							
L-FACI	Park Infrastructure	2	2	4	2.0	2.5	4.6
L-ROAD	Roads	17	1	18	18.2	40.7	59.0
	Subtotal	*19*	*3*	*22*	*20.2*	*43.3*	*63.5*
	Total All Map Classes	**1043**	**666**	**1709**	**3351.1**	**2865.6**	**6216.7**

Discussion

Accurate plot and observation point data and detailed local descriptions of the vegetation associations for FOBU were provided by project ecologists. These and additional data collected by the project photointerpreters on two field reconnaissance trips provided a strong basis and understanding for interpreting the imagery, modeling, and delineating map classes. The lead project ecologist participated in the first of these trips and shared valuable knowledge and insight with the cartographers.

Good quality, high-resolution orthoimagery provided a solid source for deriving physiognomic classes which were very useful in the subsequent Defniens (eCognition) segmentation. A semi-automated approach was used for this project as a possible means of augmenting or replacing the traditional process of manual photo-interpretation to improve the consistency, efficiency, repeatability, and cost effectiveness of vegetation mapping. This process removes potential sources of transcription error as well by eliminating the need to scan Mylar overlays, orthorectify and warp them to the orthoimagery, clean up the linework digitally, and re-attribute the polygons.

This approach used for the mapping met with mixed success, however, as shown by the low initial map accuracy (43%). 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 the sagebrush communities. Given the high quality and quantity of the plot data, the photointerpreters were optimistic about creating an association-level map. In retrospect, a savings in time and cost would have been realized if associations had been combined into map classes at the onset of the project. Instead, associations were grouped after the AA to attain the requisite program accuracy.

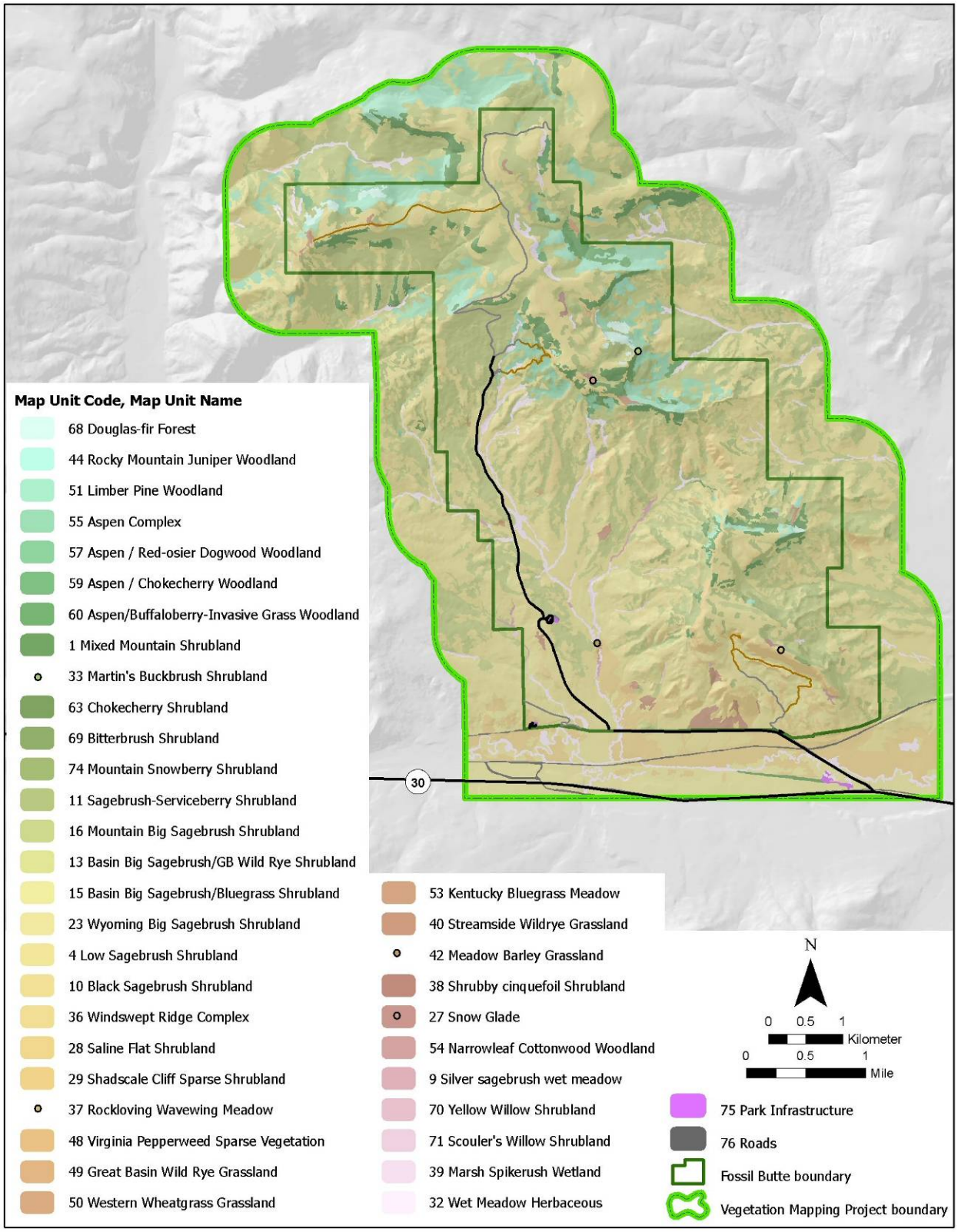


Figure 21. The FOBU vegetation map based on the final set of 39 map classes

Accuracy Assessment

Methods

Introduction

Accuracy assessment (AA) is a statistical estimate of how accurately the map created from interpreted imagery represents vegetation on the ground. The AA compares field observations of the vegetation with polygon map class labels. Errors occur when mapped polygon labels differ from field observations. Results of the AA allow users to evaluate the utility of the vegetation mapping data for particular applications.

Accuracy assessment results come in two forms: "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. Ideally, a map has both high user's and producer's accuracy.

Sampling Design

A stratified random sampling approach was used to determine AA sampling locations (ESRI and TNC 1994). The AA included most vegetation map classes and was limited to areas greater than 4500 pixels in size located within the FOBU boundary; private and federal outside of the monument were not included in the accuracy evaluation. Other restrictions to the area assessed are described below.

Sample sizes for each evaluated map class were selected using the USGS-NPS Vegetation Mapping Program guidelines (ESRI and TNC 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), it is impossible to estimate a statistically meaningful confidence interval for the sample and the accuracy of the class can only be confirmed through a census.

The RMGSC cartographers created an overlay of areas to be sampled by excluding from the accuracy assessment areas with slopes greater than 50%, the environs, and non-vegetated areas. Narrow polygons (e.g., riparian zones) and rare, small map classes were added back in to the sampling area.

Accuracy assessment sampling points were selected for each of the 67 remaining map classes using guidelines A–E. The primary set of AA evaluation sites included 1,537 potential sample points. Secondary and tertiary sets of points were generated in case some of the points in the primary set could not be accessed safely. A 40 m (131 ft) interior buffer from polygon edges was generated for the map coverage to help ensure that 0.5 ha sampling points would fall cleanly within the polygon. The 40 m buffer worked in most situations; however, for small or linear polygons the buffer was reduced or eliminated and the AA point forced into the center of the polygon. 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 orthophotograph background to guide the field crews.

Field Data Collection

Accuracy assessment point data were collected at FOBU during the summer of 2006. Field crews used GPS receivers, digital orthophotograph plots, and topographic maps to navigate precisely to each pre-selected AA point. The crews evaluated an area approximately 5,000 m^2, centered on the AA point coordinates (Appendix B). Environmental data collected in the field included elevation, slope, aspect, topographic position, landform, unvegetated surface elements, and descriptive comments. Vegetation data included leaf type and physiognomic class, as well as height and canopy cover for the dominant species in each stratum. The illustrated field key was used to identify the plant association that best described the plot. In most cases, only one plant association name was recorded. When vegetation relationships were unclear, secondary and tertiary plant association names were recorded. Plant associations occurring within 50 m of the AA point boundary were also noted in some cases. One or more 35 mm color slides were taken at each AA point to provide visual documentation of the site.

The field team collected data at 622 AA points late in the 2006 field season (Figure 22). AA point data were manually entered into the plots database and the data were subjected to a thorough quality assessment / quality check (QA/QC) prior to analysis. Thirty-nine AA points sampled in 2005 within the prescribed burn area were added to the AA dataset, for a total of 661 AA data points. Nomenclature standards and other data management procedures were the same as for the classification plot data (see Vegetation Classification and Description section). Photographic slides were converted to digital format and catalogued in the same database as the classification plot photographs.

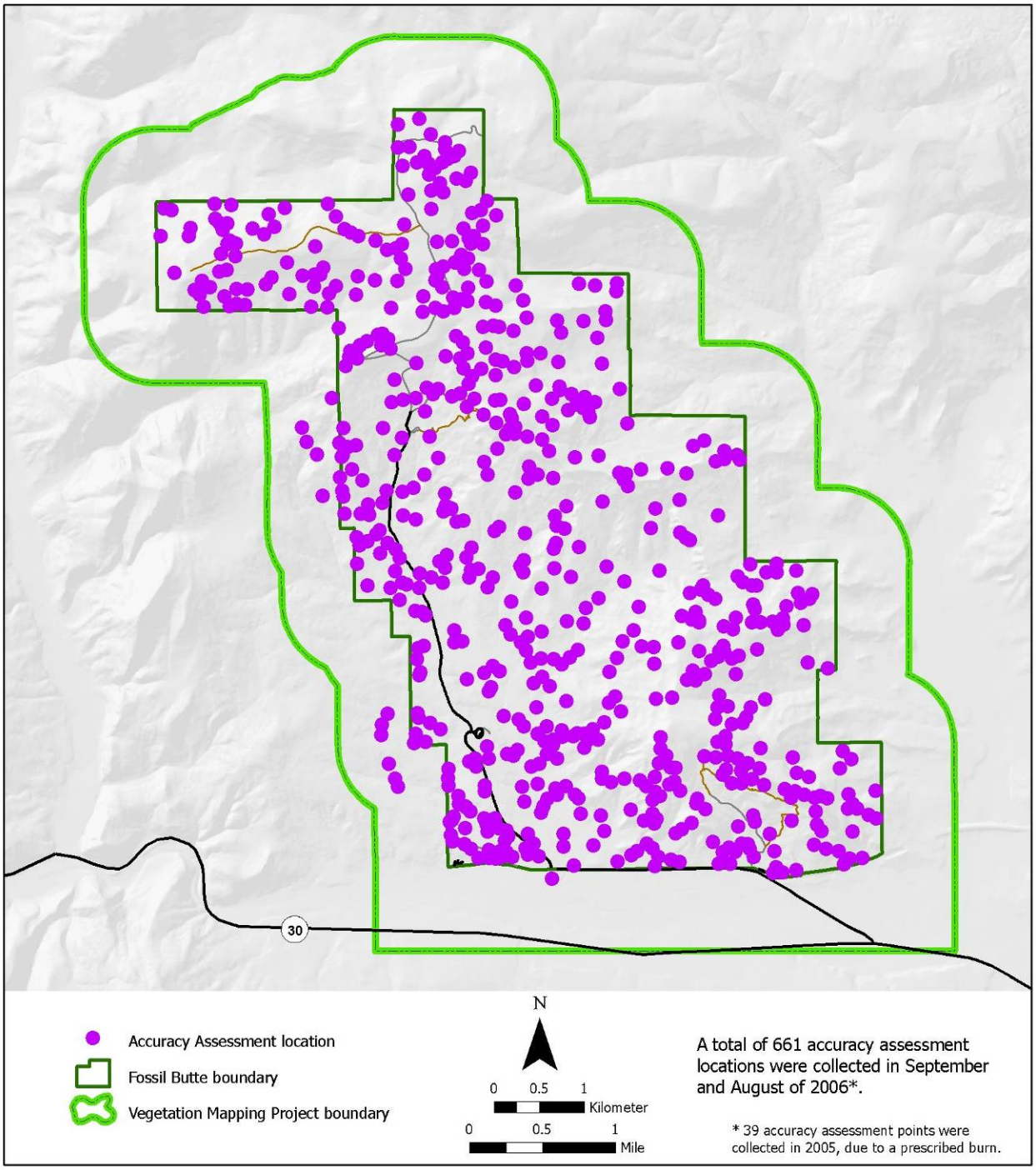


Figure 22. Location of accuracy assessment points sampled within FOBU. The accuracy of the map outside of the monument boundary was not assessed.

Data Analysis

The field data were converted into a spatial (point) data layer with coordinates and attributes and intersected with the map polygon data in ArcGIS. Nineteen AA points collected in the portion of the Monument that was burned subsequent to plot data collection but previous to AA data collection, were eliminated from the point file. All of these points were burned to such a degree

that the original vegetation was unrecognizable and a new name, Post-burn Herbaceous Vegetation, was substituted. Two points were dropped because they occurred in anomalous, unclassifiable weedy patches in an active slump within the polygon. One point was dropped because of irresolvable positional errors. Of the 661 AA data points collected in the field (39 sampled in 2005 and 622 from 2006), 639 points were used in the analysis. The field-assigned association names for each AA point were compared with the map class code for that polygon. If any of the three field names agreed with the labeled map class for a given polygon, it was considered correct. All other results were marked incorrect.

The results of the AA analysis were arrayed in a preliminary contingency table and producer's and user's accuracy were calculated. Producer's accuracy was 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 December 2007, the primary photointerpreters and project ecologists from NatureServe, NCPN, e^2M, and the USGS met to analyze the map errors revealed in the preliminary contingency table. Participants reviewed field data sheets, ground photographs, 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 included GPS position error, questionable field determinations, 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. During this meeting, patterns of error were analyzed and solutions discussed for changes to the map classes and database that would bring each map class to the program standard of 80% accuracy (Appendix I).

Table 11. Final contingency table for the map classes used at FOBU. This table represents the 15 map classes retained following the accuracy assessment and revision process[1]. Shaded boxes indicate the number of AA points that agree with the assigned map class. To read the table, columns represent the map class observed in the field, while the rows represent the map class assigned by the photointerpreter. Overall accuracy is 89% (Kappa statistic = 85.7%). User's and producer's accuracy values for each map class appear in Tables 12 and 13.

		Accuracy Assessment Field Plot Data — Commission (User's) Error															Correct		90% C.I.	
		1	4	11	13	15	16	23	28	29	32	36	40	51	55	68	#	%	-	+
Mapped Data — Omission (Producer's) Error	1	22	1	2			1			1		1		1			29	76%	61%	91%
	4		217	3			7		1			2			1		231	94%	91%	97%
	11	2	3	40			4										49	82%	72%	92%
	13				4												4	100%	88%	113%
	15					7	1	1									9	78%	49%	106%
	16	1	6	1			114	2				1		1	1		127	90%	85%	95%
	23		2				1	35	1					1			40	88%	78%	97%
	28		3					2	16								21	76%	59%	94%
	29									12		1					13	92%	76%	108%
	32						1				9				1		11	82%	58%	105%
	36		2									17	1				20	85%	69%	101%
	40												9				9	100%	94%	106%
	51	1												16			17	94%	82%	106%
	55	1	1	1											24		27	89%	77%	101%
	68															5	5	100%	90%	110%
Correct	#	27	235	47	4	7	129	40	18	13	9	22	10	19	27	5				
	%	81%	92%	85%	100%	100%	88%	88%	89%	92%	100%	77%	90%	84%	89%	100%	612 total points 89% accuracy			
90% C.I.	-	67%	89%	75%	88%	93%	83%	78%	74%	76%	94%	60%	69%	68%	77%	90%				
	+	96%	95%	95%	113%	107%	93%	97%	104%	108%	106%	94%	111%	101%	101%	110%				

[1]The remaining 22 vegetation map classes not included in this contingency table (see Tables 14 and 15) were all mapped only where known to occur from plots or AA points, thus resulting in 100% accuracy for all remaining classes. No land use map classes were accuracy assessed.

Results and Discussion

The map classes shown in tables and figures in this document represent those that remained or were created following adjustment of map classes to improve FOBU map class accuracy. Final overall map accuracy is 89% (Kappa correction = 85.7%). Individual map class accuracy ranges from 76% to 100% (Table 12 and Table 13). Individual map class producer's and user's accuracy values in tables 12 and 13 are given with their 90% confidence intervals. The width of each confidence interval is affected by sample size; the smaller the sample size, the wider the confidence interval.

The remainder of this section discusses the revisions that were made to the spatial database to meet the national standards, based on decisions reached during the February 2008 accuracy assessment meeting.

Table 12. Final FOBU vegetation map classes that met or exceeded the 80% program standard for both user's and producer's accuracy.

Map Class Code	Map Class #	Map Class Name	Producer's Accuracy (±90% CI)	User's Accuracy (±90% CI)
S-ARAR	4	Low Sagebrush Shrublands	94% ± 3%	92% ± 3%
S-SASE	11	Sagebrush – Serviceberry Shrubland	82% ± 10%	85% ± 10%
S-BBGB	13	Basin Big Sagebrush / Great Basin Widlrye Shrubland	100%	100%
S-MOSA	16	Mountain Big Sagebrush Shrublands	90% ± 5%	88% ± 5%
S-WYSA	23	Wyoming Big Sagebrush Shrublands	88% ± 10%	88% ± 10%
S-SHCL	29	Shadscale Cliff Sparse Shrubland	92% ± 16%	92% ± 16%
H-JUBA	32	Wet Meadow Herbaceous	82% ± 23%	100%
H-ELLA	40	Streamside Wildrye Grassland	100%	90% ± 21%
W-PIFL	51	Limber Pine Woodlands	94% ± 12%	84% ± 16%
F-POTR	55	Aspen Complex	89% ± 12%	89% ± 12%
F-PSME	68	Douglas-fir Forest	100%	100%

Table 13. FOBU vegetation map classes where either the user's or producer's accuracy did not meet the 80% program standard.

Map Class Code	Map Class #	Map Class Name	Producer's Accuracy (±90% CI)	User's Accuracy (±90% CI)	Confused with Map Class #
S-MXDM	1	Mixed Mountain Shrubland	76% ± 15%	81% ± 15%	11
S-BBSA	15	Basin Big Sagebrush / Bluegrass Shrubland	78% ± 29%	100%	16, 23
S-SASG	28	Saline Flat Shrubland	76% ± 18%	89% ± 15%	4, 23
C-WIND	36	Windswept Ridge Complex	85% ± 16%	77% ± 17%	4

As shown in Table 13, four map classes were retained in the final vegetation map for FOBU when either user's or producer's accuracy did not meet the 80% program standard. In all cases, the 90% confidence interval includes 80%. These map classes were accepted by monument staff

with less than 80% accuracy because they were ecologically significant and because the errors were with closely related map classes.

Nineteen vegetation map classes were retained as polygons only where known to occur from field points and observations. Reasons for retaining these map class are detailed below.

Table 14. FOBU vegetation map classes mapped only where known to occur from plots, observation, and/or AA points.

Map Class Code	Map Class #	Map Class Name	Reasons to retain map class	Confused with Map Class #
S-ARCA	9	Silver Sagebrush Wet Meadow	Monument wants to know locations of *Artemisia cana*	4
S-ARNO	10	Black Sagebrush Shrubland	Very rare vegetation type	N/A
H-SNOW	27	Snow Glade	Very rare type, occurs in small pockets	N/A
S-DAFR	38	Shrubby Cinquefoil Shrubland	Very rare vegetation tpe	N/A
H-ELPA	39	Marsh Spikerush Wetland	Very rare vegetation type	N/A
W-JUSC	44	Rocky Mountain Juniper Woodland	Very rare vegetation type	N/A
H-LEVI	48	Virginia Pepperweed Sparse Vegetation	Very rare vegetation type	N/A
H-LECI	49	Great Basin Wildrye Grassland	Monument wants to know locations of *Leymus cinereus*	Small inclusions in many other veg types
H-PASM	50	Western Wheatgrass Grassland	Rare type, occurs in small pockets	N/A
H-POPR	53	Kentucky Bluegrass Meadow	Rare vegetation type, though may be more of it as small inclusions in other veg types	N/A
W-POAN	54	Narrowleaf Cottonwood Woodland	Very rare vegetation type	N/A
W-PTCS	57	Aspen / Red-osier Dogwood Woodland	Monument wants to know locations of *Cornus sericea*	55, 59, 60
W-PTPV	59	Aspen / Chokecherry Woodland	Monument wants to know locations of *Prunus virginiana*	55, 57, 60
W-PTSC	60	Aspen / Buffaloberry - Invasive Grass Woodland	Unique aspen type of drier sites	55, 57, 59
S-PRVI	63	Chokecherry Shrubland	Monument wants to know locations of *Prunus virginiana*	Small inclusions in aspen types
S-PUTR	69	Bitterbrush Shrubland	Very rare vegetation type	36
S-SALU	70	Yellow Willow Shrubland	Very rare type, occurs in small pockets	N/A
S-SASC	71	Scouler's Willow Shrubland	Very rare type, occurs in small pockets	N/A
S-SYOR	74	Mountain Snowberry Shrubland	Very rare type, occurs in small pockets	N/A

The following three map classes are all extremely rare vegetation types in FOBU that were documented in stands too small to delineate or had too indistinct a photosignature to interpret

from the imagery; nonetheless, they were deemed important by monument staff and were thus retained as individual map classes with locations mapped as points.

Table 15. FOBU vegetation map classes mapped only as point layers.

Map Class Code	Map Class #	Map Class Name
S-CEMA	33	Martin's Buckbrush Shrubland
H-PTTE	37	Turpentine Wavewing Meadow
H-HOBR	42	Meadow Barley Grassland

References

Aase, A., K. Bush, L Clement, A. Elder, L.M. Mitchell, and M. Wilson. 2002. Fossil Butte National Monument Museum Management Plan. National Park Service, Intermountain Region, Denver, CO.

Anderson, J.R., E. Hardy, J. Roach, and R. Witter. 2002. A land use and land cover classification system for use with Remote Sensor Data. Geological Survey Professional Paper 964. U.S. Government Printing Office, Washington, D.C.

Avery, T.E. 1978. Forester's guide to aerial photo interpretation. Agriculture Handbook 308. U.S. Department of Agriculture, U.S. Forest Service, U.S. Government Printing Office, Washington, D.C.

Bailey, R.G. 2001. Descriptions of the ecoregions of the United States. 2d ed. Rev. and expanded (1st ed. 1980). Misc. Publ. No. 1391 (rev.), Washington, D.C.: USDA Forest Service. 108 p. with 1:7,500,000-scale map.

Beetle, A.A., and C.B. Marlow. 1974. A vegetative survey of Fossil Butte National Monument, Kemmerer, Wyoming. University of Wyoming Cooperative Research Report to the Yellowstone Environmental Studies Center, Wyoming Agricultural Experiment Station.

Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems. NatureServe, Arlington, VA.

Dorn, R.D., R.W. Lichvar, and J.L. Dorn. 1984. Grazing impact study on Fossil Butte National Monument, Wyoming. Report prepared for the National Park Service by Mountain West Environmental Services, Cheyenne, WY.

Driscoll, R.S., D.L. Merkel, R.L. Radloff, D.E. Snyder, and J.S. Hagihara. 1984. An ecological land classification framework for the United States. United States Department of Agriculture, Forest Service Miscellaneous Publication Number 1439. Washington, D.C. 56 pp.

Dufrêne, M. and P. Legendre. 1997. Species assemblages and indicator species: the need for a flexible asymmetrical approach. Ecological Monographs 67:345-366.

Environmental Systems Research Institute, National Center for Geographic Information and Analysis, and The Nature Conservancy. 1994. Final draft accuracy assessment procedures. NBS/NPS Vegetation Mapping Program. Prepared for the United States Department of Interior, Biological Resources Division and National Park Service.

Evenden, A. 2001. Vegetation mapping and classification project proposal: eleven Northern Colorado Plateau Network Parks, September 2001. Northern Colorado Plateau Network, National Park Service, Moab, UT. 10 p.

Evenden, A., M. Miller, M. Beer, E. Nance, S. Daw, A. Wight, M. Estenson, and L. Cudlip. 2002. Northern Colorado Plateau vital signs network and prototype cluster plan for natural resources monitoring: Phase I report [two volumes]. October 1. National Park Service, Northern Colorado Plateau Network, Moab, UT. 138 pp + app.

Federal Geographic Data Committee, Vegetation Subcommittee. 1997. Vegetation classification standard [online]. Available from: http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/vegclass.pdf [Cited April 29, 2008].

Federal Geographic Data Committee - Vegetation Subcommittee. 2008. National Vegetation Classification Standard (Version 2). FGDC-STD-005-2008. Available online: http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation.

Federal Geographic Data Committee. 1998a. Content standard for digital geospatial metadata, FGDC-STD-001-1998. Available from: http://www.fgdc.gov/metadata/contstan.html.

Federal Geographic Data Committee. 1998b. Spatial data transfer standard, FGDC-STC-002. Available from: http://www.fgdc.gov/standards/status/textstatus.html.

Fertig, W., C. Fefsdal, and J. Whipple. 1994. Wyoming Rare Plant Field Guide. Wyoming Rare Plant Technical Committee, Cheyenne. Available online at Northern Prairie Wildlife Research Center: http://www.npwrc.usgs.gov/resource/tools/wyplant/wyplant.htm

Fertig, W. and C. Kyte. 2009. Annotated checklist of vascular flora: Fossil Butte National Monument. Natural Resource Technical Report NPS/NCPN/NRTR—2009/205. National Park Service, Fort Collins, CO.

Flahault, C., and C. Schroter. 1910. Rapport sur la nomenclature phytogeopraphique. Proceedings of the Third International Botanical Congress, Brussels 1:131-164.

Glenn, W. R. 1974. Soil survey, Fossil Butte National Monument, Lincoln County, Wyoming. USDA, Soil Conservation Service.

Grossman, D.H., D. Faber-Langendoen, A.S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K.D. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International Classification of Ecological Communities: Terrestrial Vegetation of the United States. Volume I. The National Vegetation Classification System: Development, Status, and Applications. The Nature Conservancy, Arlington, VA.

Hop, K., S. Lubinski, and S. Menard. 2005. USGS-NPS Vegetation Mapping Program: Effigy Mounds National Monument, Iowa. USGS, Upper Midwest Environmental Sciences Center. La Crosse, WI. January 2005. 62 pp + Appendices A-I.

Kartesz, J. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First Edition. In: Kartesz, J.T., and C.A. Meacham. Synthesis of the North American Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.

Kyte, C.R. 2001. Vegetation Management Plan. NPS-Fossil Butte National Monument. Keammerer, WY.

McCune, B. and J.B. Grace. 2002. Analysis of Ecological Communities. MjM Software Design, Gleneden Beach, OR.

McCune, B. and M.J. Mefford. 1999. PC-ORD. Multivariate analysis of ecological data, ver. 4. MjM Software Design. Gleneden Beach, OR.

McGrew, P.O. and M. Casilliano. 1975. The Geologic History of Fossil Butte National Monument and Fossil Basin. National Park Service, Occasional Paper #3. Available at http://www.nps.gov/history/history/online_books/fobu/.

McNab, W.H. and P.E. Avers. 1994. Ecological Subregions of the United States. USDA Forest Service, WO-WSA-5. Prepared in cooperation with Regional compilers and the ECOMAP Team of the USFS.

M'Gonigle, J.W. and J.H. Dover. 1992. Geologic Map of the Kemmerer 30'x60' Quadrangle, Lincoln, Uinta, and Sweetwater Counties, Wyoming. USDI-USGS.

National Park Service [NPS]. 1980. Fossil Butte National Monument, Wyoming, General Management Plan. U.S. Department of Interior, National Park Service, Denver, Colordo.

National Park Service [NPS]. 1999. Natural Resource Challenge: The National Park Service's Action Plan for Preserving Natural Resources. In-house publication. U.S. Department of Interior, National Park Service, Washington, D.C. 21p.

National Park Service [NPS]. 2005. Fossil Butte National Monument Wildland Fire Management Plan. In-house publication, Kemmerer, Wyoming. 113 pp.

National Park Service [NPS]. 2008. Fossil Butte website, Geologic Formations. Available at http://www.nps.gov/fobu/naturescience/geologicformations.htm

NatureServe. 2003a. International Ecological Classification Standard: International Vegetation Classification. Natural Heritage Central Databases, NatureServe, Arlington, VA.

NatureServe. 2003b. International Ecological Classification Standard: Terrestrial Ecological Systems of the United States. Natural Heritage Central Databases. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer.

NatureServe Explorer. 2008. An online encyclopedia of life [Web application]. Version 7.0. Arlington, VA. Available at http://www.natureserve.org/explorer.

Petersburg, S. 2004. Personal communication with the Dinosaur National Monument Chief of Resources.

Reid, M. and P. Comer. 1998. Vegetation Alliance Descriptions of the Western U.S. Available at http://www.gap.uidaho.edu/bulletins/7/VADWUS.htm.

The Nature Conservancy and Environmental Systems Research Institute.1994a. NBS/NPS Vegetation Mapping Program: Final Draft, Standardized National Vegetation Classification System. Prepared for USDI – National Biological Survey and NPS. Arlington, VA.

The Nature Conservancy and Environmental Systems Research Institute.1994b. NBS/NPS Vegetation Mapping Program: Final Draft, Field Methods for Vegetation Mapping. Prepared for USDI – National Biological Survey and National Park Service. Arlington, VA.

The Nature Conservancy. 1997. PLOTS database system 1.1. Arlington, VA.

The Nature Conservancy. 1996. Final Draft Methodology for Assessing the Utility of Existing Data for Vegetation Mapping. NBS/NPS Vegetation Mapping Program. Prepared for the USGS-Biological Resources Division and National Park Service.

United Nations Educational, Scientific, and Cultural Organization. 1973. International classification and mapping of vegetation. UNESCO, Paris, France.

U.S. Geological Survey. 1999. Map accuracy standards. Fact sheet FS-171-99 (November 1999). Available at http://mac.usgs.gov/mac/isb/pubs/factsheets/fs17199.html.

Von Loh, J.D., T. Belote, A. Beuchling, and W. Lafferty. 2004. Vegetation Classification and Mapping Work Plan: Fossil Butte National Monument, May. Report prepared for the National Park Service under contract to engineering-environmental Management, Inc., Englewood, CO. On file at NPS-NCPN, Moab, UT.

Welsh, S.L., N.D. Atwood, S. Goodrich and L.C. Higgins. 2003. A Utah Flora. Third Edition, revised. Brigham Young University Print Services, Provo, UT. 912 p.

Western Regional Climate Center. 2008. Fossil Butte Station. Available at http://www.wrcc.dri.edu/summary/Climsmco.html. [Accessed April 20, 2008].

Appendix A
Ecological Systems of Fossil Butte National Monument

Introduction

This appendix contains summary descriptions of 17 terrestrial and riparian/wetland ecological system (ES) units (NatureServe 2003b, Comer et al. 2003) occurring at Fossil Butte National Monument. Each ecological system represents one or more National Vegetation Classification plant associations or alliances (Table 6 within the main report). Map classes were also crosswalked to ES units (Table 9 within the main report).

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

UPLAND ECOLOGICAL SYSTEMS

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 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* 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 to 3,050 m (5000-10,000 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

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: 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 Rocky Mountains montane zone. It occurs throughout the southern Rockies, north and west into Utah, Nevada, western Wyoming, and Idaho. It consists of 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 the overstory depends on the temperature and moisture conditions at the site, and the successional status of the stand. *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 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 may be 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: This system occurs throughout the southern Rockies, north and west into Utah, Nevada, eastern Wyoming (very southern in the Laramie Range and possibly on Sheep Mountain) and Idaho. Although not common, it does occur in southeastern Oregon but does not extend farther west into the Cascades.
Subnations: AZ, CO, ID, NM, NV, OR, UT, WY

CES306.955 ROCKY MOUNTAIN FOOTHILL LIMBER PINE WOODLAND

Division 306 (Rocky Mountain); Forest and Woodland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Foothill]; Forest and Woodland (Treed); Very Shallow Soil; Mineral: W/ A-Horizon <10 cm; Sand Soil Texture Aridic; Long Disturbance Interval; F-Patch/High Intensity; Needle-Leaved Tree; *Pinus flexilis, Juniperus scopulorum, J. osteosperma*
Concept Summary: This ecological system occurs in foothill and lower montane zones in the Rocky Mountains from northern Montana south to central Colorado and on escarpments across Wyoming extending out into the western Great Plains. Elevation ranges from 1000-2400 m. It occurs generally below continuous forests of *Pseudotsuga menziesii* or *Pinus ponderosa* and can occur in large stands well within the zone of continuous forests in the northeastern Rocky Mountains. It is restricted to shallow soils and fractured bedrock derived from a variety of parent material, including limestone, sandstone, dolomite, granite and colluvium. Soils have a high rock component (typically over 50% cover) and are coarse- to fine-textured, often gravelly and calcareous. Slopes are typically moderately steep to steep. At higher elevations, it is limited to the most xeric aspects on rock outcrops, and at lower elevations to the relatively mesic north aspects. Fire is infrequent and spotty because rocky substrates prevent a continuous vegetation canopy needed to spread. Vegetation is characterized by an open-tree canopy or patchy woodland that is dominated by either *Pinus flexilis, Juniperus osteosperma*, or *Juniperus scopulorum*. *Pinus edulis* is not present. A sparse to moderately dense short-shrub layer, if present, may include a variety of shrubs, such as *Arctostaphylos uva-ursi, Artemisia nova, Artemisia tridentata, Cercocarpus ledifolius, Cercocarpus montanus, Dasiphora fruticosa* ssp. *floribunda, Ericameria nauseosa, Juniperus horizontalis, Purshia tridentata, Rhus trilobata, Rosa woodsii, Shepherdia canadensis* (important in Montana stands), *Symphoricarpos albus*, or *Symphoricarpos oreophilus*. Herbaceous layers are generally sparse, but range to moderately

dense, and are typically dominated by perennial graminoids such as *Bouteloua gracilis, Festuca idahoensis, Festuca campestris, Danthonia intermedia, Leucopoa kingii, Hesperostipa comata, Koeleria macrantha, Piptatherum micranthum, Poa secunda*, or *Pseudoroegneria spicata*. Within this ecological system, there may be small patches of grassland or shrubland composed of some of the above species. In Wyoming, some limber pine stands are found up to 2440 m (8000 ft.) elevation and are still included in this system.
Range: This system occurs in foothill and lower montane zones in the Rocky Mountains from northern Montana south to central Colorado and on escarpments across Wyoming, extending out into the western Great Plains. Elevation ranges from 1000-2400 m. This system may also occur in southeastern Idaho, though it would not be common there. It is also very likely to occur north into Canada along the Front Range of Alberta, in similar ecological settings.
Subnations: CO, MT, ND, SD, WY

CES306.822 ROCKY MOUNTAIN LOWER MONTANE-FOOTHILL SHRUBLAND

Division 306 (Rocky Mountain); Shrubland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lower Montane; Lowland [Foothill]; Shrub-dominated; Very Shallow Soil; Aridic; Intermediate Disturbance Interval [Periodicity/Polycyclic Disturbance]
Concept Summary: This ecological system is found in the foothills, canyon slopes and lower mountains of the Rocky Mountains and on outcrops and canyon slopes in the western Great Plains. It ranges from southern New Mexico extending north into Wyoming, and west into the Intermountain region. These shrublands occur between 1500-2900 m elevations and are usually associated with exposed sites, rocky substrates, and dry conditions, which limit tree growth. It is common where *Quercus gambelii* is absent such as the northern Colorado Front Range and in drier foothills and prairie hills. This system is generally drier than Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818), but may include mesic montane shrublands where *Quercus gambelii* does not occur. Scattered trees or inclusions of grassland patches or steppe may be present, but the vegetation is typically dominated by a variety of shrubs including *Amelanchier utahensis, Cercocarpus montanus, Purshia tridentata, Rhus trilobata, Ribes cereum, Symphoricarpos oreophilus*, or *Yucca glauca*. In northeastern Wyoming and north into adjacent Montana, *Cercocarpus ledifolius*, usually with *Artemisia tridentata*, is the common dominant shrub. Grasses are represented as species of *Muhlenbergia, Bouteloua, Hesperostipa*, and *Pseudoroegneria spicata*. Fires play an important role in this system as the dominant shrubs usually have a severe die-back, although some plants will stump sprout. *Cercocarpus montanus* requires a disturbance such as fire to reproduce, either by seed sprout or root crown sprouting. Fire suppression may have allowed an invasion of trees into some of these shrublands, but in many cases sites are too xeric for tree growth.
Range: Found in the foothills, canyon slopes and lower mountains of the Rocky Mountains and on outcrops and canyon slopes in the western Great Plains. It ranges from southern New Mexico extending north into Wyoming, and west into the Intermountain region.
Subnations: CO, MT, NE?, NM, SD, 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; 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 1500 m and 2300 m elevation. Soils are typically deep, well-drained, and non-saline. These shrublands are dominated by *Artemisia tridentata* ssp. *tridentata* and/or *Artemisia tridentata* ssp. *wyomingensis*. Scattered *Juniperus* spp., *Sarcobatus vermiculatus*, and *Atriplex* spp. may be present in some stands. *Ericameria nauseosa, Chrysothamnus viscidiflorus, Purshia tridentata*, or *Symphoricarpos oreophilus* may codominate disturbed stands. Perennial herbaceous components typically contribute less than 25% vegetative cover. Common graminoid species include *Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus, Festuca idahoensis, Hesperostipa comata, Leymus cinereus, Pleuraphis jamesii, Pascopyrum smithii, Poa secunda*, or *Pseudoroegneria spicata*.
Range: Occurs throughout much of the western U.S., typically in broad basins between mountain ranges, plains, and foothills between 1500 m to 2300 m elevation.
Subnations: CA, CO, ID, MT, NV, OR, UT, WA, WY

CES304.785 INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE
Division 304 (Inter-Mountain Basins); Steppe/Savanna

Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Upper, Lower Montane]; Woody-Herbaceous
Concept Summary: This ecological system includes sagebrush communities occurring at montane and subalpine elevations across the western U.S. from 1000 m in eastern Oregon and Washington to over 3000 m in the southern Rockies. In British Columbia, it occurs between 450 and 1650 m in the southern Fraser Plateau and the Thompson and Okanagan basins. Climate is cool, semi-arid to subhumid. This system primarily occurs on deep-soiled to stony flats, ridges, nearly flat ridgetops, and mountain slopes. In general this system shows an affinity for mild topography, fine soils, and some source of subsurface moisture. It is composed primarily of *Artemisia tridentata* ssp. *vaseyana* (mountain sagebrush) and related taxa such as *Artemisia tridentata* ssp. *spiciformis*. *Purshia tridentata* may codominate or even dominate some stands. Other common shrubs include *Symphoricarpos* spp., *Amelanchier* spp., *Ericameria nauseosa, Peraphyllum ramosissimum, Ribes cereum*, and *Chrysothamnus viscidiflorus*. Most stands have an abundant perennial herbaceous layer (over 25% cover), but this system also includes *Artemisia tridentata* ssp. *vaseyana* shrublands. Common graminoids include *Festuca arizonica, Festuca idahoensis, Hesperostipa comata, Poa fendleriana, Elymus trachycaulus, Bromus carinatus, Poa secunda, Leucopoa kingii, Deschampsia caespitosa, Calamagrostis rubescens*, and *Pseudoroegneria spicata*. In many areas, frequent wildfires maintain an open herbaceous-rich steppe condition, although at most sites, shrub cover can be unusually high for a steppe system (>40%), with the moisture providing equally high grass and forb cover.

Range: This system is found at montane and subalpine elevations across the western U.S. from 1000 m in eastern Oregon and Washington to over 3000 m in the southern Rockies. In British Columbia, it occurs in the southern Fraser Plateau and the Thompson and Okanagan basins.
Subnations: AZ?, BC, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

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

Spatial Scale & Pattern: Large Patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Foothill]; Woody-Herbaceous; Temperate Xeric; Alkaline Soil; Aridic; Very Short Disturbance Interval; G-Landscape/High Intensity; Graminoid
Concept Summary: This ecological system occurs throughout the 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. Occurrences may be either open shrubland with patchy grasses or patchy open herbaceous layer. Disturbance may be important in maintaining the woody component. Biological soil crusts are 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

CES304.794 WYOMING BASINS DWARF SAGEBRUSH SHRUBLAND AND STEPPE
Division 304 (Inter-Mountain Basins); Shrubland

Spatial Scale & Pattern: Large Patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Foothill]; Shrub-dominated; Hills; Ridge/Summit/Upper Slope; Sideslope; Shallow Soil; Silt Soil Texture; Clay Soil Texture; Aridic; W-Landscape/High Intensity; Low *Artemisia* spp.
Concept Summary: This windswept ecological system is composed of dwarf sagebrush shrubland and shrub-steppe that forms matrix vegetation and large patches on the margins of high-elevation basins in central and southern Wyoming. Typical sites are gently rolling hills and long, gently sloping pediments and fans. These sites are very windy and have shallow, often rocky soils. The distinguishing feature of this system is a short-shrub stratum in which dwarf-shrubs (≤30 cm tall) contribute at least two-thirds of the woody canopy. Four sagebrush taxa may dominate the shrub stratum: *Artemisia tripartita* ssp. *rupicola, Artemisia nova, Artemisia arbuscula* ssp. *longiloba,* and wind-dwarfed *Artemisia tridentata* ssp. *wyomingensis*. Two or more of these sagebrushes often codominate, but any of them may occur alone. Where graminoids are common and tall, the vegetation often has the appearance of grassland without shrubs; the shrubs are obvious only when the vegetation is viewed from up close. Where

graminoids contribute less cover, the vegetation is a compact shrubland. The herbaceous component of the vegetation includes both rhizomatous and bunch-form graminoids, cushion plants, and other low-growing forbs. *Bouteloua gracilis*, a common species of Inter-Mountain Basins Big Sagebrush Steppe (CES304.778) in Wyoming, is absent.
Range: This system occurs throughout the basins of central and southern Wyoming, extending south into adjacent portions of Colorado. It also occurs on the eastern side of the Continental Divide in Montana, where *Artemisia nova* shrublands are found on calcareous substrates.
Subnations: CO, MT, WY

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

Spatial Scale & Pattern: Large Patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland; Wetland
Diagnostic Classifiers: Lowland; 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

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

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland
Diagnostic Classifiers: Lowland; Badlands; Badland; Alkaline Soil; Shale and Mudstone; Silt Soil Texture; Clay Soil Texture
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 to not occur in either of those states.
Subnations: AZ, CA, CO, ID, MT, NM, NV, UT, 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; 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, exotic shrubs such 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

CES306.824 SOUTHERN ROCKY MOUNTAIN MONTANE-SUBALPINE GRASSLAND
Division 306 (Rocky Mountain); Herbaceous

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Herbaceous; Temperate Xeric; Acidic Soil; Mineral: W/ A-Horizon >10 cm; Loam Soil Texture; Silt Soil Texture Aridic; Short Disturbance Interval; Graminoid; Cool-season Bunch Grasses
Concept Summary: This Rocky Mountain ecological system typically occurs between 2200 and 3000 m elevation on flat to rolling plains and parks or on lower sideslopes that are dry, but it may extend up to 3350 m on warm aspects. Soils resemble prairie soils in that the A-horizon is dark brown, relatively high in organic matter, slightly acidic, and usually well-drained. An occurrence usually consists of a mosaic of two or three plant associations with one of the following dominant bunch grasses: *Danthonia intermedia, Danthonia parryi, Festuca idahoensis, Festuca arizonica, Festuca thurberi, Muhlenbergia filiculmis,* or *Pseudoroegneria spicata*. The subdominants include *Muhlenbergia montana, Bouteloua gracilis*, and *Poa secunda*. These large-patch grasslands are intermixed with matrix stands of spruce-fir, lodgepole

pine, ponderosa pine, and quaking aspen forests. In limited circumstances (e.g., South Park in Colorado), they form the "matrix" of high-elevation plateaus. Small-patch representations of this system do occur at high elevations of the Trans-Pecos where they present as occurrences of *Festuca arizonica - Blepharoneuron tricholepis* Herbaceous Vegetation (CEGL004508). These occurrences often occupy sites adjacent to Madrean Oriental Chaparral (CES302.031).
Comments: Montane grasslands are very similar and intergrade with their subalpine counterparts, but are separated here to represent those species that do not occur at higher altitudes.
Range: This system occurs between 2200 and 3000 m elevation in the Colorado Rockies. Where it transitions in Wyoming to Northern Rocky Mountain Subalpine-Upper Montane Grassland (CES306.806) still needs to be clarified.
Subnations: AZ, CO, NM, UT, WY

CES306.829 ROCKY MOUNTAIN SUBALPINE-MONTANE MESIC MEADOW

Division 306 (Rocky Mountain); Herbaceous

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Diagnostic Classifiers: Montane; Upper Montane; Herbaceous; Silt Soil Texture; Clay Soil Texture; Udic; Forb;
Concept Summary: This Rocky Mountain ecological system is restricted to sites from lower montane to subalpine where finely textured soils, snow deposition, or windswept dry conditions limit tree establishment. Many occurrences are small patch in spatial character, and are often found in mosaics with woodlands, more dense shrublands, or just below alpine communities. It is typically found above 2000 m in elevation in the southern part of its range and above 600 m in the northern part. These upland communities occur on gentle to moderate-gradient slopes and relatively moist habitats. The soils are typically seasonally moist to saturated in the spring, but if so will dry out later in the growing season. These sites are not as wet as those found in Rocky Mountain Alpine-Montane Wet Meadow (CES306.812). Vegetation is typically forb-rich, with forbs often contributing more to overall herbaceous cover than graminoids. Some stands are comprised of dense grasslands, these often being taxa with relatively broad and soft blades, but where the moist habitat promotes a rich forb component. Important taxa include *Erigeron* spp., species of the family Asteraceae, *Mertensia* spp., *Penstemon* spp., *Campanula* spp., *Lupinus* spp., *Solidago* spp., *Ligusticum* spp., *Thalictrum occidentale, Valeriana sitchensis, Rudbeckia occidentalis, Balsamorhiza sagittata,* and *Wyethia* spp. Important grasses include *Deschampsia caespitosa, Koeleria macrantha,* perennial *Bromus* spp., and a number of *Carex* species. *Dasiphora fruticosa* ssp. *floribunda* and *Symphoricarpos* spp. are occasional but not abundant. Burrowing mammals can increase the forb diversity.
Comments: There are probably quite a number of *Carex*- and *Calamagrostis*-dominated types that could be cited as constituent associations.
Range: This system is very widespread in the Rocky Mountain cordillera from New Mexico north into Canada. It probably occurs in the Black Hills region, as well as the "island ranges" of central Montana.
Subnations: AZ, CO, ID, MT, NM, NV, OR, UT, WA, WY; AB, BC

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

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Foothill]; Herbaceous; Temperate Xeric; Alkaline Soil; Aridic; Graminoid
Concept Summary: This widespread ecological system occurs throughout the intermountain western U.S. on dry plains and mesas, at approximately 1450 m to 2320 m (4750-7610 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 the genera *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

RIPARIAN, WETLAND, AND MESIC ECOLOGICAL SYSTEMS

CES306.821 ROCKY MOUNTAIN LOWER MONTANE–FOOTHILL RIPARIAN WOODLAND AND SHRUBLAND

Division 306 (Rocky Mountain); Woody Wetland

Spatial Scale & Pattern: Linear
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Diagnostic Classifiers: Lower Montane; Riverine / Alluvial; Mineral: W/ A-Horizon <10 cm; Unconsolidated; Short (<5 yrs) Flooding Interval; Short (50–100 yrs) Persistence
Concept Summary: This system is found throughout the Rocky Mountain and Colorado Plateau regions within a broad elevation range from approximately 900 m to 2800 m. This system often occurs as a mosaic of multiple communities that are tree-dominated with a diverse shrub component. This system is dependent on a natural hydrologic regime, especially annual to episodic flooding. Occurrences are found within the flood zone of rivers, on islands, sand or cobble bars, and immediate 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, Symphoricarpos* spp., or *Shepherdia argentea*. *Elaeagnus angustifolia* and *Tamarix* spp. are common in some stands. The upland vegetation surrounding this riparian system ranges from grasslands to forests.
Range: Occurs throughout the Rocky Mountain and Colorado Plateau regions from approx. 900 m to 2800 m. It is also found in the island mountain ranges of central and eastern Montana.
Subnations: AZ, CO, ID, MT, NM, NV, OR, SD, UT, WY

CES306.812 ROCKY MOUNTAIN ALPINE-MONTANE WET MEADOW

Division 306 (Rocky Mountain); Herbaceous Wetland

Spatial Scale & Pattern: Small patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Diagnostic Classifiers: Alpine/Alti-Andino; Montane; Herbaceous; Seepage-fed Sloping; Mineral; Depressional; Graminoid; Deep (>15 cm) Water; Saturated Soil
Concept Summary: These are high-elevation communities found throughout the Rocky Mountains and Intermountain regions, dominated by herbaceous species found on wetter sites with very low-velocity surface and subsurface flows. They range in elevation from montane to alpine (1000-3600 m). These types occur as large meadows in montane or subalpine valleys, as narrow strips bordering ponds, lakes, and streams, and along toeslope seeps. They are typically found on flat areas or gentle slopes, but may also occur on sub-irrigated sites with slopes up to 10%. In alpine regions, sites typically are small depressions located below late-melting snow patches or on snowbeds. Soils of this system may be mineral or organic. In either case, soils show typical hydric soil characteristics, including high organic content and/or low chroma and

redoximorphic features. This system often occurs as a mosaic of several plant associations, often dominated by graminoids, including *Calamagrostis stricta, Caltha leptosepala, Cardamine cordifolia, Carex illota, Carex microptera, Carex nigricans, Carex scopulorum, Carex utriculata, Carex vernacula, Deschampsia caespitosa, Eleocharis quinqueflora, Juncus drummondii, Phippsia algida, Rorippa alpina, Senecio triangularis, Trifolium parryi,* and *Trollius laxus*. Often alpine dwarf-shrublands, especially those dominated by *Salix*, are immediately adjacent to the wet meadows. Wet meadows are tightly associated with snowmelt and typically not subjected to high disturbance events such as flooding.
Comments: Similar systems include Temperate Pacific Subalpine-Montane Wet Meadow (CES200.998) and Boreal Wet Meadow (CES103.873). Rocky Mountain Alpine-Montane Wet Meadow (CES306.812) occurs to the east of the coastal and Sierran mountains, in the semi-arid interior regions of western North America. Boreal wet meadow systems occur farther north and east in boreal regions where the climatic regime is generally colder than that of the Rockies or Pacific Northwest regions. Floristics of these three systems are somewhat similar, but there are differences related to biogeographic affinities of the species composing the vegetation.
Range: This system occurs throughout the Rocky Mountains and Intermountain West regions, ranging in elevation from montane to alpine (1000-3600 m).
Subnations: AZ, CO, ID, MT, NM, NV, OR, SD, UT, WA, WY; AB, BC

CES300.729 NORTH AMERICAN ARID WEST EMERGENT MARSH

Division 306 (Rocky Mountain); 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* spp., *Potamogeton* spp., and *Brasenia* spp.) and submergent and floating plants (*Myriophyllum* spp., *Ceratophyllum* spp., and *Elodea* spp.).
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.

DISTRIBUTION
Range: Occurs throughout much of the arid and semi-arid regions of western North America.
Divisions: 301:C, 302:C, 303:C, 304:C, 305:C, 306:C
TNC Ecoregions: 6:C, 7:C, 8:C, 9:C, 11:C, 17:C, 18:C, 19:C, 20:C, 21:C, 23:C, 24:C, 26:C, 27:C, 28:C, 29:?, 30:C, 68:C
Subnations: AB, AZ, BC, CA, CO, ID, MT, MXBC, MXCH, MXSO, ND, NE, NM, NV, OK, OR, SD, TX, UT, WA, WY

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

Introduction

This appendix contains the forms and instruction manuals used in collecting field data for the Vegetation Mapping Project. Three types of data were collected: vegetation plot, observation point, and accuracy assessment point. Vegetation plots were used primarily in developing the NVC classification for the monument. They were also used by photointerpreters to help recognize aerial photo signatures. Observation points were used primarily for assisting with photointerpretation, and secondarily for supporting NVC association descriptions and documenting non-standard vegetation types. Accuracy assessment data were used primarily for testing the thematic accuracy of the vegetation map and secondarily to support the NVC plant association descriptions.

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

Vegetation Mapping at Fossil Butte National Monument
Northern Colorado Plateau Inventory & Monitoring Network
PROJECT MANUAL - 2005

This document is intended to assist you in conducting vegetation mapping data collection at Fossil Butte National Monument (FOBU) during the 2005 field season. Detailed, field-by-field instructions for data collection are provided. These are abbreviated on 'cheat sheets' at the end of each section. This project is being directed by the Northern Colorado Plateau Network (NCPN) Inventory and Monitoring Program with assistance from engineering-environmental Management, Inc. (e^2M) and Nature Serve.

VEGETATION DATA COLLECTION INSTRUCTIONS

NAVIGATING TO PLOT

You will navigate towards each selected preliminary vegetation unit using park maps, topographic maps, handheld GPS receivers and aerial photos.

Topographic (topo) maps are useful in identifying the landscape through which you will be navigating, and in determining the elevation of a plot. Use the aerial photo maps with preliminary polygons which will help guide you to distinct patchs of vegetation and are essential in determining where to establish a plot (this will be explained in more detail). Do not blindly navigate to vegetation polygons with your GPS unit without being aware of cliffs or other obstacles in your way. Use the aerial photos and topo maps to plan your route. Please record the vegetation, and its condition, that you walk through and sample on the photo. Feel free to write comments regarding unique features as well.

Note: *In very homogenous terrain, GPS the location of your vehicle so you can find your way back! This can also help in writing the directions to your plot.*

Along the way...look around. Context is everything – you will have a much better sense of how your plots represent the landscape if you are always in analysis mode. Keep in mind that the goal of this field work is to sample all the different vegetation types that occur within the park. At the beginning of the field season a list of potential plant associations for the parks will be provided. If, on the way to a plot you see an assemblage of plants that seems unique and that is not included on the list of potential vegetation types, please sample if time allows, or at least complete an observation form. As the season progresses, this list will be updated and you will be able to recognize new plant alliances and associations more easily.

Park Special Features… in the process of navigating to plots you will encounter unique features or vegetative stands too small to sample, GPS them and note them on aerial photos and maps. These GPS points will be added to the final production map as "Park Special Features". In particular, field crews are requested to GPS the locations of springs, seeps, wetlands, and invasive species. Record general descriptive information about these features on an Observation Point Form. Finally, all NCPN parks are working on documenting with specimen vouchers all vascular plants in each park. Field crews will be supplied a working vascular plant species list for each park at the beginning of the field season. This list will indicate which plants are presently vouchered. Field crews are requested to collect herbarium quality

specimens of park vascular plant species presently not represented in the collection. Please be careful not to collect extremely rare plants. In this case a photographic voucher would be in order.

ESTABLISHING A PLOT

Plot placement

Figuring out where to place your plot is a subjective process. You'll want to place your plots in areas that seem to be both relatively homogenous and representative of the vegetation of the polygon as a whole. Avoid areas where the vegetation appears to be transitioning from one type to another and areas with anomalous or heterogeneous structure or species composition. The photos will help you identify the different vegetation types available in an area to sample – similar color, pattern and texture usually indicate similar vegetation. Take some time and do this carefully, because some of the plots you set up may be re-sampled over time in order to determine responses to management and other useful things. Look at *all* the vegetation layers to determine if the area is structurally and floristically uniform and generally try to place your plots at least 30 m (100 ft.) from what you see as the 'boundary' between this vegetation type and neighboring, different types. The exception to this rule is when you are sampling a unique type that is always going to occur in small patches and usually has sharp boundaries, such as a spring seep.

Note: In cases where a polygon is very heterogeneous, more than one plot may be needed. Again, look around; use your acquired knowledge and judgment.

Plot size and shape

The chart below indicates what size plot should be used for each vegetation type. Typically plots will be 400 m^2. In some circumstances where vegetation occurs in linear patterns, a rectangular plot may be appropriate. For example, rectangles are ideal for ridgelines, hillsides, and riparian zones, or communities where the vegetation has a patchy or irregular distribution. Squares will be well-suited to very large, homogenous vegetative stands. Selecting the shape of the plot to fit it into a given sample area is fine, but please try not to make a plot smaller than the sizes listed below. Make sure the type you are describing occupies an area of at least ½ hectare (a circle approximately 80m in diameter). This is because the standard plot is about the size of a pencil point to the photo interpreter – even ½ hectare is only the size of a pea. Vegetative communities too small for a plot should be sampled as an Observation Point (instructions for points are after plots in this packet).

If you're in a...	Square Plot, Homogenous Vegetation	Rectangular Plot, Heterogenous Vegetation
Forest (i.e., trees have their crowns overlapping, usually 60-100% total cover)	400 m^2 20 x 20m	400 m^2: 10 x 40m, 5 x 80 m, etc.
Woodland (i.e., stands of trees with crowns usually not touching and cover 10-60% or OR exceeds total shrub, dwarf-shrub, herb, and nonvascular cover).	400 m^2 20 x 20m	400 m^2: 10 x 40m, 5 x 80 m, etc.
Shrubland (i.e., dominated by shrubs greater than 0.5 m tall, usually with more than 25% cover or exceeding tree, dwarf-shrub, herb, and nonvascular cover).	400 m^2 20 x 20m	400 m^2: 10 x 40m, 5 x 80 m, etc.
Dwarf-shrubland (i.e., dominated by shrubs less than 0.5 m tall, usually with more than 25% cover OR exceeding tree, shrub, herb, and nonvascular cover).	100 m^2 10 x 10m	100 m^2: 5 x 20m, 2 x 50m, etc.
Shrub Herbaceous (i.e., forb and/or grass cover roughly	100 m^2	400 m^2:

equal to shrubs or dwarf shrubs).	10 x 10m	5 x 20m, 2 x 50m, etc.
Herbaceous (i.e., herbs or grasses dominant, usually forming more than 25 percent cover).	100 m^2 10 x 10m	400 m^2: 5 x 20m, 2 x 50m, etc.
Nonvascular (i.e., lichen or moss cover dominant, usually forming more than 10% cover).	100 m^2 10 x 10m	25 m^2 1 x 25 m, 2.5 x 10m, etc
Sparsely Vegetated (less than 10% cover).If less than 2% cover, it's a geologic type- don't sample!	1000 m^2	400 or 1000 m^2

VEGETATION PLOT SURVEY FORM INSTRUCTIONS - 2005

These instructions follow the 2005 version of the plot data sheet, field by field.

Please note that the Northern Colorado Plateau Network has developed a GPS Data Dictionary for recording several fields associated with the Vegetation Plot Survey Form and Fuels Form. Please note that all data entered into the GPS unit will also be entered manually on the paper forms.

IDENTIFIERS/LOCATORS SECTION

Plot Code
This is a unique identifier you give each sample plot using the format “PARK.XXXX”. Each field crew will be assigned a set of numbers to use (e.g., 0100-0299, 0300-0499, etc.). The same numbering convention will be used for observation points, except that the first digit is always "9". For example, the group using the numbers 101-199 would call their first plot "FOBU.0101" and their first observation point "FOBU.9101". Please record the plot code on every side of every form in the provided field.

Quad Name
Record the full name of the 7.5-minute quadrangle, such as “The Knoll”.

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

County, State
These fields will be completed in the office as part of processing the GPS data.

Site Name
This is best determined from a topo map. Select a nearby feature that is an obvious waypoint, such as the name of a canyon, road or arch. (e.g. Upheaval Dome). This name does not need to be unique. If you sample a number of plots in a small area, you can use the same site name for all of them.

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

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

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

GPS File Name
This field only needs to be filled out if you're using a unit other than the Trimble GeoXM. This is the name you give to the waypoint when you mark the plot location in your GPS unit. The GPS reading should be taken from the center of the plot. Please give the waypoint the same number as the plot, and the prefix "FP" for a Fossil Butte plot (e.g., FP241 for plot #241). If doing an observation point, the file name would be "FO" and the number (e.g., FO9101 for point #101).

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

UTM Zone
This value is already entered on the datasheet as '12S', and will remain the same throughout the park.

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

In deep canyon country it is often difficult to get a GPS reading (your machine has to be able to see at least three or four satellites). If you are unable to get a GPS reading in the plot, or if the PDOP is greater than 8 (or EPE is greater than ±50m), first try to get a signal from a higher point outside (but still close to) the plot. If that fails, you will need to estimate the UTM coordinates from the topo map, and manually enter these UTMs into the GPS unit.

Use a map that is in NAD 83 if at all possible, since the project standard is the NAD83 datum. However, you may need to use USGS 7.5 minute maps, which use the NAD27 datum. The difference in this part of the world is that the NAD83 grid is shifted about 60m west and 200m north of NAD27. To ensure that all your plots show up in the right place, please use this procedure when estimating UTM coordinates from a NAD27 topo map:

Locate your plot as accurately as possible on the topo map, using triangulation. Use the topo map, straightedge, pencil and a transparent overlay grid to obtain UTM coordinates in NAD27 (done carefully, you should be able to get to the nearest 10m). Write these coordinates down in the GPS Comments Field with the note "UTM coordinates derived from NAD27 topo map". DO NOT enter these in the UTM X and UTM Y fields. Update the settings in your GPS unit to the NAD27 datum. Create a new waypoint, give it the name of your plot, and enter the UTM coordinates you wrote down. Update the settings in your GPS unit to the NAD83 datum. This will convert the NAD27 coordinates to NAD83 without changing the coordinates you already had in your machine (there may be rounding error). Enter the converted coordinates (now in NAD 83) into the UTM X and UTM Y fields. Try to do this only once per hitch, because the more often you do it, the more likely it is that the rounding error will change the coordinates of your other (non-topo-derived) plots. You can do it in the office during datasheet cleanup and entry.

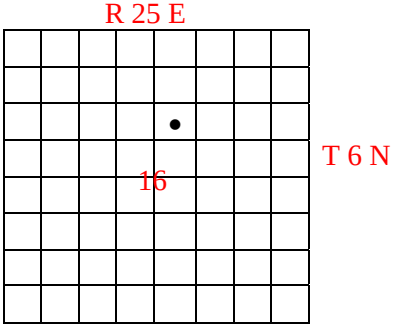
GPS Receiver
Record the name and model of the GPS unit being used to record data for the plot. If a GPS unit was not used to determine UTMs record 'none' here and be sure to complete the 'GPS Comments' field below.
GPS Receiver Error

Note the PDOP (or “Estimated Position Error" (EPE), if you’re using a Garmin unit) displayed on your GPS unit. The lower the number, the more accurate your reading.

3D Differential?
Circle Y or N accordingly. 3D differential is obtained when your GPS unit can "see" a satellite that does nothing but correct the tiny errors in the positioning or clocks of other GPS satellites. This satellite broadcasts a real-time differential correction so that your location coordinates are as accurate as possible. It is in geosynchronous orbit in the southern sky, so if you can see the southern sky, you will generally be able to get 3D differential. This system is known as the Wide-Area Augmentation System, or WAAS. The Garmin and Trimble units have a field in their setup pages for turning WAAS on or off. Please make sure that WAAS is always on.

GPS Receiver Comments:
VERY IMPORTANT: If you resorted to estimating the plot location UTMs on the topo map, note that in this field. If your usual GPS croaked and you had to borrow an old Magellan from a friend, note that. Also, if you left the plot to get a reading from a high point, record that here, along with the compass bearing and distance of the GPS location from the plot center (unless you used the offset function on the Trimble GeoXM- in that case, enter “point offset.”)

Directions to Plot
Give precise directions to the plot beginning with a landmark (e.g., a named point on the topo map, a major highway, marked trailhead) readily locatable on a 7.5 minute topo map as the starting point. Use clear sentences that will be understandable to someone who is unfamiliar with the area and has only your directions to follow. Give distances and use compass directions. Be aware of the ambiguity of words like "above", "near", beyond", "on the back side of", "past". Again, using the GPS unit to give distances can be very helpful. If plot locations lack major landmark features as guides, use township, range and sections from the topo maps. If there are no features within a reasonable distance of your plot and writing directions is taking an inordinately long time, you can use a TRS description to the nearest quarter-quarter-quarter section. TRS directions are extremely error prone, so please have your field partner check it before you leave the plot. The TRS for the plot in the section below is "NW4SW4NE4 Sec. 16, T 6 N, R 25 E".



Note: Although most plots will not be permanently marked, park staff very much want to be able to relocate them for long-term vegetation monitoring purposes. Careful documentation of the stand characteristics, access route, obvious landmarks and vegetation is therefore extremely important. DO NOT use one plot to reference the location of another; TRS is preferred.

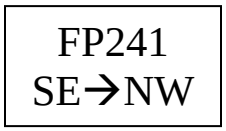
Plot Diameter, Length, Width and Azimuth,
For 400 m2 plots please indicate whether plot is a square or circle. For rectangular plots record the length and width. Also record azimuth.
Photos Taken?

Circle Y or N accordingly for plot photos.

Camera Name and Model
Circle or enter the name and model of your camera

Photos: Type/Roll Number/Frame Number/Photographer/Direction and Comments
For each photo taken at the plot record the following: *Photo type* indicate whether photo is a 'plot', 'landscape' or 'biological crust' photo. *Roll number*: record roll number (Roll numbers should be a team member's initials plus a sequential number, which are written on the film before it goes into the camera.). *Frame number*: record frame number of photo. *Photographer*: record last name of person taking photograph. *Directions/Comments*: record the direction the photos were taken from and towards (e.g., SE→NW) and any other comments to clarify contents of the photo (especially landscape/scenery photos).

Taking photographs
Take two color slides of each plot. The purpose is to get a good representation of the vegetation of the plot, not individual species. Try to include a little sky for perspective. For rectangular plots, please take the two photos from adjacent cardinal points around the plot (e.g., south and east or north and west). Photos at rectangular plots should be taken from opposite ends of the long side. Use a chalkboard to record the plot number and the direction the photo is taken. Thus, for rectangular plot 241, the board in the photo taken from the SE edge of the plot, facing NW, will read "FP241, SE→NW". Take the photograph looking across the contour if plot is on a steep slope. In addition, you will need to keep a photograph log for all photos not taken at plots. If you are in a particularly nice, rare or representative stand, please take a third slide, without the signboard in it, from any position as long as it illustrates the community well (landscape).



Plot Representativeness
Representativeness of plot in stand: Does this sample represent the vegetative community within the surrounding area? If not, were additional plots taken? Note additional species occurring outside the plot but characteristic of the stand. An example could be: "This stand is relatively large and very homogenous in species composition, although species density varies slightly. Pinyons are sparsely scattered throughout the stand but none are located inside the plot." Another example: "The area around this plot encompasses a variety of elevations and aspects, but similar slopes. Multiple plots will be done in this stand. This plot represents a predominantly herbaceous community on a northern aspect." *Note: Sometimes variation within an area is not large enough to sample, in which case you would describe surrounding communities in the "Other Comments" field on the back of the first data sheet.*

ENVIRONMENTAL DESCRIPTION SECTION

Elevation
Take this measurement from the GPS unit (if you are using the Trimble GeoXM), in meters. If you are using a different GPS unit, estimate the elevation from the topographic map. Specify on the data sheet whether the measurement is in feet or meters, and whether your elevation source was the GPS unit or the topo map.

Slope
Measure the slope in degrees using a clinometer. The degree scale is the left-hand scale as you look through the clinometer. If the slope varies in your plot, estimate an average. If the plot is on rolling microtopography, enter "variable." Describe these further under the Environmental Comments section.

Aspect
Measure the plot aspect in degrees using a compass (set for local magnetic declination). If the slope is flat, enter "n/a" for aspect. If the plot wraps around different aspects on a slope, enter "variable" and describe further under the Environmental Comments section.

Topographic Position
This is the position of the plot on its related landform. Determining this requires you to think of the landform in cross-section, which is roughly diagrammed on the back of your cheat sheet. You **must** use the terms listed below:

Interfluve (crest, summit, ridge). Linear top of ridge, hill, or mountain; the elevated area between two drainages that sheds water to the drainages.
High slope (shoulder slope, upper slope, convex creep slope). The uppermost inclined surface at the top of a slope. Includes the transition zone from backslope to summit. Surface is dominantly convex in profile and erosional in origin.
High level (mesa, summit). Level top of a plateau.
Midslope (transportational midslope). Intermediate slope position.
Backslope (dipslope). Subset of midslopes that are steep, linear, and may include cliff segments.
Step in slope (ledge, terracette). Nearly level shelf interrupting a steep slope, rock wall, or cliff face.
Lowslope (lower slope, foot slope, colluvial footslope). Inner gently inclined surface at the base of a slope. Surface profile is generally concave and a transition between midslope or backslope, and toeslope.
Toeslope (alluvial toeslope). Outermost gently inclined surface at base of a slope. In profile, usually gentle, linear and characterized by alluvial deposition.
Low level (terrace). Valley floor or shoreline representing the former position of an alluvial plain, or lake.

Landform
Enter the landform(s) that describes the site where the plot was sampled. Referring to the topo map for the landscape context may help you decide what landform(s) to choose. Note that the landform choices may describe different scales, or that a landform feature can be described by more than one term. For example, your plot may be on a ledge on the rim of a canyon. A suggested list of landforms and definitions is provided in APPENDIX 1.
Note: The topographic position selected above should relate to the scale of the landform chosen here.

Surficial Geology
Note the geologic substrate where plant community occurs. The geology map should help, but if you can't tell the geology at all or you do not have the geology map with you at the plot, put a general description (e.g., coarse sandstone, green shale, aeolian sands or obscured by soils). A list of FOBU geologic strata appears on the cheatsheet at the end of this manual.

Cowardin System
The majority of the plots you'll be sampling will be "Uplands". Any wetland plots will be in the Palustrine category. This includes riparian, hanging garden and vernal pool wetlands. They are all fed by groundwater and support vascular plant communities. The formal definition is: All nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. This category also

includes wetlands lacking such vegetation but with all of the following characteristics: (1) area less than 8 ha; (2) lacking an active wave-formed or bedrock boundary; (3) water depth in the deepest part of the basin less than 2 m (6.6 ft) at low water; and (4) ocean-derived salinities less than 0.5 parts per thousand.

Hydrology

This field will mostly be completed if you are in a wetland, however, some areas considered uplands may be subject to intermittent flooding.. Select from the following definitions (from Cowardin et al. 1979):

Permanently flooded. Water covers the land surface at all times of the year in all years.

Semipermanently flooded. Surface water persists throughout growing season in most years except during periods of drought. Land surface is normally saturated when water level drops below soil surface.

Seasonally flooded. Surface water is present for extended periods during the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is very variable, extending from saturated to a water table well below the ground surface.

Saturated. Surface water is seldom present, but substrate is saturated to surface for extended periods during the growing season.

Temporarily flooded. Surface water present for brief periods during growing season, but water table usually lies well below soil surface. Often characterizes flood-plain wetlands.

Intermittently flooded. Substrate is usually exposed, but surface water can be present for variable periods without detectable seasonal periodicity. Inundation is not predictable to a given season and is dependent upon highly localized rain storms. This modifier was developed for use in the arid West for water regimes of playa lakes, intermittent streams, and dry washes but can be used in other parts of the U.S. where appropriate. This modifier can be applied to both wetland and non-wetland situations.

Unknown. The water regime of the area is not known. The unit is labeled a non-tidal wetland.

Environmental Comments

Enter any additional noteworthy comments on the environmental setting and its effect on the vegetation. Examples include: "stunted trees due to shallow soils", "vegetation only where pockets of soil occur", or "large colluvial boulders and small rocks litter surface of soil". This field can also be used to describe site history such as fire events. This is an extremely important field for crews to document so please take the time to do a thorough job. Information from this field will be used to prepare local descriptions of the plant community and for photo interpretation.

Ground Cover

Estimate the approximate percentage of the *total* surface area covered by each category. The sum of all fields should equal 100%. A helpful hint in making ocular estimates is that in a 400 square meter plot, one 2 x 2m square is equal to 1%. The sum of the cover values should equal 100%. *Note*: For estimating live litter and live wood, visualize cutting the vegetation off at ground level. The percent ground cover is how much space the stems take up. Estimating lichens, dark cyanobacteria and moss also take an extra step in visualization. Lichens often are growing on dark cyano mounds or on exposed bedrock, but your estimate needs to reflect the percentage of ground covered by lichens, and your estimates for dark cyano or bedrock will be for non-lichen-covered surfaces. Also note that it is possible to have bare soil and sand in a plot if sand has blown in, or to have sand on the surface of the plot but the soil test results in a texture other than sand because you are sampling below the surface. If a category is present but covers less than 1% (> 0.5%) of the ground, enter a "T" on the line next to it. If a category is present but covers a tiny bit (<0.5%) of ground, enter “t”.

Soil Texture

Use a trowel to dig a hole a few inches deep (this will vary with soil depth, of course) to expose the soil at root level, from where you will take a small handful of soil to sample. APPENDIX 2 is a key to use when sampling soil texture, and an abbreviated version is on the cheat sheet. Check the appropriate field.

Soil Drainage

Soil drainage classes are defined in terms of (1) actual moisture content in excess of field moisture capacity and (2) the extent of the period during which excess water is present in the plant-root zone. Permeability, level of groundwater, and seepage are factors affecting moisture status. However, because these are not easily observed or measured in the field, they cannot generally be used as criteria of moisture status. Use the following definitions to determine soil drainage at your plot:

Rapidly drained. The soil moisture content seldom exceeds field capacity in any horizon except immediately after precipitation. Nearly all soils outside of wetlands, springs and floodplains will fall into this category. Rapidly drained soils are commonly coarse textured or soils on steep slopes located well above the water table. *These soils are characterized by strictly upland species, including rabbitbrush.*

Well drained. The soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant part of the year. Soils are usually free from mottling in the upper 3 feet, but may be mottled below this depth. B horizons, if present, are reddish, brownish, or yellowish. *Look for species that indicate periodic saturation, such as western wheatgrass, Great Basin wildrye, arctic rush or black greasewood.*

Moderately well drained. The soil moisture in excess of field capacity remains for a small but significant period of the year. Soils are commonly mottled (chroma < 2) in the lower B and C horizons or below a depth of 2 feet. The Ae horizon, if present, may be faintly mottled in fine-textured soils and in medium-textured soils that have a slowly permeable layer below the solum. In grassland soils the B and C horizons may be only faintly mottled and the A horizon may be relatively thick and dark. *Soils in this category and the next three will typically support wetland plants.*

Somewhat poorly drained. The soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year. Soils are commonly mottled in the B and C horizons; the Ae horizon, if present, may be mottled. The matrix generally has a lower chroma than in the well-drained soil on similar parent material.

Poorly drained. The soil moisture in excess of field capacity remains in all horizons for a large part of the year. Soils are usually very strongly gleyed. Except in high-chroma parent materials the B, if present, and upper C horizons usually have matrix colors of low chroma. Faint mottling may occur throughout.

Very poorly drained. Free water remains at or within 12 inches of the surface most of the year. The soils are usually very strongly gleyed. Subsurface horizons usually are of low chroma and yellowish to bluish hues. Mottling may be present but at the depth in the profile. Very poorly drained soils usually have a mucky or peaty surface horizon.

Animal Use Evidence

Comment on any evidence of use of the plot by non-domestic animals (i.e., tracks, scat, burrows, etc.). Notes on domestic animals (grazing) should be made in the next field.

Natural and Anthropogenic Disturbance

Comment on any evidence of natural or anthropogenic disturbance and specify the source, severity and effects on the vegetation. Common disturbances in plots are water gullies, colluvial deposition of rocks on slopes, flash flooding and old tin cans from cowboys or miners. Notes on livestock grazing are included in this field. Other disturbances you may encounter in the buffer include off-road vehicle use, fire, mass-wasting.

Other Comments

Record any other comments. What is the approximate spatial extent of the community you sampled? Describe the landscape context of the community. Describe the adjacent plant communities and their relationship to the plot. Are there any other landscape features or processes influencing this community? Is there an important species that occurs in the stand but is not within your plot? Is there a large amount of a dead plant material in the plot?

VEGETATION DESCRIPTION SECTION

Leaf Phenology

Select the best description for the leaf phenology of the dominant stratum. The dominant stratum is the tallest stratum that contains at least 10% cover. Leave blank for non-vascular plots.

Evergreen. Greater than 75% of the total woody cover is never without green foliage. (Some tricky examples: most *Artemisia, Coleogyne, Ephedra* and all *Atriplex* species except *canescen*s, all *Chrysothamnus* except *nauseosus* var. *junceus*)

Cold deciduous. Greater than 75% of the total woody cover sheds its foliage in connection with an unfavorable season mainly characterized by winter frost (tricky ones: *Sarcobatus vermiculatus, Tamarix* spp.).

Mixed evergreen - cold deciduous. Evergreen and deciduous species are mixed within the type and generally contribute 25-75% of the total woody cover.

Perennial. Herbaceous vegetation composed of more than 50% perennial species.

Annual. Herbaceous vegetation composed of more than 50% annual species.

Leaf Type

Select the best description for the leaf form of the dominant stratum. The dominant stratum is the uppermost stratum that contains at least 10% total plot coverage. Within that dominant stratum, the species that makes up greater than 50% of cover defines the leaf type.

Broad-leaved. Woody vegetation that is primarily broad-leaved (Sagebrush, oak, mountain mahogany).

Needle-leaved. Woody vegetation that is primarily needle-leaved (Juniper, pinyon, tamarisk).

Microphyllous. Woody cover that is primarily microphyllous (*Ephedra, Tamarix*).

Graminoid. Herbaceous vegetation composed of more than 50 percent graminoid species (grasses, sedges, rushes, etc.).

Forb (broad-leaf-herbaceous). Herbaceous vegetation composed of more than 50% broad-leaf forb species (*Phlox, Astragalus, Erigeron*, etc).

Pteridophyte. Herbaceous vegetation composed of more than 50 percent ferns or fern allies (scouring rushes).

Non-vascular. Dominated by lichens or mosses.

Mixed. As with leaf phenology, the dominant stratum may be composed approximately equally of species with several different leaf types. Describe the mix briefly or circle leaf types that apply.

Physiognomic Class

This represents what you see when you are standing in the plot looking across at the vegetation. The following definitions can be used as guidelines, but may not always apply in desert locals. For example, areas with scattered pinyon and juniper may not fit the cover classes below but they would best be described as a woodland.

Forest. Trees with their crowns overlapping (generally forming 60-100% cover).

Woodland. Open stands of trees with crowns not usually touching (generally forming 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 occupied by grasses and/or forbs.
Wooded Herbaceous. Trees forming approximately equal cover with a grass or forb component. Herbaceous. Perennial herbs (graminoids or forbs) dominant (generally forming at least 25% cover; trees, shrubs, and dwarf-shrubs generally with less than 10% cover). Herb cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and nonvascular cover, respectively.
Nonvascular. Nonvascular cover (bryophytes, lichens, and algae) dominant (generally forming at least 25% cover). Nonvascular perennial vegetation cover may be less than 25%, as long as it exceeds tree, shrub, dwarf-shrub, and herb cover.
Sparsely Vegetated. Abiotic substrate features dominant. Perennial vegetation is scattered to nearly absent and generally restricted to areas of concentrated resources. Total vegetation cover is typically less than 10% and greater than 2%. Badlands or sand dunes supporting communities of annual plants should be included in this category, regardless of cover.

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

PLANT SPECIES LIST AND STRATA FORM

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

Species/Strata Data. A two-page dual purpose form has been developed for recording information on *species* composition and cover and *strata* cover and height. Species lists and cover estimates should be completed first (white portions of form); then cover class and height class estimates for strata should be

recorded (shaded portions of form). Write out the complete species name, and use only the name in the most recent (Green) edition of “A Utah Flora” (Welsh 2003).

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

Stratum: Species names will be recorded within the appropriate stratum. It is important that all crew members are consistent in assignment of species to strata throughout this project. Following are some guidelines to use in determining strata. The ‘working draft’ plant list for each park will be used as a guide for assigning species to the appropriate stratum. Field crew members are expected to help ‘improve’ this list and associated categorization as the field season progresses.

Begin by assessing the strata at your plot. Trees are defined as single-stemmed woody plants, generally 5 m in height or greater at maturity and under optimal growing conditions. Shrubs are defined as multiple-stemmed woody plants generally less than 5 m in height at maturity and under optimal growing conditions. The exception is mature pinyon and juniper plants, which are considered trees regardless of their height.

T1 Emergent, T2 Canopy, T3 Subcanopy. A uniform stand of pine or cottonwood trees would be a good example of T2"canopy", but where they are absent you would begin with the shrubs, or herbaceous species if no shrubs are present. If the tree crowns in your plot are mostly touching and similar in height, but a given tree species is much taller that species would be a T1"emergent.” Occasionally, you will sample an area where there may be several tall, scattered cottonwoods and then shorter scattered junipers. In this case, the cottonwoods would be your "canopy" and the junipers would be the "subcanopy". You may also have cottonwoods listed in the “subcanopy” layer, if there are a number of 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, *Salix lutea* and *Prunus virginiana.*
S2 Short Shrub. <2 meters tall. For example, *Artemisia tridentata* ssp. *vaseyana, Purshia tridentata,* all *Atriplex.*
S3 Dwarf Shrub. <0.5 meters tall. For example, *Gutierrezia sarothrae.*
H1 Graminoid. All grass, sedge, rush, and spikerush species, including *Juncus arcticus.*
H2 Forb. All broadleaf flowering plants. (*Typha* is a forb.)
H3 Fern or Fern Ally. All ferns and horsetails, including *Equisetum hyemale.*
H4 Tree Seedlings. Seedlings are trees with vertical stems less than 1.5 m tall, but that may vary by species.
N Nonvascular. This is mainly dark cyanobacteria, mosses and lichens.
V Vine/liana. All vine species.
E Epiphyte. All epiphytic species.

Height can be used to define strata, but is not how species should be placed in strata. Species characteristically belong to one stratum or another (e.g., pinyon pine and juniper are canopy (T2), Utah serviceberry is a tall shrub (S1), mountain big 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., 3’ PLEJAM in burned areas at MEVE) or unusually short growth form. So even if the pines growing in cracks are only 1.5 m tall, as long as they are mature trees, they get put in the T2 category, and

get measured. About the only rule regarding height should be that the tree layer is (usually) higher than the tall shrub layer, is taller than the short shrub layer, etc.

The second thing is to avoid splitting species between strata. If a few mountain mahogany have been browsed to <1m tall, but most are 2m tall, they all get rolled into the tall shrub stratum. There are two exceptions: (1) each height class covers more than 10% of plot, or (2) there is a reproductive layer of baby shrubs or young trees.

The third thing is how to define some of the "borderline/confusing" species. What we want to avoid is some folks calling *Leptodactylon* a forb and some calling it a dwarf shrub. Ditto snakeweed. Ditto fringed sage, *Brickellia* and any number of other species. Consult your plant lists, which you should keep updated as the crew discusses which species go in which stratum.

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

Species Name: Refer to the plant list you have been provided for plant names used in this area (from *Utah Flora*). Always record the full scientific name for each species – required nomenclature is Welsh et al.'s Utah Flora (2003). Please note that columns on both sides of the page may be used to record species within each stratum.

'*' – Complete this shaded column in the strata assessment (see below).

Cover Class: Estimate the aerial / crown cover of each plant listed, using the cover class codes listed in the bottom of the page. These classes are as follows:

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

% Cover: Record continuous cover value used to make cover class estimates.
Specimen: Place a check mark in this column when a specimen has been collected for a given taxon. Keep complete set of notes in a field notebook with required information for processing herbarium specimens.

Unknowns. If you can't identify or easily key out the plant at the plot, assign a name to it to be recorded on your data sheet. For example, if you know what family it is in or its genus, label it "unknown Asteraceae sp." or "Unk. *Erigeron* sp.". If there is more than one unknown in a family, add a number to the name you give them. If you do not know the family, label the plant "Unknown 1", using consecutive numbers for additional unknowns. Record the cover class and other data for the unknown as you would for any other species. Then, take a sample of the species with as much of the plant as possible, especially

intact sexual parts, if present. Place the sample in a plastic baggie, and either label the plant (if you are putting more than one plant in the baggie) or label the baggie with the plot code, the date and the name you gave it on the data form. Plant samples in baggies can be stored in coolers or refrigerators for short periods. If you are not able to key the plant out soon after collecting it, or you intend to keep the sample for the park collection, press the plant and with a label stating the plot or location of its collection (include UTMs if the sample is not from a plot), date, collectors name and name you assigned the plant. Thoroughly label all voucher plant specimens.

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

Indicate the average height class of the stratum in the first column, using the Height Scale at the bottom of the form. The height scale for this project is as follows:

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

Enter the average percent cover class of the whole stratum in the second column, using the Cover Scale at the bottom of the form (same cover scale as for species above).
'*' – This Column is used to indicate which species in the strata are particularly abundant.

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

TREE STEM AND ROOT CROWN DIAMETERS

This portion of the form is used to record to obtain information on the size (biomass) of trees in a given plot. Record the scientific name of the species on the form and check whether the measurement is DBH or DRC. It is ok to use 6-digit alpha codes for species name in this part of the form. Please see instructions below to determine which measure should be used.

Diameter Breast Height (DBH) - all tree species except Pinyon/Juniper
In plots containing single bole trees such as Douglas fir, limber pine, and cottonwood, record the species name and diameter (in cm) of the tree stem/trunk at breast height (4.5 ft.) using a DBH tape. Often this measurement will involve only a single tree trunk, however on some occasions there may be multiple stems. In this case record all diameters associated with a given individual on the same line, separated by a comma or commas. If there are more than about 25 trees more than 4.5 feet tall, divide the plot into quarters and measure the DBH of trees in the southeast quarter/quadrant. Please note on the form that this is what you've done.

FOSSIL BUTTE NATIONAL MONUMENT VEGETATION MAPPING CHEATSHEET

LANDFORM

alluvial fan
alluvial flat
alluvial plain
alluvial terrace
alluvium
backslope
badlands
ballon
basin
basin floor
bench
blowout
bluff
borrow pit
bottomland
box canyon
braided stream
break
butte
canyon
channel
cliff
closed depression
colluvium
crest
cuesta
debris flow
deflation basin
depression
desert pavement
dip
ditch
divide
dome
drainageway
draw
earthflow
ephemeral stream
escarpment
finger ridge
flat
flood plain
foothills
gorge
gravel pit
gulch
gully
hill
hillslope
hogback
hummock
interfluve
intermittent stream
knob
knoll
landslide
ledge
levee
meander belt
mesa
mountain
natural levee
overflow channel
oxbow
pediment
perennial stream
plain
plateau
point bar
pond
pool
quarry
ravine
reef
ridge
rise
rim
rockfall
saddle
scarp
scree slope
shoulder
side slope
slope
slope alluvium
slope wash
stream terrace
summit
swale
talus slope
tank
terrace
terracettes
toeslope
valley
valley floor
valley side
wash (dry wash)

TOPOGRAPHIC POSITION

SEE THE DIAGRAM ON OTHER SIDE

VEGETATIVE STRATA

T1 = emergent tree
T2 = tree canopy
T3 = tree sub-canopy
S1 = tall shrub, > 2m
S2 = short shrub, < 2m
S3 = dwarf shrub. < 0.5m
H1 = graminoid
H2 = forb
H3 = fern or fern ally
H4 = Tree seedlings
N = nonvascular other than ferns
V = vine/liana
E = epiphyte

PARK SPECIALS (keep an eye out for)

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

PHYSIOGNOMIC CLASS

Forest: Crowns touching
Woodland: Trees>10%, crowns not touching
Shrubland: Shrubs> grass, forbs or trees
Dwarf Shrubland: Shrubland <0.5 m tall
Shrub Herbaceous: Shrubs = Forbs/grasses
Herbaceous: Grass/forbs > trees or shrubs

SOIL TEXTURE

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

SURFICIAL GEOLOGY

Obscured by soil
Aeolian sands
New Alluvium (Holocene)
Older Alluvium (pre Holocene)
Talus / Colluvium / Landslides
Eocene Wasatch
Green River Formation
Main Body of Wasatch
Wasatch Formation
Wasatch Fm- Angelo Member
Wasatch Fm- Bullpen Member
Wasatch Fm- Fossil Butte Mem

DISTURBANCE

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

PLOT SIZE

400m^2 (20x20m square):
Forests, Woodlands,

100m^2 (10x10m square):
hrublands, Dwarf-shrublands, Shrub-herbaceous, Herbaceous

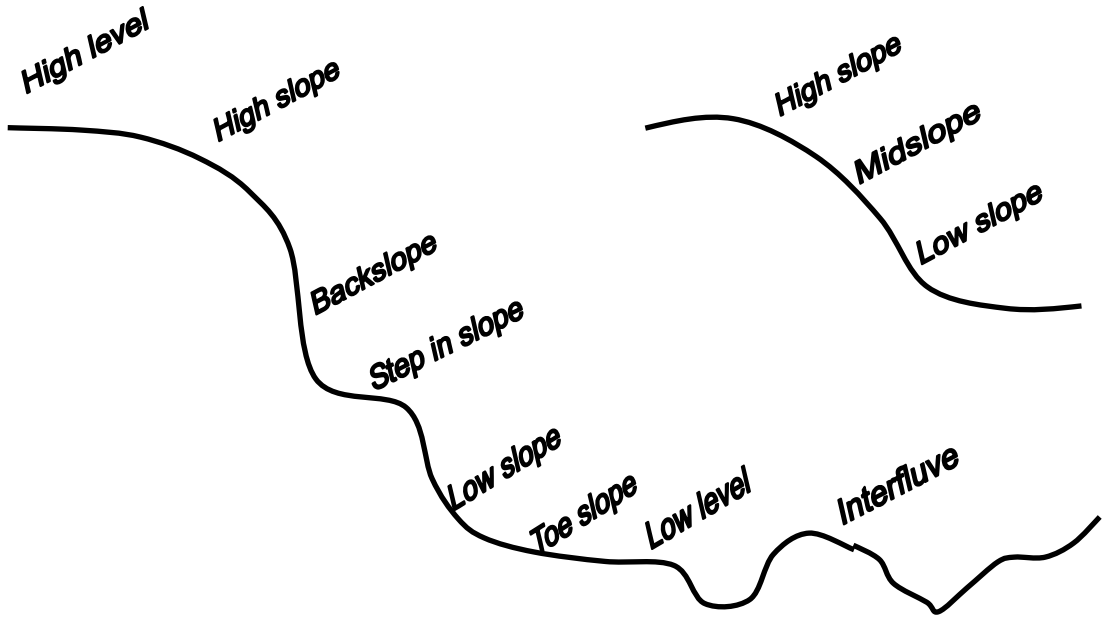
25m^2:
Non vascular

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

ASPECT

Flat
Azimuth (deg.)
Variable

TOPOGRAPHIC POSITION - CHEAT SHEET



OBSERVATION POINT FORM INSTRUCTIONS – 2005

Many fields are identical to fields on the Plot Survey Forms and will not be re-defined here.

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

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

IDENTIFIERS / LOCATORS SECTION

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

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

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

Observation Points should be assigned a code similar to Plot Survey codes to be used as a GPS file name and on the chalkboard in the photo. Observation point numbers will be assigned in the 9000 series. (For example, FOBU.9101)

ENVIRONMENTAL DESCRIPTION SECTION

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

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

Unvegetated Surface
This field is an ocular estimate of ground cover. Because there is no designated sample size for areas surveyed as Observation Points, you will have to estimate percent covers for whatever size the area is. For

this estimation, you must use the cover classes listed in the bottom right hand corner of the data sheet. If an unvegetated surface category is not present in your observation point area (e.g., water is very uncommon in the sampling units), leave the corresponding line blank.

VEGETATION DESCRIPTION SECTION

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

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

DOMINANT PLANT SPECIES LIST

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

1. **Height.** Use the number code that best describes the heights of all plant species within a given stratum. The number codes are listed in the bottom left had corner of the data sheet. These are the same height classes used for plots.
2. **Cover Class.** For this ocular estimation you are looking at the aerial cover of **all** plants within a given stratum. Use the cover class codes listed in the bottom right hand corner of the data sheet and presented below (note: these are broader cover classes than used on the plot form).

Cover Classes	
01	0 – 10%
02	10 – 25%
03	25-60%
04	60 – 100%

3. **Dominant Species (Mark species that characterize the stand with a *).** List the plant species using the full scientific name. You may find that there are not enough lines, in which case you can write in the blank area under the stratum name and number codes.
4. **% Cover.** Estimate the percent aerial cover (T-100%) for each plant species.

EXTRACURRICULAR INSTRUCTIONS - 2005

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

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

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

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

If the spring community is sizeable enough please consider conducting a regular vegetation plot, as we need this information to characterize the full suite of vegetation types.

Invasive Plant Species (Use Invasive Plant Location Log)

Invasions of aggressive non-native species are one of the largest threats to ecosystem integrity of terrestrial and aquatic systems. Field crews are requested to document 'noteworthy' populations of invasive plants on the 'Invasive Plant Log' Form (or using the data dictionary in the Trimble GeoXM GPS unit) and take photos as feasible and appropriate. We are not requesting a comprehensive inventory of all invasive plants, as that would be another full project. However, the park would appreciate having help documenting populations of invasive plants that are of especially high concern. Early detection of species populations that are small give the park a chance for control or eradication before the problem becomes too big. For example, a small population of diffuse knapweed was found 2 years ago near Upheaval Dome in Canyonlands. This represented the first occurrence of this species in the park and control efforts were immediately implemented.

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

General Floristic Inventory

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

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

OFFICE DATA ENTRY AND TRACKING – 2005

DATA ENTRY

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

SPECIES LIST MANAGEMENT

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

TRACKING PLANT ASSOCIATIONS

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

HERBARIUM SPECIMENS

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

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

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 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.

backslope - The hillslope profile position that forms the steepest and generally linear, middle portion of the slope. In profile, backslopes are commonly bounded by a convex shoulder above and a concave footslope below. They may or may not include cliff segments (i.e. free faces). Backslopes are commonly erosional forms produced by mass movement, colluvial action, and running water. Compare - summit, shoulder, footslope, toeslope.

badlands - A landscape which is intricately dissected and characterized by a very fine drainage network with high drainage densities and short, steep slopes with narrow interfluves. Badlands develop on surfaces with little or no vegetative cover, overlying unconsolidated or poorly cemented materials (clays, silts, or in some cases sandstones) sometimes with soluble minerals such as gypsum or halite.

ballon - (colloquial: western US). A rounded, dome-shaped hill, formed by erosion or uplift.

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.

bench - (not preferred) refer to structural bench.

blowout - A saucer-, cup-, or trough-shaped depression formed by wind erosion on a preexisting dune or other sand deposit, especially in an area of shifting sand, loose soil, or where protective vegetation is disturbed or destroyed; the adjoining accumulation of sand derived from the depression, where recognizable, is commonly included. Commonly small, some blowouts may be large (kilometers in diameter). Compare - deflation basin.

bluff - (a) A high bank or bold headland, with a broad, precipitous, sometimes rounded cliff face overlooking a plain or body of water, especially on the outside of a stream meander; ex. a river bluff. (b) (not preferred) use cliff. Any cliff with a steep, broad face.

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.

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.

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.

cliff - Any high, very steep to perpendicular or overhanging face of rock or earth; a precipice. Compare - bluff.

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.

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.

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.

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.

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.

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).

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.

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.

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 &

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.

gravel pit - A depression, ditch or pit excavated to furnish gravel for roads or other construction purposes; a type of borrow pit.

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.

hill - A generic term for an elevated area of the land surface, rising at least 30 m (100 ft.) to as much as 300 meters (approx. 1000 ft.) above surrounding lowlands, usually with a nominal summit area relative to bounding slopes, a well-defined, rounded outline and slopes that generally exceed 15 percent. A hill can occur as a single, isolated mass or in a group. A hill can be further specified based on the magnitude of local relief: *low hill* (30 - 90 m) or *high hill* (90 - 300 m). Informal distinctions between a hill and a mountain are often arbitrary and dependent on local convention. Compare - hillock, plateau, mountain, foothills, hills.

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.

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.

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.

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.

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.

meander belt - The zone within which migration of a meandering channel occurs; the flood-plain area included between two imaginary lines drawn tangential to the outer bends of active channel loops. Landform components of the meander-belt surface are produced by a combination of gradual (lateral and down-valley) migration of meander loops and avulsive channel shifts causing abrupt cut-offs of loop segments. Landforms flanking the sinuous stream channel include: point bars, abandoned meanders, meander scrolls, oxbow lakes, natural levees, and flood-plain splays. Meander belts may not exhibit prominent natural levee or splay forms. Flood plains of broad valleys may contain one or more abandoned meander belts in addition to the zone flanking the active stream channel.

mesa - A broad, nearly flat-topped, and usually isolated landmass bounded by steep slopes or precipitous cliff and capped by layers of resistant, nearly horizontal, rocky summit width greater than the height of bounding escarpments. (Colloquial: western US; not preferred) Also used to designate broad structural benches and alluvial terraces that occupy intermediate levels in stepped sequences of platforms bordering canyons and valleys. Compare - butte, plateau, cuesta.

mountain - A generic term for an elevated area of the land surface, rising more than 300 meters above surrounding lowlands, usually with a nominal summit area relative to bounding slopes and generally with steep sides (greater than 25 percent slope) with or without considerable bare-rock exposed. A mountain can occur as a single, isolated mass or in a group forming a chain or range. Mountains are primarily formed by tectonic activity and/or volcanic action and secondarily by differential erosion. Compare - hill, hillock, plateau, foothills, mountains.

natural levee - A long, broad low ridge or embankment of sand and coarse silt, built by a stream on its flood plain and along both sides of its channel, especially in time of flood when water overflowing the normal banks is forced to deposit the coarsest part of its load. It has a gentle slope away from the river and toward the surrounding floodplain, and its highest elevation is closest to the river bank. Compare - levee, artificial levee, meander belt.

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.

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.

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.

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.

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.

rockfall - The process, associated sediments (rockfall deposit) or resultant landform characterized by a very rapid type of *fall* dominated by downslope movement of detached rock bodies which fall freely through the air or by leaps and bounds (lacks an underlying slip face); also spelled rock fall. Compare -

debris fall, soil fall, landslide.

saddle - A low point on a ridge or interfluve, generally a divide (pass, col) between the heads of streams flowing in opposite directions. Compare - summit, crest.

scarp - An escarpment, cliff, or steep slope of some extent along the margin of a plateau, mesa, terrace, or structural bench. A scarp may be of any height. Compare - escarpment.

scree slope - A portion of a hillside or mountainslope mantled by scree and lacking an up-slope rockfall source (i.e. cliff). Compare - talus slope, scree, talus.

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.

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.

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.

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.

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.

talus slope - a portion of a hillslope or mountainslope mantled by talus and lying below a rockfall source (e.g. cliff). Compare - scree slope, scree, talus. Compare - beveled base.

tank - (colloquial: southwestern US) A natural depression or cavity in impervious rocks in which water collects and remains for the greater part of the year.

terrace - A step-like surface, bordering a valley floor or shoreline, that represents the former position of a flood plain, or lake or sea shore. The term is usually applied to both the relatively flat summit surface (tread), cut or built by stream or wave action, and the steeper slope (scarp, riser), descending to a lower

base level. Compare - stream terrace, flood-plain step. Practically, terraces are considered to be generally flat alluvial areas above the 100 yr. flood stage.

terracettes - Small, irregular step-like forms on steep hillslopes, especially in pasture, formed by creep or erosion of surficial materials that may be induced or enhanced by trampling of livestock such as sheep or cattle. Synonyms (not preferred) - catstep, sheep or cattle track.

toeslope - The hillslope position that forms the gently inclined surface at the base of a hillslope. Toeslopes in profile are commonly gentle and linear, and are constructional surfaces forming the lower part of a hill-slope continuum that grades to valley or closed-depression floors. Compare - summit, shoulder, backslope, footslope, valley floor.

valley - An elongate, relatively large, externally drained depression of the Earth's surface that is primarily developed by stream erosion or glacial activity. Compare - basin.

valley floor - A general term for the nearly level to gently sloping, lowest surface of a valley. Landforms include axial stream channels, the flood plain, flood-plain steps, and, in some areas, low terrace surfaces. Compare - flood-plain landforms, meander, braided channel, valley side.

valley side - The sloping to very steep surfaces between the valley floor and summits of adjacent uplands. Well-defined, steep valley sides have been termed valley walls (not recommended). Note: Scale, relief, and perspective may require use of closely related terms such as hill slope or mountain slope.

wash (dry wash) - (colloquial: western US.) The broad, flat- floored channel of an ephemeral stream, commonly with very steep to vertical banks cut in alluvium. Note: When channels reach intersect zones of ground-water discharge they are more properly classed as “intermittent stream” channels. Synonym - arroyo. Compare - gully.

APPENDIX: Soil Texture Key

(Modified from Brewer and McCann 1982)

Soil primarily organic:

0a. Soil is black, is saturated with water, and often smells of rotten eggs...……..**muck**
0b. Soil is dark brown, usually saturated, and consists of clearly identifiable plant parts.…...**peat**

Soil primarily mineral:

1a. Soil does not remain in a ball when squeezed, leaves your fingers clean..…….....**sand**
1b. Soil remains in a ball when squeezed ……..…….....2

Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you push up over your finger.

2a. Soil makes no ribbon but leaves your fingers dirty ……..……**loamy sand**
2b. Soil makes at least a very short ribbon.....……...3

3a. Ribbon extends less than 1 inch before breaking.….…….....4
3b. Ribbon extends 1 inch or more before breaking ….……..…….....5

4a. Add excess water to small amount of soil. Soil feels slightly gritty… ……..…**loam**
4b. Soil fees very gritty……..…….**sandy loam**
4c. Soil feels smooth....…….... **silt loam**

5a. Soil makes a ribbon that breaks when 1-2 inches long; cracks if bent into a ring.....6
5b. Soil makes a ribbon 2+ inches long; does not crack when bent into a ring ……..…7

6a. Add excess water to small amount of soil; soil feels slightly gritty…… **clay loam**
6b. Soil feels very gritty and slightly sticky..……..**sandy clay loam**
6c. Soil feels very smooth but not at all sticky….……..... **silt**
6d. Soil feels slightly gritty and slightly sticky…….…….**silty clay loam**

7a. Add excess water to a small amount of soil; soil feels gritty…..….……... **sandy clay**
7b. Soil feels smooth and sometimes sticky……..……8

8a. Soil feels smooth but leaves a gritty taste in the mouth…….…**silty clay**
8b. Soil leaves a smooth taste in the mouth, not at all gritty…….…….....**clay**

APPENDIX: Considerations for Planning

Planning for the day:

1. Safety and sustenance: Plenty of food, water, first-aid kit, raingear, sunscreen.
2. Field communications:
    a. Develop a plan with other team(s) for radio check-in time.
    b. Do you have a radio and are batteries charged? If you have a walkie talkie, do you have extra batteries for it? Does park staff know the area in which you will be working?
3. Make sure you have the right maps and photos.
4. Check your GPS (Datum set to NAD83? WAAS on? Needs new batteries?).
5. Plan the day's mission before departing using a) USGS quads, b) aerial photos, c) BLM maps.
6. Considerations for mission planning:
    a. Plan travel based on topography, best access routes, density and complexity of vegetation (more time for forest and woodland plots, less for herbaceous and scrub).
    b. Plan data collection based on priority needs; new types get higher priority.
    c. Communicate with the other team(s) to make sure you aren't duplicating effort.

Planning for the Week (do this on the first day of the trip)

1. Do you have all appropriate maps, photos?
2. Develop a reasonable estimate of the number of plots for each team broken up by day and based on an estimate of individual team's travel logistics for the week.
3. Develop plan of attack for the week to capture all essential associations in the work area.
4. Balance points two and three above with the expected work schedule of the teams and ensure adequate time-off and reduce over-time concerns.
5. Do you have all necessary information and backups for the week's planning? E.g., blank field forms, film, plenty of batteries.

Wrapup (Do this on the last day of the trip, after you have returned to base)

1. Clean, recharge and repair equipment.
2. Hold brief meeting to discuss data collection issues, things that came up during the work week, and plan for next work hitch.
3. Edit field forms and file them systematically. File observation points separately.
4. Re-file the aerial photos and maps.
5. Send exposed rolls of film to be developed.
6. Key unknown plants.
7. Enter edited data into database.

Communicate among teams / Topics for wrap-up meetings.

1. What were your questions about the polygons visited during the week?
2. Do you have any questions about the forms or fields?
3. What was accomplished, what was not accomplished?
4. Pass on developments and questions after every trip. Don't let them build up. For example, should we sample the new types we saw? Were there problems with interpreting the aerial photos, or are there personnel issues, problems in consistency in interpreting the forms, or with park-related logistics?

Materials Checklist

- Park research permit
- Topo maps
- Park and BLM maps for general navigation
- Geology map
- Aerial photos
- DBH tape and 2 tape measure(s)
- Trowel or U-dig-it, soil water bottle
- Compass with adjustable declination
- Clinometer
- GPS unit
- Plenty of AA batteries for walkie talkie
- Radio or walkie talkie and/or cell phone
- 35 mm camera & film (allow at least 3 exposures per plot plus general and scenic photos)
- Baggies for temporary storage of unknown plants, and masking tape for labeling
- Plant press & paper
- Plant Keys / Flora(s)
- Pens / sharpies
- Forms: plot survey (both pages) and observation point
- Clipboard/forms holder
- Pens, pencils, pencil lead, slate board, chalk, and chalkboard eraser or supply of clean rags
- Stapler and extra staples
- Most recent version of provisional classification of the park, with the number of plots still needed per type (updated approx. every 2 weeks)
- All ancillary information (cheat sheet, species list, floras, sampling priority list for zone, main sampling protocol).
- First aid kit, personal gear (food, water, rain gear, etc.)

Appendix B.2. Accuracy Assessment Point Field Sampling Manual

Accuracy Assessment Field Manual - 2006
Arches National Park and Fossil Butte National Monument

Northern Colorado Plateau Network Vegetation Mapping Project
National Park Service

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

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 include:

- 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 get a good GPS point, the AA point data collected may look like it is in another polygon, or if the polygons are small/narrow and the GPS 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 is actually accurate.
- AA point falls within an ecotone, which is impossible to classify but still has to be mapped as something
- Relationships between plant associations and map units (modeling) are flawed.
- The polygon is 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 what the photo interpreter saw in the bigger picture.

NAVIGATING TO A POINT

The field investigator will navigate to each selected AA point using handheld GPS receivers and maps 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 maps 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, GPS the location of the field vehicle so one can find their way back!*

Use the GPS unit to locate the point within 5-10 m of coordinates, but do not spend a lot of time trying to be exact. A 5000m2 area around each point will be evaluated, which is the size of 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 samples (e.g. a long-narrow riparian area, or point falling too close to the edge of a polygon).

At each AA point the investigator will key the vegetation to plant association within half a hectare around each point. The MMU is a relatively large area - approximately the size of a football field with endzones (50m x100m rectangle, 71m x71m square, 80m diameter circle). The shape of the MMU may need to vary depending on the shape of the mapping polygon, but for large polygons, an 80m diameter circle is easiest. If the polygon is smaller than the MMU, evaluate the whole polygon

Along the way... Identify the polygons that the target AA points are in, and if possible walk through part of the polygons on the way to the points, noting polygon boundaries. Is the map polygon uniform or variable? Is the AA point representative of the polygon? Record these observations on the AA form 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 one's life! Use good judgment. A list of 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 handle. If two distinct plant associations are present on a site, it may be helpful to 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 40 m buffer from the polygon edge is used, therefore hopefully ensuring 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 shift the center of their AA point away from the polygon edge so that it will not fall in the adjacent polygon. The AA point will be gps-ed at this new location, the checkbox "other" for plot shape will be checked, and this shifting of location will be documented by the observer at the end of the "Classification Comments" section.

AA POINT FORM INSTRUCTIONS – 2006

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 unit. Please make sure the GPS unit is set for NAD83, and that the WAAS is on (see 3D differential, below). If a Trimble unit is used, then several data fields will be collected electronically in the GPS data dictionary as well as manually recorded on the forms. Manual recording of data serves as a backup in case of GPS failure. Park-specific cheatsheets are provided at the end of this section to assist with field workers with data collection.

IDENTIFIERS / LOCATORS SECTION

AA Point code:
Accuracy assessment 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. Four letter park codes for this project are ARCH or FOBU. An example of an AA point at Arches would be ARCH_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. This will be done in the office.

State:
Enter state in which AA point occurs. This will be done in the office.

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, arch, 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 plot shape: circular or other. (Remember, other must be circled if the AA point center is shifted away from the coordinates you were given). In the case of other please provide comments in the classification comments field below.

GPS file:
This field only needs to be completed if a GPS unit other than Trimble GeoXM is being used. For instance, if a Garmin unit is being used then enter the name given to the waypoint when the AA point was marked in the GPS unit. It would be useful to assign a name that incorporates the AA point number.

Field UTMX, Field UTMY
Record the UTM easting and northing that was saved as a waypoint in the GPS. Please double check to make sure the easting is six digits and the northing is seven digits.

In deep canyon country, it is often difficult to obtain a GPS reading (the GPS has to be able to 'see' at least three or four satellites). If it is not possible to get a GPS reading in the point, or if the PDOP is greater than 8 (or EPE is greater than ±50m), first try to get a signal from a higher point outside (but still close to) the point. If that fails, then estimate the UTM coordinates from the topo map, and manually enter these UTMs into the GPS unit.

Use a map that is in NAD 83 if at all possible, since the project standard is the NAD83 datum. However, USGS 7.5 minute maps use the NAD27 datum. The difference in this part of the world is that the NAD83 grid is shifted about 60m west and 200m north of NAD27.

Coordinates derived from NAD27 topographic map?
If coordinates are manually derived from a NAD27 USGS topographic map please check the appropriate box on the field form.

To ensure that all AA points show up in the right place, please use this procedure when estimating UTM coordinates from a NAD27 topo map:

1. Locate the AA point as accurately as possible on the topo map, using triangulation or climbing to a high point.
2. Use the topo map, straightedge, pencil and a transparent overlay grid to obtain UTM coordinates in NAD27 (done carefully, one should be able to get to the nearest 10m). Write these coordinates down in the GPS Comments Field with the note "UTM coordinates derived from NAD27 topo map". DO NOT enter these in the UTM X and UTM Y fields.
3. Update the settings in the GPS unit to the NAD27 datum.
4. Create a new waypoint, give it the code of the AA point, and enter the UTM coordinates that were recorded.
5. Update the settings in the GPS unit to the NAD83 datum. This will convert the NAD27 coordinates to NAD83 without screwing up the coordinates already in the machine (there may be rounding error). Enter the converted coordinates (now in NAD 83) into the UTM X and UTM Y fields.
6. Try to do this only once per hitch, because the more often it is done then the more likely it is that the rounding error will change the coordinates of other (non-topo-derived) points. This can be done back in the office during datasheet review and data entry.

GPS Receiver:
Record the name and model of the GPS unit being used to record data for the point. If a GPS unit was not used to determine UTMs record 'none' here and be sure to complete the 'GPS Comments' field below.

GPS Receiver Error
Note the PDOP (or "Estimated Position Error" (EPE), if a Garmin unit is being used) displayed on the GPS unit. The lower the number, the more accurate the reading.

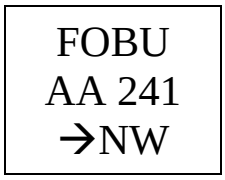
3D Differential?
3D differential is obtained when the GPS unit can "see" a satellite that does nothing but correct the tiny errors in the positioning or clocks of other GPS satellites. This satellite broadcasts a real-time differential correction so that the location coordinates are as accurate as possible. It is in geosynchronous orbit in the southern sky, so if the southern sky is visible, one will generally be able to get 3D differential. This

system is known as the Wide-Area Augmentation System, or WAAS. The Garmin and Trimble units have a field in their setup pages for turning WAAS on or off. Please make sure that WAAS is **always** on.

GPS Receiver Comments:
VERY IMPORTANT: If the field investigator resorted to estimating the AA point location UTMs on the topo map, note that in this field. If the usual GPS croaked and an old Magellan had to be borrowed from a friend, note that. Also, if the investigator had to leave the point to get a reading from a high point, record that here, along with the compass bearing and distance of the GPS location from the point center (unless offset function was used on the Trimble GeoXM- in that case, enter "point offset.")

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

Taking photographs
Take one color slide of each AA point, two if there is more than one community represented there. The purpose is to get 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 for perspective. Use a chalkboard to record the point number and the direction the photo is taken. Thus, for AA point 241, the board in the photo taken from the SE facing NW across the point will read "FOBU AA 241, →NW". Take the photographs looking across the contour if 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 an extra photograph without the signboard.



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 taken 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 has been collected. Using the environmental, stratum and cover data, key the vegetation in the half-hectare area around the AA point to association. Choose carefully! Write the name of the association in the primary association field. If the situation is borderline between two associations (e.g., some sagebrush, but also some muttongrass), write other association name in the secondary association field. A tertiary name field has also been provided for the few occasions where a third call is needed. If vegetation near 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 point does not fit the plant association key at all, then create a new name using the dominant species of each strata (as would be done 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 50m of the outside border of the half-hectare AA point being evaluated.

Representativeness of AA point:
Because AA points are randomly located within a polygon, there is no guarantee that they will land in a spot that is representative of either the polygon or of the associations included within the polygon's map unit. The point could easily land in a small gully or an inclusion that is too small to map, or an ecotone where trees are invading a shrubland, for instance. Because of this, it is important that the investigator pay attention not only to the vegetation within the ½ hectare 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 a gully or 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 being used 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 primary association to the description in the key (Good, Fair, Poor). (If you created a new name for the association, rank the representativeness as poor) Please describe briefly any difficulty experienced in using the plant association key in the ***Field Key Log*** pages in the back of the field key. It would also be helpful to have specific suggestions on how to make the key work better. The field key log will ask you for a reference to the AA point number where the problem was encountered and a description of what didn't work and your suggestions. This is extremely important! It will provide information for improving the key for the final report.

ENVIRONMENTAL DESCRIPTION SECTION

Elevation
Elevation of the AA point. If a Trimble GeoXM is being used then use the GPS unit to record elevation in meters. If a different GPS unit is being used then estimate the elevation from the topographic map. Specify on the data sheet whether the measurement is in feet or meters, and whether it was obtained from a GPS unit 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." Further information may be provided in the Environmental Comments section.

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 landforms 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 Appendix 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 plant community occurs. A list of geologic types is provided on park specific cheatsheets at the end of this document. The geology map should help, but if one is unable to decipher the geology at all or a geology map is not available at the point, then provide a general description (e.g., coarse sandstone, green shale, aeolian sands or obscured by soils).

Environmental Comments
Enter any noteworthy comments on the environmental setting and its effect on the vegetation. Examples include: "stunted trees due to shallow soils", "vegetation only where pockets of soil occur", or "large colluvial boulders and small rocks litter surface of soil". This field can also be used to describe site history such as fire events. This is an extremely important field for crews to document so please take the time to do a 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 >10cm); small rocks (gravel 0.1-10 cm); sand (0.1-2mm); bare soil; other (please specify). For this estimation use the cover classes listed below. If an unvegetated surface category is not present in the observation point area, leave the corresponding line blank.

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%

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, Coleogyne, Ephedra* and all *Atriplex* except *A. canescens*, all *Chrysothamnus* except *C. nauseosus* var. *junceus*)
Cold deciduous. Greater than 75% of the total woody cover sheds its foliage in connection with an unfavorable season mainly characterized by winter frost (tricky ones: *Sarcobatus vermiculatus, Tamarix*).
Mixed evergreen - cold deciduous. Evergreen and deciduous species are mixed within the type and generally contribute 25-75% of the total woody cover.
Perennial. Herbaceous vegetation composed of more than 50% perennial species.
Annual. Herbaceous vegetation composed of more than 50% annual species.

Leaf Type

Select the best description for the leaf form of the dominant stratum. The dominant stratum is the uppermost stratum that contains at least 10% total coverage. Within that dominant stratum, the species that makes up greater than 50% of cover defines the leaf type.

Broad-leaved. Woody vegetation that is primarily broad-leaved (Sagebrush, oak, mountain mahogany).
Needle-leaved. Woody vegetation that is primarily needle-leaved (Juniper, pinyon, tamarisk).
Microphyllous. Woody cover that is primarily microphyllous (*Ephedra*).
Graminoid. Herbaceous vegetation composed of more than 50 percent graminoid species (grasses, sedges, rushes, etc).
Forb (broad-leaf-herbaceous). Herbaceous vegetation composed of more than 50% broad-leaf forb species (*Phlox, Astragalus, Erigeron*, etc).
Pteridophyte. Herbaceous vegetation composed of more than 50 percent ferns or 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. The ‘working draft’ plant list for each park will be used as a guide for assigning species to the appropriate stratum. Field crew members are expected to help ‘improve’ this list and associated categorization as the field season progresses.

Begin by assessing the strata at 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 Purshia mexicana.
S2 Short Shrub. <2 meters tall. For example, *Coleogyne ramosissima*, all *Atriplex* species except *gareti, corrugate, gardnerii* (which are dwarf).
S3 Dwarf Shrub. <0.5 meters tall. For example, *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), blackbrush is a short shrub (S2), snakeweed is a dwarf shrub (S3), etc.), **EVEN when unusual environmental circumstances dictate that the plants have an unusually tall** (e.g., 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 not seedlings, they are assigned to 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 2m tall, they all get 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 issue 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 sage, *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 a '*'.

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.

Fossil Butte National Monument AA Cheat Sheet

LANDFORM

alluvial fan
alluvial flat
alluvial plain
alluvial terrace
alluvium
backslope
badlands
ballon
basin
basin floor
bench
blowout
bluff
borrow pit
bottomland
box canyon
braided stream
break
butte
canyon
channel
cliff
closed depression
colluvium
crest
cuesta
debris flow
deflation basin
depression
desert pavement
dip
ditch
divide
dome
drainageway
draw
earthflow
ephemeral stream
escarpment
finger ridge
flat
flood plain
foothills
gorge
gravel pit
gulch
gully
hill
hillslope
hogback
hummock
interfluve
intermittent stream
knob
knoll
landslide
ledge
levee
meander belt
mesa
mountain
natural levee
overflow channel
oxbow
pediment
perennial stream
plain
plateau
point bar
pond
pool
quarry
ravine
reef
ridge
rise
rim
rockfall
saddle
scarp
scree slope
shoulder
side slope
slope
slope alluvium
slope wash
stream terrace
summit
swale
talus slope
tank
terrace
terracettes
toeslope
valley
valley floor
valley side
wash (dry wash)

TOPOGRAPHIC POSITION

SEE THE DIAGRAM ON OTHER SIDE

VEGETATIVE STRATA

T1 = emergent tree
T2 = tree canopy
T3 = tree sub-canopy.
S1 = tall shrub, > 2m
S2 = short shrub, < 2m
S3 = dwarf shrub. < 0.5m
H1 = graminoid
H2 = forb
H3 = fern or fern ally
H4 = Tree seedlings
N = nonvascular other than ferns
V = vine/liana
E = epiphyte

PARK SPECIALS (keep an eye out for)

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

PHYSIOGNOMIC CLASS

Forest: Crowns touching
Woodland: Trees>10%, crowns not touching
Shrubland: Shrubs> grass, forbs or trees
Dwarf Shrubland: Shrubland <0.5 m tall
Shrub Herbaceous: Shrubs = Forbs/grasses
Herbaceous: Grass/forbs > trees or shrubs

SOIL TEXTURE

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

SURFICIAL GEOLOGY

Obscured by soil
Aeolian sands
New Alluvium (Holocene)
Older Alluvium (pre Holocene)
Talus / Colluvium / Landslides
Eocene Wasatch
Green River Formation
Main Body of Wasatch
Wasatch Formation
Wasatch Fm- Angelo Member
Wasatch Fm- Bullpen Member
Wasatch Fm- Fossil Butte Mem

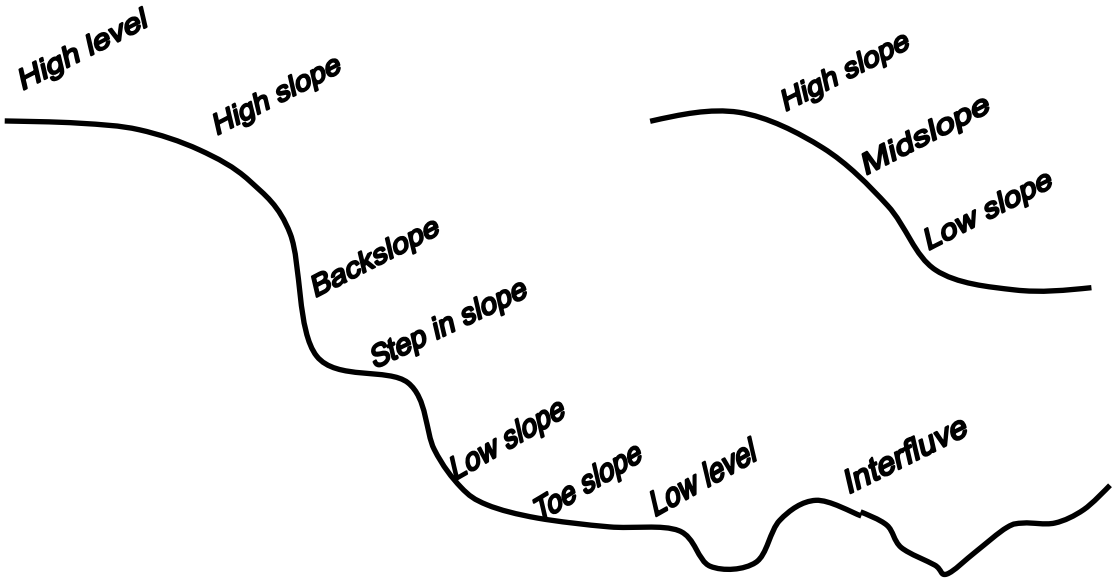
DISTURBANCE

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

ASPECT

Flat
Azimuth (deg.)
Variable

TOPOGRAPHIC POSITION - CHEAT SHEET



EXTRACURRICULAR INSTRUCTIONS - 2006

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

Springs/Seeps/Hanging Gardens (Use Observation Point Form)
These areas are considered significant ecosystems across the Colorado Plateau and have been identified as a high priority vital sign for inclusion in the long-term monitoring program. Unfortunately very little information has been documented on the location and characteristics of these areas within the parks.

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

If the spring community is sizeable enough please consider conducting a regular vegetation plot, as we need this information to characterize the full suite of vegetation types.

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

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

General Floristic Inventory
An important part of the Northern Colorado Plateau Network Program is to assist parks with the documentation of all vascular plants and vertebrate species occurring within each park. As part of the vegetation mapping project, field crews are requested to assist in the collecting of vascular plant vouchers (herbarium specimens) for parks. The park-specific plant list provided to field crews indicates whether or not a voucher has been collected for a given species. If a voucher has not been collected, field crews are to look for opportunities to make collections of these taxa. Field crews will receive training in how to collect, document and process vouchers. Specimens should contain appropriate flowering and/or fruiting material to assure correct identification. Additionally specimens should contain all appropriate plant parts

(roots, leaves, stems, flowers etc.) and as possible show the habit of the plant. Enough material should be collected to fill a herbarium sheet.

OFFICE DATA ENTRY AND TRACKING

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

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

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

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

Appendix B.3. Example of a Vegetation Plot Data Form

FOSSIL BUTTE NATIONAL MONUMENT PLOT SURVEY FORM
2005 NCPN VEGETATION MAPPING PROGRAM

SURVEY AND SITE INFORMATION

Plot Code: FOBU. 0075 Quad name: Nugget BPU Code: _____ Aerial Photo #: 104-39
Park Site Name Section 36 - Ed. Visitor's Center Location (Please Circle One): Park Environs
Survey Date 6/23/05 Surveyors S. Boyce + B. Smith

GPS file name FP0075 Field UTM X 519912 m E Field UTM Y 4632047 m N
☐ Coordinates from USGS NAD27 Quad Map (if checked enter coordinates under GPS comments)
Datum NAD 83 Zone: 12 GPS Unit: Trimble XM / Garmin Flat /Other: Map12 PDOP: 1.3 3D Differential? Y / N
GPS Comments: Error: +/- 5 m (Flat Garmin only)

Directions to Plot:
About 3/4 mile E-NE of the Visitor's Center

Plot Size: 400 m2 ☐ Square ☒ Circle | Rectangular Plot: length(m)_____ width(m)_____ | Azimuth _____

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

Roll #	Frame #	Photographer	Direction/Comments
SB2	4	S. Boyce	N→S
SB2	5	S. Boyce	E→W

Plot representativeness (discuss plot placement and explain non-representativeness)
This plot is not representative of any other type sampled. Plot was placed midslope, at the center of this bunchgrass community.

ENVIRONMENTAL DESCRIPTION

Elevation 6892 m / ft From: GPS / Map (circle one) | Slope 10° Aspect 290°
Topographic Position: midslope
Landform: ridge | Geology: Wasatch formation

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

Environmental Comments (factors controlling community/plant distribution, seral stage, fire history etc):
This ridge between two drainages is a stable community. Grasses occur uniform throughout, while shrubs are more spradic. This plot contains the best community of western blue bunchgrass at a high density. Overall there is hardly any disturbance to the area.

2005: JUN 15; V1.1 (Plot Form) 1

FOSSIL BUTTE NATIONAL MONUMENT PLOT SURVEY FORM

PLOT CODE: FOBU. 0075 DATE: _____

ENVIRONMENTAL DESCRIPTION (Continued)

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

71 Bare soil			
__ Bedrock	15 Live veg - litter	5 Moss	__ Dark cyanobacteria
2 Small rocks (0.2-10cm)	4 Live veg – wood	__ Lichen (on rocks)	__ Water
1 Large rocks (>10cm)	__ Wood (>1cm)	__ Lichen (ground)	
__ Sand (0.1-2mm)	2 Litter / duff		

Soil Texture (see cheat sheet):

__ sand	__ loamy sand	__ sandy loam	__ loam
__ silt loam	__ silt	X clay loam	__ silty clay
__ sandy clay	__ clay	__ peat	__ muck
__ sandy clay loam	__ silty clay loam		

Soil Drainage:

__ Rapidly drained	__ Well drained
X Moderately well drained	__ Somewhat poorly drained
__ Poorly drained	__ Very poorly drained

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

Animal use is evident in the form of scat

Natural and Anthropogenic Disturbance Comments (see cheat sheet for examples; describe intensity and effect on the vegetation, also whether disturbance is current, chronic, episodic or historic)

None observed

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

To the N of the slope is a drainage with a big sagebrush community. Appears to be a drainage to the south as well.

VEGETATION DESCRIPTION

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

2005: JUN 15: V1.1 (Plot Form) 2

FOSSIL BUTTE NATIONAL MONUMENT PLOT SPECIES/STRATA FORM
2005 NCPN VEGETATION MAPPING PROGRAM

Plot Code: FOBU. 0075 Date: 6-23-05

VEGETATION DESCRIPTION

Provisional Community Name: Elymus spicatus/Artemisia longiloba CT

Supplemental Form (Please Check if Used): ☐ Artemisia longiloba/Elymus spicatus/Poa secunda CT

Species/Strata: Starting with the uppermost stratum list all species with full scientific names, cover class and % cover for each species in the stratum. For each tree species estimate seedling, sapling, total cover in appropriate stratum. Once species level information is completed, then complete height class and cover class for each strata (shaded blocks). Indicate with an asterix ('*') diagnostic species for each stratum and check whether a specimen has been collected. Trees and shrubs are on the front portion of this form. Herbaceous species and non-vascular plants are on the back of this form. **List species outside the plot at the end of the table and designate with a 0 in Cover Class Column.**

SPECIES/STRATA TABLE / TREES & SHRUBS

Strata / Species Scientific Name	*	Cover Class	% Cover	Spec ✓
T1 EMERGENT Strata Height ____ Strata Cover ____				
T2 CANOPY Strata Height ____ Strata Cover ____				
T3 SUBCANOPY Strata Height ____ Strata Cover ____				
S1 TALL SHRUB (> 2m) Strata Height ____ Strata Cover ____				
S2 SHORT SHRUB (< 2m) Strata Height ____ Strata Cover ____				
Cerotoides				
S3 DWARF SHRUB (< 0.5m) Strata Height 01 Strata Cover 2				
Artemisia longiloba		1B	10	
Krascheninnikovia lanata		P	5	
Chrysothamnus viscidiflorus		P	2	
Tetradymia canescens		T	<1	
Atriplex confertifolia		T	<1	
Artemisia tridentata ssp. vaseyana		T	1	

SPECIES/STRATA TABLE / HERBACEOUS

Strata / Species Scientific Name	*	Cover Class	% Cover	Spec ✓
Ht HERBACEOUS Sum of H1, H2, H3, H4 Strata Height 01 Strata Cover 3				
H1 GRAMINOIDS Strata Height 01 Strata Cover 3				
Poa secunda		1B	10	
Elymus spicatus		1B	15	
H2 FORBS Strata Height 01 Strata Cover 1A				
Haplopappus acaulis		P	1	
Phlox hoodii		P	4	
Eriogonum brevicaule		T	<1	
Astragalus jejunus		T	<1	
Machaeranthera grindelioides		T	<1	
Stanleya viridiflora		T	<1	
Arenaria sp.		T	<1	
Cymopterus sp. (long stalk)		T	<1	
Castilleja flava		T	<1	
Machaeranthera canescens		T	<1	
Taraxacum officinale		T	<1	
H3 FERNS & ALLIES Strata Height ____ Strata Cover ____				
H4 TREE SEEDLINGS Strata Height ____ Strata Cover ____				
N NON-VASCULAR Strata Height 01 Strata Cover 1A				
Moss		1A	5	
V VINE/LIANA Strata Height ____ Strata Cover ____				

Cover Scale for Species and Strata

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

Height Scale for Strata

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

2005: JUN 15; v1.1 (Species/Strata Form) 3

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

FOSSIL BUTTE NATIONAL MONUMENT OBSERVATION SURVEY FORM
2005 NCPN VEGETATION MAPPING PROGRAM

SURVEY AND SITE INFORMATION

Point Code: FOBU. 9 0 4 1 Quad name: Nugget BPU Code: _____ Aerial Photo #: 104-24
Type of Observation (Please Circle One): VEG/OBS SPRING/HANGING GARDEN OTHER (Specify) _____
Park Site Name N. of Visitor's Center Location (Please Circle One): Park Environs
Survey Date 10/23/05 Surveyors B. Smith + S. Boyd Size of Area: 1/4 acre

GPS file name F09041 Field UTM X 518802 m E Field UTM Y 4632240 m N
☐ Coordinates from USGS NAD27 Quad Map (if checked enter coordinates under GPS comments)
Datum NAD 83 Zone: 12 GPS Unit: Trimble XM / Garmin Flat /Other: Map12 PDOP: 1.1 3D Differential? Y / N
GPS Comments: Error: +/- 5 m (Flat Garmin only)

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

Roll #	Frame #	Photographer	Direction/Comments
SB2	23	S. Boyd	W→E
SB2	24	S. Boyd	landscape - Fossil Butte W→E

ENVIRONMENTAL DESCRIPTION

Elevation 6755 m / ft From: GPS / Map (circle one) Slope 1° Aspect 80°
Topographic Position: lowlevel
Landform: drainageway Geology: Wasatch

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

Environmental Comments:
This mesic site has a dense cover of various graminoid species. Drainageway feeds into Chicken creek. Area is 150ft wide then narrows and forks. Site must have held a good deal of moisture recently; multiple mushrooms growing in area.

Unvegetated Surface: *(please use cover scale below)*
01 Bare soil; ___ Bedrock; ___ Small rocks (0.2-10cm); ___ Large rocks (>10cm); ___ Sand (0.1-2mm); ___ Wood (>1cm); 04 Litter / duff; ___ Other (describe) _____

VEGETATION DESCRIPTION

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

2005: JUN 15; V1.1 (Observation Form) 1

FOSSIL BUTTE NATIONAL MONUMENT OBSERVATION SURVEY FORM

2005 NCPN VEGETATION MAPPING PROGRAM

Provisional Community Name: Juncus balticus – Poa pratensis c.t. Herbaceous Vegetation Plot Code: FOBU. 9 04 L

	Stratum Height Class	Stratum Cover Class	Dominant Species (mark Diagnostic species with *)	% Cover
T1 Emergent				
T2 Canopy				
T3 Sub-canopy				
S1 Tall shrub (> 2 m)				
S2 Short Shrub (< 2 m)				
S3 Dwarf Shrub (< 0.5 m)	01	01	Artemisia cana	3
H Herbaceous	01	04	*Juncus balticus	20
			*Poa pratensis	20
			Carex praegracilis	15
			Eriogonum sp.	c1
			Descurainia pinnata	c1
			Achillea millefolium	c1
			Aster sp.	2
			Koeleria macranthera	1
			Taraxacum officinale	4
			Tragopogon dubius	<1
			Elymus lanceolatus	5
N Non-vascular			Penstemon eatonii	c1
			Alyssum desertorum	c1

Height Scale for strata:

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

Cover scale for strata and unvegetated surfaces:

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

2005: JUN 15; V1.1 (Observation Form) 2

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

2006 ACCURACY ASSESSMENT POINT FORM – FOSSIL BUTTE NATIONAL MONUMENT
NORTHERN COLORADO PLATEAU NETWORK VEGETATION MAPPING PROJECT

IDENTIFIERS/LOCATORS

AA Point Code: FOBU_AA. 0296 Quad name: Fossil AA Point Shape: ☒ circle ☐ other

Park Site Name Southern Border of Monument

Survey Date 9/21/06 Surveyor(s) Foderaro

GPS file name FB296 Field UTM X 520881 m E Field UTM Y 4630401 m N

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

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

Datum NAD 83 Zone: 12S Error +/-: 5 m (Flat Garmin only)

GPS Comments:

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

Roll #	Frame #	* Photographer	Direction/Comments
MF1	15	Foderaro	→ NE

PLANT ASSOCIATION INFORMATION

ASSOCIATIONS AT AA POINT	New?	OTHER ASSOCIATIONS WITHIN 50 M OF AA POINT
Primary Name Artemisia arbuscula / Sporobolus cryptandrus Shrubland / Herbaceous Vegetation	☐	1. Artemisia tridentata wyomingensis Shrubland
Secondary Name	☐	2.
Tertiary Name	☐	3.

Representativeness of point within polygon: ☐ Good ☒ Fair ☐ Poor ☐ Unk .....of association to description: ☒ Good ☐ Fair ☐ Poor

Classification Comments: (complications, uncertainties, explanation of fair/poor representativeness)
Artemisia tridentata wyomingensis Shrubland to the N. Butte is a bit further N than that. This plot has a small mixture of Sarcobatus vermiculatus and Artemisia tridentata wyomingensis

ENVIRONMENTAL DESCRIPTION

Elevation 2041 (m)/ft From: (GPS)/ Map (circle one) Slope 6 Aspect 226

Topographic Position: Low slope

Landform: Valley Floor Geology: Secondary Stream Alluvium

Environmental Comments:
Found remains of pronghorn in plot. Noise pollution due to train. A couple of narrow washes in plot. Point facing S.W. Windy, exposed area.

2006: Feb 9

2006 ACCURACY ASSESSMENT POINT FORM – FOSSIL BUTTE NATIONAL MONUMENT
NORTHERN COLORADO PLATEAU NETWORK VEGETATION MAPPING PROJECT

0296

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

/	Bedrock	/	Large rocks (cobbles, boulders > 10 cm)	/	Sand (0.1-2 mm)
P	Litter, duff	P	Small rocks (gravel, 0.2-10 cm)	06	Bare soil
T	Wood (> 1 cm)			/	Other:_____

VEGETATION DESCRIPTION

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

Strata (30')	Height Class	Cover Class	Dominant species (mark any known diagnostic species with a *)	% Cover
T1 Emergent	___	___	___	___
T2 Canopy	___	___	___	___
			___	___
			___	___
T3 Sub-canopy	___	___	___	___
			___	___
S1 Tall shrub	___	___	___	___
			___	___
			___	___
			___	___
S2 Short Shrub	02	1b	Artemisia arbuscula ssp gilvida	10
			Sarcobatus vermiculatus	2
			Chrysothamnus nauseosus	1
			Artemisia tridentata wyomingensis	1
			___	___
S3 Dwarf-shrub	01	P	Atriplex gardneri	1
			___	___
			___	___
H Herbaceous	01	02	Poa fendleriana	7
			Poa secunda	8
			Astragalus sp	T
			Phlox hastatula	1
H4 Tree Seedlings	___	___	___	___
			___	___
N Non-vascular	___	___	___	___

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

2006: Feb 9

Appendix C
Database Documentation

C.1. Plots Database Documentation

Background

This database, designed to accept 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 FOBU VegMapDB, have been used for all vegetation mapping projects conducted by NCPN. FOBU VegMapDB contains plot, observation point, and accuracy assessment data collected during project field work.

Two database files are required to use FOBU VegMapDB:

- *FOBU_PlotsAA_XP.mdb.* This "frontend" file contains all queries, forms, reports, associated modules and Visual Basic code.
- *FOBU_PlotsAA_XP_be.mdb*. This "backend" file contains the database tables.

The frontend/backend file structure allows multiple users to enter data in a network environment, and allows for easy backup and transfer of the data tables. Users typically launch the frontend file, and a utility will prompt them to establish a link to the backend file. The contents of the backend file, however, can be used independently of the frontend.

Entity Relationship Diagram

The primary tables and relationships from the backend file (FOBU_PlotsAA_XP_be.mdb) are illustrated below. The database follows the design structure of the National Park Service Natural Resource Database Template, which is based on a location record, one or more related event records, and observation data elements linked to each event.

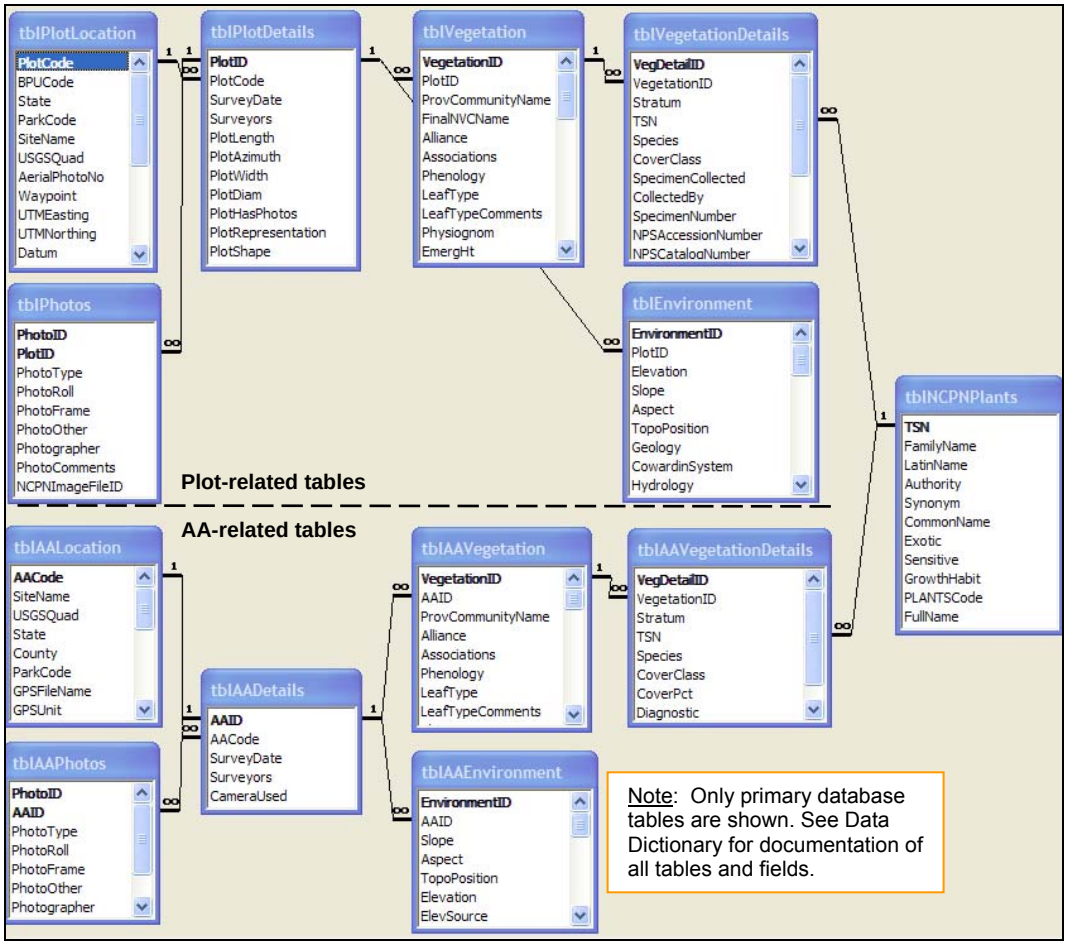


Figure 1. Entity Relationship Diagram for FOBU VegMapDB

Data Dictionary

The database consists of three types of tables: plot data, accuracy assessment data, and lookup tables that provide a standardized list of values to be used for certain data fields. Tables appear in alphabetical order within each of these three categories.

Plot-related tables

Table Name: tblBPU
Description: Not used for FOBU

Field Name	Field Description	Field Type	Field Width
BPU_record_ID	Not used for FOBU	dbLong	4
centroid_x	Not used for FOBU	dbDouble	8
centroid_y	Not used for FOBU	dbDouble	8
hectares	Not used for FOBU	dbDouble	8
BPU_code	Not used for FOBU	dbText	50
district	Not used for FOBU	dbText	75
gradsect_year	Not used for FOBU	dbLong	4
BPU_comments	Not used for FOBU	dbText	250

Table Name: tblDataMgmtLog
Description: Table containing a log of data set manipulations or database object alterations.

Field Name	Field Description	Field Type	Field Width
ActionDate	The date on which the data set was massaged or manipulated.	dbDate	8
ActionMonth	If ActionDate known to month only, use this field and the ActionYear field.	dbText	50
ActionYear	If ActionDate known to year only, use this field.	dbText	50
Action	What was done with the data set. How was it altered, 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: tblEnvironment
Description: Table containing values on environmental features and conditions of plot or observation point

Field Name	Field Description	Field Type	Field Width
EnvironmentID	Unique record identifier	dbLong	4
PlotID	Foreign key; links record to tblPlotDetails	dbLong	4
Elevation	Elevation of plot in meters as estimated from either map or GPS unit	dbLong	4
ElevSource	How elevation was derived in the field (GPS or Quad Map)	dbText	50
Slope	Slope of plot measured in degrees	dbText	50
Aspect	Aspect of plot	dbText	50
TopoPosition	Topographic position of plot; value selected from tlkpTopography	dbText	50
Landform	Landform on which plot is located, any landform could be entered by crew.	dbText	50
Geology	Geologic substrate influencing the plant community; value selected from tlkpGeology	dbText	75
CowardinSystem	If the plot is in a wetland system, select term that best describes its hydrology; value selected from tlkpCowardin	dbText	12
Hydrology	Select value that best describes hydrology of plot from tlkpHydrology	dbText	50
EnvironmentalComments	Comments on environmental setting and its effect on the vegetation; also comments on any disturbance or reproduction factors	dbMemo	0
BareSoil	Estimate to the nearest percentage of bare soil ground cover	dbText	3
Bedrock	Estimate to the nearest percentage of bedrock ground cover	dbText	3
Sand	Estimate to the nearest percentage of sand (particle size 0.1-2mm) ground cover	dbText	3
Moss	Estimate to the nearest percentage of moss ground cover	dbText	3
Other	Estimate to the nearest percentage of other type of ground cover	dbText	3
OtherPctDesc	Text field to describe the other type of ground cover.	dbText	255
Litter	Estimate to the nearest percentage of litter ground cover	dbText	3
Rocks	Estimate to the nearest percentage of rocks >10cm	dbText	3

Field Name	Field Description	Field Type	Field Width
	wide ground cover		
Lichen	Estimate to the nearest percentage of lichen ground cover	dbText	3
Wood	Estimate to the nearest percentage of wood >1cm ground cover	dbText	3
Gravel	Estimate to the nearest percentage of rocks <10cm wide ground cover	dbText	3
Water	Estimate to the nearest percentage of water ground cover	dbText	3
Cryptogam	Estimate to the nearest percentage of cryptogram ground cover	dbText	3
SoilTexture	Assessment of average soil texture from sample taken a few inches below the surface; values selected from tlkpSoilTexture	dbText	50
SoilDrainage	Soil drainage class based on actual moisture content and extent period; values selected from tlkpSoilDrainage	dbText	30
AnimalUseComments	Comments on evidence of use by non-domestic animals in plot area	dbMemo	0
DisturbanceComments	Comments on evidence of natural or anthropogenic disturbance in plot area, severity and effects on vegetation	dbMemo	0
OtherComments	Other general comments	dbMemo	0
LandscapeComments	Description of landscape context of plot, including any important landscape features influencing the community	dbMemo	0
SoilTaxonDesc	Field used for either identifying soils keyed, or to describe if large rocks or outcrops are present on the surface	dbText	255
LiveVegLitter	Estimate to the nearest percentage of live veg litter ground cover	dbText	3
LiveVegWood	Estimate to the nearest percentage of live veg wood ground cover	dbText	3
LichenRocks	Estimate to the nearest percentage of lichen covering rocks	dbText	3
LichenGround	Estimate to the nearest percentage of lichen ground cover (on the soil, associated with cryptogams)	dbText	3
DarkCyanobacteria	Estimate to the nearest percentage of dark cyanobacteria ground cover	dbText	3
TotalPct	Total percentage reported covered - calculated as QC check.	dbInteger	2

Table Name: tblEnvironmentDetails
Description: Table containing values on environmental features and conditions of plot or observation point

Field Name	Field Description	Field Type	Field Width
EnvDetailID	Unique record identifier	dbLong	4
EnvironmentID	Foreign key; links to tblEnvironment	dbLong	4
Landform	One or more landform values corresponding to plot location; any value may be entered by crew	dbText	50

Table Name: tblFinalAssociationNamesPlots
Description: Table containing final Association Names (plots) assigned by NatureServe.

Field Name	Field Description	Field Type	Field Width
PlotCode	Identifier assigned to plot by survey crew	dbText	255
Association_Name	Association Name assigned by NatureServe	dbText	255
ELC_Code	Unique ID assigned by NatureServe	dbText	255

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 FOBU plots	dbText	3
PJPhotoGuide	n/a for FOBU plots	dbText	3
SBPhotoGuide	n/a for FOBU 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 FOBU plots	dbText	3
LitterNorth	n/a for FOBU plots	dbText	3
LitterEast	n/a for FOBU plots	dbText	3
LitterSouth	n/a for FOBU plots	dbText	3
LitterWest	n/a for FOBU plots	dbText	3
DuffOrigin	n/a for FOBU plots	dbText	3
DuffNorth	n/a for FOBU plots	dbText	3
DuffEast	n/a for FOBU plots	dbText	3
DuffSouth	n/a for FOBU plots	dbText	3
DuffWest	n/a for FOBU plots	dbText	3
IsSubplot	indicate if measurements are for subplot (if plot has >25 trees, one quadrant (subplot) of plot can be measured for fuels	dbBoolean	1

Table Name: tblFuelsDetails
Description: Details on stems, height, crown width, and other attributes of trees within plot.

Field Name	Field Description	Field Type	Field Width
FuelsDetailID	Unique identifier for record	dbLong	4
FuelsID	Foreign key, links to tblFuels	dbLong	4
StemCount	Number of stems measured. Value will be 1 if forest species; >=1 if woodland species.	dbInteger	2
StemDiameter	diameter in cm of stem(s). If stem count =1 for a forest species, diameter represents dbh. If stem count is >1 for a woodland species, diameter represents the average diameter of all stems measured at crown base.	dbDouble	8
DBH	check if diameter is DBH	dbBoolean	1
DRC	check if diameter is DRC	dbBoolean	1
AVG	check if diameter is average of multiple stems	dbBoolean	1
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
WoodlandCrownWidth	Width, in meters, of woodland tree crown	dbDouble	8
WoodlandCrownHeight	Height, in meters, of woodland tree	dbDouble	8
ForestCrownBaseHeight	Height, in meters, of crown base of forest tree	dbDouble	8

Field Name	Field Description	Field Type	Field Width
ForestCrownHeight	Height, in meters, of forest tree (PP or DF)	dbDouble	8
CrownRatio	[not used]	dbText	12
StructureStage	Stage of tree; values selected from tlkpStructureStages	dbText	12
Comments	Brief comments (e.g., dead top, twinned, ladder fuels, diseased)	dbText	255

Table Name: tblGeneralPhotos
Description: Information pertaining to photos not associated with plots.

Field Name	Field Description	Field Type	Field Width
GenPhotoID	Unique record identifier	dbLong	4
GenPhotoParkCode	Four-letter abbreviation of park where photo was taken (if applicable)	dbText	50
GenPhotoDate	Date photo taken	dbDate	8
GenPhotographer	Name of photographer	dbText	75
GenPhotoDesc	General description of photo contents	dbText	250
GenPhotoUTME	UTME of photo	dbLong	4
GenPhotoUTMN	UTMN of photo	dbLong	4
GenUTMZone	UTMZone of photo UTM coordinates	dbLong	4
GenPhotoRoll10	Roll number of photo	dbText	50
GenPhotoFrame	Frame number of photo	dbText	10
GenPhotoDigFile	Digital file name of photo	dbText	50
GenPhotoComments	General comments	dbText	250

Table Name: tblGeneralSpecimens
Description: Table used to enter data on specimens collected outside of plots or observation points.

Field Name	Field Description	Field Type	Field Width
GenSpecimenID	Unique record ID	dbLong	4
GenSpecFamily	Family name of species collected	dbText	50
GenSpecLatinName	Latin name of species collected	dbText	120
GenSpecCollector	Name of person collecting specimen	dbText	50
GenSpecCollectNum	Reference of specimen assigned by collector	dbText	50
GenSpecAccNumber	NPS Accession Number of specimen	dbText	15
GenSpecCatNumber	NPS Catalog Number of specimen	dbText	15
GenSpecDate	Date collection made	dbDate	8
GenSpecUTMN	Northing of collection location	dbLong	4
GenSpecUTME	Easting of collection location	dbLong	4
GenSpecCounty	County of collection location	dbText	50
GenSpecElev	Elevation (ft) of collection location	dbLong	4
GenSpecLocality	Description of locality where specimen was collected	dbText	250
GenSpecHabitat	Description of habitat where specimen was collected	dbText	250
GenSpecAssocSpec	Associated species where specimen was collected	dbText	250
GenSpecComments	Comments field	dbText	250

Table Name: tblPhotos
Description: Details on individual photos taken of plot or observation point.

Field Name	Field Description	Field Type	Field Width
PhotoID	Unique record identifer	dbLong	4
PlotID	Foreign key, links to tblPlotDetails	dbLong	4
PhotoType	Type of photo being referenced.	dbText	16

Field Name	Field Description	Field Type	Field Width
PhotoRoll	Reference number for film roll of photo.	dbText	12
PhotoFrame	Frame number of photo within roll.	dbLong	4
PhotoOther	Other unique identifier or reference number for digital photo or name of movie file.	dbText	30
Photographer	Name of photographer.	dbText	50
PhotoComments	Brief description of photo.	dbText	80
NCPNImageFileID	Cross-reference for NCPN photo database field, 'ImageFileID', with 'PhotoOther'	dbText	50

Table Name: tblPlotCodeLink
Description: Not used

Field Name	Field Description	Field Type	Field Width
NewPlotCode	Not used	dbText	20
OldPlotCode	Not used	dbText	20

Table Name: tblPlotDetails
Description: Information on a plot that is specific to a visit

Field Name	Field Description	Field Type	Field Width
PlotID	Unique identifier for record	dbLong	4
PlotCode	Foreign key, links to tblPlotLocation	dbText	10
SurveyDate	Date plot was visited and data collected	dbDate	8
Surveyors	Names of persons collecting data at plot (last names)	dbText	75
PlotLength	Length of plot, in meters	dbText	5
PlotAzimuth	Azimuth of plot; synonymous with aspect. One or the other, or both, can be used	dbText	5
PlotWidth	Width of plot, in meters	dbText	5
PlotDiam	Diameter of plot, in meters, if plot is circular	dbText	5
PlotHasPhotos	Yes if photos are taken of plot	dbBoolean	1
PlotRepresentation	Description or discussion of representativeness of plot in stand, and in comparison to associations outside the park (if known)	dbMemo	0
PlotShape	Shape of plot	dbText	15
CameraUsed	Make and model of camera used to photograph plot	dbText	50
ObsPointArea	Estimated size of observation point	dbText	50

Table Name: tblPlotLocation
Description: Observation

Field Name	Field Description	Field Type	Field Width
PlotCode	Identifier assigned to plot by survey crew	dbText	10
BPUCode	Biophysical unit code where plot is located.	dbText	10
State	State where plot is located	dbText	2
ParkCode	Park unit where plot is located	dbText	4
SiteName	Short, descriptive name of site where plot is located	dbText	100
USGSQuad	USGS quadrangle (1:24K) where plot is located	dbText	50
AerialPhotoNo	Aerial photo number corresponding to plot location	dbText	10
Waypoint	Garmin plot code	dbText	7
UTMEasting	UTM easting of plot	dbDouble	8
UTMNorthing	UTM northing of plot	dbDouble	8
Datum	Datum of UTM coordinates	dbText	10

Field Name	Field Description	Field Type	Field Width
UTMZone	UTM zone of coordinates	dbText	4
UTM Error	error, in meters, of location data (based on reading from Garmin GPS unit)	dbText	5
PDOP	satellite Precision Dilution of Position (based on reading from Trimble GPS unit)	dbText	50
DiffCorrected	Indicate if coordinates have been differentially corrected	dbText	3
DirectionsToPlot	Precise directions to plot	dbMemo	0
County	County where plot is located.	dbText	50
GPSUnit	Manufacturer and model of GPS unit (e.g., Trimble GeoExplorer 3)	dbText	25
GPSComments	Any brief comments on GPS data collection at plot.	dbText	255
InPark	Select Yes if plot is within park boundaries.	dbBoolean	1
IsObservationPt	Yes if observation point.	dbBoolean	1
ObservationType	If observation point, type of observation. Valid entries are: veg/obs, spring/hanging garden, other.	dbText	25
ObservationComment	Comments for Other observation type.	dbMemo	0

Table Name: tblVegetation
Description: Overall vegetation characteristics of a plot or observation point

Field Name	Field Description	Field Type	Field Width
VegetationID	Unique record ID	dbLong	4
PlotID	Foreign key, links to tblPlotDetails	dbLong	4
ProvCommunityName	Community name (provisional) assigned by field crews by following naming protocols as described in field manual and training 04/04.	dbText	120
Alliance	Alliance corresponding to provisional community name	dbText	100
Associations	Association corresponding to provisional community name	dbText	100
Phenology	Leaf phenology of the dominant stratum. Field is blank for non-vascular plots	dbText	35
LeafType	Leaf form of the dominant stratum.	dbText	35
LeafTypeComments	If Leaf Type is "mixed," this field describes the multiple leaf types found in the dominant stratum.	dbText	255
Physiognom	Physiognomic class of plot (from tllkPhysiogClass)	dbText	20
EmergHt	Height class of emergent stratum (classes are in tlkpHeightClass)	dbText	2
EmergCovTot	Cover class of emergent stratum (classes are in tlkpCover)	dbText	15
EmergCovPercent	[not used]	dbText	50
CanHt	Height class of canopy stratum	dbText	2
CanCovTot	Cover class of canopy stratum	dbText	15
CanCovPercent	[not used]	dbText	50
SubHt	Height class of 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 short shrub stratum	dbText	2
ShrubCovTot	Cover class of short shrub stratum	dbText	15

Field Name	Field Description	Field Type	Field Width
ShrubCovPercent	[not used]	dbText	50
DwarfHt	Height class of dwarf shrub stratum	dbText	2
DwarfCovTot	Cover class of dwarf shrub stratum	dbText	15
SwarfCovPercent	[not used]	dbText	50
HerbHt	Height class of herbaceous stratum (all H layers)	dbText	2
HerbCovTot	Cover class of herbaceous stratum (all H layers)	dbText	15
HerbCovPercent	[not used]	dbText	50
GramHt	Height class of graminoid stratum	dbText	2
GramCovTot	Cover class of graminoid stratum	dbText	15
GramCovPercent	[not used]	dbText	50
ForbHt	Height class of forb stratum	dbText	2
ForbCovTot	Cover class of forb stratum	dbText	15
ForbCovPercent	[not used]	dbText	50
FernHt	Height class of fern and fern ally stratum	dbText	2
FernCovTot	Cover class of fern and fern ally stratum	dbText	15
FernCovPercent	[not used]	dbText	50
SeedlHt	Height class of seedling stratum	dbText	2
SeedlCovTot	Cover class of seedling stratum	dbText	15
SeedCovPercent	[not used]	dbText	50
NonvasHt	Height class of nonvascular stratum	dbText	2
NonvasCovTot	Cover class of nonvascular stratum	dbText	15
NonvasCovPercent	[not used]	dbText	50
VineHt	Height class of vine stratum	dbText	2
VineTotCov	Cover class of vine stratum	dbText	15
VineTotPercent	[not used]	dbText	50
EpiHt	Height class of epiphyte stratum	dbText	2
EpiTotCov	Cover class of epiphyte stratum	dbText	15
EpiTotPercent	[not used]	dbText	50
OutsidePlotHt	Height class of species occurring outside plot	dbText	50
OutsidePlotTotCov	Cover class of species occurring outside plot	dbText	50
OutsidePlotTotPercent	[not used]	dbText	50
PlantSpeciesComments	Comments on plant species list, particularly for species whose ID is not 100% sure	dbMemo	0

Table Name: tblVegetationDetails
Description: Species and strata-specific data related to a plot or observation point

Field Name	Field Description	Field Type	Field Width
VegDetailID	Unique record ID	dbLong	4
VegetationID	Foreign key, links to tblVegetation	dbLong	4
Stratum	Strata class from tlkpStrata	dbText	2
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
Species	Latin names of species, from tblNCPNPlants	dbText	100
CoverClass	Cover class to describe species and strata (from tlkpCover)	dbText	5
ObsPointCoverClass	Cover class for observation points (different scale than cover classes for plots)	dbText	50
PercentCover	Percent (0-100) cover of each species	dbText	5
IsDead	Check yes if the species being documented was dead	dbBoolean	1
Diagnostic	Check yes if the species is known to be diagnostic of	dbBoolean	1

Field Name	Field Description	Field Type	Field Width
	the vegetation type.		
SpecimenCollected	Check yes if a specimen of the species was collected.	dbBoolean	1
CollectedBy	Name of person collecting specimen	dbText	120
NPSAccessionNumber	Accession number corresponding to all collections made under research permit assigned by park curator	dbText	50
NPSCatalogNumber	Unique reference number for individual specimen assigned by park curator	dbText	50
SpecimenNumber	Enter the collector's reference number for the specimen collected.	dbText	20
SpecimenLocality	Brief description of collection location, suitable for specimen label	dbText	240
SpecimenHabitat	Brief description of collection habitat, suitable for specimen label	dbText	240
SpecimenAssocSpecies	Brief description of associated species in collection area, suitable for specimen label	dbText	240

Accuracy assessment-related tables

Table Name: tblAADetails
Description: Information on an AA point that is specific to a visit.

Field Name	Field Description	Field Type	Field Width
AAID	Unique identifier for record	dbLong	4
AACode	Identifier of AA record; assigned by field crew	dbText	13
SurveyDate	Date AA point was visited and data was collected	dbDate	8
Surveyors	Name(s) of persons who collected data at an AA point	dbText	75
CameraUsed	Make and model of camera used to photograph plot	dbText	50

Table Name: tblAAEnvironment
Description: Table containing values on environmental features and conditions of an AA point.

Field Name	Field Description	Field Type	Field Width
EnvironmentID	Unique record identifier	dbLong	4
AAID	Foreign key; links to tblAADetails	dbLong	4
Slope	Slope of AA point measured in degrees	dbText	50
Aspect	Aspect of AA point	dbText	50
TopoPosition	Topographic position of AA point; value selected from tlkpTopography	dbText	50
Elevation	Elevation of AA point in meters as estimated from either map or GPS unit	dbLong	4
ElevSource	How elevation was derived in the field (GPS or Quad Map)	dbText	50
EnvironmentalComments	Comments on environmental setting and its effect on the vegetation; also comments on any disturbance or reproduction factors	dbMemo	0
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

Field Name	Field Description	Field Type	Field Width
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
Geology	Geologic substrate influencing the plant community; value selected from tlkpGeology	dbText	75

Table Name: tblAAEnvironmentDetails
Description: Table containing values on environmental features and conditions of an AA point.

Field Name	Field Description	Field Type	Field Width
EnvDetailID	Unique record identifier	dbLong	4
EnvironmentID	Foreign key; provides link to tblEnvironment	dbLong	4
Landform	One or more landform values corresponding to AA point location; any value may be entered by crew	dbText	50

Table Name: tblAALocation
Description: Basic and unchanging information on AA point location.

Field Name	Field Description	Field Type	Field Width
AACode	Identifier assigned to AA point by survey crew	dbText	13
SiteName	Short, descriptive name of site where point is located	dbText	100
State	State where point is located	dbText	2
County	County where plot is located.	dbText	50
ParkCode	Park unit where point is located	dbText	4
GPSFileName	Name of corresponding GPS file	dbText	50
GPSUnit	Manufacturer and model of GPS unit (e.g., Trimble GeoExplorer 3)	dbText	25

Field Name	Field Description	Field Type	Field Width
UTMEasting	UTM easting of point	dbText	9
UTMNorthing	UTM northing of point	dbText	10
UTMZone	UTM zone of coordinates	dbText	4
DiffCorrected	Indicate if coordinates have been differentially corrected	dbText	3
Datum	Datum of UTM coordinates	dbText	10
PDOP	satellite Precision Dilution of Position (based on reading from Trimble GPS unit)	dbText	50
UTM Error	error, in meters, of location data (based on reading from Garmin GPS unit)	dbText	5
InPark	Select Yes if plot is within park boundaries.	dbBoolean	1
GPSComments	Any brief comments on GPS data collection.	dbText	255
USGSQuad	USGS quadrangle (1:24K) where point is located	dbText	50
RepresentPWP	Representativeness of point within polygon: Good, Fair, or Poor (on association page)	dbText	7
RepresentATD	Representativeness of association to description: Good, Fair, or Poor (on association page)	dbText	4
ClassificationComments	Classification comments (on association page)	dbMemo	0
PlotShape	Plot shape: Circular, Other	dbText	10

Table Name: tblAAPhotos
Description: Details on individual photos taken of an AA point.

Field Name	Field Description	Field Type	Field Width
PhotoID	Unique record identifier	dbLong	4
AAID	Foreign key; provides link to tblAADetails	dbLong	4
PhotoType	Type of photo being referenced.	dbText	16
PhotoRoll	Reference number for film roll of photo.	dbText	12
PhotoFrame	Frame number of photo within roll.	dbText	50
PhotoOther	Other unique identifier or reference number for digital photo or name of movie file.	dbText	20
Photographer	Name of photographer.	dbText	50
PhotoComments	Brief description of photo.	dbText	255
NCPNImageFileID	Cross-reference for NCPN photo database field, 'ImageFileID', with 'PhotoOther'	dbText	50

Table Name: tblAAVegAssociation
Description: Vegetation association at AA location.

Field Name	Field Description	Field Type	Field Width
VegAssocID	Unique record identifier	dbLong	4
AAID	Foreign key; provides link to tblAADetails	dbLong	4
VegAssocCode	Identification code of vegetation association; provided by NatureServe	dbText	25
VegAssocRank	Rank of vegetation association (primary, secondary, tertiary)	dbText	15
OtherAssocCode	Other associations within 50 meters	dbText	255
FieldKey	Was name obtained from field key?	dbBoolean	1
NewName	Is it a new classification name?	dbBoolean	1
Post_Field_Name	Name assigned post-field work?	dbBoolean	1

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 tlkpPhysiogClass)	dbText	20
EmergHt	Height class of emergent stratum (from tlkpHeightClass)	dbText	2
EmergCovTot	Cover class of emergent stratum (from tlkpCoverClassAA)	dbText	15
EmergCovPercent	[not used]	dbText	50
CanHt	Height class of canopy stratum	dbText	2
CanCovTot	Cover class of canopy stratum	dbText	15
CanCovPercent	[not used]	dbText	50
SubHt	Height class of subcanopy stratum	dbText	2
SubCovTot	Cover class of subcanopy stratum	dbText	15
SubCovPercent	[not used]	dbText	50
TallShHt	Height class of tall shrub stratum	dbText	2
TallShCovTot	Cover class of tall shrub stratum	dbText	15
TallShCovPercent	[not used]	dbText	50
ShrubHt	Height class of shrub stratum	dbText	2
ShrubCovTot	Cover class of shrub stratum	dbText	15
ShrubCovPercent	[not used]	dbText	50
DwarfHt	Height class of dwarf shrub stratum	dbText	2
DwarfCovTot	Cover class of dwarf shrub stratum	dbText	15
DwarfCovPercent	[not used]	dbText	50
HTotalHt	Height class of total herbaceous stratum	dbText	2
HTotalCover	Cover class of total herbaceous stratum	dbText	15
HTotalCoverPercent	[not used]	dbText	50
H4Ht	Height class of tree seedling stratum	dbText	2
H4Cover	Cover class of tree seedling stratum	dbText	15
H4CoverPercent	[not used]	dbText	50
NonvasHt	Height class of nonvascular stratum	dbText	2
NonvasCovTot	Cover class of nonvascular stratum	dbText	15
NonvasCovPercent	[not used]	dbText	50
VineHt	Height class of vine stratum	dbText	2
VineTotCov	Cover class of vine stratum	dbText	15
VineTotPercent	[not used]	dbText	50
EpiHt	Height class of epiphyte stratum	dbText	2
EpiTotCov	Cover class of epiphyte stratum	dbText	15
EpiTotPercent	[not used]	dbText	50
PlantSpeciesComments	Comments on plant species list	dbMemo	0

Field Name	Field Description	Field Type	Field Width
MultipleAssoc	Does list represent more than one association?	dbBoolean	1

Table Name: tblAAVegetationDetails
Description: Species and strata-specific data related to an AA point.

Field Name	Field Description	Field Type	Field Width
VegDetailID	Unique record ID	dbLong	4
VegetationID	Foreign key; links to tblAAVegetation	dbLong	4
Stratum	Strata class from tlkpStrataAA	dbText	2
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
Species	Latin names of species, from tblNCPNPlants	dbText	100
CoverClass	Cover class to describe species and strata (from tlkpCoverAA)	dbText	5
CoverPct	[not used]	dbText	5
Diagnostic	Check if species is known to be diagnostic of the vegetation type.	dbBoolean	1
Dead	Check if the species is dead	dbBoolean	1

Table Name: tblFinalAssociationNamesAA
Description: Table containing final Association Names (AA points) assigned by NatureServe.

Field Name	Field Description	Field Type	Field Width
AACode	Identifier of AA record; assigned by field crew	dbText	255
VegAssocName	Association Name assigned by NatureServe	dbText	255
ELC_Code	Unique ID assigned by NatureServe	dbText	255

Lookup tables

Table Name: tblNCPNPlants
Description: Master look-up table for plant species names and taxonomic information. Derived from ITIS (Integrated Taxonomic Information System)

Field Name	Field Description	Field Type	Field Width
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
FamilyName	Family name of taxon	dbText	255
LatinName	Latin name of taxon	dbText	255
Authority	Authority of Latin name	dbText	255
Synonym	Accepted synonyms of taxon	dbText	255
CommonName	Locally accepted common name for taxon	dbText	255
Exotic	Check yes if species is exotic	dbBoolean	1
Sensitive	check yes if species is threatened, endangered, or sensitive	dbBoolean	1
GrowthHabit	Select GrowthHabit for species -- habit can vary based on region; edit as needed to reflect habit in park	dbText	255
PLANTSCode	Code for taxonomic unit assigned by USDA PLANTS	dbText	255
FullName	temporary field; concatenation of Latin name and authority	dbText	255

Table Name: tlkpAAVegAssociation
Description: Lookup of vegetation association codes (CEGL codes from NatureServe) and vegetation association name.

Field Name	Field Description	Field Type	Field Width
VegAssocCode	Vegetation association code (CEGL code); assigned by NatureServe	dbText	255
VegAssocName	Final vegetation association name; assigned by NatureServe	dbText	255

Table Name: tlkpAAVegAssocRanks
Description: Rank of vegetation association (primary, secondary, tertiary).

Field Name	Field Description	Field Type	Field Width
VegAssocRank	Indicates whether the vegetation association represents a primary, secondary, or tertiary collection by field crews	dbText	255

Table Name: tlkpAlliances
Description: Look-up of provisional community names

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

Table Name: tlkpAssociations
Description: Look-up of association names

Field Name	Field Description	Field Type	Field Width
Associations	Association names from NatureServe classification	dbText	100

Table Name: tlkpCamera
Description: Lookup of Camera make/models used for plot photos.

Field Name	Field Description	Field Type	Field Width
CameraType	Model and make of camera used for photographs of plot	dbText	50
CameraComments	Additional comments on camera, including default focal length	dbText	50

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

Field Name	Field Description	Field Type	Field Width
CoverClass	(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%	dbText	50

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

Field Name	Field Description	Field Type	Field Width
CoverClass	T=<1%, P=1-5%, 1a=6-10%, 1b=11-15%, 02=16-25%, 03=26-35%, 04=36-45%, 05=46-55%, 06=56-65%, 07=66-75%, 08=76-85%, 09=86-95%	dbText	50

Table Name: tlkpCoverObs
Description: Look-up of cover classes assigned to species and strata in tblVegetationDetails for observation points.

Field Name	Field Description	Field Type	Field Width
CoverClass	01=0-10%, 02=10-25%, 03=25-60%, 04=60-100%	dbText	50

Table Name: tlkpCowardin

Description: Look-up of Cowardin system categories for Environment descriptions.

Field Name	Field Description	Field Type	Field Width
CowardinSystem	Cowardin system descriptors for environmental description of plot.	dbText	50

Table Name: tlkpElevSource
Description: Look-up of options for source of elevation data.

Field Name	Field Description	Field Type	Field Width
ElevSource	Source of elevation data entered on field forms	dbText	50

Table Name: tlkpGeology
Description: Look-up of geology types to describe substrate of plot.

Field Name	Field Description	Field Type	Field Width
Geology	Geology types used to describe substrate of plot or observation point	dbText	75

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

Field Name	Field Description	Field Type	Field Width
HeightClass	01<.5m 02=.5-1m 03=1-2m 04=2-5m 05=5-10m 06=10-15m 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	255

Table Name: tlkpLeafPhen
Description: Look-up of phenology types to describe dominant stratum (from VegMapping Manual 04/04.)

Field Name	Field Description	Field Type	Field Width
Phenology	Leaf phenology descriptors to describe dominant stratum	dbText	40

Table Name: tlkpLeafType
Description: Look-up of leaf form of dominant stratum (from VegMapping Manual 04/04)

Field Name	Field Description	Field Type	Field Width
LeafType	Leaf form description of the dominant stratum	dbText	35

Table Name: tlkpObservationType
Description: Lookup table for observation types.

Field Name	Field Description	Field Type	Field Width
ObservationType	Observation types for observation points.	dbText	25

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

Field Name	Field Description	Field Type	Field Width
ParkCode	Four-letter abbreviation for park code	dbText	4
ParkName	Full name of park where data were collected	dbText	50

Table Name: tlkpPhotoComments
Description: Lookup table of photo comments

Field Name	Field Description	Field Type	Field Width
PhotoComments	Photograph comments.	dbText	50

Table Name: tlkpPhotographer
Description: Lookup table of photographer names

Field Name	Field Description	Field Type	Field Width
Photographer	Photographer name.	dbText	50

Table Name: tlkpPhotoTypes
Description: Look-up of types of photos taken during data collection.

Field Name	Field Description	Field Type	Field Width
PhotoType	Type of photo taken, associated with plot.	dbText	50

Table Name: tlkpPhysiogClass
Description: Look-up of physiognomic types to describe each plot or observation point.

Field Name	Field Description	Field Type	Field Width
Physiognom	Physiognomic class used to describe plot	dbText	50

Table Name: tlkpPJAge
Description: Look-up of Pinyon-Juniper age classes

Field Name	Field Description	Field Type	Field Width
PJAgeClass	Pinyon- Juniper age class, if plot contains either of these two species.	dbText	15

Table Name: tlkpPlotDiameter
Description: Look-up of diameters used for circular plots.

Field Name	Field Description	Field Type	Field Width
PlotDiameter	Diameter, in meters, of circular plot	dbText	50

Table Name: tlkpPlotShapes
Description: Look-up of shapes of plots.

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

Table Name: tlkpProvisionalCommunities
Description: Not used for FOBU

Field Name	Field Description	Field Type	Field Width
ID	Not used for FOBU	dbLong	4
NVC Elcode	Not used for FOBU	dbText	255
NVC Association Name	Not used for FOBU	dbText	255
CARE plots	Not used for FOBU	dbDouble	8
COLM plots	Not used for FOBU	dbDouble	8
NABR plots	Not used for FOBU	dbDouble	8
HOVE plots	Not used for FOBU	dbDouble	8

Field Name	Field Description	Field Type	Field Width
ARCH plots	Not used for FOBU	dbDouble	8

Table Name: tlkpSoilDrainage
Description: Look-up of soil drainage classes to describe plot or observation point.

Field Name	Field Description	Field Type	Field Width
SoilDrainage	Soil drainage classes used to describe soil where plot is located	dbText	30

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

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

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

Field Name	Field Description	Field Type	Field Width
StateCode	Two-letter abbreviation for each state	dbText	2
StateName	Full name of each state in the USA	dbText	50

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

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

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

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

Table Name: tlkpStructureStages
Description: Look-up of vegetation structure stages.

Field Name	Field Description	Field Type	Field Width
StructureStage	Standard fuel model classes for forest and woodland trees indicating their position in the canopy	dbText	12

Table Name: tlkpSurveyors
Description: Look-up of teams for FOBU field data collection.

Field Name	Field Description	Field Type	Field Width
SurveyorName	Last names of crew members on each FOBU data collection team.	dbText	75

Table Name: tlkpTopography
Description: Look-up of topographic positions to describe where plot or observation point is located on its related landform.

Field Name	Field Description	Field Type	Field Width
TopoPosition	Topographic positions used to describe where plot or observation point is located on its related landform.	dbText	50

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

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

Table Name: tlkpUTMZone
Description: Look-up for UTM zones of FOBU

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

C.2 Geodatabase Documentation

Background

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

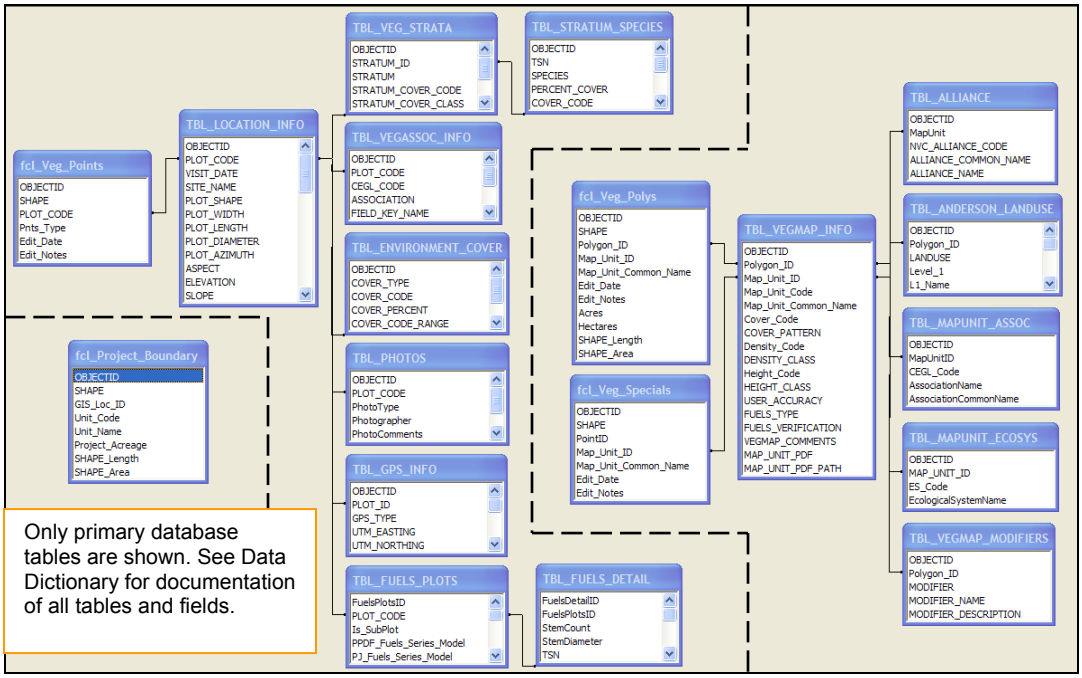


Figure 2. Entity Relationship Diagram for FOBU Geodatabase

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 (FOBU)	dbText	10

Field Name	Field Description	Field Type	Field Width
Unit_Name	Full name of national park (Fossil Butte 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
Acres	Acres per polygon, generated using ArcMap	dbDouble	8
Hectares	Hectares per polygon, generated using ArcMap	dbDouble	8
SHAPE_Length	ESRI generated	dbDouble	8
SHAPE_Area	ESRI generated	dbDouble	8

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

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

Field Name	Field Description	Field Type	Field Width
Edit_Notes	Notes regarding any edits to the point or its attributes	dbText	150

Non-spatial tables

Table Name: TBL_ALLIANCE
Description: Contains the alliances for the vegetation polygons by map unit ID.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MapUnit	The map unit identifier, used by the mappers (aka: grid_code or map class code, usually a number)	dbText	12
NVC_ALLIANCE_CODE	The NVC alliance code	dbText	20
ALLIANCE_COMMON_NAME	NVC alliance common name	dbText	250
ALLIANCE_NAME	NVC alliance latin name	dbText	250

Table Name: TBL_ANDERSON_LANDUSE
Description: Contains the Anderson Landuse classes for the vegetation polygons.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
Polygon_ID	Unique polygon code, used for relating tables (TBL_VEGMAP_INFO)	dbText	20
LANDUSE	The Anderson landuse classes of the polygon (version 1.5, January 2002)	dbDouble	8
Level_1	Anderson landuse code for level one	dbText	255
L1_Name	Anderson landuse name for level one	dbText	255
Level_2	Anderson landuse code for level two	dbText	50
L2_Name	Anderson landuse name for level two	dbText	255
Level_3	Anderson landuse code for level three	dbText	255
L3_Name	Anderson landuse name for level three	dbText	255
Level_4	Anderson landuse code for level four	dbText	255
L4_Name	Anderson landuse name for level four	dbText	255
Level_5	Anderson landuse code for level five	dbText	255
L5_Name	Anderson landuse name for level five	dbText	255
Level_6	Anderson landuse code for level six	dbText	255
L6_Name	Anderson landuse name for level six	dbText	255

Table Name: TBL_ENVIRONMENT_COVER
Description: Contains ground cover data for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
COVER_TYPE	Ground cover type	dbText	30
COVER_CODE	Cover code from field sheet - AA & observation points only	dbText	5
COVER_PERCENT	Field estimate to the nearest percentage of ground cover type (plots only).	dbDouble	8
COVER_CODE_RANGE	Cover code range - for plots with non-integer percentages.	dbText	50

Field Name	Field Description	Field Type	Field Width
COVER_PERCENT_DESC	Description of cover, if "other"	dbText	255
PLOT_CODE	Unique Plot code, used for relating tables	dbText	20

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

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

Table Name: TBL_FORMATION
Description: Contains NVC formation level data for the vegetation polygons.

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

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

Field Name	Field Description	Field Type	Field Width
FuelsDetailID	Unique identifier for record	dbLong	4
FuelsPlotsID	Foreign key to TBL_FUELS_PLOTS	dbLong	4
StemCount	Number of stems measured. Value will be 1 if forest species; >=1 if woodland species.	dbInteger	2
StemDiameter	Diameter in cm of stem(s). If stem count =1 for a forest species, diameter represents dbh. If stem count is >1 for a woodland species, diameter represents the average diameter of all stems measured at crown base.	dbDouble	8
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
Species	Species name	dbText	250
WoodlandCrownWidth	In PJ woodlands, the width of the tree crown at its widest point, in meters to the nearest half-meter	dbDouble	8
WoodlandCrownHeight	In PJ woodlands, distance from the ground to the top of the living tree crown, in meters to the nearest half-meter	dbDouble	8
ForestCrownBaseHeight	In Douglas-fir, ponderosa pine, or other tall tree woodlands, the distance from the ground to the base of the living tree crown, exclusive of dead or single branches, in meters to the nearest half-meter	dbDouble	8
ForestCrownHeight	Same as for woodlands, but for real trees	dbDouble	8
CrownRatio	The ratio of crown height to total tree height.	dbText	12
StructureStage	Describes the place of the tree in the canopy - emergent above the canopy, main canopy, sub canopy, sapling, seedling	dbText	12

Field Name	Field Description	Field Type	Field Width
Comments	General comments regarding the fuels at a specific plot.	dbText	255
PLOT_CODE	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	20

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

Field Name	Field Description	Field Type	Field Width
FuelsPlotsID	Unique identifier for record	dbLong	4
PLOT_CODE	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	20
Is_SubPlot	Indicate if measurements are for subplot (if plot has >25 trees, one quadrant (subplot) of plot can be measured for fuels. “-1” = Yes, “0” = No	dbText	4
PPDF_Fuels_Series_Model	n/a for FOBU	dbText	6
PJ_Fuels_Series_Model	n/a for FOBU	dbText	6
SB_Fuels_Series_Model	n/a for FOBU	dbText	6
PJ_Age_Class	If plot contains pinyon and/or juniper, enter value that best describes the age class of the stand	dbText	50
LitterOrigin	Litter measured in cm at origin of plot	dbText	3
LitterNorth	Litter measured in cm at 10 m north of plot center	dbText	3
LitterSouth	Litter measured in cm at 10 m south of plot center	dbText	3
LitterEast	Litter measured in cm at 10 m east of plot center	dbText	3
LitterWest	Litter measured in cm at 10 m west of plot center	dbText	3
DuffOrigin	Duff measured in cm at origin of plot	dbText	3
DuffNorth	Duff measured in cm at 10 m north of plot center	dbText	3
DuffSouth	Duff measured in cm at 10 m south of plot center	dbText	3
DuffEast	Duff measured in cm at 10 m east of plot center	dbText	3
DuffWest	Duff measured in cm at 10 m west of plot center	dbText	3

Table Name: TBL_GPS_INFO
Description: Contains information about the GPS unit and accuracies of data collected for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
PLOT_ID	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	20
GPS_TYPE	Manufacturer / model of GPS unit (e.g., Garmin Etrex or Trimble XM)	dbText	30
UTM_EASTING	UTM easting of plot	dbDouble	8
UTM_NORTHING	UTM northing of plot	dbDouble	8
UTM_ZONE	UTM zone of coordinates	dbText	3
DATUM	Datum of UTM coordinates (NAD83)	dbText	10
GPS_ERROR	Error, in meters, of location data (based on reading from Garmin GPS unit)	dbText	5
DIFF_CORRECTED	Indicates if coordinates have been differentially corrected (from Garmin screen)	dbText	3
GPS_COMMENTS	Any brief comments on GPS data collection at plot.	dbText	255
GPS_QUALITY	Indicates the quality of the GPS unit used (recreational,	dbText	35

Field Name	Field Description	Field Type	Field Width
	mapping grade)		
PDOP	Positional Dilution Of Precision reading (from Garmin screen)	dbText	30
ERROR_RANGE	General error range, in meters, of the type of GPS unit used.	dbText	20

Table Name: TBL_LOCATION_INFO
Description: Contains data about the location of the point and general observations about the area for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
PLOT_CODE	Unique Plot code, used for relating tables and feature class (fcl_Veg_Points)	dbText	20
VISIT_DATE	Date the location was visited	dbText	10
SITE_NAME	General Site name given by field crew	dbText	180
PLOT_SHAPE	The shape of the area observed as a point	dbText	20
PLOT_WIDTH	The width of the point (plot and obs only)	dbText	3
PLOT_LENGTH	The length of the point (plot and obs only)	dbText	3
PLOT_DIAMETER	The diameter of the point (plot and obs only)	dbText	5
PLOT_AZIMUTH	The azimuth of the point (plot and obs only)	dbText	5
ASPECT	Aspect of plot	dbText	10
ELEVATION	Elevation of plot in meters, generated by GPS unit	dbDouble	8
SLOPE	Slope of plot measured in degrees	dbText	15
TOPO_POSITION	Topographic position of plot	dbText	50
DIRECTIONS_PLOT	Directions to the location of the plot (plot and obs only)	dbText	255
REPRESENTATIVENESS	The representativeness of the vegetation (at plots and obs only)	dbText	255
OBSERVER	The names of the field crew member(s) observing the site.	dbText	50
IN_PARK	Indicates if the point was inside or outside the park boundary (only applicable to Plots and Observation points, all AA pts inside park. “1” = In Park, “0” = Not in park)	dbBoolean	1
UNIT_CODE	4 letter park code (FOBU)	dbText	10
AERIAL_PHOTO_NO	9X9 photo name on which the point most directly falls (2004 flight, plots & obs only)	dbText	30
STATE_CODE	State (WY)	dbText	2
USGS_NAME	USGS 1:24k Topo Name	dbText	75
COUNTY_NAME	County where plot is located (Lincoln County)	dbText	80
PHENOLOGY	Leaf phenology of the dominant stratum. Field is blank for non-vascular plots	dbText	50
PHYSIOGNOMIC_NAME	Physiognomic class of plot	dbText	80
LEAF_TYPE	Leaf form of the dominant stratum.	dbText	80
LEAF_TYPE_COMMENTS	If Leaf Type is "mixed," this field describes the multiple leaf types found in the dominant stratum.	dbText	250
PROVISIONAL_COMM_NAME	Community name (provisional) assigned by field crews by following naming protocols as	dbText	220

Field Name	Field Description	Field Type	Field Width
	described in field manual and training (plot and obs only).		
ALLIANCE	Alliance corresponding to provisional community name (plots and obs only)	dbText	150
PLANT_SPECIES_COMMENTS	Comments about the plant species observed.	dbText	200
COWARDIN_SYSTEM	If the plot is in a wetland system, select term that best describes its hydrology (Upland, Palustrine, Riverine, Lacustrine). plot and obs only	dbText	40
HYDROLOGY	Describes hydrology of plot (plot and obs only)	dbText	40
GEOLOGY	Geologic substrate influencing the plant community (plot and obs only); Surficial geology (AA points)	dbText	60
ENV_COMMENTS	Comments on environmental setting and its effect on the vegetation; also comments on any disturbance or reproduction factors	dbText	255
LANDSCAPE_COMMENTS	Description of landscape context of plot, including any important landscape features influencing the community (plot and obs only)	dbText	255
ANIMAL_USE_COMMENTS	Comments on evidence of use by non-domestic animals in plot area (plot and obs only)	dbText	255
DISTURBANCE_COMMENTS	Comments on evidence of natural or anthropogenic disturbance in plot area, severity and effects on vegetation (plot and obs only)	dbText	255
OTHER_COMMENTS	Other general comments (plot and obs only)	dbText	255
SOIL_TEXTURE	Assessment of average soil texture from sample taken a few inches below the surface (plot and obs only)	dbText	50
SOIL_DRAINAGE	Soil drainage class based on actual moisture content and extent period (plot and obs only)	dbText	30
SOIL_TAXON_DESC	Field used for either identifying soils keyed, or to describe if large rocks or outcrops are present on the surface (plot and obs only)	dbText	255

Table Name: TBL_MAPUNIT_ASSOC
Description: Contains association data for the vegetation polygons by map unit ID.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MapUnitID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	20
CEGL_Code	NVC association code	dbText	18
AssociationName	The NVC Association name (scientific)	dbText	250
AssociationCommonName	The NVC Association Common name	dbText	250

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

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MAP_UNIT_ID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10

Field Name	Field Description	Field Type	Field Width
ES_Code	Ecological System code	dbText	30
EcologicalSystemName	Ecological system name (mid-scale classification, larger than associations or alliances, smaller than ecoregions).	dbText	255

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

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
PLOT_CODE	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	50
PhotoType	Type of photo being referenced.	dbText	16
Photographer	Name of photographer.	dbText	50
PhotoComments	Brief description of photo.	dbText	255
IMAGE_ID	NCPN Photo Database (unique) file name.	dbText	50
PHOTO_PATH	Hard-coded path name to photos (update this field)	dbText	200

Table Name: TBL_STRATUM_SPECIES
Description: Contains species level data by stratum.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
SPECIES	Latin names of species	dbText	255
PERCENT_COVER	Applicable to AA data only, percent cover by species	dbText	4
COVER_CODE	Cover class code to describe species and strata	dbText	5
COVER_CLASS	Cover class to describe species and strata	dbText	50
DIAGNOSTIC	Check yes if the species is known to be diagnostic of the vegetation type.	dbInteger	2
SPECIMEN_COLLECTED	"yes" (-1) if a specimen of the species was collected.	dbInteger	2
SPECIMEN_NO	The collector's reference number for the specimen collected.	dbText	10
DEAD	Percent cover of dead species seen at plot. Not completed of every species, but always done if diagnostic species.	dbInteger	2
STRATUM_ID	Unique ID, relates to TBL_VEG_STRATA	dbLong	4

Table Name: TBL_VEG_STRATA
Description: Contains stratum data for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
STRATUM_ID	Links to strata	dbLong	4
STRATUM	Stratum name/type	dbText	20
STRATUM_COVER_CODE	stratum cover code	dbText	5
STRATUM_COVER_CLASS	stratum percentage cover class	dbText	50
STRATUM_HEIGHT_CODE	stratum height code	dbText	5
STRATUM_HEIGHT_CLASS	stratum height class in meters	dbText	50
PLOT_CODE	Unique Plot code, used for relating tables (TBL_STRATUM_SPECIES)	dbText	15

Table Name: TBL_VEGASSOC_INFO
Description: Contains association data for all points (plots, obs, and AA points) in the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
PLOT_CODE	Unique Plot code, used for relating tables	dbText	35
CEGL_CODE	CEGL (association) code	dbText	10
ASSOCIATION	Association corresponding to provisional community name	dbText	180
FIELD_KEY_NAME	Yes if association name was chosen from field key	dbText	10
CREATED_NAME	Yes if no name really fits from the field key, the surveyor will create a new name.	dbText	10
POST_AA_FIELD_NAME	Yes if association name was assigned after AA field work, based on species lists and comments fields -- during AA meetings.	dbText	10
ASSOC_RANK	Rank of vegetation association (primary, secondary, tertiary)	dbText	50
OTHER_ASSOC_50M	Other associations noted in a 50meter area beyond plot	dbText	200

Table Name: TBL_VEGMAP_INFO
Description: Contains map unit level data for each vegetation map unit polygon.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
Polygon_ID	Unique polygon code, used for relating tables and feature classes (fcl_Veg_polys)	dbText	30
Map_Unit_ID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10
Map_Unit_Code	NCPN code (e.g., S-BBSA)	dbText	10
Map_Unit_Common_Name	The name of the map unit (or map class)	dbText	250
Cover_Code	n/a for FOBU	dbText	1
COVER_PATTERN	n/a for FOBU	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	n/a for FOBU	dbText	1
HEIGHT_CLASS	n/a for FOBU	dbText	100
USER_ACCURACY	User accuracy of the map unit (determined during AA meetings). N/A means the class was not accuracy assessed.	dbText	3
FUELS_TYPE	Fuels vegetation types (if applicable)	dbText	50
FUELS_VERIFICATION	Fuels verification (if applicable)	dbText	255
VEGMAP_COMMENTS	Any comments about the particular polygon or map class.	dbText	255
MAP_UNIT_PDF	File name of pdf describing map unit (class)	dbText	50
MAP_UNIT_PDF_PATH	Hard-coded link to Map Unit description PDF document - path name (e.g. C:/FOBU/Vegetation/MapClassDescriptions/S-BBSA_mu15.pdf)	dbText	250

Table Name: TBL_VEGMAP_MODIFIERS
Description: Contains modifiers for the vegetation map unit polygons.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
Polygon_ID	Unique polygon code, used for relating tables (TBL_VEGMAP_INFO)	dbText	20
MODIFIER	Modifier code (one lower case letter)	dbText	12
MODIFIER_NAME	Name/type of modifier	dbText	50
MODIFIER_DESCRIPTION	Description of modifier	dbText	255

Appendix D
Plant Species List and Crosswalk

Three hundred thirty-three vascular plant species representing 48 families were identified during plot, observation point and accuracy assessment point data collection at Fossil Butte National Monument (FOBU). The Northern Colorado Plateau Network uses three taxonomic authorities for vascular plants: Welsh et al. 2003 as the nomenclatural authority for Utah parks, Weber and Wittmann 2001 for Colorado parks, and Nelson and Hartman 1997 for FOBU; the FOBU vegetation mapping project database reflects scientific names as assigned by Nelson and Hartman 1997 with a few names from Dorn and Lichvar 1984. 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 FOBU 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.

Family	Scientific (Nelson and Hartman 1997)	Scientific Name (Kartesz 1999)	Common_Name	TSN
Aceraceae	*Acer glabrum* Torr.	*Acer glabrum*	Rocky Mountain maple	28742
Amaranthaceae	*Amaranthus albus* L.	*Amaranthus albus*	prostrate pigweed	20719
Apiaceae	*Angelica* L.	*Angelica*	angelica	29431
	Cymopterus Raf.	*Cymopterus*	springparsley	29625
	Cymopterus acaulis (Pursh) Raf.	*Cymopterus acaulis*	plains springparsley	29628
	Cymopterus lemmonii (Coult. & Rose) Dorn	*Pseudocymopterus montanus*	alpine false springparsley	29837
	Cymopterus terebinthinus (Hook.) Torr. & Gray	*Pteryxia terebinthina*	turpentine wavewing	511934
	Ligusticum filicinum S. Wats.	*Ligusticum filicinum*	fernleaf licorice-root	29530
	Ligusticum porteri Coult. & Rose	*Ligusticum porteri*	Porter's licorice-root	29532
	Lomatium Raf.	*Lomatium*	desertparsley	29677
	Osmorhiza chilensis Hook. & Arn.	*Osmorhiza berteroi*	sweetcicely	507093
	Perideridia montana (Blank.) Dorn	*Perideridia gairdneri* ssp. *borealis*	common yampah	518708
Apocynaceae	*Apocynum androsaemifolium* L.	*Apocynum androsaemifolium*	spreading dogbane	30156
Asteraceae	*Achillea millefolium* L.	*Achillea millefolium*	common yarrow	35423
	Agoseris Raf.	*Agoseris*	agoseris	36485
	Agoseris glauca (Pursh) Raf.	*Agoseris glauca*	pale agoseris	36490
	Antennaria Gaertn.	*Antennaria*	pussytoes	36716
	Antennaria dimorpha (Nutt.) Torr. & Gray	*Antennaria dimorpha*	low pussytoes	36727
	Antennaria microphylla Rydb.	*Antennaria microphylla*	littleleaf pussytoes	185162
	Antennaria rosea Greene	*Antennaria rosea*	rosy pussytoes	36754
	Arnica L.	*Arnica*	arnica	36554
	Arnica cordifolia Hook.	*Arnica cordifolia*	heartleaf arnica	36561
	Arnica sororia Greene	*Arnica sororia*	twin arnica	36576
	Artemisia arbuscula Nutt. var. *longiloba* (Osterh.) Dorn	*Artemisia arbuscula* ssp. *longiloba*	little sagebrush	183725
	Artemisia cana Pursh	*Artemisia cana*	silver sagebrush	35454
	Artemisia dracunculus L.	*Artemisia dracunculus*	tarragon	35462
	Artemisia frigida Willd.	*Artemisia frigida*	prairie sagewort	35465
	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	519062
	Artemisia tridentata Nutt. var. *tridentata*	*Artemisia tridentata* ssp. *tridentata*	basin big sagebrush	35499
	Artemisia tridentata Nutt. var. *vaseyana* (Rydb.) Boiv.	*Artemisia tridentata* ssp. *vaseyana*	mountain big sagebrush	183740
	Artemisia tridentata Nutt. var. *wyomingensis* (Beetle & Young) Welsh	*Artemisia tridentata* ssp. *wyomingensis*	Wyoming big sagebrush	183741
	Artemisia tripartita Rydb.	*Artemisia tripartita*	threetip sagebrush	35502

Family	Scientific (Nelson and Hartman 1997)	Scientific Name (Kartesz 1999)	Common_Name	TSN
Asteraceae	*Aster* L.	*Aster*	aster	35510
	Aster foliaceus Lindl. ex DC.	*Symphyotrichum foliaceum*	alpine leafybract aster	193197
	Aster glaucodes Blake	*Eurybia glauca*	gray aster	513443
	Balsamorhiza sagittata (Pursh) Nutt.	*Balsamorhiza sagittata*	arrowleaf balsamroot	36818
	Carduus nutans L.	*Carduus nutans*	nodding plumeless thistle	35787
	Chaenactis douglasii (Hook.) Hook. & Arn.	*Chaenactis douglasii*	Douglas' dustymaiden	36987
	Chaenactis stevioides Hook. & Arn.	*Chaenactis stevioides*	Steve's dustymaiden	36998
	Chrysothamnus nauseosus (Pallas ex Pursh) Britt.	*Ericameria nauseosa*	rubber rabbitbrush	37055
	Chrysothamnus viscidiflorus (Hook.) Nutt.	*Chrysothamnus viscidiflorus*	yellow rabbitbrush	37090
	Cirsium P. Mill.	*Cirsium*	thistle	36334
	Cirsium arvense (L.) Scop.	*Cirsium arvense*	Canada thistle	36335
	Cirsium scariosum Nutt.	*Cirsium scariosum*	meadow thistle	36413
	Cirsium undulatum (Nutt.) Spreng.	*Cirsium undulatum*	wavyleaf thistle	36423
	Crepis L.	*Crepis*	hawksbeard	37168
	Crepis acuminata Nutt.	*Crepis acuminata*	tapertip hawksbeard	37169
	Crepis intermedia Gray	*Crepis intermedia*	limestone hawksbeard	37185
	Crepis occidentalis Nutt.	*Crepis occidentalis*	largeflower hawksbeard	37196
	Erigeron L.	*Erigeron*	fleabane	35803
	Erigeron concinnus (Hook. & Arn.) Torr. & Gray	*Erigeron concinnus*	Navajo fleabane	502385
	Erigeron glabellus Nutt.	*Erigeron glabellus*	streamside fleabane	35873
	Erigeron nanus Nutt.	*Erigeron nanus*	dwarf fleabane	35908
	Erigeron speciosus (Lindl.) DC.	*Erigeron speciosus*	aspen fleabane	35950
	Gutierrezia sarothrae (Pursh) Britt. & Rusby	*Gutierrezia sarothrae*	broom snakeweed	37483
	Haplopappus acaulis (Nutt.) Gray	*Stenotus acaulis*	stemless mock goldenweed	37499
	Haplopappus nuttallii Torr. & Gray	*Machaeranthera grindelioides*	rayless tansyaster	514438
	Helianthella uniflora (Nutt.) Torr. & Gray	*Helianthella uniflora*	oneflower helianthella	37598
	Hymenoxys acaulis (Pursh) Parker	*Tetraneuris acaulis*	stemless four-nerve daisy	514991
	Iva axillaris Pursh	*Iva axillaris*	povertyweed	36033
	Lactuca serriola L.	*Lactuca serriola*	prickly lettuce	36608
	Machaeranthera Nees	*Machaeranthera*	tansyaster	37970
	Machaeranthera canescens (Pursh) Gray	*Machaeranthera canescens*	hoary tansyaster	37984
	Machaeranthera grindelioides (Nutt.) Shinners	*Machaeranthera grindelioides*	rayless tansyaster	37992
	Pyrrocoma lanceolata (Hook.) Greene	*Pyrrocoma lanceolata*	lanceleaf goldenweed	37533
	Senecio L.	*Senecio*	ragwort	36084
	Senecio canus Hook.	*Packera cana*	woolly groundsel	518142
	Senecio integerrimus Nutt.	*Senecio integerrimus*	lambstongue ragwort	36148

Family	Scientific (Nelson and Hartman 1997)	Scientific Name (Kartesz 1999)	Common_Name	TSN
Asteraceae	*Senecio multilobatus* Torr. & Gray ex Gray	*Packera multilobata*	lobeleaf groundsel	518150
	Senecio serra Hook.	*Senecio serra*	tall ragwort	36182
	Solidago L.	*Solidago*	goldenrod	36223
	Solidago canadensis L.	*Solidago canadensis*	Canada goldenrod	36224
	Solidago sparsiflora Gray	*Solidago velutina*	threenerve goldenrod	505290
	Taraxacum officinale G.H. Weber ex Wiggers	*Taraxacum officinale*	common dandelion	36213
	Tetradymia canescens DC.	*Tetradymia canescens*	spineless horsebrush	38494
	Tetradymia spinosa Hook. & Arn.	*Tetradymia spinosa*	shortspine horsebrush	38499
	Townsendia nuttallii Dorn	*Townsendia nuttallii*	Nuttall's Townsend daisy	38553
	Tragopogon dubius Scop.	*Tragopogon dubius*	yellow salsify	38564
	Wyethia amplexicaulis (Nutt.) Nutt.	*Wyethia amplexicaulis*	mule-ears	38674
Berberidaceae	*Mahonia repens* (Lindl.) G. Don	*Mahonia repens*	creeping barberry	195045
Boraginaceae	*Cryptantha* Lehm. ex G. Don	*Cryptantha*	cryptantha	31765
	Cryptantha caespitosa (A. Nels.) Payson	*Cryptantha caespitosa*	tufted cryptantha	31790
	Cryptantha cinerea (Greene) Cronq.	*Cryptantha cinerea*	James' cryptantha	501822
	Hackelia patens (Nutt.) I.M. Johnston	*Hackelia patens*	spotted stickseed	31916
	Lappula redowskii auct. non (Hornem.) Greene	*Lappula occidentalis* var. *occidentalis*	flatspine stickseed	32046
	Lithospermum L.	*Lithospermum*	stoneseed	31937
	Lithospermum ruderale Dougl. ex Lehm.	*Lithospermum ruderale*	western stoneseed	31953
	Mertensia ciliata (James ex Torr.) G. Don	*Mertensia ciliata*	tall fringed bluebells	31668
	Mertensia oblongifolia (Nutt.) G. Don	*Mertensia oblongifolia*	oblongleaf bluebells	31683
	Plagiobothrys scouleri (Hook. & Arn.) I.M. Johnston	*Plagiobothrys scouleri*	Scouler's popcornflower	32016
Brassicaceae	*Alyssum desertorum* Stapf	*Alyssum desertorum*	desert madwort	23032
	Arabis L.	*Arabis*	rockcress	22671
	Arabis drummondii Gray	*Arabis drummondii*	Drummond's rockcress	22689
	Arabis holboellii Hornem.	*Arabis holboellii*	Holboell's rockcress	22702
	Chorispora tenella (Pallas) DC.	*Chorispora tenella*	crossflower	23099
	Descurainia Webb & Berth.	*Descurainia*	tansymustard	22819
	Descurainia pinnata (Walt.) Britt.	*Descurainia pinnata*	western tansymustard	22826
	Descurainia sophia (L.) Webb ex Prantl	*Descurainia sophia*	herb sophia	22843
	Erysimum capitatum (Dougl. ex Hook.) Greene	*Erysimum capitatum*	sanddune wallflower	22932
	Lepidium L.	*Lepidium*	pepperweed	22953
	Lepidium montanum var. *integrifolium* (Nutt.) C.L. Hitchc.	*Lepidium integrifolium*	thickleaf pepperweed	503378
	Lepidium perfoliatum L.	*Lepidium perfoliatum*	clasping pepperweed	22974

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Brassicaceae	*Lepidium virginicum* L.	*Lepidium virginicum*	Virginia pepperweed	22955
	Lesquerella alpina (Nutt.) S. Wats.	*Lesquerella alpina*	alpine bladderpod	23163
	Physaria (Nutt. ex Torr. & Gray) Gray	*Physaria*	twinpod	23269
	Physaria acutifolia Rydb.	*Physaria acutifolia*	sharpleaf twinpod	23270
	Physaria condensata Rollins	*Physaria condensata*	tufted twinpod	23276
	Schoenocrambe linifolia (Nutt.) Greene	*Schoenocrambe linifolia*	flaxleaf plainsmustard	23296
	Stanleya viridiflora Nutt.	*Stanleya viridiflora*	green princesplume	23331
	Streptanthus cordatus Nutt.	*Streptanthus cordatus*	heartleaf twistflower	23348
	Thelypodium Endl.	*Thelypodium*	thelypody	23392
	Thelypodium integrifolium (Nutt.) Endl. ex Walp.	*Thelypodium integrifolium*	entireleaved thelypody	23398
	Thelypodium paniculatum A. Nels.	*Thelypodium paniculatum*	northwestern thelypody	23407
	Thlaspi arvense L.	*Thlaspi arvense*	field pennycress	23422
Caprifoliaceae	*Lonicera involucrata* Banks ex Spreng.	*Lonicera involucrata*	twinberry honeysuckle	35297
	Symphoricarpos Duham.	*Symphoricarpos*	snowberry	35330
	Symphoricarpos occidentalis Hook.	*Symphoricarpos occidentalis*	western snowberry	35336
	Symphoricarpos oreophilus Gray	*Symphoricarpos oreophilus*	mountain snowberry	35338
Caryophyllaceae	*Arenaria* L.	*Arenaria*	sandwort	20235
	Arenaria fendleri Gray	*Arenaria fendleri*	Fendler's sandwort	20245
	Arenaria hookeri Nutt.	*Arenaria hookeri*	Hooker's sandwort	20247
	Arenaria kingii (S. Wats.) M.E. Jones	*Arenaria kingii*	King's sandwort	20252
	Cerastium arvense L.	*Cerastium arvense*	field chickweed	19947
	Minuartia nuttallii (Pax) Briq.	*Minuartia nuttallii*	Nuttall's sandwort	509066
	Silene L.	*Silene*	catchfly	20040
	Stellaria longipes Goldie	*Stellaria longipes*	longstalk starwort	20168
Celastraceae	*Paxistima myrsinites* (Pursh) Raf.	*Paxistima myrsinites*	Oregon boxleaf	504149
Chenopodiaceae	*Atriplex confertifolia* (Torr. & Frém.) S. Wats.	*Atriplex confertifolia*	shadscale saltbush	20519
	Atriplex gardneri (Moq.) D. Dietr.	*Atriplex gardneri*	Gardner's saltbush	20531
	Chenopodium L.	*Chenopodium*	goosefoot	20589
	Chenopodium leptophyllum (Moq.) Nutt. ex S. Wats.	*Chenopodium leptophyllum*	narrowleaf goosefoot	20616
	Halogeton glomeratus (Bieb.) C.A. Mey.	*Halogeton glomeratus*	saltlover	20692
	Kochia scoparia (L.) Schrad.	*Bassia scoparia*	Mexican-fireweed	20696
	Krascheninnikovia lanata (Pursh) A.D.J. Meeuse & Smit	*Krascheninnikovia lanata*	winterfat	503290
	Salsola australis R. Br.	*Salsola tragus*	prickly Russian thistle	520950
	Sarcobatus vermiculatus (Hook.) Torr.	*Sarcobatus vermiculatus*	greasewood	20707
Cornaceae	*Cornus sericea* L.	*Cornus sericea*	redosier dogwood	501637
Crassulaceae	*Sedum lanceolatum* Torr.	*Sedum lanceolatum*	spearleaf stonecrop	24126
Cupressaceae	*Juniperus scopulorum* Sarg.	*Juniperus scopulorum*	Rocky Mountain juniper	194872
Cyperaceae	*Carex* L.	*Carex*	sedge	39369

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	Carex athrostachya Olney	*Carex athrostachya*	slenderbeak sedge	501205
Cyperaceae	*Carex filifolia* Nutt.	*Carex filifolia*	threadleaf sedge	39600
	Carex geyeri Boott	*Carex geyeri*	Geyer's sedge	39613
	Carex microptera Mackenzie	*Carex microptera*	smallwing sedge	39699
	Carex nebrascensis Dewey	*Carex nebrascensis*	Nebraska sedge	39711
	Carex petasata Dewey	*Carex petasata*	Liddon sedge	39751
	Carex praegracilis W. Boott	*Carex praegracilis*	clustered field sedge	39767
	Carex rostrata Stokes	*Carex utriculata*	Northwest Territory sedge	501288
	Eleocharis palustris (L.) Roemer & J.A. Schultes	*Eleocharis palustris*	common spikerush	40019
Elaeagnaceae	*Shepherdia canadensis* (L.) Nutt.	*Shepherdia canadensis*	russet buffaloberry	27779
Ericaceae	*Arctostaphylos uva-ursi* (L.) Spreng.	*Arctostaphylos uva-ursi*	kinnikinnick	23530
Fabaceae	*Astragalus* L.	*Astragalus*	milkvetch	25392
	Astragalus agrestis Dougl. ex G. Don	*Astragalus agrestis*	purple milkvetch	25405
	Astragalus bisulcatus (Hook.) Gray	*Astragalus bisulcatus*	twogrooved milkvetch	25438
	Astragalus jejunus S. Wats.	*Astragalus jejunus*	starveling milkvetch	25551
	Astragalus kentrophyta Gray	*Astragalus kentrophyta*	spiny milkvetch	25553
	Astragalus lentiginosus Dougl. ex Hook.	*Astragalus lentiginosus*	freckled milkvetch	25559
	Astragalus purshii Dougl. ex Hook.	*Astragalus purshii*	woollypod milkvetch	25648
	Astragalus spatulatus Sheldon	*Astragalus spatulatus*	tufted milkvetch	25687
	Astragalus tenellus Pursh	*Astragalus tenellus*	looseflower milkvetch	25696
	Astragalus vexilliflexus Sheldon	*Astragalus vexilliflexus*	bentflower milkvetch	25719
	Hedysarum boreale Nutt.	*Hedysarum boreale*	boreal sweetvetch	26724
	Lupinus L.	*Lupinus*	lupine	25916
	Lupinus argenteus Pursh	*Lupinus argenteus*	silvery lupine	503575
	Lupinus leucophyllus Dougl. ex Lindl.	*Lupinus leucophyllus*	velvet lupine	26049
	Lupinus sericeus Pursh	*Lupinus sericeus*	silky lupine	26112
	Medicago sativa L.	*Medicago sativa*	alfalfa	183623
	Melilotus officinalis (L.) Lam.	*Melilotus officinalis*	yellow sweetclover	26150
	Oxytropis sericea Nutt.	*Oxytropis sericea*	white locoweed	26182
	Trifolium gymnocarpon Nutt.	*Trifolium gymnocarpon*	hollyleaf clover	26255
Gentianaceae	*Frasera speciosa* Dougl. ex Griseb.	*Frasera speciosa*	elkweed	502660
Geraniaceae	*Geranium richardsonii* Fisch. & Trautv.	*Geranium richardsonii*	Richardson's geranium	29118
	Geranium viscosissimum Fisch. & C.A. Mey. ex C.A. Mey.	*Geranium viscosissimum*	sticky purple geranium	29125
Grossulariaceae	*Ribes cereum* Dougl.	*Ribes cereum*	wax currant	24457
	Ribes inerme Rydb.	*Ribes inerme*	whitestem gooseberry	24473
	Ribes viscosissimum Pursh	*Ribes viscosissimum*	sticky currant	24510
Hydrophyllaceae	*Hydrophyllum capitatum* Dougl. ex Benth.	*Hydrophyllum capitatum*	ballhead waterleaf	31391

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Hydrophyllaceae	*Hydrophyllum fendleri* (Gray) Heller	*Hydrophyllum fendleri*	Fendler's waterleaf	31392
	Phacelia sericea (Graham ex Hook.) Gray	*Phacelia sericea*	silky phacelia	31592
Iridaceae	*Sisyrinchium montanum* Greene	*Sisyrinchium montanum*	strict blue-eyed grass	43269
Juncaceae	*Juncus balticus* Willd.	*Juncus balticus*	Baltic rush	39223
	Juncus longistylis Torr.	*Juncus longistylis*	longstyle rush	503256
Lamiaceae	*Agastache urticifolia* (Benth.) Kuntze	*Agastache urticifolia*	nettleleaf giant hyssop	32450
Liliaceae	*Allium* L.	*Allium*	onion	42634
	Allium geyeri S. Wats.	*Allium geyeri*	Geyer's onion	42643
	Allium textile A. Nels. & J.F. Macbr.	*Allium textile*	textile onion	42670
	Calochortus nuttallii Torr. & Gray	*Calochortus nuttallii*	sego lily	42863
	Camassia quamash (Pursh) Greene	*Camassia quamash*	small camas	42883
	Fritillaria pudica (Pursh) Spreng.	*Fritillaria pudica*	yellow fritillary	42936
	Maianthemum stellatum (L.) Link	*Maianthemum stellatum*	starry false lily of the vally	503656
	Zigadenus paniculatus (Nutt.) S. Wats.	*Zigadenus paniculatus*	foothill deathcamas	43167
	Zigadenus venenosus S. Wats.	*Zigadenus venenosus*	meadow deathcamas	43168
Linaceae	*Linum lewisii* Pursh	*Linum lewisii*	prairie flax	29214
Loasaceae	*Mentzelia laevicaulis* (Dougl. ex Hook.) Torr. & Gray	*Mentzelia laevicaulis*	smoothstem blazingstar	503779
Malvaceae	*Sidalcea oregana* (Nutt. ex Torr. & Gray) Gray	*Sidalcea oregana*	Oregon checkerbloom	21895
Onagraceae	*Epilobium* L.	*Epilobium*	willowherb	27280
	Epilobium anagallidifolium Lam.	*Epilobium anagallidifolium*	pimpernel willowherb	27283
	Epilobium angustifolium L.	*Chamerion angustifolium*	fireweed	27284
	Gayophytum ramosissimum Torr. & Gray	*Gayophytum ramosissimum*	pinyon groundsmoke	27679
	Oenothera cespitosa Nutt. [orthographic variant]	*Oenothera caespitosa*	tufted evening-primrose	565328
	Oenothera pallida Lindl.	*Oenothera pallida*	pale evening-primrose	27436
Orchidaceae	*Corallorrhiza* Gagnebin	*Corallorhiza*	coralroot	43522
	Corallorrhiza striata Lindl.	*Corallorhiza striata*	hooded coralroot	43526
Pinaceae	*Pinus flexilis* James	*Pinus flexilis*	limber pine	183343
	Pseudotsuga menziesii (Mirbel) Franco	*Pseudotsuga menziesii*	Douglas-fir	183424
Plantaginaceae	*Plantago* L.	*Plantago*	plantain	32870
	Plantago tweedyi Gray	*Plantago tweedyi*	Tweedy's plantain	32894
Poaceae	*Agropyron cristatum* (L.) Gaertn.	*Agropyron cristatum*	crested wheatgrass	182478
	Agropyron intermedium (Host) Beauv.	*Thinopyrum intermedium*	intermediate wheatgrass	522540
	Alopecurus pratensis L.	*Alopecurus pratensis*	meadow foxtail	40438
	Bromus L.	*Bromus*	brome	40478
	Bromus anomalus Rupr. ex Fourn.	*Bromus porteri*	Porter brome	40491
	Bromus carinatus Hook. & Arn.	*Bromus carinatus*	California brome	40481
	Bromus inermis Leyss.	*Bromus inermis*	smooth brome	40502
	Bromus tectorum L.	*Bromus tectorum*	cheatgrass	40524

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Poaceae	*Calamagrostis canadensis* (Michx.) Beauv.	*Calamagrostis canadensis*	bluejoint	40544
	Deschampsia cespitosa (L.) Beauv.	*Deschampsia cespitosa*	tufted hairgrass	40586
	Distichlis spicata var.*stricta* (Torr.) Scribn.	*Distichlis spicata*	inland saltgrass	40662
	Elymus cinereus Scribn. & Merr.	*Leymus cinereus*	basin wildrye	503433
	Elymus elymoides (Raf.) Swezey	*Elymus elymoides*	squirreltail	502264
	Elymus hispidus (Opiz) Melderis	*Thinopyrum intermedium*	intermediate wheatgrass	522540
	Elymus lanceolatus (Scribn. & J.G. Sm.) Gould	*Elymus lanceolatus*	streambank wheatgrass	502267
	Elymus smithii (Rydb.) Gould	*Pascopyrum smithii*	western wheatgrass	504124
	Elymus spicatus (Pursh) Gould	*Pseudoroegneria spicata*	bluebunch wheatgrass	512845
	Elymus trachycaulus (Link) Gould ex Shinners	*Elymus trachycaulus*	slender wheatgrass	502282
	Festuca idahoensis Elmer	*Festuca idahoensis*	Idaho fescue	40816
	Glyceria striata (Lam.) A.S. Hitchc.	*Glyceria striata*	fowl mannagrass	40833
	Hordeum brachyantherum Nevski	*Hordeum brachyantherum*	meadow barley	40875
	Koeleria macrantha (Ledeb.) J.A. Schultes	*Koeleria macrantha*	prairie Junegrass	503284
	Leucopoa kingii (S. Wats.) W.A. Weber	*Leucopoa kingii*	spike fescue	41832
	Melica bulbosa Geyer ex Porter & Coult.	*Melica bulbosa*	oniongrass	41851
	Muhlenbergia richardsonis (Trin.) Rydb.	*Muhlenbergia richardsonis*	mat muhly	41938
	Oryzopsis hymenoides (Roemer & J.A. Schultes) Ricker ex Piper	*Achnatherum hymenoides*	Indian ricegrass	507943
	Phleum alpinum L.	*Phleum alpinum*	alpine timothy	41063
	Phleum pratense L.	*Phleum pratense*	timothy	41062
	Poa L.	*Poa*	bluegrass	41074
	Poa cusickii Vasey	*Poa cusickii*	Cusick's bluegrass	41121
	Poa fendleriana (Steud.) Vasey	*Poa fendleriana*	muttongrass	504467
	Poa glauca Vahl	*Poa glauca*	glaucous bluegrass	41084
	Poa glaucifolia Scribn. & Williams ex Williams	*Poa arida*	plains bluegrass	41109
	Poa juncifolia Scribn.	*Poa secunda*	Sandberg bluegrass	41103
	Poa pratensis L.	*Poa pratensis*	Kentucky bluegrass	41088
	Poa secunda J. Presl	*Poa secunda*	Sandberg bluegrass	41103
	Stipa L.	*obsolete*	needlegrass	42158
	Stipa comata Trin. & Rupr.	*Hesperostipa comata*	needle and thread	42172
	Stipa lettermanii Vasey	*Achnatherum lettermanii*	Letterman's needlegrass	507946
	Stipa nelsonii Scribn.	*Achnatherum nelsonii*	Columbia needlegrass	42182
	Stipa pinetorum M.E. Jones	*Achnatherum pinetorum*	pine needlegrass	507954
Polemoniaceae	*Ipomopsis aggregata* (Pursh) V. Grant	*Ipomopsis aggregata*	scarlet gilia	31192
	Ipomopsis congesta (Hook.) V. Grant	*Ipomopsis congesta*	ballhead ipomopsis	31202
	Leptodactylon pungens (Torr.) Torr. ex Nutt.	*Leptodactylon pungens*	granite prickly phlox	31233
	Navarretia breweri (Gray) Greene	*Navarretia breweri*	Brewer's navarretia	31325
	Phlox L.	*Phlox*	phlox	30897

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Polemoniaceae	*Phlox caespitosa* Nutt.	*Phlox caespitosa*	tufted phlox	30920
	Phlox hoodii Richards.	*Phlox hoodii*	spiny phlox	30948
	Phlox longifolia Nutt.	*Phlox longifolia*	longleaf phlox	30956
	Phlox multiflora A. Nels.	*Phlox multiflora*	flowery phlox	30964
Polygonaceae	*Eriogonum* Michx.	*Eriogonum*	buckwheat	21054
	Eriogonum brevicaule Nutt.	*Eriogonum brevicaule*	shortstem buckwheat	21084
	Eriogonum caespitosum Nutt.	*Eriogonum caespitosum*	matted buckwheat	21086
	Eriogonum cernuum Nutt.	*Eriogonum cernuum*	nodding buckwheat	21090
	Eriogonum flavum Nutt.	*Eriogonum flavum*	alpine golden buckwheat	21134
	Eriogonum heracleoides Nutt.	*Eriogonum heracleoides*	parsnipflower buckwheat	21150
	Eriogonum microthecum Nutt.	*Eriogonum microthecum*	slender buckwheat	21192
	Eriogonum ovalifolium Nutt.	*Eriogonum ovalifolium*	cushion buckwheat	21212
	Eriogonum umbellatum Torr.	*Eriogonum umbellatum*	sulphur-flower buckwheat	21266
	Eriogonum umbellatum Torr. ssp. subaridum (S. Stokes) Munz	*Eriogonum umbellatum var. subaridum*	sulphur-flower buckwheat	195621
	Polygonum bistortoides Pursh	*Polygonum bistortoides*	American bistort	20879
	Rumex L.	*Rumex*	dock	20933
	Rumex crispus L.	*Rumex crispus*	curly dock	20937
	Rumex salicifolius Weinm.	*Rumex salicifolius*	willow dock	20974
Portulacaceae	*Talinum parviflorum* Nutt.	*Talinum parviflorum*	fameflower pygmyflower	20443
Primulaceae	*Androsace septentrionalis* L.	*Androsace septentrionalis*	rockjasmine	23935
	Dodecatheon pulchellum (Raf.) Merr.	*Dodecatheon pulchellum*	darkthroat shootingstar	23945
	Glaux maritima L.	*Glaux maritima*	sea milkwort	23982
Ranunculaceae	*Aquilegia coerulea* James	*Aquilegia caerulea*	Colorado blue columbine	565004
	Clematis hirsutissima Pursh	*Clematis hirsutissima*	hairy clematis	18699
	Delphinium L.	*Delphinium*	larkspur	18457
	Delphinium nuttallianum Pritz. ex Walp.	*Delphinium nuttallianum*	twolobe larkspur	18483
	Ranunculus testiculatus Crantz	*Ceratocephala testiculata*	curveseed butterwort	501365
	Thalictrum L.	*Thalictrum*	meadow-rue	18658
	Thalictrum fendleri Engelm. ex Gray	*Thalictrum fendleri*	Fendler's meadow-rue	18670
	Thalictrum venulosum Trel.	*Thalictrum venulosum*	veiny meadow-rue	18684
Rhamnaceae	*Ceanothus martinii* M.E. Jones	*Ceanothus martinii*	Martin's ceanothus	28486
Rosaceae	*Amelanchier utahensis* Koehne	*Amelanchier utahensis*	Utah serviceberry	25121
	Cercocarpus montanus Raf.	*Cercocarpus montanus*	alderleaf mountain mahogany	25136
	Geum rossii (R. Br.) Ser.	*Geum rossii*	Ross' avens	24660

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Rosaceae	*Holodiscus dumosus* (Nutt. ex Hook.) Heller	*Holodiscus dumosus*	rockspirea	25178
	Potentilla L.	*Potentilla*	cinquefoil	24666
	Potentilla anserina L.	*Argentina anserina*	silverweed cinquefoil	184598
	Potentilla fruticosa auct. non L.	*Dasiphora fruticosa* ssp. *floribunda*	shrubby cinquefoil	565123
	Potentilla gracilis Dougl. ex Hook.	*Potentilla gracilis*	slender cinquefoil	24714
	Potentilla pensylvanica L.	*Potentilla pensylvanica*	Pennsylvania cinquefoil	24736
	Prunus virginiana L.	*Prunus virginiana*	chokecherry	24806
	Purshia tridentata (Pursh) DC.	*Purshia tridentata*	antelope bitterbrush	25290
	Rosa L.	*Rosa*	rose	24807
	Rosa nutkana K. Presl	*Rosa nutkana*	Nootka rose	24835
	Rosa woodsii Lindl.	*Rosa woodsii*	Woods' rose	24847
Rubiaceae	*Galium* L.	*Galium*	bedstraw	34796
	Galium boreale L.	*Galium boreale*	licorice bedstraw	565204
	Galium trifidum L.	*Galium trifidum*	threepetal bedstraw	34806
Salicaceae	*Populus angustifolia* James	*Populus angustifolia*	narrowleaf cottonwood	22452
Salicaceae	*Populus deltoides* Bartr. ex Marsh. ssp. *wislizeni* (S. Wats.) Eck.	*Populus deltoides* ssp. *wislizeni*	Rio Grande cottonwood	524563
	Populus tremuloides Michx.	*Populus tremuloides*	quaking aspen	195773
	Salix L.	*Salix*	willow	22476
	Salix exigua Nutt.	*Salix exigua*	narrowleaf willow	22529
	Salix lutea Nutt.	*Salix lutea*	yellow willow	22555
	Salix scouleriana Barratt ex Hook.	*Salix scouleriana*	Scouler's willow	504980
Santalaceae	*Comandra umbellata* (L.) Nutt.	*Comandra umbellata*	bastard toadflax	501614
Saxifragaceae	*Heuchera parvifolia* Nutt. ex T. & G.	*Heuchera parvifolia*	littleflower alumroot	24365
	Lithophragma tenellum Nutt.	*Lithophragma tenellum*	slender woodland-star	24400
Scrophulariaceae	*Besseya wyomingensis* (A. Nels.) Rydb.	*Besseya wyomingensis*	Wyoming besseya	33501
	Castilleja Mutis ex L. f.	*Castilleja*	Indian paintbrush	33049
	Castilleja flava S. Wats.	*Castilleja flava*	yellow Indian paintbrush	33115
	Castilleja linariifolia Benth.	*Castilleja linariifolia*	Wyoming Indian paintbrush	33138
	Cordylanthus ramosus Nutt. ex Benth.	*Cordylanthus ramosus*	bushy bird's beak	33574
	Orthocarpus Nutt.	*Orthocarpus*	owl's-clover	33430
	Orthocarpus luteus Nutt.	*Orthocarpus luteus*	yellow owl's-clover	33437
	Penstemon Schmidel	*Penstemon*	beardtongue	33665
	Penstemon humilis Nutt. ex Gray	*Penstemon humilis*	low beardtongue	33704
	Penstemon paysoniorum Keck	*Penstemon paysoniorum*	Payson's beardtongue	33975
	Penstemon procerus Dougl. ex Graham	*Penstemon procerus*	littleflower penstemon	33745
	Penstemon rydbergii A. Nels.	*Penstemon rydbergii*	Rydberg's penstemon	33990

Family	Scientific (Nelson and Hartman 1997)	Scientific Name (Kartesz 1999)	Common_Name	TSN
Violaceae	*Viola* L.	*Viola*	violet	22030
	Viola adunca Sm.	*Viola adunca*	hookedspur violet	22032
	Viola nephrophylla Greene	*Viola nephrophylla*	northern bog violet	22117

Appendix E
Field Plot Crosswalk to NVC Associations

Plots, observation points, and accuracy assessment (AA) points are assigned to National Vegetation Classification associations based on their composition and structure as they were recorded in the field. Four associations in the following table were documented only during accuracy assessment (Plot codes in the right column contain the letters “AA”). Accuracy assessment points assigned to associations already described from plots or observation points are not included in this table unless they comprise the majority of field plots for the association. Element codes are used by NatureServe and state Natural Heritage Programs to track nomenclature and status of rare plants, rare animals, and communities (“elements”). Nomenclature used by the NVC follows Kartesz (1999). Communities are listed in alphabetical order by scientific name.

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plots, Observation and AA Points
Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland	CEGL001070	13	FOBU.0099, FOBU.0100, FOBU.0124, FOBU.0125, FOBU.0130, FOBU.0137, FOBU.0192, FOBU.9070, FOBU.9075, FOBU.9103, FOBU.9104, FOBU.9145, FOBU.9150
Amelanchier utahensis Shrubland	CEGL001067	4	FOBU.0059, FOBU.0147, FOBU.9021, FOBU.9024
Artemisia arbuscula ssp. longiloba / Cushion Plants Shrubland	CEGL005996	6	FOBU.0008, FOBU.0019, FOBU.0020, FOBU.0073, FOBU.0084, FOBU.9144
Artemisia arbuscula ssp. longiloba / Elymus lanceolatus Shrubland	CEGL002585	11	FOBU.0014, FOBU.0023, FOBU.0024, FOBU.0062, FOBU.0079, FOBU.0086, FOBU.0088, FOBU.0116, FOBU.9052, FOBU.9082, FOBU.9101
Artemisia arbuscula ssp. longiloba / Poa fendleriana Shrubland	CEGL005997	6	FOBU.0044, FOBU.0048, FOBU.0049, FOBU.0091, FOBU.9046, FOBU.9081
Artemisia arbuscula ssp. longiloba / Poa secunda Shrub Herbaceous Vegetation	CEGL001523	9	FOBU.0013, FOBU.0063, FOBU.0066, FOBU.0068, FOBU.0071, FOBU.0076, FOBU.9044, FOBU.9051, FOBU.9072
Artemisia arbuscula ssp. longiloba / Pseudoroegneria spicata Shrub Herbaceous Vegetation	CEGL001416	5	FOBU.0075, FOBU.0153, FOBU.0158, FOBU.9067, FOBU.9141
Artemisia arbuscula ssp. longiloba Shrubland	CEGL001414	5	FOBU.0043, FOBU.0055, FOBU.0136, FOBU.9017, FOBU.9027
Artemisia cana / Juncus balticus Shrubland	CEGL005998	6	FOBU.0016, FOBU.0069, FOBU.0077, FOBU.0114, FOBU.0146, FOBU.9048
Artemisia nova / Pseudoroegneria spicata Shrubland	CEGL001424	1	FOBU.0111
Artemisia tridentata / Elymus lanceolatus Shrubland	Park Special	2	FOBU.9092, FOBU_AA.9155
Artemisia tridentata (ssp. vaseyana, ssp. wyomingensis) - Amelanchier utahensis Shrubland	CEGL002820	9	FOBU.0018, FOBU.0050, FOBU.0056, FOBU.0064, FOBU.0085, FOBU.0117, FOBU.0152, FOBU.0155, FOBU.0157
Artemisia tridentata ssp. tridentata / Leymus cinereus Shrubland	CEGL001016	4	FOBU.0107, FOBU.9019, FOBU.9020, FOBU.9033

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plots, Observation and AA Points
Artemisia tridentata ssp. tridentata / Poa secunda Shrubland	CEGL001008	6	FOBU.0035, FOBU.0061, FOBU.0072, FOBU.9018, FOBU.9035, FOBU.9037
Artemisia tridentata ssp. vaseyana / Achnatherum lettermanii Shrubland	CEGL002811	2	FOBU_AA.0198, FOBU_AA.0607
Artemisia tridentata ssp. vaseyana / Balsamorhiza sagittata Shrubland	CEGL001020	1	FOBU.0123
Artemisia tridentata ssp. vaseyana / Elymus lanceolatus Shrubland	CEGL005318	2	FOBU.0094, FOBU.0135
Artemisia tridentata ssp. vaseyana / Leucopoa kingii Shrubland	CEGL001025	3	FOBU_AA.0005, FOBU_AA.0129, FOBU_AA.0205
Artemisia tridentata ssp. vaseyana / Leymus cinereus Shrubland	CEGL001027	11	FOBU.0046, FOBU.0096, FOBU.0115, FOBU.0132, FOBU.0139, FOBU.9023, FOBU.9028, FOBU.9042, FOBU.9079, FOBU.9083, FOBU.9087
Artemisia tridentata ssp. vaseyana / Pascopyrum smithii Shrubland	CEGL001028	1	FOBU 9001
Artemisia tridentata ssp. vaseyana / Poa fendleriana Shrubland	CEGL002812	2	FOBU.0021, FOBU.0145
Artemisia tridentata ssp. vaseyana / Poa pratensis Sagebrush Shrubland	CEGL002528	2	FOBU_AA.0280, FOBU_AA.0337
Artemisia tridentata ssp. vaseyana / Poa secunda Shrubland	CEGL001029	11	FOBU.0012, FOBU.0015, FOBU.0026, FOBU.0047, FOBU.0054, FOBU.0078, FOBU.0081, FOBU.0121, FOBU.9054, FOBU.9068, FOBU.9102
Artemisia tridentata ssp. vaseyana / Pseudoroegneria spicata Shrubland	CEGL001030	1	FOBU.9050
Artemisia tridentata ssp. wyomingensis / Disturbed Understory Semi-natural Shrubland	CEGL002083	2	FOBU.0142, FOBU.0143
Artemisia tridentata ssp. wyomingensis / Leymus cinereus Shrubland	Park Special	1	FOBU.0106
Artemisia tridentata ssp. wyomingensis / Poa secunda Shrubland	CEGL001049	4	FOBU.0004, FOBU.0005, FOBU.0006, FOBU.0074
Artemisia tridentata ssp. wyomingensis / Pseudoroegneria spicata Shrubland	CEGL001009	1	FOBU.0109

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plots, Observation and AA Points
Atriplex confertifolia - Sarcobatus vermiculatus Shrubland	CEGL001313	1	FOBU.0060
Atriplex confertifolia Wyoming Basins Shrubland	CEGL001293	2	FOBU.9022, FOBU.9084
Atriplex gardneri Dwarf-shrubland	CEGL001438	6	FOBU.0010, FOBU.0011, FOBU.0017, FOBU.0031, FOBU.9031, FOBU.9040
Atriplex gardneri - Artemisia arbuscula ssp. longiloba Dwarf Shrubland	Park Special	4	FOBU.0032, FOBU.0038, FOBU.9016, FOBU.9059
Carex nebrascensis Herbaceous Vegetation	CEGL001813	2	FOBU.0007, FOBU.9003
Ceanothus martinii Shrubland	Park Special	1	FOBU.0144
Cushion Plants Sparse Shale Vegetation	Park Special	6	FOBU.0027, FOBU.0036, FOBU.0092, FOBU.0095, FOBU.0128, FOBU.9058
Dasiphora fruticosa ssp. floribunda Shrubland [Provisional]	CEGL001105	1	FOBU.9074
Eleocharis palustris Herbaceous Vegetation	CEGL001833	2	FOBU.9008, FOBU.9055
Elymus lanceolatus Herbaceous Vegetation	CEGL002588	10	FOBU.0030, FOBU.0083, FOBU.0087, FOBU.0093, FOBU.0105, FOBU.0119, FOBU.0133, FOBU.9038, FOBU.9152, FOBU.9153
Eriogonum brevicaule - Cushion Plants Sparse Vegetation	CEGL005319	18	FOBU.0025, FOBU.0033, FOBU.0034, FOBU.0040, FOBU.0041, FOBU.0042, FOBU.0051, FOBU.0052, FOBU.0058, FOBU.0065, FOBU.9006, FOBU.9043, FOBU.9064, FOBU.9078, FOBU.9080, FOBU.9091, FOBU.9105, FOBU.9149
Hordeum brachyantherum Herbaceous Vegetation	CEGL003430	1	FOBU.9036
Juncus balticus Herbaceous Vegetation	CEGL001838	11	FOBU.0037, FOBU.0070, FOBU.0080, FOBU.0082, FOBU.0089, FOBU.0127, FOBU.9002, FOBU.9032, FOBU.9039, FOBU.9041, FOBU.9053
Juniperus scopulorum / Artemisia tridentata Woodland	CEGL000743	1	FOBU 0191

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plots, Observation and AA Points
Krascheninnikovia lanata / Achnatherum hymenoides Dwarf-shrubland	CEGL001323	3	FOBU.0103, FOBU.0151, FOBU.9065
Krascheninnikovia lanata / Poa secunda Dwarf-shrubland	CEGL001326	1	FOBU.0009
Lepidium virginicum Sparse Herbaceous Vegetation	Park Special	1	FOBU.0039
Leymus cinereus Herbaceous Vegetation	CEGL001479	6	FOBU.0045, FOBU.0108, FOBU.0138, FOBU.9047, FOBU.9069, FOBU.9085
Pascopyrum smithii Herbaceous Vegetation	CEGL001577	3	FOBU.0140, FOBU.9012, FOBU.9063
Pinus flexilis / Cercocarpus montanus - Amelanchier utahensis Woodland	CEGL005320	10	FOBU.0003, FOBU.0028, FOBU.0112, FOBU.0134, FOBU.0154, FOBU.0156, FOBU.0190, FOBU.9057, FOBU.9146, FOBU.9147
Pinus flexilis / Symphoricarpos oreophilus Woodland	CEGL005321	3	FOBU.0102, FOBU.0120, FOBU.9026
Poa pratensis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation	CEGL005265	1	FOBU.9034
Populus angustifolia / Leymus cinereus Woodland	Park Special	2	FOBU.0067, FOBU.0110
Populus tremuloides / Amelanchier alnifolia - Symphoricarpos oreophilus / Mixed Graminoid Forest	CEGL002816	6	FOBU.0118, FOBU.0122, FOBU.9056, FOBU.9142, FOBU.9143, FOBU.9148
Populus tremuloides/ Apocynum androsaemifolium Forest	Park Special	1	FOBU.9030
Populus tremuloides / Cornus sericea Forest	CEGL000582	1	FOBU.9071
Populus tremuloides / Invasive Perennial Grasses Forest	CEGL003748	1	FOBU.0098
Populus tremuloides / Prunus virginiana Woodland	CEGL002130	1	FOBU.9086
Populus tremuloides / Shepherdia canadensis Forest	CEGL000606	1	FOBU.0101
Populus tremuloides / Tall Forbs Forest	CEGL000618	1	FOBU.0126

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plots, Observation and AA Points
Populus tremuloides Woodland Alliance	A.610	1	FOBU.9029
Prunus virginiana - (Prunus americana) Shrubland	CEGL001108	4	FOBU.0129, FOBU.9151, FOBU.9073, FOBU.9076
Pseudoroegneria spicata - Cushion Plants Herbaceous Vegetation	CEGL001666	2	FOBU.0022, FOBU.0097
Pseudoroegneria spicata Herbaceous Vegetation	CEGL001660	2	FOBU.0057, FOBU.9025
Pseudotsuga menziesii / Symphoricarpos oreophilus Forest	CEGL000462	2	FOBU.0029, FOBU.0104
Pteryxia terebinthina Herbaceous Vegetation	Park Special	2	FOBU.9045, FOBU.9077
Purshia tridentata / Pteryxia terebinthina Shrubland	Park Special	1	FOBU.0090
Salix lutea / Leymus cinereus Shrubland	CEGL005322	2	FOBU.9060, FOBU.9106
Salix scouleriana Shrubland	Park Special	1	FOBU.9049
Sarcobatus vermiculatus / Artemisia tridentata Shrubland	CEGL001359	1	FOBU.0113
Sarcobatus vermiculatus / Atriplex gardneri Shrubland	CEGL001360	2	FOBU.0001, FOBU.0141
Symphoricarpos oreophilus Shrubland	CEGL002951	1	FOBU.0131
Symphyotrichum foliaceum Snow Glade Herbaceous Vegetation	Park Special	1	FOBU.9088

Appendix F
Plant Association Descriptions for Fossil Butte National Monument

The Fossil Butte National Monument (FOBU) vegetation mapping project identified 59 National Vegetation Classification (NVC) plant associations and 12 park special vegetation types representing 33 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 monument 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 FOBU. These descriptions reflect NatureServe's accumulated data and analysis. Global descriptions of NVC associations are available on NatureServe's Explorer Web site (http://www.natureserve.org/explorer); local descriptions are not. Only local descriptions are available for provisional and park special vegetation types.

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).

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Pseudotsuga menziesii / Symphoricarpos oreophilus Forest
Douglas-fir / Mountain Snowberry Forest

CODE	CEGL000462
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): Middle Rocky Mountain Montane Douglas-fir Forest and Woodland (CES306.959)

Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest (CES306.805)

Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This widespread forest association occurs in foothills, mountains and plateaus from southwestern Montana through Wyoming and Colorado to Trans-Pecos Texas, west to Arizona, Utah, and into eastern Oregon and Washington. Elevation ranges from 700-2900 m (2310-9500 ft.). This broadly defined forest association occurs as both a non-obligate riparian community and as an upland community. In more arid regions stands occur along drainages along narrow riparian areas in ravines, canyons, and up steep draws. It continues upland on steep north-facing slopes in narrow canyons where dense shade and steepness preclude any significant shrub or herbaceous understory. Elsewhere at more northern latitudes, it occurs near lower treeline on warm, dry southern aspects with moderate to very steep mid- and upper slopes and ridges. Soils are variable and range from deep silt loam to shallow, rocky substrates. Most stands have abundant litter on the ground, and some have high rock cover. The vegetation is characterized by a relatively sparse to dense evergreen tree canopy dominated by *Pseudotsuga menziesii*, sometimes with scattered large *Pinus ponderosa, Pinus flexilis, Populus tremuloides, Juniperus scopulorum,* or *Juniperus occidentalis*, especially on drier sites. *Abies concolor* is typically not present. *Symphoricarpos oreophilus* dominates the sparse to moderately dense short-shrub layer. Shrub associates vary depending on range and habitat and may include *Acer glabrum, Amelanchier* spp., *Artemisia tridentata* ssp. *vaseyana, Cercocarpus montanus, Holodiscus dumosus, Juniperus communis, Mahonia repens, Paxistima myrsinites, Prunus virginiana, Quercus gambelii, Ribes cereum, Ribes inerme, Rosa woodsii,* or *Shepherdia canadensis*. The generally sparse herbaceous layer is composed of mostly graminoids with scattered forbs.

DISTRIBUTION

Fossil Butte National Monument

This association is uncommon at the monument and represented by two plots located on Dempsey Ridge and near Ruby Point within the north-central portion of the monument.

Globally

This widespread montane forest association occurs in foothills, mountains and plateaus from southwestern Montana through Wyoming and Colorado to Trans-Pecos Texas, west to Arizona, Utah, and into eastern Oregon and Washington.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This Douglas-fir / mountain snowberry forest is uncommon within the monument, occupying two sites, one on a ridge and another on a butte. The sites are steep (27- to 35-degree slope), occur at 2320 and 2417 m elevation, and are oriented to the north and northwest. The unvegetated surface has sparse to low exposure of bare soil and cover by small and large rocks and high cover of litter. There is low cover of downed wood. The parent materials include the Fossil Butte and Angelo members of the Wasatch Formation. Soils are rapidly drained sandy clay loams.

Globally
This widespread Douglas-fir forest occurs in foothills, mountains and plateaus from southwestern Montana through Wyoming and Colorado to Trans-Pecos Texas, west to Arizona, Utah, and into eastern Oregon and Washington. Elevation ranges from 700-2900 m (2310-9500 ft.). This broadly defined forest association occurs as both a non-obligate riparian community and as an upland community. In more arid regions stands occur along drainages along narrow riparian areas in ravines, canyons, and up steep draws. It continues upland on steep north-facing slopes in narrow canyons where dense shade and steepness preclude any significant shrub or herbaceous understory. Elsewhere at more northern latitudes, it occurs near lower treeline on warm, dry southern aspects on moderate to very steep mid- and upper slopes and ridges. Soils are variable and range from deep loamy sands, silt loams, silty clay loams, sandy clay loams and peat to shallow, rocky substrates. Parent materials are also variable and may include colluvium or residuum derived from calcareous shale, sandstone, granite, limestone, rhyolite and basalt. Most stands have abundant litter on the ground, and some have high rock cover.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 90-98% in these densely vegetated stands. This association is characterized by a dense canopy comprised of 10- to 25-m tall *Pseudotsuga menziesii* trees that provides 68-85% cover, and the short shrub *Symphoricarpos oreophilus* that provides sparse cover (1-6%). The average dbh of *Pseudotsuga menziesii* trees within sampled plots is 13.6 cm; tree density is 26 and 42, respectively. Scattered subcanopy trees of *Pinus flexilis*, typically 5-10 m tall, provide sparse cover. The remaining shrub layer is low in diversity and sparse in terms of cover, including the tall shrub *Amelanchier utahensis*. The herbaceous layer is low in terms of diversity and provides sparse cover. Grasses include *Poa secunda, Leymus cinereus*, and *Elymus lanceolatus*. Forbs include *Balsamorhiza sagittata* and *Arnica cordifolia*. *Pinus flexilis* and *Pseudotsuga menziesii* seedlings provide sparse cover.

Globally
This forest is characterized by a relatively sparse to dense evergreen tree canopy dominated by *Pseudotsuga menziesii*, sometimes with scattered large *Pinus ponderosa, Pinus flexilis, Populus tremuloides, Juniperus scopulorum*, or *Juniperus occidentalis* in the canopy or subcanopy, especially on drier sites. *Abies concolor* is usually absent. *Symphoricarpos oreophilus* is present and often dominates the sparse to moderately dense shrub layer. Shrub associates vary depending on location and habitat and may include sparse cover of *Acer glabrum, Amelanchier* spp., *Artemisia tridentata* ssp. *vaseyana, Cercocarpus montanus, Holodiscus dumosus, Juniperus communis, Mahonia repens, Paxistima myrsinites, Prunus virginiana, Quercus gambelii, Ribes cereum, Ribes inerme, Rosa woodsii*, or *Shepherdia canadensis*. The generally sparse herbaceous layer is composed of mostly graminoids with scattered forbs. Associated graminoids may include *Bromus* spp., *Carex geyeri, Carex rossii, Elymus lanceolatus, Festuca idahoensis, Leucopoa kingii, Leymus cinereus, Koeleria macrantha*, and *Poa fendleriana, Poa secunda*. Common forbs include *Achillea millefolium, Arnica cordifolia, Artemisia frigida, Balsamorhiza sagittata, Thalictrum fendleri*, and *Vicia americana*.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*
Short shrub/sapling	*Symphoricarpos oreophilus*

Globally

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*
Short shrub/sapling	*Symphoricarpos oreophilus*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
This is a broadly defined *Pseudotsuga menziesii* association which includes a variety of stands from different environments that are tied together by a common widespread species, *Symphoricarpos oreophilus*.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This forest stand is controlled by slope and aspect; this area captures snow and is protected from the prevailing wind. Some trees are bowed in the lower trunk, possibly indicating that heavy snow lay against them. At least some parts of this stand burned; several large *Pseudotsuga menziesii* in the plot bear fire scars.
Fossil Butte National Monument Data: The description is based on 2005 field data (2 plots: FOBU.0029, FOBU.0104).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Drake, J. Coles, K.A. Schulz

REFERENCES: Arno 1980, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Cogan et al. 2004, Day and Wright 1985, Diamond 1993, Fischer and Bradley 1987, Hess and Wasser 1982, Johnson and Clausnitzer 1992, Johnson and Simon 1987, Johnston 1987, Jones and Ogle 2000, Kagan et al. 2000, Kittel et al. 1994, Kittel et al. 1999b, Komarkova et al. 1988b, Lillybridge et al. 1995, MTNHP 2002b, Mauk and Henderson 1984, Muldavin et al. 1996, Pfister et al. 1977, Reed 1976, Steele et al. 1981, Steele et al. 1983, Williams and Lillybridge 1983, Williams and Lillybridge 1985, Williams et al. 1990b, Wright et al. 1979, Youngblood and Mauk 1985

Populus tremuloides / Amelanchier alnifolia - Symphoricarpos oreophilus / Mixed Graminoid Forest
Quaking Aspen / Saskatoon Serviceberry - Mountain Snowberry / Mixed Graminoid Forest

CODE	CEGL002816
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 quaking aspen forest is found in northwestern Colorado and southwestern Wyoming on moderate to moderately steep slopes (10-30%) of mountains, plateaus and buttes between 2242 and 2600 m elevation. It occurs in small stands on toeslopes, slump slopes, benches, and ridges often with north aspects or in other areas that collect snow or have higher soil moisture throughout the growing season (seeps). The unvegetated surface generally has low cover of small and large rocks and high cover of leaf litter and downed wood, although in some stands the cover by large rocks may be as high as 40%. Soils are well-drained to poorly-drained with soil textures ranging from sandy loam to silt to clay loam. The vegetation is characterized by an open-to-dense tree canopy 2-10 m tall that is dominated by *Populus tremuloides* with open to dense shrub layers dominated by tall shrubs *Amelanchier alnifolia* or *Amelanchier utahensis* and short shrub *Symphoricarpos oreophilus*. Scattered *Pseudotsuga menziesii* or *Pinus flexilis* may be

present in some stands. Other tall shrubs may include *Salix scouleriana* and *Prunus virginiana*. Short- and dwarf-shrub associates, such as *Artemisia tridentata* ssp. *tridentata, Artemisia tridentata* ssp. *vaseyana, Juniperus communis, Mahonia repens, Paxistima myrsinites, Rosa woodsii, Shepherdia canadensis*, and *Ribes cereum*, may be present with low cover. The herbaceous layer is characterized by mixed graminoids, such as *Achnatherum lettermanii, Hesperostipa comata, Bromus* sp., *Carex geyeri*, and *Poa secunda*, and low cover of diverse forbs. Exotic species *Poa pratensis* and *Taraxacum officinale* are common in some stands.

DISTRIBUTION

Fossil Butte National Monument

This woodland is found on ridges and toeslopes within the monument near the Slump Trail and on the north-facing slope of the ridge to Ruby Point.

Globally

This aspen forest is found in Utah, at Dinosaur National Monument in northwestern Colorado and Fossil Butte Monument in southwestern Wyoming, and is likely more widespread in this region.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This quaking aspen / Saskatoon serviceberry - mountain snowberry forest/woodland is present at higher elevations in the northern portion of the monument and occupies toeslopes, slump slopes, and ridges. The sites are moderately steep (7- to 17-degree slopes), occur between 2242 and 2426 m elevation, and may be oriented to any aspect. The unvegetated surface has low cover of small and large rocks and high cover of litter. Downed wood ranges from low to moderate (up to 20% cover). Soils are well-drained to poorly drained clay loams derived from landslides in the Wasatch Formation.

Globally

This quaking aspen forest is found in northwestern Colorado and southwestern Wyoming on moderate to moderately steep slopes (10-30%) of mountains, plateaus and buttes between 2242 and 2600 m elevation. It occurs in small stands on toeslopes, slump slopes, benches, and ridges often with north aspects or in other areas that collect snow or have higher soil moisture throughout the growing season (seeps). The unvegetated surface generally has low cover of small and large rocks and high cover of leaf litter and downed wood, although in some stands the cover by large rocks may be as high as 40%. Soils are well-drained to poorly drained with soil textures ranging from sandy loam to silt to clay loam.

VEGETATION DESCRIPTION

Fossil Butte National Monument

The total vegetation cover is close to 100%. Stands are characterized by a dense canopy, typically 10-20 m tall, of *Populus tremuloides* with between 35 and 60% cover, and a dense shrub understory dominated by *Amelanchier utahensis* and *Symphoricarpos oreophilus*. The average dbh of *Populus tremuloides* trees within a 400-square-meter plot is 15.6 cm. Emergent *Pseudotsuga menziesii* trees are observed in some stands and *Pinus flexilis* and *Populus tremuloides* seedlings and saplings provide sparse cover in others. Associated shrubs include *Artemisia tridentata* ssp. *vaseyana, Rosa woodsii, Shepherdia canadensis, Mahonia repens*, and *Ribes cereum*. The herbaceous layer is diverse and includes *Poa pratensis, Carex geyeri, Bromus* sp. and *Poa secunda*. Forbs include *Astragalus agrestis, Chamerion angustifolium, Taraxacum officinale, Lupinus sericeus, Geranium richardsonii, Thalictrum venulosum, Mertensia oblongifolia*, and *Galium boreale*.

Globally

This association is characterized by an open-to-dense (20-80% cover) tree canopy (2-10 m tall) that is dominated by *Populus tremuloides* with open-to-dense shrub layers dominated by tall shrubs *Amelanchier alnifolia* or *Amelanchier utahensis* and short shrub *Symphoricarpos oreophilus.* Emergent *Pseudotsuga menziesii* trees are observed in some stands, and *Pinus flexilis* and *Populus tremuloides* seedlings and saplings provide sparse cover in others. The understory may have distinct tall-shrub (5-80% cover) and short-shrub (10-30% cover) layers or have a mixed appearance. Other tall shrubs may include *Salix scouleriana* and *Prunus virginiana*. Short- and dwarf-shrub associates, such as *Artemisia tridentata* ssp. *tridentata, Artemisia tridentata* ssp. *vaseyana, Juniperus communis, Mahonia repens, Paxistima myrsinites, Rosa woodsii, Shepherdia canadensis*, and *Ribes cereum*, may be present with low cover. The herbaceous layer is characterized by mixed graminoids, such as *Achnatherum lettermanii, Hesperostipa comata, Bromus* sp., *Carex geyeri*, and *Poa secunda*, and low cover of diverse forbs, such as

Astragalus agrestis, Chamerion angustifolium, Galium boreale, Geranium richardsonii, Lupinus argenteus, Lupinus sericeus, Mertensia oblongifolia, and *Thalictrum venulosum*. Exotic species *Poa pratensis* and *Taraxacum officinale* are common in some stands.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Tree canopy	*Populus tremuloides*
Tree canopy	*Amelanchier utahensis*
Short shrub/sapling	*Symphoricarpos oreophilus*

Globally

Stratum	Species
Tree (canopy & subcanopy)	*Populus tremuloides*
Tall shrub/sapling	*Amelanchier alnifolia, Amelanchier utahensis*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Poa pratensis, Taraxacum officinale

Globally
Poa pratensis, Taraxacum officinale

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

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This community is controlled by the mesic site conditions, including exposure, snow accumulation, and seepage. This forest type occupies landslide deposits below the rim. The stands are diverse with lots of fuels in the understory; fire could kill the stand. This is a mature stand with some invasion by limber pine, Douglas-fir, and Rocky Mountain juniper.
Fossil Butte National Monument Data: The description is based on 2005 field data (2 plots: FOBU.0118, FOBU.0122; 4 observation points: FOBU.9056, FOBU.9142, FOBU.9143, FOBU.9148).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Populus tremuloides / Invasive Perennial Grasses Forest
Quaking Aspen / Invasive Perennial Grasses Forest

CODE	CEGL003748
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: Palustrine

CONCEPT SUMMARY

Globally

This association is a widespread grazing-induced type found across much of the western U.S. within the range of quaking aspen, including the southern and central Rocky Mountains west into the Colorado Plateau and Great Basin into eastern California and throughout much of Idaho and Montana. Stands typically occur within the elevational range of 1830-2830 m (6000-9280 ft.) on flat to moderate (1-27%) benches, alluvial terraces and lower slopes, swales, near springs and especially along stream channels and valley bottoms where livestock congregate. Stands typically have current or past heavy grazing. Aspects and substrates are variable. Soils are often relatively mesic and well developed (Mollisols) but include sandy, silty, or clay loams derived from recent alluvium, shales, granite or volcanics. The vegetation is characterized by a moderately dense (40-60% cover) tree canopy 5-15 m tall composed of *Populus tremuloides* but may include sparse and scattered conifers, such as *Pinus contorta, Picea engelmannii*, and *Abies lasiocarpa*. There is no distinct shrub stratum; however, scattered shrubs, such as *Dasiphora fruticosa* ssp. *floribunda, Juniperus communis* var. *montana, Mahonia repens, Ribes inerme, Rosa woodsii,* and *Symphoricarpos rotundifolius*, may be present. The diagnostic feature of the understory is the lush herbaceous layer that is strongly dominated by introduced perennial graminoids, usually *Poa pratensis* (20-30% cover or more), or other introduced forage species, such as *Agrostis stolonifera, Alopecurus* spp., *Bromus inermis*, *Dactylis glomerata*, and *Phleum pratense*. Other graminoid species may include *Bromus carinatus, Bromus ciliatus, Bromus porteri, Carex* spp., *Elymus trachycaulus*, and *Juncus balticus*. Forb cover is generally low but often diverse. Forb species with high frequency include *Achillea millefolium, Artemisia ludoviciana, Astragalus miser, Fragaria* spp., *Galium boreale, Geranium viscosissimum, Ligusticum porteri, Lupinus* sp., *Potentilla* spp., *Thalictrum fendleri, Thermopsis divaricarpa*, and *Trifolium longipes*. Introduced species, such *Taraxacum officinale* and *Trifolium* spp., are common in this frequently grazing-disturbed type.

DISTRIBUTION

Fossil Butte National Monument

This association is uncommon at the monument and represented by one plot on a hill near Cundick Spring.

Globally

This association is a widespread grazing-induced type found across much of the western U.S. within the range of quaking aspen, including the southern and central Rocky Mountains west into the Colorado Plateau and Great Basin into eastern California and throughout southern and eastern Idaho and much of Montana and western Wyoming.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This quaking aspen / invasive perennial grasses forest is uncommon within the monument. It occupies saturated soils of a hill on the north side of the monument. The site is moderately steep, occurs at 2380 m elevation, and is oriented to the east. The unvegetated surface has high cover of litter and sparse exposure of bare soil. There is sparse cover of dead wood. The parent material is obscured by soil. The soils are somewhat poorly drained clay loams.

Globally

This association is a widespread grazing-induced type found across much of the western U.S. within the range of quaking aspen, including the southern and central Rocky Mountains west into the Colorado Plateau and Great Basin into eastern California and throughout much of Idaho and Montana. Stands typically occur within the elevational range of 1830-2830 m (6000-9280 ft) on typically flat to moderate (1-54%) benches, alluvial terraces and lower slopes, moist hillsides, swales, near springs and especially along stream channels and valley bottoms where livestock congregate. In semi-arid areas, stands are found on seep-saturated hillslopes. Stands typically have current or past heavy livestock grazing. Aspects and substrates are variable. Soils are often relatively mesic and well-developed (Mollisols) but include sandy, silty, or clay loams derived from recent alluvium, shales, granite or volcanics. Surface rock does not play a large role in the surface cover; however, litter and duff may comprise significant ground cover.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover is 99% in this densely vegetated stand. This association is characterized by moderate cover of the canopy tree *Populus tremuloides* (45%) and dominance of the non-native perennial grass *Poa pratensis* (up to 30% cover) in the understory. The average dbh for *Populus tremuloides* trees is 9.74 cm; 39 trees occupy the plot. Shrubs are low in diversity and provide sparse cover, including the short shrubs *Rosa woodsii, Symphoricarpos oreophilus,* and *Artemisia cana*. *Pinus flexilis* and *Populus tremuloides* seedlings provide sparse cover. Although the moderately dense herbaceous layer is diverse, it is dominated by the non-native perennial grass *Poa pratensis* with 30% cover. Other graminoids, *Carex microptera, Deschampsia caespitosa, Poa arida,* and *Poa secunda* provide sparse cover. Forbs include *Senecio integerrimus, Thalictrum fendleri, Taraxacum officinale, Achillea millefolium, Ligusticum filicinum, Maianthemum stellatum,* and *Oxypolis fendleri* and provide low cover.

Globally
This deciduous forest association is characterized by a moderately dense (40-60% cover) tree canopy 5-15 m tall composed of *Populus tremuloides* but may include sparse and scattered conifers, such as *Pinus contorta, Picea engelmannii*, and *Abies lasiocarpa*. There is no distinct shrub stratum; however, scattered shrubs, such as *Artemisia cana, Dasiphora fruticosa* ssp. *floribunda, Juniperus communis var. montana, Mahonia repens, Ribes inerme, Rosa woodsii*, and *Symphoricarpos rotundifolius*, may be present. The diagnostic feature of the understory is the lush herbaceous layer that is strongly dominated by introduced perennial graminoids, usually *Poa pratensis* (20-30% cover or more), or other introduced forage species, such as *Agrostis stolonifera, Alopecurus* spp., *Bromus inermis, Dactylis glomerata*, and *Phleum pratense*. Other graminoid species may include *Bromus carinatus, Bromus ciliatus, Bromus porteri, Carex* spp., *Deschampsia caespitosa, Elymus trachycaulus*, and *Juncus balticus*. Forb cover is generally low but often diverse. Forb species with high frequency include *Achillea millefolium, Artemisia ludoviciana, Astragalus miser, Fragaria* spp., *Galium boreale, Geranium viscosissimum, Ligusticum filicinum, Ligusticum porteri, Lupinus* sp., *Maianthemum stellatum, Potentilla* spp., *Senecio integerrimus, Thalictrum fendleri, Thermopsis divaricarpa*, and *Trifolium longipes*. Introduced species, such *Taraxacum officinale* and *Trifolium* spp., are common in this frequently grazing-disturbed type (Mueggler 1988, Powell 1988a, Padgett et al. 1989, Hansen et al. 1995).

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Tree canopy	*Populus tremuloides*
Herb (field)	*Ligusticum filicinum, Senecio integerrimus, Taraxacum officinale*
Herb (field)	*Poa arida, Poa pratensis*

Globally

Stratum	Species
Tree canopy	*Populus tremuloides*
Herb (field)	*Agrostis stolonifera, Bromus inermis, Dactylis glomerata, Phleum pratense, Poa pratensis*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Poa pratensis, Taraxacum officinale

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNA (ruderal) (26-May-2004).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
The concept of this semi-natural quaking aspen forest association includes aspen stands with understories dominated by introduced herbaceous species, especially forage species that have escaped from cultivation, such as *Agrostis*

stolonifera, Alopecurus spp., *Bromus inermis, Dactylis glomerata, Phleum pratense, Medicago sativa, Melilotus officinalis*, and *Trifolium* spp.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Several seeps emerge in this stand, so there are strips of wet vegetation separated by strips of mesic vegetation. Quaking aspen are regenerating well, so the stand is persistent. Some areas have standing water.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0098).
Local Description Authors: M. Smith and J. Von Loh, mod. K.A. Schulz
Global Description Authors: K.A. Schulz

REFERENCES: Girard et al. 1997, Hall and Hansen 1997, Hansen et al. 1995, Manning and Padgett 1995, Mueggler 1988, Mueggler and Campbell 1982, Mueggler and Campbell 1986, Padgett et al. 1989, Powell 1988a, Western Ecology Working Group n.d., Wexelman et al. 1999

Populus tremuloides / Shepherdia canadensis Forest
Quaking Aspen / Russet Buffaloberry Forest

CODE	CEGL000606
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 *Populus tremuloides* forest association occurs in eastern Idaho, western Wyoming, and central Colorado. It occurs on dry ridges between 2092 and 3078 m (6860-10,100 ft.) elevation. This association is considered one of the driest aspen types. Stands usually occur on steep low to midslopes, although stands have also occurred on near-flat terraces. Soils are often dry, well-drained sandy loams. The tree canopy is dominated by *Populus tremuloides*. Scattered conifers, such as *Abies lasiocarpa, Picea engelmannii, Pseudotsuga menziesii*, or *Pinus contorta*, are frequently present in small amounts. The shrub layer is characterized by the dominance of *Shepherdia canadensis*. *Juniperus communis* can also have high cover. Additional shrub associates can include *Amelanchier alnifolia, Rosa woodsii, Symphoricarpos oreophilus, Arctostaphylos uva-ursi*, and *Paxistima myrsinites* among others. The herbaceous layer is composed of a mix of graminoids and forbs, the latter often more abundant and diverse. Common (but not consistent) graminoid species include *Elymus trachycaulus, Bromus ciliatus,* and sometimes *Calamagrostis rubescens*. Forbs usually present (but no one species consistently so) include *Geranium viscosissimum, Lupinus argenteus, Thalictrum fendleri, Osmorhiza berteroi, Fragaria vesca, Galium boreale*, and *Achillea millefolium*. Diagnostic for this association is the prominence of *Shepherdia canadensis* in the shrub layer, below a *Populus tremuloides*-dominated overstory.

DISTRIBUTION
Fossil Butte National Monument
This association is uncommon in the monument and is represented by one plot located on a steep slope near Dempsey Ridge.

Globally
This association is known from eastern Idaho, western Wyoming, and central Colorado.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument
This quaking aspen / tall forb forest is uncommon within the monument and occupies a mesic slope of a ridge. The site occurs on a steep (22-degree slope), north-facing mid-slope at 2288 m elevation. The unvegetated surface has sparse exposure of bare soil and cover by small and large rocks and high cover of litter. There is sparse cover of downed wood. Parent materials include the sandstones and shales that have eroded and deposited during landslides. Soil is a well-drained silt loam.

Globally
This Rocky Mountain association occurs on dry ridges, slopes, benches and terraces between 2092 and 2400 m (6863-8000 ft.) elevation in Idaho and Wyoming and between 2600 and 3078 m (8550-10,100 ft.) in Colorado. This association is considered one of the driest aspen types. Stands usually occur on steep low to midslopes, although stands have also occurred on near-flat terraces. There is usually moderate to high cover of leaf litter. Soils are often dry, well-drained sandy loams or clays. Parent materials range from shale and sandstone to granite.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 99% in these densely vegetated stands. This association is characterized by a dense canopy, typically 10-15 m tall, of *Populus tremuloides* trees (55% cover) and an understory of the short shrub *Shepherdia canadensis* that provides moderate cover (30% cover). The average dbh of *Populus tremuloides* trees is 11.4 cm; sampled plots from 31 trees. Scattered *Pinus flexilis* trees, typically 2-5 m tall, provide sparse cover in the subcanopy. The remaining shrub layer is diverse, provides low cover, and includes the tall and short shrubs *Amelanchier utahensis, Rosa woodsii, Symphoricarpos oreophilus,* and *Mahonia repens*. The herbaceous layer is diverse and provides moderate cover. Grasses include *Carex geyeri, Leymus cinereus,* and *Melica bulbosa*. Forbs include *Pseudocymopterus montanus, Achillea millefolium, Galium boreale, Geranium richardsonii, Lupinus leucophyllus, Thalictrum fendleri,* and *Taraxacum officinale*. *Pinus flexilis* and *Populus tremuloides* seedlings provide sparse cover.

Globally
This *Populus tremuloides* forest association has a tree canopy dominated by *Populus tremuloides.* Scattered conifers, such as *Abies lasiocarpa, Picea engelmannii, Pseudotsuga menziesii, Pinus flexilis*, or *Pinus contorta*, are frequently present in small amounts (<25% of the tree canopy). The shrub layer is characterized by dominance of *Shepherdia canadensis*. *Juniperus communis* can also have high cover. Additional shrub associates can include *Amelanchier alnifolia, Amelanchier utahensis, Arctostaphylos uva-ursi, Cercocarpus montanus, Mahonia repens, Paxistima myrsinites, Rosa woodsii*, and *Symphoricarpos oreophilus*, among others. The herbaceous layer is composed of a mix of graminoids and forbs, the latter often more abundant and diverse. Typical (but not consistent) graminoid species include *Bromus ciliatus, Elymus lanceolatus, Elymus trachycaulus, Poa secunda*, and sometimes *Calamagrostis rubescens*. Forbs usually present (but no one species consistently so) include *Geranium richardsonii, Geranium viscosissimum, Lupinus argenteus, Thalictrum fendleri, Osmorhiza berteroi, Fragaria vesca, Galium boreale, Chamerion angustifolium, Cirsium undulatum,* and *Achillea millefolium*.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Tree canopy	*Populus tremuloides*
Short shrub/sapling	*Shepherdia canadensis*
Herb (field)	*Mahonia repens*
Herb (field)	*Pseudocymopterus montanus*, *Geranium richardsonii*

Globally

Stratum	Species
Tree canopy	*Populus tremuloides*
Tall shrub/sapling	*Shepherdia canadensis*
Short shrub/sapling	*Juniperus communis* var. *montana*
Herb (field)	*Geranium viscosissimum*
Herb (field)	*Bromus ciliatus*

OTHER NOTEWORTHY SPECIES

Fossil Butte National Monument
Taraxacum officinale

Globally
Poa pratensis

CONSERVATION STATUS RANK
Global Rank & Reasons: G3G4 (1-Feb-1996).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Distinction between this association and *Populus tremuloides / Juniperus communis* Forest (CEGL000587) is lacking in terms of species composition and is distinct only by the relatively high cover of *Shepherdia canadensis*. This community may be better classified as a woodland because most stands are relatively open (<60% cover).

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Plot is located in a depression that provides the necessary moisture for this mesic forest. This is a mesic slope with deep soils that catches snow and thus can support quaking aspen. Many *Pinus flexilis* seedlings and few *Populus tremuloides* seedlings in the plot may indicate that this stand is seral.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0101)
Local Description Authors: M. Smith and J. Von Loh, mod by K.A. Schulz
Global Description Authors: G. Kittel, mod. S.L. Neid and K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Mueggler 1988, Powell 1988a, Steele et al. 1981, Walkup 1991, Western Ecology Working Group n.d., Youngblood and Mueggler 1981

Populus tremuloides / Tall Forbs Forest
Quaking Aspen / Tall Forbs Forest

CODE	CEGL000618
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 *Populus tremuloides* forest is one of the most common and abundant aspen forest types in the Rocky Mountains. It occurs throughout mountainous areas and occurs on any aspect but tends to occur more often on north-facing slopes. It can be found on steep moist hillsides and often along narrow riparian areas. The broad-leaved deciduous tree canopy in dominated by *Populus tremuloides*. Low shrubs are virtually absent from this type. The undergrowth is characterized by a thick carpet of tall forbs (<1 m) with no one species dominant. Tall forbs include *Agastache urticifolia, Delphinium* X *occidentale, Eucephalus engelmannii, Hackelia floribunda, Heracleum maximum, Mertensia arizonica, Osmorhiza occidentalis, Senecio serra*, and *Valeriana occidentalis*. Other

herbaceous species are present, including graminoid species. Forb species in streambank stands can be different from hillside stands.

DISTRIBUTION

Fossil Butte National Monument

This association is uncommon at the monument and represented by two plots located on a bench southwest of Cundick Ridge.

Globally

This deciduous forest association occurs in the southern and central Rocky Mountains and plateaus and mountains of the Colorado Plateau and extends into the Jarbridge and Independence mountains of northeastern Nevada and into southwestern Montana.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This quaking aspen / tall forb forest is uncommon within the monument and occupies a mesic bench. The site is gentle (3-degree slope), occur from 2263 m elevation, and is oriented to the southwest. The unvegetated surface has sparse exposure of bare soil and cover by small and large rocks and high cover of litter. There is sparse cover of downed wood. Parent materials include the main body of the Wasatch Formation. Soil is a moderately well-drained clay.

Globally

This deciduous forest association occurs in the southern and central Rocky Mountains and plateaus and mountains of the Colorado Plateau and extends into the Jarbridge and Independence mountains of northeastern Nevada and into southwestern Montana. Stands occupy flat to gently sloping, moist to wet sites, often adjacent to streams. Slope positions are topographically low-lying, such as toeslopes or lower sidehills, flats, valley bottoms, and stream terraces. It is generally found on concave landforms where moisture can accumulate, rarely on convex topography. Aspect is variable, but many easterly or northerly stands are reported in the literature. Elevations are upper montane to lower subalpine and range from about 2100-3080 m (7000-10,000 ft), with most examples reported above 2745 m (9000 ft.). Soils underlying this community type are derived from alluvial deposition of a variety of parent materials, but rarely is it found on volcanic soils (Mueggler 1988). The soils are deep, well-drained loams, sandy loams to clay loams in texture (Boyce 1977, Hess and Wasser 1982). With increasing depth, coarse and rock fragments increase in proportion. Hess and Wasser (1982) report very thin litter layers, and Boyce (1977) reports a low percentage of organic matter in the A horizon. Litter and duff comprise the majority of the unvegetated ground cover.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover is 68% in these densely vegetated stands. This association is characterized by a dense canopy, typically 10-15 m tall, of *Populus tremuloides* trees (30% cover) and a moderately dense (>25% cover) herbaceous layer of tall forbs such as *Chamerion angustifolium, Aster sp.* and *Osmorhiza chilensis.* Shrub cover is relatively low (<10% cover) and includes scattered *Cercocarpus montanus, Shepherdia canadensis,* and a several other shrubs. The average dbh of *Populus tremuloides* trees is 10.7 cm; sampled plots contain from 16 trees. Scattered *Pinus flexilis* trees, typically 2-5 m tall, provide sparse cover in the subcanopy. The herbaceous layer is diverse and provides moderate cover. Grasses have low cover and include *Poa secunda, Elymus lanceolatus,* and *Leymus cinereus.* Other forbs include low cover of *Achillea millefolium Cirsium undulatum, Galium boreale, Geranium richardsonii, Lupinus leucophyllus, Maianthemum stellatum,* and *Taraxacum officinale.* Scattered *Pinus flexilis* and *Populus tremuloides* seedlings provide sparse cover.

Globally

The vegetation of this type is structurally simple but may be compositionally complex. The canopy is dominated by *Populus tremuloides,* with occasional small amounts of conifer species present (particularly *Abies lasiocarpa* and *Picea engelmannii*). Shrubs are poorly represented, but *Juniperus communis, Ribes* sp., *Sambucus racemosa*, and *Symphoricarpos oreophilus* may occur with low cover. The herbaceous layer is characterized by the presence of several species of mesic tall forbs, accompanied by a mixture of low forbs and graminoids. The unifying characteristic of this type is the presence and usual prominence of one or more members of the tall-forb group of species, the absence of distinct shrub layers, and a lack of substantial amounts of conifers in the tree layer. Members of the tall-forb guild are *Agastache urticifolia, Delphinium* X *occidentale, Eucephalus engelmannii, Hackelia*

floribunda, Heracleum maximum, Mertensia arizonica, Osmorhiza occidentalis, Senecio serra, and *Valeriana occidentalis* (Mueggler 1988). No one member of this group is consistently dominant or even present, but as a group they form the dominant cover of the herbaceous layer, often exceeding 10%. Additional low forbs may include *Achillea millefolium* var. *occidentalis, Galium boreale, Galium triflorum, Geranium richardsonii, Geranium viscosissimum, Helianthella quinquenervis, Hydrophyllum fendleri, Ligusticum filicinum, Maianthemum stellatum, Streptopus amplexifolius, Thalictrum fendleri, Urtica dioica,* and *Viola* spp. Common graminoids include *Bromus* spp., *Calamagrostis canadensis, Carex* spp., *Elymus glaucus,* and *Poa pratensis.* At higher elevations, with cooler conditions, Powell (1988a) describes two stands of this community type with *Elymus glaucus* dominating, which otherwise are floristically the same as described here. Many of the stands of this type are species-rich, and cover of the herbaceous understory is very high, usually over 200%.

MOST ABUNDANT SPECIES
*Fossil Butte National Monument*Data are not available.

Stratum	Species
Tree canopy	*Populus tremuloides*
Herb (field)	*Chamerion angustifolium, Aster* sp. and *Osmorhiza chilensis*

Globally

Stratum	Species
Tree canopy	*Populus tremuloides*
Herb (field)	*Heracleum maximum, Osmorhiza occidentalis, Valeriana occidentalis*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

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

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Plot is located in a depression that provides the necessary moisture for this mesic forest. This is a mesic slope with deep soils that catches snow and thus can support quaking aspen. Many *Pinus flexilis* seedlings and few *Populus tremuloides* seedlings in the plot may indicate that this stand is seral.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0126).
Local Description Authors: K.A. Schulz
Global Description Authors: M.S. Reid, mod. G. Kittel and K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Boyce 1977, Bunin 1975a, Bunin 1975c, CONHP unpubl. data 2003, Carsey et al. 2003a, Driscoll et al. 1984, Hess and Wasser 1982, Hoffman and Alexander 1980, Hoffman and Alexander 1983, Johnston and Hendzel 1985, Keammerer and Stoecker 1980, Kittel et al. 1994, Kittel et al. 1997a, Kittel et al. 1999a, Kittel et al. 1999b, Lewis 1975a, MTNHP 2002b, MTNHP unpubl. data, Marr et al. 1973a, Mueggler 1988, Mueggler and Campbell 1982, Mueggler and Campbell 1986, Powell 1988a, Richard et al. 1996, Western Ecology Working Group n.d., Youngblood and Mueggler 1981

Populus tremuloides / Cornus sericea Forest

Quaking Aspen / Red-osier Dogwood Forest

CODE	CEGL000582
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):	Northern Rocky Mountain Avalanche Chute Shrubland (CES306.801) Rocky Mountain Aspen Forest and Woodland (CES306.813) Rocky Mountain Subalpine-Montane Riparian Woodland (CES306.833)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This association occurs in scattered locations throughout the mountains of Colorado, Montana, Utah, Idaho, Nevada, Oregon, Washington, Wyoming, Alberta, and possibly California. This is a moist forest often located in narrow ravines where upland *Populus tremuloides* forests intermix with the riparian shrub vegetation and at the base of slopes. It occurs from 732-2500 m (2400-8200 ft.) in elevation. It also typically occurs on alluvial terraces adjacent to streams and rivers, or near springs and seeps. Stands are located on moist soil, but are not restricted to riparian or wetland habitats. Water tables average 30 cm below the surface, but water depths in several stands were greater than 1 meter. Coarse-textured soils, moderate to steep gradients, and high coarse fragments provide for rapid movement of highly aerated groundwater. Soils range from very rocky and shallow sands to deeper sandy clay loams and silty clay loams. Stands have a deciduous tree canopy that is dominated by *Populus tremuloides* with and a shrub layer dominated by *Cornus sericea*, often with several other shrub species, such as *Alnus incana*, *Betula occidentalis*, *Lonicera involucrata*, and several *Salix* spp., including *Salix geyeriana*, *Salix boothii*, *Salix lucida* ssp. *lasiandra*, or *Salix lutea*. The herbaceous undergrowth is relatively sparse, but often diverse with *Equisetum arvense*, *Maianthemum stellatum*, *Heracleum maximum*, *Actaea rubra*, and *Galium triflorum*. *Cornus sericea* is at least as abundant as other shrubs in the stand, and is often the most abundant shrub present. The obligate riparian shrub species distinguish this association from upland *Populus tremuloides* communities.

DISTRIBUTION

Fossil Butte National Monument

This association is uncommon at the monument and represented by one observation point on a bench below Fossil Butte.

Globally

This association occurs in Colorado, Montana, Utah, Idaho, Oregon, Washington, Alberta, and possibly California.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This quaking aspen / red-osier dogwood forest is uncommon within the monument and occupies a bench of the slope below Fossil Butte. The site is gentle (3-degree slope), occurs at 2258 m elevation, and is oriented to the south. The unvegetated surface has low exposure of bare soil, low cover of small and large rocks and open water, and high cover of litter. There is low cover of downed wood. The parent material is the Fossil Butte Member of the Wasatch Formation.

Globally

This is a moist forest often located in narrow ravines where upland *Populus tremuloides* forests intermix with the riparian shrub vegetation. It occurs from 732-2500 m (2400-8200 ft.) in elevation. It also typically occurs on alluvial terraces adjacent to streams and rivers, or near springs and seeps. In the intermountain basin area, stands are located on moist soil, but are not necessarily restricted to riparian or wetland habitats and occurs on benches below buttes. Water tables average 30 cm below the surface, but water depths in several stands were greater than 1 meter. Coarse-textured soils, moderate to steep gradients, and high coarse fragments provide for rapid movement of highly

aerated groundwater. Soil texture ranges from very rocky and shallow sands to deeper sandy clay loams and silty clay loams.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover is 90% in this densely vegetated stand. This association is characterized by an open canopy, typically 5-10 m tall, of the canopy tree *Populus tremuloides* (45% cover) and the short shrub *Cornus sericea* that provides 35% cover. The remaining shrub layer is low in diversity and sparse, including the mesic tall shrubs *Salix lutea, Salix exigua*, and *Amelanchier utahensis*. The herbaceous layer is low in diversity and provides sparse cover, consisting of a species of Asteraceae and the graminoids *Carex nebrascensis* and *Juncus balticus*.

Globally

This association is characterized by an overstory canopy of *Populus tremuloides*. Other trees occasionally present include *Picea engelmannii, Populus balsamifera* ssp. *trichocarpa, Juniperus scopulorum*, and *Betula papyrifera*. The shrub layer is dominated by *Cornus sericea* (with greatest cover or at least as abundant as any other shrubs present). Other shrubs that may be present include *Alnus incana, Amelanchier alnifolia, Amelanchier utahensis, Crataegus douglasii, Lonicera involucrata, Symphoricarpos* spp., and several *Salix* spp., including *Salix geyeriana, Salix lucida* ssp. *lasiandra*, or *Salix lutea*. The herbaceous undergrowth is relatively sparse, usually due to the thick shading of the shrub layer. Typical species include *Carex nebrascensis, Equisetum arvense, Galium triflorum, Juncus balticus, Heracleum maximum, Maianthemum stellatum, Actaea rubra, Aconitum columbianum*, and *Viola* spp.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Tree canopy	*Populus tremuloides*
Short shrub/sapling	*Cornus sericea*

Globally

Stratum	Species
Tree canopy	*Populus tremuloides*
Shrub/sapling (tall & short)	*Cornus sericea*

OTHER NOTEWORTHY SPECIES

Fossil Butte National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (1-Feb-1996).

CLASSIFICATION COMMENTS

Fossil Butte National Monument

Data are not available.

Globally

Padgett et al. (1989) mention two stands dominated by *Populus tremuloides* and *Cornus sericea* in the Wasatch Plateau and the Abajo Mountains of Utah [see Misc. Unclassified Tall Deciduous Tree-Dominated Communities (Padgett et al. 1989, p. 47)]. [SVC notes that much the same comments apply here as to POPBST / CORSER; there exists POPTRE / ALNINC - SALIX SPP (OR), POPTRE / LONINV (WY) and, of course, POPTRE / CORSER (CA, ID, MT, WA, G4); we will go with shrub species as habitat indicators rather than try to describe all the existing vegetation variation based on few and incomplete plots.]

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Fossil Butte National Monument Inventory Notes: The plot consists of *Populus tremuloides* trees surrounded by standing dead *Populus tremuloides* trees along the edge perhaps due to decreased water availability.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 observation point: FOBU.9071).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: G. Kittel, mod. K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Carsey et al. 2003a, Crawford 2001, Crawford 2003, Crowe and Clausnitzer 1997, Crowe et al. 2004, Driscoll et al. 1984, Evans 1989a, Hansen et al. 1990, Hansen et al. 1991, Hansen et al. 1995, IDCDC 2005, Jankovsky-Jones et al. 2001, Kagan et al. 2000, Kittel et al. 1994, Kittel et al. 1999a, Kittel et al. 1999b, Kovalchik 1993, Kovalchik 2001, MTNHP 2002b, Manning and Padgett 1995, Padgett et al. 1989, Richard et al. 1996, Titus et al. 1998, WNHP unpubl. data, Western Ecology Working Group n.d.

Juniperus scopulorum / Artemisia tridentata Woodland
Rocky Mountain Juniper / Basin Big Sagebrush Woodland

CODE	CEGL000743
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 SCOPULORUM* WOODLAND ALLIANCE (A.506) Rocky Mountain Juniper 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 occurs locally in Colorado, the portions of Wyoming surrounding the Bighorn Basin, and Montana's Greenhorn Range. Stands develop on foothills, plateaus, piedmont fans, rockslides and canyons. Elevations range from 1680 to 1830 m (5500-6000 ft.) in Montana and 2200 to 2600 m (7545-8120 ft.) in Colorado and Wyoming. Slopes are gentle to very steep (5-70%), may be oriented to any aspect, and are frequently rocky but include shaly substrates. Litter and duff are restricted to plant bases leaving much exposed soil, rock, bedrock and gravel. Bare ground also results from rill and sheet erosion and animal trailing. Soils are variable and include clay loams, sands and silt loams; some soils effervesce violently. Although this is not a riparian association, the best-developed examples occur in gullies and swales. The vegetation is characterized by a sparse to moderately dense, sometimes clumpy canopy of *Juniperus scopulorum* (constituting between 5 and 40% canopy cover) and a somewhat depauperate undergrowth as well, in which a sparse to moderate shrub layer dominated by *Artemisia tridentata* ssp. *vaseyana* or *Artemisia tridentata* ssp. *wyomingensis* is sometimes matched by a well-developed herbaceous layer. Associated shrubs may include *Amelanchier utahensis, Artemisia frigida, Juniperus communis, Mahonia repens, Opuntia polyacantha, Paxistima myrsinites, Prunus virginiana, Purshia tridentata, Ribes cereum,* and *Symphoricarpos rotundifolius*. The herbaceous layer is diverse in terms of species composition and provides sparse to moderate cover. Graminoids dominate the herbaceous layer, including *Pseudoroegneria spicata, Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Koeleria macrantha, Carex rossii, Elymus elymoides*, and *Poa fendleriana*. Forbs provide little cover but may include *Eriogonum umbellatum, Cryptantha flavoculata*, and *Physaria rollinsii*.

DISTRIBUTION
Fossil Butte National Monument
This unusual association is uncommon at the monument and represented by one plot within the only small stand in the monument located on the lower slump lobe near the Slump Trail.

Globally

This poorly documented association is known from widely scattered foothills, canyons and plateaus in Colorado, Wyoming and west-central Montana. In Wyoming it is most likely to be found around the margins of the Bighorn Basin (western flank of Bighorn Mountains, northern flank of Owl Creek Mountains, and eastern flank of Absaroka Mountains) and possibly the eastern flank of the Wind River Range. In Montana it has been cursorily documented only from the foothills and piedmont fans at the northern end of the Gravelly Range; in Colorado it occurs along the Front Range between Denver and the Wyoming state line (in the same landscape position as its Montana representation), on the western slope in the Gunnison Basin and in the northwestern part of the state. However, the ranges of the component indicator species are extensive, and the association could occur locally throughout the West.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This Rocky Mountain juniper / basin big sagebrush woodland occurs as one patch within the monument on the lower slump lobe of a slope near the Slump Trail. The site is moderately steep (13-degree slope), occurs at 2208 m elevation, and is oriented to the southwest. The unvegetated surface has moderate exposure of bare soil, moderate cover of litter, and sparse cover of small and large rocks. There is low cover of downed wood. The parent material is from the main body of the Wasatch Formation. Soils are rapidly drained clay loams.

Globally

This association is found locally in Colorado, the portions of Wyoming surrounding the Bighorn Basin and Fossil Butte, and Montana's Greenhorn Range. Stands occur on the slopes of ridges and canyons, on foothills, plateaus, piedmont fans, and soil slumps lobe rockslides. Elevation ranges from 1680 to 1830 m (5500-6000 ft.) in Montana to 2200 to 2475 m (7215-8120 ft.) in Colorado and Wyoming (Wasser and Hess 1982, Hess and Alexander 1986, Cooper et al. 1995). Slopes are gentle to very steep (5-70%), may be oriented to any aspect, and are frequently rocky. Litter and duff are restricted to plant bases, leaving much exposed soil, rock, bedrock and gravel. Soils are variable and include clay loams, sands and silt loams; some soils effervesce violently. Parent materials are variable and include colluvial and residual schists and gneisses, sandstones, limestones, shales (Wasatch Formation) and eolian sand deposits.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover is 55% in this moderately to densely vegetated stand. This woodland is characterized by an open canopy, 2-5 m tall, of the tree *Juniperus scopulorum* (8%) and moderate cover of the short shrub *Artemisia tridentata* ssp. *vaseyana* (24%). The average dbh of five *Juniperus scopulorum* trees within the plot is 16.6 cm. The tall shrub *Amelanchier utahensis* provides low cover (15%), while the short shrubs *Symphoricarpos oreophilus, Purshia tridentata,* and *Rosa woodsii* provide sparse cover. The herbaceous layer is moderate in terms of diversity and contributes sparse cover, less than 5% cover. Grasses include *Leymus cinereus, Achnatherum hymenoides*, and the non-native annual *Bromus tectorum*. Forbs include *Cirsium arvense* (a noxious non-native), *Penstemon procerus,* and *Phlox hoodii*. *Juniperus scopulorum* seedlings were observed outside of the plot.

Globally

This open woodland association is characterized by a sparse to moderately dense, sometimes clumpy canopy of *Juniperus scopulorum* (constituting between 5 and 40% canopy cover) and somewhat depauperate undergrowth as well, in which a sparse to moderate shrub layer dominated by *Artemisia tridentata* ssp. *vaseyana* or *Artemisia tridentata* ssp. *wyomingensis* is sometimes matched by a well-developed herbaceous layer. Associated shrubs may include *Amelanchier utahensis, Artemisia frigida, Cercocarpus montanus, Holodiscus dumosus, Juniperus communis, Mahonia repens, Opuntia polyacantha, Paxistima myrsinites, Prunus virginiana, Purshia tridentata, Ribes cereum,* and *Symphoricarpos rotundifolius*. The herbaceous layer is diverse in terms of species composition and provides sparse to moderate cover depending on the degree of canopy closure. Graminoids dominate the herbaceous layer and include *Pseudoroegneria spicata, Achnatherum hymenoides, Achnatherum lettermanii, Achnatherum pinetorum, Aristida purpurea, Bouteloua gracilis, Hesperostipa comata, Koeleria macrantha, Carex rossii, Elymus elymoides, Leymus cinereus*, and *Poa fendleriana*. Forbs provide little cover but may include *Arabis crandallii, Cryptantha flavoculata, Eriogonum umbellatum, Penstemon procerus, Phlox hoodii, Physaria rollinsii*, and *Potentilla fissa* (Hess and Alexander 1986).

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Tree canopy	*Juniperus scopulorum*
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*

Globally

Stratum	Species
Tree canopy	*Juniperus scopulorum*
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*, *Artemisia tridentata* ssp. *vaseyana*, *Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Achnatherum hymenoides*, *Bouteloua gracilis*, *Hesperostipa comata*, *Poa fendleriana*, *Pseudoroegneria spicata*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Bromus tectorum, *Cirsium arvense*

Globally
Arabis crandallii, *Bromus tectorum*, *Physaria rollinsii*

CONSERVATION STATUS RANK
Global Rank & Reasons: G3Q (30-Nov-1998). This association is represented by fewer than 15 sample plots, but hypothetically it could be relatively common given the current extensive distribution of indicator species for the type and unspecific habitat requirements. Neither of the indicator species are under any particular threat, and presumably the type as currently defined would thus not be imperiled; however, the graminoid component is not clearly understood or defined for this association and could be significantly altered by livestock grazing. A real question exists as to the taxonomy of this entity. If the bunchgrass component is the dominant aspect and canopy cover of *Juniperus scopulorum* and *Artemisia tridentata* is generally under 20%, then this is not technically a woodland (or shrubland). Other occurrences of the type may have been appropriately classed as shrub-steppe or grassland plant associations [see DeVelice et al. (1995)].

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Without tightly defined occurrence specifications, stands of this association may have been classified as shrub-steppe or grassland plant associations because (1) the cover of *Juniperus scopulorum* itself is sometimes so low that these stands would not have been considered woodlands but merely medium-tall temperate or subpolar grasslands with a sparse needle-leaved evergreen layer or even a medium-tall temperate or subpolar grassland with a sparse microphyllous evergreen shrub layer, and (2) alternatively, with sufficient cover of *Juniperus scopulorum* but *Artemisia tridentata* poorly represented, stands could be placed in *Juniperus scopulorum / Pseudoroegneria spicata* Woodland (CEGL000748).

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This community has become established on the lobe of a moderate-sized slump and does not occur elsewhere in the monument. As such, it may not be sustainable. It is controlled by its location and by seed dispersal mechanisms.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU 0191).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: S.V. Cooper, mod. J. Coles and K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Cooper et al. 1995, DeVelice 1992, DeVelice et al. 1995, Driscoll et al. 1984, Hess 1981, Hess and Alexander 1986, Jennings 1978, Jennings 1979, Johnston 1987, Jones 1992b, MTNHP 2002b, Wasser and Hess 1982, Western Ecology Working Group n.d.

Pinus flexilis / Cercocarpus montanus - Amelanchier utahensis Woodland
Limber Pine / Alderleaf Mountain-mahogany - Utah Serviceberry Woodland

CODE	CEGL005320
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 FLEXILIS* WOODLAND ALLIANCE (A.540) Limber Pine Woodland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Foothill Limber Pine-Juniper Woodland (CES306.955)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This limber pine woodland is only known from Fossil Butte National Monument in southwestern Wyoming. Stands occur on rims and upper slopes of ridges and buttes on gentle to steep (2- to 41-degree) slopes on all aspects between 2258 and 2413 m elevation. The unvegetated surface has low exposure of bare soil, moderate to high cover of litter, low to moderate cover of small rocks, low cover of large rocks, and sparse cover of bedrock and dead wood. Soils are moderately well-drained to rapidly-drained sandy loams, silts, and clays derived from the Wasatch Formation. This association is characterized by an open to moderately dense tree canopy, typically 10-20 m tall, of *Pinus flexilis* trees with between 6 and 48% cover, and a shrub-dominated understory consisting primarily of *Amelanchier utahensis* and *Cercocarpus montanus* with between 10 and 50% cover. Total vegetation cover ranges from 37 to nearly 100%. Scattered *Pseudotsuga menziesii* trees occur in the tree canopy of some stands. Some stands have a sparse subcanopy of sapling *Pinus flexilis, Pseudotsuga menziesii,* and *Juniperus scopulorum.* Associated shrubs include *Artemisia tridentata* ssp. *vaseyana, Chrysothamnus viscidiflorus, Holodiscus dumosus, Mahonia repens, Prunus virginiana, Ribes cereum, Shepherdia canadensis,* and *Symphoricarpos oreophilus.* The herbaceous layer is diverse but provides little cover. Common grasses include *Leymus cinereus, Pascopyrum smithii, Poa fendleriana,* and *Poa secunda*. Forbs include *Mertensia oblongifolia, Pteryxia terebinthina, Eriogonum umbellatum, Eriogonum brevicaule, Cirsium undulatum, Achillea millefolium, Lithospermum ruderale,* and *Trifolium gymnocarpon.*

DISTRIBUTION

Fossil Butte National Monument

This woodland occurs on rims and upper slopes of ridges and buttes within the monument, including Ruby Point and Dempsey's Ridge.

Globally

This woodland association is only known from Fossil Butte National Monument in southwestern Wyoming.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This limber pine / mountain mahogany - Utah serviceberry woodland occurs at the higher elevations of the northern part of the monument. It occupies rims and upper slopes of ridges and buttes. Stands are on gentle to steep (2- to 41-degree) slopes, lie between 2258 and 2413 m elevation, and are oriented to all aspects. The unvegetated surface has low exposure of bare soil, moderate to high cover of litter, low to moderate cover of small rocks, low cover of large rocks, and sparse cover of bedrock. Downed wood cover is low, up to 10% cover. Soils are moderately well-drained to rapidly-drained sandy loams, silts, and clays derived from the Wasatch Formation.

Globally

This limber pine woodland is only known from Fossil Butte National Monument in southwestern Wyoming. Stands occur on rims and upper slopes of ridges and buttes on gentle to steep (2- to 41-degree) slopes on all aspects between 2258 and 2413 m elevation. The unvegetated surface has low exposure of bare soil, moderate to high cover of litter, low to moderate cover of small rocks, low cover of large rocks, and sparse cover of bedrock and dead wood. Soils are moderately well-drained to rapidly drained sandy loams, silts, and clays derived from the Wasatch Formation.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 37% to nearly 100%. Stands are characterized by an open to dense canopy, typically 10-20 m tall, of *Pinus flexilis* trees with between 6 and 48% cover, and a shrub-dominated understory consisting primarily of *Amelanchier utahensis* and *Cercocarpus montanus* with between 10 and 50% cover. Shrub cover is inversely related to tree cover in most stands. The average dbh of *Pinus flexilis* trees in a 400-square-meter plot is around 30 cm. *Pseudotsuga menziesii* trees occur in the canopy of some stands, and sapling *Pinus flexilis, Pseudotsuga menziesii*, and *Juniperus scopulorum* provide sparse subcanopy cover. Associated shrubs include *Symphoricarpos oreophilus, Artemisia tridentata* ssp. *vaseyana, Prunus virginiana, Mahonia repens, Chrysothamnus viscidiflorus, Holodiscus dumosus, Ribes cereum*, and *Shepherdia canadensis*. The herbaceous layer is diverse but provides little cover. Common grasses include *Leymus cinereus, Poa fendleriana, Poa secunda*, and *Pascopyrum smithii*. Forbs include *Mertensia oblongifolia, Pteryxia terebinthina, Eriogonum umbellatum, Eriogonum brevicaule, Cirsium undulatum, Achillea millefolium, Lithospermum ruderale*, and *Trifolium gymnocarpon*.

Globally

This association is characterized by an open to moderately dense tree canopy, typically 10-20 m tall, of *Pinus flexilis* trees with between 6 and 48% cover, and a shrub-dominated understory consisting primarily of *Amelanchier utahensis* and *Cercocarpus montanus* with between 10 and 50% cover. Total vegetation cover ranges from 37 to nearly 100%. Scattered *Pseudotsuga menziesii* trees occur in the tree canopy of some stands. Some stands have a sparse subcanopy of sapling *Pinus flexilis, Pseudotsuga menziesii*, and *Juniperus scopulorum*. Associated shrubs include *Artemisia tridentata* ssp. *vaseyana, Chrysothamnus viscidiflorus, Holodiscus dumosus, Mahonia repens, Prunus virginiana, Ribes cereum, Shepherdia canadensis*, and *Symphoricarpos oreophilus*. The herbaceous layer is diverse but provides little cover. Common grasses include *Leymus cinereus, Pascopyrum smithii, Poa fendleriana*, and *Poa secunda*. Forbs include *Mertensia oblongifolia, Pteryxia terebinthina, Eriogonum umbellatum, Eriogonum brevicaule, Cirsium undulatum, Achillea millefolium, Lithospermum ruderale*, and *Trifolium gymnocarpon*.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Tree canopy	*Pinus flexilis*
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Cercocarpus montanus*

Globally

Stratum	Species
Tree canopy	*Pinus flexilis*
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Cercocarpus montanus*

OTHER NOTEWORTHY SPECIES

Fossil Butte National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (6-Aug-2007).

CLASSIFICATION COMMENTS

Fossil Butte National Monument

Data are not available.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Mature limber pine on ridgetop; shallow soil on bedrock that receives heavy snow accumulation. This site was grazed extensively, but there is regeneration and dense understory since it was excluded from grazing. This stand is located on the edge and upper slope of a ridge where maximum snow accumulation and wind protection occur. The trees are subject to lightning strikes, every mature tree has a scarred trunk.
Fossil Butte National Monument Data: The description is based on 2005 field data (7 plots: FOBU.0003, FOBU.0028, FOBU.0112, FOBU.0134, FOBU.0154, FOBU.0156, FOBU.0190; 3 observation points: FOBU.9057, FOBU.9146, FOBU.9147).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Pinus flexilis / Symphoricarpos oreophilus Woodland
Limber Pine / Mountain Snowberry Woodland

CODE	CEGL005321
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 FLEXILIS* WOODLAND ALLIANCE (A.540) Limber Pine Woodland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Foothill Limber Pine-Juniper Woodland (CES306.955)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This limber pine woodland is only known from Fossil Butte National Monument in southwestern Wyoming. Stands occur at higher elevations in the northern portion of the monument. It occupies high slopes and rims of ridges and a drainage. The sites are moderate to steep (5-38 degrees), north- or northwest-facing slopes between 2222 and 2416 m elevation. The unvegetated surface has low exposure of bare soil, high cover of litter, low cover of small rocks, and sparse cover of large rocks. Downed wood has up to 10% cover. The parent materials include the Fossil Butte and Angelo members of the Wasatch Formation and the main body of the Wasatch Formation. Soils are rapidly drained sandy clay loams or clay loams. This association is characterized by an open to dense canopy, typically 10-15 m tall, of the tree *Pinus flexilis* that ranges in cover from 10-55%, and an understory of the short shrub *Symphoricarpos oreophilus* that ranges in cover from less than 10 to 30%. The total vegetation cover ranges from 30-99% in these moderately to densely vegetated stands. Sapling *Pinus flexilis* and *Pseudotsuga menziesii*, typically 2-5 m tall, provide sparse subcanopy cover. The shrub layer is diverse and includes low cover of tall, short, and dwarf-shrubs such as *Amelanchier utahensis, Artemisia tridentata* ssp. *vaseyana, Cercocarpus montanus, Mahonia repens, Ribes cereum, Rosa woodsii,* and *Shepherdia canadensis*. The herbaceous layer is low in terms of diversity and provides sparse to low cover. Common grasses include *Poa pratensis, Poa fendleriana*, and *Leymus cinereus*. Forbs include *Achillea millefolium, Delphinium nuttallianum, Lappula occidentalis, Lithospermum ruderale, Mertensia oblongifolia,* and *Pteryxia terebinthina*. *Pinus flexilis* and *Pseudotsuga menziesii* seedlings provides sparse cover in some stands.

DISTRIBUTION
Fossil Butte National Monument
This woodland is found on rims and high slopes of ridges on Dempsey's Ridge and Ruby Point and the toeslope of Fossil Butte.

Globally
This limber pine woodland is only known from Fossil Butte National Monument in southwestern Wyoming.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This limber pine / mountain snowberry woodland is present at higher elevations in the northern part of the monument. It occupies high slopes and rims of ridges and a drainage. The sites are moderate to steep (5- to 38-degree slopes), occur between 2222 and 2416 m elevation, and are oriented to the north or northwest. The unvegetated surface has low exposure of bare soil, high cover of litter, low cover of small rocks, and sparse cover of large rocks. Downed wood cover is low to moderate with up to 10% cover. The parent materials include the Fossil Butte and Angelo members of the Wasatch Formation and the main body of the Wasatch Formation. Soils are rapidly drained clay loams.

Globally

This limber pine woodland is only known from Fossil Butte National Monument in southwestern Wyoming. Stands occur at higher elevations in the northern portion of the monument. It occupies high slopes and rims of ridges and a drainage. The sites are moderate to steep (5-38 degrees), north- or northwest-facing slopes between 2222 and 2416 m elevation. The unvegetated surface has low exposure of bare soil, high cover of litter, low cover of small rocks, and sparse cover of large rocks. Downed wood has up to 10% cover. The parent materials include the Fossil Butte and Angelo members of the Wasatch Formation and the main body of the Wasatch Formation. Soils are rapidly drained and generally fine-textured.

VEGETATION DESCRIPTION

Fossil Butte National Monument

The total vegetation cover ranges from 30-99% in these moderately to densely vegetated stands. This association is characterized by an open-to-dense canopy, typically 10-15 m tall, of the tree *Pinus flexilis* that ranges in cover from 10-55%, and an understory of the short shrub *Symphoricarpos oreophilus* that ranges in cover from less than 10 to 30%. The average dbh of *Pinus flexilis* trees within sampled stands is 12.3 cm, and the average number of trees per 400-square-meter plot is 11. Sapling *Pinus flexilis* and *Pseudotsuga menziesii*, typically 2-5 m tall, provide sparse understory cover. The shrub layer is diverse, provides sparse to low cover, and includes the tall, short, and dwarf-shrubs *Amelanchier utahensis, Cercocarpus montanus, Rosa woodsii, Mahonia repens, Artemisia tridentata* ssp. *vaseyana, Ribes cereum,* and *Shepherdia canadensis*. The herbaceous layer is low in terms of diversity and provides sparse to low cover. Common grasses include *Poa pratensis, Poa fendleriana,* and *Leymus cinereus*. Forbs include *Mertensia oblongifolia, Lappula occidentalis, Delphinium nuttallianum, Achillea millefolium, Pteryxia terebinthina,* and *Lithospermum ruderale*. *Pinus flexilis* and *Pseudotsuga menziesii* seedlings provides sparse cover in some plots.

Globally

This association is characterized by an open-to-dense canopy, typically 10-15 m tall, of the tree *Pinus flexilis* that ranges in cover from 10-55%, and an understory of the short shrub *Symphoricarpos oreophilus* that ranges in cover from less than 10 to 30%. The total vegetation cover ranges from 30-99% in these moderately to densely vegetated stands. Sapling *Pinus flexilis* and *Pseudotsuga menziesii*, typically 2-5 m tall, provide sparse subcanopy cover. The shrub layer is diverse and includes low cover of tall, short, and dwarf-shrubs such as *Amelanchier utahensis, Artemisia tridentata* ssp. *vaseyana, Cercocarpus montanus, Mahonia repens, Ribes cereum, Rosa woodsii,* and *Shepherdia canadensis*. The herbaceous layer is low in terms of diversity and provides sparse to low cover. Common grasses include *Poa pratensis, Poa fendleriana,* and *Leymus cinereus*. Forbs include *Achillea millefolium, Delphinium nuttallianum, Lappula occidentalis, Lithospermum ruderale, Mertensia oblongifolia,* and *Pteryxia terebinthina*. *Pinus flexilis* and *Pseudotsuga menziesii* seedlings provides sparse cover in some stands.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Tree canopy	*Pinus flexilis*
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Symphoricarpos oreophilus*

Globally

Stratum	Species
Tree canopy	*Pinus flexilis*
Tall shrub/sapling	*Amelanchier utahensis*

Short shrub/sapling *Symphoricarpos oreophilus*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Poa pratensis

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (6-Aug-2007).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This community is controlled by mesic site conditions and slope exposure. The trees are mostly mature and are reproducing. There is no apparent sign of fire. This stand occupies a depression below a cliff band that collects water from Fossil Butte allowing for a dense shrubland. The *Pinus flexilis* trees are stressed, with some standing dead trees.
Fossil Butte National Monument Data: The description is based on 2005 field data (2 plots: FOBU.0102, FOBU.0120; 1 observation point: FOBU.9026).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Populus tremuloides / Prunus virginiana Woodland
Quaking Aspen / Chokecherry Woodland

CODE	CEGL002130
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	Cold-deciduous woodland (II.B.2.N.a.)
ALLIANCE	*POPULUS TREMULOIDES* WOODLAND ALLIANCE (A.610) Quaking Aspen Woodland Alliance
ECOLOGICAL SYSTEM(S):	Northwestern Great Plains Aspen Forest and Parkland (CES303.681) Rocky Mountain Aspen Forest and Woodland (CES306.813)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This quaking aspen / choke cherry woodland is found in the north-central Great Plains of the United States and Canada and extends west into southwestern Wyoming. Stands occur on well-drained loam or clay loam soils. The canopy is open to dense. It is dominated by *Populus tremuloides*, with *Fraxinus pennsylvanica* a common associate. *Betula papyrifera* can be present to abundant. The shrub layer is very well-developed. It is dominated by *Prunus virginiana* and may contain *Amelanchier alnifolia*, *Corylus* spp., *Rosa* spp., and *Symphoricarpos occidentalis*. *Aralia nudicaulis*, *Maianthemum stellatum*, and *Galium boreale* are typically found in the herbaceous layer.

DISTRIBUTION

Fossil Butte National Monument
This association is uncommon at the monument and represented by one observation point on a bench below Fossil Butte.

Globally
This quaking aspen / choke cherry woodland is found in the north-central Great Plains of the United States and Canada extending from southwestern North Dakota west to southwestern Wyoming and north into southern Manitoba and Saskatchewan.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This quaking aspen / chokecherry woodland is uncommon within the monument and occupies a bench along the slope of Fossil Butte. The site is gentle (4-degree slope), occurs at 2215 m elevation, and is oriented to the east. The unvegetated surface has low exposure of bare soil, low cover of small and large rocks, and high cover of litter. There is sparse cover of downed wood. The parent material is the main body of the Wasatch Formation.

Globally
This quaking aspen woodland occurs on gentle to moderately steep (1-49%) slopes on the fringes of other woodlands and on cooler north- and east-facing hills and buttes up to 2215 m elevation. Sites usually receive additional moisture from deposition of blowing snow or seeps. The soils are deep (>40 cm) loam, with a pH of 7.2 to 8.0 (Girard et al. 1989) or clay loam (Wasatch Formation shale). At the eastern edge of its range, this community can be found on dry-mesic to wet-mesic sites and on flat to rolling topography.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 79% in this densely vegetated stand. This association is characterized by an open canopy, typically 10-15 m tall, of *Populus tremuloides* trees (30% cover) and the tall shrub *Prunus virginiana* that provides 11% cover. The short shrub *Symphoricarpos oreophilus* provides sparse cover. The herbaceous layer consists of grasses and forbs, including *Leymus cinereus, Cirsium undulatum*, and the non-native *Poa pratensis* that contribute moderate cover (up to 37%).

Globally
Across its range, the dominant canopy species in this community is *Populus tremuloides*, often associated with *Fraxinus pennsylvanica*. *Betula papyrifera* is sometimes present or even codominant (Girard et al. 1989). In the eastern portion of its range, *Quercus macrocarpa* and *Populus grandidentata* are also typical canopy associates. *Populus tremuloides* spreads by root suckering and this can result in high stem density, especially in younger stands. Girard et al. (1989) found 722 stems/ha in southwestern North Dakota. There is a significant shrub layer that is dominated by *Prunus virginiana*. Other common shrub species include *Ribes aureum var. villosum, Amelanchier alnifolia, Symphoricarpos occidentalis, Symphoricarpos oreophilus, Corylus* spp., *Rhus trilobata*, and *Rosa* spp. The herbaceous layer is not as well-developed as the shrub layer but is still significant. Relatively mesic species, such as *Maianthemum stellatum, Galium boreale, Aralia nudicaulis, Leymus cinereus*, and *Cirsium undulatum*, and non-native *Poa pratensis*, are frequently found in the herbaceous layer.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Tree canopy	*Populus tremuloides*
Short shrub/sapling	*Prunus virginiana*
Herb (field)	*Leymus cinereus*

Globally

Stratum	Species
Tree canopy	*Populus tremuloides*
Shrub/sapling (tall & short)	*Prunus virginiana*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument

Poa pratensis

Globally
Fraxinus pennsylvanica, Poa pratensis

CONSERVATION STATUS RANK
Global Rank & Reasons: G4G5 (3-Oct-1996).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
This association should be compared with *Populus tremuloides / Corylus* spp. / *Andropogon gerardii* Woodland (CEGL005205) in the aspen parkland tallgrass region. Drier aspen stands in the Great Plains are classified as *Populus tremuloides / Corylus cornuta* Forest (CEGL000583). This association is similar to *Populus tremuloides / Prunus virginiana* Forest (CEGL000596) found in the Black Hills, Rocky Mountains, and Colorado Plateau (Mueggler 1988). More classification work is needed to fully clarify differences between these associations.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This area receives more moisture than surrounding areas with the west end of bench containing a dense *Prunus virginiana* understory, while the east end is parklike with a dense *Leymus cinereus / Poa pratensis* understory.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 observation point: FOBU.9086).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Drake, mod. K.A. Schulz

REFERENCES: Girard et al. 1989, Greenall 1996, Hansen et al. 1984, MNNHP 1993, Midwestern Ecology Working Group n.d., Mueggler 1988, NDNHI n.d., Von Loh et al. 2000

Artemisia arbuscula ssp. *longiloba* / Cushion Plants Shrubland
Alkali Sagebrush / Cushion Plants Shrubland

CODE	CEGL005996
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 ARBUSCULA* SSP. *LONGILOBA* SHRUBLAND ALLIANCE (A.2549) Alkali Sagebrush Shrubland Alliance
ECOLOGICAL SYSTEM(S):	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe (CES304.794) Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This alkali sagebrush low shrubland is only known from Fossil Butte National Monument in southwestern Wyoming but is likely more widespread. Stands in Wyoming are moderately steep (6-18 degrees), northeast-, southeast- or south-facing slopes between 2052 and 2279 m elevation. Sites are dry and windy much of the time. The unvegetated surface has moderate to high exposure of bare soil, low cover of small and large rocks, and sparse cover of litter and downed wood. Soils are rapidly drained clays derived from the Wasatch Formation. This association is characterized by a sparse to moderate short-shrub layer dominated by *Artemisia arbuscula* ssp. *longiloba* with 8-16% cover and a relatively sparse but diverse cushion plant-dominated herbaceous layer. Total vegetation cover ranges from 20-38%

in these moderately vegetated stands. Associated short and dwarf-shrubs *Artemisia frigida, Atriplex gardneri, Krascheninnikovia lanata,* and *Tetradymia spinosa* provide sparse cover. The herbaceous layer is dominated by a cushion plant community of *Antennaria dimorpha, Arenaria hookeri, Astragalus bisulcatus, Astragalus jejunus, Eriogonum brevicaule, Minuartia nuttallii, Phlox hoodii, Stenotus acaulis,* and *Trifolium gymnocarpon*. Perennial grasses may be present, including *Achnatherum hymenoides, Elymus lanceolatus, Pascopyrum smithii,* and *Poa secunda* that provide sparse to low cover. Total cover of grasses is typically less than that of forbs.

DISTRIBUTION

Fossil Butte National Monument

This association is located on a slope of the Chicken Creek drainage and along the high slope of Ruby Point.

Globally

This alkali sagebrush association is only known from Fossil Butte National Monument in southwestern Wyoming and is likely more widespread on other windswept sites.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This alkali sagebrush / cushion plants dwarf-shrubland occupies a slope of Chicken Creek and the high slope of Ruby Point. The sites are moderately steep (6- to 18-degree slopes), occur between 2052 and 2279 m elevation, and are oriented to the northeast, southeast or south. The unvegetated surface has moderate to high exposure of bare soil, low cover of small and large rocks, and sparse cover of litter and downed wood. Parent materials include the Fossil Butte Member of the Wasatch Formation and the main body of the Wasatch Formation. Soils are rapidly drained clays.

Globally

This alkali sagebrush low shrubland is only known from Fossil Butte National Monument in southwestern Wyoming but is likely more widespread. Stands in Wyoming are moderately steep (6-18 degrees), northeast-, southeast- or south-facing slopes between 2052 and 2279 m elevation. Sites are dry and windy much of the time. The unvegetated surface has moderate to high exposure of bare soil, low cover of small and large rocks, and sparse cover of litter and downed wood. Soils are rapidly drained silts and clays derived from the Wasatch Formation.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 20-38% in these moderately vegetated stands. This association is characterized by sparse to moderate cover of the short shrub *Artemisia arbuscula* ssp. *longiloba* that ranges from 8-16%. A diverse cushion plant community provides sparse cover, including *Eriogonum brevicaule, Stenotus acaulis, Trifolium gymnocarpon, Phlox hoodii, Arenaria hookeri, Astragalus bisulcatus, Antennaria dimorpha, Minuartia nuttallii,* and *Astragalus jejunus*. The remaining shrub layer includes the short and dwarf-shrubs *Tetradymia spinosa, Artemisia frigida, Atriplex gardneri,* and *Krascheninnikovia lanata* that provide sparse cover. The herbaceous layer includes sparse grass cover; species include *Poa secunda, Achnatherum hymenoides, Elymus lanceolatus,* and *Pascopyrum smithii* that provide sparse to low cover. Total cover of grasses is typically less than total cover of forbs.

Globally

This association is characterized by a sparse to moderate short-shrub layer dominated by *Artemisia arbuscula* ssp. *longiloba* with 8-16% cover and a relatively sparse but diverse cushion plant-dominated herbaceous layer. Total vegetation cover ranges from 20-38% in these moderately vegetated stands. Associated short and dwarf-shrubs *Artemisia frigida, Atriplex gardneri, Krascheninnikovia lanata,* and *Tetradymia spinosa* provide sparse cover. The herbaceous layer is dominated by a cushion plant community of *Antennaria dimorpha, Arenaria hookeri, Astragalus bisulcatus, Astragalus jejunus, Eriogonum brevicaule, Minuartia nuttallii, Phlox hoodii, Stenotus acaulis,* and *Trifolium gymnocarpon*. Perennial grasses may be present, including *Achnatherum hymenoides, Elymus lanceolatus, Pascopyrum smithii,* and *Poa secunda* that provide sparse to low cover. Total cover of grasses is typically less than total cover of forbs.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia arbuscula* ssp. *longiloba*
Herb (field)	*Eriogonum brevicaule, Phlox hoodii, Stenotus acaulis, Trifolium gymnocarpon*
Herb (field)	*Poa secunda*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia arbuscula* ssp. *longiloba*
Herb (field)	*Eriogonum brevicaule, Phlox hoodii, Stenotus acaulis, Trifolium gymnocarpon*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Astragalus jejunus

Globally
Astragalus jejunus

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (3-Aug-2007).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This community is controlled by slope, exposure, and soils. The brownish-red clay forms active slopes with slumping ledges deposited behind vegetation and rocks. Runoff is rapid, resulting in sheet erosion and the formation of minor gullies. These soils are subject to slumping and form minor ledges behind rocks and vegetation.
Fossil Butte National Monument Data: The description is based on 2005 field data (5 plots: FOBU.0008, FOBU.0019, FOBU.0020, FOBU.0073, FOBU.0084; 1 observation point: FOBU.9144).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Knight 1994, Knight et al. 1987, Tweit and Houston 1980, Western Ecology Working Group n.d.

Artemisia arbuscula ssp. *longiloba / Elymus lanceolatus* Shrubland
Alkali Sagebrush / Streambank Wheatgrass Shrubland

CODE	CEGL002585
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 ARBUSCULA* SSP. *LONGILOBA* SHRUBLAND ALLIANCE (A.2549) Alkali Sagebrush Shrubland Alliance
ECOLOGICAL SYSTEM(S):	Inter-Mountain Basins Shale Badland (CES304.789) Colorado Plateau Mixed Low Sagebrush Shrubland (CES304.762) Wyoming Basins Dwarf Sagebrush Shrubland and Steppe (CES304.794)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally
This association occurs in northwestern Colorado and adjacent Utah, as well as southwestern Wyoming. Elevations range between 1600 and 2450 m (5250 - 8040 ft.), and sites are on gentle to moderately steep slopes oriented to any aspect. Soils are typically shallow and rocky with a clay loam texture, as they are derived from underlying Mancos, Morrison, Wasatch or Green River shale. Ground cover is mostly bare soil with organic litter concentrated under the shrubs. Surface gullying in many sites indicates that precipitation tends to run off rather than be absorbed by the soil. The vegetation is characterized by 10 to 30% cover of the dwarf-shrub *Artemisia arbuscula* ssp. *longiloba*. Other low-statured shrubs that may be present with low cover include *Atriplex confertifolia* and *Krascheninnikovia lanata*. The herbaceous layer is dominated by *Elymus lanceolatus* with 5 to 10% cover. Other common grasses include *Achnatherum hymenoides* and *Poa secunda*. Forb species are variable, but *Phlox hoodii* appears throughout the range. Total vegetation cover rarely exceeds 45%.

DISTRIBUTION
Fossil Butte National Monument
This association is located on the tops of Ruby Point and Fossil Butte.

Globally
This association is known from high plateaus in northwestern Colorado and adjacent Utah, as well as southwestern Wyoming.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This alkali sagebrush / streamside wheatgrass shrubland occupies the butte and ridgetops of Ruby Point and Fossil Butte. The sites are gentle to steep (1- to 34-degree slopes) and occur between 2066 and 2434 m elevation on a variety of aspects. The unvegetated surface has moderate to high exposure of bare soil, low to moderate cover of litter, and low cover of small and large rocks. Parent materials include the Fossil Butte Member of the Wasatch Formation or sandstones and shale that have eroded. Soils are moderately well-drained to rapidly drained clay loams.

Globally
This association occurs in northwestern Colorado and adjacent Utah, as well as southwestern Wyoming. Elevations range between 1600 and 2450 m (5250-8040 ft.), and sites are on gentle to steep slopes oriented to any aspect. Soils are typically shallow and rocky and have a silty clay loam or clay loam texture, as they are derived from underlying Mancos, Morrison, Wasatch or Green River shale deposited as alluvium or colluvium. Ground cover is mostly bare soil with organic litter concentrated under the shrubs. Bare ground, gravel and litter cover most of the unvegetated ground surface, and surface erosion (rills and gullies) in many sites indicates that precipitation tends to run off rather than be absorbed by the soil.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover ranges from 16-46% in these low to moderately vegetated stands. This association is characterized by sparse to moderate cover of the short shrub *Artemisia arbuscula* ssp. *longiloba* that ranges from 6-30% and typically sparse cover of the diagnostic dominant or codominant perennial grass *Elymus lanceolatus* that ranges in cover from 2-4%. The remaining shrub layer includes *Atriplex confertifolia, Chrysothamnus viscidiflorus, Krascheninnikovia lanata, Eriogonum microthecum, Amelanchier utahensis,* and *Artemisia tridentata* ssp. *vaseyana* that provide sparse cover. The remaining herbaceous layer is low in terms of diversity and contributes sparse to low cover. Other graminoids include *Poa secunda, Pascopyrum smithii, Achnatherum hymenoides, Leymus cinereus, Pseudoroegneria spicata,* and *Elymus elymoides*. Forbs provide sparse cover and include *Taraxacum officinale, Linum lewisii, Phlox longifolia, Eriogonum brevicaule, Phlox hoodii,* and *Trifolium gymnocarpon.*

Globally
This association is characterized by an open to moderate dwarf-shrub layer dominated by *Artemisia arbuscula* ssp. *longiloba* (10- 30% cover) with *Elymus lanceolatus* dominating the herbaceous layer (5-10% cover). Total vegetation cover ranges from 15-50%. Other low-statured shrubs that may be present with low cover include *Amelanchier utahensis, Artemisia tridentata* ssp. *vaseyana, Atriplex confertifolia, Chrysothamnus viscidiflorus, Eriogonum microthecum, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia fragilis,* and *Opuntia polyacantha*. The grass-dominated herbaceous layer includes low cover of other grasses such as *Achnatherum*

hymenoides, Elymus elymoides, Hesperostipa comata, Leymus cinereus, Pascopyrum smithii, Poa secunda, and *Pseudoroegneria spicata*. Forb species are variable, but *Phlox hoodii* appears throughout the range. Other forbs include sparse cover of *Eriogonum brevicaule, Linum lewisii, Phlox longifolia, Trifolium gymnocarpon,* and exotic *Taraxacum officinale.*

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia arbuscula* ssp. *longiloba*
Herb (field)	*Elymus lanceolatus, Poa secunda*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia arbuscula* ssp. *longiloba*
Herb (field)	*Elymus lanceolatus*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Taraxacum officinale

Globally
Data are not available.

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

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Elymus lanceolatus can be difficult to distinguish from *Pseudoroegneria spicata* and also from their hybrid, *Elymus albicans*. All three entities occur within the range of this association. It may be worth considering combining this association with *Artemisia arbuscula* ssp. *longiloba / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001416) and include stands with *Elymus albicans* as well.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Groundwater in slump deposits is fairly high, so this slope supports vegetation more typical of floodplains. Soils have polygonal cracking characteristic of shrink-swell because of high clay content. The steep slope and exposure, along with alkaline clay soils, control the community. Runoff is rapid and minor slumping at the base of shrubs creates small ledges. This soil will creep downslope when wet.
Fossil Butte National Monument Data: The description is based on 2005 field data (8 plots: FOBU.0014, FOBU.0023, FOBU.0024, FOBU.0062, FOBU.0079, FOBU.0086, FOBU.0088, FOBU.0116; 3 observation points: FOBU.9052, FOBU.9082, FOBU.9101).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Artemisia arbuscula ssp. *longiloba / Poa fendleriana* Shrubland
Alkali Sagebrush / Muttongrass Shrubland

CODE	CEGL005997
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 ARBUSCULA* SSP. *LONGILOBA* SHRUBLAND ALLIANCE (A.2549) Alkali Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Wyoming Basins Dwarf Sagebrush Shrubland and Steppe (CES304.794)
Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This alkali sagebrush low shrubland is only known from Fossil Butte National Monument in southwestern Wyoming. Stands occur on gentle to steep (2- to 24-degree), west-, northwest- or east-facing slopes between 2080 and 2450 m elevation. The unvegetated surface has moderate exposure of bare soil, moderate cover of litter, and low cover of small and large rocks. Soils are well-drained to rapidly drained clay loams or clays derived from the Wasatch Formation. This association is characterized by a sparse to moderate the short-shrub layer dominated by *Artemisia arbuscula* ssp. *longiloba* (1-20% cover) and the perennial bunchgrass *Poa fendleriana* (1-15% cover) that dominates the understory. This association includes sparsely vegetated stands as total vegetation cover ranges from 2-43%. The shrub layer includes other the short and dwarf-shrubs, such as *Artemisia tripartita, Atriplex confertifolia, Cercocarpus montanus, Chrysothamnus viscidiflorus*, and *Ericameria nauseosa*, that provide sparse cover. The typically sparse herbaceous layer includes other grasses, including *Elymus lanceolatus, Poa secunda, Poa secunda*, and *Pseudoroegneria spicata*, and forbs such as *Astragalus jejunus, Astragalus vexilliflexus, Eriogonum brevicaule, Phlox hoodii, Phlox longifolia*, and *Trifolium gymnocarpon*.

DISTRIBUTION

Fossil Butte National Monument

This association is located on a badlands formation associated with Chicken Creek, near The Bullpen and on the high slope of Ruby Point.

Globally

This alkali sagebrush low shrubland is only known from Fossil Butte National Monument in southwestern Wyoming but likely is more widespread.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This alkali sagebrush / muttongrass shrubland occupies a badlands formation of Chicken Creek and the high slope of Ruby Point. The sites are gentle to steep (2- to 24-degree slopes), occur between 2080 and 2450 m elevation, and are oriented to the west, northwest, or east. The unvegetated surface has moderate exposure of bare soil, moderate cover of litter, and low cover of small and large rocks. Parent materials include the Bullpen Member of the Wasatch Formation and the main body of the Wasatch Formation. Soils are well-drained to rapidly drained clay loams or clays.

Globally

This alkali sagebrush low shrubland is only known from Fossil Butte National Monument in southwestern Wyoming. Stands occur on gentle to steep (2- to 24-degree), west-, northwest- or east-facing slopes between 2080 and 2450 m elevation. The unvegetated surface has moderate exposure of bare soil, moderate cover of litter, and low cover of small and large rocks. Soils are well-drained to rapidly drained clay loams or clays derived from the Wasatch Formation.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 2-43% in these sparsely to moderately vegetated stands. This association is characterized by sparse to moderate cover of the short shrub *Artemisia arbuscula* ssp. *longiloba* (1-20% cover) and the perennial bunchgrass *Poa fendleriana* (1-15% cover) that dominates the understory. The remaining shrub layer includes the short and dwarf-shrubs *Cercocarpus montanus, Atriplex confertifolia, Ericameria nauseosa, Chrysothamnus viscidiflorus*, and *Artemisia tripartita* that provide sparse cover. The remaining herbaceous layer provides sparse cover and includes the grasses *Poa secunda, Poa secunda, Elymus lanceolatus*, and

Pseudoroegneria spicata. Forbs include *Eriogonum brevicaule, Astragalus vexilliflexus, Astragalus jejunus, Phlox hoodii, Trifolium gymnocarpon*, and *Phlox longifolia*.

Globally
This association is characterized by a sparse to moderate the short-shrub layer dominated by *Artemisia arbuscula* ssp. *longiloba* (1-20% cover) and the perennial bunchgrass *Poa fendleriana* (1-15% cover) that dominates the understory. This association includes sparsely vegetated stands as total vegetation cover ranges from 2-43%. The shrub layer includes other the short and dwarf-shrubs, such as *Artemisia tripartita, Atriplex confertifolia, Cercocarpus montanus, Chrysothamnus viscidiflorus*, and *Ericameria nauseosa* that provide sparse cover. The typically sparse herbaceous layer includes other grasses, including *Elymus lanceolatus, Poa secunda, Poa secunda*, and *Pseudoroegneria spicata*, and forbs such as *Astragalus jejunus, Astragalus vexilliflexus, Eriogonum brevicaule, Phlox hoodii, Phlox longifolia*, and *Trifolium gymnocarpon*.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia arbuscula* ssp. *longiloba*
Herb (field)	*Poa fendleriana*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia arbuscula* ssp. *longiloba*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Astragalus jejunus

Globally
Astragalus jejunus

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (3-Aug-2007).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This shrubland appears to tolerate the thinner soils and drier conditions of ridgelines. The site has light tan/white clay soil with a large quantity of rocks. Vegetation appears to grow horizontal to the hillside.
Fossil Butte National Monument Data: The description is based on 2005 field data (4 plots: FOBU.0044, FOBU.0048, FOBU.0049, FOBU.0091; 2 observation points: FOBU.9046, FOBU.9081).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Artemisia arbuscula ssp. *longiloba* Shrubland
Alkali Sagebrush Shrubland

CODE	CEGL001414
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 ARBUSCULA* SSP. *LONGILOBA* SHRUBLAND ALLIANCE (A.2549) Alkali Sagebrush Shrubland Alliance
ECOLOGICAL SYSTEM(S):	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe (CES304.794) Great Basin Xeric Mixed Sagebrush Shrubland (CES304.774) Columbia Plateau Low Sagebrush Steppe (CES304.080)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This alkali sagebrush shrubland is known from Fossil Butte National Monument in southwestern Wyoming and Jarbridge Mountains in northeastern Nevada but likely is more widespread. In the southern portion of the monument in Wyoming, it is distributed as large patches or stands on fine-textured alkaline soils on slopes, valley floors, interfluves, drainages and ridges, on gentle (1- to 10-degree) slopes oriented to all aspects, except northern, between 2030 and 2374 m elevation. The unvegetated surface has low to high exposure of bare soil, low to high cover of small and large rocks, litter, and downed wood. Soils are moderately well-drained to rapidly clays. The vegetation is characterized by a sparse to moderate short-shrub layer dominated by *Artemisia arbuscula* ssp. *longiloba* (4-40% cover) without a significant understory. This association also includes sparsely vegetated stands as total vegetation cover ranges from 8-75%. The shrub layer includes other short and dwarf-shrubs, such as *Amelanchier utahensis, Artemisia tridentata* ssp. *tridentata, Atriplex gardneri, Chrysothamnus viscidiflorus, Ericameria nauseosa, Krascheninnikovia lanata,* or *Symphoricarpos oreophilus* that provide sparse cover. If present, the herbaceous cover is sparse and variable with scattered grasses and forbs.

DISTRIBUTION

Fossil Butte National Monument

This association is distributed throughout the southern half of the monument.

Globally

This alkali sagebrush shrubland occurs in Fossil Butte National Monument in southwestern Wyoming and Jarbridge Mountains in northeastern Nevada. It likely occurs throughout much of the range of *Artemisia arbuscula* ssp. *longiloba*.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This alkali sagebrush shrubland is distributed as large patches or stands throughout the southern portion of the monument on fine-textured alkaline soils in slopes, valley floors, interfluves, drainages, and ridges. The sites are gentle (1- to 10-degree slopes), occur between 2030 and 2374 m elevation, and are oriented to all aspects, except northern. The unvegetated surface has low to high exposure of bare soil, low to high cover of small and large rocks, litter, and downed wood. Parent materials include the Fossil Butte Member of the Wasatch Formation and the main body of the Wasatch Formation. Soils are moderately well-drained to rapidly-drained clays or clay loams.

Globally

This alkali sagebrush shrubland is known from Fossil Butte National Monument in southwestern Wyoming and Jarbridge Mountains in northeastern Nevada. In the southern portion of the monument in Wyoming, it is distributed as large patches or stands on fine-textured alkaline soils on slopes, valley floors, interfluves, drainages and ridges, on gentle (1- to 10-degree) slopes oriented to all aspects, except northern, between 2030 and 2374 m elevation. The unvegetated surface has low to high exposure of bare soil, low to high cover of small and large rocks, litter, and downed wood. Soils are moderately well-drained to rapidly-drained fine-textured, and derived from the Wasatch Formation. Little information is available for stands in Nevada.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 8-75% in these sparsely to densely vegetated stands. This association is characterized by sparse to moderate cover of the short shrub *Artemisia arbuscula* ssp. *longiloba* that ranges in cover from 4-40%. The remaining shrub layer includes the tall, short, and dwarf-shrubs *Chrysothamnus viscidiflorus,*

Ericameria nauseosa, Artemisia tridentata ssp. *tridentata, Amelanchier utahensis, Symphoricarpos oreophilus, Atriplex gardneri*, and *Krascheninnikovia lanata* that provide sparse to low cover. If present, the herbaceous layer is typically sparse and with variable taxa. Associated grasses may include scattered *Achnatherum hymenoides, Leymus cinereus, Poa secunda, Pascopyrum smithii, Elymus lanceolatus, Poa fendleriana*, and *Elymus elymoides*. Forbs include *Phlox hoodii, Pteryxia terebinthina, Alyssum desertorum, Ceratocephala testiculata, Trifolium gymnocarpon, Stenotus acaulis, Eriogonum umbellatum, Antennaria dimorpha, Astragalus vexilliflexus, Iva axillaris, Sedum lanceolatum, Erigeron nanus*, and *Balsamorhiza sagittata*.

Globally
This broadly defined alkali sagebrush shrubland is characterized by a sparse to moderate short-shrub layer dominated by *Artemisia arbuscula* ssp. *longiloba* (4-40% cover) without a significant understory. The shrub layer may include other the short and dwarf-shrubs, such as *Amelanchier utahensis, Artemisia tridentata* ssp. *tridentata, Atriplex gardneri, Chrysothamnus viscidiflorus, Ericameria nauseosa, Krascheninnikovia lanata*, or *Symphoricarpos oreophilus*, that provide sparse cover. If present, the herbaceous cover is sparse and variable with scattered grasses and forbs. Associated grasses may include *Achnatherum hymenoides, Elymus elymoides, Elymus lanceolatus, Leymus cinereus, Pascopyrum smithii, Poa fendleriana, Poa secunda*, and forbs include *Alyssum desertorum, Antennaria dimorpha, Astragalus vexilliflexus, Balsamorhiza sagittata, Ceratocephala testiculata, Erigeron nanus, Eriogonum umbellatum, Iva axillaris, Phlox hoodii, Pteryxia terebinthina, Sedum lanceolatum, Stenotus acaulis*, and *Trifolium gymnocarpon*. This description is based on data from Wyoming, although *Festuca idahoensis* was mentioned as an associate in Nevada stands.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus*
Short shrub/sapling	*Artemisia arbuscula* ssp. *longiloba*
Herb (field)	*Poa secunda*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia arbuscula* ssp. *longiloba*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Alyssum desertorum, Ceratocephala testiculata

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G4G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
This is a broadly defined *Artemisia arbuscula* ssp. *longiloba* shrubland that characteristically lacks an herbaceous layer. It includes stands that have a moderately dense shrub canopy and lack an herbaceous layer because of disturbance and sparsely vegetated stands that are the result of harsh environments, e.g., badland or windswept sites. The *Artemisia longiloba* community described in Lewis (1975a) has very little information, and more survey and classification work are needed to clarify the range and concept of this association.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Fossil Butte National Monument Inventory Notes: This plant community is controlled by the steep, erosive, alkaline slope and dry exposure that restricts shrub cover. The slope is active and the soils are creeping downward. This ridgetop is exposed to wind and sun that likely explains the lack of taller shrubs.
Fossil Butte National Monument Data: The description is based on 2005 field data (3 plots: FOBU.0043, FOBU.0055, FOBU.0136; 2 observation points: FOBU.9017, FOBU.9027).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Lewis 1975a

Artemisia nova / Pseudoroegneria spicata Shrubland
Black Sagebrush / Bluebunch Wheatgrass Shrubland

CODE	CEGL001424
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) Wyoming Basins Dwarf Sagebrush Shrubland and Steppe (CES304.794) Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This common black sagebrush association occurs from northern Nevada to Colorado and north to Idaho and Montana. Sites are located on gently to moderately sloping, dry, often windswept hills and ridges that may be oriented to any aspect. Elevation ranges from 1400 to 2610 m (4600-8560 ft.). Soils are shallow, gravelly and are often high in calcium carbonate. Rock and gravel cover much of the unvegetated ground surface. The vegetation is characterized by a low-shrub canopy dominated by *Artemisia nova* with 5 to 30% cover. Other shrubs are generally present, although with very low cover, including *Artemisia tridentata, Chrysothamnus viscidiflorus, Grayia spinosa, Symphoricarpos longiflorus*, and *Gutierrezia sarothrae*. Graminoids usually dominate the diverse herbaceous layer, with *Pseudoroegneria spicata* being the most conspicuous of as many as 10 species, including *Poa secunda, Achnatherum hymenoides, Pascopyrum smithii, Koeleria macrantha (= Koeleria cristata), Carex filifolia, Elymus trachycaulus, Pleuraphis jamesii*, and *Hesperostipa comata*. Sparse forbs are usually present and may include *Phlox hoodii, Crepis acuminata, Astragalus miser, Stenotus acaulis, Phlox diffusa, Artemisia frigida*, and *Calochortus* spp. Some sites have scattered *Juniperus osteosperma* trees.

DISTRIBUTION
Fossil Butte National Monument
This association is uncommon at the monument and represented by one plot located on the top of Cundick Ridge.

Globally
This common and widespread association is known from northern Nevada to Colorado and north to Idaho and Montana, including the Owl Creek, Absaroka and Laramie ranges and the Wind River Basin in Wyoming and the Uinta Basin of northwestern Colorado.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This black sagebrush / bluebunch wheatgrass shrubland is uncommon within the monument. It occupies the top of Cundick Ridge close to a large, recent burn. The site is gentle (2-degree slope), occurs at 2352 m elevation, and is oriented to the southwest. The unvegetated surface has high cover of small rocks, sparse cover of large rocks, low

cover of litter, and sparse exposure of bare soil. The parent material is the Angelo Member of the Wasatch Formation. Soils are rapidly drained silt loams.

Globally
This association occurs from northern Nevada to Colorado and north to Idaho and Montana. Sites are located on gently to moderately sloping, dry, windswept hills and ridges that may be oriented to any aspect. Elevation ranges from 1400 to 2610 m (4600-8560 ft.). Soils are shallow, gravelly and are often high in calcium carbonate. Rock and gravel cover much of the unvegetated ground surface with lesser cover of bare ground and litter. Soils are typically shallow to moderately deep, rapidly drained and often calcareous. Soil textures include silt, silt loam or clay loam (Zamora and Tueller 1973, Tweit and Houston 1980, Hironaka et al. 1983, Johnston 1987). Some stands are associated with clay pan soils in North Park, Colorado (Robertson 1966). Parent materials include the sandstone, gravel, limestone, and granitic substrates in north-central Wyoming and Angelo Member of the Wasatch Formation in southwestern Wyoming.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 57% in this moderately vegetated stand. This association is characterized by low to moderate codominant cover of the short shrubs *Artemisia nova* and *Artemisia tridentata* ssp. *vaseyana* (18% each) and sparse cover of the perennial grass *Pseudoroegneria spicata* (1%). The shrub layer is moderate in terms of diversity and provides low cover. The short and dwarf-shrubs provide sparse cover and include *Chrysothamnus viscidiflorus, Symphoricarpos oreophilus, Krascheninnikovia lanata,* and *Eriogonum microthecum*. The herbaceous layer is moderate in terms of diversity and contributes low cover. Grasses include *Poa fendleriana* and *Pascopyrum smithii*. Forbs include *Comandra umbellata, Stenotus acaulis, Cordylanthus ramosus, Trifolium gymnocarpon,* and *Phlox hoodii*.

Globally
Vegetation is characterized by a low-shrub canopy dominated by *Artemisia nova* with 5 to 30% cover. Other shrubs are generally present, although with very low cover, including *Artemisia tridentata* ssp. *wyomingensis, Chrysothamnus viscidiflorus, Eriogonum microthecum, Krascheninnikovia lanata, Grayia spinosa, Gutierrezia sarothrae, Opuntia polyacantha, Symphoricarpos longiflorus,* and *Symphoricarpos oreophilus*. *Artemisia tridentata* ssp. *vaseyana* codominates some stands. Graminoids usually dominate the diverse herbaceous layer, with *Pseudoroegneria spicata* being the most conspicuous of as many as 10 species, including *Achnatherum hymenoides, Achnatherum thurberianum, Carex filifolia, Elymus trachycaulus, Hesperostipa comata, Koeleria macrantha (= Koeleria cristata), Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana, Poa secunda,* and exotic annual grass *Bromus tectorum*. Sparse forbs are usually present and may include *Antennaria microphylla, Astragalus miser, Astragalus spatulatus, Artemisia frigida, Calochortus* spp., *Crepis acuminata, Cryptantha* spp., *Comandra umbellata, Cordylanthus ramosus, Heterotheca villosa, Leptodactylon pungens, Petradoria pumila, Phlox diffusa, Phlox hoodii, Stenotus acaulis,* and *Trifolium gymnocarpon* (Zamora and Tueller 1973, Tweit and Houston 1980, Johnston 1987). Some sites may have scattered *Juniperus osteosperma* or *Pinus monophylla* trees.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia nova*, *Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Comandra umbellata*
Herb (field)	*Poa fendleriana*, *Pseudoroegneria spicata*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia nova*
Herb (field)	*Pseudoroegneria spicata*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G4G5 (1-Feb-1996). This is a common and widespread shrubland type occurring in the Great Basin, Wyoming Basins and Uinta Basin. However, this is generally a small- to moderate-patch community, limited by habitat requirements that are more specific than surrounding matrix communities.

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: The plot is located on a ridgetop that is exposed to wind and sun. A two-track trail is located through the stand. Soils are protected from runoff by gravel. This is the only location for *Artemisia nova* known within the monument.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0111).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Baker 1983c, Baker and Kennedy 1985, Blackburn et al. 1968c, Blackburn et al. 1971, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Fisser 1962, Fisser 1970, Hironaka et al. 1983, Hughes 1977, Johnston 1987, Jones 1992b, Jones and Ogle 2000, Kagan et al. 2000, Knight et al. 1987, Lucky McMine Application n.d., MTNHP 2002b, Robertson et al. 1966, Soil Conservation Service 1978, Tweit and Houston 1980, Western Ecology Working Group n.d., Zamora and Tueller 1973

Artemisia tridentata ssp. *tridentata / Leymus cinereus* Shrubland
Basin Big Sagebrush / Great Basin Wildrye Shrubland

CODE	CEGL001016
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 Steppe (CES304.778) Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This widely distributed sagebrush shrubland is a transitional community found on floodplains, terraces of perennial streams and along the edges of seasonally flooded washes and gullies of the high desert steppe of the western United States or associated relatively mesic upland sites (swales) with high water tables. Elevations range from 1600 to 2170 m (5250-7120 ft.). On terraces, slopes are level to gentle, and the substrate is alluvium or loess. Mesic upland site are gentle to steep, with substrates derived from shale and sandstone. Soils generally have silty or clay loam textures and are moderately well-drained. Stands of this association are characterized by a shrub layer dominated by *Artemisia tridentata* ssp. *tridentata* standing 1-3 m tall and an herbaceous layer dominated by *Leymus cinereus* 0.5-1.5 m tall. Some stands may take the form of a *Leymus cinereus* grassland with *Artemisia tridentata* ssp. *tridentata* on the margins, but more often stands are shrublands with grass growing in openings between shrub

canopies. Total vegetation cover ranges from 20 to 90%. *Sarcobatus vermiculatus* and *Ericameria nauseosa* may also be present in the shrub stratum. *Leymus cinereus* dominates the understory with 15 to 90% cover. Various other grasses are likely to be present, including *Bromus tectorum, Distichlis spicata*, and other grasses associated with more mesic or riparian environments. Forbs species vary among sites.

DISTRIBUTION

Fossil Butte National Monument

This shrubland occupies depressions or drainages along the slopes of Fossil Butte and on a landslide deposit near the historic quarry.

Globally

This was formerly a widespread association in the western United States. Today it is known from California to Washington and east to Montana and Colorado.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This basin big sagebrush / Great Basin wildrye shrubland occurs in depressions and drainages that intermittently or seasonally flood on Fossil Butte or an associated landslide deposit. The sites are flat to steep (0- to 20-degree slope), occur between 2080 and 2170 m elevation, and are oriented to the south or northwest. The unvegetated surface has low to moderate exposure of bare soil, moderate to high cover of litter, and low cover of small and large rocks and downed wood. The parent material is either the main body of the Wasatch Formation or sandstones and shale that have eroded and deposited during a landslide event. Soils are moderately well-drained silt loams.

Globally

This widely distributed sagebrush shrubland is a transitional community found on floodplain terraces of perennial streams, along the edges of seasonally flooded washes and gullies of the high desert steppe, or associated relatively mesic upland sites such as swales on ridge slopes or a landslide/slump below seeps on steeper slopes that have high water tables. Elevations range from 1600 to 2170 m (5250-7120 ft.). Slopes are level to gentle on terraces to moderately steep on mesic hillslopes. Substrates are variable and include alluvium, colluvium or loess. Soils generally have silty or clay loam textures and are moderately well-drained. Parent materials include sandstone and shale.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 26-77% in these moderately to densely vegetated stands. This association is characterized by low to moderate cover of the tall shrub *Artemisia tridentata* ssp. *tridentata* that ranges in cover from 10-45% and low to moderate cover of the coarse bunchgrass *Leymus cinereus* that ranges in cover from 7-30%. The remaining short-shrub layer includes *Chrysothamnus viscidiflorus, Symphoricarpos oreophilus, Purshia tridentata*, and *Artemisia arbuscula* ssp. *longiloba* that provide sparse to low cover. The remaining herbaceous layer is low to moderate in terms of diversity and contributes sparse to low cover. Associated graminoids include *Poa secunda, Poa fendleriana, Juncus balticus*, and the non-native perennial *Poa pratensis*. Forbs include *Maianthemum stellatum, Cirsium undulatum, Mertensia oblongifolia, Pteryxia terebinthina*, and *Iva axillaris*.

Globally

Stands of this association are characterized by a shrub layer dominated by *Artemisia tridentata* ssp. *tridentata* standing 1-3 m tall, and an herbaceous layer dominated by *Leymus cinereus* 0.5-1.5 m tall. Some stands may take the form of a *Leymus cinereus* grassland with *Artemisia tridentata* ssp. *tridentata* on the margins, but more often stands are shrublands with grass growing in openings between shrub canopies. *Chrysothamnus viscidiflorus, Ericameria nauseosa, Rosa woodsii, Sarcobatus vermiculatus*, and *Symphoricarpos oreophilus* may also be present in the shrub stratum. *Leymus cinereus* dominates the understory with 15 to 90% cover. Various other graminoids may be present, including *Poa secunda, Poa fendleriana, Juncus balticus, Distichlis spicata*, and other grasses associated with more mesic or riparian environments. Forbs species vary among sites but tend to be relatively mesic, such as *Achillea millefolium, Cirsium undulatum, Geranium* spp., *Iva axillaris, Maianthemum stellatum, Mertensia oblongifolia, Pteryxia terebinthina*, and *Vicia americana*. Exotic grasses *Bromus tectorum* and *Poa pratensis* may be common on disturbed sites.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Leymus cinereus*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Poa pratensis

Globally
Bromus inermis, Bromus tectorum, Poa pratensis

CONSERVATION STATUS RANK
Global Rank & Reasons: G2 (7-Apr-1998). This plant association was formerly widespread in the western United States but is now rare due to habitat loss and degradation of stands. The association is believed to be extirpated in Washington. In other western states, high-quality examples are of rare occurrence, and most stands are small and fragmented. Livestock use has reduced the quality of stands and continues to threaten remaining occurrences. Agricultural conversion has also eliminated habitat previously occupied by the association. Exotic species, including *Poa pratensis* or *Bromus tectorum*, may become locally dominant, nearly replacing the diagnostic graminoid. Incision of smaller streams and intermittent drainages throughout the West also has affected this association by dropping the water table and causing stands to dry out to the point that they will no longer support *Leymus cinereus*.

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Water table is obviously high here, at the foot of the seep that supports a stand of willows. At the time of sampling, the groundwater was at the surface. This site lies in a low depression on north side of ridge extending from Fossil Butte, which receives more moisture than the surrounding sparse herbaceous vegetation. This shrubland is visible on all ridges extending from Fossil Butte.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0107; 3 observation points: FOBU.9019, FOBU.9020, FOBU.9033).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: M. Jankovsky-Jones, mod. J. Coles and K.A. Schulz

REFERENCES: Baker 1982b, Baker 1983b, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Hess 1981, IDCDC 2005, Johnston 1987, Jones and Fertig 1996, Jones and Ogle 2000, Kagan et al. 2000, Kittel et al. 1994, Kittel et al. 1999a, MTNHP 2002b, Walford 1996, Wasser and Hess 1982

Artemisia tridentata ssp. *tridentata / Poa secunda* Shrubland
Basin Big Sagebrush / Curly Bluegrass Shrubland

CODE	CEGL001008
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)

ALLIANCE *ARTEMISIA TRIDENTATA (*SSP. *TRIDENTATA,* SSP. *XERICENSIS)* SHRUBLAND
ALLIANCE (A.830)

(Basin Big Sagebrush, Foothill Big Sagebrush) Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)
Inter-Mountain Basins Big Sagebrush Steppe (CES304.778)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This basin big sagebrush shrubland is known from the Great Basin, southern Columbia Plateau, Colorado Plateau, and Wyoming Basins. Stands occur on valley floors, drainages, and lower leeward slopes of ridges. Sites are flat to moderate sloping (1-8 degrees) and are found on all aspects. Elevation ranges between 241 m in eastern Washington up to 2095 m in southwestern Wyoming. The unvegetated surface has high exposure of bare soil, low cover of litter, and sparse cover of small rocks and downed wood. Soils are moderately well-drained to rapidly drained and vary from sandy and silty loams to silty clay loam and clay. Parent materials include sandstones and shale. The vegetation is characterized by open to moderate cover of the tall shrub *Artemisia tridentata* ssp. *tridentata* (10-35% cover) and sparse to moderate cover of the perennial bunchgrass *Poa secunda* (1-50% cover). The shrub layer includes other short and dwarf-shrubs with sparse to low cover, such as *Artemisia arbuscula* ssp. *longiloba, Artemisia tridentata* ssp. *vaseyana, Atriplex gardneri, Chrysothamnus viscidiflorus,* and *Eriogonum* spp. The herbaceous layer has low diversity. Other grasses present may include low cover of *Aristida purpurea, Elymus elymoides, Elymus lanceolatus, Hesperostipa comata, Poa glauca,* and the non-native bunchgrass *Agropyron cristatum*. *Pseudoroegneria spicata* is usually absent or sparse. Forbs have very low cover and species diversity.

DISTRIBUTION

Fossil Butte National Monument

This shrubland is located on drainages, a knoll, and the valley floor of secondary drainages of Chicken Creek.

Globally

This basin big sagebrush shrubland is reported from the Great Basin, southern Columbia Plateau, Colorado Plateau, and Wyoming Basins of Nevada, Utah and Wyoming.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This basin big sagebrush / curly bluegrass shrubland occurs within the Chicken Creek drainage on valley floors, drainages, and a knoll. Sites are gentle to moderate (1- to 8-degree slopes), occur between 2028 and 2095 m elevation, and are oriented to all aspects. The unvegetated surface has high exposure of bare soil, low cover of litter, and sparse cover of small rocks and downed wood. The parent materials include the Fossil Butte Member of the Wasatch Formation, the main body of the Wasatch Formation, and sandstones and shale that have eroded and deposited as secondary stream alluvium. Soils are moderately well-drained to rapidly drained sandy loams, loams, or clays.

Globally

This basin big sagebrush shrubland is known from the Great Basin, southern Columbia Plateau, Colorado Plateau, and Wyoming Basins. Stands occur on valley floors, drainages, and lower leeward slopes of ridges. Sites are flat to moderate sloping (1-8 degrees) and are found on all aspects. Elevation ranges between 241 m in eastern Washington up to 2095 m in southwestern Wyoming (Daubenmire 1970). The unvegetated surface has high exposure of bare soil, low cover of litter, and sparse cover of small rocks and downed wood. Soils are moderately well-drained to rapidly drained and vary from sandy and silty loams to silty clay loam and clay. Parent materials include sandstones and shale that have eroded and deposited as secondary stream alluvium.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 35-60% in these moderately to densely vegetated stands. This association is characterized by moderate cover of the tall shrub *Artemisia tridentata* ssp. *tridentata* (25-35% cover) and sparse cover of the perennial bunchgrass *Poa secunda* (1-2% cover). The remaining short- and dwarf-shrub layers provide sparse to low cover and include *Chrysothamnus viscidiflorus, Atriplex gardneri, Eriogonum microthecum, Artemisia arbuscula* ssp. *longiloba,* and *Artemisia tridentata* ssp. *vaseyana*. The remaining herbaceous layer is low in terms of

diversity and contributes sparse cover. Other grasses include *Elymus elymoides, Elymus lanceolatus, Poa glauca,* and the non-native bunchgrass *Agropyron cristatum*. Forbs include *Antennaria dimorpha, Lepidium virginicum, Ceratocephala testiculata,* and *Alyssum desertorum*.

Globally
This association is characterized by open to moderate cover of the tall shrub *Artemisia tridentata* ssp. *tridentata* (10-35% cover) and sparse to moderate cover of the perennial bunchgrass *Poa secunda* (1-50% cover). The shrub layer includes other short and dwarf-shrubs with sparse to low cover, such as *Artemisia arbuscula* ssp. *longiloba, Artemisia tridentata* ssp. *vaseyana, Atriplex gardneri, Chrysothamnus viscidiflorus*, and *Eriogonum* spp. The herbaceous layer has low diversity. Other grasses present may include low cover of *Aristida purpurea, Elymus elymoides, Elymus lanceolatus, Hesperostipa comata, Poa glauca*, and the non-native bunchgrass *Agropyron cristatum*. *Pseudoroegneria spicata* is usually absent or sparse. Forbs have very low cover and species diversity and may include *Alyssum desertorum, Antennaria dimorpha, Descurainia* sp., *Lappula occidentalis (= Lappula redowskii), Lepidium virginicum,* and *Ceratocephala testiculata* (Daubenmire 1970).

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus*
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Poa secunda*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Agropyron cristatum, Alyssum desertorum, Ceratocephala testiculata, Lepidium virginicum

Globally
Agropyron cristatum, Alyssum desertorum, Ceratocephala testiculata, Lepidium virginicum

CONSERVATION STATUS RANK
Global Rank & Reasons: G3G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Site has rapidly drained clay soil with sheet erosion and wide cracks in dried mud. Vegetation occurs on pedestals 2-5 cm above the ground. Presence of *Artemisia tridentata* ssp. *tridentata* indicates deeper soils that are moderately well-drained. Area serves as habitat for many species of wildlife.
Fossil Butte National Monument Data: The description is based on 2005 field data (3 plots: FOBU.0035, FOBU.0061, FOBU.0072; 3 observation points: FOBU.9018, FOBU.9035, FOBU.9037).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Daubenmire 1970, Driscoll et al. 1984, Moretti 1979, Moretti and Brotherson 1982, Robertson 1971, Western Ecology Working Group n.d.

*Artemisia tridentata (*ssp. *vaseyana,* ssp. *wyomingensis) - Amelanchier utahensis* Shrubland (Mountain Big Sagebrush, Wyoming Big Sagebrush) - Utah Serviceberry Shrubland

CODE	CEGL002820
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 Montane Sagebrush Steppe (CES304.785)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association has been described from Dinosaur National Monument, the Roan Plateau and the Piceance Basin in northwestern Colorado and adjacent Utah. It also occurs in southwestern Wyoming. Sites are on level to moderately sloping hills, valleys and benches. Elevation ranges from 2165 to 2600 m, and stands may be oriented to any aspect. The deep, well-drained soils are derived from sandstone, shale, loess or limestone and range in texture from clay loam and silt loam to loamy sand. Organic litter is typically a significant component of the ground surface cover. The vegetation is characterized by the codominance in the canopy of *Artemisia tridentata* (ssp. *vaseyana* or ssp. *wyomingensis*, or sometimes a hybrid of the two) and *Amelanchier utahensis* with 15 to 55% total cover. It often takes the appearance of a tall shrubland type in which clumps of serviceberry grow in a matrix of sagebrush. Although serviceberry and sagebrush are visually dominant, in some stands *Symphoricarpos oreophilus* may have the highest cover of the three shrub species. *Chrysothamnus viscidiflorus, Mahonia repens,* and *Purshia tridentata* may be minor components of the shrub canopy. *Quercus gambelii*, if present, has less than 1% cover. Graminoids tend to dominate the well-developed herbaceous layer; typical species are *Pascopyrum smithii (= Agropyron smithii), Melica spectabilis (= Bromelica spectabilis), Carex geyeri, Koeleria macrantha, Poa fendleriana, Achnatherum nelsonii* ssp. *dorei, Hesperostipa comata,* and *Achnatherum lettermanii (= Stipa lettermanii).* The forb component of the understory is usually diverse and may contribute significant cover, especially in stands that have been grazed. *Achillea millefolium, Balsamorhiza sagittata, Comandra umbellata, Crepis acuminata, Eriogonum umbellatum, Lathyrus lanszwertii var. leucanthus (= Lathyrus leucanthus), Lupinus argenteus, Penstemon caespitosus, Sphaeralcea coccinea*, and *Viola nuttallii* are common species. *Poa pratensis* may be the dominant grass in areas that have a history of grazing.

DISTRIBUTION

Fossil Butte National Monument

This shrubland is located on sheltered slopes, benches, hillsides, and drainages on the high slopes of Fossil Butte, Cundick Ridge, and Ruby Point.

Globally

This association is currently known from the highlands of Dinosaur National Monument and Black Canyon of the Gunnison National Park, as well as the Roan Plateau and Piceance Basin in northwestern Colorado and northeastern Utah. It also occurs at Fossil Butte National Monument in southwestern Wyoming and is likely more widespread.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This big sagebrush - Utah serviceberry shrubland occurs on ridges, slopes, and depressions of Fossil Butte, Cundick Ridge, and Ruby Point. Sites are gentle to steep (2- to 20-degree slopes), occur between 2211 and 2422 m elevation, and are oriented to all aspects. The unvegetated surface has moderate to high exposure of bare soil, moderate cover of litter, and low cover of small rocks and downed wood. The parent materials include the Fossil Butte Member of the Wasatch Formation and the main body of the Wasatch Formation. Soils are moderately well-drained to rapidly-drained and range from sandy loams to clays.

Globally

This association occurs on level to moderately sloping hills, plateaus, valleys, ridgetops and benches in northwestern Colorado. Sites are gentle to steep (2- to 20-degree slopes), occur at elevation ranges from 2165 to 2600 m (7100-8530 ft.), and may be oriented to any aspect. The deep, well-drained soils are derived from sandstone, shale, loess or limestone and range in texture from clay loam and silt loam to loamy sand. Organic litter is typically a significant component of the ground surface cover.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 41-74% in these moderately to densely vegetated stands. This association is characterized by low to moderate cover of the tall shrub *Amelanchier utahensis* (4-23% cover) and the short shrub *Artemisia tridentata* ssp. *vaseyana* (8-40% cover). The canopy tree *Pinus flexilis* provides sparse cover. The remaining short-shrub layer is diverse, provides sparse to low cover, and includes *Purshia tridentata, Chrysothamnus viscidiflorus, Symphoricarpos oreophilus, Ribes cereum,* and *Cercocarpus montanus*. The herbaceous layer is diverse and contributes sparse to moderate cover. The perennial grass *Poa secunda* provides sparse to low cover, while the graminoids *Elymus lanceolatus, Leucopoa kingii, Poa fendleriana, Achnatherum nelsonii, Carex geyeri, Achnatherum lettermanii,* and *Pascopyrum smithii* provide sparse cover. Forbs include *Achillea millefolium, Trifolium gymnocarpon, Taraxacum officinale, Lupinus argenteus, Cirsium undulatum, Lithospermum ruderale, Mertensia oblongifolia, Senecio integerrimus, Pteryxia terebinthina,* and *Balsamorhiza sagittata*.

Globally

This mountain shrubland association is characterized by the codominance in the canopy of *Artemisia tridentata* ssp. *vaseyana* or *Artemisia tridentata* ssp. *wyomingensis* and *Amelanchier utahensis* with 15 to 75% total cover. It often takes the appearance of a tall shrubland type in which clumps of serviceberry grow in a matrix of sagebrush. Although serviceberry and sagebrush are visually dominant, in some stands *Symphoricarpos oreophilus* may have the highest cover of the three shrub species. *Chrysothamnus viscidiflorus, Mahonia repens,* and *Purshia tridentata* may be minor components of the shrub canopy. *Quercus gambelii*, if present, has less than 1% cover. Graminoids tend to dominate the well-developed herbaceous layer; typical species are *Pascopyrum smithii (= Agropyron smithii), Melica spectabilis (= Bromelica spectabilis), Carex geyeri, Koeleria macrantha, Poa fendleriana, Achnatherum nelsonii* ssp. *dorei, Hesperostipa comata,* and *Achnatherum lettermanii (= Stipa lettermanii).* The forb component of the understory is usually diverse and may contribute significant cover, especially in stands that have been grazed. *Achillea millefolium, Balsamorhiza sagittata, Comandra umbellata, Crepis acuminata, Eriogonum umbellatum, Lathyrus lanszwertii var. leucanthus (= Lathyrus leucanthus), Lupinus argenteus, Penstemon caespitosus, Sphaeralcea coccinea,* and *Viola nuttallii* are common species. *Poa pratensis* may be the dominant grass in areas that have a history of grazing.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Symphoricarpos oreophilus*
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Poa secunda*

Globally

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Symphoricarpos oreophilus*
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana, Artemisia tridentata* ssp. *wyomingensis*

OTHER NOTEWORTHY SPECIES

Fossil Butte National Monument

Taraxacum officinale

Globally

Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jul-2005).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
There is some overlap between this community and the various sagebrush - snowberry associations in the IVC, but the codominance of *Artemisia tridentata* and *Amelanchier utahensis* distinguishes it from them. This association is not ecotonal between sagebrush shrublands and mixed mountain shrublands; instead, it appears to occupy its own habitat and can cover extensive areas.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This dense stand occupies deep soils of the most mesic sites on the slopes. This slope is protected from high winds, but the wind most likely deposits soil in the area. This aspect and slope probably receive a large snowpack, and the added moisture has allowed a dense/diverse grass understory to develop.
Fossil Butte National Monument Data: The description is based on 2005 field data (9 plots: FOBU.0018, FOBU.0050, FOBU.0056, FOBU.0064, FOBU.0085, FOBU.0117, FOBU.0152, FOBU.0155, FOBU.0157).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Keammerer and Peterson 1981, Keammerer and Stoecker 1975

Artemisia tridentata ssp. *vaseyana / Achnatherum lettermanii* Shrubland
Mountain Big Sagebrush / Letterman's Needlegrass Shrubland

CODE	CEGL002811
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. *VASEYANA* SHRUBLAND ALLIANCE (A.831) Mountain Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This shrubland occurs in the upper elevations of the sagebrush zone in plateau areas of western Colorado. Stands are located on gently to moderately sloping hills, ridgetops and benches. Elevations range from 2268 to 2609 m, and aspect is not a factor. Soils are deep, well-developed and often derived from eolian loess, although the underlying substrate may be sandstone, limestone or shale. Soil texture is silt loam or fine sandy loam. Litter covers most of the unvegetated ground surface. The vegetation of this association is characterized by a moderately closed shrub canopy dominated by *Artemisia tridentata* ssp. *vaseyana* with a well-developed and diverse herbaceous understory dominated by *Achnatherum lettermanii*. Total shrub cover generally ranges between 20 and 50%, and the shrub layer often also includes *Symphoricarpos oreophilus* and *Chrysothamnus viscidiflorus*. The herbaceous layer is dominated by graminoids and usually contains a number of species, including *Poa fendleriana, Poa secunda, Achnatherum pinetorum, Elymus lanceolatus*, and *Carex rossii* or *Carex geyeri*. Forbs vary among sites, but *Eriogonum umbellatum* is often present.

DISTRIBUTION
Fossil Butte National Monument

This association is found in the northern portion of the monument near The Bullpen.

Globally
This association has been documented from western Colorado and southwestern Wyoming. It is likely to occur elsewhere in the western U.S. at higher elevations of the sagebrush zone.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This mountain big sagebrush / Letterman's needlegrass shrubland occurs in the upper reaches of the sagebrush zone within the monument. Stands are located on gentle to moderate (8-18 degrees) mid and high slopes of hills. Elevations range from 2418 to 2462 m on cooler north- and east-facing slopes. Substrates are derived from Angelo or Bullpen members of the Wasatch Formation. Litter covers most of the unvegetated ground surface (20-40% cover) with some bare ground (5-15% cover).

Globally
This shrubland occurs in the upper elevations of the sagebrush zone in plateau areas of western Colorado. Stands are located on gently to moderately sloping hills, ridgetops and benches. Elevations range from 2268 to 2609 m, and aspect is not a factor. Soils are generally deep, well-developed and often derived from eolian loess, although the underlying substrate may be sandstone, limestone or shale. Soil texture is silt loam or fine sandy loam. Litter covers most of the unvegetated ground surface.

VEGETATION DESCRIPTION
Fossil Butte National Monument
This sagebrush shrubland has a mixed shrub canopy dominated by *Artemisia tridentata* ssp. *vaseyana* with between 20 and 30% cover. The shrub layer also contains up to 6% cover of *Symphoricarpos oreophilus*, as well as scattered individuals of *Chrysothamnus viscidiflorus, Ribes cereum, Rosa woodsii, Tetradymia canescens*, and occasional *Pinus flexilis* tree. The herbaceous layer is moderately diverse and well-developed and is dominated by *Achnatherum hymenoides* with between 5 and 8% cover. Other grasses present include *Poa fendleriana, Carex* spp., *Elymus lanceolatus, Leymus cinereus,* and *Leucopoa kingii*. The forb component is variable and has significantly less cover than the graminoid element. Common species include *Achillea millefolium, Antennaria* spp., *Eriogonum umbellatum,* and *Lupinus sericeus*.

Globally
The vegetation of this association is characterized by a moderately closed shrub canopy dominated by *Artemisia tridentata* ssp. *vaseyana* with a well-developed and diverse herbaceous understory dominated by *Achnatherum lettermanii*. Total shrub cover generally ranges between 20 and 50%, and the shrub layer often also includes *Symphoricarpos oreophilus* and *Chrysothamnus viscidiflorus*. The herbaceous layer is dominated by graminoids and usually contains a number of species, including *Poa fendleriana, Poa secunda, Achnatherum pinetorum,* and *Carex rossii* or *Carex geyeri*. Forbs vary among sites, but *Eriogonum umbellatum* is often present.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus, Symphoricarpos oreophilus*
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Achnatherum lettermanii*

Globally

Stratum	Species
Short shrub/sapling	*Symphoricarpos oreophilus*
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Achnatherum lettermanii*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available.

Globally
Astragalus anisus, Poa pratensis

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (28-Jun-2005).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Data are not available.
Fossil Butte National Monument Data: This description is based on field data collected in 2006 during accuracy assessment (2 plots: FOBU_AA.0198, FOBU_AA.0607).
Local Description Authors: K.A. Schulz
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Artemisia tridentata ssp. *vaseyana / Balsamorhiza sagittata* Shrubland
Mountain Big Sagebrush / Arrowleaf Balsamroot Shrubland

CODE	CEGL001020
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. *VASEYANA* SHRUBLAND ALLIANCE (A.831) Mountain Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This shrubland occurs on ridges, benches and mesas in the northern Colorado Plateau and western slope of the southern Rocky Mountains. Stands occur in somewhat isolated upland patches in western Colorado and in southwestern Wyoming. Slopes range from level to moderate and occur between 2300 and 2675 m (7545-8776 ft.) elevation. Soils are derived from a wide variety of substrates; textures vary accordingly from clays to sandy loams. Biological soil crusts may be present but rarely have significant cover. Total vegetation cover ranges from 25 to nearly 100%. The vegetation is characterized by a shrub canopy of *Artemisia tridentata* ssp. *vaseyana* (15-75%), often associated with *Amelanchier utahensis, Symphoricarpos oreophilus,* and *Purshia tridentata*. The herbaceous understory is dominated by *Balsamorhiza sagittata* and other forbs, including *Phlox* spp., *Eriogonum umbellatum, Castilleja linariifolia, Senecio integerrimus, Arenaria congesta*, and *Crepis acuminata*. Total herbaceous cover ranges from 10 to 30%. Grasses vary among sites and may include *Poa fendleriana, Poa secunda, Hesperostipa comata, Pseudoroegneria spicata, Achnatherum pinetorum, Achnatherum lettermanii,* and *Pascopyrum smithii*. Scattered *Juniperus osteosperma* may be present, but pinyon or juniper trees appear not to threaten stands on high slopes and ridgetops because of their relatively thin soils. Fire tends to convert these sites to grasslands dominated by the herbaceous species present before the burn.

DISTRIBUTION
Fossil Butte National Monument

This association is uncommon at the monument and represented by one plot located on a high slope on the south-facing ridge near Ruby Point.

Globally
This association is known from the northern Colorado Plateau and western slope of the southern Rocky Mountains. Stands occur in somewhat isolated upland patches in western Colorado and in southwestern Wyoming.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This mountain big sagebrush / arrowleaf balsamroot shrubland is uncommon within the monument. It occupies the ridge terminating at Ruby Point. The site is moderate (14-degree slope), occurs at 2405 m elevation, and is oriented to the south. The unvegetated surface has moderate exposure of bare soil, moderate cover of litter, and sparse cover of small rocks. The parent material is the Fossil Butte Member of the Wasatch Formation. Soils are rapidly drained clays.

Globally
This shrubland occurs on ridges, benches and mesas in the northern Colorado Plateau. Slopes range from level to moderate, and known sites occur between 2300 and 2675 m (7545-8776 ft.) elevation. Soils are derived from a wide variety of substrates, including shales, volcanic tuff and limestone; textures vary accordingly from clays to clay loams and silty loams to sandy loams. The unvegetated surface has high exposure of bare soil and low to moderate cover of small rocks and litter. Biological soil crusts may be present but rarely have significant cover.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 99% in this densely vegetated stand. This association is characterized by moderate cover of the short shrub *Artemisia tridentata* ssp. *vaseyana* (48%) and of the forb *Balsamorhiza sagittata* (26%). The shrub layer is diverse, provides low cover, and includes the short shrubs *Purshia tridentata, Amelanchier utahensis, Symphoricarpos oreophilus, Chrysothamnus viscidiflorus,* and the dwarf-shrub *Mahonia repens*. The remaining herbaceous layer is diverse and contributes low cover. Grasses include *Poa secunda* and *Leymus cinereus*. Other forbs include *Wyethia amplexicaulis, Mertensia oblongifolia*, and *Pteryxia terebinthina*.

Globally
This shrubland is characterized by a sparse to dense cover of *Artemisia tridentata* ssp. *vaseyana* (15-75%), with an herbaceous understory in which *Balsamorhiza sagittata* is the most conspicuous species. Total vegetation cover ranges from 25 to nearly 100%. Other shrubs are usually present as minor canopy elements, including *Purshia tridentata, Symphoricarpos oreophilus, Amelanchier utahensis, Chrysothamnus viscidiflorus,* and the dwarf-shrub *Mahonia repens*. Total herbaceous cover ranges from 10 to 30%. Grasses often have 5 to 10% cover in the forb-dominated understory, but amounts vary among sites, and include *Poa fendleriana, Poa secunda, Hesperostipa comata, Pseudoroegneria spicata, Achnatherum pinetorum, Achnatherum lettermanii, Leymus cinereus,* and *Pascopyrum smithii*. Common forbs in addition to *Balsamorhiza* include *Phlox* spp., *Eriogonum umbellatum, Arenaria congesta, Castilleja linariifolia, Crepis acuminata, Mertensia oblongifolia, Pteryxia terebinthina, Senecio integerrimus,* and *Wyethia amplexicaulis*. Scattered individuals of *Juniperus osteosperma* may be present with less than 10% cover.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Balsamorhiza sagittata*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Balsamorhiza sagittata*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument

Data are not available.

Globally
Data are not available.

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

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This community is controlled by exposure and the presence of a slightly concave slope that traps snow. Some seepage may occur within the plot. Runoff is rapid and some erosion is occurring in the form of small channels.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0123).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Hess and Wasser 1982, Johnston 2001, Komarkova 1986, Terwilliger and Tiedemann 1978, Western Ecology Working Group n.d.

Artemisia tridentata ssp. *vaseyana / Elymus lanceolatus* Shrubland [Provisional]
Mountain Big Sagebrush / Streambank Wheatgrass Shrubland

CODE	CEGL005318
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. *VASEYANA* SHRUBLAND ALLIANCE (A.831) Mountain Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This mountain big sagebrush shrubland is only known from Fossil Butte National Monument in southwestern Wyoming. Stands occur on the slope of The Bullpen and the north face of Fossil Butte. The sites are gentle to moderate (3-7 degrees), north- or southeast-oriented slopes between 2159 and 2469 m elevation. The unvegetated surface has sparse to high exposure of bare soil, sparse cover of small and large rocks, and sparse to high cover of litter. The soils are rapidly drained loams or clays derived from the Wasatch Formation. This association is characterized by a low to moderate short-shrub layer dominated by *Artemisia tridentata* ssp. *vaseyana* (18-40%) with the perennial grass *Elymus lanceolatus* (12-35% cover) dominating the herbaceous layer. Total vegetation cover ranges from 61-81%. The shrub layer includes other short and dwarf-shrubs with sparse to low cover, such as *Artemisia arbuscula* ssp. *longiloba, Atriplex confertifolia, Eriogonum microthecum, Krascheninnikovia lanata*, and *Symphoricarpos oreophilus*. The herbaceous layer has moderate species diversity and contributes sparse to low cover. Other grasses include *Leymus cinereus* and *Poa secunda*. Forbs include *Achillea millefolium, Lithospermum ruderale, Mertensia oblongifolia, Phlox hoodii*, and exotic *Taraxacum officinale*.

DISTRIBUTION

Fossil Butte National Monument
This association is uncommon at the monument and located on the slope of The Bullpen and the north face of Fossil Butte.

Globally
This mountain big sagebrush shrubland is only known from Fossil Butte National Monument in southwestern Wyoming and is likely more widespread in southern Wyoming and elsewhere in the western U.S.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This mountain big sagebrush / streamside wheatgrass shrubland is uncommon within the monument. It occupies the slope of The Bullpen and the north face of Fossil Butte. The sites are gentle to moderate (3- to 7-degree slopes), occur from 2159 to 2469 m elevation, and are oriented to the north or southeast. The unvegetated surface has sparse to high exposure of bare soil, sparse cover of small and large rocks, and sparse to high cover of litter. Parent materials include the Bullpen Member of the Wasatch Formation and the main body of the Wasatch Formation. The soils are rapidly drained loams or clays.

Globally
This mountain big sagebrush shrubland is only known from Fossil Butte National Monument in southwestern Wyoming. Stands occur on the slope of The Bullpen and the north face of Fossil Butte. The sites are gentle to moderate (3-7 degrees), north- or southeast-oriented slopes between 2159 and 2469 m elevation. The unvegetated surface has sparse to high exposure of bare soil, sparse cover of small and large rocks, and sparse to high cover of litter. The soils are rapidly drained and generally fine-textured, as they are derived from the Wasatch Formation.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover ranges from 61-81% in these densely vegetated stands. This association is characterized by low to moderate cover of the short shrub *Artemisia tridentata* ssp. *vaseyana* (18-40%) and the perennial grass *Elymus lanceolatus* (12-35% cover). The remaining short- and dwarf-shrub layer provides sparse cover and includes *Atriplex confertifolia, Krascheninnikovia lanata, Symphoricarpos oreophilus, Eriogonum microthecum*, and *Artemisia arbuscula* ssp. *longiloba*. The remaining herbaceous layer is moderate in terms of diversity and contributes sparse to low cover. Other grasses include *Poa secunda* and *Leymus cinereus*. Forbs include *Phlox hoodii, Taraxacum officinale, Mertensia oblongifolia, Lithospermum ruderale*, and *Achillea millefolium*.

Globally
This association is characterized by a low to moderate short-shrub layer dominated by *Artemisia tridentata* ssp. *vaseyana* (18-40%) with the perennial grass *Elymus lanceolatus* (12-35% cover) dominating the herbaceous layer. Total vegetation cover ranges from 61-81%. The shrub layer includes other short and dwarf-shrubs with sparse to low cover, such as *Artemisia arbuscula* ssp. *longiloba, Atriplex confertifolia, Eriogonum microthecum, Krascheninnikovia lanata,* and *Symphoricarpos oreophilus*. The herbaceous layer has moderate species diversity and contributes sparse to low cover. Other grasses include *Leymus cinereus* and *Poa secunda*. Forbs include *Achillea millefolium, Lithospermum ruderale, Mertensia oblongifolia, Phlox hoodii*, and exotic *Taraxacum officinale*.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Elymus lanceolatus*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Taraxacum officinale

Globally
Taraxacum officinale

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (3-Aug-2007).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
This diagnostic grass species *Elymus lanceolatus* can be confused with *Pascopyrum smithii* when spikelets are not available, as both are strongly rhizomatous wheatgrasses.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This dense shrubland is surrounded by sparse shrublands, dwarf-shrublands, and sparse herbaceous associations; perhaps snow accumulation and shelter from the wind allow this dense shrubland to survive. This shrubland occurs on clay soils that are more exposed than neighboring *Artemisia tridentata* ssp. *vaseyana* shrublands.
Fossil Butte National Monument Data: The description is based on 2005 field data (2 plots: FOBU.0094, FOBU.0135).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Artemisia tridentata ssp. *vaseyana / Leucopoa kingii* Shrubland
Mountain Big Sagebrush / Spike Fescue Shrubland

CODE	CEGL001025
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. *VASEYANA* SHRUBLAND ALLIANCE (A.831) Mountain Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This shrubland occurs either in patches or continuously on gentle to steep slopes of various aspects between 2392 to 2895 m (7840-9500 ft.) elevation in southern Idaho, Wyoming, and north-central Colorado. Soils are of a sedimentary substrate. The moderately open shrub layer is dominated by *Artemisia tridentata* ssp. *vaseyana*. *Chrysothamnus viscidiflorus, Purshia tridentata, Symphoricarpos oreophilus*, and several other shrubs may also be present. Occasionally, *Pinus flexilis* is sparsely scattered throughout stands. The herbaceous understory is dominated by *Leucopoa kingii*. Other grasses present are *Festuca idahoensis, Koeleria macrantha*, and *Poa secunda*. Common forbs include *Achillea millefolium, Balsamorhiza sagittata, Eriogonum heracleoides, Lupinus argenteus*, and *Phlox longifolia*.

DISTRIBUTION
Fossil Butte National Monument
This association is found in the northern portion of the monument near The Bullpen.

Globally
This shrubland association is found in southern Idaho and north-central Colorado, as well as western Wyoming. It may also occur in Nevada but has not been substantiated there.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This mountain big sagebrush / spike fescue shrubland occurs in the upper reaches of the sagebrush zone within the monument. Stands are located on gentle (5-7 degrees) hillslopes. Elevations range from 2392 to 2459 m on cooler north-facing slopes and on a relatively mesic south-facing slope near a drainage that was mesic enough to have *Artemisia cana* present. Substrates are derived from the Angelo or Bullpen members of the Wasatch Formation. Litter covers much of the unvegetated ground surface (20-50% cover) with low to moderate bare ground cover (5-40%).

Globally
This shrubland is found either in patches or continuously on gentle to steep slopes of various aspects between 2392 to 2895 m (7840-9500 ft.) elevation in southern Idaho, Wyoming, and north-central Colorado. Lower elevation sites are restricted to cooler northerly slopes or locally relatively mesic sites. Litter covers much of the unvegetated ground surface with low to moderate bare ground cover. Soils are of a sedimentary substrate such as the Wasatch Formation.

VEGETATION DESCRIPTION
Fossil Butte National Monument
This sagebrush shrubland has a mixed shrub canopy dominated by *Artemisia tridentata* ssp. *vaseyana* with between 16 and 20% cover. The shrub layer also contains a mixture of species such as *Symphoricarpos oreophilus, Chrysothamnus viscidiflorus, Ribes cereum*, and less commonly *Amelanchier utahensis, Artemisia arbuscula* ssp. *longiloba*, and *Purshia tridentata*. The herbaceous layer is moderately diverse and well-developed and is dominated by *Leucopoa kingii (= Festuca kingii)* with between 4 and 15% cover. Other grasses present include *Achnatherum lettermanii, Achnatherum pinetorum, Elymus lanceolatus, Koeleria macrantha*, and *Poa secunda*. The forb component is variable and has significantly less cover than the graminoid element. Common species include *Achillea millefolium, Pteryxis terebinthina (= Cymopterus terebinthinus), Eriogonum umbellatum*, and *Phlox multiflora*.

Globally
This sagebrush shrubland has a moderately open, mixed shrub canopy dominated by *Artemisia tridentata* ssp. *vaseyana*. *Chrysothamnus viscidiflorus, Purshia tridentata, Symphoricarpos oreophilus*, and several other shrubs including *Amelanchier utahensis, Artemisia arbuscula* ssp. *longiloba*, and *Ribes cereum* may also be present. Occasionally, *Pinus flexilis* is sparsely scattered throughout stands. The herbaceous understory is dominated by *Leucopoa kingii*. Other grasses present are *Achnatherum lettermanii, Achnatherum pinetorum, Elymus lanceolatus, Festuca idahoensis, Koeleria macrantha*, and *Poa secunda*. Common forbs include *Achillea millefolium, Balsamorhiza sagittata, Pteryxis terebinthina (= Cymopterus terebinthinus), Eriogonum heracleoides, Eriogonum umbellatum, Lupinus argenteus, Phlox longifolia*, and *Phlox multiflora*.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Achnatherum pinetorum, Elymus lanceolatus, Leucopoa kingii, Poa secunda*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G3 (16-Mar-2004). This shrubland association is either found in a mosaic or is continuous on gentle to steep slopes of various aspects between 2529 and 2895 m (8300-9500 ft.) elevation in southern Idaho, north-central Colorado, and some portion of Wyoming. Soils are of a sedimentary substrate. A decline in the number, condition, and size of stands is due to intensive livestock grazing, introduction of exotic species, land-use conversion (Colorado), and alteration in fire regime. Off-road vehicle recreation also results in an increase of two-track road development and fragmentation of stands.

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
This association is similar to and may be difficult to differentiate from *Artemisia tridentata* ssp. *vaseyana / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001533) and *Artemisia tridentata* ssp. *vaseyana / Pseudoroegneria spicata* Shrubland (CEGL001030). The percent cover and constancy of the dominant grass in each type are key to differentiating these three associations. Many of the forb species that contribute to the composition are present in all of the communities. Common forb species include *Balsamorhiza sagittata, Lupinus, Crepis*, and *Eriogonum* spp. (Hironaka et al. 1983, Johnson and Simon 1987, Nelson and Jensen 1987).

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Data are not available.
Fossil Butte National Monument Data: This description is based on field data collected in 2006 during accuracy assessment (3 plots: FOBU_AA.0005, FOBU_AA.0129, FOBU_AA.0205).
Local Description Authors: K.A. Schulz
Global Description Authors: J.J. Miller, mod. K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Hess 1981, Hironaka et al. 1983, Johnson and Simon 1987, Johnston 1987, Nelson and Jensen 1987, Wasser and Hess 1982

Artemisia tridentata ssp. *vaseyana / Leymus cinereus* Shrubland
Mountain Big Sagebrush / Great Basin Wildrye Shrubland

CODE	CEGL001027
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. *VASEYANA* SHRUBLAND ALLIANCE (A.831) Mountain Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This widely distributed association occupies shallow upland drainages associated with springs, slumps or seepage areas on hillslopes, as well as riparian terraces. Stands are small and isolated but occur throughout the sagebrush zone in the Great Basin, Wyoming Basins and Uinta Basin. Sites are located on gentle to moderate lee slopes (3-30%) that collect windblown snow and may be oriented to any aspect. Elevations range between 2100 and 2560 m (6890-8400 ft.). Soils are deep, well-developed, moderately well-drained and variable in texture. The underlying substrate is sandstone, marlstone or shale. Shrub cover is lower in this association than in most mountain sagebrush types. *Artemisia tridentata* ssp. *vaseyana* dominates the shrub layer with at least 10% cover. Other shrubs present are *Symphoricarpos oreophilus, Tetradymia canescens, Chrysothamnus viscidiflorus, Rosa woodsii*, and *Ericameria nauseosa*. *Leymus cinereus* is the dominant grass, usually with at least 10% cover, although cover may be lower in

stands that have been heavily grazed. Associated grasses include *Elymus lanceolatus, Bromus carinatus, Festuca idahoensis, Poa pratensis, Poa fendleriana*, and *Poa secunda*. Forb species contribute sparse cover and vary among sites. Common species include *Achillea millefolium, Balsamorhiza sagittata*, and *Phlox* spp.

DISTRIBUTION

Fossil Butte National Monument

This shrubland is located on sheltered slopes, benches, hillsides, and drainages on the slopes of Fossil Butte, near the eastern monument boundary, and near The Bullpen.

Globally

This association is widely distributed from small, isolated stands in northwestern Colorado (Dinosaur National Monument) and southwestern Wyoming (Fossil Butte National Monument). It has been reported from northern and central Nevada, northeastern Utah, southwestern Montana, southern Idaho and possibly from northeastern California.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This mountain big sagebrush / Great Basin wildrye shrubland occupies sheltered ridges, slopes, hillsides, and slumps on the eastern portion of the monument. Sites are gentle to steep (1- to 16-degree slopes), occur between 2161 and 2405 m elevation, and are oriented to all aspects. The unvegetated surface has moderate to high exposure of bare soil, low to moderate cover of litter, and low cover of small rocks and downed wood. The parent materials include the Fossil Butte Member of the Wasatch Formation, the Angelo Member of the Wasatch Formation, and the main body of the Wasatch Formation. Soils are moderately well-drained to rapidly-drained sandy clay loams, loams, or clays.

Globally

This widely distributed association occupies shallow upland drainages associated with springs, slumps or seepage areas on hillsides, as well as riparian terraces. Stands are small and isolated but occur throughout the sagebrush zone in the Great Basin, Wyoming Basins and Uinta Basin. Sites are located on gentle to moderate lee slopes (3-30%) that collect windblown snow and may be oriented to any aspect. Elevations range between 2100 and 2560 m (6890-8400 ft.). Substrates are deep, well-developed, moderately well-drained alluvial or colluvial soils with variable texture ranging from clay to sandy loam. Parent materials include sandstone, marlstone or shale. Bare soil, gravel, or litter covers most of the unvegetated ground surface.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 15-84% in these low to densely vegetated stands. This association is characterized by sparse to moderate cover of the short shrub *Artemisia tridentata* ssp. *vaseyana* (9-55% cover) and sparse to moderate cover of the coarse bunchgrass *Leymus cinereus* (1-22% cover). The canopy tree *Pinus flexilis* provides sparse cover in some stands. The remaining tall-, short-, and dwarf-shrub layer provides sparse to low cover and includes *Chrysothamnus viscidiflorus, Artemisia arbuscula* ssp. *longiloba, Ericameria nauseosa, Purshia tridentata, Cercocarpus montanus, Amelanchier utahensis*, and *Mahonia repens*. The remaining herbaceous layer is moderate in terms of diversity and contributes sparse to low cover. Other graminoids include *Poa secunda, Pascopyrum smithii, Elymus lanceolatus, Carex filifolia, Leucopoa kingii*, and *Poa fendleriana*. Forbs include *Achillea millefolium, Linum lewisii, Trifolium gymnocarpon, Mertensia oblongifolia, Lithospermum ruderale, Taraxacum officinale, Comandra umbellata, Eriogonum umbellatum, Cirsium undulatum, Pteryxia terebinthina*, and *Balsamorhiza sagittata*.

Globally

This association is relatively common within its range but tends to occur in small, isolated stands. Shrub cover is lower in this association than in most mountain sagebrush types. *Artemisia tridentata* ssp. *vaseyana* dominates the shrub layer with at least 10% cover. Other shrubs present are *Symphoricarpos oreophilus, Tetradymia canescens, Chrysothamnus viscidiflorus, Rosa woodsii*, and *Ericameria nauseosa*. *Leymus cinereus* is the dominant grass, usually with at least 10% cover, although cover may be lower in stands that have been heavily grazed. Associated graminoids include *Elymus lanceolatus, Bromus carinatus, Carex filifolia, Festuca idahoensis, Leucopoa kingii, Pascopyrum smithii, Poa fendleriana*, and *Poa secunda*. Forb species contribute sparse cover and vary among sites. Common species include *Achillea millefolium, Balsamorhiza sagittata, Cirsium undulatum, Comandra umbellata,*

Eriogonum umbellatum, Linum lewisii, Lithospermum ruderale, Mertensia oblongifolia, Phlox spp., *Pteryxia terebinthina*, and *Trifolium gymnocarpon*. Introduced species including *Bromus tectorum, Poa pratensis, Thinopyrum intermedium*, and *Taraxacum officinale* are common in some stands.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Leymus cinereus*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Leymus cinereus*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Taraxacum officinale

Globally
Bromus tectorum, Poa pratensis, Taraxacum officinale, Thinopyrum intermedium

CONSERVATION STATUS RANK
Global Rank & Reasons: G4? (1-Feb-1996).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Lowslope bench that has moderately well-drained soils allowing for increased vegetation and use of area by wildlife and as corridor to access similar stands. This is an older, mature stand of *Artemisia tridentata* ssp. *vaseyana*. This community is controlled by the moderate south-facing slope, elevation, and moisture gradient. The soils are deep and the dense shrubs capture winter snowfall that melts into the early growing season.
Fossil Butte National Monument Data: The description is based on 2005 field data (5 plots: FOBU.0046, FOBU.0096, FOBU.0115, FOBU.0132, FOBU.0139; 6 observation points: FOBU.9023, FOBU.9028, FOBU.9042, FOBU.9079, FOBU.9083, FOBU.9087).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Cooper et al. 1999, Driscoll et al. 1984, Hironaka et al. 1983, IDCDC 2005, Jensen et al. 1988a, MTNHP 2002b, Mooney 1985

Artemisia tridentata ssp. *vaseyana / Pascopyrum smithii* Shrubland
Mountain Big Sagebrush / Western Wheatgrass Shrubland

CODE	CEGL001028
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. *VASEYANA* SHRUBLAND ALLIANCE (A.831)

Mountain Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785)
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This mesic sagebrush association occurs in upland areas where snow accumulates, including swales and valley bottoms. Documented stands are known from Wyoming, Montana and northern and western Colorado. Elevations range from 2200 to 2500 m (7200-8200 ft.). Sites are level to gently sloping and may be oriented to any aspect. Soils may be derived from eolian sediments, sandstone or shale, and often have a silty loam or clay loam texture. The amount of litter on the ground surface is inversely proportional to the intensity of grazing. Total vegetation cover ranges from a low of around 20% to approximately 75%. *Artemisia tridentata* ssp. *vaseyana* dominates the shrub layer with 10 to 50% cover, and *Pascopyrum smithii* dominates a diverse herbaceous layer. Other shrubs comprise a minority of the shrub canopy, including *Symphoricarpos oreophilus, Amelanchier utahensis, Purshia tridentata, Ericameria nauseosa, Tetradymia canescens, Krascheninnikovia lanata,* and *Chrysothamnus viscidiflorus*. The grass component of the understory is often diverse and may include a combination of *Poa fendleriana, Achnatherum pinetorum, Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus, Leymus cinereus, Hesperostipa comata, Elymus elymoides,* and *Poa secunda*. Forbs such as *Artemisia frigida, Achillea millefolium,* and *Phlox hoodii* ssp. *muscoides (= Phlox bryoides)* generally contribute little cover.

DISTRIBUTION

Fossil Butte National Monument

This association is uncommon at the monument and represented by one observation point located on a gentle hillslope near the visitor center.

Globally

This association is known from Montana, northern and western Colorado, and Wyoming.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This mountain big sagebrush / western wheatgrass shrubland is uncommon within the monument and occupies a gentle hillslope near the visitor center. The site is gentle (3-degree slope), occurs at 2073 m elevation, and is oriented to the southeast. The unvegetated surface has low cover of bare soil and small rocks and high cover of litter. The parent material is the main body of the Wasatch Formation.

Globally

This mesic sagebrush association occurs in uplands in areas where snow accumulates, including swales and valley bottoms. Documented stands are in Wyoming and in northern and western Colorado, but this association is likely to be widespread. Elevations range from 2200 to 2500 m (7200-8200 ft.). Sites are level to gently sloping and may occur on any aspect. Soils may be derived from eolian deposits, sandstone or shale, and often have a silty loam or clay loam texture. The amount of litter on the ground surface is inversely proportional to the intensity of grazing.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover is 99% in this densely vegetated stand. This association is characterized by moderate cover of the short shrub *Artemisia tridentata* ssp. *vaseyana* (55%) and low cover of the perennial grass *Pascopyrum smithii* (4%). The remaining tall- and short-shrub layer provides low cover and includes *Artemisia tridentata* ssp. *tridentata* and *Artemisia arbuscula* ssp. *longiloba*. The remaining herbaceous layer is diverse and contributes moderate cover. Other grasses include *Poa secunda, Melica bulbosa,* and the non-native *Bromus inermis*. The forb *Phlox caespitosa* provides low cover, while *Achillea millefolium* provides sparse cover.

Globally

Total vegetation cover in these sagebrush shrublands ranges from 20% to approximately 75%. *Artemisia tridentata* ssp. *vaseyana* dominates the shrub layer with 10-50% cover, and *Pascopyrum smithii* dominates the diverse herbaceous layer. Other shrubs may comprise a minor component of the shrub canopy, including *Symphoricarpos oreophilus, Amelanchier utahensis, Purshia tridentata, Ericameria nauseosa, Tetradymia canescens,*

Krascheninnikovia lanata, and *Chrysothamnus viscidiflorus*. The grass component of the understory is often diverse and may include a combination of *Poa fendleriana, Achnatherum pinetorum, Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus, Leymus cinereus, Hesperostipa comata, Elymus elymoides*, and *Poa secunda*. Forbs such as *Artemisia frigida, Achillea millefolium*, and *Phlox hoodii* ssp. *muscoides (= Phlox bryoides)* generally contribute little cover.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Pascopyrum smithii*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Pascopyrum smithii*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Bromus inermis

Globally
Poa pratensis

CONSERVATION STATUS RANK
Global Rank & Reasons: G3? (1-Feb-1996).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This site consists of deep soils on a gentle hillslope supporting a mosaic of sagebrush species dominated by *Artemisia tridentata* ssp. *vaseyana*. There is some disturbance related to the visitor center construction that has led to invasion from seeded species such as *Pascopyrum smithii*.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 observation point: FOBU 9001).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles

REFERENCES: Baker 1984a, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Jones 1992b, MTNHP 2002b, Rzedowski 1981, Skull Point Mine Application n.d., Skull Point Mine Permit Renewal n.d., Smith 1966, Terwilliger and Smith 1978, Western Ecology Working Group n.d.

Artemisia tridentata ssp. *vaseyana / Poa fendleriana* Shrubland
Mountain Big Sagebrush / Muttongrass Shrubland

CODE	CEGL002812
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. *VASEYANA* SHRUBLAND ALLIANCE (A.831)

Mountain Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This sagebrush shrubland covers medium to large patches on the slopes of mesas, valleys, plateaus, hills and ridges in western Colorado, eastern Utah and southwestern Wyoming. It often occurs in a mosaic with other sagebrush communities that cover very large areas. Elevations range from 2100 to 2875 m (6900-9430 ft.). Slopes vary from gentle to steep and may be oriented to any aspect. Litter cover is generally high, and soils are deep and mostly relatively fine-textured clay loams or clays, with a few stands on sandy sites. Total vegetation cover ranges from approximately 35% to nearly 100%. The shrub layer is dominated by *Artemisia tridentata* ssp. *vaseyana* shrubs up to 1 m tall with between 20 and 50% cover. The bunchgrass *Poa fendleriana* is dominant in the herbaceous layer with 1 to 25% cover. Other shrub species present, in addition to the sagebrush, include *Purshia tridentata, Chrysothamnus viscidiflorus,* and *Symphoricarpos oreophilus*. The herbaceous layer may be sparse to dense and well-developed, diverse or depauperate, depending on location and grazing history. The grass component in particular is generally mixed, and common associated or codominant graminoids include *Koeleria macrantha, Poa secunda, Elymus lanceolatus, Bouteloua gracilis, Carex duriuscula (= Carex stenophylla), Elymus elymoides, Pseudoroegneria spicata,* and *Hesperostipa comata*. Forbs commonly present may include *Antennaria parvifolia, Castilleja linariifolia, Eriogonum umbellatum, Lupinus sericeus, Artemisia frigida,* and *Penstemon caespitosus*. Grazing has likely contributed to the increase in cover by mountain big sagebrush in these stands at the expense of native grasses. Fire would eliminate the mountain big sagebrush canopy in favor of a mixed graminoid and forb community. In the absence of fire over long periods, some stands show evidence of invasion by *Pinus edulis, Juniperus osteosperma,* or *Pseudotsuga menziesii*.

DISTRIBUTION

Fossil Butte National Monument

This shrubland is located along the western boundary of the monument and in the environs west of the monument.

Globally

This association has been documented in the Colorado Plateau and Rocky Mountains in western Colorado, eastern Utah and southwestern Wyoming. It is likely to be significantly more common than is currently known.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This mountain big sagebrush / muttongrass shrubland is uncommon within the monument and occupies slopes on the western side of the monument and in the adjacent environs. The sites are moderate (5- to 10-degree slope), occur between 2159 and 2227 m elevation, and are oriented to the east and south. The unvegetated surface has low to high exposure of bare soil, low cover of small rocks, and low to high cover of litter. The parent material is the main body of the Wasatch Formation. Soils are rapidly drained clay loams.

Globally

This sagebrush shrubland association covers medium to large patches on the slopes of mesas, valleys, plateaus, hills and ridges in western Colorado, eastern Utah and southwestern Wyoming. Elevations range from 2100 to 2875 m (6900-9430 ft.). Slopes vary from gentle to steep and may be oriented to any aspect. Litter cover is generally high, and soils are deep and mostly relatively fine-textured clay loams or clays, with a few stands on sandy sites. Parent materials include volcanic rocks and shale from the Wasatch Formation.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 38-96% in these moderately to densely vegetated stands. This association is characterized by moderate to high cover of the short shrub *Artemisia tridentata* ssp. *vaseyana* (30-65% cover) and sparse cover of the perennial bunchgrass *Poa fendleriana* (1-6% cover). The remaining tall- and short-shrub layers provide sparse to low cover and include *Amelanchier utahensis, Symphoricarpos oreophilus, Artemisia arbuscula* ssp. *longiloba, Purshia tridentata,* and *Chrysothamnus viscidiflorus*. The remaining herbaceous layer is moderate in terms of diversity and contributes sparse to low cover. Other grasses include *Leymus cinereus, Pascopyrum smithii, Pseudoroegneria spicata, Poa secunda, Elymus lanceolatus, Melica bulbosa*, the non-native annual *Bromus*

tectorum, and the non-native perennial *Poa pratensis*. Forbs include *Eriogonum cernuum, Antennaria rosea, Crepis acuminata, Eriogonum umbellatum,* and *Cirsium undulatum*.

Globally
This Wyoming big sagebrush association occurs in a mosaic with other sagebrush communities that in aggregate may cover entire landscapes. Total vegetation cover ranges from approximately 35% to nearly 100%. The shrub layer is dominated by *Artemisia tridentata* ssp. *vaseyana* shrubs up to 1 m tall with between 20 and 50% cover. The bunchgrass *Poa fendleriana* is dominant in the herbaceous layer with 1 to 25% cover. Other shrub species present, in addition to the sagebrush, include *Purshia tridentata, Amelanchier utahensis, Artemisia arbuscula* ssp. *longiloba, Chrysothamnus viscidiflorus,* and *Symphoricarpos oreophilus*. The herbaceous layer may be sparse to dense and well-developed, diverse or depauperate, depending on location and grazing history. The grass component in particular is generally mixed, and common associated or codominant graminoids include *Koeleria macrantha, Poa secunda, Elymus lanceolatus, Bouteloua gracilis, Carex duriuscula (= Carex stenophylla), Elymus elymoides, Leymus cinereus, Pascopyrum smithii, Pseudoroegneria spicata,* and *Hesperostipa comata*. Forbs commonly present may include *Antennaria parvifolia, Castilleja linariifolia, Cirsium undulatum, Eriogonum umbellatum, Lupinus sericeus, Argentina anserina, Artemisia frigida,* and *Penstemon caespitosus*. The non-native annual *Bromus tectorum* and the non-native perennial *Poa pratensis* are common in some stands.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Poa fendleriana*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Poa fendleriana*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Bromus tectorum, Poa pratensis

Globally
Bromus tectorum, Poa pratensis

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (28-Jun-2005).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Although *Poa fendleriana* is the dominant grass in the understory of this sagebrush association, it is often accompanied by other grasses, many with significant cover and indicator value. In a sagebrush landscape, the dominant grass in any given spot may depend on many variables, including grazing history and drought cycles, as well as subtle differences in soil, aspect, slope and slope position. In practice it may be difficult to distinguish this association in the field from many of the similar associations listed above.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This stand is controlled by deep soils on mesic sites - areas where snow accumulates in winter and are more protected from the prevailing wind. The stand is mature, but there is less dead wood than in other stands in the area (to the north). Plot is located in the environs of the monument as data for

the prescribed fire slated for this fall. This is a very common *Artemisia tridentata* ssp. *vaseyana* shrubland that has been recently grazed.
Fossil Butte National Monument Data: The description is based on 2005 field data (2 plots: FOBU.0021, FOBU.0145).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Artemisia tridentata ssp. *vaseyana / Poa pratensis* Sagebrush Shrubland
Mountain Big Sagebrush / Kentucky Bluegrass Sagebrush Shrubland

CODE	CEGL002528
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. *VASEYANA* SHRUBLAND ALLIANCE (A.831) Mountain Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This sagebrush shrubland is documented from Grand Teton National Park and Fossil Butte National Monument in Wyoming but likely is more widespread. It has been observed throughout the range of *Artemisia tridentata* ssp. *vaseyana* shrublands. Stands dominated by *Poa pratensis* in the undergrowth have likely been identified by the local potential dominant native graminoid (such as *Festuca idahoensis, Pascopyrum smithii*, or *Pseudoroegneria spicata*). In Grand Teton National Park, no native graminoids are present, so the potential native graminoid counterpoint to *Poa pratensis* is unknown. At Fossil Butte National Monument, several native graminoids (*Achnatherum pinetorum, Elymus lanceolatus, Leucopoa kingii, Poa fendleriana*) are present.

DISTRIBUTION
Fossil Butte National Monument
Stands were sampled in a drainage on the south side of Ruby Point and on hillslope in the northern portion of the monument.

Globally
This shrubland has been documented from Grand Teton National Park and Fossil Butte National Monument in western Wyoming but is expected to occur throughout the range of mountain big sagebrush where disturbance has converted native understory to introduced species such as *Poa pratensis*.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This mountain big sagebrush / Kentucky bluegrass shrubland occurs on relatively mesic sites in the monument. One stands is along a drainageway that runs off the south side of Ruby Ridge and is sheltered from the wind; the other is on a locally mesic, east-facing swale. Sites are gently sloping (6-8 degrees) and found between 2286 and 2436 m elevation. The unvegetated surface has moderate exposure of bare soil (20-30% cover) and low to moderate cover of litter (5-40%). The parent material is the main body of the Wasatch Formation.

Globally
This association occurs primarily on valley floors with a few occurrences on moderate slopes with various aspects. The elevation range for these sites is approximately 1950 to 2436 m (6400-7985 ft.). Soil types range from sandy loam to clay loam, sometimes with gravel present. Some stands have bare, rocky soil. Most stands occur near a large variety of man-made disturbances, which correlates with the non-native species found in many plots. Adjacent

vegetation may include a *Picea pungens* forest riparian corridor, *Populus tremuloides* woodland, *Artemisia arbuscula* shrublands, *Salix* spp. shrublands, and non-native grasslands.

VEGETATION DESCRIPTION

Fossil Butte National Monument

This open shrubland is dominated by moderate cover of the short shrub *Artemisia tridentata* ssp. *vaseyana* (20% cover) and the introduced perennial sodgrass *Poa pratensis* (8-10% cover). The remaining tall- and short-shrub layers provide sparse to low cover and include *Amelanchier utahensis, Artemisia cana* (2-8% cover), *Purshia tridentata, Salix scouleriana*, and *Symphoricarpos oreophilus*. Occasional *Populus tremuloides* trees are present on one site. The remaining herbaceous layer is moderate in terms of diversity and contributes low to moderate cover (10-30%). Other graminoids include *Achnatherum pinetorum, Elymus lanceolatus, Elymus trachycaulus, Juncus balticus, Koeleria macrantha, Leucopoa kingii, Poa fendleriana,* and the non-native perennial *Phleum pratense*. Forbs include *Agastache urticifolia, Achillea millefolium, Artemisia ludoviciana, Balsamorhiza sagittata, Iva axillaris, Lupinus sericeus, Potentilla* sp., and *Solidago* sp.

Globally

This open montane shrubland is dominated by moderate cover of the short shrub *Artemisia tridentata* ssp. *vaseyana* (10-50% cover) and the introduced perennial sodgrass *Poa pratensis* (to 50% cover). The remaining tall- and short-shrub layers provide sparse to low cover and include *Amelanchier utahensis, Artemisia cana* (2-8% cover), *Purshia tridentata, Salix scouleriana*, and *Symphoricarpos oreophilus*. Occasional *Populus tremuloides* trees are present on one site. The composition of the herbaceous layer varies considerably, both in species richness and in species composition. Other species in the low to moderate (10-30% cover) herbaceous layer tend to be relatively mesic and include graminoids *Achnatherum pinetorum, Elymus lanceolatus, Elymus trachycaulus, Festuca idahoensis, Juncus balticus, Koeleria macrantha, Leucopoa kingii, Poa fendleriana,* and the non-native perennial *Phleum pratense*. Forbs include *Agastache urticifolia, Achillea millefolium, Artemisia ludoviciana, Balsamorhiza sagittata, Eriogonum umbellatum, Lupinus sericeus, Potentilla* sp., and *Solidago* sp.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Poa pratensis*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Poa pratensis*

OTHER NOTEWORTHY SPECIES

Fossil Butte National Monument
Phleum pratense

Globally
Phleum pratense

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (29-Mar-2005).

CLASSIFICATION COMMENTS

Fossil Butte National Monument

The point near the drainage was very difficult to classify with a variety of different moisture regimes and *Artemisia cana* in the drainage bottom. Near the swale stand there are patches of *Salix scouleriana, Populus tremuloides,* and *Artemisia cana*.

Globally

This type has not been described in the literature by name but seems highly likely to occur throughout the range of the dominant sagebrush.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Data are not available.
Fossil Butte National Monument Data: This description is based on field data collected in 2006 during accuracy assessment (2 points: FOBU_AA.0280, FOBU_AA.0337).
Local Description Authors: K.A. Schulz
Global Description Authors: G. Kittel, mod. K.A. Schulz

REFERENCES: Hironaka et al. 1983, Johnston 2001, USFS 1937, Western Ecology Working Group n.d.

Artemisia tridentata ssp. *vaseyana / Poa secunda* Shrubland
Mountain Big Sagebrush / Curly Bluegrass Shrubland

CODE	CEGL001029
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. *VASEYANA* SHRUBLAND ALLIANCE (A.831) Mountain Big Sagebrush Shrubland Alliance
ECOLOGICAL SYSTEM(S):	Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785) Inter-Mountain Basins Volcanic Rock and Cinder Land (CES304.791)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Stands of this shrubland association are known from Craters of the Moon National Monument in Idaho and scattered locations in south-central and southeastern Oregon and northwestern Colorado. It is noted in northern and central Nevada, but these may be early-seral stands of other *Artemisia tridentata* ssp. *vaseyana* plant associations. At Craters of the Moon, this association is the most widespread vegetation type and is found on xeric sites with shallow soil, usually on (but not limited to) lavaflows and cinder buttes. In the Uinta Basin, stands occur on gentle to moderate slopes on high plateaus between 2072 and 2427 (6790-7960 ft.)elevation. Soils in these sites are deep and well-developed and include clay loams, silt loams and sandy loams. *Artemisia tridentata* ssp. *vaseyana* dominates stands, though other shrubs, such as *Ericameria* spp. (= *Chrysothamnus* spp.), *Eriogonum microthecum, Leptodactylon pungens, Purshia tridentata, Amelanchier utahensis*, and *Symphoricarpos oreophilus*, are also common. *Poa secunda* dominates the relatively sparse herbaceous understory. Other perennial grasses, such as *Achnatherum thurberianum, Poa fendleriana, Hesperostipa comata*, and *Pseudoroegneria spicata*, are occasionally found on pockets of better soil. Common forbs include *Eriogonum heracleoides, Eriogonum ovalifolium, Trifolium gymnocarpon*, and *Eriogonum umbellatum*.

DISTRIBUTION
Fossil Butte National Monument
This shrubland is located on the slopes of Fossil Butte, Ruby Point, The Bullpen, and the upper Chicken Creek drainage above the visitor center.

Globally
This plant association is known from Craters of the Moon National Monument in Idaho, south-central and southeastern Oregon, Dinosaur National Monument in northwestern Colorado and possibly north and central Nevada (Day and Wright 1985, Tueller and Eckert 1987, ORNHP 2001). The distribution of this association is discontinuous, partly due to the restriction of *Artemisia tridentata* ssp. *vaseyana* to cooler and moister higher elevations. However, within the range of *Artemisia tridentata* ssp. *vaseyana*, the discontinuous distribution also probably reflects the lack of sites unsuitable for the growth of perennial grasses other than *Poa secunda*.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument

This mountain big sagebrush / curly bluegrass shrubland occurs within the upper Chicken Creek drainage and on the slopes of Ruby Point, Fossil Butte, and the Bullpen. It occupies valley floors, ridges, and slopes. Sites are gentle to moderately steep (2- to 8-degree slopes), occur between 2072 and 2427 m elevation, and are oriented to the south or east. The unvegetated surface has moderate to high exposure of bare soil, low to moderate cover of litter, low cover of gravel, and sparse cover of downed wood. There is a sparse biological soil crust of mosses and lichens. The parent materials include the Fossil Butte Member of the Wasatch Formation and the main body of the Wasatch Formation. Soils are moderately well-drained to rapidly drained sandy loams or clay loams.

Globally
Stands of this plant association are known from Craters of the Moon National Monument in Idaho and scattered locations in south-central and southeastern Oregon, western Wyoming and northwestern Colorado. It is noted in northern and central Nevada, but these may be early-seral stands of other *Artemisia tridentata* ssp. *vaseyana* plant associations. At Craters of the Moon, this association is found on xeric sites with shallow soil, usually on (but not limited to) lavaflows and cinder buttes. In the Uinta Basin and southwestern Wyoming, stands occur on gentle to moderate slopes on high plateaus between 2072 and 2427 (6790-7960 ft.)elevation. Soils in these sites are deep and well-developed and include clay loams, silt loams and sandy loams. Biological soil crusts tend to be sparse with low to high cover of litter with high to low bare soil cover.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover ranges from 36-74% in these moderately to densely vegetated stands. This association is characterized by moderate cover of the tall shrub *Artemisia tridentata* ssp. *vaseyana* (15-65% cover) and sparse to low cover of the perennial bunchgrass *Poa secunda* (1-15% cover). *Pinus flexilis* seedlings and saplings are found in some stands. The remaining tall- and short-shrub layers provide sparse to low cover and include *Amelanchier utahensis, Ribes cereum, Chrysothamnus viscidiflorus*, and *Purshia tridentata*. The remaining herbaceous layer is moderate in terms of diversity and contributes sparse cover. Other graminoids include *Achnatherum nelsonii, Pascopyrum smithii, Elymus lanceolatus, Leymus cinereus, Poa pratensis, Carex geyeri, Poa fendleriana, Melica bulbosa*, and *Leucopoa kingii*. Forbs include *Delphinium nuttallianum, Achillea millefolium, Antennaria rosea, Taraxacum officinale, Crepis acuminata, Lupinus sericeus, Eriogonum flavum, Trifolium gymnocarpon, Eriogonum brevicaule, Antennaria microphylla, Comandra umbellata, Pteryxia terebinthina*, and *Balsamorhiza sagittata*. Cryptogams provide sparse cover and include mosses and lichens.

Globally
The generally open to moderately dense shrub layer is dominated by *Artemisia tridentata* ssp. *vaseyana* (15-65% cover). Other shrubs, such as *Chrysothamnus viscidiflorus, Eriogonum microthecum, Leptodactylon pungens, Purshia tridentata, Amelanchier utahensis*, and *Symphoricarpos oreophilus*, are also common. *Poa secunda* dominates the relatively sparse to moderately dense herbaceous understory with 1-20% cover. Other perennial graminoids, such as *Achnatherum thurberianum, Carex geyeri, Elymus lanceolatus, Hesperostipa comata, Leymus cinereus, Leucopoa kingii, Pascopyrum smithii, Poa fendleriana*, and *Pseudoroegneria spicata*, are occasionally found on pockets of better soil. Forb cover is generally sparse but may be moderately diverse in species composition. Common forbs include *Eriogonum brevicaule, Eriogonum flavum, Eriogonum heracleoides, Eriogonum ovalifolium, Eriogonum umbellatum, Antennaria* spp., *Balsamorhiza sagittata, Comandra umbellata, Lupinus sericeus, Pteryxia terebinthina, Trifolium gymnocarpon* and *Wyethia mollis*. *Pinus flexilis* seedlings and saplings are found in some stands.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus*
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Poa secunda*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Poa secunda*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Poa pratensis, Taraxacum officinale

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G3 (19-Jan-2001). This plant association is widely scattered in eastern Oregon, locally common in Idaho and northwestern Colorado, and probably present in Nevada. Rangewide, however, it is not abundant and it is discontinuously distributed. There are less than 100 element occurrences of this type known, though some occurrences cover large areas. The association is probably limited to the least productive soils within the range of *Artemisia tridentata* ssp. *vaseyana*. At lower elevations, these poorly developed and exposed soils are susceptible to surface disturbance and subsequent *Bromus tectorum* invasion. Once *Bromus tectorum* has invaded the *Artemisia tridentata* ssp. *vaseyana* understory, recovery of the original association after prescribed burns or wildfire becomes very difficult.

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
In contrast to stands with noticeable *Achnatherum thurberianum, Festuca idahoensis, Hesperostipa comata*, or *Pseudoroegneria spicata, Poa secunda* is the only perennial grass of significance in late-seral *Artemisia tridentata* ssp. *vaseyana / Poa secunda* stands (Day and Wright 1985). Similar plant associations documented in northern and central Nevada, such as *Artemisia tridentata* ssp. *vaseyana - Chrysothamnus viscidiflorus / Poa secunda - Wyethia mollis, Artemisia tridentata* ssp. *vaseyana / Poa secunda - Balsamorhiza sagittata*, and *Artemisia tridentata* ssp. *vaseyana - Symphoricarpos oreophilus / Poa secunda*, are described as "low seral" communities (Tueller and Eckert 1987). They are probably seral to other *Artemisia tridentata* ssp. *vaseyana - Symphoricarpos oreophilus* plant associations. For example, the indicator grass species *Poa secunda* had the highest constancy and cover in late-seral *Artemisia tridentata* ssp. *vaseyana - Symphoricarpos oreophilus / Elymus trachycaulus* and *Artemisia tridentata* ssp. *vaseyana - Symphoricarpos oreophilus / Festuca idahoensis* plant associations (Tueller and Eckert 1987).

In the Uinta Basin of northwestern Colorado (Dinosaur National Monument), stands of this association may be representative of *Artemisia tridentata* ssp. *vaseyana / Poa fendleriana* Shrubland (CEGL002812) or *Artemisia tridentata* ssp. *vaseyana / Pseudoroegneria spicata* Shrubland (CEGL001030) that have been degraded by grazing so that *Poa secunda* is dominant.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This stand has become established on the deep, mesic soils of this slope. The *Artemisia tridentata* ssp. *vaseyana* shrubs are mature with many dead branches, but the canopies are well filled out, even following several drought years. Sapling *Pinus flexilis* trees are becoming established.
Fossil Butte National Monument Data: The description is based on 2005 field data (8 plots: FOBU.0012, FOBU.0015, FOBU.0026, FOBU.0047, FOBU.0054, FOBU.0078, FOBU.0081, FOBU.0121; 3 observation points: FOBU.9054, FOBU.9068, FOBU.9102).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: C. Murphy, mod. J. Coles and K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Day and Wright 1985, Driscoll et al. 1984, Kagan et al. 2000, ORNHP unpubl. data, Tueller and Eckert 1987, Western Ecology Working Group n.d.

Artemisia tridentata ssp. *vaseyana / Pseudoroegneria spicata* Shrubland
Mountain Big Sagebrush / Bluebunch Wheatgrass Shrubland

CODE CEGL001030

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. *VASEYANA* SHRUBLAND ALLIANCE (A.831) Mountain Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Montane Sagebrush Steppe (CES304.785)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This is a common, abundant and widespread montane to subalpine sagebrush community of the western U.S. It occurs from 1829 to 3048 m (6000-10,000 ft.) elevation, on 10-59% slopes, usually on the upper part of the slope, or on ridgetops, with northeast- to south-facing aspects. Soils are generally deep Mollisols (average depth from one study was 104 cm). This association is dominated by *Artemisia tridentata* ssp. *vaseyana*, with a conspicuous herbaceous undergrowth often dominated by *Pseudoroegneria spicata*. Other shrubs are usually present, but no one species consistently so, and all generally with low cover (<10%). Shrub species include *Chrysothamnus* spp., *Tetradymia canescens, Purshia tridentata,* and *Amelanchier alnifolia*. *Symphoricarpos oreophilus* may be present but not codominant. The herbaceous undergrowth is dominated by grasses, *Pseudoroegneria spicata* usually having the highest cover. In disturbed stands, the exotic *Bromus tectorum* can be more abundant. Other grass species include *Poa fendleriana, Poa secunda (= Poa sandbergii), Bouteloua gracilis, Elymus lanceolatus (= Agropyron dasystachyum), Koeleria macrantha, Hesperostipa comata,* and *Elymus elymoides (= Sitanion hystrix). Festuca idahoensis* is usually not present, but if so, then in very low amounts. Common forbs include *Eriogonum umbellatum, Lupinus sericeus, Lupinus caudatus, Comandra umbellata, Balsamorhiza sagittata, Lithospermum ruderale*, and *Achillea millefolium*. *Bromus tectorum* may be present to dominant in stands that have been severely disturbed.

DISTRIBUTION

Fossil Butte National Monument

This association is uncommon at the monument and represented by one observation point located on Dempsey Ridge.

Globally

This common association is known from Nevada, Oregon, Idaho, Montana, Wyoming, Colorado and possibly Utah.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This mountain big sagebrush / bluebunch wheatgrass shrubland is uncommon within the monument and occurs on Dempsey Ridge. The site is gentle (3-degree slope), occurs at 2396 m elevation, and is oriented to the east. The unvegetated surface has low exposure of bare soil and low cover by small rocks, downed wood, and litter. The parent material is the Angelo Member of the Wasatch Formation.

Globally

This is a common, abundant and widespread montane to subalpine sagebrush community of the western U.S. It occurs from 1829 to 3048 m (6000-10,000 ft.) elevation, on 10-59% slopes, usually on the upper part of the slope, and on ridgetops, with northeast- to south-facing aspects. Soils are range from deep Mollisols (average depth from one study was 104 cm) to shallow, poorly developed shale soil. Soil textures range from loams to gravely clays. Parent materials include limestone, sandstone and shale.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover is 66% in this densely vegetated stand. This association is characterized by moderate cover of the short shrub *Artemisia tridentata* ssp. *vaseyana* (35%) and low cover of the perennial grass *Pseudoroegneria spicata* (8%). The short shrubs *Symphoricarpos oreophilus* and *Purshia tridentata* provide sparse cover. The remaining herbaceous layer is moderate in terms of diversity and contributes low cover. The short bunchgrass *Poa*

secunda provides low cover, while the remaining bunch grasses contribute sparse cover and include *Leucopoa kingii* and *Poa fendleriana*. Forbs include *Mertensia oblongifolia, Pteryxia terebinthina,* and *Achillea millefolium*.

Globally
This association is dominated by *Artemisia tridentata* ssp. *vaseyana*, with well-developed herbaceous undergrowth dominated by *Pseudoroegneria spicata*. Other shrubs are usually present, but no one species consistently so, and all generally with low cover (<10%). Shrub species include *Amelanchier alnifolia, Chrysothamnus* spp., *Tetradymia canescens, Purshia tridentata,* and *Symphoricarpos oreophilus* may be present, but not codominant. The herbaceous undergrowth is dominated by grasses, *Pseudoroegneria spicata* usually having the highest cover. In disturbed stands, *Bromus tectorum* can be more abundant. Other grass species include *Poa fendleriana, Poa secunda (= Poa sandbergii), Bouteloua gracilis, Elymus lanceolatus (= Agropyron dasystachyum), Koeleria macrantha, Leucopoa kingii, Hesperostipa comata*, and *Elymus elymoides (= Sitanion hystrix). Festuca idahoensis* is usually not present, but if so, then in very low amounts. Common forbs include *Eriogonum umbellatum, Lupinus sericeus, Lupinus caudatus, Comandra umbellata, Balsamorhiza sagittata, Lithospermum ruderale, Mertensia oblongifolia, Pteryxia terebinthina, Phlox hoodii, Sphaeralcea coccinea, Stenotus acaulis,* and *Achillea millefolium*.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Poa secunda, Pseudoroegneria spicata*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*
Herb (field)	*Pseudoroegneria spicata*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available.

Globally
Bromus tectorum

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

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Most of the top of this side ridge is *Artemisia arbuscula* ssp. *longiloba* dwarf-shrubland.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 observation point: FOBU.9050).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: G. Kittel, mod. J. Coles and K.A. Schulz

REFERENCES: Baker and Kennedy 1985, Bourgeron and Engelking 1994, Bramble-Brodahl 1978, CONHP unpubl. data 2003, Cooper et al. 1999, Current 1984, Driscoll et al. 1984, Eddleman and Jaindl 1994, Hironaka et al. 1983, Jensen et al. 1988a, Jensen et al. 1988b, Jones and Ogle 2000, Kagan et al. 2000, Lewis 1971, Lewis 1975a, MTNHP 2002b, Mooney 1985, Smith 1966, Terwilliger and Smith 1978, Western Ecology Working Group n.d.

Artemisia tridentata ssp. *wyomingensis* / Disturbed Understory Semi-natural Shrubland
Wyoming Big Sagebrush / Disturbed Understory Semi-natural Shrubland

CODE	CEGL002083
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA TRIDENTATA* SSP. *WYOMINGENSIS* SHRUBLAND ALLIANCE (A.832) Wyoming Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This Wyoming big sagebrush shrubland has been found in northern Arizona, western Colorado, eastern Utah and southwestern Wyoming and is likely widespread in other parts of the interior western U.S. It can occur on a variety of landscape positions on sites that are flat to moderately steep. This association has been sampled at elevations between 1455 and 2372 m (4770-7777 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 clay loams. This shrubland association has moderately open to dense vegetation cover with an open to closed short-shrub layer. The dominant shrub is *Artemisia tridentata* ssp. *wyomingensis* with low to moderate cover. Scattered *Pinus edulis, Juniperus osteosperma,* and *Juniperus scopulorum* trees (2-5 m tall) may be present with sparse cover. Other tall, short, and dwarf-shrubs that may be found are *Ericameria nauseosa, Ephedra viridis, Gutierrezia sarothrae, Sarcobatus vermiculatus,* and succulents. The herbaceous stratum has low to high cover and diversity, but weedy, exotic and invasive species, such as *Aristida purpurea, Astragalus nuttallianus, Bromus tectorum, Chenopodium album, Descurainia pinnata, Elymus elymoides, Erodium cicutarium, Lappula occidentalis, Lepidium* sp., *Phacelia crenulata,* or *Vulpia octoflora,* tend to dominate.

DISTRIBUTION

Fossil Butte National Monument

This disturbed shrubland is located in the environs south of the monument boundary and the state highway.

Globally

This association has been observed in northern Arizona, western Colorado, eastern Utah and southwestern Wyoming. It is very likely to occur in other parts of the western U.S.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This Wyoming big sagebrush / disturbed understory shrubland is uncommon at the monument and occupies grazed alluvial flats in the environs south of the monument boundary. Sites are gentle (1- to 2-degree slope), occur at 2052 m elevation, and are oriented to the east and south. The unvegetated surface has high exposure of bare soil, sparse cover of small rocks, and low cover of litter. The parent material is the main body of the Wasatch Formation. Soils are rapidly drained clay loams.

Globally

This association has been found on a variety of landscape features, including mesatops, mid- and low slopes of canyons, hills, valleys, stream terraces and alluvial flats on the Colorado Plateau and in southwestern Wyoming. Sites can be flat to moderately steep (0-15 degrees) and have any aspect. Sampled sites have elevations between 1455 and 2372 m (4770-7777 ft.). The unvegetated surface can be composed of variable amounts of litter, bare soil, and large or small rocks. Soils are typically eolian, alluvial, or colluvial loamy sands to clay loams. Finer-textured soils may include rapidly drained silt loams or clay loams derived from alluvium. Biological soil crust cover is absent to low (up to 15%).

VEGETATION DESCRIPTION

Fossil Butte National Monument
Total vegetation cover ranges from 48-76% in these moderately to densely vegetated stands. This association is characterized by moderate cover of the short shrub *Artemisia tridentata* ssp. *wyomingensis* (20-40% cover) and sparse cover from a variety of herbaceous species typically found on historically grazed sites, including the grass *Pascopyrum smithii* and the non-native forbs *Ceratocephala testiculata, Alyssum desertorum,* and *Taraxacum officinale*. The remaining short- and dwarf-shrub layers provide sparse to low cover and include *Atriplex gardneri* and *Chrysothamnus viscidiflorus*. The remaining herbaceous layer is low in terms of diversity and contributes sparse cover. Other grasses include *Elymus elymoides, Elymus lanceolatus,* and *Poa secunda*. Forbs include the natives *Trifolium gymnocarpon* and *Erigeron concinnus*.

Globally
This shrubland association has moderately open to dense herbaceous cover (28-89%) with an open to closed short-shrub layer. The dominant shrub, *Artemisia tridentata* ssp. *wyomingensis*, typically has 5-45% cover, though some stands may have more or less. Scattered *Pinus edulis, Juniperus osteosperma*, and *Juniperus scopulorum* trees (2-5 m tall) may provide up to 5-10% cover. In addition to *Artemisia tridentata* ssp. *wyomingensis*, other tall, short, and dwarf-shrubs that may be found are *Atriplex gardneri, Chrysothamnus viscidiflorus, Ericameria nauseosa, Ephedra viridis, Gutierrezia sarothrae, Sarcobatus vermiculatus*, and succulents such as *Opuntia* spp. The herbaceous stratum has low to high cover and diversity and tends to be dominated by weedy and exotic species, especially *Bromus tectorum*. Common graminoids include *Achnatherum hymenoides, Alyssum desertorum, Aristida purpurea, Bouteloua gracilis, Bromus tectorum, Vulpia octoflora, Elymus elymoides, Elymus lanceolatus, Hesperostipa comata, Pascopyrum smithii, Poa fendleriana,* and *Pleuraphis jamesii*. Forbs provide sparse to high cover and include *Astragalus nuttallianus, Ceratocephala testiculata, Chenopodium album, Descurainia pinnata, Erigeron concinnus, Erodium cicutarium, Lappula occidentalis, Lepidium* sp., *Phacelia crenulata, Plantago patagonica, Sphaeralcea coccinea, Taraxacum officinale,* and *Trifolium gymnocarpon*. Biological soil crust cover is sparse.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Atriplex gardneri*
Herb (field)	*Alyssum desertorum, Ceratocephala testiculata*
Herb (field)	*Pascopyrum smithii*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Taraxacum officinale

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNA (invasive) (14-Dec-2004).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
This association is closely related to *Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Semi-natural Shrubland (CEGL002699), and there may be overlap between the two. Clear criteria need to be developed to distinguish these associations from one another.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This stand has been grazed annually for over a century and continues to be grazed. Farther south the big sagebrush has many dead trunks; this stand is short-statured but in good condition. The shrubs dying and mostly dead are largely *Artemisia tridentata* ssp. *tridentata* that have extended their range before the drought. This site is grazed annually and heavily.
Fossil Butte National Monument Data: The description is based on 2005 field data (2 plots: FOBU.0142, FOBU.0143).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Drake, mod. J. Coles and K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Artemisia tridentata ssp. *wyomingensis / Poa secunda* Shrubland
Wyoming Big Sagebrush / Curly Bluegrass Shrubland

CODE	CEGL001049
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA TRIDENTATA* SSP. *WYOMINGENSIS* SHRUBLAND ALLIANCE (A.832) Wyoming Big Sagebrush Shrubland Alliance
ECOLOGICAL SYSTEM(S):	Great Basin Xeric Mixed Sagebrush Shrubland (CES304.774) Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777) Wyoming Basins Dwarf Sagebrush Shrubland and Steppe (CES304.794)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This open to moderately dense shrubland occurs as patches in a matrix of other shrubland or shrub-steppe types in the Columbia and Uinta basins of Washington, Oregon, Idaho, Nevada, Wyoming and Colorado. Stands are on level to moderate slopes of derived substrates such as loess deposits or alluvial fans and terraces, often modified by a veneer of alluvial cobble or gravel. Elevations range from 1675 to 2300 m (5500-7550 ft.). Soils are generally calcareous, excessively well-drained, fine-textured silts or fine sands, often deep to bedrock but sometimes with a shallow duripan that limits water infiltration. *Artemisia tridentata* ssp. *wyomingensis* dominates the shrub canopy and ranges from 15-45% cover. *Atriplex confertifolia, Purshia tridentata*, or *Ericameria nauseosa* are often present in the shrub layer. Other shrubs may be scattered through the shrub canopy. The native bunchgrass *Poa secunda* is typically dominant in the sparse to moderately dense herbaceous layer. Other grasses present have lower cover and include *Achnatherum hymenoides, Elymus elymoides, Elymus lanceolatus, Hesperostipa comata,* and *Pascopyrum smithii*. Forbs are a minor and variable component of this association.

DISTRIBUTION
Fossil Butte National Monument
This shrubland is located on ridges, slopes, and plains within the extreme southern portion of the monument.

Globally
This association has been documented from northwestern Colorado, northeastern Nevada (Jensen et al. 1988a, b), southern Idaho (Hironaka et al. 1983), the Columbia Basin of eastern Washington (Franklin and Dyrness 1969) and Oregon (Kagan et al. 2000). It is likely to occur in Wyoming and possibly also in northeastern California and southern Montana.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument

This Wyoming big sagebrush / curly bluegrass shrubland occupies ridges, slopes, and plains on the southern portion of the monument. Sites are gentle to moderate (1- to 12-degree slopes), occur between 2029 and 2066 m elevation, and are oriented to the south or southwest. The unvegetated surface has moderate to high exposure of bare soil, low to moderate cover of litter, low cover of small rocks, and sparse cover of downed wood. There is a sparse biological soil crust of mosses and lichens. The parent material is the main body of the Wasatch Formation. Soils are moderately well-drained to rapidly-drained sandy loams, clay loams, or clays.

Globally
This sparse shrubland occurs as patches in a matrix of other shrubland or shrub-steppe types in the Columbia Basin of Washington, Oregon and Idaho, extending south into northern Nevada and east into western Wyoming with outliers in northwestern Colorado. Slopes range from level to moderate, and many stands are on derived substrates such as loess deposits or alluvial fans and terraces, often modified by a veneer of alluvial cobble or gravel. Annual precipitation in the main part of the range is around 18 cm (7 inches), and the climate is characterized by hot, dry summers and cold, dry winters. Elevations range from 1675 to 2300 m (5500-7550 ft.). Soils are generally calcareous, excessively well-drained, fine-textured silts, clays or fine sands, often deep to bedrock but sometimes with a shallow duripan that limits water infiltration. The unvegetated surface has moderate to high exposure of bare soil, low to moderate cover of litter, low cover of small rocks, and sparse cover of downed wood. Parent materials include shales from the Wasatch and Moenkopi formations, sometimes modified by the presence of lag gravels of the Bishop Conglomerate.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover ranges from 33-63% in these moderately to densely vegetated stands. This association is characterized by moderate cover of the short shrub *Artemisia tridentata* ssp. *wyomingensis* (15-45% cover) and sparse cover of the perennial grass *Poa secunda* (1-4% cover). The remaining short- and dwarf-shrub layers provide sparse to low cover and include *Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Atriplex gardneri, Krascheninnikovia lanata,* and *Artemisia tridentata* ssp. *tridentata*. The remaining herbaceous layer is low in terms of diversity and contributes sparse cover. Other grasses include *Elymus elymoides, Pascopyrum smithii, Elymus lanceolatus,* and *Achnatherum hymenoides*. Forbs include *Taraxacum officinale, Phlox hoodii, Stenotus acaulis, Alyssum desertorum, Trifolium gymnocarpon, Eriogonum brevicaule,* and *Ceratocephala testiculata.* Cryptogams provide sparse cover and include mosses and lichens.

Globally
This sparse shrubland often occupies the lowest, driest sites within the shrub-steppe mosaic in which it occurs. The named species may often be the only species of note present. *Artemisia tridentata* ssp. *wyomingensis* dominates the open to moderately dense shrub canopy that generally does not exceed 1 m in height and ranges from 15-45% cover. *Atriplex confertifolia, Purshia tridentata,* or *Ericameria nauseosa* are often present in the shrub layer. Other shrubs such as *Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Atriplex gardneri, Krascheninnikovia lanata, Grayia spinosa,* or *Artemisia tridentata* ssp. *tridentata* may be scattered through the shrub canopy. The native bunchgrass *Poa secunda* is typically dominant in the sparse to moderately dense herbaceous layer. Other grasses present may include *Achnatherum hymenoides, Elymus elymoides, Elymus lanceolatus, Hesperostipa comata, Koeleria macrantha,* and *Pascopyrum smithii*. Forbs are a minor and variable component of this association. Species include *Descurainia pinnata, Eriogonum brevicaule, Petradoria pumila, Phlox hoodii, Sphaeralcea coccinea, Stenotus acaulis,* and *Trifolium gymnocarpon*. Introduced species, such as the annual grass *Bromus tectorum* and forbs *Alyssum desertorum, Ceratocephala testiculata,* and *Taraxacum officinale,* may also occur. Cryptogams usually provide sparse cover and include mosses and lichens.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Poa secunda*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*

Herb (field) *Poa secunda*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Alyssum desertorum, Ceratocephala testiculata, Taraxacum officinale

Globally
Alyssum desertorum, Bromus tectorum, Ceratocephala testiculata, Taraxacum officinale

CONSERVATION STATUS RANK
Global Rank & Reasons: G4 (1-Feb-1996). This association is widely distributed. It tends to occur as small to medium patches within a mosaic of many different types of sagebrush and related shrublands.

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Site is controlled by deep soils and slope, which is conducive to big sagebrush establishment. Historically, there was heavy grazing pressure that likely selected for big sagebrush. This area will have a prescribed burn in the fall of 2005. This stand represents one of the few small, scattered prairie dog towns that occur on the southern edge of the monument. Many mature shrubs have died back as a result of drought. The soils are clay that shed water rapidly, but erosion is minor in this community.
Fossil Butte National Monument Data: The description is based on 2005 field data (4 plots: FOBU.0004, FOBU.0005, FOBU.0006, FOBU.0074).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Caicco and Wellner 1983l, Driscoll et al. 1984, Franklin and Dyrness 1969, Hironaka et al. 1983, Jensen et al. 1988a, Jensen et al. 1988b, Kagan et al. 2000, MTNHP 2002b, WNHP unpubl. data, Western Ecology Working Group n.d.

Artemisia tridentata ssp. *wyomingensis / Pseudoroegneria spicata* Shrubland
Wyoming Big Sagebrush / Bluebunch Wheatgrass Shrubland

CODE	CEGL001009
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA TRIDENTATA* SSP. *WYOMINGENSIS* SHRUBLAND ALLIANCE (A.832) Wyoming Big Sagebrush Shrubland Alliance
ECOLOGICAL SYSTEM(S):	Great Basin Xeric Mixed Sagebrush Shrubland (CES304.774) Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This association is common and widespread throughout the sagebrush zone of the western Great Plains through southern British Columbia, south into the Great Basin, northern Colorado Plateau, and western Wyoming. Slopes may be gentle to steep, and aspect is not important in determining the distribution of this association. Stands occupy moderately deep to deep loamy soils (often with coarse fragments), sometimes with a cemented clay layer limiting

water and root penetration. Parent materials are variable. Throughout the geographic range of this type, *Artemisia tridentata* ssp. *wyomingensis* dominates a shrub layer that has at least 10% canopy cover. Total vegetation cover ranges between 20% and more than 100%, roughly evenly divided between the shrub and herbaceous strata. The shrubs *Chrysothamnus* spp., *Atriplex confertifolia, Purshia tridentata, Symphoricarpos longiflorus*, and *Amelanchier utahensis* are often present as well. The herbaceous understory is generally a diverse mix of grasses and forbs. *Pseudoroegneria spicata* contributes more cover to the diverse herbaceous layer than does any other native species, and *Achnatherum thurberianum, Festuca idahoensis, Hesperostipa comata, Poa secunda, Koeleria macrantha*, and *Poa fendleriana* are often present. Forbs are variable across the range of this type, but common species include *Eriogonum umbellatum, Sphaeralcea coccinea*, and *Balsamorhiza sagittata*. Stands in the eastern part of the geographic range often include *Gutierrezia sarothrae, Artemisia frigida*, and *Bouteloua gracilis*. The height of the sagebrush ranges from about 35 cm tall in the eastern part of the range to about 1 m tall in the western part.

DISTRIBUTION

Fossil Butte National Monument

This association is uncommon at the monument and represented by one plot located on a landslide deposit near the Fossil Quarry Trail.

Globally

This is a widespread Wyoming big sagebrush shrub type, extending from the western side of the Great Plains on the east to British Columbia on the west, and south as far as northern Nevada, southern Wyoming and northwestern Colorado.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This Wyoming big sagebrush / bluebunch wheatgrass shrubland is uncommon within the monument and occupies a landslide deposit near the historic quarry. The site is moderate (10-degree slope), occurs at 2195 m elevation, and is oriented to the south. The unvegetated surface has low exposure of bare soil and moderate cover of small rocks and litter. The parent material is shale from the Angelo Member of the Wasatch Formation that has slumped as a landslide deposit, then eroded. Soils are rapidly drained silt loams.

Globally

This association is common and widespread throughout the sagebrush zone of the western Great Plains through southern British Columbia, south into the Great Basin, northern Colorado Plateau, and western Wyoming. Elevation ranges from 1115-2300 m. Slopes may be gentle to steep, and aspect is not important in determining the distribution of this association. Stands occupy shallow to deep loamy soils (often with coarse fragments), sometimes with a cemented clay layer limiting water and root penetration. Parent materials are variable but include alluvium, colluvium, shale, sandstone and limestone.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover is 44% in this moderately vegetated stand. This association is characterized by moderate cover of the short shrub *Artemisia tridentata* ssp. *wyomingensis* (30%) and low cover of the perennial bunchgrass *Pseudoroegneria spicata* (12%). The short-shrub layer provides sparse cover and includes *Atriplex confertifolia, Symphoricarpos oreophilus*, and *Chrysothamnus viscidiflorus*. The remaining herbaceous layer is low in terms of diversity and contributes sparse cover. Other grasses include *Elymus elymoides* and *Leymus cinereus*. Forbs include *Mertensia oblongifolia* and *Streptanthus cordatus*.

Globally

Throughout the geographic range of this type, *Artemisia tridentata* ssp. *wyomingensis* dominates a shrub layer that has at least 10% canopy cover. Total vegetation cover ranges between 20% and more than 100%, roughly evenly divided between the shrub and herbaceous strata. The shrubs *Chrysothamnus* spp., *Atriplex confertifolia, Atriplex gardneri, Purshia tridentata, Symphoricarpos longiflorus*, and *Amelanchier utahensis* are often present as well. The herbaceous understory is generally a diverse mix of grasses and forbs. *Pseudoroegneria spicata* contributes more cover to the diverse herbaceous layer than does any other native species, and *Achnatherum thurberianum, Elymus elymoides, Festuca idahoensis, Hesperostipa comata, Poa secunda, Koeleria macrantha, Leymus cinereus*, and *Poa fendleriana* are often present. Forbs are variable across the range of this type, but common species include

Balsamorhiza sagittata, Eriogonum umbellatum, Mertensia oblongifolia, Sphaeralcea coccinea, and *Streptanthus cordatus*. Stands in the eastern part of the geographic range often include *Gutierrezia sarothrae, Arenaria hookeri, Artemisia frigida, Carex filifolia*, and *Bouteloua gracilis*. The height of the sagebrush ranges from about 35 cm tall in the eastern part of the range to about 1 m tall in the western part (Hironaka et al. 1983).

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Pseudoroegneria spicata*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Pseudoroegneria spicata*

OTHER NOTEWORTHY SPECIES

Fossil Butte National Monument
Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Fossil Butte National Monument
Data are not available.

Globally
Many stands of this association may be derived by grazing of *Artemisia tridentata* ssp. *wyomingensis / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001535). It may be preferable to first combine these two types, and then split them geographically. The occurrences from the Great Plains west as far as northwestern Colorado, western Wyoming, and western Montana might belong to one type characterized by the presence of *Bouteloua* spp., *Carex filifolia, Koeleria macrantha, Gutierrezia sarothrae, Artemisia frigida*, and *Opuntia polyacantha*, and by the absence of *Achnatherum thurberianum (= Stipa thurberiana)*. The occurrences from southern Idaho, northern Nevada, eastern Oregon, eastern Washington, and British Columbia could belong to a different type characterized by the presence of *Achnatherum thurberianum*, and by the absence of the other species listed above. The separation between these two types probably would occur in Idaho. Additional research will be required to clarify this issue.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Fossil Butte National Monument Inventory Notes: This plot is off the main landslide on older colluvium, with apparently much less water saturating the soil.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0109).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: B. Johnston, mod. D. Faber-Langendoen, J. Coles, K.A. Schulz

REFERENCES: Blackburn 1967, Blackburn et al. 1968a, Blackburn et al. 1968b, Blackburn et al. 1969a, Blackburn et al. 1969c, Blackburn et al. 1971, Bourgeron and Engelking 1994, Brotherson and Brotherson 1981, CONHP Ecology Team 2001, Cooper et al. 1995, Daubenmire 1970, DeVelice and Lesica 1993, DeVelice et al. 1991, Driscoll et al. 1984, Fisser 1964, Fisser 1970, Hall 1973, Heinze et al. 1962, Hironaka et al. 1983, Jensen et al. 1992, Johnston 1987, Jones 1992b, Knight et al. 1987, Lewis 1975a, MTNHP 2002b, McLean 1970, Moretti 1979, Moretti and Brotherson 1982, Mueggler and Stewart 1980, NDNHI n.d., Poulton 1955, Seminoe I Mine Application n.d., Tisdale 1947, Tweit and Houston 1980, Western Ecology Working Group n.d.

Artemisia cana / Juncus balticus Shrubland
Silver Sagebrush / Baltic Rush Shrubland

CODE	CEGL005998
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Temporarily flooded microphyllous shrubland (III.A.4.N.c.)
ALLIANCE	*ARTEMISIA CANA* TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.843) Silver Sagebrush Temporarily Flooded Shrubland Alliance

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

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This silver sagebrush shrubland is only known from Fossil Butte National Monument in southwestern Wyoming. Stands occur in low-lying riparian and wetland sites. It occupies first terraces of principle drainages, in tributary channels, or mesic swales that seasonally flood or are saturated. Sites are generally flat to gently sloping (<5%) and between 2039 and 2388 m elevation, with stands occurring in swales found on steeper slopes (to 14 degrees). The unvegetated surface has low to moderate exposure of bare soil, high cover of litter, and sparse cover of downed wood. Soils are somewhat poorly to moderately well-drained clays derived from the Angelo Member of the Wasatch Formation, and sandstones and shale that have eroded and deposited as either new alluvium or secondary stream alluvium. The vegetation is characterized by a moderate to dense short-shrub layer dominated by *Artemisia cana* (15-68% cover) and sparse to moderately dense cover of *Juncus balticus* (4-45% cover). Total vegetation cover ranges from 49-99%. The short shrub *Rosa woodsii* is typically present with sparse cover. The herbaceous layer is dominated by graminoids and has low species diversity, with *Carex praegracilis* providing low to moderate cover, while the grasses *Deschampsia caespitosa*, *Leymus cinereus*, *Poa glauca*, and *Poa secunda* provide low cover. Forbs present with sparse to low cover include *Achillea millefolium, Argentina anserina, Astragalus agrestis, Descurainia pinnata, Glyceria striata, Senecio integerrimus, Solidago gigantea,* and *Solidago velutina*. Disturbed stands may be codominated by *Poa pratensis*, along with other common introduced species, including *Ceratocephala testiculata, Iva axillaris,* and *Taraxacum officinale*.

DISTRIBUTION

Fossil Butte National Monument

This association is located along Chicken and Smallpox creeks, some tributary drainages and a swale near Cundick Spring. In the larger creeks, it occurs on the first or second terrace, stabilizing the creekbank and forcing down-cutting or meandering.

Globally

This silver sagebrush shrubland is only known from Fossil Butte National Monument in southwestern Wyoming and likely is more widespread in southern Wyoming.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This silver sagebrush / Baltic rush shrubland was sampled in low-lying riparian and wetland sites. It occupies first terraces of principle drainages, in tributary channels, or mesic swales that seasonally flood or are saturated. The sites are generally gentle (0- to 2-degree slopes), occur between 2039 and 2388 m elevation, and are oriented to the south, southwest, and west. One site in a swale is moderately steep (14-degree slope). The unvegetated surface has low to moderate exposure of bare soil, high cover of litter, and sparse cover of downed wood. The parent materials include the Angelo Member of the Wasatch Formation, sandstones and shale that have eroded and deposited as either new alluvium or secondary stream alluvium, or are obscured by soil. Soils are somewhat poorly to moderately well-drained silty clays, clay loams, or clays.

Globally
This silver sagebrush shrubland is only known from Fossil Butte National Monument in southwestern Wyoming. Stands occur in low-lying riparian and wetland sites. It occupies first terraces of principle drainages, in tributary channels, or mesic swales that seasonally flood or are saturated. Sites are generally flat to gently sloping (<5%) and between 2039 and 2388 m elevation, with stands occurring in swales found on steeper slopes (to 14 degrees). The unvegetated surface has low to moderate exposure of bare soil, high cover of litter, and sparse cover of downed wood. Soils are somewhat poorly to moderately well-drained silty clays, clay loams, or clays derived from the Angelo Member of the Wasatch Formation, and sandstones and shale that have eroded and deposited as either new alluvium or secondary stream alluvium.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover ranges from 49-99% in these moderately to densely vegetated stands. This association is characterized by moderate to dense cover of the short shrub *Artemisia cana* (15-68% cover) and sparse to moderate cover of the rush *Juncus balticus* (4-45% cover). The short shrub *Rosa woodsii* typically provides sparse cover. The remaining herbaceous layer is low in terms of diversity. The sedge *Carex praegracilis* provides low to moderate cover, while the grasses *Deschampsia caespitosa, Poa secunda, Leymus cinereus, Poa glauca,* and *Poa pratensis* provide low cover. Forbs provide sparse to low cover and include *Solidago velutina (= Solidago sparsiflora), Achillea millefolium, Taraxacum officinale, Iva axillaris, Argentina anserina, Astragalus agrestis, Descurainia pinnata, Ceratocephala testiculata, Solidago gigantea, Senecio integerrimus,* and *Glyceria striata*. Disturbed stands may be codominated by *Poa pratensis* with other introduced species including *Iva axillaris, Ceratocephala testiculata,* and *Taraxacum officinale* common.

Globally
The vegetation is characterized by a moderate to dense short-shrub layer dominated by *Artemisia cana* (15-68% cover) and sparse to moderately dense cover of *Juncus balticus* (4-45% cover). Total vegetation cover ranges from 49-99%. The short shrub *Rosa woodsii* is typically present with sparse cover. The herbaceous layer is dominated by graminoids and has low species diversity, with *Carex praegracilis* providing low to moderate cover, while the grasses *Deschampsia caespitosa, Leymus cinereus, Poa glauca,* and *Poa secunda* provide low cover. Forbs present with sparse to low cover include *Achillea millefolium, Argentina anserina, Astragalus agrestis, Descurainia pinnata, Glyceria striata, Senecio integerrimus, Solidago gigantea,* and *Solidago velutina (= Solidago sparsiflora).* Disturbed stands may be codominated by *Poa pratensis,* along with other common introduced species, such as *Ceratocephala testiculata, Iva axillaris,* and *Taraxacum officinale*.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia cana*
Herb (field)	*Carex praegracilis*, *Juncus balticus*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia cana*
Herb (field)	*Carex praegracilis*, *Juncus balticus*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Ceratocephala testiculata, Descurainia pinnata, Poa pratensis, Taraxacum officinale

Globally
Ceratocephala testiculata, Iva axillaris, Poa pratensis, Taraxacum officinale

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (3-Aug-2007).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This community occurs just above the current main drainage on the first terrace and periodically floods during large storm events. It appears as if this area was subject to a recent major storm. This shrubland occupies a bench just above a ravine filled with quaking aspen. Groundwater emerges here to support this wet meadow.
Fossil Butte National Monument Data: The description is based on 2005 field data (5 plots: FOBU.0016, FOBU.0069, FOBU.0077, FOBU.0114, FOBU.0146; 1 observation point: FOBU.9048).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Atriplex confertifolia - Sarcobatus vermiculatus Shrubland
Shadscale - Greasewood Shrubland

CODE	CEGL001313
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*ATRIPLEX CONFERTIFOLIA* SHRUBLAND ALLIANCE (A.870) Shadscale Shrubland Alliance
ECOLOGICAL SYSTEM(S):	Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784) Sonora-Mojave Mixed Salt Desert Scrub (CES302.749) Inter-Mountain Basins Shale Badland (CES304.789) Inter-Mountain Basins Greasewood Flat (CES304.780)
USFWS WETLAND SYSTEM:	Not applicable

CONCEPT SUMMARY
Globally
This shrub association is found scattered in saline soils on valley floors, alluvial terraces and alluvial fans across the Colorado Plateau and western Wyoming. Elevations range from 1350 to 2257 m, slopes range from level to moderately steep (1-65% slopes), and sites can be oriented to any aspect. Substrates are typically fine-textured and poorly drained soils such as clays, clay loams and silt loams. Total vegetation cover ranges from less than 20% to more than 50%, with the higher values tending to occur in shrublands located on valley floors and alluvial terraces. The open shrub stratum generally consists primarily of *Sarcobatus vermiculatus* shrubs with between 1 and 20% cover. *Atriplex confertifolia* shrubs are scattered throughout the canopy, with between 1 and 5% cover. Other shrubs present with minor cover include *Gutierrezia sarothrae* and *Suaeda moquinii (= Suaeda torreyana)*. The often sparse herbaceous layer is variable and can have as much as 35% cover. This layer tends to reflect a degree of disturbance; common species include *Achnatherum hymenoides, Astragalus nuttallianus, Bromus tectorum, Lappula occidentalis, Lepidium densiflorum, Plantago patagonica,* and *Sphaeralcea parvifolia*. Sparse nonvascular species are generally present on the soil surface and may have as much as 95% cover in undisturbed sites.

DISTRIBUTION
Fossil Butte National Monument
This association is uncommon at the monument and represented by one plot located on a badlands formation along the southern boundary of the monument.

Globally

This shrub association is found scattered in saline soils on valley floors, alluvial terraces and alluvial fans across the Colorado Plateau, in Arizona and Colorado and extends west into California and Nevada.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This shadscale - greasewood shrubland is uncommon within the monument and occupies badlands along the southern toeslope of Fossil Butte. The site is steep (33-degree slope), occurs at 2257 m elevation, and is oriented to the south. The unvegetated surface has high exposure of bare soil and low cover of small and large rocks. The parent material is the main body of the Wasatch Formation. Soils are rapidly drained clays.

Globally

This mixed shrub association is found in habitats across the Colorado Plateau and in western Wyoming. It occurs in habitats that are significantly saline, either because of poor drainage or high levels of salts in the soil. Miller et al. (1977) report this association as occurring in low-lying, internally drained areas such as abandoned stream channels. Recent plot data from eastern Utah, western Colorado and western Wyoming indicate that habitat for this association includes badland toeslopes, alluvial fans and stream terraces, especially those that exhibit ponding as well as low-lying areas on valley floors. Elevations range from 1350 to 2257 m. Sites range from level to moderate and occasionally steep (to 33 degrees) and can be oriented to any aspect. Substrates are well-drained to poorly drained soils with clay, clay loam, silt loam and sandy loam texture that are typically derived from alluvium, but they may include eolian sand. Soil surface typically has high cover of bare ground with low cover of litter and biological crust.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover is less than 1% in this sparsely vegetated stand. This association is characterized by sparse cover of the short shrubs *Atriplex confertifolia* and *Sarcobatus vermiculatus* (less than 1% cover in total). The remaining shrub layer consists of sparse cover of the short shrubs *Symphoricarpos oreophilus, Chrysothamnus viscidiflorus,* and *Ericameria nauseosa*. The herbaceous layer is low in terms of diversity and contributes sparse cover. Bunch grasses include *Achnatherum hymenoides, Leymus cinereus,* and *Poa fendleriana*. Forbs include *Astragalus jejunus, Eriogonum brevicaule, Physaria condensata*, and *Iva axillaris*.

Globally

This open shrubland occurs in saline habitats and usually has relatively low cover of vegetation. However, total vegetation cover ranges from less than 15% to more than 100%, with the higher values tending to occur in shrublands located on valley floors and alluvial terraces. Upland sites tend to have sparser vegetation. The shrub stratum is less than 1 m tall and is composed of *Sarcobatus vermiculatus* (1-20% cover) with *Atriplex confertifolia* shrubs scattered throughout the canopy (1-5% cover). Other shrubs present with minor cover include *Artemisia tridentata, Atriplex gardneri, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae, Opuntia* spp., *Sclerocactus parviflorus, Symphoricarpos oreophilus,* and *Suaeda moquinii (= Suaeda torreyana)*. The herbaceous layer is variable but can have as much as 35% cover. This layer tends to reflect a degree of disturbance; common species include grasses *Achnatherum hymenoides, Leymus cinereus, Pleuraphis jamesii, Poa fendleriana, Sporobolus airoides,* and forbs such as *Astragalus jejunus, Astragalus nuttallianus, Eriogonum brevicaule, Lappula occidentalis, Lepidium densiflorum, Physaria condensata, Plantago patagonica,* and *Sphaeralcea parvifolia*. Exotic species such as *Bromus tectorum* and *Iva axillaris* are often present in disturbed stands. Mosses and ground lichens are generally present and may have as much as 95% cover in undisturbed sites.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia, Sarcobatus vermiculatus*
Herb (field)	*Bromus tectorum*

OTHER NOTEWORTHY SPECIES

Fossil Butte National Monument

Data are not available.

Globally
Bromus tectorum, Iva axillaris

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

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This plot lies in the middle of an unstable badlands slope. Large and small rocks erode from the ridge and tumble through the plot. Any precipitation results in sheet and gully erosion, and there are several prominent gullies running through the site. Vegetation is sparse and subject to erosion from the soil. Soils are sealed and hard-packed.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 observation point: FOBU.0060).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Fenemore 1970, Kagan et al. 2004, Miller et al. 1977, Western Ecology Working Group n.d.

Atriplex confertifolia Wyoming Basins Shrubland
Shadscale Wyoming Basins Shrubland

CODE	CEGL001293
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) Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
These open to sparse shrublands are dominated by *Atriplex confertifolia* but lack other diagnostic species. It is widespread across western and central Wyoming north to the Bighorn Basin in Montana and also occurs in shaly sites in western Colorado and eastern Utah. Stands occur on hills, ridges and toeslopes, and often on badland sites in the Uinta Basin and Colorado Plateau. Soils are often shallow clays or clay loams derived from marine shales, with a high percentage of bare ground and gravel at the surface. Some examples are on sandy soils. Total vegetation cover generally does not exceed 35%. The short-shrub canopy is dominated by *Atriplex confertifolia*, usually accompanied by other species, including *Eriogonum corymbosum, Atriplex corrugata, Atriplex gardneri, Chrysothamnus viscidiflorus*, and *Tetradymia spinosa*. The herbaceous layer is generally sparse but ranges to moderately dense and may be relatively diverse. Common species include *Achnatherum hymenoides, Pseudoroegneria spicata, Poa secunda, Xylorhiza venusta*, and *Penstemon caespitosus*.

DISTRIBUTION

Fossil Butte National Monument

This association is uncommon at the monument and represented by two observation points located on the steep southern slopes of Fossil Butte.

Globally

This association has been described from the eastern Uinta Basin and the western Colorado Plateau in Colorado and Utah and is widespread across western and central Wyoming north to the Bighorn Basin into south-central Montana.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This shadscale shrubland is uncommon within the monument. It occupies a cliff band and hillslope within the monument. The sites are steep (23- and 41-degree slopes), occur at 2253 m elevation, and are oriented to the southwest. The unvegetated surface has high exposure of bare soil, low to moderate cover of small and large rocks and bedrock, and low cover of litter. The parent material is the Fossil Butte Member of the Wasatch Formation.

Globally

This shrubland is widespread across western and central Wyoming north to the Bighorn Basin in Montana and also occurs in shaly sites in western Colorado and eastern Utah where it is known from hills, ridges and toeslopes in the Uinta Basin and the Colorado Plateau. Sites range from nearly level to very steep (to 85% slopes) and occur at 1886-2253 m elevation. Some examples occur on the slopes of shale badlands. Soils are usually clays, silty clays, or clay loams derived from marine shales, but they may be sandy and usually have a high percentage of gravel on the soil surface. The parent material includes marine shales such as the Fossil Butte Member of the Wasatch Formation, the Mancos Formation and other Mesozoic shales.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 2-3% in these sparsely vegetated stands. This association is characterized by sparse cover of the short shrub *Atriplex confertifolia* (2%). The remaining shrub layer provides sparse cover of the tall and dwarf-shrubs *Amelanchier utahensis* and *Artemisia frigida*. The herbaceous layer is low in terms of diversity and contributes sparse cover. Bunch grasses include *Elymus lanceolatus, Leymus cinereus,* and *Poa fendleriana*. Forbs include *Eriogonum brevicaule* and *Streptanthus cordatus.*

Globally

Total vegetation cover generally does not exceed 35% and is often sparse (<10%). The open short-shrub canopy is dominated by *Atriplex confertifolia* (1-12% cover) and is usually accompanied by other species, including *Eriogonum corymbosum, Atriplex corrugata, Atriplex gardneri, Amelanchier utahensis, Artemisia frigida, Chrysothamnus viscidiflorus,* and *Tetradymia spinosa*. The herbaceous layer is generally sparse but may be diverse. Common herbaceous species include grasses *Achnatherum hymenoides, Elymus elymoides, Elymus lanceolatus, Leymus cinereus, Poa fendleriana, Poa secunda, Pseudoroegneria spicata,* and forbs, *Calochortus nuttallii, Crepis modocensis, Cryptantha* sp., *Cymopterus bulbosus, Cymopterus purpureus, Descurainia pinnata, Eriogonum brevicaule, Eriogonum umbellatum, Erysimum inconspicuum, Lappula occidentalis, Penstemon caespitosus, Streptanthus cordatus,* and *Xylorhiza venusta*. The exotic annual grass *Bromus tectorum* may have high cover in areas that have been disturbed.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia*

OTHER NOTEWORTHY SPECIES

Fossil Butte National Monument

Data are not available.

Globally
Bromus tectorum

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

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
This open shrubland association includes sparsely vegetated sites based on floristics.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: The plot consists of cliff bands of tan/white sedimentary rocks with rocky sparsely vegetated bands between layers. Small drainages or gullies are observed between vegetation patches and on sides of cliff bands. Steepness of terrain affects rock and slope stability, runoff, and vegetation establishment.
Fossil Butte National Monument Data: The description is based on 2005 field data (2 observation points: FOBU.9022, FOBU.9084).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Brotherson and Brotherson 1979, Driscoll et al. 1984, MTNHP 2002b, MTNHP unpubl. data, Western Ecology Working Group n.d.

Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland
(Utah Serviceberry, Saskatoon Serviceberry) - Alderleaf Mountain-mahogany Shrubland

CODE	CEGL001070
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*AMELANCHIER UTAHENSIS* SHRUBLAND ALLIANCE (A.916) Utah Serviceberry Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
The description for this association is based on information from Colorado and Utah; its characteristics in Nevada are unknown and will be described when more information becomes available. This plant association is found on moderate to steeply sloping colluvial slopes, canyons, ridges and in alcoves. Sites may be oriented to any aspect. Elevation ranges between 1586 and 2595 m (5200-8500 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, but can also be of fine texture and ranges from loamy sand, silt loam, sandy clay loam, silt clay loam, silty clay, to clay. The vegetation is various, from widely spaced open shrubs to dense thickets with a sparse understory relative to other mixed mountain shrub types. Total vegetation cover ranges from 20 to 93%. *Amelanchier utahensis* and *Cercocarpus montanus* are the dominants, sharing equal amounts, or more often *Amelanchier* has one-third the cover of *Cercocarpus*. Many other shrub species may be present, and some stands have as many as 16 shrub species in this association. Typical associated shrub species include *Artemisia bigelovii, Artemisia tridentata (*ssp. *tridentata,* ssp. *wyomingensis,* ssp.

vaseyana), Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Prunus virginiana, Purshia tridentata, Rhus trilobata, Fraxinus anomala, and *Tetradymia canescens*. *Symphoricarpos oreophilus* can dominate the lower shrub layer, which may also include *Brickellia microphylla, Eriogonum microthecum, Gutierrezia sarothrae, Mahonia repens,* and *Paxistima myrsinites*. Succulents such as *Opuntia* spp. or *Yucca* spp. may also have minor cover. If *Quercus gambelii* is present, cover is low (<5%). Scattered trees of *Juniperus osteosperma, Juniperus scopulorum,* or *Pinus edulis* may be present in some stands. *Achnatherum hymenoides* is the most common species in the diverse herbaceous layer. Other graminoid species may include *Poa fendleriana, Koeleria macrantha, Achnatherum lettermanii, Pascopyrum smithii, Pseudoroegneria spicata, Elymus lanceolatus, Hesperostipa comata,* and *Leymus salinus*. Forb species may include *Arenaria fendleri, Chaenactis douglasii, Cryptantha flava, Cymopterus purpureus, Balsamorhiza sagittata, Eriogonum umbellatum, Galium coloradoense, Heterotheca villosa, Lepidium montanum, Lithospermum ruderale, Petradoria pumila, Phlox longifolia, Physaria acutifolia, Senecio integerrimus, Sphaeralcea coccinea, Stanleya pinnata, Stenotus acaulis,* and *Streptanthella longirostris*. Disturbed sites may have high cover of *Bromus tectorum*.

DISTRIBUTION

Fossil Butte National Monument

This shrubland occupies steep, exposed slopes and ridges, including Ruby Point, Cundick Ridge, Fossil Butte and near the Slump Trail.

Globally

This association is documented from stands in western Colorado and Utah. It has been reported from Nevada and is likely to occur in xeric areas of mixed mountain shrubland throughout the plateaus and foothills of Colorado and in higher elevations of the Colorado Plateau, western Rocky Mountains and Intermountain West.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This Utah serviceberry - mountain-mahogany shrubland occurs on steep slopes and ridges of Ruby Point, Cundick Ridge, and Fossil Butte. Stands occupy high topographic positions on ridges, buttes, and slopes within the monument. Stands occur on gentle to steep (1- to 34-degree) slopes, lying between 2233 and 2424 m elevation, and are oriented to all aspects. The unvegetated surface has moderate to high exposure of bare soil, low to moderate cover of small rocks and litter, and low cover of large rocks and downed wood. Soils are moderately well-drained to rapidly drained, derived from the Wasatch Formation and include a range of textures from loamy sand, silt loam, sandy clay loam, silt clay loam, silty clay, to clay.

Globally

The description for this association is based on information from Colorado and Utah; its characteristics in Nevada are unknown and will be described when more information becomes available. This plant association is found on moderate to steeply sloping colluvial slopes, canyons, ridges and in alcoves. Sites may be oriented to any aspect. Elevations range between 1586 and 2500 m (5200-8200 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, from loams to silty clays, but are generally always rocky with a high cover of surface rock.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 20-93%. Stands are characterized by an open canopy, typically 1-2 m tall, of *Amelanchier utahensis* (1-30% cover) and *Cercocarpus montanus* (5-50% cover). Scattered individuals of the canopy tree *Pinus flexilis* provide sparse cover and attain heights between 2 and 5 m. Associated shrubs include *Artemisia tridentata* ssp. *vaseyana, Purshia tridentata, Chrysothamnus viscidiflorus, Prunus virginiana, Mahonia repens,* and *Symphoricarpos oreophilus*. The herbaceous layer is diverse; the composition and cover vary among stands. Common graminoids include *Achnatherum hymenoides, Pascopyrum smithii, Pseudoroegneria spicata, Poa fendleriana, Carex geyeri, Poa secunda, Elymus lanceolatus,* and *Leymus cinereus* that provide sparse to low cover. Forbs include *Senecio integerrimus, Mertensia oblongifolia, Eriogonum umbellatum, Pteryxia terebinthina, Comandra umbellata, Taraxacum officinale, Achillea millefolium, Lithospermum ruderale, Phlox hoodii, Stenotus acaulis, Eriogonum brevicaule, Physaria acutifolia, Oenothera pallida, Helianthella uniflora,* and *Balsamorhiza sagittata*.

Globally
The vegetation is characterized by a variable shrub layer ranging from open shrubs to dense thickets (20-90% cover) and a sparse understory relative to other mixed mountain shrub types. Total vegetation cover ranges from 20% to more than 90%. *Amelanchier utahensis* and *Cercocarpus montanus* are the dominants, sharing equal amounts, or more often *Amelanchier* has one-third the cover of *Cercocarpus*. Many other shrub species may be present, and some stands have of as many as 16 shrub species in this association. Typical shrub species include *Artemisia bigelovii, Artemisia tridentata (*ssp. *tridentata,* ssp. *wyomingensis,* ssp. *vaseyana), Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Prunus virginiana, 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* is the most common species in the diverse herbaceous layer. Other graminoid species may include *Poa fendleriana, Koeleria macrantha, Achnatherum lettermanii, Pascopyrum smithii, Pseudoroegneria spicata, Elymus lanceolatus, Hesperostipa comata,* and *Leymus salinus*. Forb species may include *Arenaria fendleri, Chaenactis douglasii, Cryptantha flava, Cymopterus purpureus, Balsamorhiza sagittata, Eriogonum umbellatum, Galium coloradoense, Heterotheca villosa, Lepidium montanum, Lithospermum ruderale, Petradoria pumila, Phlox longifolia, Physaria acutifolia, Senecio integerrimus, Sphaeralcea coccinea, Stanleya pinnata, Stenotus acaulis,* and *Streptanthella longirostris*. Disturbed sites may have high cover of *Bromus tectorum*.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Cercocarpus montanus*

Globally

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Cercocarpus montanus*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Taraxacum officinale

Globally
Bromus tectorum

CONSERVATION STATUS RANK
Global Rank & Reasons: G2? (12-Nov-2008). This association is well-known from Colorado and throughout Utah. It also occurs in Nevada, but no information is available on its conservation status there. Very little is known about the larger scale abiotic factors that contribute to the distribution. The global rank should be at least a G3 based on the numbers of sites documented at several National Park Service units.

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Steep, loose gravelly slopes hold only deeply rooted plants or those that can tolerate sliding soils. Soil is extremely gravelly throughout. This nearly pure stand of *Cercocarpus montanus* has become established on thin soil of a dry exposure. It likely captures enough snow in the winter to support a few *Pinus flexilis* trees around the edges. In some stands, it appears that *Cercocarpus montanus* replaces *Amelanchier utahensis*; however, soil types are similar between the two communities. This community occupies an

exposed slope but traps soil and snow blown by the prevailing winds. As a result, there is a mound of soil that forms around each shrub. In the more open portions of the stand, slope wash and soil creep deposit soil and rock behind the shrubs forming small ledges.
Fossil Butte National Monument Data: The description is based on 2005 field data (7 plots: FOBU.0099, FOBU.0100, FOBU.0124, FOBU.0125, FOBU.0130, FOBU.0137, FOBU.0192; 6 observation points: FOBU.9070, FOBU.9075, FOBU.9103, FOBU.9104, FOBU.9145, FOBU.9150).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: L. Tasker, mod. J. Coles and G. Kittel

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data, CONHP unpubl. data 2003, Driscoll et al. 1984, 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) Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This mountain shrubland association occurs at middle elevations in the foothills, mountains and mesas in north-central Utah, the Colorado Plateau and Great Basin of the western U.S. Stands occur on moderate to steep slopes characterized by talus or rockfall from further upslope. It is found on relatively warm southern aspects in the Wasatch Mountains but also occurs on northern aspects or in cold-air drainages at lower elevations and more southern latitudes. Substrates are moderately deep, rocky loams and clays. The sparse to moderately dense tall-shrub layer (10-60% cover) is dominated by the cold-deciduous shrub *Amelanchier utahensis*. *Symphoricarpos oreophilus* often dominates in the short-shrub layer. Other shrub associates may include low cover of *Acer grandidentatum, Artemisia tridentata, Chrysothamnus viscidiflorus, Ephedra viridis, Mahonia repens, Purshia tridentata, Rhus trilobata*, and *Rosa woodsii*. *Quercus gambelii* may also be present, but it is always poorly represented (<5%). Tree species are sometimes present with the tall shrubs or as a very sparse emergent layer. The sparse to moderately dense herbaceous layer is a mixture of perennial graminoids and forbs. Introduced species such as *Agropyron cristatum* and *Bromus tectorum* are common in disturbed stands.

DISTRIBUTION
Fossil Butte National Monument
This shrubland occupies steep, exposed slopes and ridges off Ruby Point and Fossil Butte.

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
Fossil Butte National Monument
This Utah serviceberry shrubland occupies high level ridges and slopes of Fossil Butte and Ruby Point. The sites are steep (19- to 46-degree slopes), occur between 2191 and 2416 m elevation, and are oriented to the south or southwest. The unvegetated surface has moderate exposure of bare soil, moderate cover of small rocks, and low

cover of large rocks, litter, and downed wood. Parent materials include the Fossil Butte Member of the Wasatch Formation and the main body of the Wasatch Formation. Soils are rapidly drained silt loams or clays.

Globally
This shrubland association occurs on foothills, canyons, ridges, mountains and mesas at elevations from 1326-2440 m (4345-8000 ft.). Stands lie on moderate to steep slopes (9-46 degrees) with a high cover of talus or rockfall. It is found on relatively warm southern aspects in the Wasatch Mountains (Yake and Brotherson 1979) but also occurs on northern aspects or in cold-air drainages at lower elevations and more southern latitudes. Substrates are rapidly drained, moderately deep, rocky or sandy soils that range include sand, silt loam and clay. Parent materials include volcanic cinder and alluvial or colluvial deposits of sandstone and shale. Canyons slopes may have a sandstone cobble veneer.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover ranges from 1-30% in these sparsely to moderately vegetated stands. This association is characterized by an open canopy, typically 1 to 2 m tall, of the tall shrub *Amelanchier utahensis* (1-11% cover). The remaining shrub layer consists of the short shrubs *Artemisia tridentata* ssp. *vaseyana, Purshia tridentata, Chrysothamnus viscidiflorus, Holodiscus dumosus, Rosa woodsii,* and *Symphoricarpos oreophilus*. The herbaceous layer is low in terms of diversity and contributes sparse cover. Common grasses include *Achnatherum hymenoides, Poa fendleriana, Leymus cinereus,* and the non-native annual *Bromus tectorum*. Forbs include *Eriogonum umbellatum, Descurainia pinnata, Balsamorhiza sagittata, Comandra umbellata, Eriogonum brevicaule,* and *Pteryxia terebinthina*.

Globally
The vegetation is characterized by a sparse to moderately dense (10-60% cover) tall-shrub layer dominated by the cold-deciduous shrub *Amelanchier utahensis*. *Symphoricarpos oreophilus* often forms a short-shrub layer. Other shrub associates may include low cover of *Acer grandidentatum, Artemisia tridentata, Chrysothamnus viscidiflorus, Ephedra viridis, Fraxinus anomala, Mahonia repens, Purshia tridentata, Rhus trilobata,* and *Rosa woodsii*. *Quercus gambelii* may also be present, but it is always poorly represented (<5% cover). Short trees of *Pinus edulis, Juniperus osteosperma,* or *Juniperus scopulorum* may be mixed in with the tall shrubs or emerge above as a very sparse tree layer. The sparse to moderate herbaceous layer is a mixture of perennial graminoids and forbs. Herbaceous species include *Bromus carinatus, Koeleria macrantha, Achnatherum nelsonii* ssp. *dorei, 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
Fossil Butte National Monument

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*

Globally

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Symphoricarpos oreophilus*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Bromus tectorum, Descurainia pinnata

Globally
Agropyron cristatum, Bromus tectorum

CONSERVATION STATUS RANK
Global Rank & Reasons: G4 (19-Sep-2000).

CLASSIFICATION COMMENTS
Fossil Butte 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
Fossil Butte National Monument Inventory Notes: Community occupies a steep limestone exposure that is armored by small, angular gravel and small rocks. Runoff is rapid and the slope has small ledges that form behind shrubs. Steep slope with large quantity of rocks, sparsely vegetated.
Fossil Butte National Monument Data: The description is based on 2005 field data (2 plots: FOBU.0059, FOBU.0147; 2 observation points: FOBU.9021, FOBU.9024).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Drake

REFERENCES: Bourgeron and Engelking 1994, Carmichael et al. 1978, Cogan et al. 2004, Crane 1982, Driscoll et al. 1984, Eddleman and Jaindl 1994, Western Ecology Working Group n.d., Yake and Brotherson 1979

Prunus virginiana - (Prunus americana) Shrubland
Chokecherry - (American Plum) Shrubland

CODE	CEGL001108
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	*PRUNUS VIRGINIANA* SHRUBLAND ALLIANCE (A.919) Chokecherry Shrubland Alliance
ECOLOGICAL SYSTEM(S): (CES306.994)	Northern Rocky Mountain Montane-Foothill Deciduous Shrubland
	Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822) Western Great Plains Wooded Draw and Ravine (CES303.680)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This widespread small-patch shrubland occurs throughout much of the western Great Plains, Rocky Mountain and interior western U.S. It occurs in the foothills and lower slopes of mountain ranges, along higher creeks, in moist soils that receive bedrock runoff in the Colorado Plateau, and in draws and ravines of high plateaus and the Great Plains. The elevational range is 680 to 2652 m (2234-8700 ft.). This association grows at the interface between larger riparian areas and the adjacent upland and occurs as small dense thickets, narrow bands or irregular patches. It often occupies draws, ephemeral creeks in steep narrow-bottomed canyons, and shallow ravines. It can occur on slopes below seeps and springs and on high slopes where snow collects. Shrub cover ranges from 100% to more open stands of 30%. Shrub cover is generally greater in drainage bottoms and on lowermost slopes, and less on upper slopes. *Prunus virginiana* is usually the dominant shrub species, but *Prunus americana* may be solely present to codominant as well. Stands can be dominated by one species but are often a mix of three to six other shrub species, which can be as abundant and even more abundant than *Prunus*. Other shrubs include *Rhus trilobata, Ribes aureum, Ribes lacustre, Ribes inerme, Salix exigua, Sambucus* spp., *Amelanchier* spp., *Amorpha canescens, Symphoricarpos oreophilus, Symphoricarpos occidentalis, Juniperus scopulorum, Rosa woodsii*, and *Toxicodendron rydbergii*. In drainage bottoms, herbaceous cover is usually sparse, less than 10%. On slopes, the shrubs typically occur in some grassland type, and graminoid cover can be greater than 75%. Herbaceous species include *Heracleum maximum, Juncus balticus, Maianthemum stellatum, Muhlenbergia montana, Leymus cinereus*, and *Pascopyrum smithii*. Exotic species *Bromus inermis, Cirsium arvense, Poa pratensis*, and *Bromus tectorum* are common on disturbed sites.

DISTRIBUTION

Fossil Butte National Monument

This uncommon association is represented by 1 plot and 3 observation points within the monument and is located on relative mesic sites, such as in a snow-catching depression on top of the Fossil Butte, on a cool, protected slope below a bench on the northeast aspect of Fossil Butte, along Slump Trail and near a spring.

Globally

This is a widespread small-patch mesic shrubland that occurs throughout much of the western Great Plains, Rocky Mountain and interior western U.S.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This chokecherry shrubland is uncommon within the monument and is located on relative mesic sites, such as in a snow-catching depression on top of the Fossil Butte and on a cool, protected slope below a bench on the northeast aspect of Fossil Butte. Sites are gentle to moderately steep (5- to 20-degree slopes), occur between 2207 and 2311 m elevation, and are frequently oriented to the northeast. The unvegetated surface has low to moderate exposure of bare soil, litter and downed wood. The parent material is the main body of the Wasatch Formation. Soils are well-drained clay loams.

Globally

This widespread small-patch shrubland occurs throughout much of the western Great Plains, Rocky Mountain and interior western U.S. It occurs in the foothills and lower slopes of mountains, along higher creeks, in moist soils that receive bedrock runoff in the Colorado Plateau, and in draws and ravines of plateaus and the Great Plains. The elevational range is 716 to 2846 m (2234-9330 ft.), and slopes are gentle to steep (to 20 degrees). This association often grows at the interface between larger riparian areas and the adjacent upland, as well as on higher ridges where snow collects, and occurs as small dense thickets, narrow bands or irregular patches. It often occupies draws, ephemeral creeks in steep narrow-bottomed canyons, and shallow ravines. It can occur on slopes below seeps and springs. Stands can also occur as small pockets on higher terraces or as narrow bands along the high-water mark of steep banks and incised channels. It also grows at the base of cliffs adjacent to rivers. Slope varies from flat to very steep, with variable aspects, and can be associated with rock outcrops and talus. Stands are typically on very well-drained, rocky soils but occasionally have finer soils. Soil texture ranges from sandy loam to clay loam.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 50 -100% in this tall shrubland. This association is characterized by an open to dense shrub layer dominated or codominated by the tall shrub *Prunus virginiana* (10-80% cover). Some stands may be codominated by *Amelanchier utahensis*. The tree *Populus tremuloides* may provide sparse cover. Shrubs may be diverse, provide relatively sparse cover, and include *Arctostaphylos uva-ursi, Artemisia tridentata* ssp. *vaseyana, Mahonia repens, Purshia tridentata, Ribes cereum, Rosa woodsii,* and *Symphoricarpos oreophilus*. The herbaceous layer is diverse and typically sparse (<10% cover) with few species present with greater than 5% cover. However, one plot has high cover of *Helianthella uniflora* (25%). Grasses include *Achnatherum nelsonii, Elymus lanceolatus,* and *Leymus cinereus*. Forbs include *Balsamorhiza sagittata, Comandra umbellata, Delphinium nuttallianum, Eriogonum umbellatum var. subaridum, Geranium viscosissimum, Mertensia oblongifolia, Lithospermum ruderale,* and *Osmorhiza berteroi*.

Globally

This association is widespread and varies significantly across it range. Shrub cover ranges from 100% to more open stands of 30%, with the higher values tending to occur in sites located in drainage bottoms and on lowermost slopes, and the lower values on higher slopes. *Prunus virginiana* is usually the dominant shrub species, but *Prunus americana* may be solely present to codominant. Stands can be dominated by one species but are often a mix of three to six other shrub species, which can be as abundant and sometimes more abundant than *Prunus.* Other shrubs include *Rhus trilobata, Ribes aureum, Ribes lacustre, Ribes inerme, Rosa* spp., *Salix exigua, Sambucus* spp., *Amelanchier* spp., *Amorpha canescens, Artemisia tridentata, Ericameria nauseosa, Symphoricarpos oreophilus, Symphoricarpos occidentalis, Juniperus scopulorum, Rosa woodsii, Mahonia repens,* and *Toxicodendron* spp. The tree *Populus tremuloides* may provide sparse cover. In drainage bottoms, herbaceous cover is usually sparse, less than 10%. On slopes, the shrubs typically occur in a matrix of other shrubland or grassland types, and graminoid cover can be greater than 75%. Herbaceous species are variable. Graminoids include *Achnatherum lettermanii,*

Achnatherum nelsonii, Artemisia frigida, Bromus carinatus, Carex vallicola, Elymus lanceolatus, Elymus trachycaulus, Juncus balticus, Leymus cinereus, Muhlenbergia montana, Pascopyrum smithii, and *Poa fendleriana*. Forb species are often diverse but are often relatively mesic. Common species include *Achillea millefolium, Agastache urticifolia, Balsamorhiza sagittata, Delphinium nuttallianum, Erigeron flagellaris, Eriogonum umbellatum, Geranium viscosissimum, Heracleum maximum, Heterotheca villosa, Maianthemum stellatum, Mertensia oblongifolia, Osmorhiza berteroi, Potentilla hippiana*, and *Psoralidium lanceolatum*. Exotic herbaceous species may be present, including *Bromus inermis, Cirsium arvense, Poa pratensis*, and *Bromus tectorum*, especially on disturbed sites.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Tall shrub/sapling	*Prunus virginiana*
Short shrub/sapling	*Amelanchier utahensis, Symphoricarpos oreophilus*
Herb (field)	*Balsamorhiza sagittata, Helianthella uniflora, Lithospermum ruderale*
Herb (field)	*Leymus cinereus*

Globally

Stratum	Species
Short shrub/sapling	*Prunus americana, Prunus virginiana*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available.

Globally
Bromus inermis, Bromus tectorum, Cirsium arvense, Pascopyrum smithii, Poa pratensis, Prunus americana, Symphoricarpos occidentalis

CONSERVATION STATUS RANK
Global Rank & Reasons: G4Q (1-Feb-1996). This type is widespread, but it represents a broadly defined dominance type, with little information on the associated species or habitats that might help define the type more precisely. If, e.g. a Great Plains type was separated out from the other types, such a type could be relatively rare.

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
This is a widespread and highly variable, yet distinct, type. In semi-arid regions, it is restricted to mesic and wet areas that often occur as small patches or limited to streambanks. Kovalchik (1987) briefly describes a similar type called Mixed Shrub Canyon Bottom Association from 4 plots. It occurs in low-elevation canyons below U.S. Forest Service ownership in eastern Oregon. Tall shrubs include *Prunus virginiana, Amelanchier alnifolia, Rosa woodsii, Cornus sericea, Salix* spp., *Prunus subcordata*, and/or *Alnus incana*. This may be the same concept.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Data are not available.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0129; 3 observation points: FOBU.9151, FOBU.9073, FOBU.9076).
Local Description Authors: K.A. Schulz
Global Description Authors: D. Faber-Langendoen, mod. G. Kittel, J. Coles, K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, CONHP pers. comm., CONHP unpubl. data 2003, Caicco and Wellner 1983n, Carsey et al. 2003a, Copeland 1980a, Driscoll et al. 1984, Evans 1989a, Evans 1989b, Hall and Hansen 1997, Hansen et al. 1991, Hansen et al. 1995, IDCDC 2005, Johnston 1987, Jones 1992b, Jones and Walford 1995, Kagan et al. 2000, Kittel et al. 1996, Kittel et al. 1999b, Kovalchik 1987, Kudray et al. 2004, MTNHP 2002b, Manning and Padgett 1995, Marriott pers. comm., Von Loh et al. 1999, Western Ecology Working Group n.d.

Symphoricarpos oreophilus Shrubland
Mountain Snowberry Shrubland

CODE	CEGL002951
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	*SYMPHORICARPOS OREOPHILUS* SHRUBLAND ALLIANCE (A.2530) Mountain Snowberry Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This low-statured shrubland is known from Colorado, southern Utah, western Wyoming and central Oregon. It generally occurs as small patches on level, gentle to moderately steep to steep slopes between 2070 and 3183 m (6800-8440 ft.) elevation, on all aspects. Soils are rapidly drained sandy clay to silty clay loams or clay loams. It is overlooked as a community type because it often occupies the "transition zone" between forests and grasslands or between riparian vegetation and drier upslope communities. This shrubland is often 0.3-0.9 m (1-3 ft.) tall. *Symphoricarpos oreophilus* or closely related *Symphoricarpos* species, *Symphoricarpos rotundifolius*, or *Symphoricarpos palmeri* dominate the shrub canopy. Other shrubs can be present but in much less abundance and may include *Artemisia tridentata, Chrysothamnus viscidiflorus, Amelanchier utahensis, Purshia tridentata*, and *Cercocarpus montanus*. Trees from neighboring forests may appear and range from several conifer species to aspen, but rarely have more than single digit cover. The herbaceous undergrowth is highly variable, both in abundance (total cover ranging from 1-30%) and in species composition, depending on local topographic position and geographic locale. Most often it is a rich mix of graminoids and forbs, but it can be dominated by graminoids. Typical graminoid species include *Poa pratensis* and *Carex geyeri*. Forb species include *Eriogonum umbellatum, Geranium viscosissimum, Balsamorhiza sagittata,* and *Agastache urticifolia*. *Achillea millefolium* and *Poa pratensis* are common in disturbed stands.

DISTRIBUTION

Fossil Butte National Monument

This association is uncommon at the monument and represented by one plot located on a series of benches along the north face of Fossil Butte.

Globally

This association has currently been described from Zion National Park in southwestern Utah, several locations in southeastern Utah and southwestern Wyoming.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This mountain snowberry shrubland is uncommon within the monument and occupies a series of benches on the north-facing slope of Fossil Butte. The site is moderately steep (9-degree slope), occurs at 2216 m elevation, and is oriented to the north. The unvegetated surface has moderate exposure of bare soil and low cover of litter and downed wood. The parent material is the main body of the Wasatch Formation. Soils are well-drained clay loams.

Globally

This low-statured shrubland is known from Colorado, southern Utah, western Wyoming and central Oregon. It generally occurs as small patches on level, gentle to moderately steep to steep slopes between 2070 and 3183 m (6800-8440 ft.) elevation, on all aspects. Soils are rapidly drained sandy clay to silty clay loams or clay loams. It is overlooked as a community type because it often occupies the "transition zone" between forests and grasslands (Johnson and Clausnitzer 1992) or between riparian vegetation and drier upslope communities. It occupies steep slopes or even terrain, in depressions or gentle drainages on undulating plateaus, on canyon ridges, and mounded

topography. It occurs on shallow or deeper sandy loam to clay loam soils with little surface rock. Stands generally occur on gentle to steep slopes, often facing south, but is also found on all aspects.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover is 18% in this low to moderately vegetated stand. This association is characterized by low to moderate cover of the short shrub *Symphoricarpos oreophilus* (15%). *Pinus flexilis* trees occupy the benches and provide sparse cover. The tall- and short-shrub layers are diverse, provide sparse cover, and include *Artemisia tridentata* ssp. *vaseyana, Chrysothamnus viscidiflorus, Amelanchier utahensis, Purshia tridentata*, and *Cercocarpus montanus*. The herbaceous layer is diverse and contributes sparse cover with no species present in greater than trace amounts. Grasses include *Poa fendleriana* and *Leymus cinereus*. Forbs include *Eriogonum umbellatum, Comandra umbellata, Lithospermum ruderale,* and *Linum lewisii*.

Globally

This low-statured shrubland is often 0.3-0.9 m (1-3 ft.) tall, and total vegetation cover ranges from 15 to 45%. *Symphoricarpos oreophilus* or closely related *Symphoricarpos* species, *Symphoricarpos rotundifolius*, or *Symphoricarpos palmeri* dominate the shrub canopy. Other shrubs can be present but in much less abundance. Other shrub species include *Amelanchier alnifolia, Prunus virginiana, Ribes cereum, Artemisia tridentata, Ericameria nauseosa, Rosa woodsii, Mahonia repens*, and *Artemisia nova*. The herbaceous undergrowth is highly variable, both in abundance (total cover ranging from 1-30%) and in species composition, depending on local topographic position and geographic locale. It can consist of a mix of graminoids and forbs but is more often dominated by graminoids. Typical graminoid species include *Poa pratensis* and *Carex geyeri*. Other graminoid species include *Festuca thurberi, Elymus trachycaulus, Leymus cinereus, Pascopyrum smithii, Elymus repens, Calamagrostis rubescens, Carex geyeri, Carex hoodii, Bromus ciliatus, Achnatherum* spp., and *Poa fendleriana*. Forbs are usually present and highly variable. In Colorado, forb species include *Geranium richardsonii, Galium boreale, Symphyotrichum ascendens, Vicia americana, Heliomeris multiflora,* and *Potentilla pulcherrima*; in Wyoming, *Eriogonum umbellatum, Geranium viscosissimum, Balsamorhiza sagittata,* and *Agastache urticifolia*; and in Utah, *Lathyrus brachycalyx, Lupinus argenteus, Artemisia campestris, Mentha x piperita, Penstemon* spp., *Mertensia arizonica, Mertensia oblongifolia, Eriogonum racemosum, Tragopogon dubius*, and *Achillea millefolium*. In central Oregon, forb species include *Eriogonum heracleoides, Potentilla glandulosa, Potentilla gracilis, Geum triflorum, Lupinus* spp., *Erigeron* spp., and *Clarkia pulchella*. *Achillea millefolium* is common to degraded stands in Colorado, southern Utah, and central Oregon stands.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Symphoricarpos oreophilus*

Globally

Stratum	Species
Short shrub/sapling	*Symphoricarpos oreophilus*

OTHER NOTEWORTHY SPECIES

Fossil Butte National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Aug-2001).

CLASSIFICATION COMMENTS

Fossil Butte National Monument

Data are not available.

Globally

This association may be dominated by *Symphoricarpos oreophilus* or closely related *Symphoricarpos* species such as *Symphoricarpos rotundifolius* or *Symphoricarpos palmeri* that ecologically function similarly and can be difficult to distinguish taxonomically at certain times of the year.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Plot is in the middle of a series of benches. On the benches, the *Amelanchier utahensis* is taller as are the other shrubs. *Artemisia tridentata* ssp. *vaseyana* is more plentiful on the slopes between the benches. Area is heavily used by wildlife.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0131).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: G. Kittel, mod. J. Coles

REFERENCES: Cogan et al. 2004, Johnson and Clausnitzer 1992, Johnston 1987, Komarkova 1986

Dasiphora fruticosa ssp. *floribunda* Shrubland [Provisional]
Shrubby-cinquefoil Shrubland

CODE	CEGL001105
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d.)
ALLIANCE (A.958)	*DASIPHORA FRUTICOSA* TEMPORARILY FLOODED SHRUBLAND ALLIANCE Shrubby-cinquefoil Temporarily Flooded Shrubland Alliance
ECOLOGICAL SYSTEM(S):	Rocky Mountain Subalpine-Montane Mesic Mesic Meadow (CES306.829) Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This montane to subalpine shrubland is reported in the southern Rocky Mountains, the Ruby Mountains of northeastern Nevada, and on the Paunsaugunt Plateau in southern Utah. Stands occur on stream terraces and benches above the channel, on drier edges of wetlands, on broad gently sloping valley bottoms and floodplains, and on moderately steep mesic slopes near springs. Elevation ranges from 2213-2690 m (7300-9700 ft.). Aspect is variable. Soils vary in amount of rock fragments, texture (clay loam to sandy loam) and depth. Vegetation is characterized by an open to moderately dense (20-50% cover) shrub layer dominated by *Dasiphora fruticosa* ssp. *floribunda*. A diverse mixture of graminoids and forbs characterizes the sparse to lush (10-50%) herbaceous layer. Graminoids, such as *Achnatherum lettermanii, Bromus porteri, Carex deweyana, Danthonia intermedia, Juncus balticus, Elymus trachycaulus, Festuca saximontana, Festuca thurberi, Leymus cinereus, Muhlenbergia montana*, and *Poa pratensis*, often dominate the herbaceous layer. The more common forbs include *Antennaria rosea, Antennaria microphylla, Erigeron pumilus, Eriogonum umbellatum, Fragaria virginiana* ssp. *glauca, Potentilla pulcherrima, Potentilla gracilis, Achillea millefolium var. occidentalis, Campanula rotundifolia, Cirsium scariosum, Fragaria virginiana, Galium boreale, Iris missouriensis, Pseudocymopterus montanus, Taraxacum officinale*, and *Thalictrum fendleri*.

DISTRIBUTION
Fossil Butte National Monument
This association is uncommon at the monument and represented by one observation point located on a bench on the northeast-facing slope of Fossil Butte.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument
This shrubby-cinquefoil shrubland is uncommon within the monument and occupies a bench on the northeast face of Fossil Butte. The site is gentle (3-degree slope), occurs at 2213 m elevation, and is oriented to the north. The unvegetated surface has low exposure of bare soil, low cover by small rocks, and high cover of litter. The parent material is the main body of the Wasatch Formation.

Globally
This montane to subalpine shrubland is reported in the southern Rocky Mountains, the Ruby Mountains of northeastern Nevada, and on the Paunsaugunt Plateau in southern Utah. Stands occur on stream terraces and benches above the channel, on drier edges of wetlands, on broad gently sloping valley bottoms and floodplains, and on moderately steep mesic slopes near springs. Elevation ranges from 2213-2690 m (7300-9700 ft.). Aspect is variable. Soils vary in amount of rock fragments, texture (clay loam to sandy loam) and depth.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 42% in this moderately vegetated stand. This association is characterized by moderate cover of the short shrub *Dasiphora fruticosa* ssp. *floribunda* (24%). The remaining shrub layer provides sparse cover, including the short shrubs *Ericameria nauseosa, Artemisia tridentata* ssp. *vaseyana*, and *Symphoricarpos oreophilus*. The herbaceous layer is low in terms of diversity and contributes low cover. The graminoids *Juncus balticus, Leymus cinereus*, and *Poa pratensis* provide sparse cover. A species of aster provides low cover, while the forbs *Achillea millefolium* and *Potentilla gracilis* provide sparse cover.

Globally
This shrubland is characterized by an open to moderately dense (20-50% cover) shrub layer dominated by *Dasiphora fruticosa* ssp. *floribunda*, sometimes with *Artemisia cana, Artemisia tridentata*, and *Rosa woodsii* present to codominant. *Deschampsia caespitosa* is absent, and *Juncus balticus* has low cover (<5%). Alpine meadow species are scarce or absent, such as *Carex rupestris var. drummondiana, Carex elynoides, Calamagrostis purpurascens, Festuca brachyphylla, Geum rossii var. turbinatum, Poa reflexa*, and *Trifolium dasyphyllum*. A diverse mixture of graminoids and forbs characterize the sparse to lush (10-50%) herbaceous layer. Graminoids, such as *Achnatherum lettermanii, Bromus porteri, Carex deweyana, Danthonia intermedia, Juncus balticus, Elymus trachycaulus, Festuca saximontana, Festuca thurberi, Muhlenbergia montana*, and *Poa pratensis*, often dominate the herbaceous layer. The more common forbs include *Antennaria rosea, Antennaria microphylla, Erigeron pumilus, Eriogonum umbellatum, Fragaria virginiana* ssp. *glauca, Potentilla pulcherrima, Potentilla gracilis, Achillea millefolium var. occidentalis, Campanula rotundifolia, Cirsium scariosum, Fragaria virginiana, Galium boreale, Iris missouriensis, Pseudocymopterus montanus, Taraxacum officinale*, and *Thalictrum fendleri*.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Dasiphora fruticosa* ssp. *floribunda*

Globally

Stratum	Species
Short shrub/sapling	*Dasiphora fruticosa* ssp. *floribunda*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Poa pratensis

Globally
Poa pratensis

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

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Dasiphora fruticosa ssp. *floribunda* shrublands and steppe are highly variable and need more survey and classification work to clarify diagnostic characteristics.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: First area that we have seen *Dasiphora fruticosa* ssp. *floribunda* shrubs. Observation point is in the middle of a bench surrounded by *Artemisia tridentata / Amelanchier utahensis* shrubland. Area receives extra moisture seeping from Fossil Butte, which explains the presence of *Juncus balticus*. Exposed soil has alkaline characteristics.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 observation point: FOBU.9074).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. G. Kittel

REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Loope 1969

Salix lutea / Leymus cinereus Shrubland
Yellow Willow / Great Basin Wildrye Shrubland

CODE	CEGL005322
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d.)
ALLIANCE	*SALIX LUTEA* TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.980) Yellow Willow Temporarily Flooded Shrubland Alliance

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

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This yellow willow riparian shrubland is only known from Fossil Butte National Monument in southwestern Wyoming. Stands occur in mesic drainages and landslide deposits. Sites are gentle or steep (2- to 22-degree) southern slopes at 2020-2177 m elevation. The unvegetated surface has high cover of litter, low exposure of bare soil, and low cover of small and large rocks and downed wood. Soils are fine-textured and derived from the Wasatch Formation or sandstones and shale that have eroded and deposited during a landslide. The vegetation is characterized by an open to dense shrub canopy (2-5 m tall) dominated by *Salix lutea* (8-85% cover) and sparse to moderately dense cover of the coarse bunchgrass *Leymus cinereus* (3-40%). Total vegetation cover is 75-92% in these moderately to densely vegetated stands. Other shrubs may be present including sparse cover of *Rosa woodsii* and *Artemisia tridentata* ssp. *tridentata*. Other herbaceous species present are the graminoid *Juncus balticus* and the forb *Maianthemum stellatum* that provide sparse cover.

DISTRIBUTION
Fossil Butte National Monument
This shrubland occupies drainages on the southern slope of Fossil Butte and a landslide deposit near the historic quarry.

Globally
This riparian shrubland association is only known from Fossil Butte National Monument in southwestern Wyoming.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument

This yellow willow / Great Basin wildrye shrubland is uncommon within the monument. It occupies mesic drainages and mesic landslide deposit. The sites are gentle or steep (2- or 22-degree slope), occur at 2020 and 2177 m elevation, and are oriented to the south. The unvegetated surface has high cover of litter, low exposure of bare soil, and low cover of small and large rocks and downed wood. The parent materials include the main body of the Wasatch Formation or sandstones and shale that have eroded and deposited during a landslide.

Globally
This yellow willow riparian shrubland is only known from Fossil Butte National Monument in southwestern Wyoming. Stands occur in mesic drainages and landslide deposits. Sites are gentle or steep (2- to 22-degree) southern slopes at 2020-2177 m elevation. The unvegetated surface has high cover of litter, low exposure of bare soil, and low cover of small and large rocks and downed wood. Soils are fine-textured and derived from the Wasatch Formation or sandstones and shale that have eroded and deposited during a landslide.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 75-92% in these moderately to densely vegetated stands. This association is characterized by an open to shrub canopy, typically 2-5 m tall, of the tall shrub *Salix lutea* (8-85% cover) and sparse to moderately dense cover of the coarse bunchgrass *Leymus cinereus* (3-40%). The remaining shrub layer consists of the short shrubs *Rosa woodsii* and *Artemisia tridentata* ssp. *tridentata* that provide sparse cover. The remaining herbaceous species present are the graminoids *Juncus balticus, Carex praegracilis, Poa fendleriana* and the forbs *Achillea millefolium, Comandra umbellata* and *Maianthemum stellatum* that provide sparse cover. The exotic species *Cirsium arvense* is present in some stands

Globally
The vegetation is characterized by an almost continuous shrub canopy (2-5 m tall) dominated by *Salix lutea* (80-85% cover) and sparse cover of the coarse bunchgrass *Leymus cinereus* (3-5%). Total vegetation cover is 75-92% in these moderately to densely vegetated stands. Other shrubs may be present including sparse cover of *Rosa woodsii* and *Artemisia tridentata* ssp. *tridentata*. Other herbaceous species present are the graminoids *Juncus balticus, Carex praegracilis, Poa fendleriana* and the forbs *Achillea millefolium, Comandra umbellata* and *Maianthemum stellatum* that provide sparse cover. The exotic species *Cirsium arvense* is present in some stands.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Tall shrub/sapling	*Salix lutea*
Herb (field)	*Leymus cinereus*

Globally

Stratum	Species
Tall shrub/sapling	*Salix lutea*
Herb (field)	*Leymus cinereus*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (6-Aug-2007).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally

The taxonomy and geography for *Salix lutea* and *Salix ligulifolia* are often confused in the western U.S. According to Dorn (1995), Colorado, Arizona and New Mexico predominantly have *Salix ligulifolia* (which Dorn calls *Salix eriocephala var. ligulifolia*). It also occurs in far southeastern Wyoming. While California, Nevada, Utah, eastern Oregon, Idaho, Montana (mountains) and most of Wyoming have *Salix lutea* (which Dorn calls *Salix eriocephala var. watsonii*) (G. Kittel pers. comm. 2008).

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: A small landslide of Green River shale over Wasatch Formation bedrock, with enough water coming through it to support this willow stand as well as a lush *Leymus cinereus - Juncus balticus* meadow downslope. There may be some drying of the site; half the willows are dead, and willows on the stand margin are entirely dead. This shrubland occurs in a drainageway and grows on a sideslope seep. Willows are stressed by drought.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0002; 2 observation points: FOBU.9060, FOBU.9106).
Local Description Authors: M. Smith and J. Von Loh, mod by K.A. Schulz
Global Description Authors: K.A. Schulz

REFERENCES: Dorn 1995, Western Ecology Working Group n.d.

Sarcobatus vermiculatus / Artemisia tridentata Shrubland
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)	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 stream terraces and floodplains of the Intermountain West. The presence of other shrubs in the canopy indicates less saline conditions than found in *Sarcobatus vermiculatus* Disturbed Shrubland (CEGL001357). Soils are deep and generally sandy, but a few sites are on well-drained silt loams or clays. 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 exotic species may dominate the field layer.

DISTRIBUTION
Fossil Butte National Monument
This association is uncommon at the monument and represented by one plot located on the flats near the monument entrance.

Globally

This mixed bottomland shrubland is characteristic of stream terraces and floodplains of the Intermountain West. Stands are reported from the Colorado Plateau and Great Basin from western Colorado and Utah, extending to Big Horn Basin across western Wyoming and south-central Montana.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This greasewood - big basin sagebrush shrubland is uncommon within and adjacent to the monument and occupies an alluvial fan near the monument entrance. The site is gentle (2-degree slope), occurs at 2027 m elevation, and is oriented to the south. The unvegetated surface has high exposure of bare soil and low cover of litter. The parent materials are shales and sandstones that have been deposited as secondary stream alluvium. Soils are moderately well-drained clays.

Globally

This minor shrub association occurs on stream terraces, alluvial fans, floodplains, toeslopes and valley floors. Elevations range from 1300 to 2027 m. The slopes are generally gentle, and the upper soil layers are somewhat saline. Soils are deep and generally sandy, but a few sites are on well-drained silt loams or clays. The parent materials are sandstones and shales that have eroded and deposited as secondary stream alluvium or eolian sand deposits. Bare soil and litter cover most of the ground surface. Biological soil crusts are commonly present and can provide up to 60% cover.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover is 67% in this densely vegetated stand. This association is characterized by moderate cover of the short shrub *Sarcobatus vermiculatus* (25%) and low cover of the short shrub *Artemisia tridentata* ssp. *wyomingensis* (12%). The tall and short shrubs *Artemisia tridentata* ssp. *tridentata, Atriplex confertifolia,* and *Chrysothamnus viscidiflorus* provide low cover. The herbaceous layer is moderate in terms of diversity and contributes low cover. Grasses include *Poa secunda* and *Elymus lanceolatus*. Forbs include *Phlox hoodii, Ceratocephala testiculata,* and *Antennaria dimorpha*.

Globally

This mixed bottomland shrubland is characteristic of stream 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, Atriplex confertifolia, Ericameria nauseosa, Chrysothamnus viscidiflorus*, and *Opuntia polyacantha* are common minor elements of the open to moderately dense shrub canopy. Total shrub cover is between 5 and 50%. The understory is variable; cover by herbaceous species may be sparse to dense, or exotic species may dominate the field layer. Common graminoids include *Elymus lanceolatus, Poa secunda,* and the exotic annual grass *Bromus tectorum*. Additional grasses with low cover may include *Achnatherum hymenoides, Aristida purpurea, Hesperostipa comata*, and *Sporobolus airoides*. Common forbs include *Antennaria dimorpha, Chaenactis stevioides, Cryptantha crassisepala, Descurainia pinnata, Lappula occidentalis, Lepidium densiflorum, Oenothera pallida, Phlox hoodii, Plantago patagonica, Streptanthella longirostris,* and exotic species *Ceratocephala testiculata, Erodium cicutarium,* and *Salsola tragus*. Scattered *Juniperus osteosperma* may be present in some stands. Cryptogam cover is moderate, up to 35%.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Short shrub/sapling	*Sarcobatus vermiculatus*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*

Globally

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus*
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*, *Artemisia tridentata* ssp. *wyomingensis*

OTHER NOTEWORTHY SPECIES

Fossil Butte National Monument
Bromus tectorum, Ceratocephala testiculata, Salsola tragus

Globally
Bromus tectorum, Ceratocephala testiculata, Erodium cicutarium, Salsola tragus

CONSERVATION STATUS RANK
Global Rank & Reasons: G4 (1-Feb-1996).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This community is controlled by the heavy clay soil, alkalinity, and drainage pattern. This stand is the only extensive stand in the project area. In the monument, there is sparse greasewood on badlands formations and small stringers along a few drainages.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0113).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Lesica and DeVelice 1992, MTNHP 2002b

Sarcobatus vermiculatus / Atriplex gardneri Shrubland
Greasewood / Gardner's Saltbush Shrubland

CODE	CEGL001360
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)	Greasewood Intermittently Flooded Shrubland Alliance
ECOLOGICAL SYSTEM(S):	Inter-Mountain Basins Greasewood Flat (CES304.780) Inter-Mountain Basins Wash (CES304.781) Western Great Plains Badlands (CES303.663) Inter-Mountain Basins Playa (CES304.786) Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This "badlands" association is reported from eastern Utah and western Colorado, across Wyoming to Big Horn Basin and up to northeastern Montana. Stands occur on all aspects of moderately steep to steep eroded slopes or on toeslopes composed of clay or shale sediments. Substrates are fine-textured, alkaline and saline, have low permeability, and are composed of acidic shale, bentonite, or some other highly erodible material. Bare ground and gravel make up the majority (80%) of the ground surface. The vegetation is characterized by a sparse to moderately dense (20-40% cover) woody layer codominated by the short shrub *Sarcobatus vermiculatus* and the dwarf-shrub *Atriplex gardneri*. Other shrubs and dwarf-shrubs include scattered *Artemisia tridentata, Picrothamnus desertorum,*

Atriplex confertifolia, Ericameria nauseosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Suaeda calceoliformis, Suaeda moquinii, and *Tetradymia canescens*. The graminoid layer, if present, is sparse and may include *Poa secunda, Achnatherum hymenoides, Elymus elymoides,* and the introduced annual *Bromus tectorum*. The forb layer is highly variable in cover and composition because much of it is annual, such as *Endolepis dioica* and *Lappula squarrosa*. Common perennial forbs include *Iva axillaris, Machaeranthera canescens,* and *Allium textile*.

DISTRIBUTION

Fossil Butte National Monument

This association is uncommon at the monument and located on a drainage terrace of Smallpox Creek near the monument entrance and on a badlands slope south of Fossil Butte.

Globally

This shrubland association occurs on semi-arid shaly sites in western U.S. from western Colorado and eastern Utah across western Wyoming to Big Horn Basin in north-central Wyoming and northeastern Montana.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This greasewood / Gardner's saltbush shrubland is uncommon within the monument and occupies a drainage terrace of Smallpox Creek near the monument entrance and a badlands slope. The sites are gentle to steep (2- and 23-degree slopes), occur at 2020 and 2074 m elevation, and are oriented to the south. The unvegetated surface has high exposure of bare soil, sparse to low cover of litter and small and large rocks, and sparse cover of downed wood. The parent materials include the main body of the Wasatch Formation and sandstones and shale that have eroded and deposited as alluvium. Soils range from moderately well-drained to rapidly drained clays.

Globally

This "badlands" association is reported from lower to middle elevations (1423-2074 m) in eastern Utah, northwestern Colorado, and across much of Wyoming to northeastern Montana. Stands occur on alluvial flats and gentle to steep (to 23 degrees) eroded slopes or toeslopes and evaporational depressions eroded in clay or shale sediments. Substrates are fine-textured, alkaline and saline, have low permeability, and are derived from marine shale, bentonite, or other highly erodible material. Bare ground and gravel make up the majority (80% or more) of the ground surface, which may also have a white crust from the evaporation of saline soil water. The parent materials include Manco Shale and Wasatch Formation and other sandstones and shales that have eroded and deposited as alluvium.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover is sparse (4%) to moderate (43%) in these small stands. This association is characterized by sparse to moderate cover of the short shrub *Sarcobatus vermiculatus* (2-35%) and sparse cover of the dwarf-shrub *Atriplex gardneri* (1%). The tall and dwarf-shrubs *Artemisia tridentata* ssp. *tridentata, Krascheninnikovia lanata,* and *Tetradymia canescens* provide sparse cover. The herbaceous layer is low in terms of diversity and contributes sparse cover. Grasses include *Poa secunda, Achnatherum hymenoides, Elymus lanceolatus,* and the non-native perennial *Poa pratensis*. Forbs include the non-native annuals *Amaranthus blitoides* and *Lepidium perfoliatum* and the native *Erigeron concinnus.*

Globally

The vegetation in this association is characterized by a sparse to moderately dense (less than 15 to 40% cover) woody layer codominated by the short shrub *Sarcobatus vermiculatus* and the dwarf-shrub *Atriplex gardneri*. Other shrubs and dwarf-shrubs include scattered *Artemisia tridentata, Picrothamnus desertorum, Atriplex confertifolia, Ericameria nauseosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Suaeda calceoliformis, Suaeda moquinii,* and *Tetradymia canescens.* The graminoid layer, if present, is sparse and may include *Poa secunda, Achnatherum hymenoides, Elymus elymoides, Pascopyrum smithii,* and the introduced annual *Bromus tectorum*. The forb layer is highly variable in cover and composition because much of it is annual, such as *Endolepis dioica,* and *Lappula squarrosa*. Common perennial forbs include *Iva axillaris, Machaeranthera canescens,* and *Allium textile*. The exotic species *Halogeton glomeratus* may be abundant in disturbed stands.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus*
Herb (field)	*Atriplex gardneri*
Herb (field)	*Poa secunda*

Globally

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus*
Short shrub/sapling	*Atriplex gardneri*, *Gutierrezia sarothrae*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Amaranthus blitoides, Lepidium perfoliatum, Poa pratensis

Globally
Bromus tectorum, Halogeton glomeratus

CONSERVATION STATUS RANK
Global Rank & Reasons: G4? (1-Feb-1996).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
This type should be compared to *Sarcobatus vermiculatus / Pseudoroegneria spicata* Shrubland (CEGL001367). The two types may be synonymous since they occupy the same badlands slope habitat.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This community is controlled by hot, dry exposures and tight clay soil. The vegetation occupies knolls and drainage sides above the most active erosion. Erosion reshapes the face of this badlands exposure. This greasewood stand has become established on the first terrace of Smallpox Creek. It is the only pure stand in the monument, probably controlled by alkaline clay soils and the depth to groundwater.
Fossil Butte National Monument Data: The description is based on 2005 field data (2 plots: FOBU.0001, FOBU.0141).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, Branson et al. 1976, DeVelice and Lesica 1993, DeVelice et al. 1991, DeVelice et al. 1995, Driscoll et al. 1984, Hamner 1964, Jones 1992b, MTNHP 2002b, Medicine Bow Mine Application n.d., Sweetwater Uranium Project 1978, Ungar et al. 1969, Von Loh 2000, Von Loh et al. 2002

Krascheninnikovia lanata / Achnatherum hymenoides Dwarf-shrubland
Winterfat / Indian Ricegrass Dwarf-shrubland

CODE	CEGL001323
PHYSIOGNOMIC CLASS	Dwarf-shrubland (IV)
PHYSIOGNOMIC SUBCLASS	Evergreen dwarf-shrubland (IV.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.N.)
FORMATION	Extremely xeromorphic evergreen subdesert dwarf-shrubland (IV.A.2.N.a.)
ALLIANCE	*KRASCHENINNIKOVIA LANATA* DWARF-SHRUBLAND ALLIANCE (A.1104) Winterfat Dwarf-shrubland Alliance
ECOLOGICAL SYSTEM(S):	Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788) Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This dwarf-shrubland occurs in the Great Basin, western and southern Colorado and western Wyoming. Sites include gently sloping valley bottoms and toeslopes, and steep, shaly windswept ridges. Soils are shallow, rapidly drained sandy loam to silty clay loam derived from alluvium and shale. The ground surface has moderate to high cover (40-85%) of bare soil; gravel cover is variable. This vegetation is characterized by an open to moderately dense (to 25% cover) dwarf-shrub canopy dominated by *Krascheninnikovia lanata*, with the medium-tall bunchgrass *Achnatherum hymenoides* in the understory. The dwarf-shrub layer is low in diversity. Other dwarf-shrubs may include *Artemisia tridentata* ssp. *wyomingensis, Atriplex canescens, Ericameria parryi*, and *Grayia spinosa*. Herbaceous vegetation is typically patchy and sparse, but may form an open to moderately dense herbaceous layer with low species diversity. *Achnatherum hymenoides* is a constant species with up to 10% cover. Other common species include *Elymus elymoides, Pascopyrum smithii, Pleuraphis jamesii*, and a variety of native forbs including *Chenopodium* sp., *Eriogonum* spp., *Eriophyllum pringlei, Mentzelia multiflora, Opuntia polyacantha, Phacelia* sp., and *Sphaeralcea coccinea*. The introduced species *Bromus inermis, Bromus tectorum, Halogeton glomeratus*, and *Salsola tragus* are common in disturbed sites.

DISTRIBUTION

Fossil Butte National Monument

This association is uncommon at the monument and represented by plots sampled on steep ridges off Dempsey Ridge and on the Fossil Butte rim.

Globally

This dwarf-shrubland is reported from the San Luis Valley and Western Slope in the southern Rocky Mountains, the northern Great Basin and western Wyoming. It likely is more widespread in the intermountain western U.S.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This winterfat dwarf-shrubland is uncommon within the monument. It occupies windswept, barren ridges as well as the top and rim of Fossil Butte. Stands are on gentle to steep (22-degree) slopes, occur between 2261 and 2320 m elevation, and are oriented to the south or west. The unvegetated surface has moderate to high exposure of bare soil or small rock, low to moderate cover of large rocks, and low exposure of bedrock. Soils are rapidly drained sandy clay loams or loamy sands derived from the Wasatch Formation.

Globally

This dwarf-shrubland occurs in the Great Basin, western and southern Colorado and western Wyoming. Sites include gently sloping valley bottoms and toeslopes, and steep, shaly windswept ridges. Soils are shallow, sandy or silty clay loams, or less often loamy sand. Parent materials are alluvium and shale often derived from the Morrison or Wasatch formations. The ground surface has moderate to high cover (40-85%) of bare soil (Blackburn et al. 1968c, 1969c). Gravel cover is variable.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 6-33%. Stands are characterized by sparse to low cover of the dwarf-shrub *Krascheninnikovia lanata* and sparse understory cover of the perennial bunchgrass *Achnatherum hymenoides*. Associated shrubs include *Chrysothamnus viscidiflorus, Atriplex confertifolia*, and *Artemisia frigida* that provide sparse cover. The remaining herbaceous layer is low in terms of diversity and contributes sparse cover. Other grasses include *Elymus lanceolatus, Poa secunda*, and *Pseudoroegneria spicata*. Forbs include *Astragalus jejunus, Streptanthus cordatus, Physaria condensata, Machaeranthera canescens, Phlox hoodii, Packera cana, Pteryxia terebinthina, Penstemon paysoniorum, Eriogonum brevicaule*, and *Astragalus spatulatus.*

Globally

This vegetation is characterized by an open to moderately dense (to 25% cover) dwarf-shrub canopy dominated by *Krascheninnikovia lanata*, with the medium-tall bunchgrass *Achnatherum hymenoides* in the understory. The dwarf-shrub layer is variable but generally low in diversity. Other dwarf-shrubs may include *Artemisia dracunculus, Artemisia frigida, Artemisia tridentata* ssp. *wyomingensis, Atriplex canescens, Atriplex confertifolia,*

Chrysothamnus viscidiflorus, Ericameria nauseosa, Ericameria parryi, and *Grayia spinosa*. Herbaceous vegetation is typically patchy and sparse, but may form an open to moderately dense herbaceous layer with low species diversity. *Achnatherum hymenoides* is a constant species with up to 10% cover. Other species present with low cover may include other grasses such as *Bouteloua gracilis, Elymus elymoides, Elymus lanceolatus, Hesperostipa comata, Pascopyrum smithii, Pleuraphis jamesii, Poa secunda*, and *Pseudoroegneria spicata*, and forbs *Almutaster pauciflorus, Androsace septentrionalis, Astragalus jejunus, Astragalus spatulatus, Chenopodium leptophyllum, Eriogonum brevicaule, Eriogonum lonchophyllum, Eriophyllum pringlei, Machaeranthera canescens, Mentzelia multiflora, Opuntia polyacantha, Phacelia* sp., *Phlox hoodii, Pteryxia terebinthina*, and *Sphaeralcea coccinea*. Introduced species *Bromus inermis, Bromus tectorum, Halogeton glomeratus*, and *Salsola tragus* are common in disturbed sites.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus*
Herb (field)	*Krascheninnikovia lanata*
Herb (field)	*Achnatherum hymenoides*

Globally

Stratum	Species
Short shrub/sapling	*Krascheninnikovia lanata*
Herb (field)	*Achnatherum hymenoides*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available.

Globally
Bromus inermis, Bromus tectorum, Halogeton glomeratus, Salsola tragus

CONSERVATION STATUS RANK
Global Rank & Reasons: G4 (23-Feb-1994).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This steep, barren slope is unique, distinct, and sharply bounded from surrounding communities. Steep eroding slope and hot exposure maintain the community. Vegetation is rooted around rocks and at the base of small slumping ledges. The sandy, rocky substrate controls this community, a dwarf-shrubland also maintained by high wind exposure. Erosion appears to be low and the area appears to be stable.
Fossil Butte National Monument Data: The description is based on 2005 field data (2 plots: FOBU.0103, FOBU.0151; 1 observation point: FOBU.9065).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Baker 1984a, Blackburn et al. 1968c, Blackburn et al. 1969c, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Daubenmire 1970, DeVelice et al. 1995, Driscoll et al. 1984, Fautin 1946, Francis 1986, Soil Conservation Service 1978, Western Ecology Working Group n.d.

Krascheninnikovia lanata / Poa secunda Dwarf-shrubland

Winterfat / Curly Bluegrass Dwarf-shrubland

CODE	CEGL001326
PHYSIOGNOMIC CLASS	Dwarf-shrubland (IV)
PHYSIOGNOMIC SUBCLASS	Evergreen dwarf-shrubland (IV.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.N.)
FORMATION	Extremely xeromorphic evergreen subdesert dwarf-shrubland (IV.A.2.N.a.)
ALLIANCE	*KRASCHENINNIKOVIA LANATA* DWARF-SHRUBLAND ALLIANCE (A.1104) Winterfat Dwarf-shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)
Inter-Mountain Basins Playa (CES304.786)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This dwarf-shrubland occurs in scattered locations in the interior western U.S. from the Columbia Plateau of eastern Washington and Oregon, Idaho, western Wyoming, western Colorado and likely northern Nevada. Sites are variable, and information is not available on some stands. Sites range from steep colluvial canyon slopes at around 1700 m elevation with large rocks strewn on sandy loam soil in western Colorado to gently sloping sites at 2063 m elevation with southeastern aspects on clay loam soil in western Wyoming. In eastern Washington, stands occur on gentle alluvial slopes to moderately steep mountain midslopes at 163-488 m elevation on sandy loam soils. The vegetation is characterized by dwarf-shrubs and short grasses with *Krascheninnikovia lanata* dominating the woody layer (10-50% cover). Associated shrubs and dwarf-shrubs include *Artemisia frigida, Chrysothamnus viscidiflorus, Ericameria nauseosa, Eriogonum corymbosum,* and *Opuntia polyacantha*. The shortgrass *Poa secunda* is often the only conspicuous perennial grass, although *Achnatherum hymenoides, Elymus elymoides*, and *Pascopyrum smithii* are common associates. Forb species are diverse, weedy, low in cover, and inconsistent among sites. Annuals usually appear in all communities; the exotic grass *Bromus tectorum* is usually the most abundant annual. *Pseudoroegneria spicata* is either absent or provides <1% cover. Mosses and lichens cover the soil surface in many sites.

DISTRIBUTION

Fossil Butte National Monument

This association is uncommon at the monument and represented by one plot located on a flat above Smallpox Creek.

Globally

This winterfat association occurs in scattered locations in the interior western U.S. from the Columbia Plateau of eastern Washington and Oregon, southern Idaho, western Wyoming, western Colorado and likely northern Nevada. Washington stands are found in Benton, Yakima, Grant and adjacent counties. In Oregon, it occurs only in the northern Basin and Range in Malheur and Harney counties.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This winterfat / curly bluegrass dwarf-shrubland is uncommon within the monument and occupies a windswept plain southwest of the visitor center. The site is gentle (1-degree slope), occurs at 2063 m elevation, and is oriented to the southeast. The unvegetated surface has moderate exposure of bare soil, moderate cover of small rocks, and low cover of litter. The parent material is the main body of the Wasatch Formation. Soils are rapidly drained clay loams.

Globally

This winterfat association occurs in scattered locations in the interior western U.S. from the Columbia Plateau of eastern Washington and Oregon, Idaho, western Wyoming, western Colorado and likely northern Nevada. Sites are variable, and information is limited on some examples. Sites in Colorado include steep colluvial canyon slopes at around 1700 m elevation with large rocks strewn on sandy loam soil. In western Wyoming, a site there is gently sloping at 2063 m elevation with a southeastern aspect. The unvegetated surface has moderate exposure of bare soil, moderate cover of small rocks, and low cover of litter. The parent material is the main body of the Wasatch Formation. Soils are rapidly drained and fine-textured. Daubenmire (1970) describes stands from Grant and Yakima

counties in Washington that occur on gentle alluvial slopes to moderately steep mountain midslopes with elevation ranging from 163-488 m. Substrates for one stand is sandy loam soil. Data for other stands are not available.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover is 40% in this moderately vegetated stand. This association is characterized by moderate cover of the dwarf-shrub *Krascheninnikovia lanata* (22%) and sparse cover of the perennial bunchgrass *Poa secunda* (3%). The short shrub *Chrysothamnus viscidiflorus* provides sparse cover. The herbaceous layer is low in terms of diversity and contributes sparse cover. Other grasses include *Pascopyrum smithii* and *Elymus elymoides*. Forbs include *Alyssum desertorum, Ceratocephala testiculata*, and *Phlox hoodii*. Cryptogam cover does not exceed 2% and includes moss.

Globally

This dwarf-shrub association has an open to moderately dense shrub canopy and a sparse to moderately dense herbaceous layer. *Krascheninnikovia lanata*, less than 0.5 m tall, dominates this community contributing 10-50% to total plant cover. Associated shrubs and dwarf-shrubs may be present with low cover, including *Artemisia frigida, Chrysothamnus viscidiflorus, Ericameria nauseosa, Eriogonum corymbosum*, and *Opuntia polyacantha*. The shortgrass *Poa secunda* is often the only conspicuous perennial grass, although *Achnatherum hymenoides, Elymus elymoides*, and *Pascopyrum smithii* are common associates. Forb species are diverse, weedy, low in cover, and inconsistent among sites, but native recorded species include *Erigeron piperianus, Erigeron poliospermus, Helianthus cusickii, Phlox hoodii*, and *Sphaeralcea munroana*. Annuals usually appear in all communities; the exotic grass *Bromus tectorum* is usually the most abundant annual, however, *Ceratocephala testiculata* is also common in many stands. *Pseudoroegneria spicata* is absent or provides <1% cover. Mosses and lichens cover the soil surface in many sites.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus*
Herb (field)	*Krascheninnikovia lanata*
Herb (field)	*Poa secunda*

Globally

Stratum	Species
Short shrub/sapling	*Krascheninnikovia lanata*
Herb (field)	*Poa secunda*

OTHER NOTEWORTHY SPECIES

Fossil Butte National Monument

Data are not available.

Globally

Bromus tectorum, Descurainia pinnata

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (11-Dec-2000). Although this community is widespread, locally it never is very common. It occurs in very hot, dry habitats and provides significant protein for livestock in the winter (hence the common name winterfat). Cattle have significantly degraded many of the occurrences. Many of the remnants in Oregon are included in Research Natural Areas, which provides limited protection from livestock. The number of occurrences is estimated from a single local vegetation classification survey and state heritage program information. This association is also threatened by introduced plants, such as *Bromus tectorum*, and agriculture conversion.

CLASSIFICATION COMMENTS

Fossil Butte National Monument

Data are not available.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This stand occupies deep soils and a dry exposure that is very wind-blown. The lack of sagebrush cover may be due to the fire history, exposure, or to ground squirrel and prairie dog activity.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0009).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: R.C. Crawford, mod. J. Coles and K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Daubenmire 1970, DeVelice et al. 1995, Driscoll et al. 1984, Fautin 1946, Kagan et al. 2000, Kagan et al. 2004, WNHP unpubl. data, Western Ecology Working Group n.d.

Atriplex gardneri Dwarf-shrubland
Gardner's Saltbush Dwarf-shrubland

CODE	CEGL001438
PHYSIOGNOMIC CLASS	Dwarf-shrubland (IV)
PHYSIOGNOMIC SUBCLASS	Evergreen dwarf-shrubland (IV.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen dwarf-shrubland (IV.A.2.N.)
FORMATION	Facultatively deciduous subdesert dwarf-shrubland (IV.A.2.N.b.)
ALLIANCE	*ATRIPLEX GARDNERI* DWARF-SHRUBLAND ALLIANCE (A.1110) Gardner's Saltbush Dwarf-shrubland Alliance
ECOLOGICAL SYSTEM(S):	Inter-Mountain Basins Mat Saltbush Shrubland (CES304.783) Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This dwarf-shrubland association is reported from northern and eastern Utah, western Colorado, Wyoming and Montana. Sites are flat to steep (58%). Soils are calcareous, alkaline, and typically saline and fine-textured. One site has a gravelly/cobbly substrate. Total vegetation cover is generally sparse, rarely exceeding 15%. The vegetation is composed solely of or dominated by *Atriplex gardneri* without an herbaceous layer. Associated shrubs may include minor cover of *Atriplex confertifolia, Atriplex corrugata, Chrysothamnus viscidiflorus, Ephedra torreyana, Eriogonum corymbosum, Gutierrezia sarothrae, Picrothamnus desertorum, Sarcobatus vermiculatus,* and/or *Tetradymia spinosa*. No herbaceous layer is reported, though scattered grasses such as *Achnatherum hymenoides, Pleuraphis jamesii,* and *Elymus elymoides* may be present. Invasive species including *Bromus tectorum, Halogeton glomeratus*, and *Malcolmia africana* are present in some stands. Biological soil crusts may cover up to 50% of the ground surface. The dominance of *Atriplex gardneri* and the lack of a significant herbaceous layer are diagnostic of this association.

DISTRIBUTION
Fossil Butte National Monument
This association is located on clay soils of toeslopes and alluvial fans within and outside the southern boundary of the monument to the railroad tracks.

Globally
This dwarf-shrubland association is reported from northern and eastern Utah, western Colorado, Wyoming and Montana, but likely has a wider distribution in the interior West. *Atriplex gardneri* is common on shales that cover large areas of the Colorado Plateau, such as the Moenkopi, Mancos, Wasatch, and Morrison formations.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This Gardner's saltbush dwarf-shrubland occurs on patches of highly alkaline clay soils near the southern monument boundary on toeslopes, alluvial fans, and a ridge. The sites are gentle to moderate (1- to 10-degree slope), occur between 2037 and 2101 m elevation, and are oriented to the north, east, or south. The unvegetated surface has high

exposure of bare soil, low cover of small rocks, and sparse to low cover of litter. The parent materials include the main body of the Wasatch Formation and sandstones and shale that have eroded and deposited as secondary stream alluvium. Soils are rapidly drained clays.

Globally
This dwarf-shrubland association is reported from northern and eastern Utah, western Colorado, Wyoming and Montana. Elevation ranges from 1196-2101 m. Climate is temperate and semi-arid. In Utah stands occur in Curlew Valley, a dry Pleistocene lakebed north of the Great Salt Lake, and alluvial fans and hillsides along the Green River and slopes of badland ridges and canyonsides, colluvial slopes, ridges, hills, badlands, mesas, and benches along the Colorado River. Sites are flat to steep (58%). Soils are calcareous, alkaline, and typically saline and fine-textured, often derived from alluvium or shale from Chinle, Moenkopi, Mancos, Morrison, and Wasatch formations. One site has a gravelly/cobbly substrate. Bare soil covers much of the unvegetated surface.

VEGETATION DESCRIPTION
Fossil Butte National Monument
The total vegetation cover ranges from 21-35% in these moderately vegetated stands. This association is characterized by low to moderate cover of the dwarf-shrub *Atriplex gardneri* that ranges from 8-25% cover. The remaining shrub layer provides sparse cover and includes the short and dwarf-shrubs *Artemisia tridentata* ssp. *wyomingensis, Tetradymia spinosa, Picrothamnus desertorum, Sarcobatus vermiculatus, Artemisia arbuscula* ssp. *longiloba*, and *Krascheninnikovia lanata*. The herbaceous layer is low in terms of diversity and contributes sparse cover. Grasses include *Elymus lanceolatus, Pascopyrum smithii, Poa secunda*, and the non-native bunchgrass *Agropyron cristatum*. Forbs include *Ceratocephala testiculata, Phlox hoodii, Stenotus acaulis*, and *Antennaria dimorpha*.

Globally
This association is broadly defined as a dwarf-shrubland composed solely of or dominated by *Atriplex gardneri* without a herbaceous layer. Total vegetation cover is generally sparse, rarely exceeding 15%, and sometimes as low as 1% or as high as 35%. Associated shrubs may include scattered *Artemisia arbuscula* ssp. *longiloba, Artemisia tridentata* ssp. *wyomingensis, Atriplex confertifolia, Atriplex corrugata, Chrysothamnus viscidiflorus, Ephedra torreyana, Eriogonum corymbosum, Gutierrezia sarothrae, Krascheninnikovia lanata, Picrothamnus desertorum, Sarcobatus vermiculatus*, and/or *Tetradymia spinosa*. No herbaceous layer is reported, though scattered clumps of grass such as *Achnatherum hymenoides, Pleuraphis jamesii*, and *Elymus elymoides* or occasional *Eriogonum inflatum* may be present. Invasive species such as *Agropyron cristatum, Bromus tectorum, Ceratocephala testiculata, Halogeton glomeratus*, and *Malcolmia africana* are present in some stands. Biological soil crusts may cover up to 50% of the ground surface; those stands that are protected from grazing are advanced in development and include *Collema* sp., *Fulgensia* sp., *Psora* sp., mosses, and dark cyanobacteria. The dominance of *Atriplex gardneri* and the lack of a significant herbaceous layer are diagnostic of this association.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Atriplex gardneri*
Herb (field)	*Phlox hoodii*
Herb (field)	*Poa secunda*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex gardneri*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Agropyron cristatum, Ceratocephala testiculata, Pascopyrum smithii

Globally
Agropyron cristatum, Bromus tectorum, Ceratocephala testiculata, Halogeton glomeratus, Malcolmia africana

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
This association is poorly defined and is only referred to as a "pure, evidently stable stand of saltsage" in Mitchell et al. (1966). Mitchell et al. (1966) investigated the relatively sharp boundaries between the *Atriplex gardneri* and the *Krascheninnikovia lanata* communities at their study site; no edaphic factor was identified to explain the abrupt change. This association is separated from other *Atriplex gardneri*-dominated associations by the lack of codominant shrubs or significant herbaceous layer. It includes both sparse stands growing on harsh, windswept sites and/or strong saline/alkaline substrates, and occasional moderately dense to dense saltbush stands that lack an herbaceous layer because of disturbance. Some stands may be a seral community in areas with a history of over-grazing by livestock. More classification work is needed to further define this association.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This community is controlled by grazing, exposure, clay soils, and rapid runoff. It is grazed annually, which helps maintain the dwarf-shrub/cushion plant nature of the stand. The species composition is less than for comparable sites in the monument, however, these sites are lower on the alluvial fan and lie below the highway super-elevation, which could restrict sheetflow and result in drier conditions.
Fossil Butte National Monument Data: The description is based on 2005 field data (4 plots: FOBU.0010, FOBU.0011, FOBU.0017, FOBU.0031; 2 observation points: FOBU.9031, FOBU.9040).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, Branson et al. 1976, Driscoll et al. 1984, Gates et al. 1956, Johnston 1987, MTNHP 2002b, MTNHP unpubl. data, Mitchell et al. 1966, Von Loh 2000

Leymus cinereus Herbaceous Vegetation
Great Basin Wildrye Herbaceous Vegetation

CODE	CEGL001479
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	Tall bunch temperate grassland (V.A.5.N.b.)
ALLIANCE	*LEYMUS CINEREUS* HERBACEOUS ALLIANCE (A.1204) Great Basin Wildrye Herbaceous Alliance
ECOLOGICAL SYSTEM(S):	Inter-Mountain Basins Greasewood Flat (CES304.780) Columbia Basin Palouse Prairie (CES304.792) Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This Great Basin lyme grass association is found along lower elevation riparian corridors and some moderately alkaline valley bottomlands from Colorado to the Pacific Coast states. Elevations range between 305 and 780 m (1000-2550 ft.) in northeastern and central Oregon, between 915 and 1525 m (3000-5000 ft.) in the Great Basin, and from 1830 to 2451 m (6000-8036 ft.) in western Colorado and southwestern Wyoming. Generally, stands of this type are described as growing on mesic sites with more soil moisture than is available to the surrounding vegetation, including mesic swales and seeps, canyon bottoms, foothill ravines, moist bottomlands, and along streams. Sites are flat to steep and occur on all aspects. Soils are rapidly drained, often with a shallow water table. Soil texture is variable and ranges from silty clays to deep loamy sands derived from alluvium and colluvium. The vegetation is

characterized by a tall (over 1.5 m), moderately dense to more typically dense grassland dominated by high cover (30-95%) of *Leymus cinereus*. Other plants are found mainly between the clumps of *Leymus cinereus* or on the edges of the dense stands. Scattered shrubs may be present, including *Artemisia tridentata, Chrysothamnus viscidiflorus, Ericameria nauseosa, Rhus trilobata, Ribes* spp., *Rosa* spp., and *Symphoricarpos oreophilus*. Associated species occurring at lower cover include graminoids such as *Achnatherum hymenoides, Achnatherum lettermanii, Carex douglasii, Elymus glaucus, Hesperostipa comata, Juncus balticus, Pascopyrum smithii*, and introduced species *Bromus tectorum* and *Poa pratensis*, and forbs such as *Achillea millefolium, Agastache urticifolia, Castilleja* spp., *Iris missouriensis, Potentilla gracilis var. flabelliformis, Rumex crispus, Sidalcea oregana, Stephanomeria minor,* and *Vicia americana*. *Claytonia perfoliata* is always associated in northwestern Oregon, while more alkaline forbs (*Suaeda* spp.) are more important in northern Great Basin valleys.

DISTRIBUTION

Fossil Butte National Monument

This grassland occupies disturbed ridges and slopes along the western edge of the monument, forms patches through the central portion, and occurs along a creekbed near the eastern edge of the monument.

Globally

This type is found mainly in the Great Basin and the Intermountain Region, and just reaches the western part of the Northern Great Plains. Although it occupies a small amount of area in Oregon or in any western state, it has a fairly large range. Unfortunately, few high-quality remnants remain.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This Great Basin wildrye herbaceous association is scattered throughout the monument, occurring as patches and small stands in mesic habitats. This grassland occupies steep slopes, buttes, and a valley side that seasonally floods. The sites are moderate to steep (5- to 33-degree slopes), occur between 2200 and 2371 m elevation, and are oriented to the south, southeast, or southwest. The unvegetated surface has low to high exposure of bare soil, low cover of small and large rocks, and low to high cover by litter. The parent materials include the Fossil Butte Member of the Wasatch Formation, the main body of the Wasatch Formation, or sandstones and shale that have eroded and deposited as colluvium. Soils are well-drained to rapidly drained clays or silty clays.

Globally

This association is found along lower elevation riparian corridors and some moderately alkaline valley bottomlands. Elevations range between 305 and 780 m (1000-2550 ft.) in northeastern and central Oregon, between 915 and 1525 m (3000-5000 ft.) in the Great Basin, and from 1830 to 2451 m (6000-8036 ft.) in western Colorado and southwestern Wyoming. Generally, stands tend to be patchy and grow on mesic sites with more soil moisture than is available to the surrounding vegetation, including mesic swales and seeps (Thilenius et al. 1995), foothill ravines (Knight et al. 1976), moist bottomlands (Stoddart 1941), along streams (Mueggler and Stewart 1980), and on gentle slopes in canyon bottoms in Oregon. Sites are flat to steep and occur on all aspects. Soils are rapidly drained, often with a shallow water table. Soil texture is variable and ranges from silty clays to deep loamy sands. Parent materials are alluvium or colluvium derived from a variety of parent materials, including sandstone, shale, and volcanic rocks.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 4-83% in these sparsely to densely vegetated stands. This association is characterized by sparse to dense cover of the coarse perennial bunchgrass *Leymus cinereus* that ranges from 2-70% cover. The shrub layer provides sparse to low cover and includes *Amelanchier utahensis*, *Symphoricarpos oreophilus*, *Purshia tridentata*, and *Artemisia tridentata* ssp. *vaseyana*. The remaining herbaceous layer is low to moderate in terms of diversity and contributes sparse to low cover. Associated graminoids include the annual non-native *Bromus tectorum* and the native bunchgrass *Achnatherum hymenoides*. In one stand that seasonally floods, the forb *Agastache urticifolia* provides moderate cover. Other forbs provide sparse to low cover and include *Iva axillaris, Mertensia oblongifolia, Balsamorhiza sagittata, Pteryxia terebinthina*, and *Eriogonum brevicaule*.

Globally

The association is a characteristically tall (over 1.5 m), moderately dense to more typically dense grassland dominated by high cover (30-95%) of *Leymus cinereus*. Other plants are found mainly between the clumps of *Leymus cinereus* or on the edges of the dense stands. Scattered shrubs may be present, including *Amelanchier*

utahensis, Artemisia tridentata, Chrysothamnus viscidiflorus, Ericameria nauseosa, Purshia tridentata, Rhus trilobata, Ribes spp., *Rosa* spp., and *Symphoricarpos oreophilus*. Associated species occurring at lower cover include graminoids such as *Achnatherum hymenoides, Achnatherum lettermanii, Carex douglasii, Elymus glaucus, Hesperostipa comata, Juncus balticus, Pascopyrum smithii*, and introduced species *Bromus tectorum* and *Poa pratensis*, and forbs such as *Achillea millefolium, Agastache urticifolia, Balsamorhiza sagittata, Castilleja* spp., *Eriogonum brevicaule, Iris missouriensis, Iva axillaris, Mertensia oblongifolia, Pteryxia terebinthina, Potentilla gracilis var. flabelliformis, Rumex crispus, Sidalcea oregana, Stephanomeria minor*, and *Vicia americana*. *Claytonia perfoliata* is always associated in northwestern Oregon, while more alkaline forbs (*Suaeda* spp.) are more important in northern Great Basin valleys.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Herb (field)	*Leymus cinereus*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Bromus tectorum

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G2G3Q (29-Mar-1999). This is a very widespread community, being found in many western states, but is badly degraded everywhere. It has declined markedly throughout its range, and probably represents two or more separate community types. This type was formerly very abundant in interior valleys. Early settlers described the very tall grasslands (up to their horses backs) in many areas. Most of these sites have been converted to agriculture. Even as described here as a broad association floristically and geographically - the size and quality of most occurrences should make it a G2. More knowledge of its distribution is needed, but it should remain a priority for conservation. Most sites are threatened by livestock grazing, agriculture, altered stream hydrology, and altered fire regime.

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Stands of *Leymus cinereus* are widely distributed in the Intermountain Region and the Great Basin, but little quantitative information is available on the composition of stands in different areas. The type has been very poorly sampled, since there are only a few examples which have not been significantly altered from grazing and altered stream function. This is therefore a broadly defined association that could be split. This *Leymus cinereus* Herbaceous Vegetation association includes stands growing on relatively non-saline soils in a variety of landscape positions, and is based on the limited information in the literature. It is also very likely that the types found along alluvial terraces in the somewhat alkaline, mid- to high-elevation valleys in the Blue Mountains and the Basin and Range are very different from the non-alkaline, low-elevation stream drainages from the Columbia Basin. Until additional reference sites are found, the type will have to be treated as a single community.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This plot is located on a steep, sliding shale slope on the side of Fossil Butte with unstable soils and rock falls. Community is more diverse and lush than communities above and below, possibly because of greater water availability.
Fossil Butte National Monument Data: The description is based on 2005 field data (3 plots: FOBU.0045, FOBU.0108, FOBU.0138; 3 observation points: FOBU.9047, FOBU.9069, FOBU.9085).

Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: G.P. Jones and M.P. Murray, mod. K.A. Schulz

REFERENCES: Aldous and Shantz 1924, Baker 1982b, Baker 1984a, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Daubenmire 1970, Daubenmire 1988, DeVelice 1992, Dean 1960, Driscoll et al. 1984, Ferchau 1973, IDCDC 2005, Johnson and Simon 1985, Johnson and Simon 1987, Jones and Ogle 2000, Keammerer 1977, Knight et al. 1976, MTNHP 1988, MTNHP 2002b, Mueggler and Stewart 1980, Stoddart 1941, Thilenius et al. 1995, Thorne Ecological Institute 1973a, USFS 1937, Vories 1974, WNHP unpubl. data, Walker and Brotherson 1982

Elymus lanceolatus Herbaceous Vegetation
Streambank Wheatgrass Herbaceous Vegetation

CODE	CEGL002588
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	*ELYMUS LANCEOLATUS* HERBACEOUS ALLIANCE (A.1242) Streambank Wheatgrass Herbaceous Alliance
ECOLOGICAL SYSTEM(S):	Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824) Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This streamside wild rye grassland occurs on rolling upland terrain in northwestern Colorado, northeastern Utah and southwestern Wyoming. Stands typically occur as patches and small stands on dry to mesic habitats at elevations from 1600 to 2470 m (5250-8100 ft.). Sites are located on generally level to gentle slopes, but may occur on steep slopes. Aspect is not important in determining this community. Soils are generally well-developed, fine-textured silt loams or clay loams derived from shale or eolian loess, less often from alluvium. Litter or bare soil cover much of the unvegetated ground surface. The vegetation is dominated by the perennial grass *Elymus lanceolatus*. Other grasses are generally present, usually with much less cover, and include *Hesperostipa comata, Poa fendleriana, Poa secunda, Achnatherum hymenoides, Elymus elymoides, Leymus cinereus, Pascopyrum smithii*, and *Pseudoroegneria spicata*. Exotics such as *Agropyron cristatum, Bromus inermis* and *Bromus tectorum* may be present in disturbed stands. A variety of forb species may also be present with low to moderate cover. Some of the more consistent species include *Lupinus argenteus, Silene menziesii, Agoseris glauca, Sphaeralcea coccinea*, and *Phlox* spp. Shrubs such as *Amelanchier utahensis* and *Symphoricarpos oreophilus* may occur with minimal cover. Shrubs may provide trace cover, including *Chrysothamnus viscidiflorus* and *Krascheninnikovia lanata*.

DISTRIBUTION
Fossil Butte National Monument
This grassland occupies disturbed ridges and slopes along the exposed high slopes and rims of Ruby Point, Fossil Butte, and Dempsey Ridge, forms patches on badlands formations in the Chicken Creek drainage, and occurs along roadbeds adjacent to the main entrance road.

Globally
This association is known from northwestern Colorado, northeastern Utah and southwestern Wyoming.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This streamside wheatgrass herbaceous association is distributed throughout the monument, occurring as patches and small stands on dry to mesic habitats. This perennial grassland occupies butte rims, steep slopes, ridges, hills, and an introduced roadbed. The sites are gentle to steep (1- to 35-degree slopes), occur between 2032 and 2470 m elevation, and are oriented to all aspects. The unvegetated surface has moderate to high exposure of bare soil, low to

moderate cover of small and large rocks, low cover of litter, and sparse cover of downed wood. The parent materials include the Fossil Butte, Bullpen, and Angelo members of the Wasatch Formation, the main body of the Wasatch Formation, or materials that have been imported as roadbed material. Soils are rapidly drained sandy clay loams, sandy loams, clay loams, or loams.

Globally
This grassland occurs on rolling upland terrain in northwestern Colorado, northeastern Utah and southwestern Wyoming. Stands typically occur as patches and small stands on dry to mesic habitats. This perennial grassland is found on flat to gentle slopes of valleys, benches, stream terraces and butte rims, and steeper slopes of ridges and hills. Sites are located on generally level to gentle slopes, but include slopes up to 35 degrees. Elevations range from 1600 to 2470 m (5250-8100 ft.). Aspect is not important in determining this community. Soils are generally well-developed, fine-textured silt loams or clay loams, and less often coarse-textured loams, that are derived from shale or eolian loess, less often from alluvium. Litter or bare soil cover much of the unvegetated ground surface. The unvegetated surface has moderate to high exposure of bare soil, low to moderate cover of small and large rocks, and moderate to low cover of litter.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover ranges from 15-42% in these low to moderately vegetated stands. This association is characterized by sparse to moderate cover of the perennial rhizomatous grass *Elymus lanceolatus* that ranges from 6-25% cover. The shrub layer provides sparse to low cover and includes the short and dwarf-shrubs *Krascheninnikovia lanata, Artemisia arbuscula* ssp. *longiloba, Tetradymia canescens, Chrysothamnus viscidiflorus,* and *Atriplex gardneri*. The remaining herbaceous layer is low to moderate in terms of diversity and contributes sparse to low cover. Associated graminoids include *Poa secunda, Poa fendleriana, Pascopyrum smithii, Elymus elymoides, Leymus cinereus*, the non-native annual *Bromus tectorum*, the non-native bunchgrass *Agropyron cristatum*, and the non-native rhizomatous grass *Bromus inermis*. Forbs provide sparse to low cover, including *Iva axillaris, Achillea millefolium, Linum lewisii, Phlox hoodii, Astragalus jejunus, Packera cana, Comandra umbellata, Eriogonum brevicaule*, and the non-natives *Taraxacum officinale, Melilotus officinalis*, and *Ceratocephala testiculata*.

Globally
This association is dominated by the perennial grass *Elymus lanceolatus*. Other grasses are generally present, usually with much less cover, and include *Hesperostipa comata, Poa fendleriana, Poa secunda, Achnatherum hymenoides, Elymus elymoides, Leymus cinereus, Pascopyrum smithii*, and *Pseudoroegneria spicata*. Non-native grasses *Agropyron cristatum, Bromus inermis*, and *Bromus tectorum* may be common in disturbed stands. A variety of forb species may also be present with low to moderate cover. Some of the more consistently present species include *Achillea millefolium, Agoseris glauca, Astragalus jejunus, Comandra umbellata, Eriogonum brevicaule, Iva axillaris, Linum lewisii, Lupinus argenteus, Packera cana, Phlox hoodii, Silene menziesii, Sphaeralcea coccinea*, and non-natives *Ceratocephala testiculata, Melilotus officinalis*, and *Taraxacum officinale*. Occasional shrubs, such as *Amelanchier utahensis, Artemisia arbuscula* ssp. *longiloba, Atriplex gardneri, Chrysothamnus viscidiflorus, Krascheninnikovia lanata, Symphoricarpos oreophilus*, and *Tetradymia canescens*, may occur with minimal cover.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Herb (field)	*Elymus lanceolatus*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Agropyron cristatum, Astragalus jejunus, Bromus tectorum, Ceratocephala testiculata, Melilotus officinalis, Pascopyrum smithii, Taraxacum officinale

Globally

Agropyron cristatum, Astragalus jejunus, Bromus inermis, Bromus tectorum, Ceratocephala testiculata, Melilotus officinalis, Taraxacum officinale

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (7-Apr-2005).

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Rhizomatous *Elymus lanceolatus* can easily be confused with the bunchgrass *Pseudoroegneria spicata*, especially in disturbed areas or on steep slopes, where bunches can spread out. It is also difficult to distinguish reliably from the hybrid of the two species, *Elymus albicans*, which is prevalent east of the Continental Divide but which also occurs at Dinosaur National Monument. Further work is necessary to clarify the ranges and habitats of the three grasses so that *Elymus lanceolatus* Herbaceous Vegetation (CEGL002588) can be readily distinguished from *Pseudoroegneria spicata* Herbaceous Vegetation (CEGL001660).

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This community is controlled by the constant exposure to wind and sun. The exposed geology (badlands) controls this environment. This site is steep, rocky, and barren and documents the vegetation of the road shoulder, including cut-and-fill slopes typically from 2-5 m in width that consists of introduced and native herbaceous species.
Fossil Butte National Monument Data: The description is based on 2005 field data (7 plots: FOBU.0030, FOBU.0083; FOBU.0087, FOBU.0093, FOBU.0105, FOBU.0119, FOBU.0133; 3 observation points: FOBU.9038, FOBU.9152, FOBU.9153).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Pascopyrum smithii Herbaceous Vegetation
Western Wheatgrass Herbaceous Vegetation

Western Wheatgrass Mixedgrass Prairie

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) Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824) Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This midgrass prairie type is found in the northern and western Great Plains, Rocky Mountains, Colorado Plateau, and the interior western United States and Canada at elevations from 600-3000 m. 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 typically clay, clay loam, and silt loam but may include sand or loamy sand. *Pascopyrum smithii* strongly

dominates the open to dense (15-100% cover) mixedgrass herbaceous layer that grows 0.5-1 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 and other grasslands are also found in this community, including *Artemisia ludoviciana, Eriogonum* spp., *Bouteloua gracilis, Nassella viridula*, and *Hesperostipa 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

Fossil Butte National Monument

This grassland occupies disturbed ridges and slopes along the western edge of the monument and along a creekbed near the eastern 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 Canada, ranging from North Dakota and Saskatchewan, south to Nebraska and Colorado, and west to northern Arizona, Utah and Idaho.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This western wheatgrass grassland is uncommon within the monument, occurring as small stands on a slope, ridge, and creekbed that intermittently floods. The sites are moderate (2- to 7-degree slopes), occur between 2070 and 2128 m elevation, and are oriented to the south or east. The unvegetated surface has high exposure of bare soil, moderate cover of litter, and low cover of small rocks. The parent material is either the main body of the Wasatch Formation or sandstones and shale that have eroded and deposited as secondary stream alluvium. Soils are rapidly drained clays.

Globally

This grassland association is widespread in the northern and western Great Plains of the U.S. and Canada, Rocky Mountains, Colorado Plateau, and the intermountain western United States. Elevation ranges from 600-3000 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 typically deep (40-100 cm), slightly alkaline and well-developed with clay, clay loam, and silt loam textures, but also coarser textures such as sand and loamy sand. Some stands occur on perched water tables. Parent materials include Quaternary landslide deposits, volcanic rocks, sandstones and shale that have eroded and deposited as secondary stream alluvium.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 17-53% in these moderately to densely vegetated stands. This association is characterized by moderate cover of the perennial rhizomatous grass *Pascopyrum smithii* that ranges in cover from 12-35%. Scattered short shrubs include *Artemisia arbuscula* ssp. *longiloba, Artemisia tridentata* ssp. *vaseyana*, and *Artemisia cana*. The remaining herbaceous layer is low to moderate in terms of diversity and contributes sparse to low cover. Associated graminoids include the annual non-native *Bromus tectorum*, along with *Juncus balticus, Poa pratensis, Poa secunda*, and *Poa fendleriana*. In one stand where sheep have been yarded, the non-native annual forb *Descurainia sophia* provides moderate cover. Other forbs provide sparse to low cover and include *Iva axillaris, Alyssum desertorum, Ceratocephala testiculata*, and *Achillea millefolium*.

Globally

This association is characterized by an open to dense (15-100% cover) mixedgrass herbaceous layer that grows 0.5-1 m tall and is strongly dominated by *Pascopyrum smithii*. Herbaceous cover may be significantly less on drier sites or after scarce cool-season precipitation. Other graminoids that co-occur and may achieve local dominance are *Bouteloua gracilis, Distichlis spicata, Eleocharis palustris, Koeleria macrantha*, and *Sporobolus airoides*. Many other species common in prairies and other grasslands are also found in this community, including *Achnatherum lettermanii, Achillea millefolium, Artemisia frigida, Artemisia ludoviciana, Bouteloua curtipendula, Carex* spp., *Eriogonum* spp., *Hesperostipa comata, Juncus balticus, Lupinus argenteus, Nassella viridula, Poa fendleriana, Poa secunda, Schizachyrium scoparium*, and *Solidago* sp. Shrubs and dwarf-shrubs are rare in this community, but

occasional woody plants, such as *Artemisia arbuscula* ssp. *longiloba, Artemisia tridentata, Ericameria nauseosa, Krascheninnikovia lanata, Rhus trilobata*, or *Symphoricarpos* spp., may be present. Introduced species, such as *Agropyron cristatum, Cirsium arvense, Bromus japonicus, Bromus tectorum, Ceratocephala testiculata, Conyza canadensis, Iva axillaris, Lactuca serriola, Melilotus* spp., *Poa pratensis, Salsola kali, Sisymbrium altissimum*, and *Taraxacum officinale*, are common in some stands, especially where disturbed.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Herb (field)	*Descurainia sophia*
Herb (field)	*Pascopyrum smithii*

Globally

Stratum	Species
Herb (field)	*Pascopyrum smithii*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Alyssum desertorum, Bromus tectorum, Ceratocephala testiculata, Descurainia sophia, Poa pratensis

Globally
Agropyron cristatum, Bromus japonicus, Bromus tectorum, Ceratocephala testiculata, Cirsium arvense, Conyza canadensis, Iva axillaris, Lactuca serriola, Poa pratensis, Salsola kali, Sisymbrium altissimum, Taraxacum officinale

CONSERVATION STATUS RANK
Global Rank & Reasons: G3G5Q (1-Feb-1996).

CLASSIFICATION COMMENTS
Fossil Butte 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). In Alberta, this association is clearly dominated by dense, nearly pure stands of *Pascopyrum smithii* and tends to occur in depressions in areas of fine-textured saline soils with a hardpan layer. The hardpan holds rain and spring runoff.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Area shows signs of grazing with cattle tracks and areas of *Bromus tectorum*. On the boundary fence, there is a gate in the creekbed, which possibly provides access for livestock. This is a site where sheep were yarded historically when grazing this area of the monument. It is affected by nutrient loading, compaction, and physical disturbance so that it now supports flixweed and western wheatgrass.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0140; 2 observation points: FOBU.9012, FOBU.9063).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Drake, mod. K.A. Schulz and J. Coles

REFERENCES: ANHIC 2005, 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, Thompson and Hansen 2002, Von Loh 2000, Vujnovic and Bentz 2001, Western Ecology Working Group n.d.

Poa pratensis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation
Kentucky Bluegrass - (Western Wheatgrass) Semi-natural Herbaceous Vegetation

CODE	CEGL005265
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d.)
ALLIANCE	*POA PRATENSIS* SEMI-NATURAL HERBACEOUS ALLIANCE (A.3562) Kentucky Bluegrass Semi-natural Herbaceous Alliance
ECOLOGICAL SYSTEM(S):	Central Mixedgrass Prairie (CES303.659) Northwestern Great Plains Mixedgrass Prairie (CES303.674) Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This Kentucky bluegrass type is potentially widespread throughout the Great Plains and into the midwestern United States and Canada, and at montane elevations in the Colorado Plateau and southern Rocky Mountains. Stands can occur in a wide variety of upland human-disturbed and native habitats. The vegetation is dominated by medium-tall (0.5-1 m) graminoids. The dominant grass is *Poa pratensis*, considered to be both a native and naturalized species from Eurasia. Other native species may occur as well, but they are generally less than 10% cover. Native species may include mixed-grass prairie grasses, such as *Pascopyrum smithii* and *Hesperostipa comata*, as well as others. Where native species are conspicuous enough to identify the native plant association that could occupy the site, the stand should be typed as such. This type includes only naturalized examples of *Poa pratensis* stands. Maintained lawns are treated as cultural types.

DISTRIBUTION

Fossil Butte National Monument

This association is uncommon at the monument and represented by one observation point located on a small seep.

Globally

This Kentucky bluegrass type is potentially widespread throughout the Great Plains and into the midwestern United States and Canada. Stands are also found on upland sites in the northwestern Great Plains and occur elsewhere in the western U.S. where *Poa pratensis* has invaded native western rangeland.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This Kentucky bluegrass - (western wheatgrass) semi-natural herbaceous association is uncommon within the monument and occupies a small seep that is seasonally flooded. The slope is moderate (10 degrees), occurs at 2145 m elevation, and is oriented to the south. The unvegetated surface has moderate cover of litter, low cover of small rocks, and low exposure of bare soil. The parent material is the main body of the Wasatch Formation.

Globally

This Kentucky bluegrass type is potentially widespread throughout the Great Plains and into the midwestern United States and Canada, at montane elevations in the Colorado Plateau and southern Rocky Mountains, and elsewhere in the western U.S. where the introduced perennial *Poa pratensis* has invaded native western rangeland. Stands can occur in a wide variety of upland human-disturbed and native habitats. Stands in western North Dakota are found on deep, well-developed, fine-textured soils that are topographically situated to receive supplemental moisture in the form of runoff from adjacent slopes. Such conditions exist in the toeslopes of upland draws and drainages, and in shallow depressions on north- and east-facing, nearly level slopes. Stands in the semi-arid western U.S. are typically found at montane elevations (1799-2574 m) on lowland and relatively mesic upland sites, such as canyon floors and

swales on high terraces with permanently saturated soils. Substrates are also typically finer-textured, poorly drained alluvial soils. The unvegetated surface has a moderate to high cover of litter.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover is approximately 70% in this densely vegetated stand. This association is characterized by moderate cover of the graminoids *Poa pratensis* (40%) and *Juncus balticus* (20%). The remaining herbaceous layer is diverse but contributes low cover. Associated graminoids include *Koeleria macrantha, Carex praegracilis*, and the non-native *Alopecurus pratensis*. Forbs include *Descurainia pinnata, Artemisia ludoviciana, Taraxacum officinale, Arnica sororia, Sidalcea oregana, Potentilla gracilis, Achillea millefolium*, and *Penstemon rydbergii*.

Globally

The vegetation is dominated by medium-tall (0.5-1 m) graminoids. The dominant grass is *Poa pratensis*, considered to be both a native and naturalized species from Eurasia (Great Plains Flora Association 1986, Gleason and Cronquist 1991). Other native species may occur as well, but they are generally less than 10% cover. Native species may include mixedgrass prairie grasses, such as *Pascopyrum smithii* and *Hesperostipa comata*, as well as other mesic forbs, such as *Achillea millefolium* and exotic *Taraxacum officinale*.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Herb (field)	*Achillea millefolium*
Herb (field)	*Juncus balticus, Koeleria macrantha, Poa pratensis*

Globally

Stratum	Species
Herb (field)	*Poa pratensis*

OTHER NOTEWORTHY SPECIES

Fossil Butte National Monument

Alopecurus pratensis, Descurainia pinnata, Taraxacum officinale

Globally

Poa pratensis, Taraxacum officinale

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (17-Jun-1999). This is primarily a naturalized type from Europe and Asia, widely planted for lawns and pasture, and it has escaped into a variety of habitats (Great Plains Flora Association 1986, Gleason and Cronquist 1991). Although native populations do exist and may be integral parts of some prairie and other native habitats, most stands that are thoroughly dominated by *Poa pratensis* are a result of human modifications to the habitat.

CLASSIFICATION COMMENTS

Fossil Butte National Monument

Data are not available.

Globally

The debate over whether *Poa pratensis* is either native or introduced appears to be resolved in favor of it being both (Great Plains Flora Association 1986, Gleason and Cronquist 1991). The Great Plains Flora Association (1986) cites Boivin and Love (1960) as the source of this decision. Gleason and Cronquist (1991) state that in most parts of their Manual's range (Northeast and Midwest United States and adjacent Canada) the species is introduced, but that it is probably native along their northern boundary and in Canada.

This type could be narrowly restricted to mixed-grass prairie stands where *Poa pratensis* dominates to the exclusion of most other species, or it could be expanded to include almost any naturalized stand dominated by *Poa pratensis*. Where native species are conspicuous enough to identify the native plant association that could occupy the site, the stand should be typed as such. This type includes only naturalized examples of *Poa pratensis* stands. Maintained lawns are treated as cultural types.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: The small seep is adjacent to a low sagebrush dwarf-shrubland. The vegetation may transition to a sagebrush community if drought continues long-term.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 observation point: FOBU.9034).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: D. Faber-Langendoen, mod. K.A. Schulz

REFERENCES: Butler et al. 2002, Gleason and Cronquist 1991, Great Plains Flora Association 1986, MTNHP 2002b, Midwestern Ecology Working Group n.d., NDNHI n.d., Trammell 1994, USFS 1937, Von Loh et al. 2000

Pseudoroegneria spicata - Cushion Plants Herbaceous Vegetation
Bluebunch Wheatgrass - Cushion Plants Herbaceous Vegetation

CODE	CEGL001666
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	*PSEUDOROEGNERIA SPICATA* HERBACEOUS ALLIANCE (A.1265) Bluebunch Wheatgrass Herbaceous Alliance
ECOLOGICAL SYSTEM(S):	Rocky Mountain Alpine Turf (CES306.816) Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765) Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This association is found in foothills of southwestern and south-central Montana. It is also known from the high limestone plateaus and ridges of Dinosaur National Monument in northwestern Colorado and Fossil Butte National Monument in southwestern Wyoming. In south-central Montana, this type occurs at elevations between 1250 and 1680 m (4100-5500 ft.). In southwestern Montana, it has been documented from 2580 m (8450 ft.) elevation but is noted in reconnaissance from 2075 to 2685 m (6800-8800 ft.) elevation. In Colorado, elevations range from 1650 to 2650 m (5400-8700 ft.), and in Wyoming from 2350 and 2400 m (7710-7875 ft.). This community occurs on moderately deep, rocky and gravelly soils derived from limestone or calcareous sandstone of mesas, ridgetops, plateaus and saddles, and the upper slopes of outwash plains. The primary influencing environmental factor is wind; in most examples of this type, wind deflation has produced a gravel-paved surface. This herbaceous type is characterized by the presence of short-statured, compact cushion plants of the genera *Arenaria, Astragalus, Hymenoxys, Phlox, Cryptantha, Stenotus, Heterotheca, Eriogonum,* and in the Bighorn region, *Sphaeromeria capitata*. *Pseudoroegneria spicata* is present at relatively low canopy cover, although many other species of grasses may also be present. Scattered dwarfed shrubs may be scattered throughout.

DISTRIBUTION
Fossil Butte National Monument
This association is uncommon at the monument and represented by plots located on a ridgetop approximately 150 m west of Ruby Point and near The Bullpen.

Globally
This association is found in the Tendoy Mountains in southwestern Montana, the Pryor Mountains and adjacent Bighorn Canyon area in south-central Montana, and in Dinosaur National Monument in northwestern Colorado. It may also occur in the Bighorn Mountains of north-central Wyoming.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument

This bluebunch wheatgrass - cushion plants grassland is uncommon within the monument and occupies windswept ridges west of Ruby Point and near The Bullpen. Stands are on moderate to steep (10- to 28-degree) slopes, lie between 2350 and 2400 m elevation, and are oriented generally to the west or south. The unvegetated surface has high cover of large and small rocks and low exposure of bare soil. Soils are rapidly drained clays derived from the Wasatch Formation.

Globally
This association is found in the Tendoy Mountains in southwestern Montana and the Pryor Mountains and adjacent Bighorn Canyon area in south-central Montana. It is also known from the high limestone plateaus and ridges of Dinosaur National Monument in northwestern Colorado and Fossil Butte National Monument in southwestern Wyoming. In the Pryor Mountains, this type occurs at foothill elevations between 1250 and 1680 m (4100-5500 ft.). In the Tendoy Mountains, it has been documented from 2580 m (8450 ft.) elevation but is noted in reconnaissance from 2075 to 2685 m (6800-8800 ft.). In Colorado, elevations range from 1650 to 2650 m (5400-8700 ft.), and in Wyoming from 2350 and 2400 m (7710-7875 ft.). This community occurs on moderately deep, rocky and gravelly soils derived from limestone, shale or calcareous sandstone of mesas, ridgetops, plateaus and saddles and the upper slopes of outwash plains. Slopes are moderately steep to steep and may be oriented to any aspect. The unvegetated surface of these windswept sites typically has high cover of large and small rocks and low exposure of bare soil often forming a near-pavement.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is between 20 and 25%. Stands are dominated by *Pseudoroegneria spicata* with lesser cover by *Poa secunda, Poa fendleriana*, and *Leucopoa kingii*. Scattered shrubs include *Artemisia frigida* and *Krascheninnikovia lanata*. Associated herbaceous species tend to be cushion plant species including *Eriogonum brevicaule, Linum lewisii, Phlox hoodii*, and *Arenaria* spp. *Pinus flexilis* trees are located outside the plot.

Globally
At first glance from the distance, this association appears as a barren, windswept ridge. Under closer observation, it is a species-rich, diverse community of grasses and forbs. This herbaceous type is characterized by the presence of short-statured, compact cushion plants in the genera *Arenaria, Astragalus, Hymenoxys, Phlox, Cryptantha, Stenotus, Heterotheca, Eriogonum*, and in the Bighorn region, *Sphaeromeria capitata*. *Pseudoroegneria spicata* is present at relatively low canopy cover, and other grasses present may include *Hesperostipa comata, Poa fendleriana, Poa secunda, Koeleria macrantha, Leucopoa kingii*, and *Achnatherum hymenoides*. Dwarfed shrubs may be scattered throughout the community, including *Artemisia tridentata* ssp. *vaseyana, Krascheninnikovia lanata, Tetradymia canescens, Cercocarpus montanus, Artemisia nova, Artemisia frigida*, and *Gutierrezia sarothrae*.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia frigida*
Herb (field)	*Astragalus spatulatus*, *Eriogonum brevicaule*
Herb (field)	*Pseudoroegneria spicata*

Globally

Stratum	Species
Herb (field)	*Astragalus spatulatus*, *Erigeron nematophyllus*, *Eriogonum tumulosum*, *Heterotheca villosa*, *Petradoria pumila*, *Phlox austromontana*, *Phlox hoodii*, *Stenotus acaulis*
Herb (field)	*Achnatherum hymenoides*, *Hesperostipa comata*, *Koeleria macrantha*, *Poa fendleriana*, *Poa secunda*, *Pseudoroegneria spicata*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available.

Globally
Sphaeromeria capitata

CONSERVATION STATUS RANK
Global Rank & Reasons: G3? (28-Dec-1999). This association is known from two geographic areas in Montana; the low hills and outwash plains along the south slope of the Pryor Mountains and Bighorn Canyon in south-central Montana, and the Tendoy Mountains in south-west Montana. This type also is suspected to correlate with an exposed-site, *Pseudoroegneria spicata*-dominated type in western Montana, wherein *Eriogonum ovalifolium* (cushion form) is codominant. This vegetation is naturally found as small landscape patches and may be more extensive than currently known.

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
This type was described by DeVelice and Lesica (1993) as the *Agropyron spicatum* / cushion plant community type, but no clear vegetational parameters were described for the type; in their key this was a default type dropping out at the bottom of the key. To incorporate this type into a comprehensive classification a means of treating the `cushion plant' component would have to be found. It would be a first step to name the various cushion plants that could serve as alternative diagnostic species and also specify what species would not be expected due to severity of these sites.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This sparse community is controlled by aspect, rocky shale soils, and exposure to the prevailing wind. The soil creeps some to form small ledges behind vegetation, but the slope is well-armored to protect against erosion. This community is on a steeper slope than the *Artemisia arbuscula* ssp. *longiloba* shrubland just to the north, and on shallower soils than the *Artemisia tridentata* ssp. *vaseyana* - *Symphoricarpos oreophilus* shrubland on the other side of the ravine to the south. There is evidence of shrink-swell movement in the soils here, as well as sheet erosion. Most of the plants reproduce by sending out lateral shoots; it would be difficult for seedlings to become established before shrink-swell action levered them out. This is probably why herbaceous species grow better than shrubs here.
Fossil Butte National Monument Data: The description is based on 2005 field data (2 plots: FOBU.0022, FOBU.0097).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: C. Jean, mod. J. Coles and K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Cooper et al. 1999, DeVelice and Lesica 1993, Driscoll et al. 1984, MTNHP 2002b, Western Ecology Working Group n.d.

Pseudoroegneria spicata Herbaceous Vegetation
Bluebunch Wheatgrass Herbaceous Vegetation

CODE	CEGL001660
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	*PSEUDOROEGNERIA SPICATA* HERBACEOUS ALLIANCE (A.1265) Bluebunch Wheatgrass Herbaceous Alliance
ECOLOGICAL SYSTEM(S):	Western Great Plains Foothill and Piedmont Grassland (CES303.817) Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824) Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

This grassland association occurs on rock outcrops, talus, mesas, plateaus, windswept bluffs, ridgetops and mountains in northern Colorado, northeastern and northern Utah and western and southwestern Wyoming. It frequently occurs on moderately to steep, mid- to high-slope landforms, although gentle slopes are not uncommon. Sites are relatively xeric and are often found on southerly aspects at lower elevations or on harsh or on windswept areas at higher elevation sites. Substrates are typically shallow, often calcareous, rocky soils. Ground surface often has significant cover of bare ground, gravel and/or rock (10-90% cover). Stands are also reported east of the Continental Divide in Rocky Mountain National Park on a windward knoll and at Grand Teton National Park from a very steep northeast-facing high slope. The vegetation is characterized by an open herbaceous layer that is typically dominated by the cool-season, perennial bunchgrass *Pseudoroegneria spicata* with low to moderate cover (5-30%) and low-growing forbs. *Koeleria macrantha* is repeatedly present in low abundance. Other dry grasses may be present with low cover (less than half the cover of *Pseudoroegneria spicata*). A sparse dwarf-shrub layer (<10% cover) occurs with a variety of woody species of *Artemisia, Atriplex confertifolia, Cercocarpus, Eriogonum, Gutierrezia, Krascheninnikovia* or *Tetradymia* depending on elevation and substrate. There are several to many low-growing forbs (cushion plants) present with low cover, such as *Arenaria* spp., *Arenaria hookeri, Astragalus* spp., *Paronychia sessiliflora, Phlox* spp., *Stenotus acaulis, Tetraneuris acaulis,* and *Townsendia incana*. There are no clear dominants in this list, and the percent cover of each species present will vary from site to site. A diverse and abundant forb layer probably indicates a degraded occurrence.

DISTRIBUTION

Fossil Butte National Monument

This association is uncommon in the monument and is represented by sample plots located on the slope below Fossil Butte and on top of Cundick Ridge.

Globally

This association occurs in Piceance Basin and Dinosaur National Park in western Colorado and the Cache Valley of northeastern Utah. Stands are reported from Fossil Butte National Monument and Grand Teton National Park in Wyoming and Rocky Mountain National Park in Colorado.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This bluebunch wheatgrass association is uncommon within the monument and occupies the windward upper slopes and tops of ridges. Stands are on gentle to moderately steep (3- to 17-degree) slopes, occur between 2247 and 2382 m elevation, and have a generally west orientation. The unvegetated surface has high exposure of bare soil and low cover of large and small rocks. The clay soils are derived from the Wasatch Formation.

Globally

This herbaceous association occurs in northern Colorado, northeastern and northern Utah, and western and southwestern Wyoming (Hull and Hull 1974, Baker 1982b, Baker and Kennedy 1985). Stands occur on rock outcrops, talus, mesas, plateaus, windswept bluffs, ridgetops and mountains. It frequently occurs on moderate to steep, mid- to high-slope landforms, although gentle slopes are not uncommon. Elevation ranges between 1680 and 2840 m (5500-9310 ft.) in Colorado and down to 1340-1590 m (4400-5200 ft.) in Utah. Stands reported from Fossil Butte National Monument and Grand Teton National Park occur between 2234 and 2382 m (7328-7810 ft.) elevation on well-drained clay soils that are very prone to erosion. Sites are relatively xeric and are often found on southerly aspects at lower elevations or on harsh, steep or windswept areas at higher elevations. Substrates are typically shallow, often calcareous, rocky soils and include sandstone and marlstone of the Uinta and Green River formations, Madison limestone, Mancos shale, Wasatch Formation shale and Morgan/Round Valley and Lodore formations and granite. Ground surface often has significant cover of bare ground, gravel and/or rock (10-90% cover). Evidence of erosion is often present.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 16-42%. Stands are dominated by *Pseudoroegneria spicata*. Scattered shrubs are present, but most have only trace cover: *Artemisia arbuscula* ssp. *longiloba, Chrysothamnus viscidiflorus, Krascheninnikovia lanata,* and *Atriplex confertifolia* are the common species. Associated herbaceous species include *Poa fendleriana, Poa secunda, Mertensia oblongifolia, Penstemon paysoniorum, Phlox hoodii, Astragalus jejunus, Linum lewisii* and *Achillea millefolium*. *Pinus flexilis* seedlings provide sparse cover.

Globally
This association is characterized by an open vegetation layer that is typically dominated by the cool-season, perennial bunchgrass *Pseudoroegneria spicata* with low to moderate cover (7-30%) and low-growing forbs. *Koeleria macrantha* is repeatedly present in low abundance. Other grasses may include *Achnatherum hymenoides, Hesperostipa comata, Poa fendleriana,* and *Poa secunda*; if present, they have low cover (less than half the cover of *Pseudoroegneria spicata*). A sparse dwarf-shrub layer (<10% cover) may be present and includes a variety of woody species, such as *Artemisia arbuscula* ssp. *longiloba, Artemisia frigida, Artemisia nova, Artemisia tridentata, Atriplex confertifolia, Cercocarpus intricatus, Cercocarpus montanus, Chrysothamnus greenei, Chrysothamnus viscidiflorus, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Gutierrezia sarothrae, Krascheninnikovia lanata, Rosa woodsii, Ribes cereum, Symphoricarpos oreophilus,* or *Tetradymia canescens,* depending on elevation and substrate. Several-to-many low-growing forbs (often cushion plants) are present with low cover but not codominant. Species may include *Arenaria fendleri, Arenaria hookeri, Astragalus jejunus, Astragalus spatulatus, Astragalus tenellus, Chaetopappa ericoides, Draba oligosperma, Eriogonum lonchophyllum, Heterotheca villosa, Leptodactylon pungens, Lesquerella alpina, Linum lewisii, Machaeranthera grindelioides, Mertensia oblongifolia, Paronychia sessiliflora, Penstemon paysoniorum, Phlox austromontana, Phlox hoodii, Sphaeralcea coccinea, Stenotus acaulis, Tetraneuris acaulis, Townsendia incana,* and *Trifolium gymnocarpon*. There are no clear dominants in this list, and the percent cover of each species present will vary from site to site. A diverse and abundant forb layer probably indicates a degraded occurrence (R. Rondeau pers. comm. 1998). Introduced species such as *Agropyron cristatum, Bromus briziformis*, or *Bromus tectorum* are present in some stands.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Atriplex confertifolia, Chrysothamnus viscidiflorus*
Herb (field)	*Leymus cinereus, Poa fendleriana, Pseudoroegneria spicata*

Globally

Stratum	Species
Herb (field)	*Heterotheca villosa*
Herb (field)	*Pseudoroegneria spicata*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Astragalus jejunus, Penstemon paysoniorum

Globally
Agropyron cristatum, Astragalus jejunus, Bromus briziformis, Bromus tectorum, Penstemon paysoniorum

CONSERVATION STATUS RANK
Global Rank & Reasons: G2 (30-Nov-1998). This association is known only from northern Colorado and northwestern Wyoming but is expected to occur in Utah. Grazing has a negative effect on this association, and it is believed that it now occupies a very small portion of the original range. Baker (1982b) reports that *Pseudoroegneria spicata* does not tolerate grazing and will eventually convert to *Koeleria macrantha* or *Poa secunda* grassland if grazing pressures continue. Baker (1982b) also estimates that at least two-thirds of the original *Pseudoroegneria spicata* grassland community in the Piceance Basin has been replaced by *Koeleria macrantha* grasslands. The size of most occurrences is very small, five under 15 acres and two under 60 acres.

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
This association needs to be compared with *Pseudoroegneria spicata* - Cushion Plants Herbaceous Vegetation (CEGL001666) of Pryor Mountains and Bighorn Canyon in south-central Montana, the Tendoy Mountains in southwest Montana and as described in Dinosaur National Monument in northwestern Colorado. It is distinguished by its lack of significant cover by cushion plants. Both associations occur on windswept ridgelines on calcareous

substrates, have relatively sparse vegetation cover and contain cushion plants. The range of this association needs further review, especially disjunct stands, because the diagnostic grass in this association can be readily confused with awned *Elymus lanceolatus* (note if rhizomes are present, whereas *Pseudoroegneria spicata* has no rhizomes). Also *Pseudoroegneria spicata* ssp. *inermis* (awnless) is often confused with *Pascopyrum smithii* (note asymmetrical glume) or other wheatgrasses.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: The clay soils lead to rapid runoff. *Atriplex confertifolia* has experienced massive die-off with less than 20% of shrubs still alive. Ground is very dry and the high clay content prevents water from infiltrating the soil. The soil does not show signs of erosion.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0057; 1 observation point: FOBU.9025).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: D. Zoellner, mod. K.A. Schulz and J. Coles

REFERENCES: Baker 1982b, Baker and Kennedy 1985, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Hull and Hull 1974, Jones and Ogle 2000, Rondeau pers. comm.

Hordeum brachyantherum Herbaceous Vegetation
Meadow Barley Herbaceous Vegetation

CODE	CEGL003430
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 BRACHYANTHERUM* TEMPORARILY FLOODED HERBACEOUS
ALLIANCE (A.2585)	Meadow Barley Temporarily Flooded Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Wash (CES304.781)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This association is found at 348-2684 m (1140-8800 ft.) elevation in widely scattered mountain, basin, foothill, and valley locations ranging from the Central Coast Ranges of California, Central Valley, northwestern California, to the northern half of the Great Basin in Nevada through the southern one-third of Idaho and into southwestern Wyoming. The association is found along both intermittent and perennial streams but most commonly occurs in ephemerally moist to semipermanently saturated, often spring-fed, meadows and swales. It occurs in low- to moderate-gradient valley bottoms that range from very narrow to very wide with clayey, silty, or fine loamy soil. It is a small-patch community, generally occupying 0.1 to 1 acres. *Hordeum brachyantherum* typically forms a continuous layer with cover ranging from 25% to nearly 100%. Cover of graminoid associates varies and may include *Carex athrostachya, Carex microptera, Danthonia californica, Deschampsia caespitosa, Eleocharis palustris, Elymus trachycaulus, Poa secunda*, which is occasionally codominant, and/or *Poa pratensis*. Forb cover is sparse and is characterized by *Camassia quamash, Epilobium* spp., *Mimulus guttatus, Iris missouriensis, Rumex crispus, Symphyotrichum* spp., and various vernal annuals. At Pinnacles National Monument, stands can have many introduced herbaceous species (sometimes more that 30% relative cover) and typically occur in seasonal wetland meadows and adjacent to streams, with clay or silt loam soils that include serpentine or other poor-nutrient soils.

DISTRIBUTION
Fossil Butte National Monument
This association is uncommon in the monument and represented by one observation point located on a restoration site near Chicken Creek and the visitor center.

Globally
This association occurs in widely scattered mountain and basin locations ranging from the northern half of the Great Basin in Nevada through the southern one-third of Idaho and extending into southwestern Wyoming. It is also reported from west-central California. *Hordeum brachyantherum* occurs across western North America so this association is likely more widespread.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This meadow barley association is uncommon within the monument and occupies a restored and re-vegetated channel of Chicken Creek near the visitor center that seasonally floods. The site is gentle (1-degree slope), occurs at 2045 m elevation, and is oriented to the southeast. The unvegetated surface has moderate exposure of bare soil and moderate cover of litter. The parent materials are sandstones and shale that has eroded and deposited as secondary stream alluvium.

Globally
This association is found at 348-2684 m (1140-8800 ft.) elevation in widely scattered mountain, basin, foothill, and valley locations ranging from the Central Coast Ranges of California, Central Valley, northwestern California, to the northern half of the Great Basin in Nevada through the southern one-third of Idaho and into southwestern Wyoming. The association is found along both intermittent and perennial streams, but most commonly it occurs in ephemerally moist to semipermanently saturated, often spring-fed, meadows and swales. It occurs in low- to moderate-gradient valley bottoms that range from very narrow to very wide with clayey, silty, or fine loamy soil. It is a small-patch community, generally occupying 0.1 to 1 acres. Parent materials are sandstones and shale that have eroded and deposited as secondary stream alluvium.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 42% in this moderately vegetated stand. This association is characterized by moderate cover of the perennial grass *Hordeum brachyantherum* (25%). The short shrub *Artemisia cana* provides sparse cover. Other grasses include *Poa secunda* and *Deschampsia caespitosa* that provide sparse to low cover. Forb diversity is low and provides sparse cover, including *Argentina anserina, Pyrrocoma lanceolata*, and *Taraxacum officinale*.

Globally
This association is characterized by moderate to dense cover of the perennial grass *Hordeum brachyantherum,* which typically forms a continuous layer with cover ranging from 25% to nearly 100%. Cover of graminoid associates varies and may include *Carex athrostachya, Carex microptera, Danthonia californica, Deschampsia caespitosa, Eleocharis palustris, Elymus trachycaulus,* and *Poa secunda (= Poa nevadensis),* which generally provide sparse to low cover but may occasionally codominate. Forb diversity is low and provides sparse cover, including *Argentina anserina, Camassia quamash, Epilobium* spp., *Iris missouriensis, Mimulus guttatus, Pyrrocoma lanceolata, Symphyotrichum* spp., and various vernal annuals. Introduced species such as *Poa pratensis, Rumex crispus,* and *Taraxacum officinale* are common in some stands. In California, characteristic species include a mixture of graminoids *Bromus diandrus, Bromus hordeaceus, Juncus balticus, Leymus triticoides,* and *Lolium perenne* ssp. *multiflorum,* and forbs such as *Heliotropium curassavicum, Hirschfeldia incana, Lactuca serriola, Medicago polymorpha,* and *Rumex crispus*. At Pinnacles National Monument, stands can have many introduced herbaceous species (sometimes more that 30% relative cover) and typically occur in seasonal wetland meadows and adjacent to streams, with clay or silt loam soils that include serpentine or other poor-nutrient soils.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Herb (field)	*Argentina anserina*
Herb (field)	*Deschampsia caespitosa, Hordeum brachyantherum*

Globally

Stratum	Species
Herb (field)	*Hordeum brachyantherum*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Poa pratensis, Rumex crispus, Taraxacum officinale

Globally
Bromus diandrus, Centaurea solstitialis, Hirschfeldia incana, Lactuca serriola, Lolium perenne ssp. *multiflorum, Medicago polymorpha, Poa pratensis, Rumex crispus, Taraxacum officinale*

CONSERVATION STATUS RANK
Global Rank & Reasons: G2 (25-Sep-2007). *Hordeum brachyantherum* is a wide-ranging, but infrequently observed, association found at 348 to 2684 m (1141-8800 ft.) elevation in mountain and basin locations scattered from California's Central Coast Ranges, Central Valley, northwestern California, the northern half of Nevada, on through the southern one-third of Idaho. There are only about 16 occurrences currently known, although more are expected to be found throughout the association's range. The association occurs in a variety of ephemerally moist to semipermanently saturated sites along both intermittent and perennial streams, but most often in spring-fed meadows and swales. Ephemerally moist wetlands at low to mid elevations in the Intermountain West are naturally patchy and uncommon in this semi-arid area. Many of these sites have been cultivated or seeded with hay grasses and are now unsuitable to support this association. In addition, many springs (such as those feeding *Hordeum brachyantherum* sites) have been, and continue to be, diverted for cattle water storage. Other sites have been heavily grazed by livestock leading to invasion by *Poa pratensis* or other exotic species. Overall, *Hordeum brachyantherum* is an early-seral species resilient to moderate grazing disturbance. Based on the natural and human-caused rarity of potential habitat for this association, current threats, and low number of occurrences, this association is best ranked as G2 rather than G3. Further inventory may find higher quality stands of this association.

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
This association has been quantitatively defined with 9 plots by Manning and Padgett (1995) from eastern and northern Nevada, supplemented with two plots and two stand observations from central and southern Idaho (Jankovsky-Jones et al. 2001, IDCDC 2002). The *Poa secunda* (formerly *Poa nevadensis*) plant association is closely related to this plant association and *Poa secunda* and *Hordeum brachyantherum* can sometimes codominate in some in stands. According to Manning and Padgett (1995), if a stand in which both species occur is clearly dominated by *Poa secunda*, the stand is placed in the *Poa secunda* plant association. If the species have nearly equivalent cover, the stand is placed in the *Hordeum brachyantherum* plant association. Generally, the site conditions must be fairly moist for the *Hordeum brachyantherum* plant association, and much drier for the *Poa secunda* plant association.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This site has been re-vegetated with the mesh still present on the ground.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 observation point: FOBU.9036).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: C. Murphy, mod. G. Kittel and K.A. Schulz

REFERENCES: Evens and San 2004, Hansen and Hall 2002, IDCDC 2005, IDCDC unpubl. data 2002, Jankovsky-Jones et al. 2001, Manning and Padgett 1995, Smith 1998b, Western Ecology Working Group n.d.

Carex nebrascensis Herbaceous Vegetation
Nebraska Sedge Herbaceous Vegetation

Nebraska Sedge Wet Meadow

CODE	CEGL001813
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 (A.1417)	*CAREX NEBRASCENSIS* SEASONALLY FLOODED HERBACEOUS ALLIANCE Nebraska Sedge Seasonally Flooded Herbaceous Alliance
ECOLOGICAL SYSTEM(S):	Boreal Wet Meadow (CES103.873) North American Arid West Emergent Marsh (CES300.729) Inter-Mountain Basins Interdunal Swale Wetland (CES304.059) Northwestern Great Plains Floodplain (CES303.676) Western Great Plains Open Freshwater Depression Wetland (CES303.675) Rocky Mountain Alpine-Montane Wet Meadow (CES306.812) Western Great Plains Floodplain (CES303.678) Western Great Plains Wooded Draw and Ravine (CES303.680) Temperate Pacific Subalpine-Montane Wet Meadow (CES200.998)
USFWS WETLAND SYSTEM:	Palustrine

CONCEPT SUMMARY

Globally

This minor wetlands community occurs on the western Great Plains and throughout much of the western U.S. Elevation ranges from 1000-2800 m (3300-9200 ft.). Stands form open meadows that occur along the margins of streambanks, flat floodplains, and lakes often forming a band along the alluvial terrace, or on marshy areas surrounding springs and below seeps on lower hillslopes. This association is often found on well-developed soil, but occurs on a wide variety of soil types that tend to be fine-textured alluvium, or clay to organic and are typically gleyed and mottled near the surface because of the high water table most of the growing season. The vegetation is characterized by a moderately dense to dense perennial graminoid layer dominated or codominated by *Carex nebrascensis*. Other graminoid species may be present such as *Carex praegracilis, Calamagrostis stricta, Deschampsia caespitosa, Eleocharis palustris, Glyceria striata, Juncus balticus, Schoenoplectus pungens*, or *Triglochin maritima*. Forb cover is generally low, but can be high in moist locations. Scattered short shrubs may be present in some stands.

DISTRIBUTION

Fossil Butte National Monument

This uncommon association is located within the Smallpox Creek drainage.

Globally

This sedge meadow type is widely distributed from the western Great Plains into the western mountains of the United States, ranging from South Dakota and Montana to possibly as far west as Washington, south to California and east to New Mexico.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This Nebraska sedge wetland association is uncommon within the monument and occupies drainages with saturated soils and surface water. The sites are gentle (2- to 3-degree slopes), occur between 2019 and 2037 m elevation, and are oriented to the south or east. The unvegetated surface has high cover of litter, low exposure of bare soil, and low cover of small rocks and downed wood. The parent materials are sandstones and shale that erode and deposit as secondary stream alluvium of the Holocene Epoch. The soils are very poorly drained organic muck.

Globally

This wetland plant association occurs on the western Great Plains and throughout much of the western U.S. Elevation ranges from 1000-2800 m (3300-9200 ft.). Stands form open meadows that occur along the margins of streambanks, flat floodplains, and lakes often forming a band along the alluvial terrace. Stands have also been sampled from marshy areas surrounding springs and below seeps on lower hillslopes. This association is often found on well-developed soil, but occurs on a wide variety of soil types ranging from saturated organics to Mollisols to

Entisols. Soils tend to be fine-textured alluvium, ranging from sandy, silty loam, clay loam, or clay to organic and are typically gleyed and mottled near the surface because of the high water table most of the growing season.

VEGETATION DESCRIPTION

Fossil Butte National Monument

The total vegetation cover ranges from 67-77% in these densely vegetated stands. The association is characterized by the rhizomatous graminoid *Carex nebrascensis* that contributes between 55 and 58% cover. Scattered short shrubs of *Ericameria nauseosa* and *Artemisia cana* provide sparse cover. The remaining herbaceous layer is low in terms of diversity and contributes sparse to low cover. *Juncus balticus*, another rhizomatous graminoid, provides low cover. Forbs provide sparse cover and include *Argentina anserina, Potentilla pensylvanica*, and *Plantago tweedyi*.

Globally

These wetlands are characterized by a moderately dense to dense perennial graminoid layer dominated or codominated by *Carex nebrascensis* (25-99% cover), that generally forms small- to medium-sized meadows. Stands often are nearly pure *Carex nebrascensis*, but a variety of other graminoid species may be present such as *Carex praegracilis, Calamagrostis stricta, Calamagrostis canadensis, Deschampsia caespitosa, Eleocharis palustris, Glyceria striata, Juncus balticus, Schoenoplectus pungens*, or *Triglochin maritima*. Forb cover is generally low, but can be high in moist locations. Common forbs include *Eurybia integrifolia, Geum macrophyllum, Mentha arvensis, Mimulus glabratus, Heracleum maximum*, and *Ranunculus cymbalaria*. Introduced species *Poa pratensis*, *Poa palustris, Cirsium arvense*, and *Melilotus officinalis* may also be common. Scattered shrubs *Artemisia cana, Betula occidentalis, Ericameria nauseosa, Dasiphora fruticosa* ssp. *floribunda*, sapling *Populus tremuloides, Salix monticola*, and *Salix brachycarpa* may be occasionally present in some stands. In Nebraska, common species include *Agrostis stolonifera, Carex hystericina, Carex pellita, Eleocharis erythropoda, Equisetum* spp., *Juncus balticus, Schoenoplectus pungens*, and *Triglochin* spp. (Steinauer and Rolfsmeier 2000).

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Herb (field)	*Argentina anserina*
Herb (field)	*Carex nebrascensis, Juncus balticus*

Globally

Stratum	Species
Herb (field)	*Carex nebrascensis*

OTHER NOTEWORTHY SPECIES

Fossil Butte National Monument

Data are not available.

Globally

Cirsium arvense, Melilotus officinalis, Poa palustris, Poa pratensis

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (1-Feb-1996). This type is widely distributed, but many examples have been heavily grazed by cattle, lowering their floristic quality.

CLASSIFICATION COMMENTS

Fossil Butte National Monument

Data are not available.

Globally

In the Black Hills, classification of stands was problematic due to identification problems with *Carex nebrascensis* and *Carex aquatilis*. The two are difficult to distinguish based on available keys and written descriptions (Marriott and Faber-Langendoen 2000).

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Fossil Butte National Monument Inventory Notes: This wetland community is controlled by saturated soils that quake when walked upon. This nearly pure stand occupies the drainage bottom, with slightly drier areas supporting *Juncus balticus* in narrow bands on either side.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0007; 1 observation point: FOBU.9003).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Drake, mod. D. Faber-Langendoen and K.A. Schulz

REFERENCES: Baker 1982b, Beguin and Major 1975, Bourgeron and Engelking 1994, Butler et al. 2002, CONHP unpubl. data 2003, Carsey et al. 2003a, Christy 2004, Christy and Cornelius 1980, Cogan et al. 2004, Cooper and Cottrell 1990, Crowe and Clausnitzer 1997, Crowe et al. 2004, Driscoll et al. 1984, Durkin et al. 1994b, Durkin et al. 1995a, Evans 1989b, Griffiths 1902, Hall 1973, Hall and Hansen 1997, Hansen et al. 1988b, Hansen et al. 1991, Hansen et al. 1995, IDCDC 2005, Jankovsky-Jones et al. 1999, Jankovsky-Jones et al. 2001, Johnston 1987, Jones 1992b, Jones and Walford 1995, Kagan et al. 2000, Kierstead and Pogson 1976, Kittel et al. 1994, Kittel et al. 1996, Kittel et al. 1999a, Kittel et al. 1999b, Kovalchik 1987, MTNHP 2002b, Manning and Padgett 1991, Manning and Padgett 1995, Marriott and Faber-Langendoen 2000, Mutz and Queiroz 1983, Padgett et al. 1988b, Padgett et al. 1989, Ratliff 1982, Reid and Pickford 1946, Steinauer and Rolfsmeier 2000, Youngblood et al. 1985a, Youngblood et al. 1985b

Eleocharis palustris Herbaceous Vegetation
Common Spikerush Herbaceous Vegetation

Common Spikerush Wet Meadow

CODE	CEGL001833
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	*ELEOCHARIS (PALUSTRIS, MACROSTACHYA)* SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1422)
	(Common Spikerush, Page Spikerush) Seasonally Flooded Herbaceous Alliance
ECOLOGICAL SYSTEM(S):	Boreal Wet Meadow (CES103.873) Inter-Mountain Basins Greasewood Flat (CES304.780) Northwestern Great Plains Mixedgrass Prairie (CES303.674) Western Great Plains Open Freshwater Depression Wetland (CES303.675) Rocky Mountain Alpine-Montane Wet Meadow (CES306.812) Western Great Plains Closed Depression Wetland (CES303.666) Temperate Pacific Subalpine-Montane Wet Meadow (CES200.998) Willamette Valley Wet Prairie (CES204.874) Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821) North American Arid West Emergent Marsh (CES300.729)
USFWS WETLAND SYSTEM:	Palustrine

CONCEPT SUMMARY
Globally
This spikerush wet meadow community is found in the central Great Plains of the United States and Canada and in the western United States. Elevations range from near sea level to 3050 m (0-10,000 ft.). Stands occur in small depressions in intermittent streambeds or depression ponds that flood early in the season and may dry out by summer. Soils are generally fine-textured. Stands are composed of submersed and emergent rooted vegetation under 1 m tall that is dominated by *Eleocharis palustris*, often in nearly pure stands. Vegetative cover can be sparse to dense (10-90%), but *Eleocharis palustris* is the dominant species, and the only species with 100% constancy. Other species, when present, can contribute as much as 40% cover, but never exceed that of the *Eleocharis palustris* cover.

DISTRIBUTION

Fossil Butte National Monument

This uncommon association is represented by a stock pond outside the western boundary of the monument and a beaver pond within the Twin Creek drainage.

Globally

This spikerush wet meadow community is found in the central Great Plains of the United States and Canada and throughout the western United States including the desert Southwest.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This common spikerush wetland association is uncommon within the monument, occupying two shallow ponds: a stock pond and a beaver pond that are semipermanently flooded. The sites are flat with no discernible aspect and occur at 2053 and 2225 m elevation. The unvegetated surface has low exposure of bare soil, low cover of litter and downed wood, and high cover of water. The parent material is the main body of the Wasatch Formation; it is obscured by soil at the beaver pond.

Globally

This wetland occurs across the central and northwestern Great Plains and western United States. Elevations range from near sea level to 3050 m (0-10,000 ft.). In the western mountains, it occurs in valleys and canyon bottoms on the banks and in the overflow channels of low-gradient streams, as well as along the margins of ponds and lakes. On the Great Plains, this community occurs in small depressions in intermittent streambeds, depression ponds that flood early in the season and dry out by summer, and small prairie potholes. It can also occur in the bottom of ephemeral ponds or playas on floodplain terraces of large rivers, and around semipermanently flooded beaver ponds and stock tanks. In wet years, stands may remain ponded throughout the growing season. Soils range from organic to silty clay to fine loam formed from weathered siltstone and shale or eolian loess. Soils are reported as slightly alkaline.

VEGETATION DESCRIPTION

Fossil Butte National Monument

The total vegetation cover ranges from 18-37% in these moderately vegetated stands. The association is characterized by *Eleocharis palustris* that contributes between 15 and 35% cover. The remaining herbaceous layer includes the graminoids *Carex utriculata* and *Muhlenbergia richardsonis* that provide sparse cover.

Globally

This wetland association is dominated by submersed and emergent rooted vegetation under 1 m tall. The species composition can be quite variable, but this community is easy to recognize by the bright green, nearly pure stands of *Eleocharis palustris*. Vegetation cover can be sparse to dense (10-90%), but *Eleocharis palustris* is the dominant species, and the only species with 100% constancy. Other species, when present, can contribute as much as 40% cover, but never exceed that of the *Eleocharis palustris* cover. Some of this variation is described from Colorado (Baker and Kennedy 1985, Kittel et al. 1999b). Co-occurring species in low-elevation stands on the western slope can include *Phalaris arundinacea, Juncus balticus, Hordeum jubatum, Equisetum* spp., *Pascopyrum smithii, Schoenoplectus americanus, Sparganium angustifolium*, species of *Lemna* and *Potamogeton*, as well as the introduced *Melilotus officinalis* and *Bromus inermis*. On the eastern plains of Colorado co-occurring species can include *Leersia oryzoides, Schoenoplectus pungens, Panicum virgatum, Carex pellita*, and *Spartina pectinata*. At montane elevations, other graminoids, such as *Carex aquatilis, Carex utriculata*, and *Deschampsia caespitosa*, are present. Forb cover is typically low but can be occasionally abundant (30%) in some stands. Forb species include *Pedicularis groenlandica, Rhodiola integrifolia*, and *Caltha leptosepala*.

In stands from eastern Washington, associates include *Carex utriculata, Cicuta douglasii*, and species of *Glyceria* and *Potamogeton*. In northwestern Nebraska, stands are dominated by *Eleocharis acicularis* and *Eleocharis palustris* which commonly cover the bottoms of the pools and emerge above the water as the pools dry out. Ephemeral submersed aquatics, such as *Callitriche palustris, Potamogeton diversifolius*, and *Marsilea vestita*, may be present. As the pools dry out in mid-summer, ephemeral annual forbs, such as *Limosella aquatica* and *Plagiobothrys scouleri*, may appear. By late summer *Amaranthus californicus* and *Gnaphalium palustre* may dominate in the lowest parts of the depression (Steinauer and Rolfsmeier 2000). In southwestern South Dakota, vegetation is composed of nearly homogeneous stands of *Eleocharis palustris*. Other emergents, such as *Polygonum amphibium, Marsilea vestita*, and *Eleocharis ovata*, are occasionally found. Herbaceous cover is greater than 75%

except in areas of deeper open water where floating and submerged aquatic plants occur, including *Bacopa rotundifolia* and *Heteranthera limosa* (H. Marriott pers. comm. 1999). In lower elevation Utah stands, *Glaux maritima, Distichlis spicata*, and *Juncus balticus* are important associates (Brotherson and Barnes 1984).

Few stand data are available for Colorado examples. Generally, it appears that this community is dominated by *Eleocharis palustris*, forming a scattered to dense overstory, often with few associated species. Commonly associated graminoids include *Hordeum jubatum* and *Pascopyrum smithii*. Forbs present may include *Atriplex argentea, Polygonum aviculare*, and *Rorippa sinuata* (Baker and Kennedy 1985). The higher elevation stands may include a slightly different suite of species, but no stand data are available. Ramaley (1942) described a *Distichlis spicata*-dominated salt meadow on a lakeshore in the San Luis Valley which was ringed by *Eleocharis palustris*. Communities in Utah include *Eleocharis acicularis* and *Alopecurus aequalis* as likely associates (Padgett et al. 1989).

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Herb (field)	*Eleocharis palustris*

Globally

Stratum	Species
Herb (field)	*Eleocharis palustris*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available.

Globally
Bromus inermis, Dactylis glomerata, Lactuca serriola, Medicago sativa, Melilotus officinalis, Polygonum aviculare, Sonchus asper, Taraxacum officinale, Trifolium pratense, Trifolium repens

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

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This tiny beaver pond is currently holding less than 1 foot of water, but is likely to stay wet throughout much of the growing season. Because the water still has some depth, the *Eleocharis palustris* is pretty sparse in the middle of the pond. The edge of the stock pond has a high degree of cattle access and is barren due to trampling.
Fossil Butte National Monument Data: The description is based on 2005 field data (2 observation points: FOBU.9008, FOBU.9055).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: D. Faber-Langendoen, mod. K. Schulz, M.S. Reid, G. Kittel, J. Coles

REFERENCES: Baker 1983c, Baker and Kennedy 1985, Billings 1945, Boggs 2000, Bork 1978, Boss 1983, Bourgeron and Engelking 1994, Brotherson and Barnes 1984, Bunin 1985, CONHP unpubl. data 2003, Carsey et al. 2003a, Christy 2004, Cooper 1993, Cooper and Severn 1992, Crow 1968, Crow 1977, Crowe and Clausnitzer 1997, Crowe et al. 2004, Driscoll et al. 1984, Durkin et al. 1995a, Easterday and Mamone 1980, Ellis et al. 1979, Evans 1989b, Evenden 1990, Flowers 1962, Hall and Hansen 1997, Hansen et al. 1988a, Hansen et al. 1988b, Hansen et al. 1991, Hansen et al. 1995, Harris 1954, Henderson and McAllister 1983, Heusser 1960, IDCDC 2005, Jankovsky-Jones et al. 1999, Jankovsky-Jones et al. 2001, Johnston 1987, Kagan et al. 2000, Kettler and McMullen

1996, Kierstead and Pogson 1976, Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1997a, Kittel et al. 1999a, Kittel et al. 1999b, Kovalchik 1987, Kovalchik 1993, Kovalchik 2001, Kunze 1994, MTNHP 2002b, Manning and Padgett 1991, Manning and Padgett 1995, Marriott 1985, Marriott pers. comm., Moseley 1998, Murray 2000, Mutel 1973, Mutel and Marr 1973, Padgett 1981, Padgett et al. 1988b, Padgett et al. 1989, Penfound 1953, Ramaley 1919a, Ramaley 1942, Seyer 1981, Shephard 1995, Stearns-Roger, Inc. 1978, Steinauer and Rolfsmeier 2000, Stewart 1940, Titus and Christy 1996a, Titus and Christy 1999, Von Loh 2000, WNHP unpubl. data, Youngblood et al. 1985a

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)
Northern Columbia Plateau Basalt Pothole Ponds (CES304.058)
Western Great Plains Open Freshwater Depression Wetland (CES303.675)
Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)
Temperate Pacific Subalpine-Montane Wet Meadow (CES200.998)
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This Baltic rush community is found widely throughout the western United States and into western Canada. This wet meadow vegetation occurs as small to extensive, open to typically dense patches on flat stream benches, along overflow channels, and near springs. Habitats are often alkaline meadows and may have long-term grazing disturbance. Soils are variable and range from poorly to well-drained, sandy clay loam to fine sand-textured and are usually mottled or gleyed. Stands are characterized by a dense sward of *Juncus balticus*. In montane zones and the Great Basin, minor cover of *Carex* species, including *Carex aquatilis, Carex praegracilis, Carex nebrascensis,* or *Carex utriculata,* is often present; other common species include *Deschampsia caespitosa, Distichlis spicata, Glyceria striata, Hordeum jubatum, Muhlenbergia asperifolia, Pascopyrum smithii, Phleum alpinum,* and *Sporobolus airoides*. The introduced perennial sod grasses *Poa pratensis* or *Agrostis stolonifera* codominate some stands. Forb cover is generally low and includes wetland species such as *Caltha leptosepala, Rumex aquaticus,* and *Dodecatheon pulchellum*. *Iris missouriensis* can be common in heavily grazed stands. Shrubs are not common. This association is often considered to be a grazing-induced community since it increases with disturbance, though it can be a stable late-seral community.

DISTRIBUTION

Fossil Butte National Monument

This herbaceous association occupies drainages, streambeds, and seeps and springs. The drainages are intermittently flooded within the monument, especially the larger Smallpox and Chicken creeks and their tributaries.

Globally

This Baltic rush wet meadow community is found widely throughout the western United States, ranging from South Dakota and Nebraska west to Washington, south to California, and east to New Mexico. It also occurs in western Canada.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This Baltic rush herbaceous association is scattered on mesic sites throughout the monument, occurring primarily as patches and small, linear stands in drainages and streambeds. This wetland association occupies drainages, floodplains, channels, swales, and intermittent streams that either flood seasonally or are permanently saturated/inundated. The sites are gentle (1- to 5-degree slope) with one site established on a seep or spring and having a moderate slope (12 degrees), occur between 2019 and 2230 m elevation, and are oriented to all aspects. The unvegetated surface has low to moderate exposure of bare soil, low to high cover of litter, low cover of small rocks, and some sites have low cover of standing water. Parent materials include the main body of the Wasatch Formation or sandstones and shale that have eroded and deposited as secondary stream alluvium or new alluvium. Soils are moderately well-drained to poorly drained clay loam, peat, or muck.

Globally

This broadly defined and widespread herbaceous wetland community is found throughout western North America. Elevation ranges from 138 to 3500 m (454-11,475 ft.). Far northern stands in the Boreal Plains are at about 800 m (2625 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 from deeply entrenched to very sinuous (Kittel et al. 1999b). In the boreal regions, this community occurs more commonly on gradual sandy shorelines. Soils are also variable and range from sandy and well-drained to poorly drained silty clay loam or silty clay alluvium to organic muck; however, soils tend to be finer-textured, alkaline and may be saline (Brotherson and Barnes 1984, Padgett et al. 1989, Kittel et al. 1999b). Sites with sandy soils are usually saturated for part of the growing season or have high water tables. Cobbles and gravel are common on many sites, and gleyed and mottled horizons are often present because of flooding or high water tables (Kittel et al. 1999b).

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from 43-96% in these moderately to densely vegetated stands. This association is characterized by moderate to high cover of the graminoid *Juncus balticus* that ranges in cover from 15-80%. Short shrubs are often observed along the edges of the drainages and streambeds supporting this association and include *Artemisia cana* and *Sarcobatus vermiculatus*. The diversity of herbaceous species is low in individual stands but varies widely among stands. Associated graminoids include *Poa pratensis, Carex praegracilis, Hordeum brachyantherum, Deschampsia caespitosa, Koeleria macrantha, Carex nebrascensis, Poa arida*, and *Carex athrostachya* that provide sparse to low cover. Forbs include *Taraxacum officinale, Potentilla gracilis, Argentina anserina, Achillea millefolium, Galium boreale, Agoseris glauca*, and *Ceratocephala testiculata*.

Globally

This broadly defined association is characterized by a low (<50 cm), open to typically dense graminoid layer dominated by the rhizomatous perennial *Juncus balticus*. In montane zones and the Great Basin, minor cover of *Carex* species, including *Carex aquatilis, Carex praegracilis, Carex microptera, Carex nebrascensis*, or *Carex utriculata*, is often present. Other common graminoids include *Deschampsia caespitosa, Distichlis spicata, Glyceria striata, Hordeum brachyantherum, Hordeum jubatum, Muhlenbergia andina, Muhlenbergia asperifolia, Pascopyrum smithii, Poa nemoralis* ssp. *interior, Phleum alpinum*, and *Sporobolus airoides*. Forb cover is generally low but may include *Achillea millefolium, Artemisia ludoviciana, Caltha leptosepala, Cirsium scariosum, Dodecatheon pulchellum, Glaux maritima, Iris missouriensis, Maianthemum stellatum, Rumex aquaticus, Polygonum bistortoides, Potentilla plattensis*, and *Solidago canadensis*. Shrubs and dwarf-shrubs are not common; however, *Artemisia frigida* cover may be significant in some stands, and occasional *Artemisia cana, Artemisia tridentata* ssp. *tridentata, Dasiphora fruticosa* ssp. *floribunda, Ericameria nauseosa, Populus* spp., *Rosa woodsii, Salix* spp., or *Sarcobatus vermiculatus* shrubs may occur. Some stands may be codominated by the introduced perennial sod grasses *Poa pratensis, Bromus inermis*, or *Agrostis stolonifera*. Other introduced species, such as *Cirsium arvense, Cirsium vulgare, Erodium cicutarium, Iva axillaris, Lactuca serriola, Phleum pratense, Taraxacum officinale, Thinopyrum intermedium, Trifolium* spp., *Tragopogon dubius*, and *Xanthium strumarium*, may occur in disturbed stands.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Herb (field)	*Juncus balticus*

Globally

Stratum	Species
Herb (field)	*Juncus balticus*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Ceratocephala testiculata, Poa pratensis, Taraxacum officinale

Globally
Agrostis stolonifera, Bromus inermis, Cirsium arvense, Cirsium vulgare, Erodium cicutarium, Iva axillaris, Lactuca serriola, Phleum pratense, Poa pratensis, Taraxacum officinale, Thinopyrum intermedium, Tragopogon dubius, Xanthium strumarium

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

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
This association is often considered to be a grazing-induced community since it increases with grazing disturbance. Based on the extensive geographic and environmental range (from alpine meadows to sagebrush-dominated landscapes), it verges on astonishing that any number of *Juncus balticus* associations have not been recognized.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: *Juncus balticus* occurs about one foot higher in elevation than the main channel. This area appears to be the headwaters of Chicken Creek. The plot has some standing water but may dry as the summer progresses.
Fossil Butte National Monument Data: The description is based on 2005 field data (6 plots: FOBU.0037, FOBU.0070, FOBU.0080, FOBU.0082, FOBU.0089, FOBU.0127; 5 observation points: FOBU.9002, FOBU.9032, FOBU.9039, FOBU.9041, FOBU.9053).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: J. Drake, mod. D. Faber-Langendoen, K.A. Schulz, L. Allen, G. Kittel

REFERENCES: ANHIC 2005, 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, Christy 2004, Cogan et al. 2004, Cowardin et al. 1979, Crowe and Clausnitzer 1997, Crowe et al. 2004, Donnelly et al. 2006, Driscoll et al. 1984, Evans 1989b, Evenden 1990, Faber-Langendoen 2001, Flowers 1962, Hall and Hansen 1997, Hansen et al. 1995, Henderson and McAllister 1983, Hess 1981, IDCDC 2005, Jankovsky-Jones et al. 1999, Jankovsky-Jones et al. 2001, Johnston 1987, Jones 1992b, Jones and Walford 1995, Kagan et al. 2000, Kartesz 1994a, Kierstead and Pogson 1976, Kittel and Lederer 1993, Kittel et al. 1997a, Kittel et al. 1999a, Kittel et al. 1999b, Klein et al. 2007, Komarkova 1986, Kovalchik 1987, Kunze 1994, MTNHP 2002b, Manning 1988, Manning and Padgett 1991, Manning and Padgett 1992, Muldavin et al. 2000a, Murray 2000, Mutel 1973, Mutz and Graham 1982, Olson and Gerhart 1982, Padgett 1981, Padgett 1982, Padgett et al. 1989, Rector 1979, Richard et al. 1996, Shupe et al. 1986, Stewart 1940, Taylor 1980, Taylor and Teare 1979a, Thompson and Hansen 2002, Titus and Christy 1996a, Tuhy and Jensen 1982, Volland 1976, WNHP unpubl. data, Wasser and Hess 1982, Western Ecology Working Group n.d., Youngblood et al. 1985a

Artemisia arbuscula ssp. *longiloba / Poa secunda* Shrub Herbaceous Vegetation
Alkali Sagebrush / Curly Bluegrass Shrub Herbaceous Vegetation

CODE	CEGL001523
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.)

ARTEMISIA ARBUSCULA SSP. *LONGILOBA* SHRUB HERBACEOUS ALLIANCE (A.2552)
ALLIANCE Alkali Sagebrush Shrub Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Great Basin Xeric Mixed Sagebrush Shrubland (CES304.774)
Columbia Plateau Low Sagebrush Steppe (CES304.080)
Wyoming Basins Dwarf Sagebrush Shrubland and Steppe (CES304.794)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This short shrub-steppe association is found between 1450 and 2600 m (4750-8530 ft.) elevation in northern Nevada, southwestern Idaho, southwestern Wyoming and north-central Colorado. It is located on gentle to moderate slopes or rolling uplands, ridges, alluvial fans, and basin bottoms on most aspects. Soils tend to be a heavy clay loam. *Artemisia arbuscula* ssp. *longiloba* dominates the shrub overstory. Traces to low cover of *Purshia tridentata, Chrysothamnus viscidiflorus,* and *Ericameria nauseosa* may also be present. *Elymus elymoides* and *Festuca idahoensis* are consistently present along with *Poa secunda*. Common forbs include *Allium acuminatum, Eriogonum caespitosum,* and *Phlox hoodii*.

DISTRIBUTION

Fossil Butte National Monument

This association is scattered throughout the southern half of the monument.

Globally

This low-shrub association is found on the Owyhee Plateau in southwestern Idaho, north-central Colorado (Middle Park), and northeastern Nevada (Elko County). It is also believed to be present to fairly common in the southwestern quarter of Wyoming.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This alkali sagebrush / curly bluegrass shrub herbaceous vegetation occupies alkaline soils of slopes, valley floors, buttes, and ridges of the southern half of the monument. The sites are gentle to steep (1- to 25-degree slopes), occur between 2048 and 2375 m elevation, and are oriented to all aspects. The unvegetated surface has high exposure of bare soil, low to moderate cover of small rocks, and low cover of litter. Parent materials include the Angelo Member of the Wasatch Formation and the main body of the Wasatch Formation. Soils are moderately well-drained to rapidly-drained loamy sand, clay loam, or clay.

Globally

This short shrub-steppe association is found between 1450 and 2600 m (4750-8530 ft.) elevation in northern Nevada, southwestern Idaho, southwestern Wyoming and north-central Colorado. Stands occur on gentle to moderate slopes or rolling uplands, ridges, alluvial fans, and basin bottoms on most aspects. The unvegetated surface has moderate to high exposure of bare soil, low to moderate cover of small rocks, and low to moderate cover of litter. Soils tend to be heavy clay loams and clays derived from alluvium and the Troublesome Formation (Colorado) or Wasatch Formation (Wyoming) but also include well-drained to rapidly drained loamy sand.

VEGETATION DESCRIPTION

Fossil Butte National Monument

This association is scattered throughout the southern portion of the monument on alkaline soils. Total vegetation cover ranges from 20-64% in these moderately to densely vegetated stands. This association is characterized by sparse to moderate cover of the short shrub *Artemisia arbuscula* ssp. *longiloba* that ranges in cover from 4-40% and sparse to low cover of the perennial bunchgrass *Poa secunda* that ranges in cover from 1-12%. The remaining shrub layer includes the short and dwarf-shrubs *Atriplex gardneri, Chrysothamnus viscidiflorus, Eriogonum microthecum, Tetradymia canescens,* and *Krascheninnikovia lanata*. The remaining herbaceous layer is low to moderate in terms

of diversity and contributes sparse to low cover. Associated graminoids include *Elymus lanceolatus, Achnatherum hymenoides, Poa glauca, Poa fendleriana*, and *Achnatherum lettermanii*. Forbs provide sparse to low cover and include *Trifolium gymnocarpon, Phlox hoodii, Mertensia oblongifolia, Alyssum desertorum, Ceratocephala testiculata, Taraxacum officinale, Eriogonum umbellatum, Stenotus acaulis, Iva axillaris, Phlox multiflora, Pteryxia terebinthina, Antennaria dimorpha,* and *Arenaria kingii*.

Globally
This association has an open to moderately dense short-shrub layer dominated by *Artemisia arbuscula* ssp. *longiloba* with sparse to moderate cover of *Poa secunda* consistently present in the herbaceous layer. Other shrubs often present with low cover include *Artemisia tridentata, Chrysothamnus viscidiflorus, Ericameria nauseosa, Purshia tridentata, Symphoricarpos* spp., and *Tetradymia canescens*. Grass associates include *Elymus elymoides* and *Poa fendleriana* along with *Poa secunda*. *Pseudoroegneria spicata* is usually absent or has low cover. Other associated graminoids include *Achnatherum hymenoides, Achnatherum lettermanii, Elymus lanceolatus, Festuca idahoensis,* and *Poa glauca*. Forbs provide sparse to low cover and include *Agoseris glauca, Allium acuminatum, Arenaria kingii, Antennaria dimorpha, Collinsia parviflora, Eriogonum caespitosum, Eriogonum umbellatum, Lomatium* spp., *Mertensia oblongifolia, Phlox hoodii, Phlox longifolia, Phlox multiflora, Pteryxia terebinthina, Stenotus acaulis*, and *Trifolium gymnocarpon*. Exotics such as *Alyssum desertorum, Bromus tectorum, Ceratocephala testiculata, Iva axillaris*, and *Taraxacum officinale* are common on disturbed sites.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia arbuscula* ssp. *longiloba*
Herb (field)	*Phlox hoodii*
Herb (field)	*Poa secunda*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia arbuscula* ssp. *longiloba*
Herb (field)	*Phlox hoodii*
Herb (field)	*Poa secunda*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Alyssum desertorum, Ceratocephala testiculata, Taraxacum officinale

Globally
Alyssum desertorum, Bromus tectorum, Ceratocephala testiculata, Iva axillaris, Taraxacum officinale

CONSERVATION STATUS RANK
Global Rank & Reasons: G3Q (26-Feb-2004). This low-shrub habitat is found in southwestern Idaho (Owyhee Plateau), north-central Colorado (Middle Park), and northeastern Nevada (Elko County). However, the number of documented and predicted occurrences is low (less than 50). Stands are located predominately on northerly and southeasterly aspects of gentle to moderate slopes, ridges, and basin bottoms between 1600 and 2600 m (5250-8500 ft.) elevation. Soils tend to be a heavy clay loam. Stands are increasingly threatened by the introduction of exotic species, intensive range management, ORV use, and the alteration of fire disturbance regimes.

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Fossil Butte National Monument Inventory Notes: The soils have high clay content and runoff is rapid. Historically these slopes may have been grazed. There are no signs of fire, and patches of shrubs occur in drainages or in saddles on the hillslopes. This area appears to be grazed periodically by cattle.
Fossil Butte National Monument Data: The description is based on 2005 field data (6 plots: FOBU.0013, FOBU.0063, FOBU.0066, FOBU.0068, FOBU.0071, FOBU.0076; 3 observation points: FOBU.9044, FOBU.9051, FOBU.9072).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Blackburn et al. 1968b, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Jones 1992b, Tiedemann et al. 1987, Western Ecology Working Group n.d., Zamora and Tueller 1973

Artemisia arbuscula ssp. *longiloba / Pseudoroegneria spicata* Shrub Herbaceous Vegetation
Alkali Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation

CODE	CEGL001416
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	*ARTEMISIA ARBUSCULA* SSP. *LONGILOBA* SHRUB HERBACEOUS ALLIANCE (A.2552) Alkali Sagebrush Shrub Herbaceous Alliance
ECOLOGICAL SYSTEM(S):	Great Basin Xeric Mixed Sagebrush Shrubland (CES304.774) Wyoming Basins Dwarf Sagebrush Shrubland and Steppe (CES304.794) Columbia Plateau Low Sagebrush Steppe (CES304.080)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This alkali sagebrush / bluebunch wheatgrass shrub herbaceous vegetation is known from Fossil Butte National Monument and Gros Ventre Range in western Wyoming and south into North Park, Colorado. Stands occur on flats, buttes and ridges. The sites are flat to steep (up to 21-degree slopes) and occur between 2100 and 2440 m 7000-8000 ft. elevation. The unvegetated surface has low to moderate exposure of bare soil, moderate cover of small rocks, and low cover of large rocks, litter, and downed wood. Soils are well-drained to poorly drained (clay pan) and fine-textured. Vegetation is characterized by a sparse to open shrub canopy dominated by *Artemisia arbuscula* ssp. *longiloba* with the understory dominated by *Pseudoroegneria spicata* with up to 15% cover. Associated shrubs include low cover of *Atriplex confertifolia, Chrysothamnus viscidiflorus, Krascheninnikovia lanata, Eriogonum microthecum, Artemisia frigida*, and *Artemisia tridentata* ssp. *vaseyana*. The remaining herbaceous layer is moderately diverse and contributes sparse to low cover. Common species include *Achillea millefolium, Astragalus jejunus, Crepis intermedia, Elymus elymoides, Eriogonum* spp., *Phlox hoodii, Poa secunda*, and *Stenotus acaulis*.

DISTRIBUTION
Fossil Butte National Monument
This association is located on the tops of Ruby Point and Fossil Butte, as well as on a low ridge east of the visitor center.

Globally
This association occurs in Fossil Butte National Monument and Gros Ventre Range in western Wyoming, in North Park, Colorado, and is likely more widespread in the intermountain western U.S.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument

This alkali sagebrush / bluebunch wheatgrass shrub herbaceous vegetation is uncommon within the monument. It occupies the butte and ridge of Ruby Point and Fossil Butte, as well as a low ridge east of the Visitor Center. The sites are gentle to steep (1- to 21-degree slopes), occur between 2101 and 2406 m elevation, and are oriented to the north, west, or southeast. The unvegetated surface has low to moderate exposure of bare soil, moderate cover of rocks, litter, and downed wood. Soils are well-drained and are derived from the Wasatch Formation.

Globally
This shrub herbaceous vegetation is known from Fossil Butte National Monument and Gros Ventre Range in western Wyoming and south into North Park, Colorado. Stands occur on flats, buttes and ridges. The sites are flat to steep (up to 21-degree slopes), occur between 2100 and 2440 m (7000-8000 ft.) elevation, and are oriented to the north, west, or southeast. The unvegetated surface has low to moderate exposure of bare soil, moderate cover of small rocks, and low cover of large rocks, litter, and downed wood. Substrates are often shallow, well-drained to poorly drained (clay pan), fine-textured soils derived from the Wasatch Formation or Coalmont Formation shales.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover ranges from 20-55% in these moderately to densely vegetated stands. Stands are characterized by an open canopy of *Artemisia arbuscula* ssp. *longiloba* with an understory dominated by *Pseudoroegneria spicata* with up to 15% cover. Associated shrubs include *Atriplex confertifolia, Chrysothamnus viscidiflorus, Krascheninnikovia lanata, Eriogonum microthecum, Artemisia frigida,* and *Artemisia tridentata* ssp. *vaseyana*. The remaining herbaceous layer is moderately diverse and contributes sparse to low cover. Common species include *Poa secunda, Elymus elymoides, Phlox hoodii, Stenotus acaulis, Achillea millefolium, Astragalus jejunus, Eriogonum ovalifolium, Crepis intermedia,* and *Eriogonum brevicaule*.

Globally
This association is characterized by a sparse to open shrub canopy dominated by *Artemisia arbuscula* ssp. *longiloba* with the understory dominated by *Pseudoroegneria spicata* with up to 15% cover. Associated shrubs include *Atriplex confertifolia, Chrysothamnus viscidiflorus, Krascheninnikovia lanata, Eriogonum microthecum, Artemisia frigida,* and *Artemisia tridentata* ssp. *vaseyana*. The remaining herbaceous layer contributes sparse to low cover. Common species include *Achillea millefolium, Astragalus jejunus, Crepis intermedia, Elymus elymoides, Eriogonum brevicaule, Eriogonum ovalifolium, Eriogonum umbellatum, Phlox hoodii, Poa secunda,* and *Stenotus acaulis*.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia arbuscula* ssp. *longiloba*
Herb (field)	*Poa secunda, Pseudoroegneria spicata*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia arbuscula* ssp. *longiloba*
Herb (field)	*Pseudoroegneria spicata*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Astragalus jejunus

Globally
Astragalus jejunus

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

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Soils are shallow and shrubs are on hummocks. Swales are present where water collects during storm events. Slopes appear stable and shrubs are uniformly distributed. This plot is controlled by clayey soils and high wind exposure. Overall there is hardly any disturbance to the area.
Fossil Butte National Monument Data: The description is based on 2005 field data (3 plots: FOBU.0075, FOBU.0153, FOBU.0158; 2 observation points: FOBU.9067, FOBU.9141).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Bramble-Brodahl 1978, CONHP unpubl. data 2003, Driscoll et al. 1984, Jones 1992b, Terwilliger and Smith 1978, Western Ecology Working Group n.d.

Eriogonum brevicaule - Cushion Plants Sparse Vegetation
Shortstem Wild Buckwheat - Cushion Plants Sparse Vegetation

CODE	CEGL005319
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII)
PHYSIOGNOMIC SUBCLASS	Unconsolidated material sparse vegetation (VII.C.)
PHYSIOGNOMIC GROUP	Sparsely vegetated soil flats (VII.C.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural sparsely vegetated soil flats (VII.C.4.N.)
FORMATION	Soil slumps or landslides (VII.C.4.N.a.)
ALLIANCE	*PSEUDOROEGNERIA SPICATA* - CUSHION PLANTS SPARSELY VEGETATED
ALLIANCE (A.1876)	Bluebunch Wheatgrass - Cushion Plants Sparsely Vegetated Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This association is only known from Fossil Butte National Monument in southwestern Wyoming. It is a sparse cushion plant community that occupies shallow soils over limestone-derived gravel and bedrock on hillslopes, badland formations, buttes, and ridges. The sites are gentle to steep (3- to 42-degree slopes), occur between 2041 and 2362 m elevation, and are oriented to the south, southwest, or west. The unvegetated surface has moderate to high exposure of bare soil, low to moderate cover of small rocks, low cover of large rocks, and sparse cover of litter and downed wood. The vegetation is characterized by sparse cover of the cushion plant *Eriogonum brevicaule* (<1-10% cover) with a slightly different composition of cushion plants and other xeric species in each stand. Total vegetation cover ranges from less than 1 to 34% in these sparsely to moderately vegetated stands. Scattered short- and dwarf-shrubs may be present such as *Artemisia frigida, Atriplex confertifolia, Chrysothamnus viscidiflorus, Artemisia arbuscula* ssp. *longiloba*, and *Krascheninnikovia lanata*. The herbaceous layer is dominated by cushion plants with sparse cover of grasses such as *Poa secunda, Elymus lanceolatus,* and *Pseudoroegneria spicata*. Other common forbs may include *Antennaria dimorpha, Astragalus spatulatus, Astragalus jejunus, Astragalus vexilliflexus, Cryptantha caespitosa, Erigeron nanus, Eriogonum umbellatum, Minuartia nuttallii, Packera cana, Phlox hoodii, Physaria acutifolia, Pteryxia terebinthina, Physaria condensata, Stenotus acaulis,* and *Trifolium gymnocarpon.*

DISTRIBUTION
Fossil Butte National Monument
This cushion plant community occupies shallow, limestone-derived soils on the exposed slopes of Ruby Point, Cundick Ridge, and Fossil Butte and the badlands formation near Chicken Creek, the historic quarry, and the southern boundary of the monument.

Globally

This association is currently only known from Fossil Butte National Monument in southwestern Wyoming, but it is likely more widespread in Wyoming and adjacent states.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This sparse cushion plant community occupies shallow soils over limestone-derived gravel and bedrock on hillslopes, badland formations, buttes, and ridges. The sites are gentle to steep (3- to 42-degree slopes), occur between 2041 and 2362 m elevation, and are oriented to the south, southwest, or west. The unvegetated surface has moderate to high exposure of bare soil, low to moderate cover of small rocks, low cover of large rocks, and sparse cover of litter and downed wood. The parent materials include the Fossil Butte Member of the Wasatch Formation and the main body of the Wasatch Formation. Soils are rapidly drained sandy clay loam, clay loam, or clay.

Globally

This association is currently only known from Fossil Butte National Monument in southwestern Wyoming.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover ranges from less than 1 to 34% in these sparsely to moderately vegetated stands. This association is characterized by sparse cover of the cushion plant *Eriogonum brevicaule* (<1-10% cover) with a slightly different composition of cushion plants and other xeric species in each stand. The short- and dwarf-shrub layers provide sparse cover and may include low cover of *Artemisia frigida, Ericameria nauseosa, Atriplex gardneri, Atriplex confertifolia, Chrysothamnus viscidiflorus, Artemisia arbuscula* ssp. *longiloba,* and *Krascheninnikovia lanata*. The herbaceous layer is moderate in terms of diversity in each individual stand, but the composition of each stand varies. Grasses include *Poa secunda, Elymus lanceolatus, Leymus cinereus, Achnatherum hymenoides, Pascopyrum smithii*, and *Pseudoroegneria spicata* that provide sparse to low cover. Forbs include *Physaria acutifolia, Astragalus jejunus, Astragalus spatulatus, Astragalus vexilliflexus, Phlox hoodii, Comandra umbellata, Iva axillaris, Hedysarum boreale, Zigadenus paniculatus, Minuartia nuttallii, Stenotus acaulis, Trifolium gymnocarpon, Antennaria dimorpha, Pteryxia terebinthina, Physaria condensata, Erigeron nanus, Cryptantha caespitosa, Packera cana,* and *Eriogonum umbellatum.*

Globally

This association is currently only known from Fossil Butte National Monument in southwestern Wyoming.

MOST ABUNDANT SPECIES

Fossil Butte National Monument

Stratum	Species
Herb (field)	*Astragalus spatulatus, Eriogonum brevicaule, Stenotus acaulis*
Herb (field)	*Poa secunda*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Fossil Butte National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (6-Aug-2007).

CLASSIFICATION COMMENTS

Fossil Butte National Monument

Data are not available.

Globally

As currently defined *Eriogonum brevicaule* is always present in this association.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: In this badland community, *Eriogonum brevicaule* is present in every plot, but the dominant species varies from site to site; however, the dominant will be an herbaceous species. These communities mostly have cushion plants. The soils are very compacted in some areas, where no vegetation occurs. Community exists because a thin belt of limestone is close to the surface. Most of the ground surface is covered by chips and rocks of limestone.
Fossil Butte National Monument Data: The description is based on 2005 field data (10 plots: FOBU.0025, FOBU.0033, FOBU.0034, FOBU.0040, FOBU.0041, FOBU.0042, FOBU.0051, FOBU.0052, FOBU.0058, FOBU.0065; 8 observation points: FOBU.9006, FOBU.9043, FOBU.9064, FOBU.9078, FOBU.9080, FOBU.9091, FOBU.9105, FOBU.9149).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Knight et al. 1987, Western Ecology Working Group n.d.

Populus tremuloides Woodland Alliance
Quaking Aspen Woodland Alliance

CODE	A.610
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	Cold-deciduous woodland (II.B.2.N.a.)
ALLIANCE	*POPULUS TREMULOIDES* WOODLAND ALLIANCE (A.610) Quaking Aspen Woodland Alliance
ECOLOGICAL SYSTEM(S):	Northwestern Great Plains Aspen Forest and Parkland (CES303.681) Rocky Mountain Aspen Forest and Woodland (CES306.813)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Woodlands included in this alliance occur from the Great Lakes and northern Great Plains to the interior northwestern United States. Elevations range from up to 2900 m in Montana and Oregon to less than 500 m in the lake states. Climate is temperate, continental and ranges from semi-arid to subhumid. Stands have a sparse to moderately dense canopy of the cold-deciduous broad-leaved tree *Populus tremuloides*, 5-20 m tall. Other trees may include scattered conifers in the western extent or several deciduous broad-leaved trees from the Great Plains to the Great Lakes. Stands may have irregular canopies of young and old trees, or tall, dense immature trees, or mature trees. Often these stands are found on rocky, dry or disturbed sites that limited the density of tree canopy. The shrub layer can be sparse, but is often dense and diverse especially in the plains. The herbaceous layer is sparse to moderately dense and is typically dominated by graminoids. In the northern Great Plains and western Great Lakes area these *Populus tremuloides*-dominated stands may have an abundance of *Acer rubrum, Populus balsamifera*, or *Populus grandidentata*. *Betula papyrifera, Fraxinus pennsylvanica*, and *Quercus macrocarpa* are common associates. The shrub layer is well-developed, with 40-90% cover in northwestern Minnesota. Common shrub species include *Amelanchier alnifolia, Corylus* spp., *Prunus virginiana, Ribes aureum, Rosa* spp., and *Symphoricarpos occidentalis. Cornus sericea* and *Salix* spp. are common on wetter sites. The herbaceous layer is not as well-developed as the shrub layer but is still significant. *Andropogon gerardii, Aralia nudicaulis, Galium boreale, Maianthemum canadense*, and *Maianthemum stellatum* are typically found in the herbaceous layer.

In the western United States, scattered conifers of *Pinus ponderosa* or *Pinus contorta* may be present in these stands. Shrubs have a sparse to moderately dense layer (10-60% cover) dominated by *Symphoricarpos albus, Amelanchier alnifolia* or *Physocarpus malvaceus* with scattered *Ribes lacustre*. The graminoid layer is also sparse to moderately dense (3-40% canopy cover) and is dominated by the perennial grass *Elymus glaucus* with *Carex* spp. The sparse to

moderately dense (10-40% cover) and often diverse forb layer includes *Achillea millefolium, Fragaria virginiana, Galium* spp., *Geum macrophyllum, Maianthemum stellatum, Osmorhiza* spp., and *Veratrum californicum.* Exotic grasses, such as the perennial *Poa pratensis*, are often common in stands disturbed by grazing. Stands are largely limited to gentle (0-20%) slopes but may be steep in mountains and canyons. Canopy cover of these *Populus tremuloides* woodlands is limited by environmental factors such as aridity, poor site conditions or frequent disturbance. Sites vary with geography. Near the Great Lakes, this alliance occurs on rocky sites with shallow soils and exposed patches of granite bedrock. In the Great Plains, it is found on well-drained, moderately deep to deep loam soils. Along the prairie-forest border, this alliance can be found on dry-mesic to wet-mesic sites on flat to rolling topography. In northwestern Montana, stands are found on steep scree slopes in the Mission Mountains. In Oregon, stands occur in riparian and seepage areas in the mountains, foothills and plains. Sites include floodplains, valley bottoms, footslopes, mesic basins and draws, and at higher elevations rocky slopes on mountains and canyonsides. In more mesic areas sites are often transitional between true riparian and upland. Soils are derived from alluvium, ash and colluvium. Soil texture ranges from fine sandy loam to clay loam. Adjacent vegetation includes deciduous and coniferous forests in more mesic areas, and grasslands and shrublands where more xeric..

DISTRIBUTION

Fossil Butte National Monument

This uncommon type is represented by one observation point in a drainage near the base of Cundick Ridge.

Globally

These woodlands are found from the interior northwestern U.S., across the Northern Great Plains to the Great Lakes and New England. Stands have been reported from Oregon, Wyoming, Montana, North Dakota, Minnesota and potentially occur in Nevada, Idaho and Michigan. In Canada stands occur in Ontario, Manitoba, and Saskatchewan.

ENVIRONMENTAL DESCRIPTION

Fossil Butte National Monument

This quaking aspen woodland alliance is uncommon within the monument and occurs in very small stands associated with springs. It occupies a drainage with some standing water. The site is gentle (5-degree slope), occurs at 2257 m elevation, and is oriented to the south. The unvegetated surface has moderate exposure of bare soil and low cover of small and large rocks and litter. There is low cover of downed wood. The soil parent material is the main body of the Wasatch Formation.

Globally

Woodlands included in this alliance occur from the Great Lakes and northern Great Plains to the interior northwestern U.S. Elevations range from up to 2900 m in Montana and Oregon to less than 500 m in the lake states. Climate is temperate, continental and ranges from semi-arid to subhumid. Stands are largely limited to gentle (0-20%) slopes, but may be steep in mountain and canyons. Canopy cover of these Populus tremuloides woodlands is limited by environmental factors such as aridity, poor site conditions or frequent disturbance. Sites vary with geography. Near the Great Lakes, this alliance occurs on rocky sites with shallow soils and exposed patches of granite bedrock. In the Great Plains, it is found on well-drained, moderately deep to deep loam soils. Along the prairie-forest border, this alliance can be found on dry-mesic to wet-mesic sites on flat to rolling topography. In northwestern Montana, stands are found on steep scree slopes in the Mission Mountains. In Oregon, stands occur in riparian and seepage areas in the mountains, foothills and plains. Sites include floodplains, valley bottoms, footslopes, mesicdraws, and at higher elevations rocky slopes on mountains and canyonsides. In more mesic areas sites are often transitional between true riparian and upland. Soils are derived from alluvium, ash and colluvium. Soil texture ranges from fine sandy loam to clay loam.

Adjacent vegetation includes deciduous and coniferous forests in more mesic areas, and grasslands and shrublands where more xeric.

VEGETATION DESCRIPTION

Fossil Butte National Monument

Total vegetation cover is 33%. The vegetation is characterized by a moderately dense canopy, typically 10-15 m tall, of *Populus tremuloides* trees (45% cover) with scattered emergent *Pinus flexilis* trees, typically 15-20 m tall. *Pinus flexilis* and *Juniperus scopulorum* saplings provide sparse cover. There is no developed shrub layer, but scattered *Salix lutea, Salix exigua, Rosa woodsii,* and *Prunus virginiana* may be present. The herbaceous layer contributes

sparse cover and includes *Leymus cinereus, Poa fendleriana, Juncus balticus, Asteraceae sp., Chamerion angustifolium,* and *Cirsium undulatum.*

Globally
These woodlands occur from the northwestern United States to the western Great Lakes. Stands have a sparse to moderately dense canopy of the cold deciduous broad-leaved tree Populus tremuloides 5-20 m tall. Other trees may include scattered conifers in the western extent or several deciduous broad-leaved trees from the Great Plains to the Great Lakes. Stands may have irregular canopies of young and old trees, or tall, dense immature trees, or mature trees. Often these stands are found on rocky, dry or disturbed sites that limited the density of tree canopy. The shrub layer can be sparse, but is often dense and diverse especially in the plains. The herbaceous layer is sparse to moderately dense and is typically dominated by graminoids.

In the northern Great Plains and western Great Lakes area these *Populus tremuloides* dominated stands may have an abundance of *Acer rubrum, Populus balsamifera* or *Populus grandidentata. Betula papyrifera, Fraxinus pennsylvanica,* and *Quercus macrocarpa* are common associates. The shrub layer is well-developed, with 40-90% cover in northwestern Minnesota (MNNHP 1993). Common shrub species *include Amelanchier alnifolia, Corylus* spp*., Prunus virginiana, Ribes aureum, Rosa* spp*., and Symphoricarpos occidentalis. Cornus sericea* and *Salix* spp. are common on wetter sites. The herbaceous layer is not as well-developed as the shrub layer but is still significant. *Andropogon gerardii, Aralia nudicaulis, Galium boreale, Maianthemum canadense,* and *Maianthemum stellatum* are typically found in the herbaceous layer.

In the western U.S. scattered conifers of *Pinus ponderosa* or *Pinus contorta* may be present in these stands. Shrubs have a sparse to moderately dense layer (10-60% cover) dominated by *Symphoricarpos albus, Amelanchier alnifolia* or *Physocarpus malvaceus* with scattered *Ribes lacustre*. The graminoid layer is also sparse to moderately dense (3-40% canopy cover) and is dominated by the perennial grass *Elymus glaucus* with *Carex* spp. The sparse to moderately dense (10-40% cover) and often diverse forb layer includes *Achillea millefolium, Fragaria virginiana, Galium* spp*., Geum macrophyllum, Maianthemum stellatum, Osmorhiza* spp., and *Veratrum californicum*. Exotic grasses, such as the perennial *Poa pratensis*, are often common in stands disturbed by grazing.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Tree canopy	*Populus tremuloides, Pinus flexilis*

Globally

Stratum	Species
Tree canopy	*Populus tremuloides*

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not applicable

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Observation Point FOBU.9029 has a depauperate understory and cannot be classified to association at this time.

Globally
Fire is necessary to maintain stands of this alliance, especially in the more mesic eastern portion of its range (MNNHP 1993). As stands in this alliance age, the composition begins to change, and they can become similar to stands in the *Populus tremuloides* Forest Alliance (A.274), *Quercus macrocarpa* Forest Alliance (A.245), or

Quercus macrocarpa Woodland Alliance (A.620). Knight (1994) described *Populus tremuloides*-dominated foothill woodlands in Wyoming that occur in drainages, hillside seeps and just below large snowdrifts (snowglades).

CLASSIFICATION CONFIDENCE: Not applicable

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: There are standing pools of water from a nearby spring combined with runoff from Cundick Ridge to the north. There are approximately 15% dead quaking aspen within the plot primarily due to clay soil slumping with some death possibly due to drought.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 observation point: FOBU.9029).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: K.A. Schulz

REFERENCES: Chappell et al. 1997, Crowe and Clausnitzer 1997, Eyre 1980, Faber-Langendoen et al. 1996, Girard et al. 1989, Knight 1994, Kovalchik 1987, MNNHP 1993, Padgett 1982, Servheen and Lee 1979, Swain and Kearsley 2001, Western Ecology Working Group n.d., Williams and Lillybridge 1983, Williams and Smith 1990

Artemisia tridentata / Elymus lanceolatus Shrubland [Park Special]
Big Sagebrush / Streambank Wheatgrass 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 Big Sagebrush Shrubland (CES304.777)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Fossil Butte National Monument
This uncommon community is represented by one observation point located on a landslide deposit near the historic quarry.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This big sagebrush / streambank wheatgrass shrubland is uncommon within the monument. It occupies a landslide deposit near the historic quarry. The slope and aspect are variable and the site occurs at 2130 m elevation. The unvegetated surface has low exposure of bare soil and low cover of small and large rocks and litter. The parent materials are sandstones and shale that have eroded and deposited as colluvium.

Globally
Data are not available.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 50% in this moderately vegetated stand. This community is characterized by moderate cover of the short shrub *Artemisia tridentata* ssp. *wyomingensis* (35%) and low cover of the perennial rhizomatous grass *Elymus lanceolatus* (6%). The remaining short-shrub layer provides sparse cover and includes *Chrysothamnus*

viscidiflorus and Artemisia arbuscula ssp. *longiloba*. The remaining herbaceous layer is moderate in terms of diversity and contributes sparse cover. Other grasses include *Leymus cinereus* and *Elymus elymoides.* Forbs include *Mertensia oblongifolia, Pteryxia terebinthina,* and *Lithospermum ruderale*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Elymus lanceolatus*

Globally
Data are not available

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available.

Globally
Data are not available

CONSERVATION STATUS RANK
Global Rank & Reasons: Not applicable

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Lighter colored patches in the polygon are much sparser versions of the surrounding species, not unique communities.
Fossil Butte National Monument Data: The description is based on 2005 field data and 2006 accuracy assessment data (1 plot: FOBU_AA.9155 and 1 observation point: FOBU.9092).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: Data are not available

REFERENCES: Western Ecology Working Group n.d.

Artemisia tridentata ssp. *wyomingensis / Leymus cinereus* Shrubland [Park Special]
Wyoming Big Sagebrush / Great Basin Lyme Grass 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 Big Sagebrush Shrubland (CES304.777)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Fossil Butte National Monument
This uncommon community is represented by one plot within the monument located on a landslide deposit near the Fossil Quarry Trail.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This Wyoming big sagebrush / Great Basin lyme grass shrubland is uncommon within the monument and is considered a park special for vegetation mapping purposes. It occupies a landslide deposit near the historic quarry on Fossil Butte. The site is gentle (3-degree slope), occurs at 2153 m elevation, and is oriented to the southwest. The unvegetated surface has moderate exposure of bare soil and moderate cover of litter. The parent material is shale from the Green River Formation that was part of a landslide deposit. Soils are moderately well-drained silty clay loams.

Globally
Data are not available.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 41% in this moderately vegetated stand. This community is characterized by moderate cover of the short shrub *Artemisia tridentata* ssp. *wyomingensis* (25%) and low cover of the perennial grass *Leymus cinereus* (12%). The short-shrub layer provides low cover and includes *Atriplex confertifolia, Ericameria nauseosa, Atriplex confertifolia,* and *Chrysothamnus viscidiflorus.* The remaining herbaceous layer is low in terms of diversity and contributes sparse cover. Other grasses include *Poa secunda* and *Achnatherum lettermanii.* Forbs include *Mertensia oblongifolia* and the non-native annual *Salsola tragus*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Leymus cinereus*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Salsola tragus

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not Applicable

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Water table is obviously high here, at the foot of the seep that supports a stand of willows. At the time of sampling, the groundwater was at the surface. This site lies in a low depression on north side of ridge extending from Fossil Butte, which receives more moisture than the surrounding sparse herbaceous vegetation. This shrubland is visible on all ridges extending from Fossil Butte.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0106)
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: Data are not available

REFERENCES: Western Ecology Working Group n.d.

Atriplex gardneri - Artemisia arbuscula ssp. *longiloba* Dwarf Shrubland [Park Special]
Gardner's Saltbush - Alkali Sagebrush 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): Wyoming Basins Dwarf Sagebrush Shrubland and Steppe (CES304.794)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Fossil Butte National Monument
This unique community is located on clay soils of alluvial fans, a swale, and a badlands formation near the southern boundary of the monument and near the historic quarry.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This Gardner's saltbush - alkali sagebrush dwarf-shrubland occurs on alkaline clay soils within the monument and is considered a park special for vegetation mapping purposes. This dwarf-shrubland occupies patches of alkaline, clay soils on alluvial fans, a badlands formation, and a swale. The sites are flat to moderate (0- to 13-degree slope), occur between 2033 and 2155 m elevation, and are oriented to the south. The unvegetated surface has high exposure of bare soil and low cover of small and large rocks and litter. The parent materials include the main body of the Wasatch Formation and sandstones and shale that have eroded and deposited as secondary stream alluvium or new alluvium. Soils are rapidly drained clays.

Globally
Data are not available.

VEGETATION DESCRIPTION
Fossil Butte National Monument
The total vegetation cover ranges from 6-17% in these sparsely vegetated stands. This community is characterized by sparse cover of the dwarf-shrub *Atriplex gardneri* that ranges from <1-2% cover and the short shrub *Artemisia*

arbuscula ssp. *longiloba* that ranges from <1-6% cover. The remaining shrub layer provides sparse cover and includes the short and dwarf-shrubs *Tetradymia spinosa, Picrothamnus desertorum, Sarcobatus vermiculatus, Chrysothamnus viscidiflorus, and Krascheninnikovia lanata*. The herbaceous layer is low in terms of diversity and contributes sparse cover. Grasses include *Elymus lanceolatus, Poa secunda, Elymus elymoides, Poa fendleriana, and Achnatherum hymenoides.* Forbs include *Ceratocephala testiculata, Phlox hoodii, Taraxacum officinale, Alyssum desertorum, Trifolium gymnocarpon, Lepidium perfoliatum,* and *Antennaria dimorpha*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Artemisia arbuscula* ssp. *longiloba*, *Atriplex gardneri*
Herb (field)	*Phlox hoodii*
Herb (field)	*Poa secunda*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Ceratocephala testiculata, Taraxacum officinale, Alyssum desertorum, Lepidium perfoliatum

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not Applicable

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Site is a broad alluvial fan bisected by rills that are heavily vegetated. Soils have a heavy clay component with rapid runoff. No rills or obvious erosion patterns in the plot, but there is a drainage channel along the east side of the plot. Vegetation raised 2-5 cm above the bare soil in clumps or hummocks. Alkaline soils support species adapted to these conditions.
Fossil Butte National Monument Data: The description is based on 2005 field data (2 plots: FOBU.0032, FOBU.0038; 2 observation points: FOBU.9016, FOBU.9059).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: Data are not available

REFERENCES: Western Ecology Working Group n.d.

Ceanothus martinii Shrubland [Park Special]
Martin's Buckbrush 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): Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Fossil Butte National Monument
This uncommon community is represented by one plot within the monument located on a high slope along the eastern edge of Cundick Ridge.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This Martin's ceanothus shrubland is uncommon within the monument and is considered a park special for vegetation mapping purposes. It occupies the upper ridge along the eastern slope of Cundick Ridge. The site is steep (41-degree slope), occurs at 2261 m elevation, and is oriented to the southeast. The unvegetated surface has high exposure of bare soil, moderate cover of small rocks, and low cover of large rocks. The parent material is the Fossil Butte Member of the Wasatch Formation. Soils are moderately well-drained clays.

Globally
Data are not available.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 7% in this sparsely vegetated stand. This community is characterized by sparse cover of the short shrub *Ceanothus martinii* (3%). Scattered *Pinus flexilis* trees occupy this slope and provide sparse cover. The tall- and short-shrub layers are low in diversity, provide sparse cover, and include *Artemisia arbuscula* ssp. *longiloba, Amelanchier utahensis, Purshia tridentata,* and *Cercocarpus montanus*. The herbaceous layer is low in terms of diversity and contributes sparse cover. Grasses include *Achnatherum hymenoides* and *Poa secunda.* Forbs include *Oenothera caespitosa, Cryptantha cinerea* var. *jamesii,* and *Penstemon paysoniorum.*

Globally
Data are not available.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Ceanothus martini, Cercocarpus montanus*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not Applicable

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Light tan/whitish clay soil is rocky, on a steep slope, and prone to downhill movement. It is not clear why *Ceanothus martinii* grows along this ridge versus other locations in the monument.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0144)
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: Data are not available

REFERENCES: Western Ecology Working Group n.d.

Cushion Plants Sparse Shale 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 Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Fossil Butte National Monument
This cushion plant community occupies shallow, limestone-derived clay soils on the exposed slopes of Ruby Point and the Bullpen and terraces and badlands near Chicken Creek.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
Most examples of this sparse cushion plant community occupy shallow, clayey soils of badlands or overlying limestone on hillslopes, badlands, valley floors, and ridges. The sites are flat to steep (0- to 22-degree slopes) and lie between 2032 and 2462 m elevation. The unvegetated surface has moderate to high exposure of bare soil, moderate to high cover of small rocks, low cover of large rocks, and sparse cover of litter. Soils are rapidly drained sandy or silty clay loams or clays derived from the Wasatch Formation and the Angelo Member if the Green River Formation.

Globally
Data are not available.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover ranges from 1-33%. This community is not characterized by any one dominant species; rather each stand has a slightly different composition of cushion plants and other xeric species. Shrubs are present but do not provide enough cover to constitute a stratum; common species include *Artemisia frigida, Artemisia tridentata* ssp. *tridentata, Atriplex gardneri, Artemisia arbuscula* ssp. *longiloba,* and *Krascheninnikovia lanata.* The herbaceous layer is low in terms of diversity in each individual stand, but the composition of each stand varies. Grasses present may include *Poa secunda, Poa fendleriana, Elymus lanceolatus, Pascopyrum smithii,* and *Pseudoroegneria spicata* with low cover. Forbs include *Erigeron nanus, Sedum lanceolatum, Phlox hoodii, Arenaria hookeri, Astragalus spatulatus, Eriogonum ovalifolium, Stenotus acaulis, Packera cana, Eriogonum umbellatum, Physaria condensata, Astragalus jejunus, Eriogonum caespitosum,* and *Eurybia glauca*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Herb (field)	*Stenotus acaulis, Erigeron nanus, Phlox hoodii, Astragalus spatulatus*
Herb (field)	*Poa secunda*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Ceratocephala testiculata

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not Applicable

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: In this badland community the dominant species varies from site to site, but the dominant will be an herbaceous species. These communities mostly have cushion plants. The soils are very compacted in some areas, where no vegetation occurs. Community exists because a thin belt of limestone is close to the surface here. Most of the ground surface is covered by chips and rocks of limestone.
Fossil Butte National Monument Data: The description is based on 2005 field data (5 plots: FOBU.0027, FOBU.0036, FOBU.0092, FOBU.0095, FOBU.0128; 1 observation point: FOBU.9058).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: Data are not available

REFERENCES: Western Ecology Working Group n.d.

Lepidium virginicum Sparse Herbaceous Vegetation [Park Special]
Poor-man's Peppergrass Sparse 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 Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Fossil Butte National Monument
This uncommon community is represented by one plot within the monument located on an alluvial fan east of Chicken Creek.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This poor-man's peppergrass sparse herbaceous vegetation community is uncommon within the monument and is considered a park special for vegetation mapping purposes. It occupies an alluvial fan east of Chicken Creek. The site is gentle (1-degree slope), occurs at 2039 m elevation, and is oriented to the southwest. The unvegetated surface has high exposure of bare soil and high cover of litter. The parent material is the main body of the Wasatch Formation. Soils are rapidly drained clays. The clay prevents moisture from infiltrating the soils creating more xeric conditions than surrounding areas. This combined with the hardpan surface and high degree of erosion prevents the establishment of shrubs and perennial forbs and grasses.

Globally
Data are not available.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 45% in this moderately vegetated stand. This community is characterized by moderate cover of the annual forb *Lepidium virginicum* (40%). The shrub layer is low in diversity and provides sparse cover by the short shrub *Chrysothamnus viscidiflorus* and the dwarf-shrub *Atriplex gardneri*. The remaining herbaceous layer is low in terms of diversity and contributes sparse cover. Grasses include *Poa fendleriana* and *Poa secunda*. Other forbs include *Trifolium gymnocarpon* and *Ceratocephala testiculata*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Herb (field)	*Lepidium virginicum*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not Applicable

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: The high clay content of the soil creates a hardpan surface layer with evidence of rapid drainage. There are some patches of cracked, bare soil between clumps of vegetation.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0111)
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: Data are not available

REFERENCES: Western Ecology Working Group n.d.

Populus angustifolia / Leymus cinereus Woodland [Park Special]
Narrowleaf Cottonwood / Great Basin Lyme Grass 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): Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Fossil Butte National Monument
This uncommon community is represented by two plots located on the top of a slump on the southern face of Fossil Butte.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This narrowleaf cottonwood / Great Basin lyme grass woodland is uncommon within the monument and considered a park special for vegetation mapping purposes. It occupies a bench and slope on the upper southern face of Fossil Butte. The site is gentle to steep (2- to 25-degree slope), occurs between 2167 and 2171 m elevation, and is oriented to the east and south. The unvegetated surface has low exposure of bare soil, sparse to low cover of small and large rocks, and low cover of litter. There is low cover of downed wood. The parent material slumps from and represents

the main body of the Wasatch Formation. Soils are rapidly- to poorly-drained depending on slope and are clay loam in texture.

Globally
Data are not available.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover ranges from 34-85% in this moderately to densely vegetated stand. This community is characterized by an open canopy, typically 10-15 m tall, of the riparian tree *Populus angustifolia* (20-25% cover) and an understory of the tall bunchgrass *Leymus cinereus* that provides sparse to dense cover (4-40% cover). The average dbh for *Populus angustifolia* trees within the stand is 126.8 cm, and the average number of trees per plot is 6. The shrub layer provides sparse to low cover and includes the tall and short shrubs *Artemisia tridentata* ssp. *tridentata, Amelanchier utahensis, Symphoricarpos oreophilus,* and *Rosa woodsii*. The remaining herbaceous layer is moderate in terms of diversity and provides sparse cover. Other graminoids include *Carex geyeri, Poa secunda,* and *Poa fendleriana.* Forbs include *Eurybia glauca, Comandra umbellata, Maianthemum stellatum,* and *Astragalus bisulcatus.*

Globally
Data are not available.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Tree canopy	*Populus angustifolia*
Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Short shrub/sapling	*Artemisia arbuscula* ssp. *longiloba, Atriplex gardneri*
Herb (field)	*Eurybia glauca*
Herb (field)	*Leymus cinereus*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available
Descurainia pinnata

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not Applicable

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Site formed following slumping off Fossil Butte. A seep on the plot originates from Fossil Butte, which has enabled the narrowleaf cottonwood trees to become established. There are a few dead narrowleaf cottonwood trees in the stand. However, regeneration is occurring, with several saplings observed in the plot. The area has been affected by drought.

Fossil Butte National Monument Data: The description is based on 2005 field data (2 plots: FOBU.0067, FOBU.0110).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: Data are not available

REFERENCES: Western Ecology Working Group n.d.

Populus tremuloides/ Apocynum androsaemifolium Forest [Park Special]
Quaking Aspen / Spreading Dogbane Forest [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): Rocky Mountain Aspen Forest and Woodland (CES306.813)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Fossil Butte National Monument
This uncommon community is represented by one observation point on benches on a slope below Cundick Ridge.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This quaking aspen / spreading dogbane forest is uncommon within the monument and is considered a park special for vegetation mapping purposes. It occupies benches on the slope below Cundick Ridge. The site has a variable slope (0 and 6 degrees), occurs at 2253 m elevation, and is oriented to the south. The unvegetated surface has high cover of litter, low exposure of bare soil, and low cover of small rocks. There is low cover of downed wood. The parent material is the main body of the Wasatch Formation.

Globally
Data are not available.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 99% in this densely vegetated stand. This community is characterized by high cover of the canopy tree *Populus tremuloides* (65%) and moderate cover of the dwarf-shrub *Apocynum androsaemifolium* (26%). The remaining shrub layer is low in diversity and provides sparse cover, including the short shrubs *Rosa woodsii* and *Symphoricarpos oreophilus*. The herbaceous layer is low in terms of diversity and provides sparse cover. Graminoids include *Leymus cinereus, Juncus balticus,* and *Carex nebrascensis.* Forbs include *Cirsium undulatum* and *Galium boreale*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Tree canopy	*Populus tremuloides*
Short shrub/sapling	*Apocynum androsaemifolium, Symphoricarpos oreophilus*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not Applicable

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This quaking aspen grove is situated on stable ground with less than 5% mortality unlike the quaking aspen groves east of the plot. Plot represents two benches connected by a 6-degree slope. The quaking aspen stand is heavily used by animals with elk and mule deer scat and bedding sites and small rodent burrows scattered throughout the plot. Standing water exists on both benches.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 observation point: FOBU.9030)
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: Data are not available

REFERENCES: Western Ecology Working Group n.d.

Pteryxia terebinthina Herbaceous Vegetation [Park Special]
Rockloving Wavewing 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 Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Fossil Butte National Monument
This uncommon community is represented by two observation points on the rim of Fossil Butte.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This rockloving wavewing herbaceous vegetation community is uncommon within the monument and is considered a park special for vegetation mapping purposes. It occupies the rim atop Fossil Butte. The sites are gentle to moderate (4- to 10-degree slopes), occur at 2277 to 2284 m elevation, and are oriented to the south or northwest. The unvegetated surface has low cover of litter, moderate exposure of bare soil, and moderate exposure of small and large rocks. The parent material is the main body of the Wasatch Formation.

Globally
Data are not available.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 18% in these sparsely vegetated stands. This community is characterized by low cover of the perennial forb *Pteryxia terebinthina* that ranges from 5-15% cover. The short- and dwarf-shrub layers provide sparse cover and include *Chrysothamnus viscidiflorus, Artemisia arbuscula* ssp. *longiloba,* and *Krascheninnikovia lanata*. The remaining herbaceous layer is low in terms of diversity and contributes sparse to low cover. Grasses include *Achnatherum hymenoides* and *Elymus lanceolatus.* Other forbs include *Linum lewisii, Arenaria hookeri, Packera cana,* and *Phlox hoodii*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Herb (field)	*Pteryxia terebinthina, Arenaria hookeri*
Herb (field)	*Elymus lanceolatus*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not Applicable

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: The slope is exposed to high winds, which may limit shrub growth.

Fossil Butte National Monument Data: The description is based on 2005 field data (2 observation points: FOBU.9045, FOBU.9077).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: Data are not available

REFERENCES: Western Ecology Working Group n.d.

Purshia tridentata / Pteryxia terebinthina Shrubland [Park Special]
Bitterbrush / Rockloving Wavewing 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 Shale Badland (CES304.789)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Fossil Butte National Monument
This uncommon community is represented by one plot within the monument located on a high slope of Fossil Butte.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This bitterbrush / rockloving wavewing shrubland is uncommon within the monument and is considered a park special for vegetation mapping purposes. It occupies the high slope near the rim of Fossil Butte. The site is steep (25-degree slope), occurs at 2269 m elevation, and is oriented to the south. The unvegetated surface has high exposure of bare soil and sparse cover of small and large rocks. The parent material is the main body of the Wasatch Formation. Soils are rapidly drained silt loams.

Globally
Data are not available.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 19% in this sparsely vegetated stand. This community is characterized by sparse to low cover of the short shrub *Purshia tridentata* (8%) and sparse cover of the perennial forb *Pteryxia terebinthina* (3%). The tall- and short-shrub layers are low in terms of diversity and provide sparse cover; shrubs include *Artemisia tridentata* ssp. *vaseyana, Amelanchier utahensis, Atriplex confertifolia,* and *Chrysothamnus viscidiflorus.* The herbaceous layer is low in terms of diversity and contributes sparse cover. Grasses include *Achnatherum hymenoides, Leymus cinereus, Elymus lanceolatus,* and the non-native annual *Bromus tectorum*. Additional forbs include the cushion plants *Eriogonum brevicaule* and *Physaria condensata.*

Globally
Data are not available.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Short shrub/sapling	*Purshia tridentata, Amelanchier utahensis*
Herb (field)	*Pteryxia terebinthina*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Bromus tectorum

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not Applicable

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: There is moderate erosion on this steep slope. Some of the shrub species have low-statured, matted growth forms probably due to high winds. Harsh weather and exposure appear to be controlling community.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 plot: FOBU.0090).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: Data are not available

REFERENCES: Western Ecology Working Group n.d.

Salix scouleriana Shrubland [Park Special]
Scouler's Willow 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): Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Fossil Butte National Monument
This uncommon community is represented by one observation point within the monument located on a bench near Cundick Spring.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This Scouler's willow shrubland is uncommon within the monument and is considered a park special for vegetation mapping purposes. It occupies a bench near Cundick Spring that is intermittently flooded. The site is gentle (3-degree slope), occurs at 2445 m elevation, and is oriented to the east. The unvegetated surface has high cover of litter. The parent material is obscured by soil.

Globally
Data are not available.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 99% in this densely vegetated stand. This community is characterized by an almost continuous canopy of the tall shrub *Salix scouleriana* (80% cover) that is between 2 and 5 m tall. The remaining shrub layer consists of sparse cover of the short shrub *Symphoricarpos oreophilus*. The herbaceous layer is low in terms of diversity and contributes moderate cover. The grasses *Calamagrostis canadensis* and *Melica bulbosa* provide low to moderate cover, while *Poa pratensis* provides sparse cover. Forbs provide low cover and include *Thalictrum venulosum*, *Galium trifidum*, and *Osmorhiza berteroi*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Tall shrub/sapling	*Salix scouleriana*
Herb (field)	*Osmorhiza berteroi*
Herb (field)	*Calamagrostis canadensis, Melica bulbosa*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Poa pratensis

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not Applicable

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: This observation point is located on one of several damp benches resulting from collapse of the slope that support tiny stands of quaking aspen, willow, and/or mesic herbaceous species. In this observation point, *Salix scouleriana* is a very tall shrub with trunks branched well above the ground.

Fossil Butte National Monument Data: The description is based on 2005 field data (1 observation point: FOBU.9049).
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: Data are not available

REFERENCES: Western Ecology Working Group n.d.

Symphyotrichum foliaceum Snow Glade Herbaceous Vegetation [Park Special]
Alpine Leafybract Aster Snow Glade 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): Rocky Mountain Subalpine-Montane Mesic Mesic Meadow (CES306.829)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Fossil Butte National Monument
This uncommon community is represented by one observation point located on a lee slope of a ridge on the northern end of the monument.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Fossil Butte National Monument
This alpine leafy bract aster snow glade herbaceous community is uncommon within the monument and is considered a park special for vegetation mapping purposes. It occupies the leeward slope of a ridge on the northern end of the monument and occurs as small patches in the vicinity. The site is moderate (6-degree slope), occurs at 2379 m elevation, and is oriented to the east. The unvegetated surface has high exposure of bare soil and low cover of small rocks and litter. The parent material is the Angelo Member of the Wasatch Formation.

Globally
Data are not available.

VEGETATION DESCRIPTION
Fossil Butte National Monument
Total vegetation cover is 57% in this moderately to densely vegetated stand. This community is characterized by moderate cover of the perennial forb *Symphyotrichum foliaceum* (55%). The remaining herbaceous layer is low in terms of diversity and provides sparse cover including the grass *Koeleria macrantha.* Other forbs include *Achillea millefolium, Gayophytum ramosissimum,* and *Taraxacum officinale.*

Globally
Data are not available.

MOST ABUNDANT SPECIES
Fossil Butte National Monument

Stratum	Species
Herb (field)	*Symphyotrichum foliaceum*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES
Fossil Butte National Monument
Data are not available

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not Applicable

CLASSIFICATION COMMENTS
Fossil Butte National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Fossil Butte National Monument Inventory Notes: Patches of leafy aster form nearly monotypic stands in these snow glades. They are located on the lee side of ridges that collect snow blown over the ridge. The patches are small, but some may be large enough to be mapped as small polygons.
Fossil Butte National Monument Data: The description is based on 2005 field data (1 observation point: FOBU.9088)
Local Description Authors: M. Smith and J. Von Loh
Global Description Authors: Data are not available

REFERENCES: Western Ecology Working Group n.d.

Bibliography for Fossil Butte National Monument

ANHIC [Alberta Natural Heritage Information Centre]. 2005. Community database files. Alberta Natural Heritage Information Centre, Parks and Protected Areas Division, Alberta Community Development, Edmonton.

Agee, J. K., and J. Kertis. 1987. Forest types of the north Cascades National Park Service complex. Canadian Journal of Botany 65:1520-1530.

Agee, J. K., and R. Wasem. 1987. Stetattle Creek Research Natural Area. Federal Research Natural Areas in Oregon and Washington. Supplement No. 25. 25 pp.

Aldous, A. E., and H. L. Shantz. 1924. Types of vegetation in the semiarid portion of the United States and their economic significance. Journal of Agricultural Research 28(2):99-128.

Alexander, B. G., Jr., E. L. Fitzhugh, F. Ronco, Jr., and J. A. Ludwig. 1987. A classification of forest habitat types of the northern portion of the Cibola National Forest, NM. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-143. Fort Collins, CO. 35 pp.

Alexander, B. G., Jr., F. Ronco, Jr., A. S. White, and J. A. Ludwig. 1984b. Douglas-fir habitat types of northern Arizona. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-108. Fort Collins, CO. 13 pp.

Alexander, B. G., Jr., F. Ronco, Jr., E. L. Fitzhugh, and J. A. Ludwig. 1984a. A classification of forest habitat types of the Lincoln National Forest, New Mexico. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-104. Fort Collins, CO. 29 pp.

Alexander, R. M. 1986. Classification of the forest vegetation of Wyoming. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Note RM-466. Fort Collins, CO. 10 pp.

Alexander, R. R. 1985. Major habitat types, community types, and plant communities in the Rocky Mountains. USDA Forest Service General Technical Report RM-123. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 105 pp.

Alexander, R. R., and F. Ronco, Jr. 1987. Classification of the forest vegetation on the national forests of Arizona and New Mexico. USDA Forest Service Research Note RM-469. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Allard, D. J. 1990. Southeastern United States ecological community classification. Interim report, Version 1.2. The Nature Conservancy, Southeast Regional Office, Chapel Hill, NC. 96 pp.

Anderson, W. E. 1956. Some soil-plant relationships in eastern Oregon. Journal of Range Management 9:171-175.

Annable, C. R. 1985. Vegetation and flora of the Funeral Mountains, Death Valley National Monument. California-Nevada Cooperative National Park Resources Studies Unit, National Park Service/University of Nevada Contribution 016/07. Las Vegas, NV. 188 pp.

Arno, S. F. 1980. Forest fire history in the northern Rockies. Journal of Forestry 78(8):460-465.

Atzet, T. A., D. E. White, L. A. McCrimmon, P. A. Martinez, P. R. Fong, and V. D. Randall. 1996. Field guide to the forested plant associations of southwestern Oregon. USDA Forest Service, Pacific Northwest Region. Technical Paper R6-NR-ECOL-TP-17-96. Portland, OR.

Atzet, T., and D. L. Wheeler. 1984. Preliminary plant associations of the Siskiyou Mountains Province, Siskiyou National Forest. USDA Forest Service, Pacific Northwest Region, Portland, OR.

BIA [Bureau of Indian Affairs]. 1979. The secretarial land use plan for the addition to the Havasupai Indian Reservation. Unpublished draft Environmental Statement INT DES 79-42. Prepared by USDI BIA, Phoenix Area Office with the assistance of Office of Arid Land Studies, University of Arizona, Tucson.

BLM [Bureau of Land Management]. 1979a. Pages 2-6 to 2-15 in: Grand Junction Resource Area grazing management-draft environmental statement.

Bachrach, J. H. 1951. The plant communities of a valley in the montane forest of the Colorado Front Range. Unpublished thesis, University of Colorado, Boulder. 68 pp.

Badaracco, R. J. 1971. An interpretive resource analysis of Pawnee Buttes, Colorado. Unpublished dissertation, Colorado State University, Fort Collins. 341 pp.

Bader, E. H. 1932. The vegetation of the Mesa Verde National Park, Colorado. Unpublished thesis, University of Colorado, Boulder. 64 pp.

Baker, W. L. 1980a. Alpine vegetation of the Sangre De Cristo Mountains, New Mexico: Gradient analysis and classification. Unpublished thesis, University of North Carolina, Chapel Hill. 55 pp.

Baker, W. L. 1982b. Natural vegetation of the Piceance Basin, Colorado. Appendix D, pages 1-113 in: J. S. Peterson and W. L. Baker, editors. Inventory of the Piceance Basin, Colorado. Unpublished report for the Bureau Land Management, Craig, CO.

Baker, W. L. 1983a. Alpine vegetation of Wheeler Peak, New Mexico, USA: Gradient analysis, classification, and biogeography. Arctic and Alpine Research 15(2):223-240.

Baker, W. L. 1983b. Some aspects of the presettlement vegetation of the Piceance Basin, Colorado. Great Basin Naturalist 43(4):687-699.
Baker, W. L. 1983c. Natural vegetation of part of northwestern Moffat County, Colorado. Unpublished report prepared for the State of Colorado Natural Areas Program, Department of Natural Resources, Denver by Colorado Natural Heritage Inventory, Denver.
Baker, W. L. 1983d. A preliminary classification of the natural vegetation of Colorado. Unpublished report prepared for the Colorado Natural Heritage Inventory, Denver. 17 pp.
Baker, W. L. 1984a. A preliminary classification of the natural vegetation of Colorado. Great Basin Naturalist 44(4):647-676.
Baker, W. L., and S. C. Kennedy. 1985. Presettlement vegetation of part of northwestern Moffat County, Colorado, described from remnants. Great Basin Naturalist 45(4):747-777.
Barbour, M. G., and J. Major, editors. 1977. Terrestrial vegetation of California. John Wiley and Sons, NY. 1002 pp.
Barbour, M. G., and J. Major, editors. 1988. Terrestrial vegetation of California: New expanded edition. California Native Plant Society, Special Publication 9, Sacramento. 1030 pp.
Barrows, J. S., E. W. Mogren, K. Rowdabaugh, and R. Yancik. 1977. The role of fire in ponderosa pine and mixed conifer ecosystems. Final report, Cooperative report between the National Park Service and Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 101 pp.
Bassett, D., M. Larson, and W. Moir. 1987. Forest and woodland habitat types of Arizona south of the Mogollon Rim and southwestern New Mexico. Edition 2. USDA Forest Service, SW Region, Albuquerque, NM.
Bear Creek Uranium Mine Application. No date. Unpublished report No. 399 prepared for Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne, WY.
Beatley, J. C. 1975. Climates and vegetation pattern across the Mojave/Great Basin desert transition of southern Nevada. The American Midland Naturalist 93:53-70.
Beatley, J. C. 1976. Vascular plants of the Nevada Test Site and central-southern Nevada: Ecological and geographic distributions. Technical Information Center, Energy Research and Development Administration. TID-26881. Prepared for Division of Biomedical and Environmental Research. 297 pp.
Beetle, A. A., and K. L. Johnson. 1982. Sagebrush in Wyoming. Wyoming Agricultural Experiment Station Bulletin 779. University of Wyoming, Laramie.
Beguin, C., and J. Major. 1975. Contribution a l'etude phytosociologique et ecologique des marais de la Sierra Nevada (Californie). Phytocoenologia 2:349-367.
Bighorn Coal Mine. No date. Application No. 213-T2, on file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.
Billings, W. D. 1945. The plant associations of the Carson Desert region, western Nevada. Butler University Botanical Studies 7:89-123.
Billings, W. D. 1949. The shadscale vegetation zone of Nevada and eastern California in relation to climate and soils. The American Midland Naturalist 42(1):87-109.
Blackburn, W. H. 1967. Plant succession on selected habitat types in Nevada. Unpublished thesis, University of Nevada, Reno. 162 pp.
Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1968a. Vegetation and soils of the Mill Creek Watershed. Nevada Agricultural Experiment Station Bulletin R-43. Reno. 69 pp.
Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1968b. Vegetation and soils of the Crowley Creek Watershed. Nevada Agricultural Experiment Station Bulletin R-42. Reno. 60 pp.
Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1968c. Vegetation and soils of the Duckwater Watershed. Nevada Agricultural Experiment Station Bulletin R-40. Reno. 76 pp.
Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1969a. Vegetation and soils of the Cow Creek Watershed. Nevada Agricultural Experiment Station Bulletin R-49. Reno. 80 pp.
Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1969b. Vegetation and soils of the Coils Creek Watershed. Nevada Agricultural Experiment Station Bulletin R-48. Reno. 81 pp.
Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1969c. Vegetation and soils of the Churchill Canyon Watershed. Nevada Agricultural Experiment Station Bulletin R-45. Reno. 157 pp.
Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1969d. Vegetation and soils of the Pine and Mathews Canyon Watersheds. Nevada Agricultural Experiment Station Bulletin R-46. Reno. 111 pp.
Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1971. Vegetation and soils of the Rock Springs Watershed. Nevada Agricultural Experiment Station Bulletin R-83. Reno. 116 pp.
Blackburn, W. H., and P. T. Tueller. 1970. Pinyon and juniper invasion in black sagebrush communities in east-central Nevada. Ecology 51:841-848.

Blackhawk Coal Company. 1981. Vegetation resources. Chapter 9 Section 9.2, pages 9-1 through 9-27 in: Mining and Reclamation Plan for Willow Creek Mine, Blackhawk Coal Company. Utah Division of Oil, Gas & Mining Number ACT/007/002. Salt Lake City, UT.

Boggs, K. 2000. Classification of community types, successional sequences and landscapes of the Copper River Delta, Alaska. USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-469. Portland, OR. March 2000. 244 pp.

Bond, H. E. 1959. Revegetation and disintegration of pocket gopher mounds on Black Mesa, Colorado. Unpublished thesis, Colorado State University, Fort Collins.

Bork, J. L. 1978. A survey of the vascular plants and vertebrates of Upper Table Rock. M.S. thesis, Southern Oregon State College, Ashland. 91 pp.

Boss, T. R. 1983. Vegetation ecology and net primary productivity of selected freshwater wetlands in Oregon. Ph.D. dissertation, Oregon State University, Corvallis. 236 pp.

Bourgeron, P. S., L. D. Engelking, H. C. Humphries, E. Muldavin, and W. H. Moir. 1995. Assessing the conservation value of the Gray Ranch: Rarity, diversity and representativeness. Desert Plants 11:2-3.

Bourgeron, P. S., and L. D. Engelking, editors. 1994. A preliminary vegetation classification of the western United States. Unpublished report. The Nature Conservancy, Western Heritage Task Force, Boulder, CO. 175 pp. +app.

Boutton, T. W., A. T. Harrison, and B. N. Smith. 1980. Distribution of biomass of species differing in photosynthetic pathway along an altitudinal transect in southwestern Wyoming grasslands. Oecologia 45:287-298.

Boyce, D. A. 1977. Vegetation of the South Fork of the White River Valley, Colorado. Unpublished dissertation, University of Colorado, Boulder. 312 pp.

Bradley, W. G. 1964. The vegetation of the desert game range with special reference to the desert bighorn. Pages 43-67 in: Transcripts of the Desert Bighorn Council. Las Vegas, NV.

Bragg, T. B., and L. C. Hulbert. 1976. Woody plant invasion of unburned Kansas bluestem prairie. Journal of Range Management 29(1):19-24.

Bramble-Brodahl, M. K. 1978. Classification of *Artemisia* vegetation in the Gros Ventre area, Wyoming. M.S. thesis, University of Idaho, Moscow.

Branson, F. A., R. F. Miller, and I. S. McQueen. 1961. Soil-water availability and use by grasslands on adjacent stony and shale-derived soils in Colorado. Short papers in geologic and hydrologic sciences. U.S. Geological Survey Professional Paper 424C:251-253.

Branson, F. A., R. F. Miller, and I. S. McQueen. 1964. Effects of two kinds of geologic materials on plant communities and soil moisture. American Society of Agronomy Special Publication 5:165-175.

Branson, F. A., R. F. Miller, and I. S. McQueen. 1965. Plant communities and soil moisture relationships near Denver, Colorado. Ecology 46(3):311-319.

Branson, F. A., R. F. Miller, and I. S. McQueen. 1967. Geographic distribution and factors affecting the distribution of salt desert shrubs in the United States. Journal of Range Management 29(5):287-296.

Branson, F. A., R. F. Miller, and I. S. McQueen. 1976. Moisture relationships in twelve northern desert shrub communities near Grand Junction, Colorado. Ecology 57:1104-1124.

Branson, F. A., and J. B. Owen. 1970. Plant cover, runoff, and sediment yield relationships on Mancos shale in western Colorado. Water Resources Research 6:783-790.

Brayshaw, T. C. 1965. The dry forest of southern British Columbia. Pages 65-75 in: V. J. Krajina, editor. Ecology of western North America. Volume I, illustrated. University of British Columbia, Department of Botany.

Brooks, R. E., and S. E. Clemants. Juncaceae. Pages 211-267 in: Flora of North America Editorial Committee, editors. Flora of North America. Volume 22. Oxford University Press, New York, NY.

Brotherson, J. D. 1987. Plant community zonation in response to soil gradients in a saline meadow near Utah Lake, Utah County, Utah. Great Basin Naturalist 47(2):322-333.

Brotherson, J. D., L. L. Rasmussen, and R. D. Black. 1986. Comparative habitat and community relationships of *Atriplex confertifolia* and *Sarcobatus vermiculatus* in central Utah. Great Basin Naturalist 46(2):348-357.

Brotherson, J. D., and K. J. Brotherson. 1979. Ecological and community relationships of *Eriogonum corymbosum* (Polygonaceae) in the Uinta Basin, Utah. Great Basin Naturalist 39:177-191.

Brotherson, J. D., and S. J. Barnes. 1984. Habitat relationships of *Glaux maritima* in central Utah. Great Basin Naturalist 44(2):299-309.

Brotherson, J. D., and W. T. Brotherson. 1981. Grazing impacts on the sagebrush communities of central Utah. Great Basin Naturalist 41(3):335-340.

Brown, D. E., editor. 1982. Biotic communities of the American Southwest-United States and Mexico. Desert Plants Special Issue 4(1-4):1-342.

Brown, R. W. 1971. Distribution of plant communities in southeastern Montana badlands. The American Midland Naturalist 85(2):458-477.

Bujakiewicz, A. 1975. Vegetational zonation in the Front Range of the Rocky Mountains, Colorado. USA. Fragmenta Floristica et Geobotanica 21:99-142.

Bundy, R. M., J. V. Baumgartner, M. S. Reid, P. S. Bourgeron, H. C. Humphries, and B. L. Donohue. 1996. Ecological classification of wetland plant associations in the Lahontan Valley, Nevada. Prepared for Stillwater National Wildlife Refuge and USDI Fish & Wildlife Service. 53 pp. + inventories, tables and graphs.

Bunin, J. E. 1975a. Aspen forests of the west slope of the Park Range, north-central Colorado. Unpublished paper presented at the 1975 AIBS/ESA Meetings, 17-22 August 1975, Oregon State University, Corvallis. 22 pp.

Bunin, J. E. 1975c. The vegetation of the west slope of the Park Range, Colorado. Unpublished dissertation, University of Colorado, Boulder. 235 pp.

Bunin, J. E. 1985. Vegetation of the City of Boulder, Colorado open space lands. Report prepared for the City of Boulder, Real Estate/Open Space, Boulder, CO. 114 pp.

Burns, R. M., and B. H. Honkala, technical coordinators. 1990a. Silvics of North America: Volume 1. Conifers. USDA Forest Service. Agriculture Handbook 654. Washington, DC. 675 pp.

Butler, J., D. Crawford, S. Menard, and T. Meyer. 2002. Lacreek National Wildlife Refuge, South Dakota. USGS-USFWS Vegetation Mapping Program. Final report. Technical Memorandum 8260-02-02, Remote Sensing and GIS Group, Technical Service Center, Bureau of Reclamation, Denver, CO.

CONHP [Colorado Natural Heritage Program]. 2003. Unpublished data. List of Elements and Elcodes converted and entered into Biotics Tracker 4.0. CO Natural Heritage Program, Colorado State University, Fort Collins, CO.

CONHP [Colorado Natural Heritage Program]. No date. Biological and Conservation Data (BCD) System. Unpublished field survey data. Colorado Natural Heritage Program, CO State University, Fort Collins, CO.

CONHP [Colorado Natural Heritage Program]. Personal communication. Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Cacek, T. L. 1973. An ecological interpretation of north central Colorado. Unpublished dissertation, Colorado State University, Fort Collins. 261 pp.

Caicco, S. L., and C. A. Wellner. 1983a. Research Natural Area recommendation for City of Rocks. Unpublished report prepared for USDI Bureau of Land Management, Burley District, Idaho by Idaho Natural Areas Coordinating Committee. On file at Idaho Conservation Data Center, Boise, ID. 12 pp.

Caicco, S. L., and C. A. Wellner. 1983c. Research Natural Area recommendation for Southwest Lemhi Range. Unpublished report prepared for USDI Bureau of Land Management, Idaho Falls District, Idaho by Idaho Natural Areas Coordinating Committee. On file at Idaho Conservation Data Center, Boise, ID.

Caicco, S. L., and C. A. Wellner. 1983f. Research Natural Area recommendation for Menan Buttes. Unpublished report prepared for USDI Bureau of Land Management, Idaho Falls District, Idaho by Idaho Natural Areas Coordinating Committee. 10 pp.

Caicco, S. L., and C. A. Wellner. 1983g. Research Natural Area recommendation for Middle Canyon Alluvial Fan. Unpublished report prepared for USDI Bureau of Land Management, Idaho Falls District, Idaho by Idaho Natural Areas Coordinating Committee.

Caicco, S. L., and C. A. Wellner. 1983h. Research Natural Area recommendation for Brass Cap Kipuka. Unpublished report prepared for USDI Bureau of Land Management, Shoshone District, Idaho by Idaho Natural Areas Coordinating Committee. 15 pp.

Caicco, S. L., and C. A. Wellner. 1983i. Research Natural Area recommendation for Substation Tract. Unpublished report prepared for USDI Bureau of Land Management, Shoshone District, Idaho by Idaho Natural Areas Coordinating Committee. 11 pp.

Caicco, S. L., and C. A. Wellner. 1983j. Research Natural Area recommendation for Big Juniper Kipuka. Unpublished report prepared for USDI Bureau of Land Management, Shoshone District, Idaho by Idaho Natural Areas Coordinating Committee.

Caicco, S. L., and C. A. Wellner. 1983k. Research Natural Area recommendation for East Fork Salmon River Bench. Unpublished report prepared for USDI Bureau of Land Management, Salmon District, Idaho by Idaho Natural Areas Coordinating Committee. 14 pp.

Caicco, S. L., and C. A. Wellner. 1983l. Research Natural Area recommendation for Antelope Flat. Unpublished report prepared for USDI, Bureau of Land Management, Salmon District, Idaho by Idaho Natural Areas Coordinating Committee. 12 pp.

Caicco, S. L., and C. A. Wellner. 1983n. Research Natural Area recommendation for Little Jacks Creek. Unpublished report prepared for USDI Bureau of Land Management, Boise District, Idaho by Idaho Natural Areas Coordinating Committee. 14 pp.

Campbell, V. O. 1977. Certain edaphic and biotic factors affecting vegetation in the shadscale community of the Kaiparowitz area. Unpublished thesis, Brigham Young University, Provo, UT. 59 pp.

Carmichael, R. S., O. D. Knipe, C. P. Pase, and W. W. Brady. 1978. Arizona chaparral: Plant associations and ecology. USDA Forest Service Research Paper RM-202. 16 pp.

Carsey, K., D. Cooper, K. Decker, D. Culver, and G. Kittel. 2003b. Statewide wetlands classification and characterization: Wetland plant associations of Colorado. Prepared for Colorado Department of Natural Resources, Denver, by Colorado Natural Heritage Program, College of Natural Resources, Colorado State University, Fort Collins. 79 pp. [http://www.cnhp.colostate.edu/documents/2003/wetland_classification_final_report_2003.pdf]

Carsey, K., G. Kittel, K. Decker, D. J. Cooper, and D. Culver. 2003a. Field guide to the wetland and riparian plant associations of Colorado. Colorado Natural Heritage Program, Fort Collins, CO.

Chappell, C. 1994. Natural forests of the Puget Lowland, Washington. Northwest Science Abstract.

Chappell, C., R. Crawford, J. Kagan, and P. J. Doran. 1997. A vegetation, land use, and habitat classification system for the terrestrial and aquatic ecosystems of Oregon and Washington. Unpublished report prepared for Wildlife habitat and species associations within Oregon and Washington landscapes: Building a common understanding for management. Prepared by Washington and Oregon Natural Heritage Programs, Olympia WA, and Portland, OR. 177 pp.

Christensen, E. M. 1963. The foothill bunchgrass vegetation of central Utah. Ecology 44(1):156-158.

Christensen, E. M., and S. L. Welsh. 1963. Presettlement vegetation of the valleys of western Summit and Wasatch counties, Utah. Proceedings of the Utah Academy of Science, Arts and Letters 40:163-174.

Christy, J. A. 2004. Native freshwater wetland plant associations of northwestern Oregon. Oregon Natural Heritage Information Center, Oregon State University, Portland, OR.

Christy, J. A., and L. C. Cornelius. 1980. Katherine Ordway Sycan Marsh Preserve: Preliminary classification of plant communities. The Nature Conservancy, Oregon Field Office, Portland.

Clausnitzer, R. R., and B. A. Zamora. 1987. Forest habitat types of the Colville Indian Reservation. Unpublished report prepared for the Department of Forest and Range Management, Washington State University, Pullman. 110 pp.

Coenenberg, J. G., and E. J. Depuit. 1979. Baseline wildlife studies, Crow Coal Lease, southeastern Montana, 1975-1978. Montana Agricultural Experiment Station, Reclamation Research Unit, Bozeman, MT. 133 pp.

Cogan, D., M. Reid, K. Schulz, and M. Pucherelli. 2004. Zion National Park, Utah 1999-2003. Vegetation Mapping Project. Technical Memorandum 8260-03-01. Remote Sensing and GIS Group Technical Service Center, Bureau of Reclamation, Denver, CO. Appendix F: Vegetation Association Descriptions for Zion.

Cole, D. N. 1982. Vegetation of two drainages in Eagle Cap Wilderness, Wallowa Mountains, Oregon. USDA Forest Service Research Paper INT-288.

Collins, E. I., R. W. Lichvar, and E. F. Evert. 1984. Description of the only known fen-palsa in the 48 contiguous United States. Arctic and Alpine Research 16:255-258.

Colorado Natural Heritage Program Ecology Team. 2001. A classification of the native vegetation of Colorado. Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Comer, P. (editor), L. Allen, S. Cooper, D. Faber-Langendoen, and G. Jones. 1999. Selected shrubland and grassland communities of the northern Great Plains. Report to the Nebraska National Forest. The Nature Conservancy.

Cooper, D. J. 1993. Wetlands of the Crested Butte region: Mapping, functional evaluation, and hydrologic regime. Prepared for Town of Crested Butte and the U.S. Environmental Protection Agency, Region VIII, Denver, CO.

Cooper, D. J., and C. Severn. 1992. Wetlands of the San Luis Valley, Colorado: An ecological study and analysis of the hydrologic regime, soil chemistry, vegetation and the potential effects of a water table drawdown. Report submitted to the State of Colorado Division of Wildlife, the USDI Fish & Wildlife Service and the Rio Grande Water Conservation District.

Cooper, D. J., and T. R. Cottrell. 1990. Classification of riparian vegetation in the northern Colorado Front Range. Unpublished report prepared for The Nature Conservancy, Colorado Field Office, Boulder. 115 pp.

Cooper, S. V. 1975. Forest habitat types of northwestern Wyoming and contiguous portion of Montana and Idaho. Unpublished dissertation, Washington State University, Pullman. 190 pp.

Cooper, S. V., C. Jean, and B. L. Heidel. 1999. Plant associations and related botanical inventory of the Beaverhead Mountains Section, Montana. Unpublished report to the Bureau of Land Management. Montana Natural Heritage Program, Helena. 235 pp.

Cooper, S. V., K. E. Neiman, R. Steele, and D. W. Roberts. 1987. Forest habitat types of northern Idaho: A second approximation. USDA Forest Service, Intermountain Research Station. General Technical Report INT-236. Ogden, UT. 135 pp. [reprinted in 1991]

Cooper, S. V., P. Lesica, R. L. DeVelice, and T. McGarvey. 1995. Classification of southwestern Montana plant communities with emphasis on those of Dillon Resource Area, Bureau of Land Management. Montana Natural Heritage Program, Helena, MT. 154 pp.

Cooper, S. V., and B. L. Heidel. 1997. Population status and ecology of trembling aspen and black cottonwood communities on the Blackfeet Indian Reservation. Prepared for the Blackfeet Nation-Fish and Wildlife Department and the USDI Fish & Wildlife Service by Montana Natural Heritage Program, Helena, MT.

Cooper, S., and R. Pfister. 1981. Forest habitat types of the Blackfeet Indian Reservation. Review Draft, 5/21/81, for Bureau of Indian Affairs, Wind River Agency, Fort Washakie, WY.

Copeland, W. N. 1978. Botanical survey of Eight Dollar Mountain, May 6-9, 1978. Oregon Natural Heritage Data Base, Portland, OR.

Copeland, W. N. 1979. Harney Lake RNA Guidebook, Supplement #9. USDA Forest Service Experiment Station, Portland, OR.

Copeland, W. N. 1980a. The Lawrence Memorial Grassland Preserve, a biophysical inventory with management recommendations. June 1980. Unpublished report prepared by The Nature Conservancy Field Office, Portland, Oregon. 161 pp.

Copeland, W. N., and S. E. Greene. 1982. Stinking Lake Research Natural Area. Supplement #12 to Franklin, J. F., F. C. Hall, C. T. Dyrness and C. Maser. 1972. Federal research natural areas in Oregon and Washington: A guidebook for scientists and educators. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, OR.

Costello, D. F. 1944b. Important species of the major forage types in Colorado and Wyoming. Ecological Monographs 14:107-134.

Costello, D. F. 1954. Vegetation zones in Colorado. Pages iii-x in: H. D. Harrington, editor. Manual of the plants of Colorado. Sage Books, Denver.

Cotter-Ferguson Project. No date. Application No. 490, on file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Biological Service Program. FWS/OBS-79/31. Washington, DC. 103 pp.

Cox, B. J. 1968. A vegetational comparison of the Gothic and Galena Mountain area. Transactions of the Missouri Academy of Science 2:72-83.

Crane, M. F. 1982. Fire ecology of Rocky Mountain Region forest habitat types. USDA Forest Service final report. 272 pp.

Crawford, R. C. 2001. Initial riparian and wetland classification and characterization of the Columbia Basin in Washington. Prepared for Environmental Protection Agency and Bureau of Land Management, Spokane District. Washington Natural Heritage Program, WA Department of Natural Resources, Olympia. 83 pp.

Crawford, R. C. 2003. Riparian vegetation classification of the Columbia Basin, Washington. Natural Heritage Report 2003-03. Washington Natural Heritage Program, Washington Department of Natural Resources, Olympia. 98 pp. plus appendices.

Cronquist, A., A. H. Holmgren, N. H. Holmgren, J. L. Reveal, and P. K. Holmgren. 1977. Intermountain flora: Vascular plants of the Intermountain West, U.S.A. Volume 6: The Monocotyledons. Columbia University Press, New York. 584 pp.

Cross, A. F. 1991. Vegetation of two southeastern Arizona desert marshes. Madrono 38(3):185-194.

Crouch, G. L. 1983. Effects of commercial clear-cutting of aspen on understory vegetation and wildlife habitat values in southwestern Colorado. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Paper RM-246. Fort Collins, CO.

Crow, J. H. 1968. Plant ecology of the Copper River Delta, Alaska. Ph.D. thesis, Washington State University, Pullman. 120 pp.

Crow, J. H. 1977. Salt marshes of Port Valdez, Alaska, and vicinity: A baseline study. Final report. Newark College of Arts and Sciences, Rutgers University, New Brunswick, NJ. 113 pp.

Crowe, E. A., B. L. Kovalchik, and M. J. Kerr. 2004. Riparian and wetland vegetation of central and eastern Oregon. Oregon Natural Heritage Information Center, Institute for Natural Resources, Oregon State University, Portland. 473 pp. [<http://oregonstate.edu/ornhic/ publications.html>]

Crowe, E. A., and R. R. Clausnitzer. 1997. Mid-montane wetland plant associations of the Malheur, Umatilla, and Wallowa-Whitman national forests. USDA Forest Service, Pacific Northwest Region. Technical Paper R6-NR-ECOL-TP-22-97.

Culwell, L. D., and K. L. Scow. 1982. Terrestrial vegetation inventory: Dominy Project Area, Custer County, Montana 1979-1980. Unpublished technical report for Western Energy Company by Westech, Helena, MT. 144 pp. plus 15 pp. appendix.

Current, F. B. 1984. The distribution and description of the vegetation of Battle Mountain as explained by abiotic factors. Unpublished dissertation, University of Wyoming, Laramie.

Curry, R. R. 1962. Geobotanical correlations in the alpine and subalpine regions of the Tenmile Range, Summit County, Colorado. Unpublished thesis, University of Colorado, Boulder. 133 pp.

Dastrup, B. C. 1963. Vegetational changes of the Uinta Basin since settlement. Unpublished thesis, Brigham Young University, Provo, UT. 118 pp.

Daubenmire, R. 1952. Forest vegetation of northern Idaho and adjacent Washington, and its bearing on concepts of vegetation classification. Ecological Monographs 22(4):301-330.

Daubenmire, R. 1988. Steppe vegetation of Washington. Washington State University Cooperative Extension Service Publication EB1446. (Revised from and replaces Washington Agricultural Experiment Station Publication XT0062.) 131 pp.

Daubenmire, R. 1992. Palouse prairie. Pages 297-312 in: R. T. Coupland, editor. Natural grasslands introduction and Western Hemisphere. Ecosystems of the world, Volume 8A. Elsevier Publishing Company, Amsterdam.

Daubenmire, R. F. 1970. Steppe vegetation of Washington. Washington State University Agricultural Experiment Station Technical Bulletin No. 62. 131 pp.

Daubenmire, R. F., and J. B. Daubenmire. 1968. Forest vegetation of eastern Washington and northern Idaho. Washington State University Agricultural Experiment Station Technical Bulletin No. 60. 104 pp.

Day, T. A. 1985. Plant association and soil factors in primary succession on cinder cones in Idaho. Unpublished thesis, University of Idaho, Moscow. 62 pp.

Day, T. A., and R. G. Wright. 1985. The vegetation types of Craters of the Moon National Monument. Forestry, Wildlife, and Range Experiment Station Bulletin No. 38. University of Idaho, Moscow. 6 pp.

DeByle, N. V. 1985. Managing wildlife habitat with fire in the aspen ecosystem. Pages 73-82 in: Fire's effects on wildlife habitat-Symposium proceedings. USDA Forest Service General Technical Report INT-186. Intermountain Research Station, Ogden, UT.

DeByle, N. V. 1989. Aspen ecology and management in the western United States. Pages 11-20 in: USDA Forest Service General Technical Report.

DeByle, N. V., and R. P. Winokur, editors. 1985. Aspen: Ecology and management in the western United States. USDA Forest Service General Technical Report RM-119. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 283 pp.

DeVelice, R. L. 1983. Forest vegetation of northern New Mexico and southern Colorado. Unpublished dissertation, New Mexico State University, Las Cruces. 191 pp.

DeVelice, R. L. 1992. Classification of the plant communities of Beaverhead, Silver Bow, and Madison counties, Montana. Volume I (text). Prepared for the Montana Natural Heritage Program, Helena, MT. 35 pp.

DeVelice, R. L., G. J. Daumiller, P. S. Bourgeron, and J. O. Jarvie. 1992. Assessing the representativeness of nature preserves in the upper Blackfoot River area, Montana. The Northwest Environmental Journal 8(1):___.

DeVelice, R. L., J. A. Ludwig, W. H. Moir, and F. Ronco, Jr. 1986. A classification of forest habitat types of northern New Mexico and southern Colorado. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-131. Fort Collins, CO. 59 pp.

DeVelice, R. L., J. Lichthardt, and P. S. Bourgeron. 1991. A preliminary classification of the plant communities of northeastern Montana. Prepared for the Montana Natural Heritage Program. Helena, MT. 144 pp.

DeVelice, R. L., S. V. Cooper, J. T. McGarvey, J. Lichthardt, and P. S. Bourgeron. 1995. Plant communities of northeastern Montana: A first approximation. Montana Natural Heritage Program, Helena, MT. 116 pp.

DeVelice, R. L., and J. A. Ludwig. 1983a. Climax forest series of northern New Mexico and southern Colorado. Pages 45-53 in: Proceedings of the Workshop on Southwestern Habitat Types, 6-8 April 1983, Albuquerque, NM. USDA Forest Service, Southwest Region, Albuquerque, NM.

DeVelice, R. L., and P. Lesica. 1993. Plant community classification for vegetation on BLM lands, Pryor Mountains, Carbon Co., Montana. Unpublished report by MT Natural Heritage Program, Helena, MT. 78 pp.

Dean, M. L. 1960. A taxonomic and ecologic study of the vascular plants of a section of the Owyhee River Canyon in Oregon. M.S. thesis, Oregon State University, Corvallis.

Del Moral, R., and J. N. Long. 1977. Classification of montane forest community types in the Cedar River drainage of western Washington, U.S.A. Canadian Journal of Forest Research 7(2):217-225.

Despain, D. G. 1973a. Vegetation of the Big Horn Mountains, Wyoming, in relation to substrate and climate. Ecological Monographs 43(3):329-354.

Diamond, D. D. 1993. Classification of the plant communities of Texas (series level). Unpublished document. Texas Natural Heritage Program, Austin. 25 pp.

Dick-Peddie, W. A. 1986. Draft manuscript for book on vegetation of New Mexico to be published by University of New Mexico Press.

Dick-Peddie, W. A. 1993. New Mexico vegetation: Past, present, and future. University of New Mexico Press, Albuquerque. 244 pp.

Doescher, P. S., R. F. Miller, S. R. Swanson, and A. H. Winward. 1986. Identification of the *Artemisia tridentata* ssp. *wyomingensis/Festuca idahoensis* habitat type in eastern Oregon. Northwest Science 60(1):55-60.

Donart, G. B., D. D. Sylvester, and W. C. Hickey. 1978b. Potential natural vegetation-New Mexico. New Mexico Interagency Range Commission Report 11.

Donart, G. B., D. Sylvester, and W. Hickey. 1978a. A vegetation classification system for New Mexico, USA. Pages 488-490 in: Rangeland Congress, Denver, CO, 14-18 August 1978. Society for Range Management, Denver.

Donnelly, P., D. Lindsey, E. Muldavin, Y. Chauvin, and A. Browder. 2006. Vegetation communities of Bosque del Apache National Wildlife Refuge. Prepared by U.S. Fish and Wildlife Service, National Wildlife Refuge Remote Sensing Lab, Albuquerque, NM, and Natural Heritage New Mexico, University of New Mexico, Albuquerque. Final report submitted to U.S. Fish and Wildlife Service, Southwest Region (R2), National Wildlife Refuge System (NWR), NWR Remote Sensing Lab, Division of Planning. 27 pp. [http://www.fws.gov/data/documents/BDA%20NVCS%20Veg%20Community%20Report%20Example.pdf]

Dorn, R. D. 1969. Relations of moose, cattle and willows in southwestern Montana. Unpublished thesis, Montana State University, Bozeman. 79 pp.

Dorn, R. D. 1995. A taxonomic study of *Salix* section *Cordatae* subsection *Luteae* (Salicaceae). Brittonia 47(2):160-174.

Dorn, R. D. 1997. Rocky Mountain region willow identification field guide. Renewable Resources R2-RR-97-01. USDA Forest Service, Rocky Mountain Region, Denver, CO. 107 pp.

Douglas, G. W. 1971. An ecological survey of potential natural areas in the North Cascades National Park complex. Unpublished report prepared for Intercampus Education and Science Preserves Commission, State of Washington. 137 pp.

Driese, K. L., W. A. Reiners, E. H. Merrill, and K. G. Gerow. 1997. A digital land cover map of Wyoming, USA: A tool for vegetation analysis. Journal of Vegetation Science 8:133-146.

Driscoll, R. S., D. L. Merkel, D. L. Radloff, D. E. Snyder, and J. S. Hagihara. 1984. An ecological land classification framework for the United States. USDA Forest Service. Miscellaneous Publication No. 1439. Washington, DC. 56 pp.

Durkin, P., M. Bradley, E. Muldavin, and P. Mehlhop. 1994b. A riparian/wetland vegetation community classification of New Mexico: Pecos River Basin. Unpublished report for New Mexico Environment Department Surface Water Quality Bureau.

Durkin, P., M. Bradley, E. Muldavin, and P. Mehlhop. 1995a. Riparian/wetland vegetation community classification of Rio Grande: A classification and site evaluation. Unpublished report for New Mexico Environment Department Surface Water Quality Bureau. New Mexico Natural Heritage Program, Albuquerque.

Dwyer, D. D., and R. D. Pieper. 1967. Fire effects on blue gramma-pinyon-juniper rangeland in New Mexico. Journal of Range Management 20:359-362.

Dyrness, C. T., J. F. Franklin, and W. H. Moir. 1974a. A preliminary classification of forest communities in the central portion of the western Cascades of Oregon. Coniferous Forest Biome Bulletin 4:1-123.

Earth Resource Technology. No date. Vanguard II Mine Application No. 334-T2, on file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.

Easterday, J. C., and M. S. Mamone. 1980. Vegetation of Warner Valley. Pages 3-66 in: C. Gilman, project director. Analysis of the aquatic habitats of Warner Valley with relation to land use patterns. Final report. National Science Foundation Grant SPI-78-03490. Department of Fisheries and Wildlife, Oregon State University, Corvallis. 175 pp.

Eddleman, L. E., and R. Jaindl. 1994. Great Basin National Park vegetation analysis. USDI National Park Service Technical Report NPS/PNROSU/NRTR-94/02. USDI National Park Service, PNW Region. 110 pp.

Eggler, W. A. 1941. Primary succession on volcanic deposits in southern Idaho. Ecological Monographs 11(3):278-298.

Ellis, S. L., T. Shoemaker, and R. Sanz. 1979. Inventories of plants, birds, mammals, reptiles, and amphibians of the Unaweep Canyon Springs, Mesa County, Colorado. Unpublished report prepared for Colorado Natural Areas Program, Department of Natural Resources, Denver.

Ellis, S., and P. Hackney. 1981. Vegetation baseline report: Clear Creek property. Unpublished report prepared for Chevron Shale Oil Co., Denver, CO, by Environmental Research and Technology Inc., Fort Collins, CO.

Empire Engineering and Land Surveying. 1986. Vegetation resources, Volume 2, Chapter 9, Sections 9.0-9.3, pages 9-1 through 9-19 and 9-38 through 9-41 in: Mining and Reclamation Plan for Black Jack Mine Number 1. Report for New Tech Mining Corporation. Utah Division of Oil, Gas, and Mining Act/019/004. Salt Lake City, UT.

Evans, S. 1989a. Riparian survey of Washington's Columbia Basin. Unpublished report prepared for The Nature Conservancy Washington Natural Heritage Program, Olympia, Washington.

Evans, S. 1989b. Provisional riparian and aquatic wetland plant communities on the Columbia Plateau. Unpublished report prepared under Contract No. C0089098, with Washington State Department of Ecology. 52 pp.

Evenden, A. G. 1990. Ecology and distribution of riparian vegetation in the Trout Creek Mountains of southeastern Oregon. Ph.D. dissertation, Oregon State University, Corvallis. 156 pp.

Evens, J. M., S. San, and J. Taylor. 2004. Vegetation classification and mapping of Peoria Wildlife Area, South of New Melones Lake, Tuolumne County, California. Prepared by California Native Plant Society, Sacramento, CA, in collaboration with J. Menke of Aerial Information Systems, Redlands, CA. 175 pp.

Evens, J. M., and E. Kentner. 2006. Classification of vegetation associations from the Mount Tamalpais Watershed, Nicasio Reservoir, and Soulajule Reservior in Marin County, California. Report for the Marin Municipal Water District. California Native Plant Society, Sacramento.

Evens, J., and S. San. 2004. Vegetation associations of a serpentine area: Coyote Ridge, Santa Clara County, California. Unpublished report. California Native Plant Society, Sacramento, CA.

Eyre, F. H., editor. 1980. Forest cover types of the United States and Canada. Society of American Foresters, Washington, DC. 148 pp.

FEIS [Fire Effects Information System]. 1998. USDA Forest Service. URL http://www.fs.fed.us/database/feis/.

Faber-Langendoen, D., and Midwest State Natural Heritage Program Ecologists. 1996. Terrestrial vegetation of the midwest United States. International classification of ecological communities: Terrestrial vegetation of the United States. The Nature Conservancy, Arlington, VA.

Faber-Langendoen, D., editor. 2001. Plant communities of the Midwest: Classification in an ecological context. Association for Biodiversity Information, Arlington, VA. 61 pp. plus appendix (705 pp.).

Faden, A. O. 1977. Vegetation zonation of a Mohave Desert playa. Unpublished thesis, University of Nevada, Las Vegas.

Fautin, R. W. 1946. Biotic communities of the northern desert shrub biome in western Utah. Ecological Monographs 16(4):251-310.

Fenemore, R. M., Jr. 1970. Plant succession in a receding lake bed in the western Great Basin. Unpublished thesis, University of Nevada, Reno.

Ferchau, H. A. 1973. Vegetation inventory analysis & impact study of the Parachute Creek area, Garfield County, Colorado. Part II, Volume 1, Chapter VI:1-77 in: Unpublished Colony Environmental Report for Colony Develop. Operation, Denver, prepared by Thorne Ecological Institute, Boulder.

Fike, J. 1999. Terrestrial and palustrine plant communities of Pennsylvania. Pennsylvania Natural Diversity Inventory. Pennsylvania Dept. of Conservation and Recreation. Bureau of Forestry. Harrisburg, PA. 86 pp.

Fischer, W. C., and A. F. Bradley. 1987. Fire ecology of western Montana forest habitat types. USDA Forest Service General Technical Report INT-223. Intermountain Research Station, Ogden, UT. 95 pp.

Fischer, W. C., and B. D. Clayton. 1983. Fire ecology of Montana forest habitat types east of the Continental Divide. USDA Forest Service, Intermountain Forest Range Experiment Station. General Technical Report INT-141. Ogden, UT. 83 pp.

Fisser, H. G. 1962. An ecological study of the *Artemisia tripartita* subsp. *rupicola* and related shrub communities in Wyoming. Unpublished dissertation, University of Wyoming, Laramie.

Fisser, H. G. 1964. Range survey in Wyoming's Big Horn Basin of Wyoming. Wyoming Agricultural Experiment Station Bulletin 424.

Fisser, H. G. 1970. Exclosure studies with transects of permanent plots, 1969 results. University of Wyoming Cooperative Research Report to the USDI Bureau of Land Management, sections I-IV. Wyoming Agricultural Experiment Station. Science Report 240. Laramie, WY. 128 pp.

Fisser, H. G., D. C. Trueblood, and C. H. Butterfield. 1980. Soil-vegetation relationships on rangeland exclosures in the Overland Planning Unit of south central Wyoming. University of Wyoming Scientific Report Number 1042. Wyoming Agricultural Experiment Station, Laramie.

Fisser, H. G., J. R. Wight, J. R. Flesland, and L. D. Robinson. 1965. *Halogeton* research, 1964 results. University of Wyoming Cooperative Research Report to the USDI Bureau of Land Management, Sections I-VI. Wyoming Agricultural Experiment Station. Mimeographed Circular pages 1-82. University of Wyoming, Laramie.

Fitzhugh, E. L., W. H. Moir, J. A. Ludwig, and F. Ronco, Jr. 1987. Forest habitat types in the Apache, Gila, and part of the Cibola national forests. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-145. Fort Collins, CO. 116 pp.

Flowers, S. 1962. Vegetation of Morrow Point and Blue Mesa Reservoir basins of the upper Gunnison River, Colorado. Pages 47-102 in: A. M. Woodbury, editor. Ecological studies of the flora and fauna of the Curecanti Reservoir Basins, western Colorado. University of Utah, Anthropological Papers No. 59 (Upper CO Series #8).

Fonda, R. W., and J. A. Bernardi. 1976. Vegetation of Sucia Island in Puget Sound, Washington. Bulletin of the Torrey Botanical Club 103(3):99-109.

Francis, R. E. 1983. Sagebrush-steppe habitat types in northern Colorado: A first approximation. Pages 67-71 in: Proceedings of the Workshop on Southwestern habitat types. USDA Forest Service, Southwestern Region, Albuquerque, NM.

Francis, R. E. 1986. Phyto-edaphic communities of the Upper Rio Puerco Watershed, New Mexico. USDA Forest Service, RM Forest and Range Experiment Station. Research Paper RM-272. Fort Collins, CO. 73 pp.

Francis, R. E., and E. F. Aldon. 1983. Preliminary habitat types of a semiarid grassland. Pages 62-66 in: W. H. Moir and L. Hendzel, technical coordinators. Proceedings of the workshop on southwestern habitat types, 6-8 April 1983, Albuquerque, NM. USDA Forest Service, Southwestern Region, Albuquerque, NM.

Franklin, J. F., W. H. Moir, M. A. Hemstrom, S. E. Greene, and B. G. Smith. 1988. The forest communities of Mount Rainier National Park. USDI National Park Service. Scientific Monograph Series 19. Washington, DC. 194 pp.

Franklin, J. F., and C. T. Dyrness. 1969. Vegetation of Oregon and Washington. USDA Forest Service Research Paper PNW-80. Pacific Northwest Forest and Range Experiment Station, Portland, OR. 216 pp.

Franklin, J. F., and C. T. Dyrness. 1973. Natural vegetation of Oregon and Washington. USDA Forest Service, PNW Forest and Range Experiment Station. General Technical Report PNW-8. Portland, OR. 417 pp.

Freeman, C. E., and W. A. Dick-Peddie. 1970. Woody riparian vegetation in the Black and Sacramento Mountain ranges, southern New Mexico. The Southwestern Naturalist 15(2):145-164.

Ganskopp, D. C. 1979. Plant communities and habitat types of the Meadow Creek Experimental Watershed. Unpublished thesis, Oregon State University, Corvallis. 162 pp.

Gates, D. H., L. A. Stoddart, and C. W. Cook. 1956. Soil as a factor influencing plant distribution on salt-deserts of Utah. Ecological Monographs 26(2):155-175.

Giese, T. G. 1975. The ecology of the Middle Blue River Valley, Summit County, Colorado, with an analysis of modifications due to powerline construction. Unpublished thesis, University of Colorado, Boulder. 109 pp.

Girard, M. M., H. Goetz, and A. J. Bjugstad. 1989. Native woodland habitat types of southwestern North Dakota. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Paper RM-281. Fort Collins, CO. 36 pp.

Girard, M., D. L. Wheeler, and S. B. Mills. 1997. Classification of riparian communities on the Bighorn National Forest. R2-RR-97-02. USDA Forest Service, Rocky Mountain Region, Sheridan, WY. 308 pp.

Gleason, H. A., and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. New York Botanical Garden, Bronx, NY. 910 pp.

Godfread, C. 1994. The vegetation of the Little Missouri Badlands of North Dakota. Pages 17-24 in: Proceedings of the Leafy Spurge Strategic Planning Workshop, March 29-30, Dickinson, ND.

Goodding, L. N. 1923. An interesting area of limber pine extending into southwestern Nebraska. Journal of Forestry 21:175-176.

Graham, E. H. 1937. Botanical studies in the Uinta Basin of Utah and Colorado. Annals of the Carnegie Museum 26:28-432.

Graybosch, R. A., and H. Buchanan. 1983. Vegetative types and endemic plants of the Bryce Canyon Breaks. Great Basin Naturalist 43:701-712.

Great Plains Flora Association. 1986. Flora of the Great Plains. University Press of Kansas, Lawrence. 1402 pp.

Green, R. N., and K. Klinka. 1994. A field guide to site interpretation for the Vancouver Forest Region. British Columbia Ministry of Forests. ISSN 0229-1622 Land Management Handbook 28. 285 pp.

Greenall, J. A. 1996. Manitoba's terrestrial plant communities. MS Report 96-02, Manitoba Conservation Data Centre, Winnipeg.

Griffiths, D. 1902. Forage conditions in the northern border of the Great Basin. USDA Bureau of Plant Industry Bulletin 15.

Gross, J. E. 1955. A vegetation survey of the Poudre bighorn sheep range. Unpublished paper prepared for Big Game Management, WM-190D, Colorado State University, Fort Collins. 65 pp.

Grossman, D. H., K. Lemon Goodin, and C. L. Reuss, editors. 1994. Rare plant communities of the conterminous United States: An initial survey. The Nature Conservancy. Arlington, VA. 620 pp.

Hadley, R. F., and F. A. Branson. 1965. Surficial geology and microclimatic effects on vegetation, soils and geomorphology in the Denver, Colorado, area. Pages 56-63 in: Guidebook for 1-day field conferences-Boulder area, CO. 7th International Association for Quaternary Research Congress. Nebraska Academy of Science.

Hall, F. C. 1973. Plant communities of the Blue Mountains in eastern Oregon and southeastern Washington. USDA Forest Service, Pacific Northwest Region. R6 Area Guide 3-1. 62 pp.

Hall, J. B., and P. L. Hansen. 1997. A preliminary riparian habitat type classification system for the Bureau of Land Management districts in southern and eastern Idaho. Riparian and Wetland Research Program, School of Forestry, University of Montana. Idaho Bureau of Land Management, Technical Bulletin No. 97-11. 381 pp.

Hamner, R. W. 1964. An ecological study of *Sarcobatus vermiculatus* communities of the Big Horn Basin, Wyoming. Unpublished thesis, University of Wyoming, Laramie.

Hansen, M., J. Coles, K. A. Thomas, D. Cogan, M. Reid, J. Von Loh, and K. Schulz. 2004c. USGS-NPS Vegetation Mapping Program: Sunset Crater National Monument, Arizona, vegetation classification and distribution. U.S. Geological Survey Technical Report. Southwest Biological Science Center, Flagstaff, AZ.

Hansen, P. L. 1985. An ecological study of the vegetation of the Grand River/Cedar River, Sioux, and Ashland districts of the Custer National Forest. Unpublished dissertation, South Dakota State University. 257 pp.

Hansen, P. L., G. R. Hoffman, and A. J. Bjugstad. 1984. The vegetation of Theodore Roosevelt National Park, North Dakota: A habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-113. Fort Collins, CO. 35 pp.

Hansen, P. L., K. Bogs, R. Pfister, and J. Joy. 1990. Classification and management of riparian and wetland sites in central and eastern Montana. Draft version 2. Montana Riparian Association, Montana Forest and Conservation Experiment Station, School of Forestry. University of Montana, Missoula, MT. 279 pp.

Hansen, P. L., R. D. Pfister, K. Boggs, B. J. Cook, J. Joy, and D. K. Hinckley. 1995. Classification and management of Montana's riparian and wetland sites. Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Miscellaneous Publication No. 54. 646 pp. + posters.

Hansen, P. L., S. W. Chadde, and R. D. Pfister. 1988b. Riparian dominance types of Montana. University of Montana Miscellaneous Publication 49. MT Forest and Conservation Experiment Station, Missoula. 411 pp.

Hansen, P. L., and G. R. Hoffman. 1988. The vegetation of the Grand River/Cedar River, Sioux, and Ashland districts of the Custer National Forest: A habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-157. Fort Collins, CO. 68 pp.

Hansen, P. L., and J. B. Hall. 2002. Classification and management of the USDI Bureau of Land Management's riparian and wetland sites in eastern and southern Idaho. Unpublished draft prepared for the Upper Snake River District, Bureau of Land Management, by Bitterroot Restoration, Inc., Corvallis, MT.

Hansen, P., K. Boggs, and R. Pfister. 1991. Classification and management of riparian and wetland sites in Montana. Unpublished draft version prepared for Montana Riparian Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula. 478 pp.

Hansen, P., S. Chadde, R. Pfister, J. Joy, D. Svoboda, J. Pierce, and L. Myers. 1988a. Riparian site types, habitat types, and community types of southwestern Montana. Draft Version 1. MT Riparian Association, Missoula.

Hanson, H. C. 1929. Range resources of the San Luis Valley. Pages 5-61 in: Range resources of the San Luis Valley. Bulletin 335. Colorado Experiment Station, Fort Collins, CO.

Hanson, H. C. 1957. The use of basic principles in the classification of range vegetation. Journal of Range Management 10:26-33.

Hanson, H. C., L. D. Love and M. S. Morris. 1931. Effects of different systems of grazing by cattle upon a western wheat grass type of range near Fort Collins, CO. CO Agricultural Experiment Station Bulletin 377. 82 pp.

Hanson, H. C., and E. Dahl. 1956. Some grassland communities in the mountain-front zone in northern Colorado. Vegetatio 7:249-270.

Hanson, H. C., and W. S. Ball. 1928. An application of Raunkiaer's law of frequency to grazing studies. Ecology 9:467-473.

Hanson, H. C., and W. Whitman. 1938. Characteristics of major grassland types in western North Dakota. Ecological Monographs 8:58-114.

Harper, K. T., and R. A. Jaynes. 1986. Some edaphic and compositional characteristics of *Artemisia tridentata* and associated plant communities in southeastern Utah. Pages 265-272 in: E. D. McArthur and B. L. Welch, compilers. Proceedings-Symposium on the Biology of *Artemisia* and *Chrysothamnus*, 9-13 July, Provo, UT. USDA Forest Service, General Technical Report INT-200. Intermountain Research Station, Ogden, UT.

Harris, S. W. 1954. An ecological study of the waterfowl of the Potholes area, Grant County, Washington. American Midland Naturalist 52:403-432.

Heinze, D. H., R. E. Eckert, and P. T. Tueller. 1962. The vegetation and soils of the Steptoe Watershed. Unpublished report prepared for the USDI Bureau of Land Management. 40 pp.

Hemstrom, M. A., S. E. Logan, and W. Pavlat. 1987. Plant association and management guide, Willamette National Forest. USDA Forest Service Report R6-Ecol 257-B-86. Pacific Northwest Region, Portland, OR. 312 pp.

Henderson, J. A., D. A. Peter, R. Lesher, and D. C. Shaw. 1989. Forested plant associations of the Olympic National Forest. USDA Forest Service, Pacific Northwest Region. R6-ECOL-TP-001-88. Portland, OR. 502 pp.

Henderson, J. S., and M. L. McAllister. 1983. Downey Lake, an inventory of vegetation and wildlife. The Nature Conservancy, Portland, OR.

Hendrickson, D. A., and W. L. Minckley. 1984. Cienegas - Vanishing climax communities of the American Southwest. Desert Plants 6(3):131-175.

Hermann, F. J. 1970. Manual of the Carices of the Rocky Mountains and Colorado Basin. Agriculture Handbook No. 374. USDA Forest Service, Washington, DC. 397 pp.

Hess, K. 1981. Phyto-edaphic study of habitat types of the Arapaho-Roosevelt National Forest, Colorado. Unpublished dissertation, Colorado State University, Fort Collins. 558 pp.

Hess, K., and C. H. Wasser. 1982. Grassland, shrubland, and forest habitat types of the White River-Arapaho National Forest. Unpublished final report 53-82 FT-1-19. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 335 pp.

Hess, K., and R. R. Alexander. 1986. Forest vegetation of the Arapaho and Roosevelt national forests in northcentral Colorado: A habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Paper RM-266. Fort Collins, CO. 48 pp.

Heusser, C. J. 1960. Late-Pleistocene environments of North Pacific North America. American Geographic Society Special Publication 35. American Geographical Society, New York. 308 pp.

Hironaka, M. 1978. Basic synecological relationships of the Columbia River sagebrush type. University of Idaho, Forest Wildlife and Range Experiment Station Contribution Number 124:27-31.

Hironaka, M., M. A. Fosberg, and A. H. Winward. 1983. Sagebrush-grass habitat types of southern Idaho. Forestry, Wildlife, and Range Experiment Station Bulletin No. 15, University of Idaho, Moscow. 44 pp.

Hoffman, G. R., and R. R. Alexander. 1976. Forest vegetation of the Bighorn Mountains, Wyoming: A habitat type classification. USDA Forest Service Research Paper RM-170. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 38 pp.

Hoffman, G. R., and R. R. Alexander. 1980. Forest vegetation of the Routt National Forest in northwestern Colorado: A habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-221. Fort Collins, CO. 41 pp.

Hoffman, G. R., and R. R. Alexander. 1983. Forest vegetation of the White River National Forest in western Colorado: A habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Paper RM-249. Fort Collins, CO. 36 pp.

Hoffman, G. R., and R. R. Alexander. 1987. Forest vegetation of the Black Hills National Forest of South Dakota and Wyoming: A habitat type classification. Research Paper RM-276. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 48 pp.

Holecheck, J. L., and T. Stephenson. 1983. Comparison of big sagebrush in northcentral New Mexico under moderately grazed and grazing excluded conditions. Journal of Range Management 36:455-456.

Holland, R. F. 1986b. Preliminary descriptions of the terrestrial natural communities of California. Unpublished report prepared for the California Department of Fish and Game, Nongame-Heritage Program and Natural Diversity Database, Sacramento. 156 pp.

Holstein, G. 2001. Pre-agricultural grassland in central California. Madroño 48(4):253-264.

Horton, L. E. 1971. Vegetation and ecological relationships, west slope of the Teton study area, Targhee National Forest. USDA Forest Service, Intermountain Region. Unpublished mimeographed report. 50 pp. plus appendices.

Hughes, H. G. 1977. Factors influencing vegetative and reproductive phenology of black sagebrush (*Artemisia nova* Nels.). Unpublished thesis, University of Wyoming, Laramie.

Hull, A. C., Jr., and M. K. Hull. 1974. Presettlement vegetation of Cache Valley, Utah and Idaho. Journal of Range Management 27(1):27-29.

Hyde, R. M. 1964. Vegetation in Sunlight Basin, Park County, Wyoming. Unpublished dissertation, University of Wyoming, Laramie.

Hyder, D. N., R. E. Bement, E. E. Remmenga, and C. Terwilliger, Jr. 1966. Vegetation-soils and vegetation-grazing relations from frequency data. Journal of Range Management 19:11-17.

IDCDC [Idaho Conservation Data Center]. 2002. Unpublished riparian and wetland association occurrence and plot data on file at the Idaho Conservation Data Center, Idaho Department of Fish and Game, Boise, ID.

IDCDC [Idaho Conservation Data Center]. 2005. Wetland and riparian plant associations in Idaho. Idaho Conservation Data Center, Idaho Department of Fish and Game, Boise. [http://fishandgame.idaho.gov/tech/CDC/ecology/wetland_riparian_assoc.cfm] (accessed 14 June 2005).

IDCDC [Idaho Conservation Data Center]. No date. Unpublished data on file at Idaho Conservation Data Center, Department of Fish and Game, Boise, ID.

Ibrahim, K. M., N. E. West, and D. L. Goodwin. 1972. Phytosociological characteristics of perennial *Atriplex*-dominated vegetation of southeastern Utah. Vegetatio 24:13-22.

Jameson, D. A., J. A. Williams, and E. W. Wilton. 1962. Vegetation and soils of Fishtail Mesa, Arizona. Ecology 43:403-410.

Jankovsky-Jones, M., C. J. Murphy, and C. L. Coulter. 2001. Riparian and wetland plant associations of southwestern Idaho in the Lower Snake River District, Bureau of Land Management. Idaho Conservation Data Center, Idaho Department of Fish and Game, Boise.

Jankovsky-Jones, M., S. K. Rust, and R. K. Moseley. 1999. Riparian reference areas in Idaho: A catalog of plant associations and conservation sites. USDA Forest Service, Rocky Mountain Research Station. General Technical Report RMRS-GTR-20. Ogden, UT. 141 pp.

Jennings, R. H. 1978. Vegetation. Pages 1-103 in: H. A. Ferchau, editor. Buttes Gas and Oil Iron Hill-Powderhorn Environmental Study 1977, Volume II, Chapter 8. Western State College, Gunnison, CO.

Jennings, R. H. 1979. Vegetation of the Iron Hill complex, Powderhorn, Colorado: An environmental baseline inventory and analysis. Unpublished thesis. Western State College, Gunnison, CO. 211 pp.

Jensen, M. E., L. S. Peck, and M. V. Wilson. 1988a. A sagebrush community type classification for mountainous northeastern Nevada rangelands. Great Basin Naturalist 48(4):422-433.

Jensen, M. E., L. S. Peck, and M. V. Wilson. 1988b. Vegetation characteristics of mountainous northeastern Nevada sagebrush community types. The Great Basin Naturalist 48(4):403-421.

Jensen, M., F. Heisner, J. DiBenedetto, L. Wessman, and G. Phillips. 1992. Ecological sites and habitat types of the Little Missouri National Grassland and western North Dakota (Draft II). Custer National Forest, Billings, MT, and Northern Region, USDA Forest Service. Missoula, MT.

Johnson, C. G., Jr. 1985a. Plant associations of Hells Canyon National Recreation Area. USDA Forest Service Pacific Northwest Region.

Johnson, C. G., Jr., and S. A. Simon. 1987. Plant associations of the Wallowa-Snake Province Wallowa-Whitman National Forest. USDA Forest Service, Pacific Northwest Region, Wallowa-Whitman National Forest. Technical Paper R6-ECOL-TP-255A-86. 399 pp. plus appendices.

Johnson, C. G., and R. R. Clausnitzer. 1992. Plant associations of the Blue and Ochoco Mountains. USDA Forest Service, Pacific Northwest Region, Wallowa-Whitman National Forest R6-ERW-TP-036-92. 163 pp. plus appendices.

Johnson, C. G., and S. A. Simon. 1985. Plant associations of the Wallowa Valley Ranger District, Part II: Steppe. USDA Forest Service, Pacific Northwest Region, Wallowa-Whitman National Forest. 258 pp.

Johnston, B. C. 1987. Plant associations of Region Two: Potential plant communities of Wyoming, South Dakota, Nebraska, Colorado, and Kansas. R2-ECOL-87-2. USDA Forest Service, Rocky Mountain Region. Lakewood, CO. 429 pp.

Johnston, B. C. 2001. Ecological types of the Upper Gunnison Basin. USDA Forest Service. Technical Report R2-RR-2001-01. Rocky Mountain Region. Denver, CO.

Johnston, B. C., and L. Hendzel. 1985. Examples of aspen treatment, succession and management in western Colorado. USDA Forest Service, Range Wildlife Fisheries and Ecology. Denver, CO. 164 pp.

Jones, G. 1992b. Wyoming plant community classification (Draft). Wyoming Natural Diversity Database, Laramie, WY. 183 pp.

Jones, G. P. 1989b. Survey of plant species and communities of interest in the Beaver Rim Area of Critical Environmental Concern. Report submitted to the Bureau of Land Management, Rawlins District Office, under Work Effort No. WY030-09-4352-06-2512. Wyoming Natural Diversity Database, Laramie, WY.

Jones, G. P., and G. M. Walford. 1995. Major riparian vegetation types of eastern Wyoming. Submitted to Wyoming Department of Environmental Quality, Water Quality Division. Wyoming Natural Diversity Database, Laramie, WY. 245 pp.

Jones, G. P., and W. Fertig. 1996. Plant associations and plant species of special concern in the Jack Morrow Hills ecosystem. Unpublished report prepared for the Bureau of Land Management, Rock Springs District by the Wyoming Natural Diversity Database. 2 volumes.

Jones, G., and S. Ogle. 2000. Characterization abstracts for vegetation types on the Bighorn, Medicine Bow, and Shoshone national forests. Prepared for USDA Forest Service, Region 2 by the Wyoming Natural Diversity Database, University of Wyoming.

Jones, George P. Personal communication. Ecologist, Wyoming Natural Diversity Database, Laramie, WY.

Jorgensen, H. E. 1979. Vegetation of the Yellow Water Triangle, Montana. Montana Department of Fish and Game, in cooperation with the Bureau of Land Management. Helena, MT. 57 pp.

Kagan, J. 1997. Draft of Oregon and Washington vegetation report. Oregon Natural Heritage Program, Portland.

Kagan, J. S. 1985. Status report for *Thelypodium howellii* ssp. *spectabilis*. Unpublished report by Oregon Natural Heritage Program for U.S. Fish and Wildlife Service. On file at OR Natural Heritage Program, Portland, OR.

Kagan, J. S. 1987c. Draft species management guide for *Astragalus robbinsii var. alpiniformis*. Challenge grant funding with USDA Forest Service. Oregon Natural Heritage Data Base, The Nature Conservancy, Portland.

Kagan, J. S., J. A. Christy, M. P. Murray, and J. A. Titus. 2000. Classification of native vegetation of Oregon. Oregon Natural Heritage Program, Portland. 63 pp.

Kagan, J. S., J. A. Christy, M. P. Murray, and J. A. Titus. 2004. Classification of native vegetation of Oregon. January 2004. Oregon Natural Heritage Information Center, Portland. 52 pp.

Kahler, L. J. 1973. Correlation of slope exposure with differences in the composition of the vegetation community at 7000 feet in Clear Creek Canyon west of Golden, Colorado. Unpublished thesis, University of Colorado, Boulder. 105 pp.

Kartesz, J. T. 1994a. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. Second edition. Volume 1--Checklist. Timber Press, Portland, OR. 622 pp.

Kartesz, J. T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First edition. In: J. T. Kartesz and C. A. Meacham. Synthesis of the North American Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.

Keammerer, W. R. 1974b. Vegetation of Parachute Creek Valley. Pages 4-91 in: Environmental inventory and impact analysis of a proposed utilities corridor in Parachute Creek Valley, Co. Unpublished report prepared for Colony Development Operation, Denver, Colo.

Keammerer, W. R. 1977. Final report: Vegetation baseline studies, oil shale tract C-b. Unpublished report. Stoecker-Keammerer and Associates, Ecological Consultants, Boulder, CO. 183 pp.

Keammerer, W. R. 1987. Bentonite regional vegetation study. Prepared for Crook County Bentonite Producers and Wyoming Department of Environmental Quality, Land Quality Division, by Stoeker-Keammerer and Associates, Boulder, CO.

Keammerer, W. R., and R. E. Stoecker. 1975. Vegetation and wildlife studies along proposed corridors for oil shale tract C-b. Unpublished report prepared for Shell Oil Co., Denver, by Stoecker-Keammerer and Associates, Boulder, CO. 86 pp.

Keammerer, W. R., and R. E. Stoecker. 1980. Vegetation and wildlife studies for the Mount Emmons project. Unpublished report prepared for AMAX Environmental Services, Inc., by Stoecker-Keammerer and Associates, Ecological Consultants, Boulder, CO. 3 volumes.

Keammerer, W. R., and S. J. Peterson. 1981. Vegetation studies on the Naval Oil Shale Reserve. Unpublished report prepared for TRW Energy Systems Group, McLean, Virginia, by Stoecker-Keammerer and Associates, Ecological Consultants, Boulder, CO. 77 pp.

Kearney, T. H., and R. H. Peebles, and collaborators. 1969. Arizona flora. University of California, Berkeley, CA. 1085 pp.

Keeler-Wolf. T., and X. Thomas. 2000. Draft descriptions of vegetation alliances for the Mojave Ecosystem Mapping project. California Natural Diversity Database. California Department of Fish and Game.

Kettler, S., and A. McMullen. 1996. Routt National Forest riparian vegetation classification. Report prepared for Routt National Forest by the Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Kierstead, J., and T. Pogson. 1976. A summer flora of the Alvord Basin. Appendix 1. Pages 1-1 to 1-54 in: K. Roberts, editor. A preliminary ecological survey of the Alvord Basin. Final Technical Report. NSF-SOS (76-08175). Eastern Oregon State College. 15 pp. plus 6 appendices.

Kittel, G. M., and N. D. Lederer. 1993. A preliminary classification of the riparian vegetation of the Yampa and San Miguel/Dolores river basins. Unpublished report prepared for Colorado Department of Health and the Environmental Protection Agency by The Nature Conservancy, Colorado Field Office, Boulder.

Kittel, G., E. Van Wie, M. Damm, R. Rondeau, S. Kettler, A. McMullen, and J. Sanderson. 1999b. A classification of riparian and wetland plant associations of Colorado: A user's guide to the classification project. Colorado Natural Heritage Program, Colorado State University, Fort Collins CO. 70 pp. plus appendices.

Kittel, G., E. Van Wie, M. Damm, R. Rondeau, S. Kettler, and J. Sanderson. 1999a. A classification of the riparian plant associations of the Rio Grande and Closed Basin watersheds, Colorado. Unpublished report prepared by the Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Kittel, G., E. Van Wie, and M. Damm. 1997a. A classification of the riparian vegetation of the South Platte Basin (and part of Republican River Basin), Colorado. Submitted to Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Prepared by Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Kittel, G., R. Rondeau, N. Lederer, and D. Randolph. 1994. A classification of the riparian vegetation of the White and Colorado River basins, Colorado. Final report submitted to Colorado Department of Natural Resources and the Environmental Protection Agency. Colorado Natural Heritage Program, Boulder. 166 pp.

Kittel, G., R. Rondeau, and A. McMullen. 1996. A classification of the riparian vegetation of the Lower South Platte and parts of the Upper Arkansas River basins, Colorado. Submitted to Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Prepared by Colorado Natural Heritage Program, Fort Collins. 243 pp.

Kittel, G., R. Rondeau, and S. Kettler. 1995. A classification of the riparian vegetation of the Gunnison River Basin, Colorado. Submitted to Colorado Department of Natural Resources and the Environmental Protection Agency. Prepared by Colorado Natural Heritage Program, Fort Collins. 114 pp.

Klein, A., J. Crawford, J. Evens, D. Hickson, and T. Keeler-Wolf. 2007. Vegetation alliances and associations of the northern Sierra Nevada foothills, California. A report to Habitat Conservation Division, California Department of Fish and Game, California Native Plant Society, Sacramento.

Kleiner, E. F. 1968. Comparative study of grasslands of Canyonlands National Park. Unpublished dissertation, University of Utah, Salt Lake City. 58 pp.

Klimas, C. V. 1988a. River regulation effects on floodplain hydrology and ecology. Pages 40-49 in: D. D. Hook, W. H. McKee, Jr., H. K. Smith, J. Gregory, V. G. Burrell, Jr., M. R. DeVoe, R. E. Sojka, S. Gilbert, R. Banks, L. H. Stolzy, C. Brooks, T. D. Matthews and T. H. Shear, editors. 1988. The ecology and management of wetlands: I. Ecology of wetlands. Timber Press, Portland, OR.

Knight, D. H. 1994. Mountains and plains: Ecology of Wyoming landscapes. Yale University Press, New Haven, MA. 338 pp.

Knight, D. H., G. P. Jones, Y. Akashi, and R. W. Myers. 1987. Vegetation ecology in the Bighorn Canyon National Recreation Area. Unpublished report prepared for the USDI National Park Service and University of Wyoming-National Park Service Research.

Knight, D. H., R. J. Hill, and A. T. Harrison. 1976. Potential natural landmarks in the Wyoming Basin, terrestrial and aquatic ecosystems. Unpublished report prepared for the USDI National Park Service. Contract 9900X20047.

Komarkova, V. 1986. Habitat types on selected parts of the Gunnison and Uncompahgre national forests. Unpublished final report prepared for USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 270 pp. plus appendices.

Komarkova, V. K., R. R. Alexander, and B. C. Johnston. 1988b. Forest vegetation of the Gunnison and parts of the Uncompahgre national forests: A preliminary habitat type classification. USDA Forest Service. Research Paper RM-163. 65 pp.

Komarkova, V., A. Peters, G. Kamani, W. Jones, V. Howard, H. Gordon, and K. Southwick. 1988a. Natural recovery of plant communities on disturbance plots and history of land use in the Niwot Ridge/Green Lakes Valley, Front Range, Colorado. University of Colorado Longterm Ecological Research Working Paper 88/1. Boulder, CO. 46 pp.

Kovalchik, B. L. 1987. Riparian zone associations - Deschutes, Ochoco, Fremont, and Winema national forests. USDA Forest Service Technical Paper 279-87. Pacific Northwest Region, Portland, OR. 171 pp.

Kovalchik, B. L. 1993. Riparian plant associations on the national forests of eastern Washington - Draft version 1. USDA Forest Service, Colville National Forest, Colville, WA. 203 pp.

Kovalchik, B. L. 2001. Classification and management of aquatic, riparian and wetland sites on the national forests of eastern Washington. Part 1: The series descriptions. 429 pp. plus appendix. [http://www.reo.gov/col/wetland_classification/wetland_classification.pdf]

Krajina, V. J. 1969. Ecology of western North America. Volume II. Illustrated, University of British Columbia, Department of Botany.

Kuchler, A. W. 1964. Potential natural vegetation of the conterminous United States. American Geographic Society Special Publication 36. New York, NY. 116 pp.

Kudray, G., P. Hendricks, E. Crowe, and S. Cooper. 2004. Riparian forests of the Wild and Scenic Missouri River: Ecology and management. Report to the Lewistown Field Office, Bureau of Land Management. Montana Natural Heritage Program, Helena, MT. 29 pp. plus appendices.

Kunze, L. M. 1994. Preliminary classification of native, low elevation, freshwater wetland vegetation in western Washington. Washington State Department of Natural Resources, Natural Heritage Program. 120 pp.

Kurzius, M. 1981. Vegetation and flora of the Grapevine Mountains, Death Valley National Monument, California - Nevada. Unpublished thesis, University of Nevada, Las Vegas.

Ladyman, J. A. R., and E. Muldavin. 1996. Terrestrial cryptograms of Pinyon-Juniper woodlands in the Southwestern United States: A review. USDA Forest Service General Technical Report RM-GTR-280. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 33 pp.

Langenheim, J. H. 1962. Vegetation and environmental patterns in the Crested Butte area, Gunnison County, Colorado. Ecological Monographs 32:249-285.

Lanner, R. M., and S. B. Vander Wall. 1980. Dispersal of limber pine seed by Clark's nutcracker. Journal of Forestry 78(10):637-639.

Larson, M., and W. H. Moir. 1987. Forest and woodland habitat types of northern New Mexico and northern Arizona. Edition 2. USDA Forest Service, Southwestern Region, Albuquerque, NM.

Leary, K. D., and P. M. Peterson. 1984. Soil analyses in relation to vegetation in the Cottonwood Mountains, Death Valley National Monument. University of Nevada Cooperative National Park Resources Studies Unit Report 036/01, Las Vegas.

Lee, L. C., and C. J. Jonkel. 1980. The vegetation structure and ecology of grizzly bear habitat in the Pine and Antelope Butte Wetlands, Montana. Unpublished Border Grizzly Project Special Report 36. University of Montana, Missoula. 63 pp.

Lesica, P., and R. L. DeVelice. 1992. Plant communities of the Pryor Mountains. Preliminary report prepared by the Montana Natural Heritage Program, Helena, MT.

Leucite Hills Mine Application. No date. No. 520-T2, on file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.

Lewis, M. E. 1971. Flora and major plant communities of the Ruby-East Humboldt Mountains with special emphasis on Lamoille Canyon. Unpublished report compiled for USDA Forest Service, Region IV, Ogden, UT. 62 pp.

Lewis, M. E. 1975a. Plant communities of the Jarbidge Mountain Complex, Humboldt National Forest. Unpublished report compiled for USDA Forest Service, Region IV, Ogden, UT. 22 pp.

Lillybridge, T. R., B. L. Kovalchik, C. K. Williams, and B. G. Smith. 1995. Field guide for forested plant associations of the Wenatchee National Forest. USDA Forest Service General Technical Report PNW-GTR-359, Pacific Northwest Research Station, Portland. Portland, OR. 335 pp.

Loope, L. L. 1969. Subalpine and alpine vegetation of northeastern Nevada. Unpublished thesis, Duke University, Durham, NC.

Lucky McMine Application. No date. Nos. 356C and 356C-A2, on file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.

Lundberg, C. E. 1977. The local composition and distribution of vegetation in the soda ash producing area of Sweetwater County, Wyoming. Unpublished thesis, University of Wyoming, Laramie.

Lusby, G. C., G. T. Turner, J. R. Thompson, and V. H. Reid. 1963. Hydrologic and biotic characteristics of grazed and ungrazed watersheds of the Badger Wash Basin in western Colorado, 1953-1958. U.S. Geological Survey Water-Supply Paper 1532-B.

Lynn, R., M. Larson, D. Hoeft, L. Todd, T. Raetz, L. Fager, and G. Barranco. No date. Black Hills National Forest ecological land units study. USDA Forest Service, Black Hills National Forest, SD.

MNNHP [Minnesota Natural Heritage Program]. 1993. Minnesota's native vegetation: A key to natural communities. Version 1.5. Minnesota Department of Natural Resources, Natural Heritage Program, St. Paul, MN. 110 pp.

MTNHP [Montana Natural Heritage Program]. 1988. Draft guide to the natural vegetation of Montana. Montana Natural Heritage Program, Helena. 389 pp.

MTNHP [Montana Natural Heritage Program]. 2002b. List of ecological communities for Montana. Montana Natural Heritage Program, Montana State Library, Helena, MT.

MTNHP [Montana Natural Heritage Program]. No date. Unpublished data on file. Helena, MT.

Manning, M. 1988. Ecology and rooting characteristics of four intermountain meadow community types. Unpublished thesis, University of Nevada, Reno.

Manning, M. E., and W. G. Padgett. 1991. Riparian community type classification for the Humboldt and Toiyabe national forests, Nevada and eastern California. Unpublished draft report prepared for USDA Forest Service, Intermountain Region Ecology and Classification Program, Ogden, UT. 490 pp.

Manning, M. E., and W. G. Padgett. 1992. Riparian community type classification for the Humboldt and Toiyabe national forests, Nevada and eastern California. USDA Forest Service, Intermountain Region Ecology and Classification Program. 274 pp.

Manning, M. E., and W. G. Padgett. 1995. Riparian community type classification for Humboldt and Toiyabe national forests, Nevada and eastern California. USDA Forest Service, Intermountain Region. 306 pp.

Marr, J. W., D. A. Boyce, and J. W. Todd. 1973b. Preliminary report on the Redcliff project, Eagle County, Colorado. Unpublished report to the D. E. Fleming Company, Denver, and the Colorado River Water Conservation District, Glenwood Springs, by University of Colorado, Boulder. 9 pp.

Marr, J. W., D. Buckner, and C. Mutel. 1973a. Ecological analyses of potential shale oil products pipeline corridors in Colorado and Utah. Unpublished report prepared for Colony Development Operation, Atlantic Richfield Company, Denver, by Thorne Ecological Institute and University of Colorado, Boulder. 96 pp. plus appendices.

Marr, J. W., R. Fritz, J. Meyer, and P. Murphy. 1979. Final report-terrestrial plant ecology-stand ecosystem data tables, Juniper/Cross Mountain Project. Report prepared for Colorado River Water Conservation District, Glenwood Springs, CO, by University of Colorado, Boulder. 47 pp.

Marr, J. W., and D. L. Buckner. 1974. Colorado to Wyoming pipeline corridor study. Unpublished report for Colony Development Operation, Atlantic Richfield Co., Denver by Thorne Ecological Institute, Boulder, CO. 79 pp.

Marriott, H. J. 1985. Flora of the northwestern Black Hills, Crook and Weston counties, Wyoming. Unpublished M.S. thesis, Department of Botany, University of Wyoming, Laramie.

Marriott, H. J., and D. Faber-Langendoen. 2000. The Black Hills community inventory. Volume 2: Plant community descriptions. The Nature Conservancy, Midwest Conservation Science Center and Association for Biodiversity Information, Minneapolis, MN. 326 pp.

Marriott, Hollis J. Personal communication. Former Heritage Botanist, WYNDD, and former Public Lands Coordinator, The Nature Conservancy. 655 N. Cedar, Laramie, WY 82070. (307) 721-4909.

Martin, W. C., and C. R. Hutchins. 1980. Flora of New Mexico. Volume 1. A. R. Strauss and Cramer, Germany. 1276 pp.

Mauk, R. L., and J. A. Henderson. 1984. Coniferous forest habitat types of northern Utah. USDA Forest Service. General Technical Report INT-170. Intermountain Forest and Range Experiment Station, Ogden, UT. 89 pp.

Mayfield, M. M., and J. Kjelmyr. 1984. Boardman Research Natural Area. Supplement No. 17 to: J. F. Franklin, F. C. Hall, C. T. Dyrness, and C. Maser. 1972. Federal Research Natural Areas in Oregon and Washington: A guidebook for scientists and educators. Pacific Northwest Forest and Range Experiment Station, Portland, OR.

McArthur, E. D., and B. L. Welch, compilers. 1986. Proceedings-Symposium on the biology of *Artemisia* and *Chrysothamnus*. 1984 July 9-13, Provo, Utah. USDA Forest Service General Technical Report INT-200. Intermountain Research Station, Ogden, UT. 398 pp.

McLean, A. 1970. Plant communities of the Similkameen Valley, British Columbia, and their relationships to soils. Ecological Monographs 40(4):403-424.

Medicine Bow Mine Application. No date. Application No. 331-T1, on file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.

Midwestern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Minneapolis, MN.

Miller, D. A., D. A. Mouat, and B. D. Treadwell. 1977. Remote sensing analysis and literature survey pertaining to the vegetation of the Petrified Forest National Park. Report of work performed under NASA and the National Park Service. 48 pp.

Milton, N. M., and T. L. Purdy. 1983. Plant and soil relationships in two hydrothermally altered areas of the Great Basin. Great Basin Naturalist 43(3):457-469.

Mitchell, J. E., N. E. West, and R. W. Miller. 1966. Soil physical properties in relation to plant community patterns in the shadscale zone of northwestern Utah. Ecology 47(4):627-630.

MNNHP [Minnesota Natural Heritage Program]. 1993. Minnesota's native vegetation: A key to natural communities. Version 1.5. Minnesota Department of Natural Resources, Natural Heritage Program, St. Paul, MN. 110 pp.

Moir, W. H. 1969b. Steppe communities in the foothills of the Colorado Front Range and their relative productivities. The American Midland Naturalist 81(2):331-340.

Moir, W. H., and J. A. Ludwig. 1979. A classification of spruce-fir and mixed conifer habitat types of Arizona and New Mexico. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Paper RM-207. Fort Collins, CO. 47 pp.

Mooney, M. J. 1985. A preliminary classification of high elevation sagebrush-grass plant vegetation in northern and central Nevada. Unpublished thesis, University of Nevada, Reno. 118 pp.

Moran, P. 1981. Patterns of plant life at Pawnee National Grassland: A manual for the interpreter. Unpublished report prepared for the Pawnee National Grasslands, Greeley, CO. 88 pp.

Moretti, M. C. 1979. Vegetation and soil factors in relation to slope position: A study of plant communities on foothill knolls in the Uintah Basin of Utah. Unpublished thesis, Brigham Young University, Provo. 31 pp.

Moretti, M. C., and J. D. Brotherson. 1982. Vegetation and soil factors in relation to slope position of foothill knolls in the Uinta Basin of Utah. Great Basin Naturalist 42(1):81-90.

Morgan, M. D. 1969. Ecology of aspen in Gunnison County, Colorado. The American Midland Naturalist 82(1):204-228.

Moseley, R. K. 1998. Riparian and wetland community inventory of 14 reference areas in southwestern Idaho. Technical Bulletin 98-5. USDI Bureau of Land Management, Boise State Office, Boise, ID. 52 pp.

Mozingo, H. 1987. Shrubs of the Great Basin: A natural history. University of Nevada Press, Las Vegas. 342 pp.

Mueggler, W. F. 1988. Aspen community types of the Intermountain Region. USDA Forest Service General Technical Report INT-250. Intermountain Research Station, Ogden, UT. 135 pp.

Mueggler, W. F., and R. B. Campbell, Jr. 1982. Aspen community types on the Caribou and Targhee national forests in southeastern Idaho. USDA Forest Service, Intermountain Forest and Range Experiment Station. Research Paper INT-294. Ogden, UT. 32 pp.

Mueggler, W. F., and R. B. Campbell, Jr. 1986. Aspen community types of Utah. USDA Forest Service Research Paper INT-362, Intermountain Forest and Range Experiment Station, Ogden, UT.

Mueggler, W. F., and W. L. Stewart. 1980. Grassland and shrubland habitat types of western Montana. USDA Forest Service, General Technical Report INT-66. Intermountain Forest and Range Experiment Station. Ogden, UT. 154 pp.

Muldavin, E. 1994. Organ Mountains sensitive species and plant community inventory. Unpublished report prepared by the New Mexico Natural Heritage Program, Albuquerque.

Muldavin, E. H., R. L. DeVelice, and F. Ronco, Jr. 1996. A classification of forest habitat types southern Arizona and portions of the Colorado Plateau. USDA Forest Service General Technical Report RM-GTR-287. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 130 pp.

Muldavin, E., P. Durkin, M. Bradley, M. Stuever, and P. Mehlhop. 2000a. Handbook of wetland vegetation communities of New Mexico: Classification and community descriptions (volume 1). Final report to the New Mexico Environment Department and the Environmental Protection Agency prepared by the New Mexico Natural Heritage Program, University of New Mexico, Albuquerque, NM.

Muldavin, E., and P. Mehlhop. 1992. A preliminary classification and test vegetation map for White Sands Missile Range and San Andreas National Wildlife Refuge, New Mexico. University of New Mexico, New Mexico Natural Heritage Program.

Murphy, P. H. 1982. The forest vegetation of the Lost Creek area in the southern Front Range, Colorado. Unpublished thesis, University of Colorado, Boulder. 145 pp.

Murray, M. P. 2000. Wetland plant associations of the western hemlock zone in the central coastal and westslope Cascade Mountains. Unpublished report, Oregon Natural Heritage Program, Portland, OR. 82 pp. http://www.natureserve.org/nhp/us/or/nw_or_wetlands.pdf

Mutel, C. F. 1973. An ecological study of the plant communities of certain montane meadows in the Front Range of Colorado. Unpublished thesis, University of Colorado, Boulder. 77 pp.

Mutel, C. F. 1976. From grassland to glacier: An ecology of Boulder County, Colorado. Johnson Publishing Company, Boulder. 169 pp.

Mutel, C., and J. W. Marr. 1973. A vegetative study of three montane herbaceous basins. Journal of the Colorado-Wyoming Academy of Science 7(4):28 (Abstract).

Mutz, K. M., and J. Queiroz. 1983. Riparian community classification for the Centennial Mountains and South Fork Salmon River, Idaho. Unpublished report prepared for USDA Forest Service Intermountain Region under contract 53-84M8-2-0048 by Meiiji Resource Consultants, Layton, UT. 168 pp.

Mutz, K. M., and R. Graham. 1982. Riparian community type classification-Big Piney Range District, Wyoming. Unpublished report prepared for USDA Forest Service, Intermountain Region under contract 53-84M8-1-974, by Meiiji Resource Consultants, Layton, UT. 88 pp.

NDNHI [North Dakota Natural Heritage Inventory]. No date. Vegetation classification of North Dakota. North Dakota Natural Heritage Inventory, North Dakota Parks & Recreation Department, Bismarck.

NVNHP [Nevada Natural Heritage Program]. 2003. National Vegetation Classification for Nevada. Nevada Natural Heritage Program, Department of Conservation and Natural Resources, Carson City. 26 September 2003.

Nelson, L. P., and M. E. Jensen. 1987. Sagebrush-grass community types of the Humboldt National Forest. Unpublished report prepared for USDA Forest Service, Humboldt National Forest, Elko, NV. 80 pp.

Nichols, J. T. 1964a. Soil-vegetation relationships of the 15-mile drainage, Washakie County, Wyoming. Unpublished dissertation, University of Wyoming, Laramie.

Nichols, J. T. 1964b. Effect of protection from grazing on two vegetative types in the Big Horn Basin of Wyoming. Wyoming Range Management 192:60-69.

Northcutt, B. E. 1978. The plant ecology of Butler Wash, southeastern Utah. Unpublished thesis, University of Colorado, Boulder. 118 pp.

ORNHP [Oregon Natural Heritage Program]. No date. Unpublished data files. Oregon Natural Heritage Program, The Nature Conservancy, Portland, OR.

Ogilvie, R. T. 1962. Ecology of spruce forests on the east slope of the Rocky Mountains in Alberta. Unpublished dissertation, Washington State University, Pullman. 189 pp.

Olson, R. A., and W. A. Gerhart. 1982. A physical and biological characterization of riparian habitat and its importance to wildlife in Wyoming. Unpublished report prepared for Wyoming Fish and Game Department, Cheyenne, WY. 188 pp.

Oswald, E. T. 1966. A synecological study of the forested moraines of the valley floor of Grand Teton National Park, Wyoming. Unpublished thesis, Montana State University, Bozeman. 101 pp.

Padgett, W. G. 1981. Ecology of riparian plant communities in southern Malheur National Forest. M.S. thesis. Oregon State University, Corvallis. 143 pp.

Padgett, W. G. 1982. Ecology of riparian plant communities in southern Malheur National Forest. Unpublished thesis, Oregon State University, Corvallis. 143 pp.

Padgett, W. G., A. P. Youngblood, and A. H. Winward. 1988b. Riparian community type classification of Utah. USDA Forest Service, Intermountain Region Publication R4-ECOL-88-01. Ogden, UT.

Padgett, W. G., A. P. Youngblood, and A. H. Winward. 1989. Riparian community type classification of Utah and southeastern Idaho. USDA Forest Service, IM Region. Report R4-ECOL-89-01. Ogden, UT. 191 pp.

Padgett, W. G., and M. E. Manning. 1988. Preliminary riparian community type classification for Nevada. Draft. Unpublished report prepared for USDA Forest Service Region IV, Intermountain Region Ecology and Classification Program, Ogden, UT.

Palmer, E. J. 1929. The ligneous flora of the Davis Mountains. Journal of Arnold Arboretum 10:8-45.

Paulsen, H. A., Jr. 1969. Forage values on a mountain grassland-aspen range in western Colorado. Journal of Range Management 22:102-107.

Peet, R. K. 1975. Forest vegetation of the east slope of the northern Colorado Front Range. Unpublished dissertation, Cornell University, Ithaca, NY.

Peet, R. K. 1978a. Latitudinal variation in southern Rocky Mountain forests. Journal of Biogeography 5:275-289.

Peet, R. K. 1981. Forest vegetation of the Colorado Front Range. Vegetatio 45:3-75.

Peet, R. K. 1988. Forests of the Rocky Mountains. Pages 64-101 in: M. G. Barbour and W. D. Billings, editors. North American Terrestrial Vegetation. Cambridge University Press, New York.

Penfound, W. T. 1953. Plant communities of Oklahoma lakes. Ecology 34:561-583.

Peterson, P. M. 1984. Flora and physiognomy of the Cottonwood Mountains, Death Valley National Monument, California. University of Nevada Cooperative National Park Resources Studies Unit Report CPSU/UNLV 022/06. Las Vegas, NV.

Pfister, R. D., B. L. Kovalchik, S. F. Arno, and R. C. Presby. 1977. Forest habitat types of Montana. USDA Forest Service. General Technical Report INT-34. IM Forest and Range Experiment Station, Ogden, UT. 174 pp.

Plumb, G. A. 1988. An algorithmic approach to automated vegetation mapping of Big Bend National Park, Texas. Ph.D. dissertation, University of Kansas, Lawrence. 449 pp.

Potter, L. D., R. C. Reynolds, Jr., and E. T. Louderbough. 1985. Mancos shale and plant community relationships: Analysis of shale, soil, and vegetation transects. Journal of Arid Environments 9:147-165.

Potter, L. D., and D. R. Moir. 1961. Phytosociological study of burned and unburned deciduous woods, Turtle Mountains, North Dakota. Ecology 42:468-480.

Poulton, C. E. 1955. Ecology of the non-forested vegetation in Umatilla and Morrow counties, Oregon. Unpublished dissertation. State College of Washington, Pullman. 166 pp.

Powell, D. C. 1988a. Aspen community types of the Pike and San Isabel national forests in south-central Colorado. USDA Forest Service, Rocky Mountain Region, Report R2-ECOL-88-01. 254 pp.

Price, K. P., and J. D. Brotherson. 1987. Habitat and community relationships of cliffrose (*Cowania mexicana var. stansburiana*) in central Utah. Great Basin Naturalist 47(1):132-151.

Prodgers, R. 1978. Circle West vegetation baseline study: Final report. Circle West Technical Report No. 1. Energy Division, Montana Department of Natural Resources and Conservation, Helena. 115 pp.

Ralston, G. L. 1969. Plant zonation on dune sands of Washoe Lake, Washoe County, Nevada. Unpublished thesis, University of Nevada, Reno.

Ramaley, F. 1909. The silva of Colorado. IV. Forest formations and forest trees. University of Colorado Studies 6:249-281.

Ramaley, F. 1916b. Dry grassland of a high mountain park in northern Colorado. The Plant World 19(4):249-270.

Ramaley, F. 1919a. The role of sedges in some Colorado plant communities. American Journal of Botany 6:120-130.

Ramaley, F. 1919b. Some mountain plant communities of sandy soil. The Plant World 22(11):313-329.

Ramaley, F. 1927. Colorado plant life. University of Colorado Semicentennial series 1877-1927. Volume II. 299 pp.

Ramaley, F. 1942. Vegetation of the San Luis Valley in southern Colorado. University of Colorado Studies, Series D, 1:231-277.

Rasmussen, L. L., and J. D. Brotherson. 1986. Response of winterfat (*Ceratoides lanata*) communities to release from grazing pressure. Great Basin Naturalist 46(1):148-156.

Ratliff, R. D. 1982. A meadow site classification for the Sierra Nevada, California. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station. General Technical Report PSW-10. Berkeley, CA. 16 pp.

Ratliff, R. D., and S. E. Westfall. 1988. Biomass trends in a Nebraska sedge meadow, Sierra National Forest, California. Aquatic Botany 30:109-124.

Rector, C. D. 1979. Lower Gunnison River Basin wetland inventory and evaluation. Unpublished thesis, University of Colorado, Boulder. 71 pp.

Reed, R. M. 1971. Aspen forests of the Wind River Mountains, Wyoming. The American Midland Naturalist 86(2):327-343.

Reed, R. M. 1976. Coniferous forest habitat types of the Wind River Mountains, Wyoming. The American Midland Naturalist 95(1):159-173.

Reid, E. H., and G. D. Pickford. 1946. Judging mountain meadow range condition in eastern Oregon and eastern Washington. USDA Circular 748. 31 pp.

Reid, M. S., L. S. Engelking, and P. S. Bourgeron. 1994. Rare plants communities of the conterminous United States, Western Region. Pages 305-620 in: D. H. Grossman, K. L. Goodin, and C. L Reuss, editors. Rare plant communities of the conterminous United States, a initial survey. The Nature Conservancy, Arlington, VA.

Richard, C., G. Kittel, and S. Kettler. 1996. A classification of the riparian vegetation of the San Juan National Forest. Draft 1 report. Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Rickard, W. H., and J. C. Beatley. 1965. Canopy-coverage of the desert shrub vegetation mosaic of the Nevada Test Site. Ecology 46(4):524-529.

Roberts, D. W. 1980. Forest habitat types of the Bear's Paw Mountains and Little Rocky Mountains, Montana. Unpublished thesis, Department of Forestry, University of Montana, Missoula. 116 pp.

Roberts, D. W., D. W. Wight, and G. P. Hallsten. 1992. Plant community distribution and dynamics in Bryce Canyon NP. Unpublished final report for Bryce Canyon National Park Project PX1200-7-0966. 146 pp.

Robertson, D. R., J. L. Nielsen, and N. H. Bare. 1966. Vegetation and soils of alkali sagebrush and adjacent big sagebrush ranges in North Park, Colorado. Journal of Range Management 19:17-20.

Robertson, J. H. 1971. Changes on a sagebrush-grass range in Nevada ungrazed for 30 years. Journal of Range Management 24:397-400.

Rogers, C. M. 1953. The vegetation of the Mesa de Maya region of Colorado, New Mexico, and Oklahoma. Lloydia 16(4):257-290.

Rominger, J. M., and L. A. Paulik. 1983. A floristic inventory of the plant communities of the San Francisco Peaks Research Natural Area. USDA Forest Service General Technical Report RM-96. Rocky Mountain Forest and Range Experiment Station, Ft Collins, CO. 9 pp.

Rondeau, Renee. Personal communication. Interim Director/Ecologist, Colorado Natural Heritage Program, Colorado State University, 254 General Services Building, Fort Collins, CO, 80523.

Ross, R. L., E. P. Murray, and J. G. Haigh. 1973. Soil and vegetation inventory of near-pristine sites, Montana. USDA Soil Conservation Service, Bozeman, MT. 55 pp.

Rzedowski, J. 1981. Vegetaciòn de México. Editorial Limusa, Mexico City, Mexico. 432 pp.

Sanderson, J., and M. March. 1996. Extreme rich fens of South Park, Colorado: Their distribution, identification, and natural heritage significance. Report submitted to Park County, the Colorado Department of Natural Resources, and the Environmental Protection Agency. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Sarr, D. 1995. Grazing, graminoids, and hysteresis: Exploring relationships between livestock production, riparian communities, and ecosystem recovery in the southern Sierra Nevada, California. Unpublished M.A. thesis, University of California, Santa Barbara. 167 pp.

Savage, D. E. 1968. The relationship of sage grouse to upland meadows in Nevada. Unpublished thesis, University of Nevada, Reno.

Sawyer, J. O., and T. Keeler-Wolf. 1995. A manual of California vegetation. California Native Plant Society, Sacramento. 471 pp.

Schlatterer, E. F. 1972. A preliminary description of plant communities found on the Sawtooth, White Cloud, Boulder, and Pioneer mountains. Unpublished report prepared for USDA Forest Service, Intermountain Region, Ogden, UT. 111 pp.

Schramm, D. R. 1982. Floristics and vegetation of the Black Mountains, Death Valley National Monument. Unpublished report prepared for the University of Nevada, Las Vegas.

Seminoe I Mine Application. No date. Application No. 378-T1, on file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne, WY.

Seminoe II Mine Application. No date. Application No. 377-T2, on file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.

Servheen, C., and L. C. Lee. 1979. Mission Mountain grizzly bear studies, an interim report, 1976-1978. Border Grizzly Project, Montana Forest and Conservation Experiment Station, University of Montana, School of Forestry, Missoula, MT. 299 pp.

Severson, K. E., and J. F. Thilenius. 1976. Classification of quaking aspen stands in the Black Hills and Bear Lodge Mountains. USDA Forest Service Research Paper RM-166. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 24 pp.

Seyer, S. C. 1981. Survey of vegetation of 18 lakes in Wallowa-Whitman National Forest, Oregon. USDA Forest Service, Forest Sciences Laboratory, Corvallis, Oregon. 47 pp.

Shanks, D. L. 1977. Aerial photo densitometry for rangeland planning and evaluation. Unpublished thesis, Colorado State University, Fort Collins. 66 pp.

Shantz, H. L. 1906. A study of the vegetation of the mesa region east of Pike's Peak, the *Bouteloua* formation. II. Development of the formation. Botanical Gazette 42:179-207.

Shantz, H. L. 1911. Natural vegetation as an indicator of the capabilities of land for crop production in the Great Plains area. USDA Bureau of Plant Industry Bulletin 201. 100 pp.

Shantz, H. L. 1923. The natural vegetation of the Great Plains region. Annals of the Association of American Geographers 13:81-107.

Shephard, M. E. 1995. Plant community ecology and classification of the Yakutat Foreland, Alaska. R10-TP-56. USDA Forest Service, Alaska Region. 213 pp. plus appendices.

Shepherd, H. R. 1975. Vegetation of two dissimilar bighorn sheep ranges in Colorado. Colorado Division of Wildlife Report 4. 223 pp.

Shepperd, W. D. 1990. Initial growth, development, and clonal dynamics of regenerated aspen in the Rocky Mountains. USDA Forest Service Research Paper RM-312. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 8 pp.

Shiflet, T. N., editor. 1994. Rangeland cover types of the United States. Soc. for Range Management. Denver, CO. 152 pp.

Shupe, J. B., J. D. Brotherson, and S. R. Rushforth. 1986. Patterns of vegetation surrounding springs in Goshen Bay, Utah County, Utah, U.S.A. Hydrobiologia 139:97-107.

Singh, T., and N. E. West. 1971. Comparison of some multivariate analyses of perennial *Atriplex* vegetation in southeastern Utah. Vegetatio 23(5-6):289-313.
Skull Point Mine Application. No date. Application No. 2335-T2, on file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.
Skull Point Mine Permit Renewal. No date. On file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.
Smith, E. L., Jr. 1966. Soil-vegetation relationships of some *Artemisia* types in North Park, Colorado. Unpublished dissertation, Colorado State University, Fort Collins. 27 pp.
Smith, J. No date (b). Comprehensive data base for surface mining in Wyoming. Unpublished data, Department of Environmental Quality, Land Quality Division, Cheyenne.
Smith, S. 1994b. Ecological guide to eastside pine plant associations, northeastern California. USDA Forest Service, Pacific Southwest Region, R5-ECOL-TP-004. 174 pp.
Smith, S. 1998b. Riparian community type classification for national forests in northeastern California: First approximation. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.
Smith, T. L. 1991. Natural ecological communities of Pennsylvania. First revision. Unpublished report. Pennsylvania Science Office of The Nature Conservancy, Middletown, PA. 111 pp.
Sneddon, L., M. Anderson, and K. Metzler. 1996. Community alliances and elements of the Eastern Region. Unpublished report. The Nature Conservancy, Eastern Heritage Task Force, Boston, MA. 235 pp.
Soil Conservation Service. 1978. Range site descriptions for Colorado. Technical Guide, Section II-E. USDA Soil Conservation Service, Colorado State Office, Denver.
Spies, T. A., J. F. Franklin, and M. Klopsch. 1990. Canopy gaps in Douglas-fir forests of the Cascade Mountains. Canadian Journal of Forest Research 20:649-658.
Stearns-Roger, Inc. 1978. Rawhide Energy Project. Transmission system, ecological investigations. Volume II. Technical baseline report to Platte River Power Authority. 51 pp.
Steele, R., R. D. Pfister, R. A. Ryker, and J. A. Kittams. 1981. Forest habitat types of central Idaho. USDA Forest Service General Technical Report INT-114. Intermountain Forest and Range Experiment Station, Ogden, UT. 138 pp.
Steele, R., S. V. Cooper, D. M. Ondov, D. W. Roberts, and R. D. Pfister. 1983. Forest habitat types of eastern Idaho - western Wyoming. USDA Forest Service General Technical Report INT-144. Intermountain Forest and Range Experiment Station, Ogden, UT. 122 pp.
Steele, R., and K. Geier-Hayes. 1995. Major Douglas-fir habitat types of central Idaho: A summary of succession and management. USDA Forest Service General Technical Report INT-GTR-331. USDA Forest Service Intermountain Research Station, Ogden, UT.
Steger, R. E. 1970. Soil moisture and temperature relationships of six salt desert shrub communities in northcentral Wyoming. Unpublished thesis, University of Wyoming, Laramie.
Steinauer, G., and S. Rolfsmeier. 2000. Terrestrial natural communities of Nebraska. Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 143 pp.
Stewart, B. K. 1940. Plant ecology and paleoecology of the Creede Valley, Colorado. Unpublished dissertation, University of Colorado, Boulder. 154 pp.
Stoddart, L. A. 1941. The palouse grassland association in northern Utah. Ecology 22(2):158-163.
Stoecker-Keammerer Consultants. No date (a). Black Thunder Mine Application No. 233-T3, on file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.
Stoecker-Keammerer Consultants. No date (b). Coal Creek Mine Application No. 483-T1, on file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.
Strong, L. L. 1980. Estimating phytomass production of habitat types on sagebrush steppe. Unpublished thesis, Colorado State University, Fort Collins. 133 pp.
Stuever, M. C., and J. S. Hayden. 1997a. Plant associations of Arizona and New Mexico. Edition 3. Volume 2: Woodlands. USDA Forest Service, Southwestern Region, Habitat Typing Guides. 196 pp.
Stuever, M. C., and J. S. Hayden. 1997b. Plant associations of Arizona and New Mexico. Edition 3. Volume 1: Forests. USDA Forest Service, Southwestern Region. Habitat Typing Guides. 291 pp.
Sturges, D. L. 1968. Hydrologic properties of peat from a Wyoming mountain bog. Soil Science 106:262-264.
Swain, P. C., and J. B. Kearsley. 2001. Classification of natural communities of Massachusetts. September 2001 draft. Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife. Westborough, MA.
Sweetwater Uranium Project. 1978. Application No. 481, on file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.

Tart, D. L. 1996. Big sagebrush plant associations of the Pinedale Ranger District. Final review draft. Bridger-Teton National Forest, Jackson WY. 97 pp.

Taylor, A. H. 1980. Plant communities and elevation in the diked portion of Joe Ney Slough: A baseline assessment of a marsh restoration project in Coos Bay, Oregon. M.S. thesis. Oregon State University, Corvallis. 105 pp.

Taylor, D. W., and K. A. Teare. 1979a. Ecological survey of the vegetation of the proposed Trelorita Research Natural Area, Shasta-Trinity National Forest, Trinity County, California. Unpublished report. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Terwilliger, C., Jr., and E. L. Smith. 1978. Range resource types in North Park, Colorado. Colorado State University Range Science Department Science Series 32. 48 pp.

Terwilliger, C., Jr., and J. A. Tiedemann. 1978. Habitat types of the mule deer critical winter range and adjacent steppe region of Middle Park, Colorado. Unpublished report prepared for USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 108 pp.

Terwilliger, C., K. Hess, and C. Wasser. 1979a. Key to the preliminary habitat types of Region 2. Addendum to initial progress report for habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO.

Thilenius, J. F., G. R. Brown, and A. L. Medina. 1995. Vegetation on semi-arid rangelands, Cheyenne River Basin, Wyoming. USDA Forest Service. General Technical Report RM-GTR-263. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 60 pp.

Thompson, W. H., and P. L. Hansen. 2002. Classification and management of riparian and wetland sites of Alberta's Grasslands Natural Region and adjacent subregions. Bitterroot Restoration, Inc., Cows and Fish, Lethbridge. 416 pp.

Thorne Ecological Institute. 1973a. Environmental setting of the Parachute Creek Valley: An ecological inventory. Unpublished report prepared for Colony Development Operations, Atlantic Richfield Company, by Thorne Ecological Institute, Boulder, CO. [Veg.: pages 36-40, map].

Thorne Ecological Institute. 1973b. Pages 26-30 in: Part 1 of Vegetation. The Colony Environmental Study - Parachute Creek, Garfield County, Colorado. Unpublished report prepared for Colony Development Operation by Thorne Ecological Institute, Boulder, CO.

Tiedemann, J. A. 1978. Phyto-edaphic classification of the Piceance Basin. Unpublished dissertation, Colorado State University, Fort Collins. 281 pp.

Tiedemann, J. A., R. E. Francis, C. Terwilliger, Jr., and L. H. Carpenter. 1987. Shrub-steppe habitat types of Middle Park, Colorado. USDA Forest Service Research Paper RM-273. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 20 pp.

Tiedemann, J. A., and C. Terwilliger, Jr. 1978. Phyto-edaphic classification of the Piceance Basin. Colorado State University, Range Science Department Science Series 31. 265 pp.

Tisdale, E. W. 1947. The grasslands of the southern interior of British Columbia. Ecology 28(4):346-382.

Tisdale, E. W. 1979. A preliminary classification of Snake River Canyon grasslands in Idaho. Forestry, Wildlife, and Range Experiment Station Bulletin No. 32, University of Idaho, Moscow. 8 pp.

Tisdale, E. W. 1986. Canyon grasslands and associated shrublands of west-central Idaho and adjacent areas. Bulletin No. 40. Forest, Wildlife and Range Experiment Station, University of Idaho, Moscow. 42 pp.

Tisdale, E. W., M. Hironaka, and M. A. Fosberg. 1965. An area of pristine vegetation in Craters of the Moon National Monument, Idaho. Ecology 46(3):349-352.

Tisdale, E. W., and A. McLean. 1957. The Douglas fir zone of southern British Columbia. Ecological Monographs 27:247-266.

Titus, J. H., M. Kerr, E Crowe, and B. Kovalchik. 1998. Riparian zones of eastern Oregon. Oregon Natural Heritage Program, Portland.

Titus, J. H., and J. A. Christy. 1996a. Vegetation of Big Marsh, Deschutes National Forest, Oregon. Report to Deschutes National Forest. Oregon Natural Heritage Program, The Nature Conservancy, Portland.

Titus, J. H., and J. A. Christy. 1999. Vegetation of Big Marsh, Deschutes National Forest. Natural Areas Journal. Report to the USDA Forest Service. Unpublished manuscript at ORNHP, Portland. [in press]

Topik, C. 1989. Plant associations and management guide for the *Abies grandis* zone Gifford Pinchot National Forest. USDA Forest Service, Pacific Northwest Region R6-ECOL-TP-006-88. Portland, OR. 110 pp.

Topik, C., N. M. Halverson, and D. G. Brockway. 1986. Plant associations and management guide for the western hemlock zone. USDA Forest Service, Pacific Northwest Region. Gifford Pinchot National Forest. R6-ECOL-230a-1986, Portland, OR. 137 pp.

Topik, C., N. M. Halverson, and T. High. 1988. Plant associations and management guide of the ponderosa pine, Douglas-fir, and grand fir zone, Mt. Hood NF. USDA Forest Service R6-ECOL-TP-004-88. 136 pp.

Trammell, M. A. 1994. Exotic plants of Theodore Roosevelt National Park: Extent, distribution, and ecological impact. M.S. thesis, University of South Dakota. 174 pp.

Tueller, P. T., D. H. Heinze, and R. E. Eckert. 1966. A tentative list of existing Nevada plant communities (A third approximation). Unpublished report prepared for the Department of Range Wildlife and Forestry, University of Nevada, Reno. 14 pp.

Tueller, P. T., and R. E. Eckert, Jr. 1987. Big sagebrush (*Artemisia tridentata vaseyana*) and longleaf snowberry (*Symphoricarpos oreophilus*) plant associations in northeastern Nevada. Great Basin Naturalist 47(1):117-131.

Tueller, P. T., and W. H. Blackburn. 1974. Condition and trend of the big sagebrush/needle-and-thread habitat type in Nevada. Journal of Range Management 27(1):36-40.

Tuhy, J. S., and J. A. MacMahon. 1988. Vegetation and relict communities of Glen Canyon National Recreation Area. Unpublished final report prepared for USDI National Park Service, Rocky Mountain Region, Lakewood, CO. Utah State University, Logan. 299 pp.

Tuhy, J. S., and S. Jensen. 1982. Riparian classification for the Upper Salmon and Middle Fork Salmon River drainages, Idaho. Unpublished report prepared for the USDA Forest Service, Intermountain Region by White Horse Associates, Smithfield, UT. 183 pp.

Tweit, S., and K. Houston. 1980. Grassland and shrubland habitat types of the Shoshone National Forest. USDA Forest Service, Rocky Mountain Region, Shoshone National Forest.

U.S. Bureau of Reclamation. 1976. Flora and terrestrial vertebrate studies of the Grand Valley, Colorado. Pages 56-85 and 283-354 in: Final report to the USBOR by Ecology Consultants, Inc., Fort Collins, CO.

USFS [U.S. Forest Service]. 1937. Range plant handbook. Dover Publications Inc., New York. 816 pp.

USFS [U.S. Forest Service]. 1992. Draft habitat types of the Little Missouri National Grasslands. Medora and McKenzie ranger districts, Custer National Forest. Dickinson, ND.

USFWS and Stone Lakes NWR [U.S. Fish and Wildlife Service and Stone Lakes National Wildlife Refuge]. 2006. Stone Lakes National Wildlife Refuge: Draft conservation plan. U.S. Fish and Wildlife Service and Stone Lakes National Wildlife Refuge, Sacramento and Elk Grove, CA. [www.library.fws.gov/CCPs/stonelakes_draft.pdf]

Ungar, I. A., W. Hogan, and M. McClennand. 1969. Plant communities of saline soils at Lincoln, Nebraska. The American Midland Naturalist 82(2):564-577.

Utah Environmental and Agricultural Consultants. 1973. Pages 2-38 in: Environmental setting, impact, mitigation and recommendations for a proposed oil products pipeline between Lisbon Valley, Utah and Parachute Creek, Colorado. Unpublished report for Colony Development Operation, Atlantic Richfield Company, Denver, CO.

Van Auken, O. W., and J. K. Bush. 1988. Dynamics of establishment, growth, and development of black willow and cottonwood in the San Antonio River forest. Texas Journal of Science 40:269-277.

Van Pelt, N. S. 1978. Woodland parks in southeastern Utah. Unpublished thesis, University of Utah, Salt Lake City.

Vanderhorst, J., S. V. Cooper, and B. Heidel. 1998. Botanical and vegetation survey of Carter County, Montana. Unpublished report prepared for the Bureau of Land Management. Montana Natural Heritage Program, Helena. 116 pp. + app.

Vest, E. D. 1962b. The plant communities and associated fauna of Dugway Valley in western Utah. Unpublished dissertation, University of Utah, Salt Lake City.

Vestal, A. G. 1913. Plains vegetation adjoining the mountains: The region about Boulder in Colorado. Unpublished thesis, University of Colorado, Boulder. 40 pp.

Vestal, A. G. 1914. Prairie vegetation of a mountain-front area in Colorado. Botanical Gazette 58(5):377-400.

Vestal, A. G. 1919. Phytogeography of the eastern mountain front in Colorado. I. Physical geography and distribution of vegetation. Botanical Gazette 68(3):153-193.

Volland, L. A. 1976. Plant communities of the central Oregon pumice zone. USDA Forest Service R-6 Area Guide 4-2. Pacific Northwest Region, Portland, OR. 113 pp.

Volland, L. A. 1978. Trends in standing crop and species composition of a rested Kentucky bluegrass meadow over an 11-year period. Pp. 525-529 in: D.N. Hyder, ed. Proceedings, 1st International Rangeland Congress, Denver, CO.

Volland, L. A., and J. D. Dell. 1981. Fire effects on Pacific Northwest forest and range vegetation. USDA Forest Service. Pacific Northwest Region, Portland, OR. 23 pp.

Von Loh, J. 2000. Draft local descriptions of the vegetation associations of Ouray National Wildlife Refuge. USGS Bureau of Reclamation, Remote Sensing and GIS Group, Denver Federal Center, Denver.

Von Loh, J., D. Cogan, D. Faber-Langendoen, D. Crawford, and M. Pucherelli. 1999. USGS-NPS Vegetation Mapping Program, Badlands National Park, South Dakota. USDI Bureau of Reclamation. Technical Memorandum No. 8260-99-02. Denver, CO.

Von Loh, J., D. Cogan, D. J. Butler, D. Faber-Langendoen, D. Crawford, and M. J. Pucherelli. 2000. USGS-NPS Vegetation Mapping Program, Theodore Roosevelt National Park, North Dakota. USBR Technical Service Center. U.S. Department of the Interior, Bureau of Reclamation's Remote Sensing and GIS Group, Denver Federal Center, Denver, CO.

Von Loh, J., D. Cogan, K. Schulz, D. Crawford, T. Meyer, J. Pennell, and M. Pucherelli. 2002. USGS-USFWS Vegetation Mapping Program, Ouray National Wildlife Refuge, Utah. USDI Bureau of Reclamation, Remote Sensing and GIS Group, Technical Memorandum 8260-02-03. Denver Federal Center, Denver, CO.

Vories, K. C. 1974. A vegetation inventory and analysis of the Piceance Basin and adjacent drainages. Unpublished thesis. Western State College of Colorado, Gunnison. 243 pp.

Vujnovic, K., and J. Bentz. 2001. Preliminary classification of native wheat grass (Agropyron spp.) community types in Alberta. Alberta Natural Heritage Information Centre, Alberta Environment. Edmonton AB. 362 pp.

WNHP [Washington Natural Heritage Program]. No date. Unpublished data files. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.

Walford, G. M. 1996. Statewide classification of riparian and wetland dominance types and plant communities - Bighorn Basin segment. Report submitted to the Wyoming Department of Environmental Quality, Land Quality Division by the Wyoming Natural Diversity Database. 185 pp.

Walker, G. R., and J. D. Brotherson. 1982. Habitat relationships of basin wildrye in the high mountain valleys of central Utah. Journal of Range Management 35(5):628-633.

Walkup, C. J. 1991. Shepherdia canadensis. In: Fire Effects Information System. USDA Forest Service, RM Research Station, Fire Sciences Laboratory. [http://www.fs.fed.us/database/feis/] (accessed March 4, 2005)

Ward, R. T., W. Slauson, and R. L. Dix. 1974. The natural vegetation in the landscape of the Colorado oil shale region. Pages 9-17 in: C. W. Cook, editor. Surface rehabilitation of land disturbances resulting from oilshale development. Information Series 11, Environmental Resource Center, Colorado State University, Fort Collins.

Warren, P. L., K. L. Reichhardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982. Vegetation of Grand Canyon National Park. Cooperative National Park Resources Studies Unit Technical Report 9. Tucson, AZ. 140 pp.

Wasser, C. H., and K. Hess. 1982. The habitat types of Region II. USDA Forest Service: A synthesis. Final report prepared for USDA Forest Service, RM Forest and Range Experiment Station, Fort Collins, CO. 140 pp.

Watson, J. R. 1912. Plant geography of north central New Mexico: Contributions from the Hull Botanical Laboratory. Botanical Gazette 54:194-217.

Weaver, J. E., and F. W. Albertson. 1956. Grasslands of the Great Plains: Their nature and use. Johnsen Publishing Co., Lincoln, NE. 395 pp.

Wells, P. V. 1965. Scarp woodlands, transported soils, and concept of grassland climate in the Great Plains region. Science 148:246-249.

Wells, P. V. 1970a. Postglacial vegetational history of the Great Plains. Science 167:1574-1582.

Wells, P. V. 1970b. Historical factors controlling vegetation patterns and floristic distributions in the central plains region of North America. Pages 211-221 in: W. Dort and J. D. Jones, editors. Pleistocene and recent environments of the central Great Plains. University of Kansas Press, Lawrence.

Welsh, S. L., N. D. Atwood, S. Goodrich, and L. C. Higgins, editors. 1987. A Utah flora. Great Basin Naturalist Memoirs 9. Provo, UT. 894 pp.

West, N. E. 1983a. Great Basin-Colorado Plateau sagebrush semi-desert. Pages 331-349 in: N. E. West, editor. Temperate deserts and semi-deserts. Ecosystems of the world, Volume 5. Elsevier Publishing Company, Amsterdam.

West, N. E. 1983b. Intermountain salt desert shrublands. Pages 375-397 in: N. E. West, editor. Temperate deserts and semi-deserts. Ecosystems of the world, Volume 5. Elsevier Publishing Company, Amsterdam.

West, N. E. 1983c. Western Intermountain sagebrush steppe. Pages 351-374 in: N. E. West, editor. Temperate deserts and semi-deserts. Ecosystems of the world, Volume 5. Elsevier Publishing Company, Amsterdam.

West, N. E., F. D. Provenza, P. S. Johnson, and M. K. Owens. 1984. Vegetation change after 13 years of livestock grazing exclusion on sagebrush semidesert in west central Utah. Journal of Range Management 37(3):262-264.

West, N. E., and K. I. Ibrahim. 1968. Soil-vegetation relationships in the shadscale zone of southeastern Utah. Ecology 49(3):445-456.

Western Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Boulder, CO.

Western Resources Development Corporation. No date (a). North Antelope Mine Application No. 532-T2. On file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.

Wexelman, D., D. Zemudio, and T. Zemudio. 1999. Ecological riparian systems of the eastern slope of the Sierra Nevada Toiyabe National Forest. U.S. Forest Service Intermountain Region.

Williams, C.K., B.F. Kelly, B.G. Smith, and T.R. Lillybridge. 1995. Forest plant associations of the Colville National Forest. General Technical Report PNW-GTR-360. USDA Forest Service, PNW Region, Portland, OR. 140 pp.

Williams, C. K., T. R. Lillybridge, and B. G. Smith. 1990b. Forested plant associations of the Colville National Forest. Report prepared for USDA Forest Service, Colville National Forest, Colville, WA. 133 pp.

Williams, C. K., and B. G. Smith. 1990. Forested plant associations of the Wenatchee National Forest. Unpublished draft prepared by the USDA Forest Service, Pacific Northwest Region, Portland, OR. 217 pp.

Williams, C. K., and T. R. Lillybridge. 1983. Forested plant associations of the Okanogan National Forest. USDA Forest Service, Pacific Northwest Region. R6-Ecol-132b-1983. 140 pp.

Williams, C. K., and T. R. Lillybridge. 1985. Forested plant associations of the Colville National Forest. Draft. Unpublished field guide prepared for USDA Forest Service.

Williams, C. S. 1961. Distribution of vegetation in the Wind River Canyon, Wyoming. Unpublished thesis, University of Wyoming, Laramie.

Winward, A. H. 1970. Taxonomic and ecological relationships of the big sagebrush complex in Idaho. Unpublished dissertation, University of Idaho, Moscow. 90 pp.

Wooten, S. A. 1980. Vegetation recovery following disturbance on the Central Plains Experimental Range. Unpublished thesis, Colorado State University, Fort Collins.

Wright, H. A., L. F. Neuenschwander, and C. M. Britton. 1979. The role and use of fire in sagebrush-grass and pinyon-juniper plant communities: A state of the art review. USDA Forest Service General Technical Report INT-58. Intermountain Forest and Range Experiment Station. Ogden, UT.

Yake, S., and J. D. Brotherson. 1979. Differentiation of serviceberry habitats in the Wasatch Mountains of Utah. Journal of Range Management 32(4):379-386.

Young, J. A., R. A. Evans, B. A. Roundy, and J. A. Brown. 1986. Dynamic landforms and plant communities in a pluvial lake basin. Great Basin Naturalist 46(1):1-21.

Youngblood, A. P., W. G. Padgett, and A. H. Winward. 1985a. Riparian community type classification of eastern Idaho-western Wyoming. USDA Forest Service, Intermountain Region. R4-Ecol-85-01. Ogden, UT. 78 pp.

Youngblood, A. P., W. G. Padgett, and A. H. Winward. 1985b. Riparian community type classification of northern Utah and adjacent Idaho. Unpublished report prepared for USDA Forest Service, Intermountain Region, Ogden, UT. 104 pp.

Youngblood, A. P., and R. L. Mauk. 1985. Coniferous forest habitat types of central and southern Utah. USDA Forest Service, Intermountain Research Station. General Technical Report INT-187. Ogden, UT. 89 pp.

Youngblood, A. P., and W. F. Mueggler. 1981. Aspen community types on the Bridger-Teton National Forest in western Wyoming. USDA Forest Service. Research Paper INT-272. Intermountain Forest and Range Experiment Station, Ogden, UT. 34 pp.

Zamora, B. A. 1983. Forest habitat types of the Spokane Indian Reservation. Agricultural Research Center, Washington State University Research Bulletin XB-0936-1983.

Zamora, B., and P. T. Tueller. 1973. *Artemisia arbuscula, A. longiloba,* and *A. nova* habitat types in northern Nevada. Great Basin Naturalist 33(4):225-242.

Appendix G
Illustrated Keys to the Plant Associations of Fossil Butte National Monument

Introduction

A diverse assemblage of plant associations were characterized by field data collection conducted in 2005 under the US Geological Survey and National Park Service's Vegetation Mapping Program. To assist in the accurate field identification of the 71 plant associations, alliances, and park special vegetation types described for Fossil Butte National Monument, this dichotomous key has been developed and is illustrated with images taken during vegetation sampling.

It is the intent of the key to allow identification of plant associations with one or a combination of dominant species. Because of natural variation within plant associations and potential observer bias, it is possible that a community could be keyed to an association using more than one of the physiognomic keys. For sites that occupy 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 Fossil Butte National Monument vegetation map so that all research may have a common focal point, relative to the baseline year of aerial photography (2004) and field data collection (2005).

How To Use The Keys

The keys approach plant association identification on two levels. The first level is physiognomic, allowing the user to determine which major group is being evaluated, e.g., forest, woodland, tall shrubland, shrubland, dwarf-shrubland, graminoid, or forb. The second level allows identification to plant association based on dominant species canopy cover and to a lesser extent, habitat. As an aid to observers in the field, photographs representing both typical situations and variation within vegetation types are shown below the association names.

When using this key, you may have difficulty arriving at an association that precisely describes your community. There are several possible reasons for this problem and each has a solution:

1. You are observing vegetation that you think is an herbaceous or shrubland community, but it has some tree cover. In this case, try keying the vegetation through the woodland key as well as the herbaceous or shrubland key. In general with any layer, if it does not cover at least 8% (tree layer) or 5% (shrub or herbaceous layers), it is ignored. The exception is in very sparse communities (see #4 below).

2. The diagnostic layer consists of woody plants that may appear in either a shrub or a tree form, depending on site conditions and age. These species include *Pinus flexilis, Populus tremuloides, Prunus virginiana,* and *Juniperus scopulorum.* In this key, *Pinus flexilis* and *Juniperus scopulorum* are ALWAYS considered to be evergreen trees, *Populus tremuloides* a deciduous tree, and *Prunus virginiana* is considered a tall shrub, regardless of its height or growth form.

3. You can follow a key to a certain point, but you clearly have something not described in the key. This is to be expected occasionally – very likely you are either in an ecotone or have an association that was not found during the sampling phase of the project.

4. Communities that are sparsely vegetated (e.g. < 10% to15% 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. "Sparse" vegetation is defined as having total vascular plant cover of < 10%.

5. Focus on the perennial species in the community, unless the community consists almost entirely of annuals or ephemerals or is highly disturbed or degraded.

Key I: Major Physiognomic Groups of Fossil Butte National Monument

1a) Vegetation woody or appearing woody; dominated by trees, shrubs, or shrub-like herbs; total vegetation cover may range from sparse (<10%) to dense (>60%); occurring in wetland to upland habitats - **2**

1b) Vegetation herbaceous or appearing non-woody and occasionally extremely sparse; dominated by grasses, grass-like herbs (graminoids), and broad-leaf herbs (forbs), sometimes with sparse or low woody cover (shrub herbaceous). Total vegetation cover may range from sparse (<10%) to dense (>60%) in wetland to upland habitats. Characteristic genera include *Achnatherum, Symphyotrichum, Carex, Pteryxia, Eleocharis, Elymus, Eriogonum, Hordeum, Juncus, Lepidium, Leymus, Pascopyrum, Poa, Phlox,* and *Pseudoroegneria* **Key IV**

2a) Vegetation of forest (predominantly interlocking tree canopies) or woodland (predominantly open, non-interlocking canopies); characteristic genera include *Juniperus, Pinus, Populus, Prunus,* and *Pseudotsuga.* If the community is predominantly a montane shrubland with a few scattered *Pinus flexilis* or *Pseudotsuga menziesii* (<8% cover) please see **2b** **Key II**

2b) Vegetation of shrubs or shrub-like herbs; canopies may interlock, but are often less dense; characteristic genera include *Amelanchier, Artemisia, Atriplex, Ceanothus, Cercocarpus, Dasiphora, Krascheninnikovia, Prunus, Purshia, Salix, Sarcobatus,* and *Symphoricarpos*. Include some montane shrublands with scattered *Pinus flexilis* or *Pseudotsuga menziesii* (8% or less tree cover) **Key III**

Key II: Forest and Woodland Associations of Fossil Butte National Monument

1a) Deciduous forests or woodlands occupying mesic habitats, including north-facing slopes, seeps, springs, and drainages and including some mixed deciduous-evergreen woodlands on cold slopes. Canopy dominants include *Populus* and *Prunus*, rarely with *Pinus flexilis* as a canopy element - **2**

1b) Evergreen forests or woodlands occupying more xeric ridgetops, butte edges, slopes, and toeslope habitats; canopy dominants include *Pinus*, *Pseudotsuga*, and *Juniperus.* Tree cover may be less than <8% in sparsely vegetated communities where trees still have as much or more cover than any other layer - **11**

2a) (1) Forests or woodlands dominated by *Populus tremuloides*, typically occupying north-facing, high elevation slopes such as Fossil Butte, the ridge to Ruby Point, Dempsey Ridge, and Cundick Ridge. In xeric or post-fire situations, the trees may be dwarfed to little more than tall shrub stature - **3**

2b) Woodlands dominated by *Populus angustifolia* trees and growing on seeps and slumps on the southeast rim of Fossil Butte or dominated by *Prunus virginiana* tree-like shrubs occurring in small patches on mesic alluvial deposits - **10**

3a) (2) Forests or woodlands dominated by *Populus tremuloides*, usually located in the lee of ridges where snow collects. The subcanopy stratum typically is dominated by (sometimes dense) *Pinus flexilis* trees or tall shrubs such as *Amelanchier utahensis* and/or *Prunus virginiana* (these may be browsed by elk to a shorter stature). *Symphoricarpos oreophilus* is nearly always present and may dominate the short shrub layer - **4**

3b) Forests or woodlands dominated by *Populus tremuloides,* usually located in the lee of ridges where snow collects and on seeps; although shrubs with tree-like stature may be present, they do not form a stratum. The understory is generally a mix of shorter shrubs and herbaceous species, dominated by *Poa pratensis, Cornus sericea, Epilobium angustifolium, Apocynum androsaemifolium, Shepherdia canadensis,* and/or *Symphoricarpos oreophilus* - **6**

4a) (3) *Populus tremuloides* woodlands with a poorly developed understory without enough shrubs to constitute a stratum and with no clear dominant species in the herbaceous layer. Stands tend to be very small and associated with hillside seeps and slumps - ***Populus tremuloides* Woodland Alliance [Map Class 55]**

4b) *Populus tremuloides* forests or woodlands with a shrub understory dominated by *Amelanchier utahensis* or *Prunus virginiana.* Lower layers may contain diverse shrubs, graminoids, and forbs, but *Symphoricarpos oreophilus* is nearly always present - **5**

5a) (4) *Populus tremuloides* forests or woodlands with a shrub layer characterized by low to moderate cover by *Amelanchier utahensis* and *Symphoricarpos oreophilus* – ***Populus tremuloides / Amelanchier alnifolia - Symphoricarpos oreophilus /*** **Mixed Graminoid Forest [Map Class 55]**

5b) *Populus tremuloides* forests or woodlands with a shrub layer characterized by *Prunus virginiana*. *Leymus cinereus* and *Poa pratensis*, may provide sparse to moderate cover - ***Populus tremuloides / Prunus virginiana*** **Forest [Map Class 59]**

6a) (4) *Populus tremuloides* forests or woodlands with an understory dominated by herbaceous species; although shrubs are generally present, they do not constitute a stratum. Dominant species include *Apocynum androsaemifolium, Ligusticum filicinum, Epilobium angustifolium* and *Poa pratensis* - **7**

6b) *Populus tremuloides* forests or woodlands with a short shrub understory dominated by *Cornus sericea, Shepherdia canadensis*, and/or *Symphoricarpos oreophilus* **- 9**

7a) (6) *Populus tremuloides* forests or woodlands with an understory dominated by *Poa pratensis.* Native forbs have moderate cover - ***Populus tremuloides* / Invasive Perennial Grasses Forest [Map Class 60]**

7b) *Populus tremuloides* forests or woodlands with an understory dominated by herbaceous species, either *Epilobium angustifolium*, *Ligusticum filicinum*, or *Apocynum androsaemifolium* - **8**

8a) (7) *Populus tremuloides* forests or woodlands with an herbaceous stratum dominated by *Apocynum androsaemifolium*, apparently restricted to a seep on Cundick Ridge - ***Populus tremuloides / Apocynum androsaemifolium* Forest [Map Class 60]**

No photo available

8b) *Populus tremuloides* forests or woodlands with an understory dominated by tall forbs, among which *Epilobium angustifolium* and *Ligusticum filicinum* are the most

conspicuous species. Scattered *Shepherdia canadensis* and *Cercocarpus montanus* may be present - ***Populus tremuloides* / Tall Forbs Forest [Map Class 55]**

9a) (6) *Populus tremuloides* forests or woodlands with an undestory characterized by *Cornus sericea*; stands apparently restricted to a bench on the slope of Cundick Ridge - ***Populus tremuloides / Cornus sericea* Forest [Map Class 57]**

9b) *Populus tremuloides* forests or woodlands with a short shrub understory dominated by *Shepherdia canadensis*; *Symphoricarpos oreophilus* is usually present with low cover - ***Populus tremuloides / Shepherdia canadensis*** **Forest [Map Class 60]**

10a) (2) *Populus angustifolia* woodlands restricted to slumping, seepy slopes on the south-face of Fossil Butte. A short shrub layer is dominated by *Artemisia tridentata*. *Leymus cinereus* provides sparse to moderate understory cover - ***Populus angustifolia / Leymus cinereus*** **Woodland [Map Class 54]**

10b) *Prunus virginiana* shrublands that attain tree-like heights and trunk diameters greater than 10 cm. Small stands occur on mesic sites in valleys and benches. *Amelanchier utahensis* may have significant cover in the understory – ***Prunus virginiana – (Prunus americana)*** **Shrubland [Map Class 63]**

11a) (1) Evergreen forests or woodlands occupying ridgetops, upper slopes, or slumps, characterized by scattered *Juniperus scopulorum* or moderately dense *Pseudotsuga menziesii* stands - **12**

11b) Evergreen forests or woodlands occupying upland habitats including ridges, slopes, benches, and toeslopes, dominated by *Pinus flexilis* trees, sometimes with a few *Pseudotsuga menziesii* in the understory or emerging from the canopy. The understory is dominated by *Amelanchier utahensis, Cercocarpus montanus*, and/or *Symphoricarpos oreophilus* - **13**

12a) (11) *Juniperus scopulorum* trees growing on a slump adjacent to the Slump Trail, forming a sparse woodland stand with an understory dominated by *Artemisia tridentata* ssp. *vaseyana* shrubs **- *Juniperus scopulorum / Artemisia tridentata* Woodland [Map Class 44]**

12b) *Pseudotsuga menziesii* forest and woodland stands on the slopes of Dempsey Ridge and near Ruby Point; stands have low understory shrub cover dominated by *Symphoricarpos oreophilus* **- *Pseudotsuga menziesii / Symphoricarpos oreophilus* Woodland [Map Class 68]**

13a) (11) *Pinus flexilis* woodlands on moderate to steep slopes and ridges. Scattered *Pseudotsuga menziesii* may emerge from the canopy. *Amelanchier utahensis* and/or *Cercocarpus montanus* dominate the shrub understory. *Symphoricarpos oreophilus* may be present to co-dominant – ***Pinus flexilis / Cercocarpus montanus – Amelanchier utahensis* Woodland [Map Class 51]**

13b) *Pinus flexilis* woodlands occurring on moderate to steep slopes, toeslopes, and ridges. The understory is dominated by *Symphoricarpos oreophilus* – ***Pinus flexilis / Symphoricarpos oreophilus*** **Woodland [Map Class 51]**

Key III: Shrub and Shrub Herbaceous Associations of Fossil Butte National Monument

1a) Tall or short shrublands occupying wetlands, riparian areas, floodplains, valley floors, seeps emerging on slopes and benches, or other habitats that have a high ground water table, are saturated, or periodically flooded. Characteristic plants include *Artemisia cana, Dasiphora, Prunus,* or *Salix* - **2**

1b) Tall, short, or dwarf-shrubland or shrub herbaceous vegetation occupying upland habitats or dry, high alluvial terraces. Characteristic genera include *Amelanchier, Artemisia* (*nova, arbuscula* or *tridentata*), *Atriplex, Ceanothus, Cercocarpus, Krascheninnikovia, Purshia, Sarcobatus,* or *Symphoricarpos* - **6**

2a) (1) Short shrublands occupying low terraces of perennial drainages, drainage bottoms, or swales with high ground water tables, or occurring on moist benches. Characteristic species include *Artemisia cana* or *Dasiphora fruticosa* - **3**

2b) Tall shrublands occupying springs, seeps, moist benches, moist toeslopes, or mesic sites on valley floors. Characteristic genera include *Prunus* or *Salix* - **4**

3a) (2) *Dasiphora fruticosa* ssp. *floribunda* shrublands occupying a mesic bench on the northeast-facing slope of Fossil Butte – ***Dasiphora fruticosa* ssp. *floribunda* Shrubland [Map Class 38]**

3b) *Artemisia cana* shrublands occurring on first terraces of Chicken and Smallpox Creeks, in intermittent tributary drainages with high ground water tables, or in mesic swales. *Juncus balticus* provides sparse to moderate cover – ***Artemisia cana / Juncus balticus*** **Shrubland [Map Class 9]**

4a) (2) Small stands of tall shrubs on mesic sites; *Prunus virginiana* dominates or co-dominates with *Amelanchier utahensis*. *Populus tremuloides* saplings are common – ***Prunus virginiana – (Prunus americana)*** **Shrubland [Map Class 63]**

4b) Small stands of tall shrubs occurring on saturated soils and shallow standing water of seeps and springs, *Salix* spp. provide moderate to dense cover - **5**

5a) (4) *Salix scouleriana* stands occurring on saturated soils of seeps on a bench near Cundick Spring – ***Salix scouleriana*** **Shrubland [Map Class 71]**

5b) *Salix lutea* stands with sparse cover of the tall bunchgrass *Leymus cinereus*, occurring on saturated soils of seeps in drainages and on slumps or benches, and in shallow water of small ponds – ***Salix lutea / Leymus cinereus*** **Shrubland [Map Class 70]**

6a) (1) Tall, short, or dwarf-shrubland or shrub herbaceous vegetation occupying a variety of upland habitats ranging from dry to sites with a moderately high ground water table and dominated by shrub species of *Artemisia* - **7**

6b) Tall, short, or dwarf-shrublands occupying dry upland habitats and dominated by species of *Amelanchier, Atriplex, Ceanothus, Cercocarpus, Krascheninnikovia, Purshia, Sarcobatus*, or *Symphoricarpos* - **31**

7a) (6) Short shrubland or shrub herbaceous vegetation co-dominated by *Artemisia nova* and *Artemisia tridentata;* the understory is a diverse mix of grass and forb species, including *Pseudoroegneria spicata* – ***Artemisia nova / Pseudoroegneria spicata*** **Shrubland [Map Class 10]**

7b) Tall, short, or dwarf-shrubland or shrub herbaceous vegetation dominated by varieties of *Artemisia arbuscula* or *Artemisia tridentata*. *Artemisia nova* may be present with low relative cover - **8**

8a) (7) Short or dwarf-shrubland or shrub herbaceous vegetation characterized by sparse to dense cover of *Artemisia arbuscula* ssp. *longiloba* with no developed understory or a variety of grasses and cushion plants in the understory, occurring in nearly monotypic stands on dry, clayey uplands. *Atriplex gardneri* is typically absent - **9**

8b) Tall or short shrublands characterized by sparse to dense cover of *Artemisia tridentata* ssp. *tridentata, A. tridentata* ssp. *vaseyana,* or *A. tridentata* ssp. *wyomingensis,* with a variety of understory species, occurring on dry uplands or sites with moderately high ground water tables - **14**

9a) (8) *Artemisia arbuscula* ssp. *longiloba* shrublands, sometimes mixed with other shrubs such as *Sarcobatus vermiculatus, Atriplex confertifolia* or *Artemisia tridentata,* with a sparse understory of mixed herbaceous species with no clear dominant and occurring on a variety of landscape positions – ***Artemisia arbuscula* ssp. *longiloba* Shrubland [Map Class 4]**

9b) *Artemisia arbuscula* ssp. *longiloba* shrubland or shrub herbaceous vegetation occurring on clay soils of a variety of landscape positions and characterized in the understory by cushion plants and/or species of *Elymus, Poa,* or *Pseudoroegneria* - **10**

10a) (9) Shrubland or shrub herbaceous vegetation characterized by sparse to moderate cover of *Artemisia arbuscula* ssp. *longiloba* and low to moderate cover of *Poa secunda* or *Pseudoroegneria spicata. Elymus lanceolatus* is absent or has very low relative cover compared with other grasses. Cushion plants have less cover than the grasses - **11**

10b) Short shrublands characterized by low to dense cover of *Artemisia arbuscula* ssp. *longiloba* and lesser cover by species of cushion plants, *Elymus lanceolatus*, or *Poa fendleriana. Poa secunda* may be co-dominant in the herbaceous layer - **12**

11a) (10) Shrubland or shrub herbaceous vegetation characterized by sparse to low cover of *Artemisia arbuscula* ssp. *longiloba* with an understory dominated by *Poa secunda.* Cushion plants are always present but have less cover than the grasses*;* stands generally occupy dry south-facing slopes, benches, and ridges – ***Artemisia arbuscula* ssp. *longiloba / Poa secunda* Shrub Herbaceous Vegetation [Map Class 4]**

11b) Shrubland or shrub herbaceous vegetation characterized by sparse to low cover of the short shrub *Artemisia arbuscula* ssp. *longiloba* and an understory dominated by *Pseudoroegneria spicata.* Cushion plants are present but with less cover than the grasses*;* stands generally occupy north-facing slopes, benches, and ridges – ***Artemisia arbuscula* ssp. *longiloba / Pseudoroegneria spicata* Shrub Herbaceous Vegetation [Map Class 4]**

12a) (10) Open shrublands of *Artemisia arbuscula* ssp. *longiloba* occupying dry, exposed slopes and ridgetops. Cushion plants such as *Antennaria, Arenaria, Astragalus, Cymopterus, Erigeron, Haplopappus, Phlox, Physaria, Trifolium,* and others dominate the understory. Grasses are present but are a minor element of the understory – ***Artemisia arbuscula* ssp. *longiloba* / Cushion Plants Shrubland [Map Class 4]**

12b) *Artemisia arbuscula* ssp. *longiloba* short shrublands occupying more mesic slopes and ridgetops, with understories dominated by *Elymus lanceolatus* or *Poa* spp. - **13**

13a) (12) *Artemisia arbuscula* ssp. *longiloba* shrublands occurring on Ruby Point and Fossil Butte, with an understory dominated by the rhizomatous grass *Elymus lanceolatus. Poa secunda* may be co-dominant and cushion plants such as *Phlox* spp. are often conspicuous – ***Artemisia arbuscula* ssp. *longiloba* / *Elymus lanceolatus* Shrubland [Map Class 4]**

13b) *Artemisia arbuscula* ssp. *longiloba* shrublands, sometimes sparse, occurring on Ruby Point and the Chicken Creek badlands. The understory is dominated by the short bunchgrass *Poa fendleriana.* Cushion plants are usually present but with less cover than the grasses – ***Artemisia arbuscula* ssp. *longiloba* / *Poa fendleriana* Shrubland [Map Class 4]**

14a) (8) *Artemisia tridentata* ssp. *wyomingensis* shrublands on a landslide on Cundick Ridge; the understory is dominated by the rhizomatous grass *Elymus lanceolatus* – ***Artemisia tridentata / Elymus lanceolatus*** **Shrubland [Map Class 23]**

14b) Tall or short shrublands occurring on a variety of habitats throughout the monument and dominated by the *Artemisia tridentata* ssp. *tridentata, A. tridentata* ssp. *vaseyana*, or *A. tridentata* ssp. *wyomingensis* - **15**

15a) (14) *Artemisia tridentata* ssp. *tridentata* tall shrublands occupying mesic drainages, swales, toeslopes, or high terraces in valleys. The understory is dominated by rhizomatous or bunch grasses, including *Leymus cinereus, Pascopyrum smithii*, or *Poa secunda* - **16**

15b) *Artemisia tridentata* ssp. *vaseyana* or *A. t.* ssp. *wyomingensis* shrublands occupying diverse habitats and with an understory characterized by species of grasses or forbs, or by a disturbed (sparse and weedy) understory - **17**

16a) (15) *Artemisia tridentata* ssp. *tridentata* shrublands occurring in the Chicken Creek drainage system, on valley floors, and on mesic terraces and knolls. The understory is dominated by the short bunchgrass *Poa secunda*, although other grasses such as *Poa fendleriana* and *Elymus lanceolatus* may be codominant in the understory – ***Artemisia tridentata* ssp. *tridentata / Poa secunda* Shrubland [Map Class 15]**

16b) *Artemisia tridentata* ssp. *tridentata* shrublands occurring in depressions on benches or along drainages emanating from Fossil Butte. The understory is dominated (at least visually) by *Leymus cinereus* – ***Artemisia tridentata* ssp. *tridentata / Leymus cinereus* Shrubland [Map Class 13]**

17a) (15) Mixed shrublands in which *Artemisia tridentata* ssp. *vaseyana* is co-dominant with *Amelanchier utahensis,* occurring on hillsides, slopes, benches, ridges, and drainage-sides – ***Artemisia tridentata* (ssp. *vaseyana*, ssp. *wyomingensis*) – *Amelanchier utahensis* Shrubland [Map Class 11]**

17b) Shrublands dominated by *Artemisia tridentata* ssp. *vaseyana* or *A. tridentata* ssp. *wyomingensis* and occurring on a variety of upland habitats; the understory is dominated by forbs or grasses, or may be sparse and weedy - **18**

18a) (17) *Artemisia tridentata* ssp. *vaseyana* shrublands occurring in a variety of habitats, with an understory dominated by forbs and grasses such as *Achnatherum lettermanii, Balsamorhiza sagittata, Elymus lanceolatus, Pascopyrum smithii, Leymus cinereus, Leucopoa kingii, Poa fendleriana, Poa pratensis, Poa secunda* or *Pseudoroegneria spicata* - **19**

18b) *Artemisia tridentata* ssp. *wyomingensis* shrublands on dry plains and slopes near the southern monument boundary. The understory may be disturbed and weedy or it may be dominated by bunchgrasses similar to *Artemisia tridentata* ssp. *vaseyana* shrublands - **28**

19a) (18) *Artemisia tridentata* ssp. *vaseyana* shrublands with an understory dominated by *Balsamorhiza sagittata.* This association is known only from the slopes of the ridge leading to Ruby Point – ***Artemisia tridentata* ssp. *vaseyana* / *Balsamorhiza sagittata* Shrubland [Map Class 16]**

19b) *Artemisia tridentata* ssp. *vaseyana* shrublands with an understory dominated by rhizomatous or bunch grasses - **20**

20a) (19) *Artemisia tridentata* ssp. *vaseyana* shrublands with an understory dominated by the rhizomatous grasses *Elymus lanceolatus, Poa pratensis,* or *Pascopyrum smithii*. *Leymus cinereus* is absent or has very low relative cover - **21**

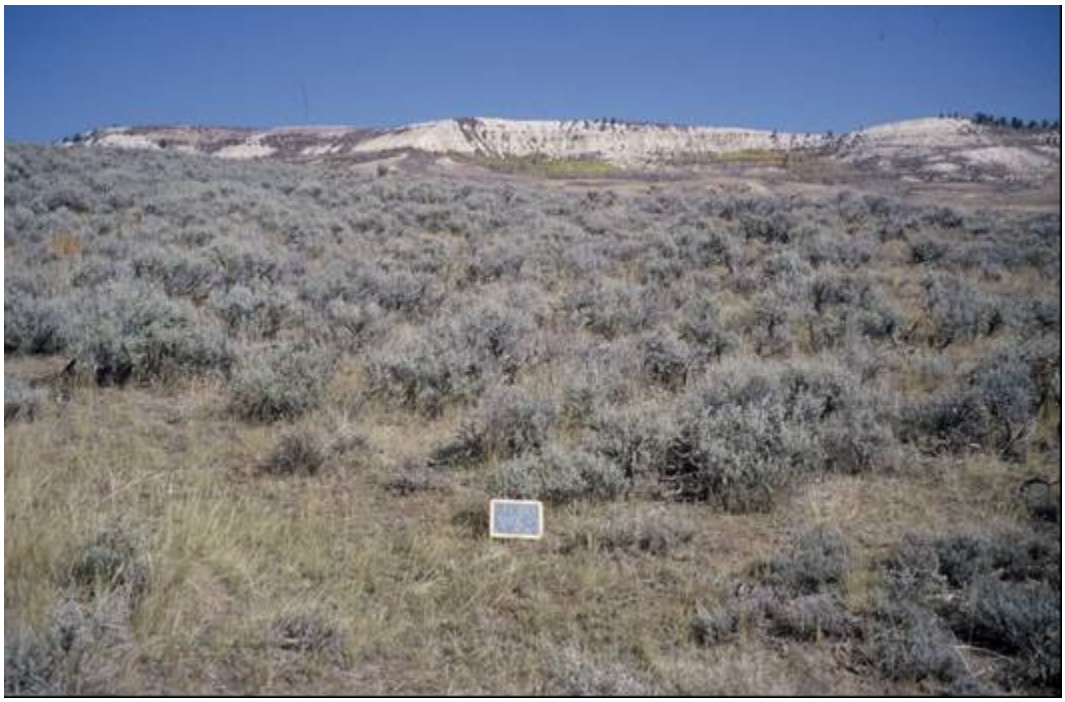
20b) *Artemisia tridentata* ssp. *vaseyana* shrublands with an understory dominated by bunchgrasses such as *Achnatherum lettermanii, Poa fendleriana, Poa secunda, Pseudoroegneria spicata, Leucopoa kingii*,or *Leymus cinereus* - **23**

21a) (20) *Artemisia tridentata* ssp. *vaseyana* shrublands occurring near the visitor center; *Pascopyrum smithii* provides sparse to low cover in the understory. Other grasses may be present to co-dominant, as is *Phlox cespitosa* – ***Artemisia tridentata* ssp. *vaseyana* / *Pascopyrum smithii* Shrubland [Map Class 16]**

21b) *Artemisia tridentata* ssp. *vaseyana* shrublands in the northern part of the monument with an understory dominated or co-dominated by *Elymus lanceolatus* on slopes or *Poa pratensis* in swales - **22**

22a) (21) Mesic *Artemisia tridentata* ssp. *vaseyana* shrublands in the northern part of the monument around Ruby Point with an herbaceous understory dominated by *Poa pratensis*. Sites tend to be mesic swales; willows, silver sagebrush and aspen may occur nearby - ***Artemisia tridentata* ssp. *vaseyana* / *Poa pratensis* Sagebrush Shrubland [Map Class 16]**

22b) *Artemisia tridentata* ssp. *vaseyana* shrublands occurring on exposed slopes of The Bullpen and Fossil Butte. *Elymus lanceolatus* provides low to moderate cover with few other grasses present – ***Artemisia tridentata* ssp. *vaseyana* / *Elymus lanceolatus* Shrubland [Map Class 16]**



23a) (20) *Artemisia tridentata* ssp. *vaseyana* shrublands with an understory dominated by the bunchgrasses *Pseudoroegneria spicata, Achnatherum lettermanii,* or *Leymus cinereus*. *Poa fendleriana* or *Poa secunda* may be present to co-dominant - **24**

23b) *Artemisia tridentata* ssp. *vaseyana* shrublands with an understory dominated by the bunchgrasses *Poa fendleriana, Leucopoa kingii* or *Poa secunda*. *Pseudoroegneria spicata* and *Leymus cinereus* are generally absent, but *Elymus lanceolatus* may be present to co-dominant - **26**

24a) (23) *Artemisia tridentata* ssp. *vaseyana* shrublands found only on a dry summit of the Dempsey Ridge system. The understory is characterized by low cover of *Pseudoroegneria spicata,* usually accompanied by a few other grasses and cushion plants – ***Artemisia tridentata* ssp. *vaseyana* / *Pseudoroegneria spicata* Shrubland [Map Class 16]**

24b) *Artemisia tridentata* ssp. *vaseyana* shrublands on hillslopes, but not usually on ridge crests, with an understory dominated by the bunchgrasses *Achnatherum lettermanii* or *Leymus cinereus*. *Poa fendleriana* or *Poa secunda* may be present to co-dominant - **25**

25a) (24) *Artemisia tridentata* ssp. *vaseyana* shrublands, widespread from Fossil Butte north to the Bullpen on mesic sites on slopes, benches, hillsides, and in drainages. The understory is characterized by sparse to moderate cover of *Leymus cinereus. Elymus lanceolatus* or *Pascopyrum smithii* may be present to co-dominant - ***Artemisia tridentata* ssp. *vaseyana* / *Leymus cinereus* Shrubland [Map Class 16]**

25b) *Artemisia tridentata* ssp. *vaseyana* shrublands in the northern part of the monument on hill slopes. The grass understory is dominated by *Achnatherum lettermanii*, although *Leymus cinereus* and *Poa fendleriana* are generally also present - ***Artemisia tridentata* ssp. *vaseyana* / *Achnatherum lettermanii* Shrubland [Map Class 16]**

26a) (23) *Artemisia tridentata* ssp. *vaseyana* shrublands occurring along the western monument boundary. The understory is characterized by sparse cover of *Poa fendleriana* – ***Artemisia tridentata* ssp. *vaseyana* / *Poa fendleriana* Shrubland [Map Class 16]**

26b) *Artemisia tridentata* ssp. *vaseyana* shrublands occurring on slopes throughout the monument, either with a sparse understory dominated by *Poa secunda* or a denser herbaceous layer that includes *Leucopoa kingii* as a dominant species - **27**

27a) (26) *Artemisia tridentata* ssp. *vaseyana* shrublands occurring on slopes throughout the monument and with an understory characterized by sparse to low cover of *Poa secunda* with few other herbaceous species present – ***Artemisia tridentata* ssp. *vaseyana* / *Poa secunda* Shrubland [Map Class 16]**

27b) *Artemisia tridentata* ssp. *vaseyana* shrublands occurring on hillslopes in the northern part of the monument, especially around The Bullpen. *Leucopoa kingii* is prominent in the understory and either dominant or co-dominant with *Elymus lanceolatus* and *Poa secunda* - ***Artemisia tridentata* ssp. *vaseyana* / *Leucopoa kingii* Shrubland [Map Class 16]**

28a) (18) *Artemisia tridentata* ssp. *wyomingensis* shrublands, known only from the environs adjacent to the southwestern monument boundary. The understory is disturbed by livestock grazing, resulting in a sparse understory containing low cover of the exotic forbs *Alyssum desertorum, Ranunculus testiculatus,* and *Taraxacum officinale* – ***Artemisia tridentata* ssp. *wyomingensis* / Disturbed Understory Semi-natural Shrubland [Map Class 23]**

28b) *Artemisia tridentata* ssp. *wyomingensis* shrublands distributed through the southern, lower-elevation parts of the monument. The understory is dominated by the bunchgrasses *Poa secunda, Pseudoroegneria spicata* or *Leymus cinereus* - **29**

29a) (28) *Artemisia tridentata* ssp. *wyomingensis* shrublands, sometimes with a sparse or disturbed understory, but dominated by the bunchgrass *Poa secunda* – ***Artemisia tridentata* ssp. *wyomingensis* / *Poa secunda* Shrubland [Map Class 23]**

29b) *Artemisia tridentata* ssp. *wyomingensis* shrublands occurring on the Fossil Quarry Trail with an understory dominated by *Pseudoroegneria spicata* or *Leymus cinereus* - **30**

30a) (29) *Artemisia tridentata* ssp. *wyomingensis* shrublands with an understory characterized by low cover of *Pseudoroegneria spicata* – ***Artemisia tridentata*** **ssp.** ***wyomingensis / Pseudoroegneria spicata*** **Shrubland [Map Class 23]**

30b) *Artemisia tridentata* ssp. *wyomingensis* shrublands with an understory characterized by low cover of *Leymus cinereus* – ***Artemisia tridentata* ssp. *wyomingensis* / *Leymus cinereus* Shrubland [Map Class 23]**

31a) (6) Dwarf-shrubland, shrub herbaceous or sparse vegetation dominated by *Atriplex gardneri* or *Krascheninnikovia lanata,* sometimes with sparse to low cover by *Artemisia arbuscula* ssp. *longiloba* - **32**

31b) Tall or short shrublands dominated by species of *Amelanchier, Atriplex, Ceanothus, Cercocarpus, Purshia, Sarcobatus,* or *Symphoricarpos* - **35**

32a) (31) *Atriplex gardneri*-dominated dwarf-shrublands occurring along the monument's southern boundary - **33**

32b) *Krascheninnikovia lanata*-dominated shrubland, shrub steppe or sparse vegetation, widely distributed through the central portion of the monument and characterized by sparse cover of *Poa secunda* or *Achnatherum hymenoides* - **34**

33a) (32) Dwarf-shrublands on relatively level sites or in swales with less than 20% vegetative cover, co-dominated by *Atriplex gardneri* and *Artemisia arbuscula* ssp. *longiloba,* each providing less than 5% cover – ***Atriplex gardneri – Artemisia arbuscula* ssp. *longiloba* Dwarf-shrubland [Map Class 4]**

33b) Dwarf-shrublands with 10 to 35% cover, dominated by *Atriplex gardneri*. Other shrubs may provide sparse cover, including *Artemisia arbuscula* ssp. *longiloba, Artemisia tridentata* ssp. *wyomingensis, Krascheninnikovia lanata*, or *Sarcobatus vermiculatus* – ***Atriplex gardneri* Dwarf-shrubland [Map Class 4]**

34a) (32) Dwarf-shrubland, shrub-herbaceous or sparse vegetation dominated by *Krascheninnikovia lanata*, limited to Dempsey Ridge and characterized by an understory with sparse cover of *Achnatherum hymenoides*. Other grasses and a few cushion plants are usually present – ***Krascheninnikovia lanata / Achnatherum hymenoides*** **Dwarf-shrubland [Map Class 36]**

34b) *Krascheninnikovia lanata* dwarf-shrublands limited to the flats above Smallpox Creek; the understory is characterized by sparse cover of *Poa secunda* and cushion plants. *Achnatherum hymenoides* is absent – ***Krascheninnikovia lanata / Poa secunda*** **Dwarf-shrubland [Map Class 36]**

35a) (31) Shrublands, sometimes extremely sparse and occurring on dry, alkaline to saline habitats; dominated by *Atriplex confertifolia* and/or *Sarcobatus vermiculatus* - **36**

35b) Shrublands occurring on diverse habitats that are better vegetated and more mesic. Dominant species are *Amelanchier, Ceanothus, Cercocarpus, Purshia*, or *Symphoricarpos* - **39**

36a) (35) *Atriplex confertifolia* short shrublands occurring on cliffs and steep, clayey high slopes of Fossil Butte; stands total 3% or less cover; *Sarcobatus vermiculatus* absent or very sparse - ***Atriplex confertifolia*** **Wyoming Basins Shrubland [Map Class 29]**

36b) Shrublands, sometimes sparse, co-dominated or dominated by *Sarcobatus vermiculatus* - **37**

37a) (36) Extremely sparse vegetation on the badland toeslopes of Fossil Butte; stands consist of 1% or less total cover; the most conspicuous species are *Atriplex confertifolia* and *Sarcobatus vermiculatus,* but no species has more than trace cover – ***Atriplex confertifolia – Sarcobatus vermiculatus*** **Shrubland [Map Class 28]**

37b) Shrublands characterized by *Sarcobatus vermiculatus* in which *Atriplex confertifolia* is sparse or absent - **38**

38a) (37) *Sarcobatus vermiculatus* shrublands occupying deep soils and mesic sites along minor drainages south of the monument boundary; stands contain low cover by *Artemisia tridentata* ssp. *wyomingensis* or *A. tridentata* ssp. *tridentata* – ***Sarcobatus vermiculatus* – *Artemisia tridentata* Shrubland [Map Class 28]**

38b) *Sarcobatus vermiculatus* shrublands occupying dry soils of alluvial fans or badland swales or slopes in the southern portion of the monument; stands also contain sparse cover by *Atriplex gardneri* – ***Sarcobatus vermiculatus – Atriplex gardneri*** **Shrubland [Map Class 28]**

39a) (35) Shrublands occupying ridgetops, butte margins, or slopes and dominated by *Amelanchier utahensis* and/or *Cercocarpus montanus,* or *Artemisia tridentata,* sometimes with scattered young *Pinus flexilis* emerging from the shrub layer (<8% cover). If present, *Ceanothus martini* and *Purshia tridentata* have low relative cover **- 40**

39b) Shrubland or shrub herbaceous vegetation on slopes, hillsides, ridgetops, or bluff margins and dominated by *Ceanothus martinii, Purshia tridentata,* or *Symphoricarpos oreophilus* **- 42**

40a) (39) Open mixed mountain shrublands occurring on steep slopes and ridges of Ruby Point and Fossil Butte. *Amelanchier utahensis* provides sparse to low cover and is associated with sparse to low cover of *Artemisia tridentata* ssp. *vaseyana, Purshia tridentata,* and/or *Symphoricarpos oreophilus. Cercocarpus montanus* is absent – ***Amelanchier utahensis* Shrubland [Map Class 1]**

40b) Open to dense shrublands dominated by *Amelanchier utahensis, Cercocarpus montanus* or a combination of the two, with or without *Artemisia tridentata* as a co-dominant shrub **- 41**

41a) (40) Shrublands co-dominated by *Amelanchier utahensis* and *Artemisia tridentata* ssp. *vaseyana* or *Artemisia tridentata* ssp. *wyomingensis*; occurring on hillsides, slopes, benches, ridges, and drainage-sides. If *Juniperus scopulorum* provides an open canopy of around 10%, please go to Key II, couplet 11a – ***Artemisia tridentata* (ssp. *vaseyana*, ssp. *wyomingensis*) – *Amelanchier utahensis* Shrubland [Map Class 11]**

41b) Mixed mountain shrublands occurring on steep, exposed slopes and ridges of Ruby Point, Cundick Ridge, and Fossil Butte, in which either *Amelanchier utahensis* or *Cercocarpus montanus* is dominant but *Artemisia tridentata* is present with relatively sparse cover. *Pinus flexilis* may be present with less than 8% cover and the herbaceous understory consists of a mix of forbs and grasses – ***Amelanchier (utahensis, alnifolia) – Cercocarpus montanus*** **Shrubland [Map Class 1]**

42a) (39) *Ceanothus martinii* shrubland occurring on the high slopes of Cundick Ridge; *Ceanothus martinii* provides up to 3% cover and is usually mixed with other shrubs such as *Amelanchier utahensis, Cercocarpus montanus, Artemisia arbuscula* ssp. *longiloba,Symphoricarpos oreophilus,* and *Purshia tridentata* – ***Ceanothus martinii*** **Shrubland [Map Class 33]**

42b) Shrublands occurring on the slopes of Fossil Butte, characterized by stands with up to 20% cover of *Purshia tridentata* or *Symphoricarpos oreophilus* - **43**

43a) (42) *Purshia tridentata* shrublands occurring on the rim of Fossil Butte; the understory includes significant cover by the forb *Pteryxia terebinthina* (up to 3%). Perennial grasses may dominate the herbaceous layer – ***Purshia tridentata / Pteryxia terebinthina*** **Shrubland [Map Class 69]**

43b) *Symphoricarpos oreophilus* shrublands occurring on a series of benches on the north-facing slope of Fossil Butte – ***Symphoricarpos oreophilus*** **Shrubland [Map Class 74]**

Key IV: Herbaceous, Shrub Herbaceous and Sparsely Vegetated Associations of Fossil Butte National Monument

1a) Herbaceous vegetation of mesic sites maintained by a high water table or surface water, including wetlands, perennial streams, floodplains, and seeps; stands dominated by species of *Carex*, *Eleocharis*, *Hordeum*, *Juncus*, *Leymus*, or *Poa* - **2**

1b) Herbaceous and short shrub herbaceous vegetation occupying xeric and upland sites including buttes, slopes, ridges, hilltops, and benches; community not maintained by surface or ground water; stands dominated by species of *Artemisia (frigida)*, *Symphyotrichum*, *Pteryxia*, *Elymus*, *Eriogonum*, *Lepidium*, *Pascopyrum*, *Poa*, or *Pseudoroegneria* - **7**

2a) (1) Wetland herbaceous vegetation dominated by *Carex*, *Eleocharis*, or *Juncus* - **3**

2b) Wetland herbaceous vegetation dominated by *Hordeum*, *Leymus*, or *Poa* - **5**

3a) (2) Herbaceous vegetation characteristic of the margins of permanently or semi-permanently flooded livestock or beaver ponds. Stands are typically small and dominated by *Eleocharis palustris*; associated graminoids may include *Carex utriculata* and *Muhlenbergia richardsonii* - ***Eleocharis palustris*** **Herbaceous Vegetation [Map Class 39]**

3b) Herbaceous vegetation growing in active channels, saturated drainages, or swales; also associated with seeps and springs - **4**

4a) (3) *Juncus balticus* communities usually occurring in dense stands on saturated first terraces of Chicken and Smallpox creeks and their tributaries; stands are typically linear patches or occupy the drainage bottom; they may also occupy seeps **- *Juncus balticus* Herbaceous Vegetation [Map Class 32]**

4b) *Carex nebrascensis* communities occurring mostly in dense stands on saturated or inundated channel bottoms in Chicken and Smallpox creeks; also found below springs and seeps. Stands are typically small, linear patches. Associated species often include *Potentilla anserina* and *Potentilla pensylvanica* - ***Carex nebrascensis* Herbaceous Vegetation [Map Class 32]**

5a) (2) *Hordeum brachyantherum* communities occupying the saturated restored or revegetated banks of Chicken Creek **- *Hordeum brachyantherum* Herbaceous Vegetation [Map Class 42]**

5b) Mesic sites supporting the native tall bunchgrass *Leymus cinereus* or the non-native, rhizomatous grass *Poa pratensis* **- 6**

6a) (5) *Poa pratensis* grasslands associated with seasonally flooded seeps, often with sparse cover by *Juncus balticus*. *Pascopyrum smithii* may be present - ***Poa pratensis* - *(Pascopyrum smithii*) Semi-natural Herbaceous Vegetation [Map Class 53]**

6b) *Leymus cinereus* communities, sometimes sparse, occurring in isolated patches and stands on mesic sites, including seeping slopes, swales, drainages, benches, and springs. Shrubs may have up to 10% cover but shrub cover is always less than *Leymus cinereus*. Associated species include the shrubs *Salix lutea, Artemisia tridentata* ssp. *vaseyana, Purshia tridentata* and the forbs *Agastache urticifolia*, and *Balsamorhiza sagittata* - ***Leymus cinereus* Herbaceous Vegetation [Map Class 49]**

7a) (1) Shrub herbaceous vegetation characterized by individual *Artemisia arbuscula* ssp. *longiloba* shrubs scattered in a bunchgrass community dominated by *Achnatherum hymenoides, Poa secunda* or *Pseudoroegneria spicata*. *Artemisia arbuscula* ssp. *longiloba* cover is typically less than 10% - **8**

7b) Herbaceous vegetation, sometimes sparse, dominated by cushion plants, other low-growing forbs, and grasses. Scattered short shrubs or dwarf-shrubs may be present - **9**

8a) (7) Shrub herbaceous vegetation with low cover of *Artemisia arbuscula* ssp. *longiloba*. The community is dominated by *Poa secunda.* Stands generally occupy dry, south-facing slopes, benches, and ridges **- *Artemisia arbuscula* ssp. *longiloba* / *Poa secunda* Shrub Herbaceous Vegetation [Map Class 4]**

8b) Shrub herbaceous vegetation with low cover of *Artemisia arbuscula* ssp. *longiloba*. The community is dominated by the medium-tall bunchgrass *Pseudoroegneria spicata*. Stands generally occupy north-facing slopes, benches, and ridges **- *Artemisia arbuscula* ssp. *longiloba* / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation [Map Class 4]**

9a) (7) Herbaceous communities dominated by species of upright forbs such as *Symphyotrichum, Pteryxia,* or *Lepidium,* or cushion plant-dominated communities characterized by a variety of caespitose or low-growing species of *Artemisia, Astragalus, Erigeron, Eriogonum, Phlox,* and *Physaria* - **10**

9b) Herbaceous dominated by species of *Elymus, Pascopyrum, Poa,* or *Pseudoroegneria,* although low-growing forbs and cushion plants may have significant cover - **14**

10a) (9) Forb communities on clay soils of an alluvial fan east of Chicken Creek and characterized by moderate cover of *Lepidium virginicum* and sparse cover of *Poa fendleriana* and *Poa secunda* **- *Lepidium virginicum* Sparse Herbaceous Vegetation [Map Class 48]**

10b) Tall forb communities occurring in snow glades at the northern end of the monument or low cushion plant communities, often sparse, on shallow shale soils of exposed high slopes and ridges throughout the monument - **11**

11a) (10) Forb communities occupying snow glades near The Bullpen or windswept depressions on Fossil Butte, dominated by *Symphyotrichum foliaceum* or *Pteryxia terebinthina* - **12**

11b) Cushion plant communities (usually relatively sparse) occupying exposed windswept slopes and ridgetops throughout the monument - **13**

12a) (11) *Symphyotrichum foliaceum* stands occurring in small patches on leeward slopes that collect snow; total cover is moderate **- *Symphyotrichum foliaceum* Snow Glade Herbaceous Vegetation [Map Class 27]**

12b) Stands of *Pteryxia terebinthina* occurring with sparse to low cover in small, windswept depressions atop Fossil Butte. Associated herbaceous species include *Elymus lanceolatus* and *Arenaria hookeri* **- *Pteryxia terebinthina* Herbaceous Vegetation [Map Class 37]**

13a) (11) Sparsely vegetated cushion plant communities characterized by <1% to 10% cover of *Eriogonum brevicaule* (not always the dominant forb). Each site supports a different suite of associated cushion plants and grasses, most commonly including *Poa secunda, Haplopappus acaulis, Physaria acutifolia* and *Astragalus spatulatus* **- *Eriogonum brevicaule* - Cushion Plants Herbaceous Vegetation [Map Class 36]**

13b) Herbaceous vegetation, often sparse, on shallow shale soils and dominated by cushion and low-growing forbs, including *Haplopappus acaulis, Erigeron nanus, Phlox hoodii, Artemisia frigida, Astragalus spatulatus*. Grasses present with low cover include *Elymus lanceolatus* and *Poa secunda. Eriogonum brevicaule* is absent. Each site supports a different suite of associated cushion plant species and grasses. Taller woody shrubs such as *Artemisia* spp. have less than 5% cover and always less cover than the herbaceous species **- Cushion Plants Sparse Shale Vegetation [Map Class 36]**

14a) (9) Grassland communities characterized by sparse to moderate cover of the rhizomatous grasses *Elymus lanceolatus* or *Pascopyrum smithii* - **15**

14b) *Pseudoroegneria spicata*-dominated grasslands. Common associates include *Artemisia frigida* and cushion plants, *Poa secunda, Leymus cinereus,* or *Poa fendleriana* - **16**

15a) (14) *Pascopyrum smithii*-dominated grasslands on historically grazed ridges, slopes, and intermittently flooded creek beds; associated non-native forb and grass species include *Bromus tectorum, Descurainia sophia,* and *Ranunculus testiculatus. Elymus lanceolatus* may occasionally be co-dominant **- *Pascopyrum smithii* Herbaceous Vegetation [Map Class 50]**

15b) *Elymus lanceolatus*-dominated grasslands on ridges, slopes, and badlands where shallow clay soils restrict water availability; stands also occur on the fill slope of the main monument access road; associated non-native forb and grass species include *Agropyron cristatum, Bromus tectorum,* and *Ranunculus testiculatus. Pascopyrum smithii* is absent or has very low cover - ***Elymus lanceolatus* Herbaceous Vegetation [Map Class 40]**

16a) (14) Grasslands on stable slopes dominated by *Pseudoroegneria spicata; Poa fendleriana* or *Leymus cinereus* may have significant cover. *Poa secunda* and cushion plants such as *Eriogonum brevicaule* and *Astragalus spatulatus* are sparse to absent **- *Pseudoroegneria spicata* Herbaceous Vegetation [Map Class 36]**

16b) *Pseudoroegneria spicata* grasslands on ridgetops, often where the soil surface has been scoured to a gravel-paved surface. *Poa secunda* is present to co-dominant, and the cover of low-growing forbs such as *Eriogonum brevicaule, Astragalus spatulatus,* and *Artemisia frigida* is significant **- *Pseudoroegneria spicata* - Cushion Plants Herbaceous Vegetation [Map Class 36]**

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Appendix H
Modified Anderson Land Use-Land Cover Classification

This classification was used as the primary attribute for areas of developed land within and around Fossil Butte National Monument. Every polygon was assigned an Anderson Land Use or Land Cover code in addition to its vegetation attributes.

Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
1.0 Water	1.1 Open Water	1.11 Stream/river			
		1.12 Canal/ditch	1.121 Lined canal/ditch		
			1.122 Unlined canal/ditch		
		1.13 Lake/pond			
		1.14 Reservoir			
		1.15 Bay/estuary			
		1.16 Sea/ocean			
	1.2 Perennial Ice/Snow	1.21 Snowfield			
		1.22 Glacier			
2.0 Developed	2.1 Residential	2.11 Single-family residential			
		2.12 Multi-family residential			
	2.2 Non-residential Developed	2.21 Commercial/Light Industry	2.211 Major Retail		
			2.212 Mixed/Minor Retail and Services		
			2.213 Office		
			2.214 Light industry		
		2.22 Heavy Industry	2.221 Petro-chemical Refinery		
		2.23 Communications and Utilities			
		2.24 Institutional	2.241 Schools		
			2.242 Cemeteries		
		2.25 Agricultural Business	2.251 Aquiculture		
			2.252 Confined feeding		
		2.26 Transportation	2.261 Airport		
		2.27 Entertainment/ Recreation	2.271 Golf Course		
			2.272 Urban Parks		
	2.3 Mixed Urban				
3.0 Bare	3.1 Transitional				
	3.2 Quarries/Strip mines/Gravel pits				
	3.3 Bare Rock/Sand				
	3.4 Flats				

Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
	3.5 Disposal				
4.0 Vegetated	4.1 Woody	4.11 Forested	4.111 Deciduous		
			4.112 Evergreen		
			4.113 Mixed		
		4.12 Shrub land	4.121 Deciduous		
			4.122 Evergreen		
			4.123 Mixed		
			4.124 Desert scrub		
		4.13 Orchards/vineyards/ groves	4.131 Irrigated Orchard/ vineyards/groves		
			4.132 Citrus		
			4.133 Non-managed Citrus		
		4.14 Mixed Forest/Shrub			
	4.2 Herbaceous	4.21 Natural Herbaceous	4.211 Natural Grassland		
		4.22 Planted/cultivated	4.221 Fallow/Bare Fields		
			4.222 Small Grains	4.2221 Irrigated small grains	
			4.223 Row Crops	4.2231 Irrigated row crops	
				4.2232 Sugar Cane	
			4.224 Planted grasses	4.2241 Pasture/ hay	4.22411 Irrigated Pasture/hay
				4.2242 Other grass	4.22421 Irrigated Other grass
			4.225 Irrigated Planted/ cultivated		
	4.3 Wetlands	4.31 Woody wetlands			
		4.32 Emergent wetlands			

Classification Definitions

1.0 WATER - area covered by water, snow, or ice with less than 25% vegetated or developed cover, unless specifically included in another category.

1.1 Open Water - all areas of open water with less than 25% vegetative or developed cover

1.11 Stream/river - a natural body of flowing water. Includes streams and rivers that have been channelized in order to control flooding or erosion or to maintain flow for navigation.

1.12 Canal/ditch - a man-made open waterway constructed to transport water, to irrigate or drain land, to connect two or more bodies of water, or to serve as a waterway for watercraft. Collection should include the right of ways and associated dikes and levees.

1.121 Lined canal/ditch - a canal or ditch lined with concrete or other impervious material preventing passage of water into underlying strata.

1.122 Unlined canal/ditch - a canal or ditch constructed with dirt or other porous material allowing water to drain.

1.13 Lake/pond - a non-flowing, naturally-existing, body of water. Includes water impounded by natural occurrences and artificially regulated natural lakes. The delineation of a lake is based on the areal extent of water at the time the imagery was acquired.

1.14 Reservoir - any artificial body of water, unless specifically included in another category. It can lie in a natural basin or a man-constructed basin. The delineation of a reservoir is based on the areal extent of water at the time the imagery was acquired. (The water control structures are classified as Communications/Utilities).

2.0 DEVELOPED - Areas of the earth that have been improved by man. Includes all "built-up" and urban areas of the landscape. Does NOT include mining lands, croplands, or waste-disposal areas (dumps). This land use category takes precedence over a land cover category when the criteria for more than one category are met.

2.1 Residential - lands containing structures used for human habitation

2.11 Single-family Residential - Lands used for housing residents in single-family dwelling units. Includes trailer parks, mobile home parks, and entire "farmsteads" when there is a home in the complex. (If no home is in the complex, it should be classified as Agricultural Business.) Single-family residential buildings located within another category, such as military family housing, should be identified in this category.

2.12 Multi-family Residential - All lands devoted to housing more than one family on a permanent or semi-permanent basis, group living situations, and their associated grounds. Includes apartments, apartment complexes, duplexes, triplexes, attached row houses, condominiums, retirement homes, nursing homes, and residential hotels. Residential buildings located within another category, such as barracks and dormitories, should be identified in this category when possible, (except residential buildings within convents and monasteries - include these with Institutional).

2.2 Non-residential Developed - Any "developed" area or feature that is used for a purpose other than habitation.

2.21 Commercial/Light Industry - structures and associated grounds used for the sale of products and services, for business, or for light industrial activities. Includes all retail and wholesale operations. Include "industrial parks" and other features that cannot be clearly classified as either a retail service or light industry, such as heavy equipment yards, machinery repair, and junkyards.

2.211 Major Retail - This category includes shopping malls, retail "outlet centers," and "superstores" that draw clientele from a regional area. Major retail centers consist of extremely large single buildings or a complex of large buildings and their parking lots. Malls usually house one or two major department stores and numerous small retail stores. Includes outlet centers, "superstores", multi-plex movie theaters,

and huge warehouse-type stores. The structures themselves are often several acres in size and have extensive parking lots.

2.212 Mixed/Minor Retail and Services - Includes individual stores and services of various sizes and associated grounds and parking. Includes neighborhood strip malls and shopping centers, veterinarian services, small movie theaters, gas stations and auto repair shops, garden centers, motels, small auto dealerships, public parking lots, lumber yards, art galleries, farm supply stores, flea-markets, bars and restaurants, grocery stores, and commercial "truck stops". Many small office buildings will have no features to distinguish them from retail stores and will fall in this category.

2.213 Office - structures and their associated grounds and parking, that provide financial, professional, administrative, and informational type services. Includes administrative government offices (e.g., IRS and State Motor Vehicles offices) trade schools, professional medical office complexes, research facilities/centers, and banks. Usually only office buildings in office complexes or in downtown areas will be distinguishable as offices. Small, single-story office buildings may blend in with minor retail.

2.214 Light industry - structures and their associated grounds and facilities that are used primarily to produce or process some finished product; or as a wholesale distribution center. Activities include design, assembly, finishing, packaging, warehousing or shipping of products rather than processing raw materials. The materials used in light industry have generally been processed at least once. They are generally "clean" industries that do not produce lots of waste materials. Use this category as a default for those facilities with semi-truck and trailer activity around loading docks, but that cannot be classified as either retail services or heavy industry. Includes electronic firms, clothing and furniture manufacture, grain elevators, printing plants, commercial bakeries, shipping and distribution centers, sand/gravel sorting facilities, secondary buildings associated with a mining or quarrying site, and generic warehouses.

2.22 Heavy Industry - structures and their associated grounds used for heavy fabrication, manufacturing and assembling parts that are, in themselves, large and heavy; or for processing raw materials such as iron ore, timber, and animal products. Accumulated raw materials are subject to treatment by mechanical, chemical, or heat processing to render them suitable for further processing, or to produce materials from that finished products are created. Heavy industries generally require large amounts of energy and raw materials and produce a significant amount of waste products. Indicators of heavy industry may be stockpiles of raw materials, energy producing sources and fuels, waste disposal areas and ponds, transportation facilities capable of handling heavy materials, smokestacks, furnaces, tanks, and extremely large buildings that are complex in outline and roof structure. Include associated waste piles and waste ponds. Heavy industry is usually located away from residential areas. Includes steel mills, paper mills, lumber mills, cotton gins, chemical plants, cement and brick plants, smelters, rock crushing machinery, and ore-processing facilities associated with mining.

2.23 Communications and Utilities - structures or facilities and associated grounds used for the generation of power and communications, the treatment or storage of drinking water, waste management, flood control, or the distribution and storage of gas

and oil not associated with a unique feature. Includes pumping stations (oil, gas, or water), tank farms, power plants, electric substations, sewage treatment facilities and ponds, garbage collection facilities (not the final dumping ground - these are included in Bare), dams, levees, and spillways of appropriate dimensions, filtration plants, and heavy concentrations of antennas or satellite dishes; along with the related operational buildings.

2.24 Institutional - specialized government or private features that meet the educational, religious, medical, governmental, protective, and correctional needs of the public. Parking lots and associated grounds are included with these features. Includes public and private schools (not day care), state capitols, city halls, courthouses, libraries, churches, convents, monasteries, hospitals and training hospitals, post offices, police and fire departments, prisons, and military bases. Only the military-business areas of a military base are classified here; residential, airport, athletic fields, and vegetated areas are classified in the appropriate category.

2.241 Schools/Universities - public and private schools, seminaries, university campuses, and associated lands. Include the entire "core campus" area, along with athletic fields and vegetated areas. This category does not include day care centers or commercial trade schools, both of that are commercial uses.

2.242 Cemeteries - structures and lands devoted to burial of the dead. Includes mausoleums, service areas, and parking lots.

2.25 Agricultural Business - structures and all associated grounds used for raising plants or animals for food or fiber. Includes fish farms and hatcheries, feedlots, poultry farms, dairy farms, temporary shipping and holding pens, animal breeding or training facilities, and greenhouses. (Farmsteads including a dwelling are classified as residential, not agricultural business.)

2.251 Aquiculture site - a set of pools of water and related structures used for producing fish, shellfish, or aquatic plants.

2.252 Confined feeding operation - structures and associated pens, storage facilities, waste areas, and ponds that are used for raising meat and dairy cattle, hogs, poultry, or other animals. These features must have a relatively permanent and high animal population density. Temporary holding pens and thoroughbred horse farms usually do not qualify.

2.26 Transportation - Roads, railroads, airports, port facilities, and their associated lands. Roads and railroads include the right-of-way, interchanges, and median strips. Category includes railroad stations, railroad yards, bus stations, highway maintenance yards, school bus parking and service yards, and park-and-ride lots. Port facilities include loading and unloading facilities, docks, locks and, temporary storage areas. Associated warehousing and transfer stations for truck or rail are included only if they appear to be an integral part of the airport or port facility. Nearby but separate warehouses will be classified as light industry.

2.27 Entertainment and Recreational - areas and structures used predominantly for athletic or artistic events, or for leisure activities, and all associated lands and developed parking areas. Includes outdoor amphitheaters, drive-in theaters, campgrounds, zoos, sports arenas (including indoor arenas), developed parks and playgrounds, community recreation centers, museums, amusement parks, public swimming pools, fairgrounds, and ski complexes (not the ski slopes). Marinas with over 25% of water surface covered

by docks and boats are included here.

2.271 Golf Course - structures, associated grounds, driving ranges, and interspersed natural areas used for the game of golf.

2.272 Urban Parks - designated open space in urban settings used for outdoor recreation. Include grass fields and associated structures, parking lots, and facilities. Includes city parks, "green-belt" urban parks, and athletic fields not associated with a school. Does not include undeveloped "open space" on the periphery of urban areas or undeveloped regional, state, or national park areas.

2.3 Mixed Urban - developed areas that have such a mixture of residential and non-residential features where no single feature meets the minimum mapping unit specification. This category is used when more than one-third of the features in an area do not fit into a single category. Often applicable in the central, urban-core area of cities.

3.0 BARE - undeveloped areas of the earth not covered by water that exhibit less than 25% vegetative cover or less than 5% vegetative cover if in an arid area. The earth's surface may be composed of bare soil, rock, sand, gravel, salt deposits, or mud.

3.1 Transitional Bare - areas dynamically changing from one land cover/land use to another, often because of land use activities. Includes all construction areas, areas transitioning between forest and agricultural land, and urban renewal areas that are in a state of transition.

3.2 Quarries/Strip Mines/Gravel Pits - areas of extractive mining activities with significant surface disturbance. Vegetative cover and overburden are removed for the extraction of deposits such as coal, iron ore, limestone, copper, sand and gravel, or building and decorative stone. Current mining activity does not need to be identifiable. Inactive or unreclaimed mines and pits are included in this category until another land cover or land use has been established. Includes strip mines, open-pit mines, quarries, borrow pits, oil and gas drilling sites, and gravel pits with their associated structures, waste dumps, and stockpiles.

3.3 Bare Rock/Sand - includes bare bedrock, natural sand beaches, sand bars, deserts, desert pavement, scarps, talus, slides, lava, and glacial debris.

3.4 Flats - A level landform composed of unconsolidated sediments of mud, sand, gravel, or salt deposits. Includes coastal tidal flats and interior desert basin flats and playas.

3.5 Disposal - designated areas where refuse is dumped or exists, such as landfills, trash dumps, or hazardous-waste disposal sites. Reclaimed disposal areas or those covered with vegetation do not qualify.

4.0 VEGETATED - areas having generally 25% or more of the land or water with vegetation. Arid or semi-arid areas may have as little as 5% vegetation cover.

4.1 Woody Vegetation - land with at least 25% tree and (or) shrub canopy cover.

4.11 Forested - land where trees form at least 25% of the canopy cover.

4.111 Deciduous Forest - area dominated by trees where 75% or more of the canopy cover can be determined to be trees that loose all their leaves for a specific season of the year.

4.112 Evergreen Forest - area dominated by trees where 75% or more of the canopy cover can be determined to be trees that maintain their leaves all year.

4.113 Mixed Forest - areas dominated by trees where neither deciduous nor evergreen species represent more than 75% of the canopy cover.

4.12 Shrub land - areas where trees have less than 25% canopy cover and the existing vegetation is dominated by plants that have persistent woody stems, a relatively low growth habit, and that generally produce several basal shoots instead of a single shoot. Includes true shrubs, trees that are small or stunted because of environmental conditions, desert scrub, and chaparral. In the eastern US, include former cropland or pasture lands that are now covered by brush to the extent that they are no longer identifiable or usable as cropland or pasture. Clear-cut areas will exhibit a stage of shrub cover during the regrowth cycle. Some common species that would be classified as shrub land are mountain mahogany, sagebrush, and scrub oaks.

4.121 Deciduous Shrub land - areas where 75% or more of the land cover can be determined to be shrubs that lose all their leaves for a specific season of the year.

4.122 Evergreen Shrub land - areas where 75% or more of the land cover can be determined to be shrubs that keep their leaves year round.

4.123 Mixed Shrub land - areas dominated by shrubs where neither deciduous nor evergreen species represent more than 75% of the land cover.

4.124 Desert Scrub - land areas predominantly in arid and semi-arid portions of the southwestern U.S. Existing vegetation is sparse and often covers only 5-25% of the land. Example species include sagebrush, creosotebush, saltbush, black greasewood, and cactus.

4.13 Planted/Cultivated Woody (Orchards/Vineyards/Groves) - areas containing plantings of evenly spaced trees, shrubs, bushes, or other cultivated climbing plants usually supported and arranged evenly in rows. Includes orchards, groves, vineyards, cranberry bogs, berry vines, and hops. Includes tree plantations planted for the production of fruit, nuts, Christmas tree farms, and commercial tree nurseries. Exclude pine plantations and other lumber or pulp wood plantings that will be classified as Forest.

4.131 Irrigated Planted/Cultivated Woody - orchards, groves, or vineyards where a visible irrigation system is in place to supply water.

4.14 Mixed Forest/Shrub – areas dominated by forest and shrub where neither species represent more than 75% of the canopy cover.

4.2 Herbaceous Vegetation - areas dominated by non-woody plants such as grasses, forbs, ferns and weeds, either native, naturalized, or planted. Trees must account for less than 25% canopy cover while herbaceous plants dominate all existing vegetation.

4.21 Natural Herbaceous - areas dominated by native or naturalized grasses, forbs, ferns and weeds. It can be managed, maintained, or improved for ecological purposes such as weed/brush control or soil erosion. Includes vegetated vacant lots and areas where it cannot be determined whether the vegetation was planted or cultivated such as in areas of dispersed grazing by feral or domesticated animals. Includes landscapes dominated by grass-like plants such as bunch grasses, Palouse grass, palmetto prairie areas, and tundra vegetation, as well as true prairie grasses.

4.211 Natural Grasslands - natural areas dominated by true grasses. Includes undisturbed tall-grass and short-grass prairie in the Great Plains of the U.S.

4.22 Planted/Cultivated Herbaceous - areas of herbaceous vegetation planted and/or cultivated by humans for agronomic purposes in developed settings. The majority of vegetation in these areas is planted and/or maintained for the production of food, feed, fiber, pasture, or seed. Temporarily flooded are included in this category. Do not

include harvested areas of naturally occurring plants such as wild rice and cattails.

4.221 Fallow/Bare Fields - areas within planted or cultivated regions that have been tilled or plowed and do not exhibit any visible vegetation cover.

4.222 Small Grains - areas used for the production of grain crops such as wheat, oats, barley, graham, and rice. Category is difficult to distinguish from cultivated grasses grown for hay and pasture. Indicators of small grains may be a less than 10% slope, annual plowing and seeding, distinctive field patterns and sizes, different timing of green-up and harvest, different harvesting practices, a very "even" texture and tone, or regional variations discovered during field checks.

4.223 Row Crops - areas used for the production of crops or plants such as corn, soybeans, vegetables, tobacco, flowers and cotton. Fields that exhibit characteristics similar to row crops, but that do not have any other distinguishing features for a more specific category may be included.

4.2231 Irrigated Row Crops - areas used for the production of row crops where a visible irrigation system is in place to supply water.

4.224 Cultivated grasses - areas of herbaceous vegetation, including perennial grasses, legumes, or grass-legume mixtures that are planted by humans and used for erosion control, for seed or hay crops, for grazing animals, or for landscaping purposes.

4.2241 Pasture/Hay - areas of cultivated perennial grasses and/or legumes (e.g., alfalfa) used for grazing livestock or for seed or hay crops. Pasturelands can have a wide range of cultivation levels. It can be managed by seeding, fertilizing, application of herbicides, plowing, mowing, or baling. Pastureland has often been cleared of trees and shrubs, is generally on steeper slopes than cropland, is intended to graze animals at a higher density than open rangeland, and is often fenced and divided into smaller parcels than rangeland or cropland. Hay fields may be more mottled than small grain fields as they are not plowed annually and may be harvested and baled two or three times a year in some locations.

4.22411 Irrigated Pasture/Hay - areas used as pasture or hay fields where a visible irrigation system is in place to supply water.

4.2242 Other planted grasses - areas of other cultivated grass such as turf and sod farms.

4.22421 Irrigated other grasses - areas of other cultivated grasses where a visible irrigation system is in place to supply water.

4.225 Irrigated Planted Herbaceous - land that is growing some indistinguishable crop or grass, but is obviously irrigated.

4.3 Vegetated Wetland - areas where the water table is at, near, or above the land surface for a significant part of most years and vegetation indicative of this covers more than 25% of the land surface. Wetlands can include marshes, swamps situated on the shallow margins of bays, lakes, ponds, streams, or reservoirs; wet meadows or perched bogs in high mountain valleys, or seasonally wet or flooded low spots or basins. Do not include agricultural land that is flooded for cultivation purposes.

4.31 Woody Wetland - areas dominated by woody vegetation. Includes seasonally flooded bottomland, mangrove swamps, shrub swamps, and wooded swamps including those around bogs. Wooded swamps and southern flood plains contain primarily

cypress, tupelo, oaks, and red maple. Central and northern flood plains are dominated by cottonwoods, ash, alder, and willow. Flood plains of the Southwest may be dominated by mesquite, saltcedar, seepwillow, and arrowweed. Northern bogs typically contain tamarack or larch, black spruce, and heath shrubs. Shrub swamp vegetation includes alder, willow, and buttonbush.

4.32 Emergent Herbaceous Wetlands - areas dominated by wetland herbaceous vegetation that is present for most of the growing season. Includes fresh-water, brackish-water, and salt-water marshes, tidal marshes, mountain meadows, wet prairies, and bogs.

Appendix I
Accuracy Assessment Analysis Results

This index contains the results of the analysis of accuracy assessment field data. Each of the 661 accuracy assessment (AA) field plots was compared with the polygon in which it occurred. If the field data matched the polygon label, the plot was deemed correct. If it did not, it was marked incorrect and underwent further analysis as to the type and pattern of error, and the best way to resolve the error.

We approached the error analysis with the idea that error can enter a map and dataset from many sources, most of which are out of the photointerpreter's control. These sources of error include:

- Label transcription error by the technician who created the digital mapping database
- Locational error in the field (e.g. canyons or dense forests where GPS receivers are unable to receive satellite signals, or small or narrow polygons, so sample is taken in a different polygon than was intended)
- Transcription error by persons entering AA data into the relational database
- Transcription error by persons creating the AA contingency table
- Field key is difficult to use (fault may lie with key or with classification)
- Field key does not include all plant associations present within the monument
- Field crew error, either by mis-identifying diagnostic species in the field, or by not reading the key carefully, thus resulting in a wrong call when the mapped polygon is actually correct
- Point falls within an ecotone, which is impossible to classify but which still must be mapped to a class
- The polygon includes patches of varying vegetation that are too small to map individually; the mapper had to choose the visually dominant type to name the polygon
- The photos were flown and/or the plot data collected in a year or season either much drier or much wetter than the year/season in which the AA was performed

These types of error may affect the accuracy of a map even when the map concepts are good. We therefore felt justified in making adjustments to the map class definitions, association-map class crosswalk, field key, and in a few cases, the map polygon labels to account for what we considered to be "false" (i.e., not in control of the mapper) errors.

The initial (uncorrected) accuracy of the FOBU vegetation map was 21%. We therefore inspected the original plot data, plot photographs, and aerial imagery for approximately 480 plots of accuracy assessment field data to create the table that follows. The final step in the process was to present the table in March 2008 to FOBU natural resources staff and ask for their input for solutions we would apply to the final map. In some cases, their preference was different than our recommendation; in every case, we followed the preference of monument staff.

Original Map Class	Original Map Class Name	Final Map Class	Final Map Class Name	Problem	Proposed Resolution	Ecology	AA meeting Final Decision
1	Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland	1	Mixed Mountain Shrubland	Poor accuracy; most often confused with 2,11,29	Combine 1, 2, and 11	Relatively mesic shrublands typically dominated or codominated by *Amelanchier utahensis*	Combine 1&2. Keep 11 separate and re-check points called wrong
2	Amelanchier utahensis Shrubland			Poor accuracy; most often confused with 1,11,17,51	Combine 1, 2, and 11		
3	Artemisia arbuscula ssp. longiloba / Cushion Plants Dwarf Shrubland	4	Low Sagebrush Shrubland	Good producer's accuracy; user's most often confused with 4,7	Combine 3,4,5,7,8, 29,36,40,41,45,47,64, 65	Typically sparse, low shrublands, sparse grasslands and cushion plant communities that occur on harsh, shaley, windswept sites. Vegetation is variable: *Artemisia arbuscula* ssp. *longiloba, Atriplex confertifolia, Elymus lanceolatus, Eriogonum brevicaule, Krascheninnikovia lanata, Poa secunda, Pseudoroegneria spicata* and various cushion plants may dominate	Combine polygons of 3, 4, 5, 7, 8 and 13. Retain linework, based on shrub density. Retain map class 13 as buffered points around vegetation and AA plots known to have ARTRT/LEYCIN
4	Artemisia arbuscula ssp. longiloba / Elymus lanceolatus Shrubland			Poor accuracy; most often confused with or 3,5,7,8,16,41,73	Combine 3,4,5,7,8, 29,36,40,41,45,47,64, 65		
5	Artemisia arbuscula ssp. longiloba / Poa fendleriana Shrubland			Poor user's accuracy; most often confused with 4,7	Combine 3,4,5,7,8, 29,36,40,41,45,47,64, 65		
7	Artemisia arbuscula ssp. longiloba / Pseudoroegneria spicata Shrub Herbaceous Vegetation			100% user's accuracy, 15% producer's accuracy - confused with 3,4,5,8,13,41	Combine 3,4,5,7,8, 29,36,40,41,45,47,64, 65		
8	Artemisia arbuscula ssp. longiloba Shrubland			Poor accuracy; most often confused with 4,7,13,15,21,31	Combine 3,4,5,7,8, 29,36,40,41,45,47,64, 65		
9	Artemisia cana / Juncus balticus Shrubland	9	Silver sagebrush wet meadow	Poor accuracy; confused with (user's) or 12,15,32,43	Combine 9,32,43	Mesic shrublands and wetlands found in drainages, in swales and bottomlands. *Artemisia cana, Carex nebrascensis, and Juncus balticus* dominate	Retain polygons of MU9 where known to occur from plots and AA points. Add association from MU 9 to crosswalk for MU 32 and relabel remaining polygons as MU 32.
10	Artemisia nova / Pseudoroegneria spicata Shrubland	10	Black Sagebrush Shrubland	100% producer's accuracy; rare type restricted to 2 locations; 1 of 2 correct for user's	Add GPS-recorded polygon of this class to database. Retain one other small polygon (<MMU size) with AA point in it.	Documented on a south-facing slope in a mosaic with other mixed mountain shrubs and on an exposed ridge top with mountain big sagebrush and a mixed grassy understory	Accept proposed solution

Original Map Class	Original Map Class Name	Final Map Class	Final Map Class Name	Problem	Proposed Resolution	Ecology	AA meeting Final Decision
11	Artemisia tridentata (ssp. vaseyana, ssp. wyomingensis) - Amelanchier utahensis Shrubland	11	Sagebrush - Serviceberry Shrubland	Poor accuracy; most often confused with 1,2,51	Combine 1, 2, and 11	Occurs on slopes and toeslopes of all aspects as well as on ridgetops throughout the monument	Maintain 11 as a separate map unit. AA point problems may have to do with key; review wrong calls in polygons of this map class.
12	Artemisia tridentata ssp. wyomingensis / Elymus lanceolatus Shrubland	23	Wyoming Big Sagebrush Shrubland	Poor accuracy; most often confused with 21, 25. All ARTRT types mapped poorly but not confused with each other. This was erroneously classified and lumped into ARTRT type	Combine 12,23,24,25,26. Change association name to Artemisia tridentata / Elymus lanceolatus Shrubland. (ARTRW dominates at FOBU)	Lower elevation (usually <2100 m) sagebrush shrublands dominated or codominated by *Artemisia tridentata* ssp. *wyomingensis* or ssp. *tridentata* (mesic inclusions) with a variety of grasses in the understory	Accept proposed solution
13	Artemisia tridentata ssp. tridentata / Leymus cinereus Shrubland	13	Basin Big Sagebrush / Great Basin Wild Rye Shrubland	Poor accuracy; most often confused with 4,7,8,13,17,18; All ARTRT types mapped poorly but not confused with each other	Combine 13,15,16,17,18,19,20, 21,22	Higher elevation (>2000 m) sagebrush shrublands dominated or codominated by *Artemisia tridentata* ssp. *vaseyana or A. t.* ssp. *tridentata* (drainages)	Rename most polygons to the combined 3-8 type. Retain polygons of MU 13 where known to occur from plots and AA points.
15	Artemisia tridentata ssp. tridentata / Poa secunda Shrubland	15	Basin Big Sagebrush / Bluegrass Shrubland	100% producer's accuracy; most often confused with 7,8,21,25,26 (user's). All ARTRT types mapped poorly but not confused with each other.	Combine 13,15,16,17,18,19,20, 21,22	Lower elevation basin big sagebrush shrublands with a bluegrass understory occurring mainly in the southern end of the park along stream terraces	Leave MU15 alone
16	Artemisia tridentata ssp. vaseyana / Balsamorhiza sagittata Shrubland	16	Mountain Big Sagebrush Shrubland	Poor accuracy. Rare type that is difficult to map. All but one polygon in burn area. No AA points in non-burn polygon	Combine 13,15,16,17,18,19,20, 21,22	Higher elevation mountain sagebrush shrublands with a variety of grasses in the understory. One of the most common vegetation types in FOBU	Combine 16-22 into a mountain sagebrush map class
17	Artemisia tridentata ssp. vaseyana / Elymus lanceolatus Shrubland			Poor accuracy; most often confused with 2,21 (user's) and 13 & 18 (producer's)			

Original Map Class	Original Map Class Name	Final Map Class	Final Map Class Name	Problem	Proposed Resolution	Ecology	AA meeting Final Decision
18	Artemisia tridentata ssp. vaseyana / Leymus cinereus Shrubland			Poor accuracy; most often confused with 4,11,17			
19	Artemisia tridentata ssp. vaseyana / Pascopyrum smithii Shrubland			Rare type with no AA points			
20	Artemisia tridentata ssp. vaseyana / Poa fendleriana Shrubland			All 20 polygons located in burn area			Remove MU20 from AA analysis
21	Artemisia tridentata ssp. vaseyana / Poa secunda Shrubland			Poor accuracy; most often confused with 8,11,12 (user's) and 15,17,23,25 (producer's)			Combine 16-22 into a mountain sagebrush map class
22	Artemisia tridentata ssp. vaseyana / Pseudoroegneria spicata Shrubland			Poor accuracy, only 2 AA points; confused with 11 (user's) and 4 (producer's)			
23	Artemisia tridentata ssp. wyomingensis / Disturbed Understory Semi-natural Shrubland	23	Wyoming Big Sagebrush Shrubland	100% producer's accuracy; most often confused with 8,21,25 (user's)	Combine 12,23,24,25,26	Lower elevation (usually <2100 m) sagebrush shrublands dominated or codominated by *Artemisia tridentata* ssp. *wyomingensis* or ssp. *tridentata* (mesic inclusions) with a variety of grasses in the understory	Accept proposed solution
24	Artemisia tridentata ssp. wyomingensis / Leymus cinereus Shrubland			Poor accuracy; only 4 AA points; confused with 7,13,72 (user's) and 1,73 (producer's)			
25	Artemisia tridentata ssp. wyomingensis / Poa secunda Shrubland			Poor accuracy; confused with 12,13,21,26 (user's); 12,15,23,31,72 (producer's)			
26	Artemisia tridentata ssp. wyomingensis / Pseudoroegneria spicata Shrubland			100% user's accuracy; 1 AA point; 13% accuracy producer's; confused with 1,12,13,15,25			

Original Map Class	Original Map Class Name	Final Map Class	Final Map Class Name	Problem	Proposed Resolution	Ecology	AA meeting Final Decision
27	Aster foliaceous Snow Glade Herbaceous Vegetation	27	Snow Glade	100% producer's accuracy; confused with 17,18, 21 (user's). MMU issue; most patches are too small to pull out from the imagery.	Retain three small polygons with clear photosignature documented by plots or AA points	Small stands where *Aster foliaceous* is the dominant species	Accept proposed solution
28	Atriplex confertifolia - Sarcobatus vermiculatus Shrubland	28	Saline Flat Shrubland (Shadscale-Greasewood Phase)	Poor accuracy; confused with 4,8,31,73 (user's) and 73 (producer's)	Combine 28,31,72,73	Saline/alkaline bottomland sites. *Atriplex gardneri and/or Sarcobatus vermiculatus* dominate. *Artemisia tridentata* or *Artemisia arbuscula* ssp. *longifolia* may codominate	Accept proposed solution; except MU 31, which should go with the rest of the low sagebrush map unit
29	Atriplex confertifolia Wyoming Basins Shrubland	29	Shadscale Cliff Sparse Shrubland	Poor accuracy, only 3 AA points; confused with 1,3,41	Combine 3,4,5,7,8, 29,36,40,41,45,47,64, 65	Steep, south-facing slopes in southern section of the park	Remap polygons to omit steep slopes (Shadscale). Combine rest of polygons of map classes 36,40,41,45,47,64,65
31	Atriplex gardneri - Artemisia arbuscula ssp. longiloba Dwarf Shrubland	4	Low Sagebrush Shrubland	Poor accuracy;confused with 4,7,8,25,40,73 (user's) and 8,28,41 (producer's)	Some lowland polys originally AA'd to 40 need to add 31 as a call; will therefore be correct. Combine 28,31,72,73	Sparse stands along southern park boundary where *Atriplex gardneri* is dominant or co-dominant with *Artemisia arbuscula* ssp. *longiloba*	Too difficult to distinguish from polygons of MC 4. Combine with the rest of the low sagebrush map units (4-8) and keep separate from the saline flats shrubland unit. Code polygons with known ATRGAR presence as minor code 31.
32	Carex nebrascensis Herbaceous Vegetation	32	Wet Meadow Herbaceous	100% producer's accuracy. Poor user's accuracy; confused with 9,56. Most polygons <MMU	Combine with other wetland types: MC 9,32,43	Wetland herbaceous species including *Carex* and *Juncus* occur along drainages throughout the monument	Accept proposed solution; but retain polygons of MU9 where known to occur. Add association from MC 9 and 43 to crosswalk.
33	Ceanothus martinii Shrubland	33	Martin's Buckbrush Shrubland	Poor accuracy, 0 of 1 correct; Rare type that is difficult to map	Map known locations as buffered points	Small stand dominated by *Ceanothus martinii*	Retain as a point layer only (one point)

Original Map Class	Original Map Class Name	Final Map Class	Final Map Class Name	Problem	Proposed Resolution	Ecology	AA meeting Final Decision
36	Cushion Plant Sparse Shale Vegetation	36	Windswept Ridge Complex	80% user's accuracy; confused with 8,40 (producer's)	Combine 3,4,5,7,8, 29,36,40,41,45,47,64, 65	Exposed ridge tops with sparse vegetation dominated by cushion plants	Combine 36,41,45,47,64,65 into a sparse, windswept ridgeline type
37	Pteryxia terebinthina Herbaceous Vegetation	37	Turpentine Wavewing Meadow	Poor accuracy.Type occurs <MMU and is restricted to snow glades, which are often inclusions of other map classes	Merge all polygons into surroundings (too small to pull out separately). Retain as a point layer only (one point).	Small stand dominated by *Pteryxia terebinthina*	Accept proposed solution
38	Dasiphora fruticosa ssp. floribunda Shrubland	38	Shrubby cinquefoil Shrubland	100% user's and producer's accuracy	Keep as is	Small stand dominated by *Dasiphora fruticosa* ssp. *floribunda*	OK
39	Eleocharis palustris Herbaceous Vegetation	39	Marsh Spikerush Wetland	Poor accuracy, 0 of 1 correct; Most polygons <MMU	Retain one tiny polygon around clearly visible stock pond	Small stand surrounding stock pond	Accept proposed solution
40	Elymus lanceolatus Herbaceous Vegetation	40	Streamside Wildrye Grassland	Poor accuracy; confused with 7,8,36 (user's) and 5,31,41,47,48 (producer's)	Combine 3,4,5,7,8, 29,36,40,41,45,47,64, 65	Small stands near drainages, as well as several larger stands along the southern park boundary	Retain polygons where known to have 40 grasslands (e.g., Ruby point). Most polygons with AA points in lowlands should become MU 4.
41	Eriogonum brevicaule - Cushion Plants Herbaceous Vegetation	36	Windswept Ridge Complex	Good producer's accuracy; poor user's accuracy; confused with 3,4,7,31,40	Combine 3,4,5,7,8, 29,36,40,41,45,47,64, 65	See “Ecology” description for map class 36	Combine 36,41,45,47,64,65 into a sparse, windswept ridgeline time
42	Hordeum brachyantherum Herbaceous Vegetation	42	Meadow Barley Grassland	Poor accuracy; confused with 53; Only 1 known site	Merge all polygons into surroundings (too small to pull out separately). Retain as a point layer only.	Small stand dominated by *Hordeum brachyantherum*	Accept proposed solution
43	Juncus balticus Herbaceous Vegetation	32	Wet Meadow Herbaceous	80% user's accuracy; confused with 9 (producer's)	Leave as is or combine 9,32,43	See “Ecology” description for map class 32	Accept proposed solution; but retain polygons of MU9 where known to occur. Add association from MC 9 and 42 to crosswalk.
44	Juniperus scopulorum / Artemisia tridentata Woodland	44	Rocky Mountain Juniper Woodland	100% user's and producer's accuracy; 1 of 1 correct	OK	Small stand dominated by *Juniperus scopulorum*	OK

Original Map Class	Original Map Class Name	Final Map Class	Final Map Class Name	Problem	Proposed Resolution	Ecology	AA meeting Final Decision
45	Krascheninnikovia lanata / Achnatherum hymenoides Dwarf-shrubland	36	Windswept Ridge Complex	100% producer's accuracy; poor user's accuracy; confused with 1,4,49,64	Combine 3,4,5,7,8, 29,36,40,41,45,47,64, 65	See "Ecology" description for map class 36	Combine 36,41,45,47,64,65 into a sparse, windswept ridgeline type
47	Krascheninnikovia lanata / Poa secunda Dwarf-shrubland			100% producer's accuracy; 50% user's accuracy; confused with 40			
48	Lepidium virginicum Sparse Herbaceous Vegetation	48	Virginia Pepperweed Sparse Vegetation	Poor accuracy, confused with 40; few known sites	Retain one small polygon with point in it	Small stand dominated by *Lepidium virginicum*	Accept proposed solution
49	Leymus cinereus Herbaceous Vegetation	49	Great Basin Wildrye Grassland	Poor accuracy; confused with 7,11,18 (user's) and 13,17,21,45 (producer's); stands are small (<MMU) inclusions in other types. e.g., AA385 call is based on FOBU0108 which is a seep-fed LECI stand in a sparse ATCO shrubland	Retain two polygons with points in them that are big enough to see a clear grassy photosignature.	Small patch mesic inclusions on disturbed ridges, shale slopes (seeps) and in creekbeds. Scattered AMEUTA,SYMORE, PURTRI, and ARTRV may occur. Ecologically could move ARTRV MU, but may not gain much in accuracy	Accept proposed solution
50	Pascopyrum smithii Herbaceous Vegetation	50	Western Wheatgrass Grassland	Poor accuracy, 1 AA point; occurs < MMU	Retain three small polygon with points in them that are big enough to see a clear grassy photosignature.	Small stands dominated by *Pascopyrum smithii*	Accept proposed solution
51	Pinus flexilis / Cercocarpus montanus - Amelanchier utahensis Woodland	51	Limber Pine Woodland	Poor accuracy; confused most often with 52, 56 (user's) and 2,11,52 (producer's)	Combine 51 and 52	Most stands take the form of montane shrublands with scattered young limber pine Coud be classed as either woodlands or shrublands	Accept proposed solution. Review AA points in MU 51, 52 polygons that were classed as 1 or 2 and see if any have enough tree

Original Map Class	Original Map Class Name	Final Map Class	Final Map Class Name	Problem	Proposed Resolution	Ecology	AA meeting Final Decision
52	Pinus flexilis / Symphoricarpos oreophilus Woodland			Poor accuracy, only 3 AA points; only confused with 51 (user's & producer's)			cover to call 51 or 52
53	Poa pratensis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation	53	Kentucky Bluegrass Meadow	Poor accuracy; AA0039 is wrong, based on small patch FOBU.9034 POPR stand. 1 AA point	Retain two small polygons around known occurrences from a plot and AA point	Small stands dominated by *Poa pratensis*	Accept proposed solution
54	Populus angustifolia / Leymus cinereus Woodland	54	Narrowleaf Cottonwood Woodland	100% user's & producer's accuracy. 1 AA point	Keep as is: one polygon with two AA points and two plots	One documented stand that occurs near a seep on a terrace of the low slope of Fossil Butte	OK
55	Populus tremuloides - Pinus flexilis Forest	55	Aspen Complex	Poor accuracy; 1 AA point confused with 56 (ecologically similar)	Combine 55,56,58	Aspen dominated or codominated woodlands	Accept proposed solution; retain linework
56	Populus tremuloides / Amelanchier utahensis - Symphoricarpos oreophilus Woodland			Good user's accuracy; confused with 2,18,32,51,55,58,63,70 (producer's). AA.563 has AMUT-SYOR no POTR			
57	Populus tremuloides / Cornus sericea Forest	57	Aspen / Red-osier Dogwood Woodland	100% user's & producer's accuracy. 1 AA point	Keep as is	Small stand of aspen with dogwood understory that occurs where there is an active seep	Retain as separate polygon
58	Populus tremuloides / Ligusticum filicinum Forest	55	Aspen Complex	100% producer's accuracy; 1of 2 correct for user's accuracy; confused with 56; rare type	Combine 55,56,58	Aspen dominated or codominated woodlands	Accept proposed solution, merge polygons with neighboring MC55 polys
59	Populus tremuloides / Prunus virginiana Woodland	59	Aspen / Chokecherry Woodland	1 of 1 correct; 100% accuracy. AA point was PRVI shrubland inclusion < MMU in aspen forest	Keep as is, map known locations as buffered points, or combine with 55,56,58	These are wet stands, often at the base of seeping, north-facing cliffs	Retain as a separate polygon
60	Populus tremuloides / Shepherdia canadensis Forest	60	Aspen / Buffaloberry - Invasive Grass	100% user's & producer's accuracy, 1 AA point	Keep as is or merge with other aspen types	Aspen stands where buffaloberry or invasive grasses are the dominant	Retain as separate polygons

Original Map Class	Original Map Class Name	Final Map Class	Final Map Class Name	Problem	Proposed Resolution	Ecology	AA meeting Final Decision
62	Populus tremuloides/ Apocynum androsaemifolium Forest		Woodland	Only 1 AA point; small patch type within larger aspen stand keyed to 60. AA point mislabled based on close proximity of this plot	Map known location as buffered point within 60 stand or add to 60	understory	Add to 60 polygon, delete this map unit
63	Prunus virginiana - (Prunus americana) Shrubland	63	Chokecherry Shrubland	100% producer's accuracy; confused with 37,56,59 (user's)	AA point is on edge of <MMU poly. If remove 2 AA points then 2 of 3 correct.	Small stands dominated by *Prunus virginiana*	Accept proposed solution
64	Pseudoroegneria spicata - Cushion Plants Herbaceous Vegetation	36	Windswept Ridge Complex	60% accuracy (user's); confused with 7,8 (user's) and 3,4,45,64 (producer's)	Combine 3,4,5,7,8, 29,36,40,41,45,47,64, 65	See “Ecology” description for map class 36	Combine 36,41,45,47,64,65 into a sparse, windswept ridgeline type
65	Pseudoroegneria spicata - Poa fendleriana Herbaceous Vegetation			Poor accuracy, only 3 AA points; confused with 4,7,64 (user's)			
68	Pseudotsuga menziesii / Symphoricarpos oreophilus Forest	68	Douglas-fir Forest	75% accuracy; 1 point confused with 60 (user's) and 51 (producer's)	Leave as is	High elevation, north-facing slopes with Douglas-fir dominant	Accept with lower accuracy, because of management interest (edge of range)
69	Purshia tridentata / Pteryxia terebinthina Shrubland	69	Bitterbrush Shrubland	OK on second call, 1 AA point was a split plot with AMUT, CEMO, and PUTR with PTTE present	Correct, leave as is	One small stand dominated by *Purshia tridentata*	OK
70	Salix lutea / Leymus cinereus Shrubland	70	Yellow Willow Shrubland	Poor accuracy; confused with 18,56,73 (user's). Stands tend to be <MMU inclusions in other types and restricted to seeps	Retain one small polygon (<MMU) with points in it	One small stand dominated by *Salix lutea*	Accept proposed solution

Original Map Class	Original Map Class Name	Final Map Class	Final Map Class Name	Problem	Proposed Resolution	Ecology	AA meeting Final Decision
71	Salix scouleriana Shrubland	71	Scouler's Willow Shrubland	100% accuracy. 1 AA point	OK	One small stand dominated by *Salix scouleriana*	OK
72	Sarcobatus vermiculatus / Artemisia tridentata Shrubland	28	Saline Flat Shrubland (Shadscale-Greasewood Phase)	80% user's accuracy; AA.165 confused with 25 (user's) and producer's confusion with 13,24,73	Combine 28,31,72,73	Large stands on saline flats along southern park boundary with greasewood dominant to codominant	Accept proposed solution. Except 31, which should go with the rest of the low sagebrush
73	Sarcobatus vermiculatus / Atriplex gardneri Shrubland			75% producer's accuracy (errors with 28,31); user's confused with 4,7,12,24,28			
74	Symphoricarpos oreophilus Shrubland	74	Mountain Snowberry Shrubland	Poor accuracy; confused with 4,7 (user's) and 2 (producer's); most polys <MMU	Merge all polygons into surroundings (too small to pull out separately). Retain as one polygon with an AA point in it.	Small stands dominated by *Symphoricarpos oreophilus*	Accept proposed solution

Appendix J
Vegetation Map Class Descriptions for Fossil Butte National Monument

Introduction

This document provides a visual guide and description of the vegetated map classes for the Fossil Butte National Monument Vegetation Mapping Project. Thirty-seven vegetation map classes are described in this guide. Land use map classes are not included.

Each of the vegetation map classes associated with this project is documented by:

- ground photographs
- a list of component NVC associations
- common plant species
- examples of each map class signature taken from the ortho imagery with delineated polygons
- a description of the photo signature
- a description of the ecology and distribution of the map class
- polygon statistics report (polygon number, size, area and proportion)
- accuracy assessment results for each map class

This guide does not attempt to show all variations within each vegetation map class; only the most common or significant representations are included. These should be sufficient to give the user a feel for the imagery and an understanding of the relationships between the vegetation classification and mapping.

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Upland Forest and Woodland

Map Class 44
Rocky Mountain Juniper Woodland (W-JUSC)

Photo credits: NCPN

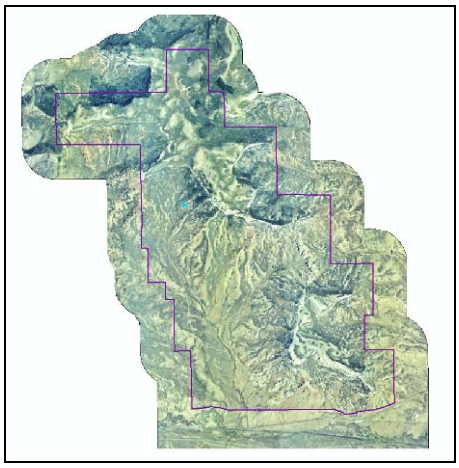
Associations
Juniperus scopulorum / Artemisia tridentata Woodland

Common species
- *Juniperus scopulorum*
- *Artemisia tridentata* ssp. *vaseyana*
- *Leymus cinereus*
- *Amelanchier utahensis*
- *Symphoricarpos oreophilus*

W-JUSC Map Class Statistics

Type:	Association
Frequency:	1 total polygons
	1 polygons in FOBU
	0 polygons in the environs
Total project area:	0.6 hectares / 1.5 acres (<0.1 %)
	0.6 hectares / 1.5 acres in FOBU
	0 hectares / 0 acres in the environs
Average Polygon Size:	0.6 hectares / 1.5 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

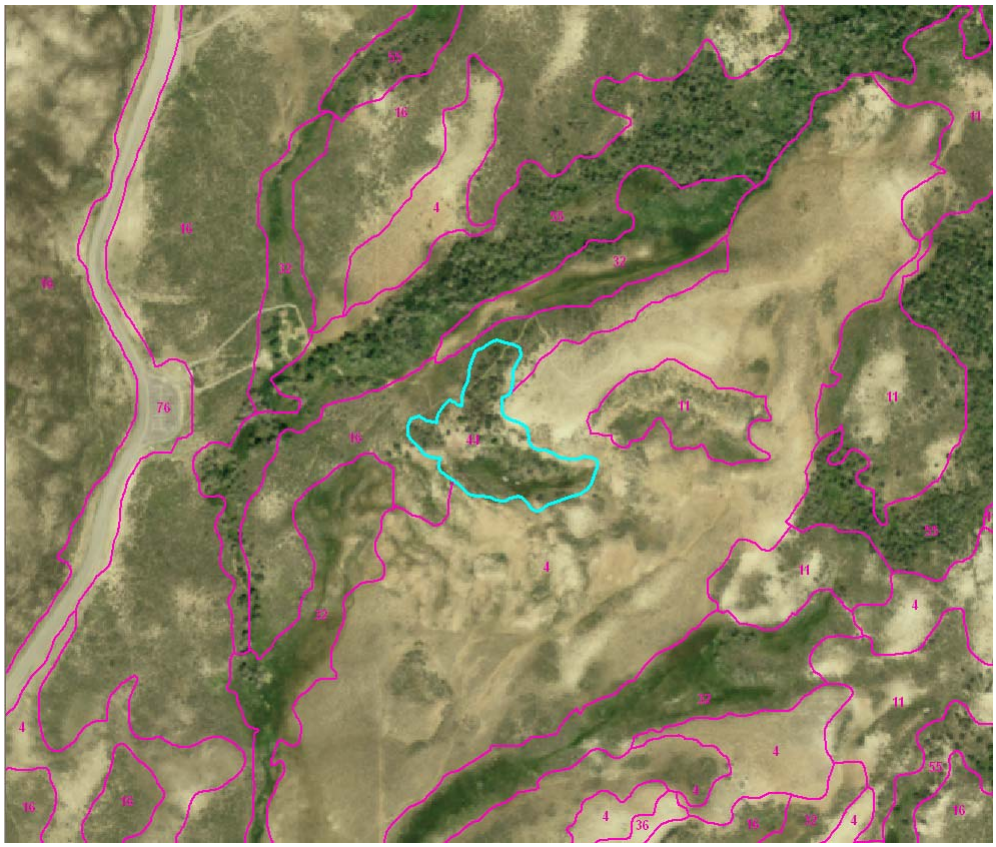
Distribution in Mapping Area



Distribution/Ecology/Composition
An isolated, open stand of Rocky Mountain juniper with a mountain big sagebrush understory occurs on a slump lobe in the upper reaches of the Chicken Creek drainage. Adjacent communities are mesic (quaking aspen, Baltic rush) and are additional signs of the groundwater flow that caused the slump. Utah serviceberry and Great Basin wildrye are common components of the woodland understory. The Rocky Mountain juniper stand consists of approximately 10 trees growing within a mountain big sagebrush shrubland. Young juniper trees are becoming established within an adjacent quaking aspen stand. Future movement by the slump may threaten the stand.

Interpretation

This map class was delineated only where it was documented by ground data or field observations. It is limited to a single, small stand.



Example of photo signature for map class W-JUSC (#44).

Map Class 51
Limber Pine Woodland (W-PIFL)

Photo credits: NCPN

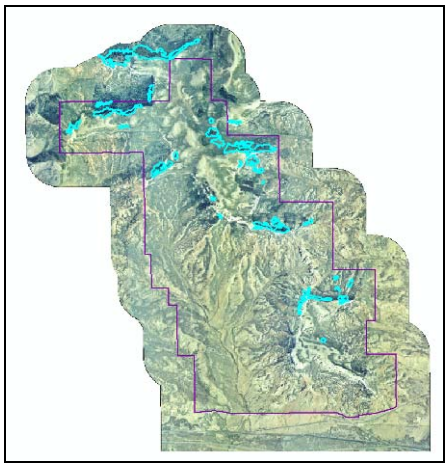
Associations
Pinus flexilis / Cercocarpus montanus - Amelanchier utahensis Woodland
Pinus flexilis / Symphoricarpos oreophilus Woodland

Common species
- *Pinus flexilis*
- *Artemisia tridentata* ssp. *vaseyana*
- *Symphoricarpos oreophilus*
- *Amelanchier utahensis*
- *Cercocarpus montanus*
- *Pteryxia terebinthina*

W-PIFL Map Class Statistics

Type:	Complex
Frequency:	44 total polygons 39 polygons in FOBU 5 polygons in the environs
Total project area:	119 hectares / 293 acres (1.9 %) 77 hectares / 190 acres in FOBU 42 hectares / 103 acres in the environs
Average Polygon Size:	2.7 hectares / 6.7 acres
Producer's accuracy:	94% ± 12%
User's accuracy:	84% ± 16%

Distribution in Mapping Area



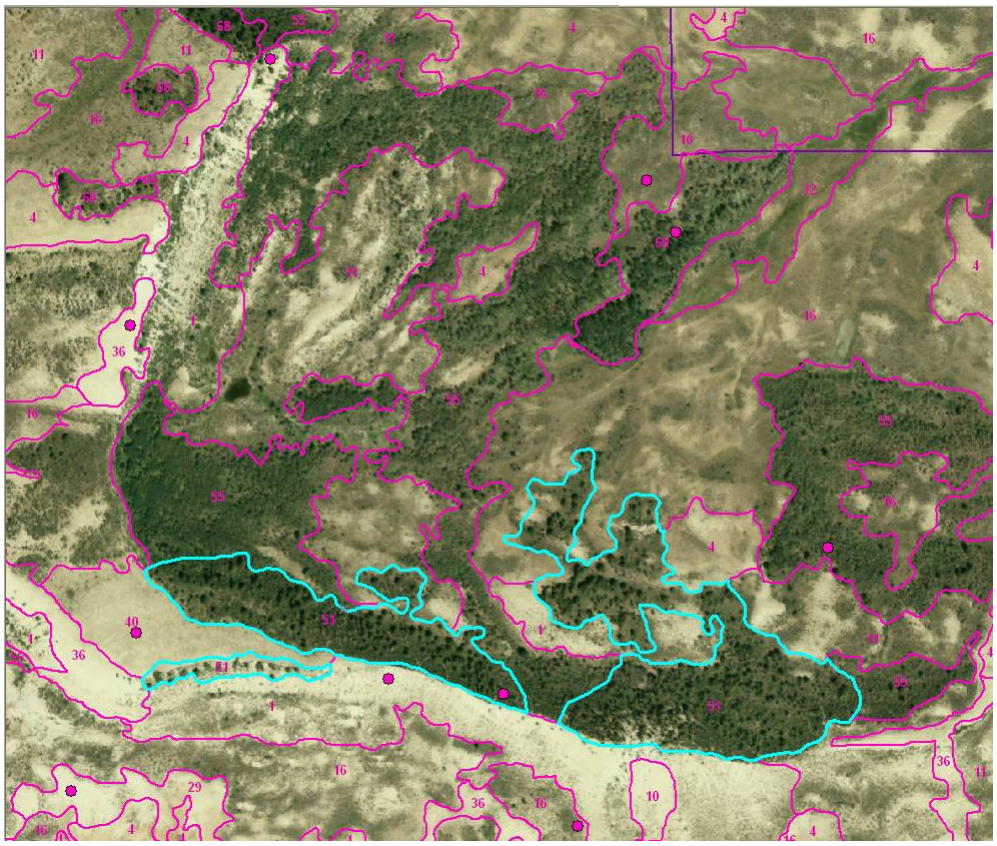
Distribution/Ecology/Composition
This is a common woodland type at higher elevations within the monument. It is the result of limber pine invading mountain mahogany and Utah serviceberry shrublands in the absence of fire. Stands generally have an open tree canopy of sapling to young-mature limber pine, sometimes with scattered Douglas-fir, and a mixed shrub understory composed of mountain mahogany, Utah serviceberry, mountain snowberry, ocean spray, bitterbrush, and mountain big sagebrush. Herbaceous species have much less cover than shrubs. Sites tend to be rocky, north- to east-facing upper ridge slopes.

Fire would kill the limber pine but would stimulate most of the mountain shrubs to resprout. Over time, natural fires would create a mosaic of mountain shrublands with and without limber pine; the exact

composition depending on the time since the last burn.

Interpretation

This is a common wooded map class within the mapping area, occurring in small to medium-sized, elongated to irregular polygons. Most stands are situated on the shallow soils of ridgelines, upper slopes, and rims. The characteristic signature is a rough medium green punctuated by dark green dots and patches representing limber pine trees.



Example of photo signature for map class W-PIFL (#51).

Map Class 55
Aspen Complex (F-POTR)

Photo credits: NCPN

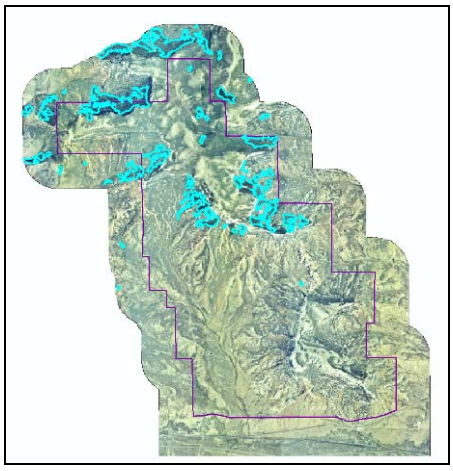
Associations
Populus tremuloides / Amelanchier utahensis - Symphoricarpos oreophilus / Mixed Graminoid Forest
Populus tremuloides / Tall Forbs Forest
Populus tremuloides Woodland Alliance

Common species
- *Populus tremuloides*
- *Amelanchier utahensis*
- *Symphoricarpos oreophilus*
- *Galium septentrionale*
- *Ligusticum filicinum*
- *Pinus flexilis*
- *Rosa woodsii*
- *Chamerion angustifolium*
- *Geranium richardsonii*

F-POTR Map Class Statistics

Type:	Complex
Frequency:	66 total polygons
	32 polygons in FOBU
	34 polygons in the environs
Total project area:	232 hectares / 574 acres (3.7 %)
	124 hectares / 306 acres in FOBU
	109 hectares / 269 acres in the environs
Average Polygon Size:	3.5 hectares / 8.7 acres
Producer's accuracy:	89% ± 12%
User's accuracy:	89% ± 12%

Distribution in Mapping Area

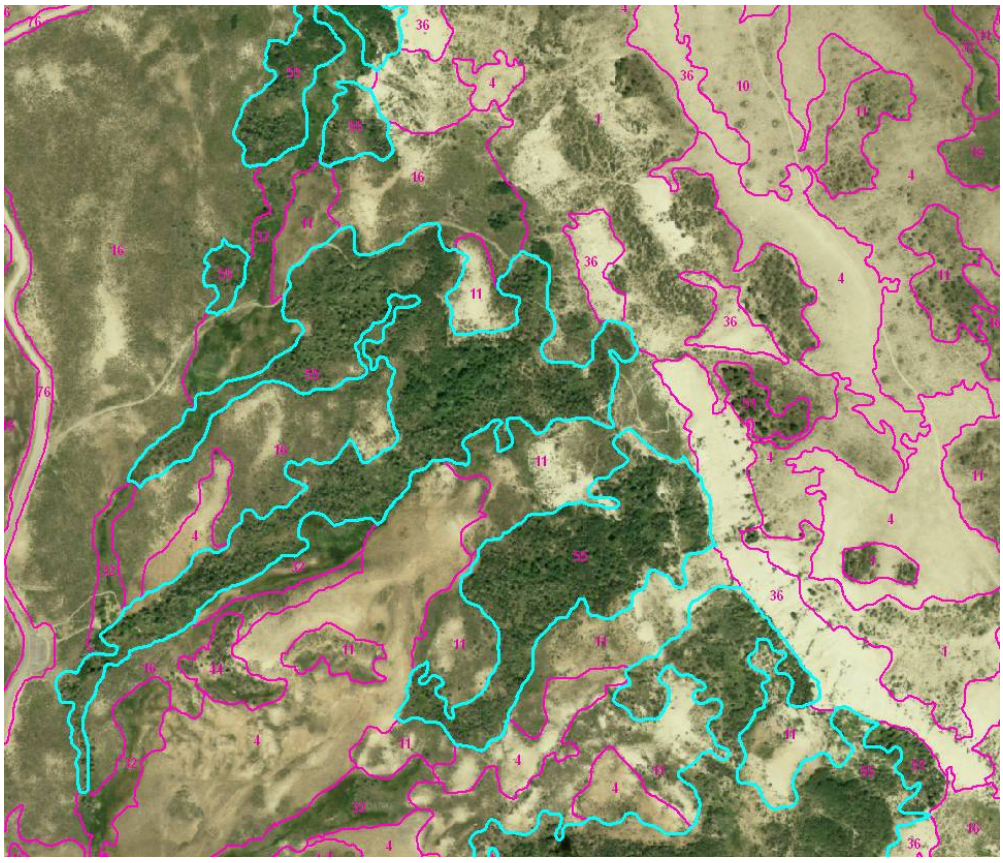


Distribution/Ecology/Composition
At FOBU, quaking aspen stands tend to occupy mesic slopes. This map class was designed to include most quaking aspen stands within the monument, except those with specialized understory species that were mapped as encountered (see other quaking aspen map classes below). Stands vary from a few stems clustered around a seep to large stands on north-facing slopes that collect and hold snow far into the spring. Most stands, especially on wetter sites, are self-perpetuating, sending up root sprouts when mature stems die, while a few have Douglas-fir saplings or limber pine in the understory and may eventually become

coniferous woodlands. The wettest quaking aspen stands have chokecherry and willows in the understory. Mesic stands have serviceberry, and dry stands have either common juniper or buffaloberry. Forbs and grasses have high cover and diversity in most stands. Fires generally kill the conifers, but stimulate the quaking aspen to re-sprout. Quaking aspen stands of FOBU support all ages of trees and all stages of succession to coniferous forest.

Interpretation

This is a common map class within the mapping area, occurring in small to medium, regular polygons. It is generally associated either with seeps or with areas where snow collects. A slightly rough, relatively bright green signature representing the quaking aspen crowns is characteristic. The canopy is usually closed and the understory species generally are not visible.



Example of photo signature for map class F-POTR (#55).

Map Class 57
Aspen / Red-osier Dogwood Woodland (W-PTCS)

Photo credits: NCPN

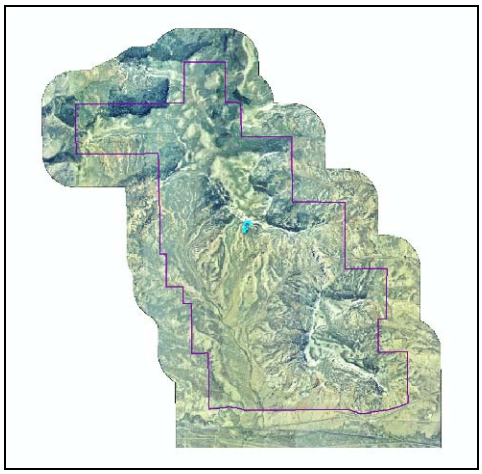
Associations
Populus tremuloides / Cornus sericea Forest

Common species
- *Populus tremuloides*
- *Cornus sericea*

W-PTCS Map Class Statistics

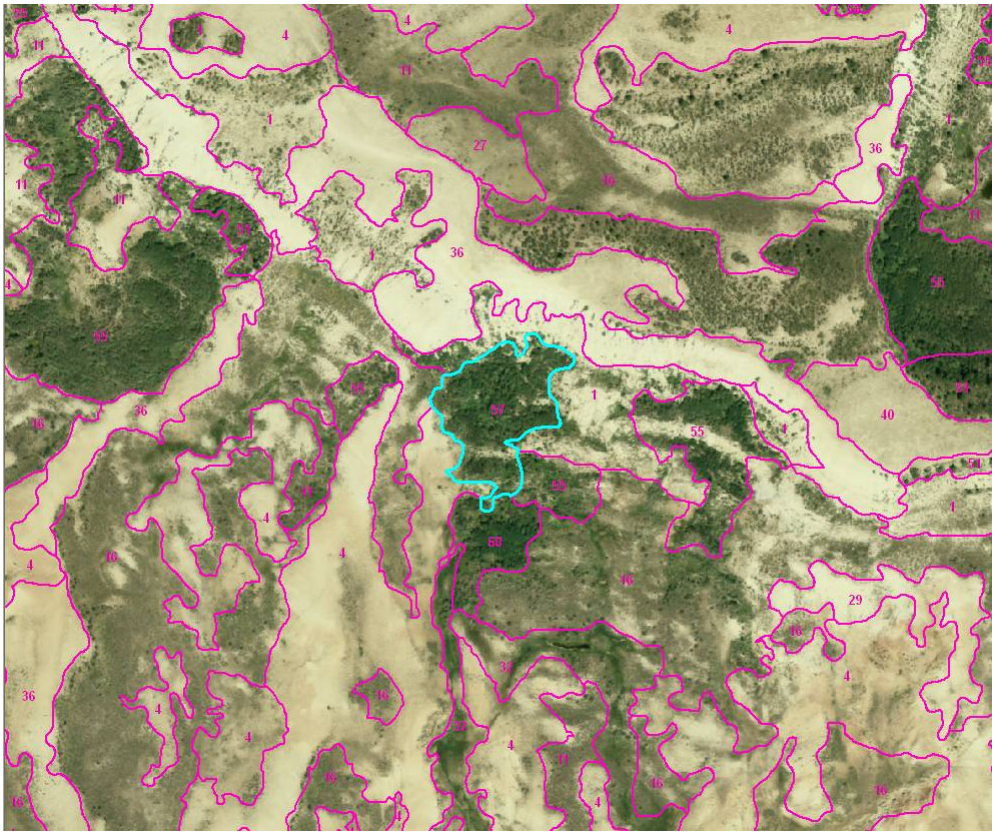
Type:	Association
Frequency:	1 total polygons
	1 polygons in FOBU
	0 polygons in the environs
Total project area:	1.8 hectares / 4.5 acres (0 %)
	1.8 hectares / 4.5 acres in FOBU
	0 hectares / 0 acres in the environs
Average Polygon Size:	1.8 hectares / 4.5 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area



Distribution/Ecology/Composition
This map class is intended to highlight the presence of an unusual, very wet quaking aspen community. The documented stand contains pools and running water. Dead quaking aspen trunks on the outer margins of the stand suggest that the groundwater level is reduced from what it was when those stems were established. It also suggests the vulnerability of the entire stand to additional reductions in spring flow. The understory of this stand contains few species other than red-osier dogwood.

Interpretation
This map class was mapped only where it was documented by ground data or field observations. It is limited to a single, small stand with the same photosignature as the other aspen map classes.



Example of photo signature for map class W-PTCS (#57).

Map Class 59
Aspen / Chokecherry Woodland (W-PTPV)

Photo credits: NCPN

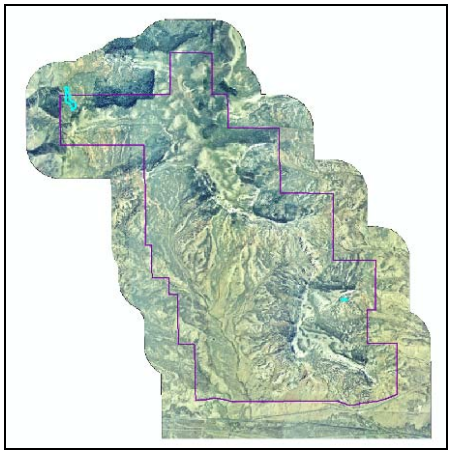
Associations
Populus tremuloides / Prunus virginiana Woodland

Common species
- *Populus tremuloides*
- *Cirsium undulatum*
- *Poa pratensis*
- *Prunus virginiana*
- *Leymus cinereus*

W-PTPV Map Class Statistics

Type:	Association
Frequency:	3 total polygons
	2 polygons in FOBU
	1 polygons in the environs
Total project area:	5 hectares / 13 acres (0.1 %)
	4 hectares / 10 acres in FOBU
	1 hectares / 3 acres in the environs
Average Polygon Size:	1.8 hectares / 4.4 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

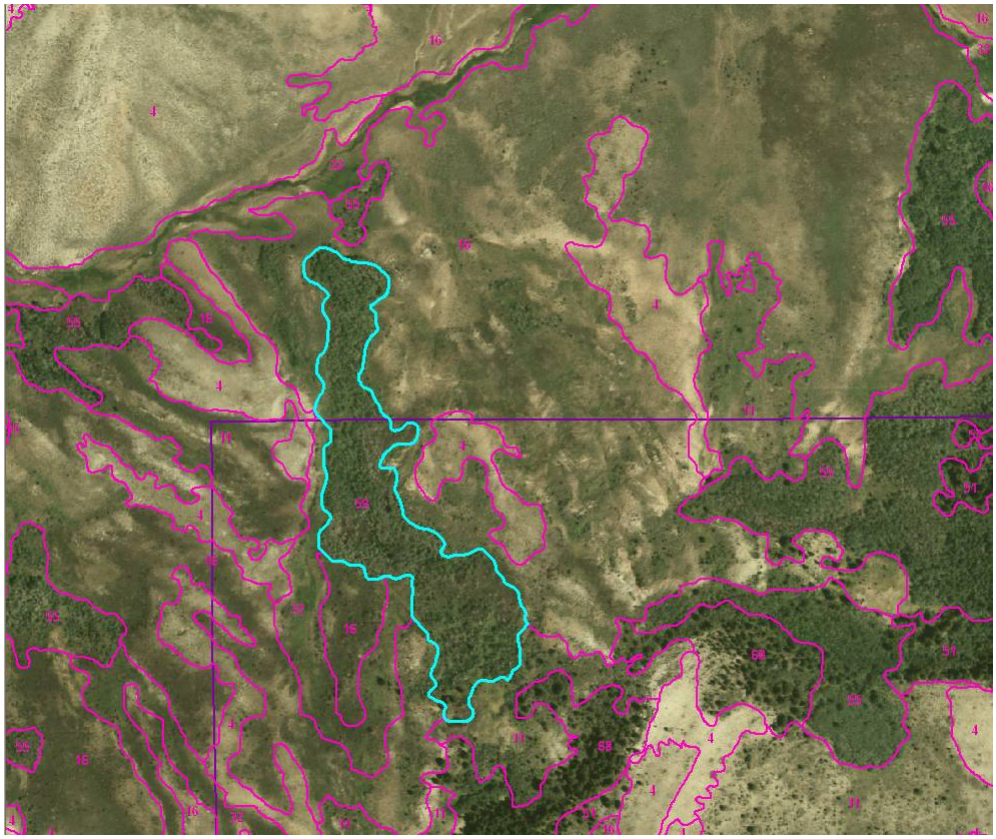
Distribution in Mapping Area



Distribution/Ecology/Composition
This map class was designed to highlight the presence of an unusual, mesic quaking aspen community. The known examples occur in ephemeral drainageways and other sites where, although there is no surface water, the moisture-holding capacity of the soil is high enough to support mesic species such as chokecherry, serviceberry, and mountain snowberry. There are few herbaceous species because of the dense canopy closure created by the quaking aspen and understory shrubs. This habitat is heavily used by elk for summer shelter and winter forage.

Interpretation

This map class was mapped only where it was documented by ground data or field observations. It has the same photosignature as the other quaking aspen map classes.



Example of photo signature for map class W-PTPV (#59).

Map Class 60
Aspen / Buffaloberry – Invasive Grass Woodland (W-PTSC)

Photo credits: NCPN

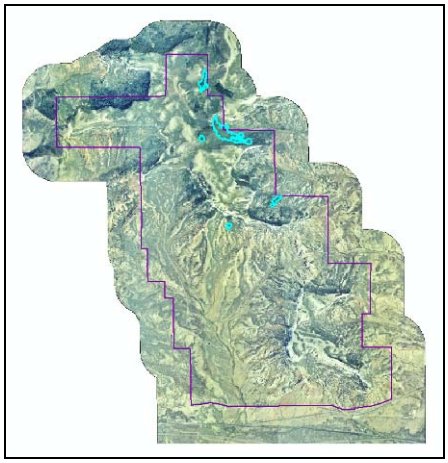
Associations
Populus tremuloides / Invasive Perennial Grasses Forest
Populus tremuloides / Shepherdia canadensis Forest
Populus tremuloides / Apocynum androsaemifolium Forest

Common species
- *Populus tremuloides*
- *Symphoricarpos oreophilus*
- *Poa pratensis*
- *Artemisia tridentata*
- *Shepherdia canadensis*
- *Apocynum androsaemifolium*
- *Elymus cinereus*

W-PTSC Map Class Statistics

Type:	Complex
Frequency:	11 total polygons
	5 polygons in FOBU
	6 polygons in the environs
Total project area:	28 hectares / 68 acres (0.4 %)
	27 hectares / 66 acres in FOBU
	1 hectares / 2 acres in the environs
Average Polygon Size:	2.5 hectares / 6.2 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area



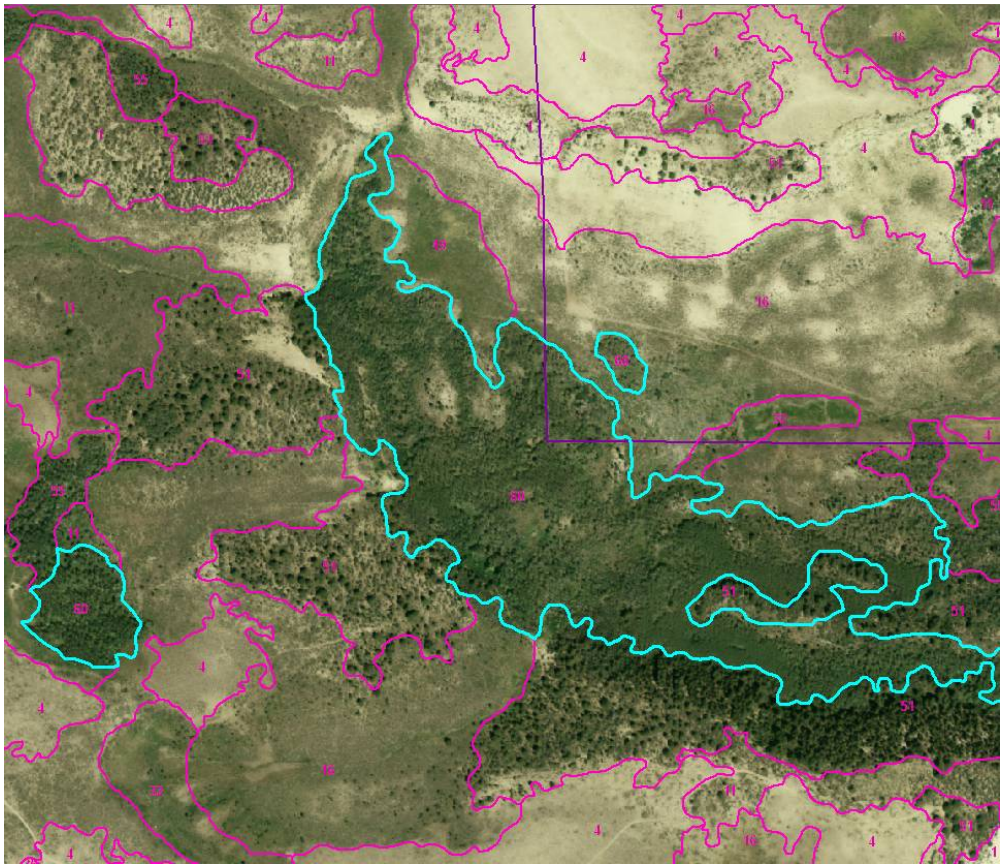
Distribution/Ecology/Composition
This map class is designed to highlight an unusual quaking aspen community. Stands of this type are generally inclusions on drier sites within larger quaking aspen stands with a variety of understory species. Buffaloberry dominates the understory, although creeping Oregon grape and mountain snowberry may also have significant cover. The herbaceous layer is diverse and often includes invasive grass species.

The quaking aspen community with an understory of dogbane was recorded once within the monument on a stabilized slump bench at the head of the Chicken Creek drainage. The documented stand showed evidence

of being heavily used by elk and mule deer. Standing water exists within the stand, and there was reproduction (young quaking aspen sprouts) on the margins of the stand. Mountain snowberry is the only other shrub present in the understory. The herbaceous layer is diverse but contributes little cover.

Interpretation

Small patches of this type are found within larger quaking aspen stands. This map class was mapped only where it was documented by ground data or field observations. It has the same photosignature as the other quaking aspen map classes.



Example of photo signature for map class W-PTSC (#60).

Map Class 68
Douglas-fir Forest (F-PSME)

Photo credits: NCPN

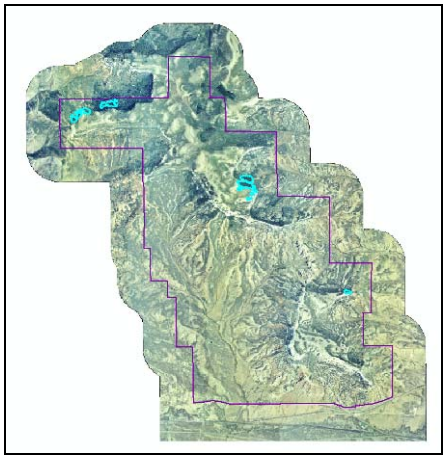
Associations
Pseudotsuga menziesii / Symphoricarpos oreophilus Forest

Common species
- *Pseudotsuga menziesii*
- *Amelanchier utahensis*
- *Pinus flexilis*
- *Symphoricarpos oreophilus*

F-PSME Map Class Statistics

Type:	Association
Frequency:	9 total polygons
	9 polygons in FOBU
	0 polygons in the environs
Total project area:	19 hectares / 47 acres (0.3 %)
	19 hectares / 47 acres in FOBU
	0 hectares / 0 acres in the environs
Average Polygon Size:	2.1 hectares / 5.2 acres
Producer's accuracy:	100%
User's accuracy:	100%

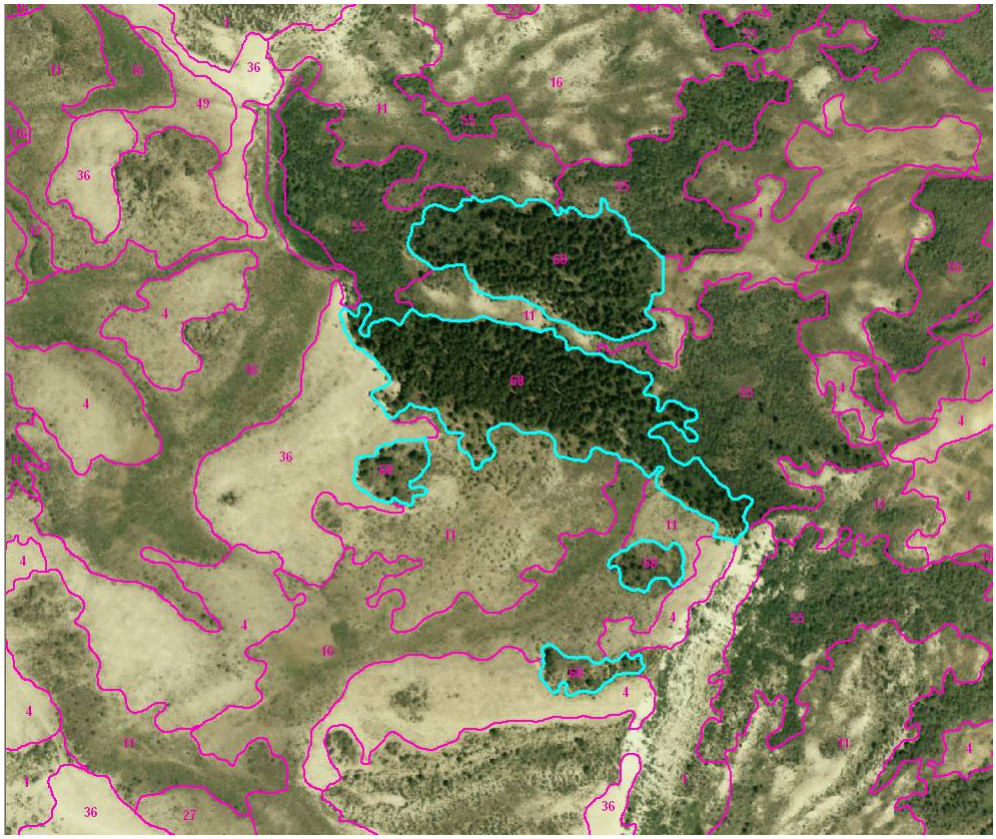
Distribution in Mapping Area



Distribution/Ecology/Composition
This forest type tends to be restricted to steep, cold slopes that may be too dry for quaking aspen. Stands generally have a dense tree canopy, with little growing in the deeply shaded understory except scattered mountain snowberry, Utah serviceberry, and bunchgrasses. Douglas-fir trees appear in a few quaking aspen and limber pine stands, but there is no evidence of succession to a closed Douglas-fir forest in these rockier, more exposed settings.

Interpretation
This map class occurs in a few small to medium-sized polygons at the upper elevations of the mapping area and is generally restricted to north-facing slopes. The signature is similar to that of limber pine woodlands, but can be distinguished because of the narrow, pointed crowns characteristic of Douglas-fir trees. The sparse understory is generally not visible because the forest canopy is closed. However, a brighter signature

associated with a more open canopy occurs in stands on west- and south-facing slopes with a *Purshia tridentata* understory.



Example of photo signature for map class W-PSME (#68).

Upland Shrublands

Map Class 1
Mixed Mountain Shrubland (S-MXDM)

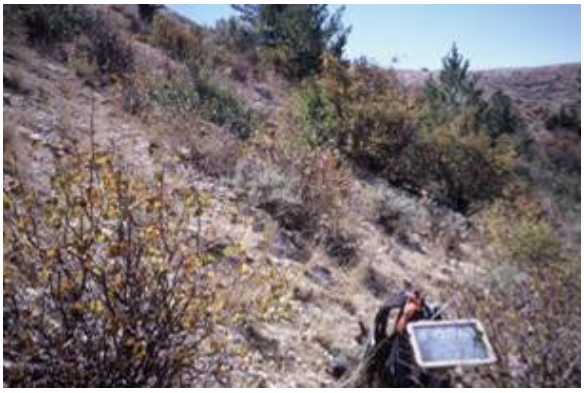


Photo credits: NCPN

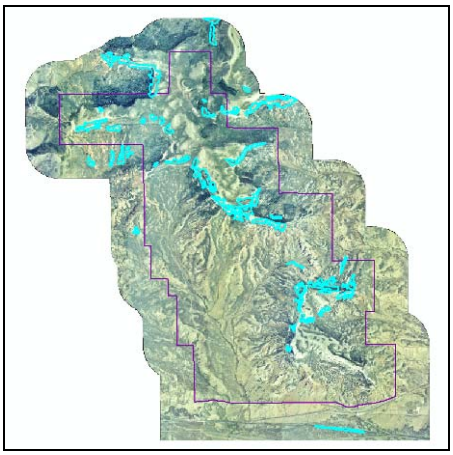
Associations
Amelanchier utahensis Shrubland
Amelanchier (utahensis, alnifolia) - *Cercocarpus montanus* Shrubland

Common species
- *Amelanchier utahensis*
- *Cercocarpus montanus*
- *Purshia tridentata*
- *Leymus cinereus*
- *Pteryxia terebinthina*
- *Artemisia tridentata* ssp. *Vaseyana*
- *Chrysothamnus viscidiflorus*
- *Elymus lanceolatus*
- *Symphoricarpos oreophilus*

S-MXDM Map Class Statistics

Type:	Complex
Frequency:	56 total polygons
	40 polygons in FOBU
	16 polygons in the environs
Total project area:	166 hectares / 411 acres (2.7 %)
	104 hectares / 258 acres in FOBU
	62 hectares / 153 acres in the environs
Average Polygon Size:	3 hectares / 7.3 acres
Producer's accuracy:	76% ± 15%
User's accuracy:	81% ± 15%

Distribution in Mapping Area

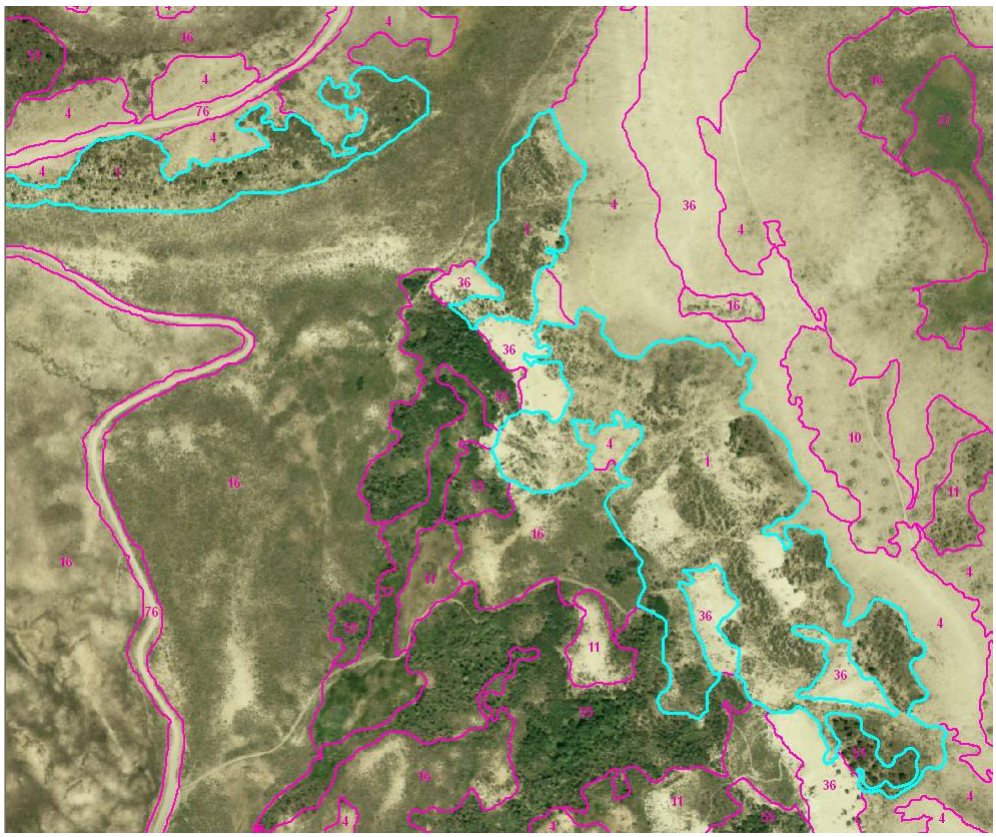


Distribution/Ecology/Composition
This is the most common non-sagebrush shrubland community within FOBU. It occurs throughout the monument on rims and steep upper slopes of Green River shale. Most, but not all stands are on north- or east-facing slopes. Relatively mesic stands typically are dominated or codominated by Utah serviceberry

with lesser cover by chokecherry, mountain mahogany, bitterbrush, mountain big sagebrush, oceanspray, and mountain snowberry. Utah serviceberry is less important in drier stands. This shrubland is usually open, and shows heavy use by grazing ungulates. The herbaceous layer is diverse but is generally sparse. Many stands include young limber pine trees, suggesting a fire-driven cycle of open limber pine woodlands with a shrub understory and mixed mountain shrublands.

Interpretation

This map class is common at the middle and upper elevations of the monument. It has a characteristically variable signature, with gray green speckles representing mountain big sagebrush shrubs, while darker, round speckles represent serviceberry and darker, ragged speckles generally represent mountain mahogany. Many stands include scattered dark dots representing invading limber pine trees.



Example of photo signature for map class S-MXDM (#1).

Map Class 4
Low Sagebrush Shrublands (S-ARAR)

Photo credits: NCPN

Associations

Artemisia arbuscula ssp. *longiloba* / Cushion Plants Dwarf-shrubland
Artemisia arbuscula ssp. *longiloba / Elymus lanceolatus* Shrubland
Artemisia arbuscula ssp. *longiloba / Poa fendleriana* Shrubland
Artemisia arbuscula ssp. *longiloba / Poa secunda* Shrub Herbaceous Vegetation
Artemisia arbuscula ssp. *longiloba / Pseudoroegneria spicata* Shrub Herbaceous Vegetation
Artemisia arbuscula ssp. *longiloba* Shrubland
Atriplex gardneri Dwarf-shrubland
Atriplex gardneri – Artemisia arbuscula ssp. *longiloba* Dwarf-shrubland

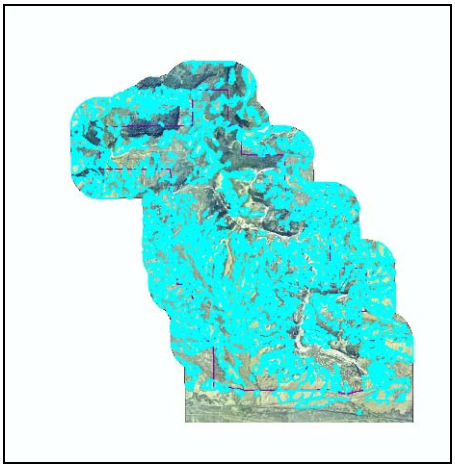
Common species

- *Artemisia arbuscula* ssp. *longiloba*
- *Chrysothamnus viscidiflorus*
- *Atriplex gardneri*
- *Phlox* spp.
- *Trifolium gymnocarpon*
- *Atriplex confertifolia*
- *Krascheninnikovia lanata*
- *Eriogonum brevicaule*
- *Poa fendleriana*
- *Elymus lanceolatus*

S-ARAR Map Class Statistics

Type:	Complex
Frequency:	646 total polygons 401 polygons in FOBU 245 polygons in the environs
Total project area:	2,161 hectares / 5,341 acres (34.8 %) 1161 hectares / 2868 acres in FOBU 1,001 hectares / 2,473 acres in the environs
Average Polygon Size:	3.3 hectares / 8.3 acres
Producer's accuracy:	94% ± 3%
User's accuracy:	92% ± 3%

Distribution in Mapping Area



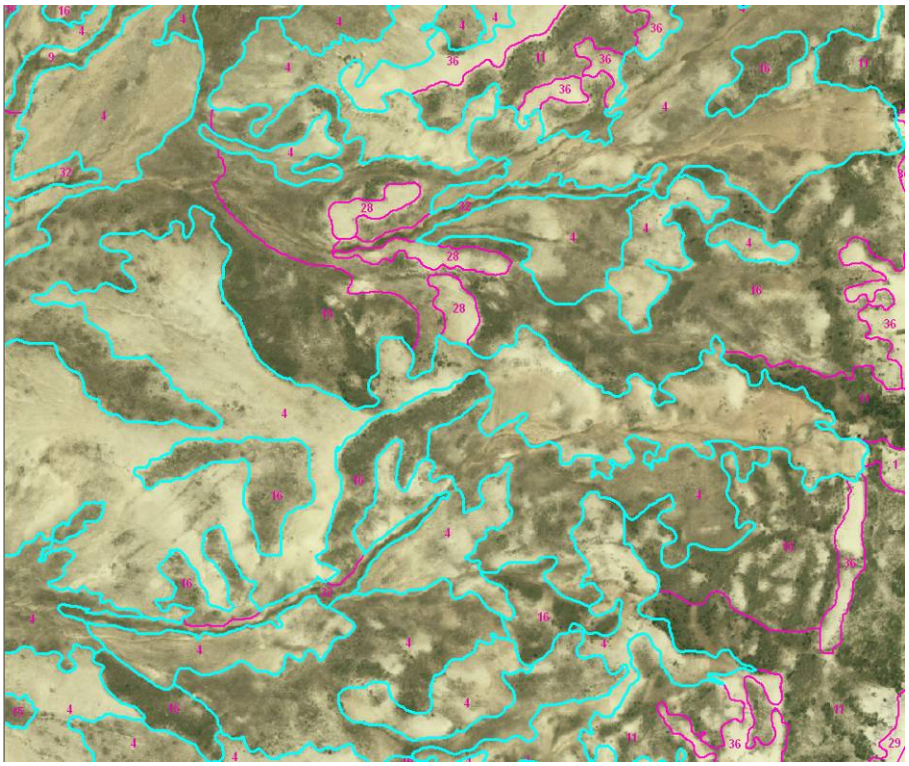
Distribution/Ecology/Composition

Alkali sagebrush shrublands are common throughout FOBU, occurring on low elevation flats, valley sides, and ridgelines at high elevations. Although there is soil development, the soils are generally thin and alkaline. The shrub canopy is typically open to sparse, and may contain other low shrub species, including big sagebrush species, winterfat, shadscale, and yellow rabbitbrush, depending on substrate and disturbance history. The understory is variable, and probably has been reduced in cover by a history of livestock grazing. Grasses contribute most of the herbaceous cover, especially curly bluegrass, streamside wildrye, and bluebunch wheatgrass. The greatest diversity of forbs occurs in stands at high elevations, where the low-growing plants typical of FOBU's windswept ridgelines are dominant: shortstem buckwheat, Navajo fleabane, hollyleaf clover, stemless mock goldenweed, and paintbrush.

Gardner's saltbush stands with or without alkali sagebrush, documented in the geodatabase by an 'ATGA' modifier, occur on saline flats and shallow swales at the lowest elevations within the monument. The documented stands are on soils derived from Wasatch Formation clays in the valleys of Chicken and Twin creeks. The typical community includes scattered shrubs of alkali sagebrush, Gardner saltbush, bud sage, winterfat, and black greasewood. The few perennial herbaceous species include bottlebrush squirreltail, curly bluegrass, streamside wildrye; most of the herbaceous cover is weedy annual or biennial forbs.

Interpretation

This map class is common at both the higher elevations of the monument, usually with a sparse grass understory, as well as on clay flats at the lower elevations, usually with Gardner saltbush. Both types of stands have a smooth-appearing texture, with the slight roughness imparted by the shrubs visible generally only under magnification. The color ranges from a uniform, light gray green, representing the sparse vegetation and the reflectivity of the substrate, to a darker gray green for stands with denser shrubs.



Example of photo signature for map class S-ARAR (#4).

Map Class 10
Black Sagebrush Shrubland (S-ARNO)

Photo credits: NCPN

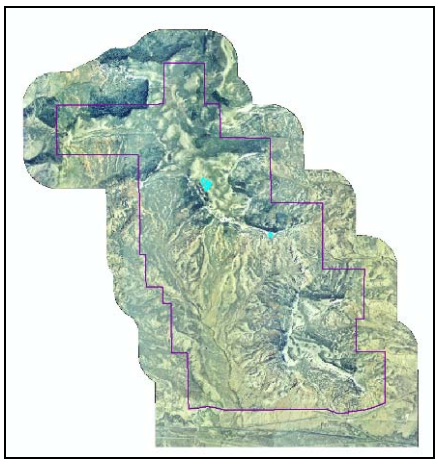
Associations
Artemisia nova / Pseudoroegneria spicata Shrubland

Common species
- *Artemisia nova*
- *Comandra umbellata*
- *Pseudoroegneria spicata*
- *Artemisia tridentata* ssp. *vaseyana*
- *Pascopyrum smithii*

S-ARNO Map Class Statistics

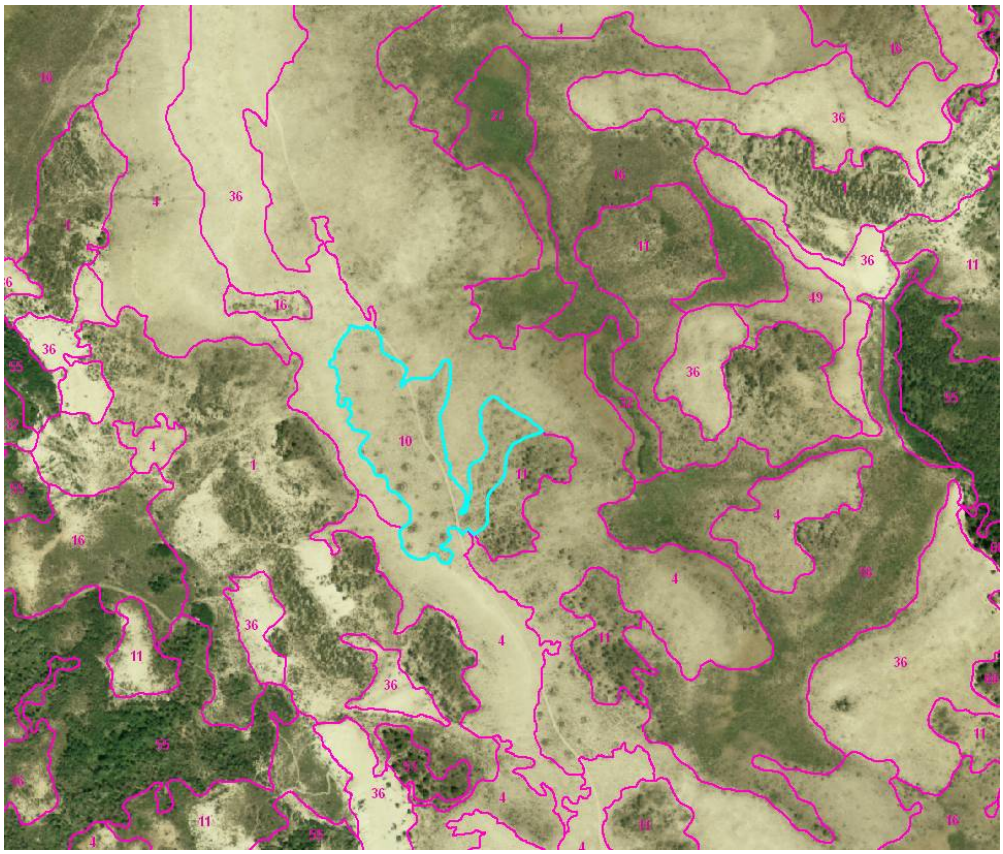
Type:	Association
Frequency:	2 total polygons
	2 polygons in FOBU
	0 polygons in the environs
Total project area:	3 hectares / 8 acres (<0.1 %)
	3 hectares / 8 acres in FOBU
	0 hectares / 0 acres in the environs
Average Polygon Size:	1.6 hectares / 3.8 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area



Distribution/Ecology/Composition
This rare shrubland was recorded from two sites within the monument, both located on the ridge that connects The Bullpen and Fossil Butte. Some stands are mixed, with mountain big sagebrush or mountain mahogany codominant with black sagebrush in the canopy. Native grasses contribute most of the cover in the herbaceous layer; the most consistent species include curly bluegrass, muttongrass, streamside wildrye, and bluebunch wheatgrass. Forbs vary significantly from stand to stand, and do not provide more than a few percent cover.

Interpretation
This rare map class was delineated only where it was documented by ground data or field observations. It is limited to two small stands/polygons. It has no signature distinct from surrounding shrublands.



Example of photo signature for map class S-ARNO (#10).

Map Class 11
Sagebrush – Serviceberry Shrubland (S-SASE)

Photo credits: NCPN

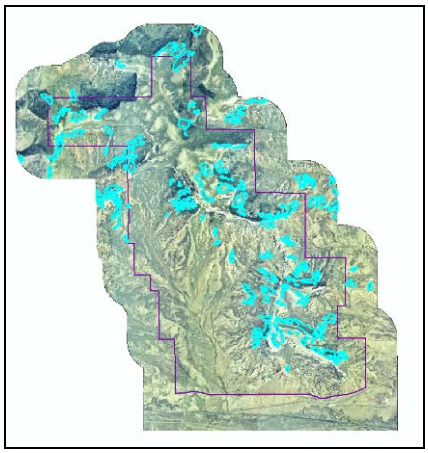
Associations
*Artemisia tridentata (*ssp. *vaseyana,* ssp. *wyomingensis) - Amelanchier utahensis* Shrubland

Common species
- *Amelanchier utahensis*
- *Purshia tridentata*
- *Elymus lanceolatus*
- *Lithospermum ruderale*
- *Poa secunda*
- *Artemisia tridentata* ssp. *vaseyana*
- *Symphoricarpos oreophilus*
- *Eriogonum umbellatum*
- *Phlox longifolia*

S-SASE Map Class Statistics

Type:	Association
Frequency:	138 total polygons
	94 polygons in FOBU
	44 polygons in the environs
Total project area:	287 hectares / 710 acres (4.6 %)
	204 hectares / 504 acres in FOBU
	83 hectares / 205 acres in the environs
Average Polygon Size:	2.1 hectares / 5.1 acres
Producer's accuracy:	82% ± 10%
User's accuracy:	85% ± 10%

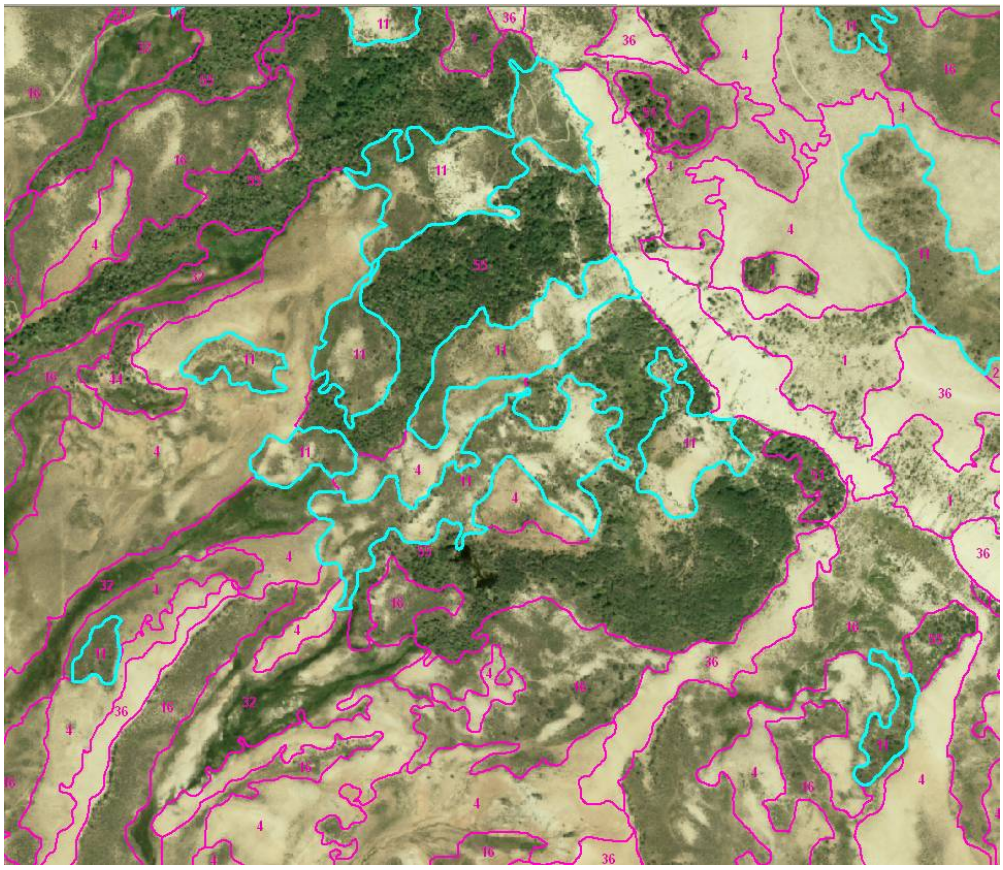
Distribution in Mapping Area



Distribution/Ecology/Composition
Most stands are on level sites to moderate slopes at higher elevations. These are typically sagebrush shrublands with scattered, emergent Utah serviceberry shrubs and an understory containing mountain snowberry and yellow rabbitbrush. They require deeper soils than other mixed mountain shrubland types, and have a diverse herbaceous layer. Common forb species include milkvetch, larkspur, sulfur buckwheat, stoneseed, bluebells, phlox, and hollyleaf clover. Grasses provide good cover and include Great Basin wildrye, streamside wildrye, muttongrass, curly bluegrass, and Letterman needlegrass. These communities are susceptible to fire and would tend to convert to forb-rich meadows after fire.

Interpretation

This common map class is distributed across the higher elevations of the mapping area. The characteristic signature is similar to that of Mixed Mountain Shrubland (map class #1), but is generally smoother-textured and lacks the dark, ragged speckles of mountain mahogany. The predominant color is the grayish-green of big sagebrush species with darker, rounded green dots representing serviceberry.



Example of photo signature for map class S-SASE (#11).

Map Class 13
Basin Big Sagebrush / Great Basin Wildrye Shrubland (S-BBGB)

Photo credits: NCPN

Associations
Artemisia tridentata ssp. *tridentata / Leymus cinereus* Shrubland

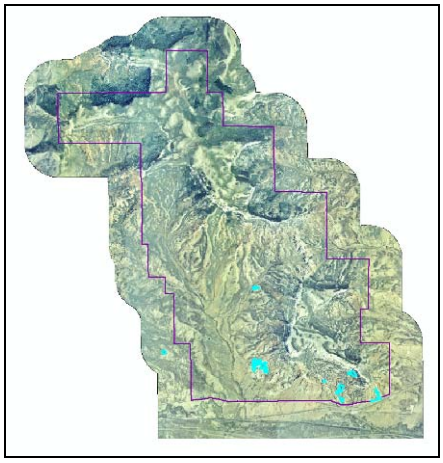
Common species
- *Chrysothamnus viscidiflorus*
- *Leymus cinereus*
- *Artemisia tridentata* ssp. *tridentata*
- *Mertensia oblongifolia*

S-BBGB Map Class Statistics

Type: Association

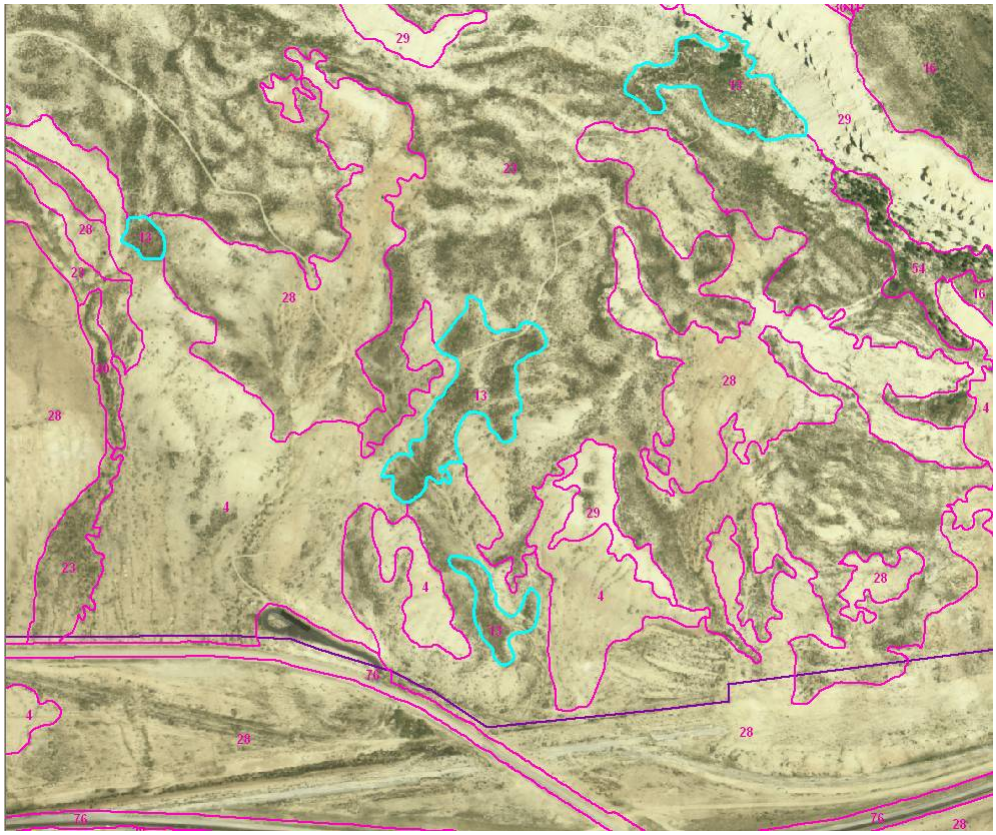
Frequency:	13 total polygons
	11 polygons in FOBU
	2 polygons in the environs
Total project area:	11 hectares / 26 acres (0.2 %)
	10 hectares / 24 acres in FOBU
	1 hectares / 2 acres in the environs
Average Polygon Size:	0.8 hectares / 2 acres
Producer's accuracy:	100%
User's accuracy:	100%

Distribution in Mapping Area



Distribution/Ecology/Composition
Stands of basin big sagebrush with Great Basin wildrye were likely common historically in swales and on floodplains throughout FOBU. A few stands remain, but grazing and dropping water tables allowed western wheatgrass, streamside wildrye, and Baltic rush to replace most of the Great Basin wildrye. The canopy in stands of this map class may be dominated by either mountain big sagebrush or basin big sagebrush. Stands experiencing chronic disturbance have yellow rabbitbrush as a canopy codominant.

Interpretation
This uncommon map class appears on the imagery as dark, clumpy patches in the middle of other sagebrush types. Polygons are generally small and often linear.



Example of photo signature for map class S-BBGB (#13).

Map Class 15
Basin Big Sagebrush / Bluegrass Shrubland (S-BBSA)

Photo credits: NCPN

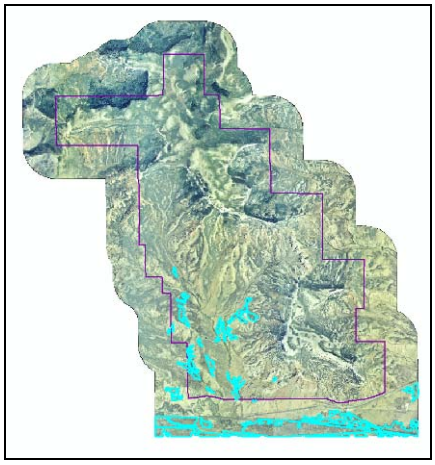
Associations
Artemisia tridentata ssp. *tridentata / Poa secunda* Shrubland

Common species
- *Chrysothamnus viscidiflorus*
- *Artemisia arbuscula* var. *longiloba*
- *Poa secunda*
- *Artemisia tridentata* ssp. *tridentata*
- *Poa fendleriana*

S-BBSA Map Class Statistics

Type:	Association
Frequency:	51 total polygons 22 polygons in FOBU 29 polygons in the environs
Total project area:	241 hectares / 595 acres (3.9 %) 46 hectares / 114 acres in FOBU 195 hectares / 481 acres in the environs
Average Polygon Size:	4.7 hectares / 11.7 acres
Producer's accuracy:	78% ± 29%
User's accuracy:	100%

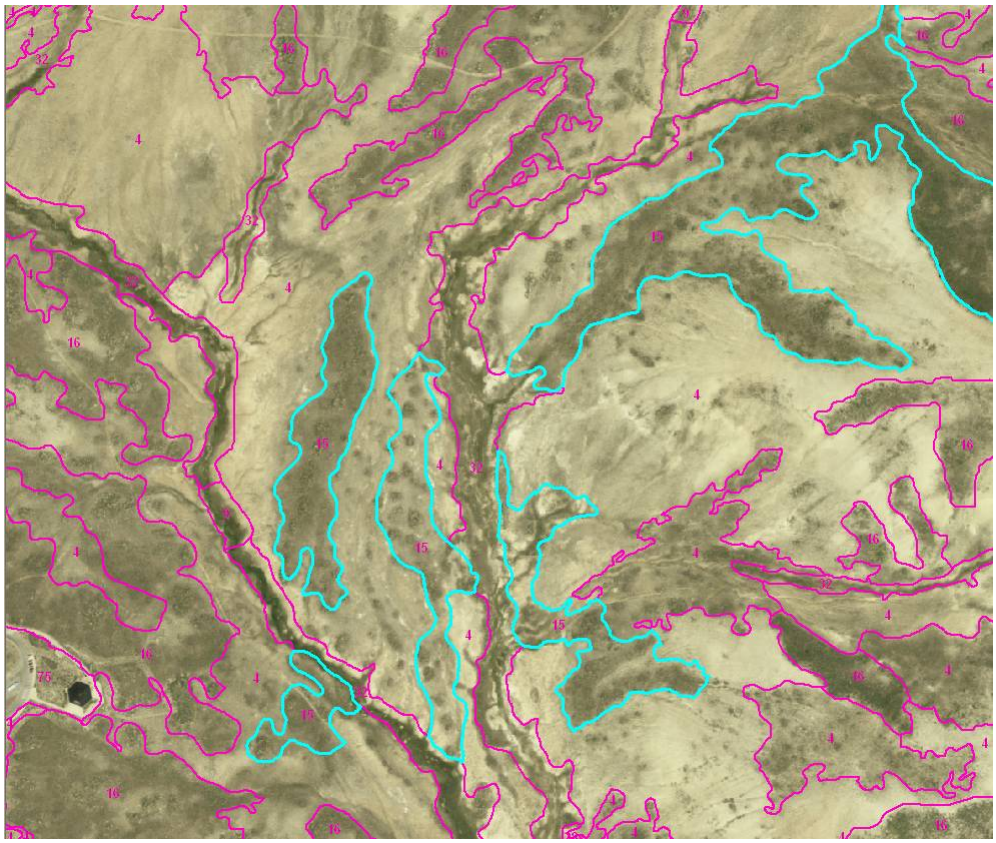
Distribution in Mapping Area



Distribution/Ecology/Composition
Polygons of this map class occur primarily on well-drained alluvial soils on the floodplain of lower Chicken Creek. This community type represents an altered community. Historically, Great Basin wildrye was probably the dominant grass in the understory of these stands, but grazing and dropping water tables eliminated it in favor of curly bluegrass and muttongrass, which are both more drought- and grazing-tolerant. The remainder of the herbaceous layer is variable and contributes only a few percent cover.

Interpretation

This uncommon map class occurs primarily in the southern half of the study area, especially south of Highway 30 outside the monument where regular grazing by sheep occurs. It does not have a distinct photosignature, but was mapped by developing models from plot data.



Example of photo signature for map class S-BBSA (#15).

Map Class 16
Mountain Big Sagebrush Shrublands (S-MOSA)

Photo credits: NCPN

Associations

Artemisia tridentata ssp. *vaseyana / Achnatherum lettermanii Shrubland*
Artemisia tridentata ssp. *vaseyana / Balsamorhiza sagittata* Shrubland
Artemisia tridentata ssp. *vaseyana / Elymus lanceolatus* Shrubland
Artemisia tridentata ssp. *vaseyana / Leucopoa kingii* Shrubland
Artemisia tridentata ssp. *vaseyana / Leymus cinereus* Shrubland
Artemisia tridentata ssp. *vaseyana / Pascopyrum smithii* Shrubland
Artemisia tridentata ssp. *vaseyana / Poa fendleriana* Shrubland
Artemisia tridentata ssp. *vaseyana / Poa pratensis* Sagebrush Shrubland
Artemisia tridentata ssp. *vaseyana / Poa secunda* Shrubland
Artemisia tridentata ssp. *vaseyana / Pseudoroegneria spicata* Shrubland

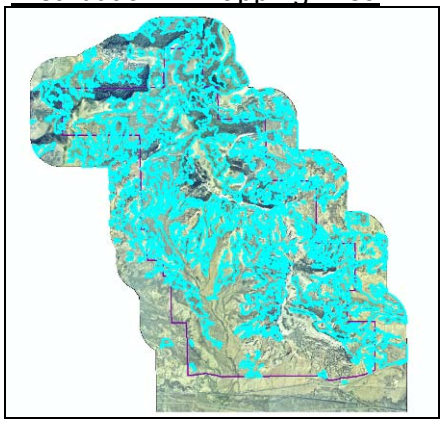
Common species

- *Artemisia tridentata* ssp. *vaseyana*
- *Amelanchier utahensis*
- *Chrysothamnus viscidiflorus*
- *Balsamorhiza sagittata*
- *Leymus cinereus*
- *Poa fendleriana*
- *Phlox longifolia*
- *Pascopyrum smithii*
- *Purshia tridentata*
- *Symphoricarpos oreophilus*
- *Elymus lanceolatus*
- *Pseudoroegneria spicata*
- *Poa secunda*
- *Poa pratensis*

S-MOSA Map Class Statistics

Type:	Complex
Frequency:	316 total polygons
	171 polygons in FOBU
	145 polygons in the environs
Total project area:	1,853 hectares / 4,580 acres (29.8 %)
	996 hectares / 2460 acres in FOBU
	858 hectares / 2,120 acres in the environs
Average Polygon Size:	5.9 hectares / 14.5 acres
Producer's accuracy:	90% ± 5%
User's accuracy:	88% ± 5%

Distribution in Mapping Area

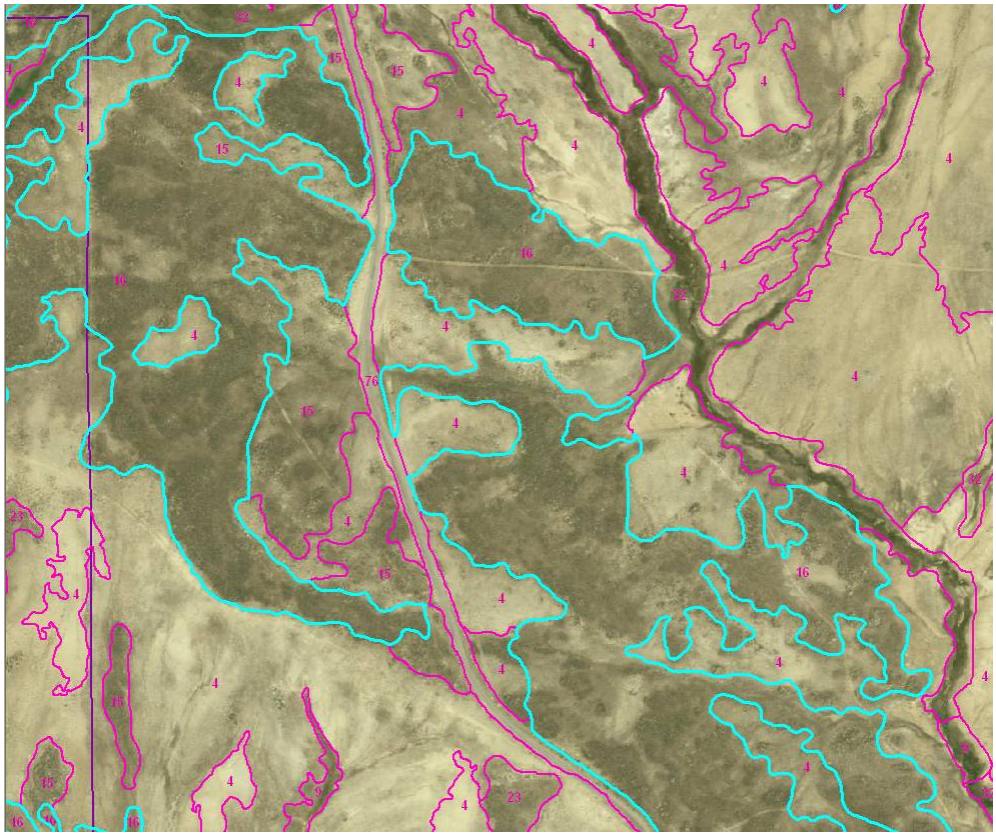


Distribution/Ecology/Composition

This is the most common big sagebrush community covering hills and flats above the approximate elevation of the monument visitor center. Apparent hybrids between Wyoming big sagebrush and mountain big sagebrush were frequently noted by the field crews. Mesic stands have higher cover by grasses including western wheatgrass, streamside wildrye, and Great Basin wildrye. Stands on windy or well-drained sites have higher cover by curly bluegrass, bluebunch wheatgrass, spike fescue, or Letterman's needlegrass. Forbs including lupine and arrowleaf balsamroot are common and conspicuous. Fire is an important process to remove decadent mountain big sagebrush; burned stands become forb-rich meadows that revert to mountain big sagebrush within a few decades.

Interpretation

The boundary between mountain big sagebrush and Wyoming big sagebrush communities was determined to be approximately at the elevation of the visitor center. In general, mountain big sagebrush communities were described above this elevation, with Wyoming sagebrush communities dominating the slopes around and below the visitor center. The characteristic photosignature for both community types is a moderately rough-textured, gray green color. Polygons of this map class are generally medium to large in size, and regular to irregular in shape.



Example of photo signature for map class S-MOSA (#16).

Map Class 23
Wyoming Big Sagebrush Shrublands (S-WYSA)

Photo credits: NCPN

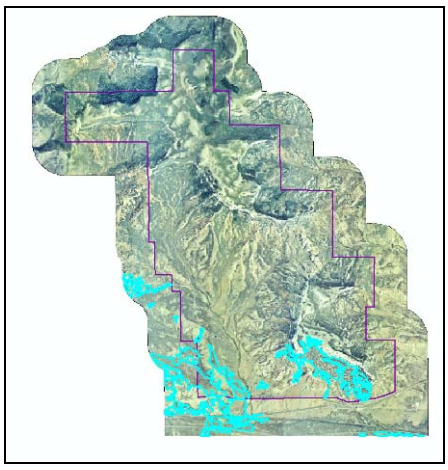
Associations
Artemisia tridentata / Elymus lanceolatus Shrubland
Artemisia tridentata ssp. *wyomingensis* / Disturbed Understory Semi-natural Shrubland
Artemisia tridentata ssp. *wyomingensis / Leymus cinereus* Shrubland
Artemisia tridentata ssp. *wyomingensis / Poa secunda* Shrubland
Artemisia tridentata ssp. *wyomingensis / Pseudoroegneria spicata* Shrubland

Common species
- *Artemisia tridentata* var. *wyomingensis*
- *Chrysothamnus viscidiflorus*
- *Leymus cinereus*
- *Pseudoroegneria spicata*
- *Elymus elymoides*
- *Elymus lanceolatus*
- *Poa secunda*
- *Trifolium gymnocarpon*

S-WYSA Map Class Statistics

Type:	Complex
Frequency:	65 total polygons
	20 polygons in FOBU
	45 polygons in the environs
Total project area:	278 hectares / 687 acres (4.5 %)
	133 hectares / 329 acres in FOBU
	145 hectares / 358 acres in the environs
Average Polygon Size:	4.3 hectares / 10.6 acres
Producer's accuracy:	88% ± 10%
User's accuracy:	88% ± 10%

Distribution in Mapping Area

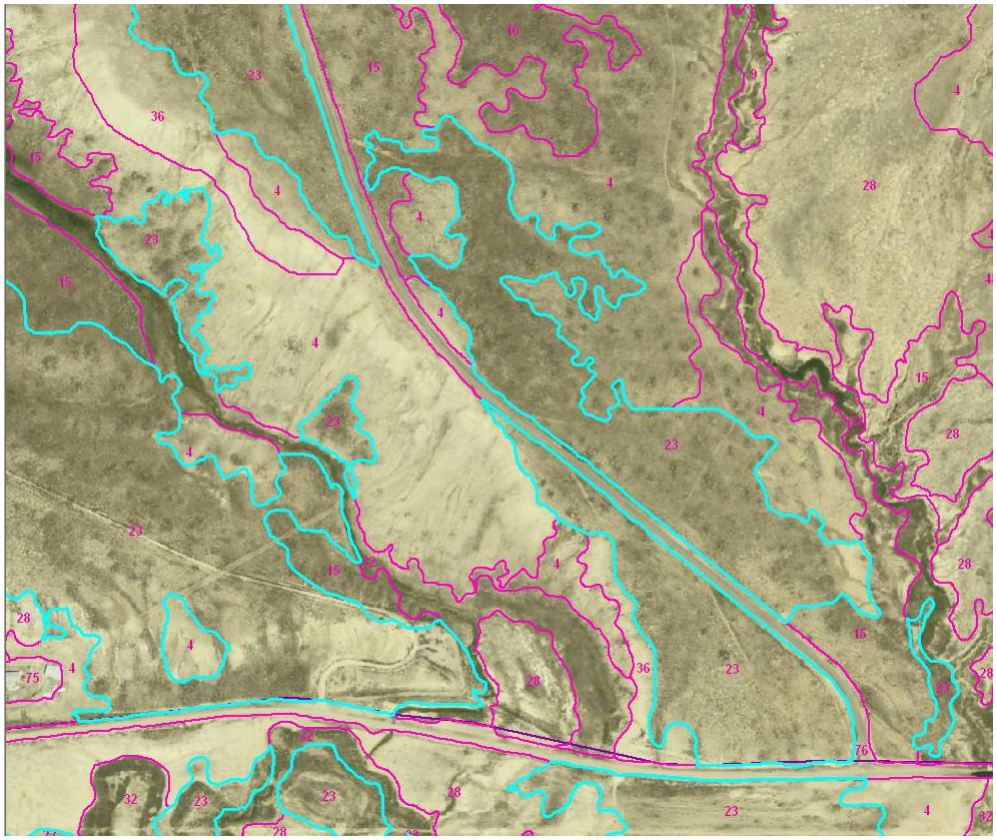


Distribution/Ecology/Composition
This is the common big sagebrush community covering hills and flats at and below the approximate elevation of the monument visitor center in the southwest corner of FOBU. Stands have between 10 and 35% Wyoming big sagebrush cover, and the most common associated shrub is yellow rabbitbrush. The understory is variable; in some stands, grasses including bluebunch wheatgrass, curly bluegrass, streamside wildrye, or

Great Basin wildrye may dominate the often sparse herbaceous layer. In other stands, forbs have more cover, especially species such as phlox, hollyleaf clover, and snakeweed.

Interpretation

The boundary between mountain big sagebrush and Wyoming big sagebrush communities was determined to be approximately at the elevation of the visitor center. In general, mountain big sagebrush communities were described above this elevation, with Wyoming big sagebrush communities dominating the slopes around and below the visitor center. The characteristic photosignature for both community types is a moderately rough-textured, gray green color. Polygons of this map class are generally medium-to-large in size, and regular to irregular in shape.



Example of photo signature for map class S-WYSA (#23).

Map Class 28
Saline Flat Shrublands (S-SASG)

Photo credits: NCPN

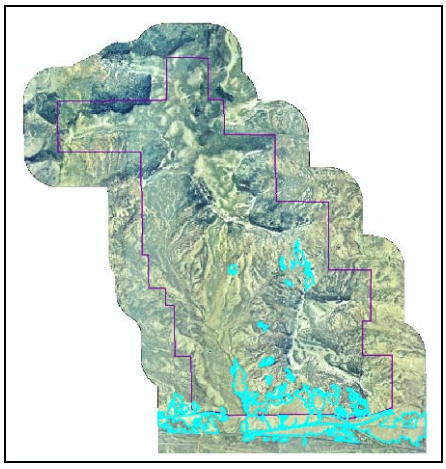
Associations
Atriplex confertifolia - Sarcobatus vermiculatus Shrubland
Sarcobatus vermiculatus / Artemisia tridentata Shrubland
Sarcobatus vermiculatus / Atriplex gardneri Shrubland

Common species
- *Artemisia arbuscula* ssp. *longifolia*
- *Atriplex confertifolia*
- *Sarcobatus vermiculatus*
- *Artemisia tridentata*
- *Atriplex gardneri*

S-SASG Map Class Statistics

Type:	Complex
Frequency:	53 total polygons
	26 polygons in FOBU
	27 polygons in the environs
Total project area:	325 hectares / 804 acres (5.2 %)
	117 hectares / 290 acres in FOBU
	208 hectares / 513 acres in the environs
Average Polygon Size:	6.1 hectares / 15.2 acres
Producer's accuracy:	76% ± 18%
User's accuracy:	89% ± 15%

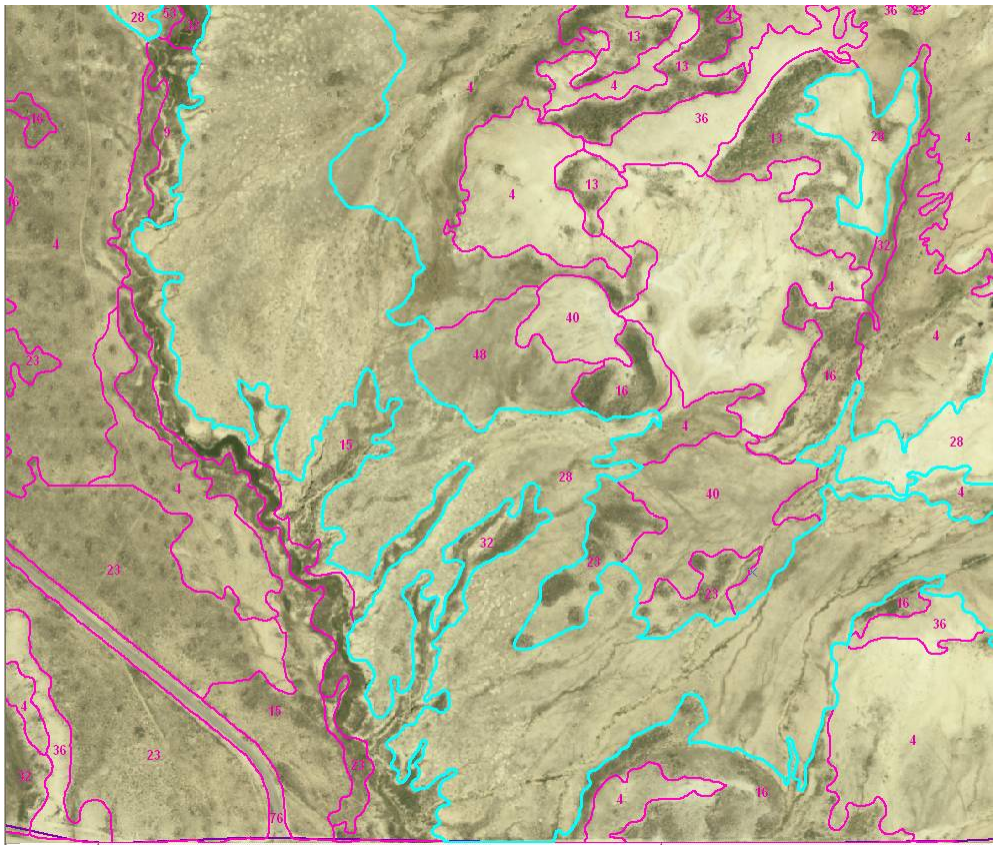
Distribution in Mapping Area



Distribution/Ecology/Composition
Stands of this map class are associated with the flats and low badlands of Smallpox, Chicken, and Twin creeks near the southern monument boundary. The soils are dense alkaline clays derived primarily from the Wasatch Formation. Black greasewood dominates these stands, with lesser cover provided by Wyoming big sagebrush, alkali sagebrush, shadscale, and winterfat. Bottlebrush squirreltail and curly bluegrass are the most consistent perennial herbaceous species.

Interpretation

This common map class occupies saline or alkaline bottomland sites in southern portion of the monument, especially along Smallpox Creek. A sparse form of the type occurs on clay badlands. The photosignature is a distinctive, fairly light gray green, with faint speckling representing the small shrubs visible under magnification. The low vegetative cover means that the primary color is that of the underlying substrate.



Example of photo signature for map class S-SASG (#28).

Map Class 29
Shadscale – Cliff Sparse Shrubland (S-SHCL)

Photo credits: NCPN

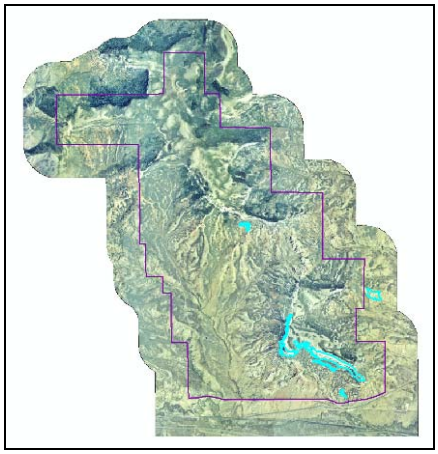
Associations
Atriplex confertifolia Wyoming Basins Shrubland

Common species
- *Atriplex confertifolia*
- *Krascheninnikovia lanata*

S-SHCL Map Class Statistics

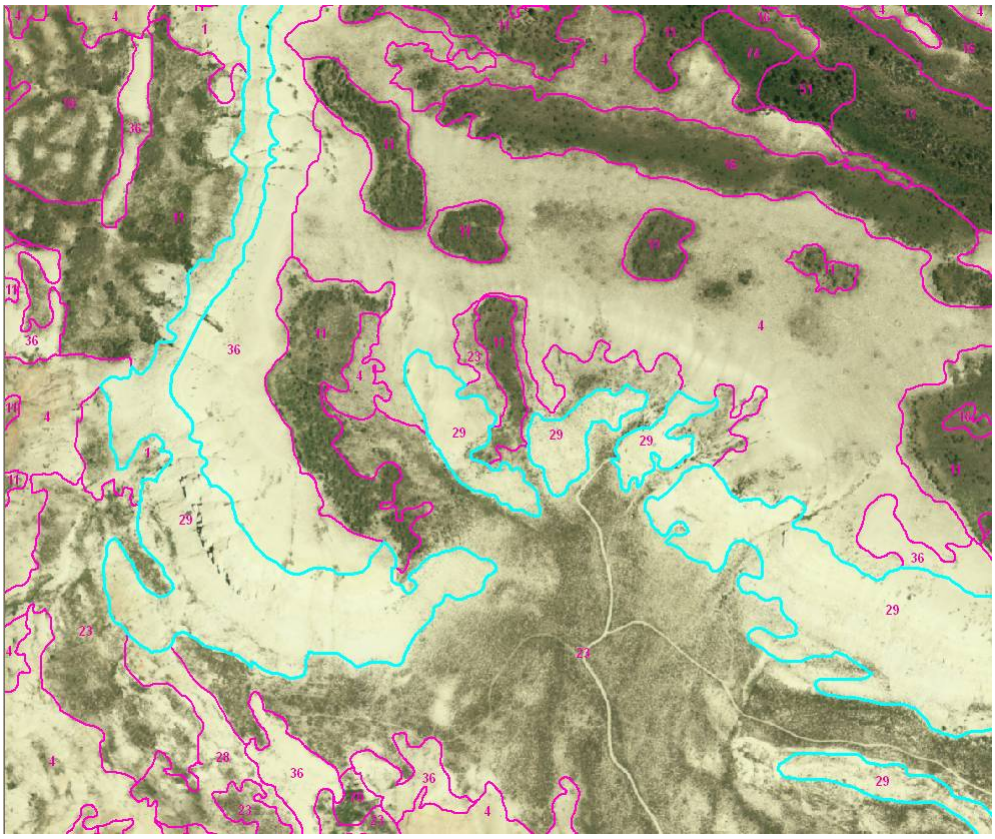
Type:	Association
Frequency:	9 total polygons
	8 polygons in FOBU
	1 polygons in the environs
Total project area:	40 hectares / 99 acres (0.6 %)
	35 hectares / 86 acres in FOBU
	5 hectares / 13 acres in the environs
Average Polygon Size:	4.5 hectares / 11 acres
Producer's accuracy:	92% ± 16%
User's accuracy:	92% ± 16%

Distribution in Mapping Area



Distribution/Ecology/Composition
This unusual community is restricted to extremely steep slopes on Fossil Butte with little soil development. Shadscale, rooted in cracks in the shale, provides a very sparse shrub canopy, sometimes as little as a few percent. Only two stands were sampled because most are on slopes too steep to traverse safely and without potential damag to fossils. The herbaceous species in this community are also sparse, and are generally those species typical of shale exposures, including shortstem buckwheat, fringed sage, and Great Basin wildrye.

Interpretation
This uncommon map class is restricted to steep, cliffy shale exposures. Vegetation is extremely sparse; therefore the dominant photosignature is the light gray color of the substrate.



Example of photo signature for map class S-SHCL (#29).

Map Class 33
Martin's Buckbrush Shrubland (S-CEMA)

Photo credits: NCPN

Associations
Ceanothus martinii Shrubland

Common species
- *Amelanchier utahensis*
- *Cercocarpus montanus*
- *Ceanothus martinii*
- *Achnatherum hymenoides*

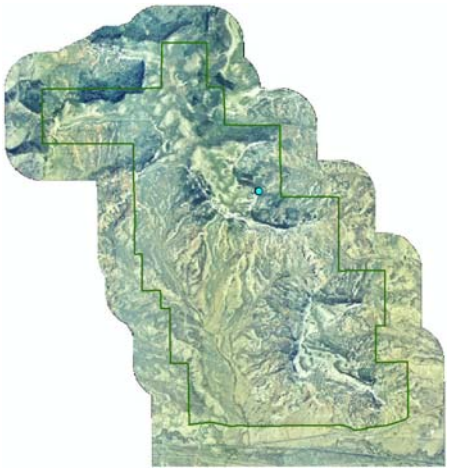
S-CEMA Map Class Statistics

Type: Association
Frequency: 1 plot, no polygons

Total project area: N/A

Average Polygon Size: N/A
Producer's accuracy: N/A
User's accuracy: N/A

Distribution in Mapping Area



Distribution/Ecology/Composition
This extremely rare community is a variant on the mixed mountain shrubland that is common on rocky upper ridge slopes. The shrub layer contains Martin's buckbrush in addition to the more common mountain mahogany and Utah serviceberry. Canopy cover is sparse on this steep, unstable slope. Although there are many species in the understory, few have more than trace cover.

Interpretation
This map class exists as a single plot in a stand too small to map as its own polygon.

Map Class 63
Chokecherry Shrubland (S-PRVI)

Photo credits: NCPN

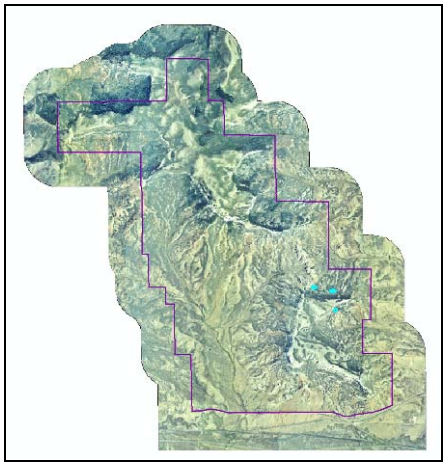
Associations
Prunus virginiana - (Prunus americana) Shrubland

Common species
- *Amelanchier utahensis*
- *Symphoricarpos oreophilus*
- *Prunus virginiana*
- *Leymus cinereus*

S-PRVI Map Class Statistics

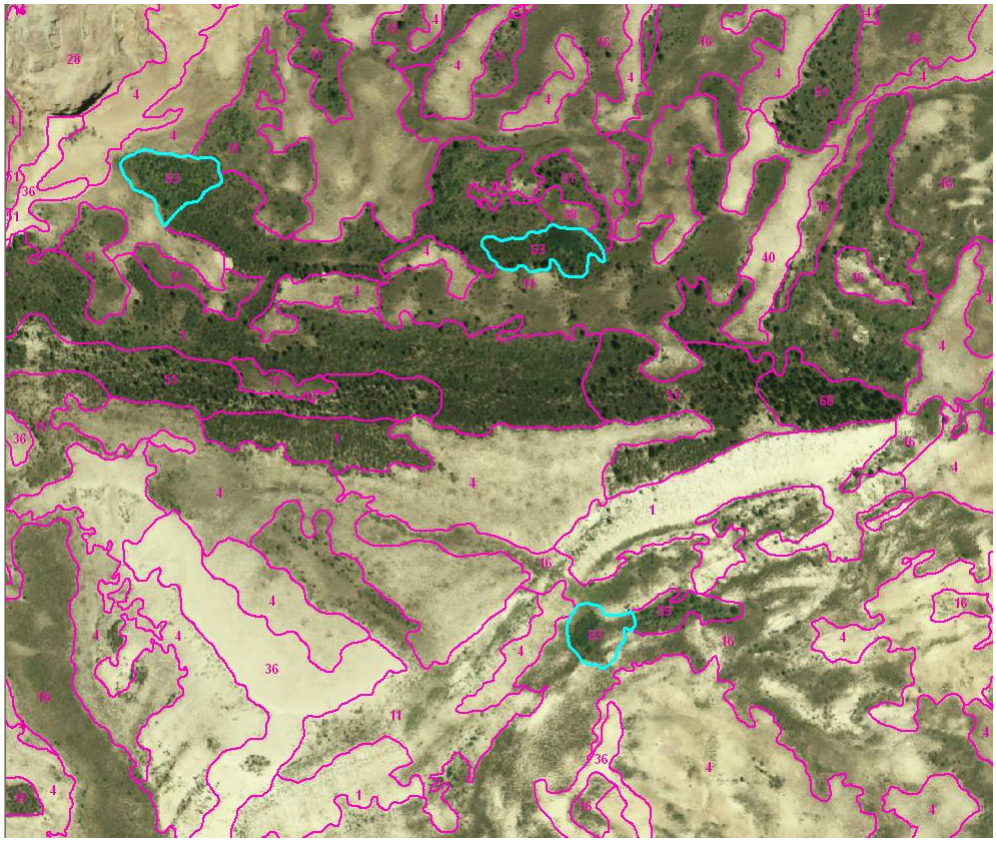
Type:	Association
Frequency:	3 total polygons
	3 polygons in FOBU
	0 polygons in the environs
Total project area:	2 hectares / 4 acres (<0.1 %)
	2 hectares / 4 acres in FOBU
	0 hectares / 0 acres in the environs
Average Polygon Size:	0.5 hectares / 1.3 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area



Distribution/Ecology/Composition
This map class is designed to highlight the presence of dense thickets of chokecherry, which have particular value to wildlife. All stands are associated with cool, mesic sites, often within quaking aspen forests or mixed mountain shrublands, with a few isolated stands associated with groundwater seepage. Few understory species can compete with the chokecherry except for the occasional Utah serviceberry and forbs.

Interpretation
This rare community type most often occurs as small patches within quaking aspen stands and mixed mountain shrublands. It is usually associated with seeps. The signature is difficult to differentiate from that of serviceberry – dark, slightly rough irregular green dots or patches. This map class was mapped only where it was documented by ground data or field observations. It is limited to three small stands.



Example of photo signature for map class S-PRVI (#63).

Map Class 69
Bitterbrush Shrubland (S-PUTR)

Photo credit: NCPN

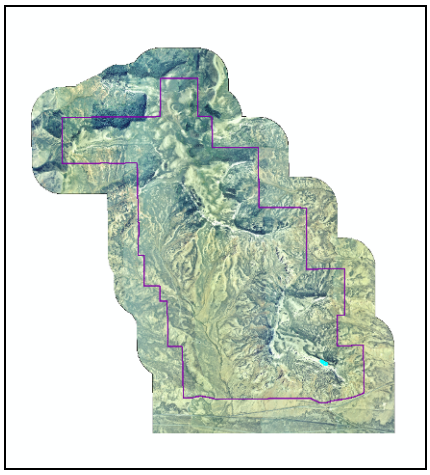
Associations
Purshia tridentata / Pteryxia terebinthina Shrubland

Common species
- *Amelanchier utahensis*
- *Purshia tridentata*
- *Eriogonum brevicaule*
- *Chrysothamnus viscidiflorus*
- *Achnatherum hymenoides*
- *Pteryxia terebinthina*

S-PUTR Map Class Statistics

Type:	Association
Frequency:	1 total polygons
	1 polygons in FOBU
	0 polygons in the environs
Total project area:	1.1 hectares / 2.8 (<0.1 %)
	1.1 hectares / 2.8 in FOBU
	0 hectares / 0 acres in the environs
Average Polygon Size:	1.1 hectares / 2.8 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

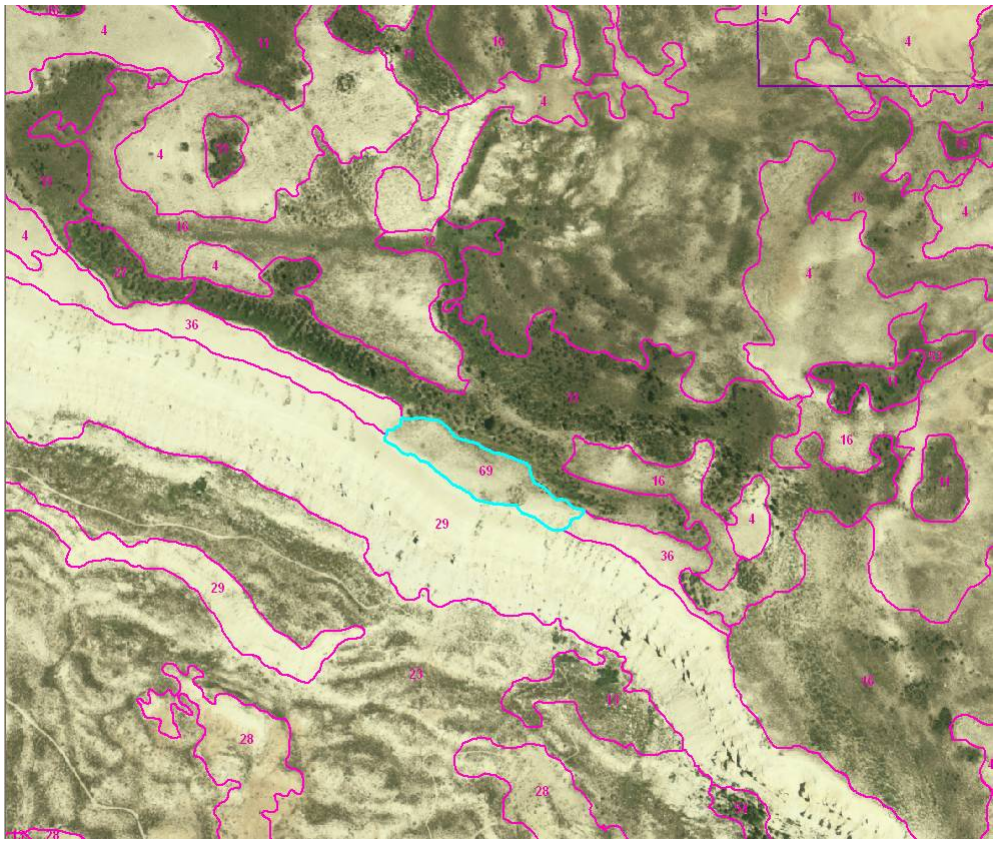
Distribution in Mapping Area



Distribution/Ecology/Composition
Bitterbrush is a common element of both mountain big sagebrush and mountain mahogany-serviceberry shrublands throughout the higher elevations of the monument. As a distinct community, bitterbrush shrublands are extremely rare at FOBU. Bitterbrush dominates a sparse shrubland with scattered Utah serviceberry growing near the southern rim of Fossil Butte. The substrate is rocky and sandy, and is exposed to high winds that rake the rim. The herbaceous layer is also sparse, and includes species typical of these exposed shale rims: rockloving wavewing, shortstem buckwheat, and species of ricegrass.

Interpretation

This map class was mapped only where it was documented by ground data or field observations. It is limited to a single, small stand.



Example of photo signature for map class S-PUTR (#69).

Map Class 74
Mountain Snowberry Shrubland (S-SYOR)

Photo credit: NCPN

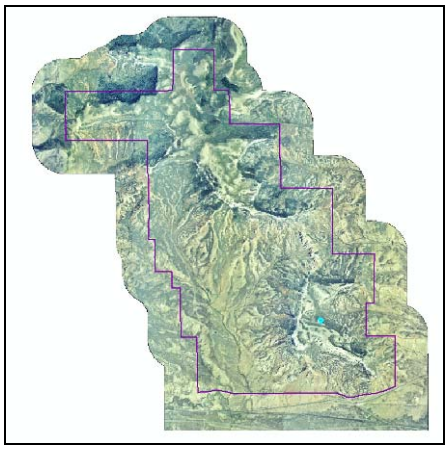
Associations
Symphoricarpos oreophilus Shrubland

Common species
- *Symphoricarpos oreophilus*

S-SYOR Map Class Statistics

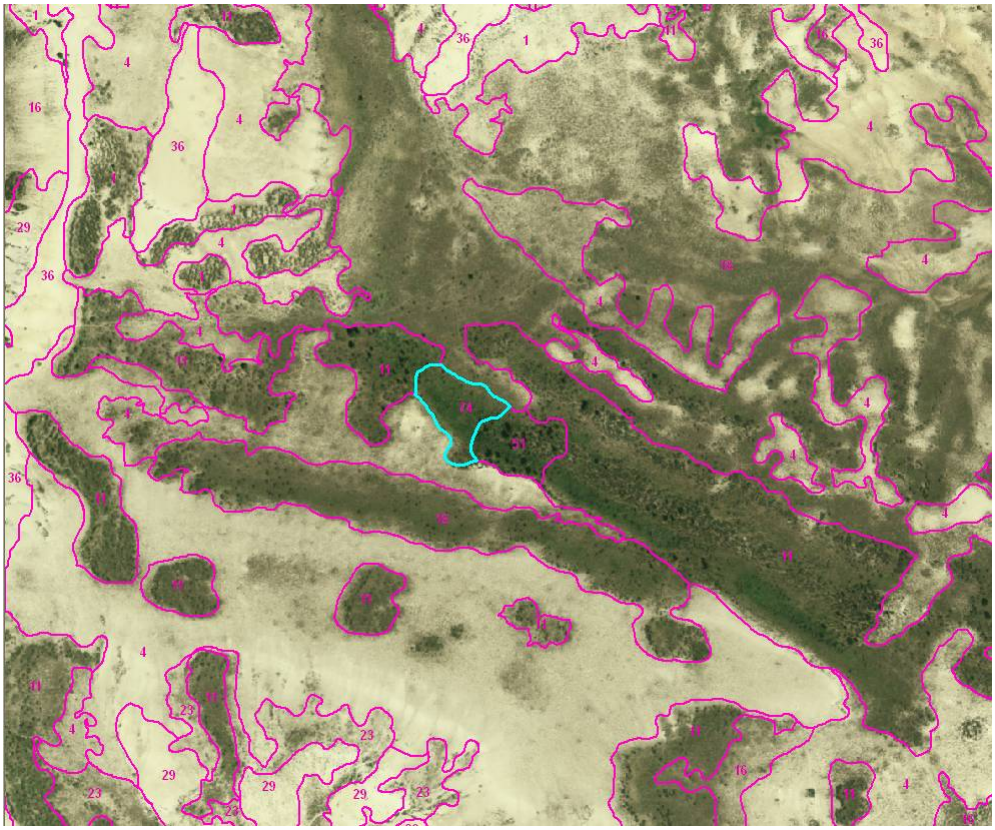
Type:	Association
Frequency:	1 total polygons
	1 polygons in FOBU
	0 polygons in the environs
Total project area:	0.7 hectares / 1.6 acres (<0.1 %)
	0.7 hectares / 1.6 acres in FOBU
	0 hectares / 0 acres in the environs
Average Polygon Size:	0.7 hectares / 1.6 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area



Distribution/Ecology/Composition
This map class represents an extremely rare community type that occurs on north-facing slump benches. The known stand is in a mosaic with stands of chokecherry, mountain big sagebrush, and serviceberry. The understory in this community is diverse, but no species has more than trace cover.

Interpretation
This map class was mapped only where it was documented by ground data or field observations. It is limited to a single, small stand.



Example of photo signature for map class S-SYOR (#74).

Upland Herbaceous Communities

Map Class 27
Snow Glade (H-SNOW)

Photo credits: NCPN

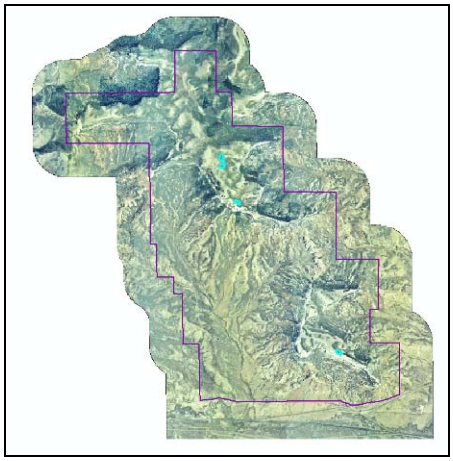
Associations
Symphyotrichum foliaceum Glade Herbaceous Vegetation

Common species
- *Achillea millefolium*
- *Symphyotrichum foliaceum*
- *Gayophytum ramosissimum*

H-SNOW Map Class Statistics

Type:	Association
Frequency:	3 total polygons
	3 polygons in FOBU
	0 polygons in the environs
Total project area:	4 hectares / 9 acres (0.1 %)
	4 hectares / 9 acres in FOBU
	0 hectares / 0 acres in the environs
Average Polygon Size:	1.2 hectares / 3.1 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

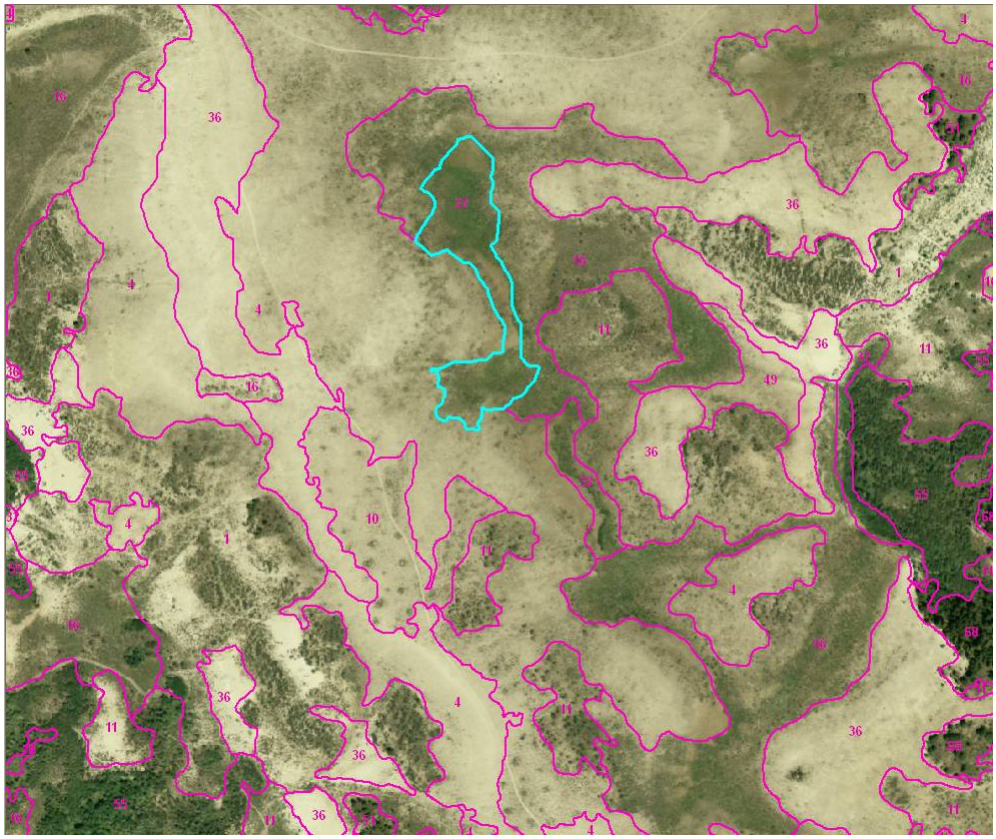
Distribution in Mapping Area



Distribution/Ecology/Composition
This map class describes a community type similar in setting to the rockloving wavewing meadow described below. It occupies "snow glades", which are depressional areas just downwind of windswept ridgelines and thus are hollows that collect drifting snow. A variety of forbs and grasses occur with the alpine leafybract aster.

Interpetation

This map class was mapped only where it was documented by ground data or field observations. It is limited to three small stands.



Example of photo signature for map class H-SNOW (#27).

Map Class 36
Windswept Ridge Complex (C-WIND)

Photo credits: NCPN

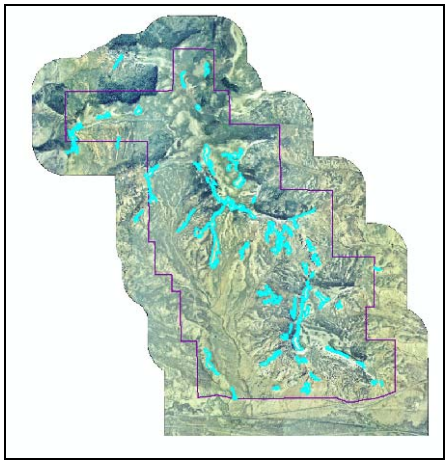
Associations
Cushion Plants Sparse Shale Vegetation
Eriogonum brevicaule - Cushion Plants Herbaceous Vegetation
Krascheninnikovia lanata / Achnatherum hymenoides Dwarf-shrubland
Krascheninnikovia lanata / Poa secunda Dwarf-shrubland
Pseudoroegneria spicata Herbaceous Vegetation
Pseudoroegneria spicata - Cushion Plants Herbaceous Vegetation

Common species
- *Krascheninnikovia lanata*
- *Eriogonum brevicaule*
- *Pseudoroegneria spicata*
- *Astragalus spathulatus*
- *Poa fendleriana*
- *Poa secunda*

C-WIND Map Class Statistics

Type:	Complex/Mosaic
Frequency:	C-WIND 65 polygons in FOBU 15 polygons in the environs
Total project area:	131 hectares / 323 acres (2.1 %) 124 hectares / 306 acres in FOBU 7 hectares / 16 acres in the environs
Average Polygon Size:	1.6 hectares / 4 acres
Producer's accuracy:	85% ± 16%
User's accuracy:	77% ± 17%

Distribution in Mapping Area

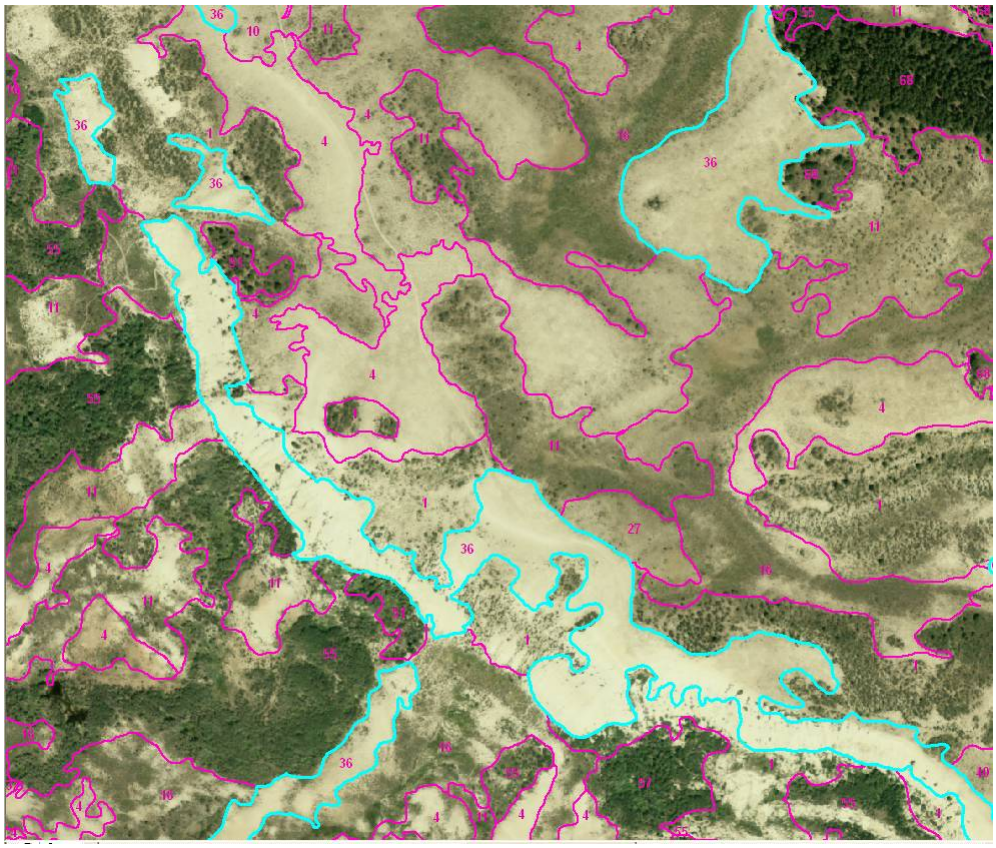


Distribution/Ecology/Composition
This map class represents a group of associations that occur in a mosaic on the most exposed summits and windswept ridgelines. In growth form these communities resemble dry alpine tundra; the forbs tend to be cushion plants including shortstem buckwheat and phlox, and the grasses are small, tough bunchgrasses including curly bluegrass and bluebunch wheatgrass. The soil is extremely shallow and rocky, which inhibits

the growth of most shrubs. The environmental conditions ensure that this community is stable over long periods, although it is extremely vulnerable to erosion if disturbed by slumping, grazing, roads, or recreation.

Interpretation

This map class is common at the higher elevations of the monument, but is restricted to slopes and ridgelines that are most exposed to the prevailing winds. The photosignature is a characteristic bright white color, occasionally with a few gray specks representing scattered shrubs.



Example of photo signature for map class C-WIND (#36).

Map Class 37
Turpentine Wavewing Meadow (H-PTTE)

Photo credit: NCPN

Associations
Pteryxia terebinthina Herbaceous Vegetation

Common species
- *Pteryxia terebinthina*
- *Elymus lanceolatus*
- *Achnatherum hymenoides*

H-PTTE Map Class Statistics

Type:	Association
Frequency:	Mapped as points, no polygons
Total project area:	N/A
Average Polygon Size:	N/A
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area

Distribution/Ecology/Composition
This unusual community type is known from two small stands on top of Fossil Butte. It is restricted to bowl-shaped depressions near the rim where snow collects. Soils are shallow and rocky, which likely limits shrub growth.

Interpretation
This map class was mapped as a point layer only using ground data or field observations.

Map Class 40
Streamside Wildrye Grassland (H-ELLA)

Photo credits: NCPN

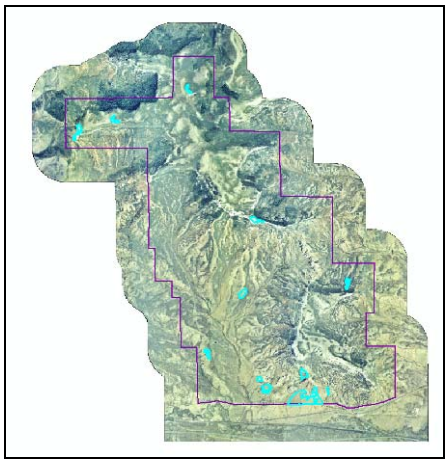
Associations
Elymus lanceolatus Herbaceous Vegetation

Common species
- *Chrysothamnus viscidiflorus*
- *Elymus lanceolatus*
- *Poa secunda*
- *Kraschenninnikovia lanata*
- *Phlox hoodii*

H-ELLA Map Class Statistics

Type:	Association
Frequency:	13 total polygons
	12 polygons in FOBU
	1 polygons in the environs
Total project area:	37 hectares / 90 acres (0.6 %)
	36 hectares / 88 acres in FOBU
	1 hectares / 2 acres in the environs
Average Polygon Size:	2.8 hectares / 6.9 acres
Producer's accuracy:	100%
User's accuracy:	90% ± 21%

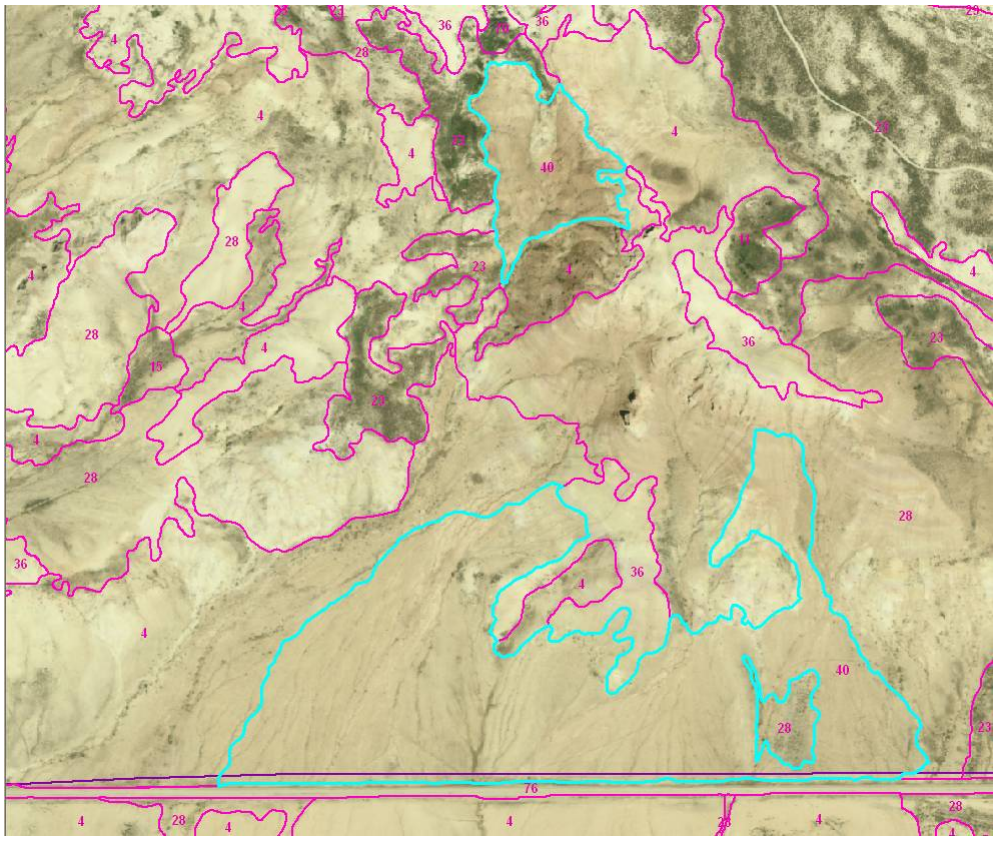
Distribution in Mapping Area



Distribution/Ecology/Composition
Streamside wildrye is a common understory element of many shrubland communities at FOBU, but it can also dominate herbaceous communities occurring below ridge or hill summits. These sites are not as exposed to the wind as the cushion plant communities, but they tend to be on the upwind side of these ridges, so they are also not sites where snow collects. Muttongrass, western wheatgrass, and curly bluegrass are other common grasses, and there is usually a variety of shrubs scattered throughout the community, especially alkali sagebrush, winterfat, and horsebrush. This grassland could potentially also develop in burned sagebrush stands that had a strong element of streamside wildrye in their understory.

Interpretation

This map class has two distinct photosignatures based on environmental setting. Stands on windward slopes have a similar photosignature to other sparsely vegetated grasslands at FOBU: generally smooth-textured and a light gray color (e.g., Ruby Point). A mesic community dominated by the same species occupies seeps and narrow drainages with a darker, smooth-textured signature.



Example of photo signature for map class H-ELLA (#40).

Map Class 48
Virginia Pepperweed Sparse Vegetation (H-LEVI)

Photo credits: NCPN

Associations
Lepidium virginicum Sparse Herbaceous Vegetation

Common species
- *Lepidium virginicum*
- *Trifolium gymnocarpon*
- *Elymus lanceolatus*

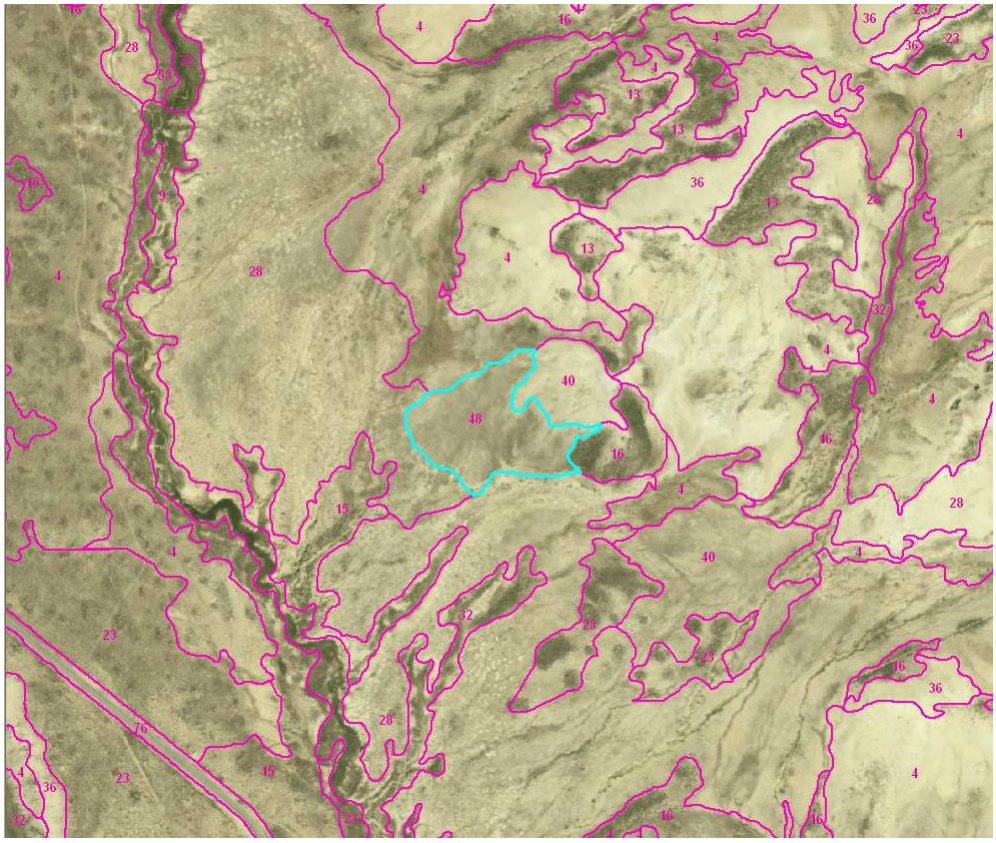
H-LEVI Map Class Statistics

Type:	Association
Frequency:	1 total polygons
	1 polygons in FOBU
	0 polygons in the environs
Total project area:	2 hectares / 5 acres (<0.1 %)
	2 hectares / 5 acres in FOBU
	0 hectares / 0 acres in the environs
Average Polygon Size:	2 hectares / 5 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area

Distribution/Ecology/Composition
Virginia pepperweed is an annual weedy mustard of disturbed sites. It dominates a small area near the southern boundary of the monument on an alkaline clay flat that may have been a bedding or feeding area for domestic livestock. Sheet erosion was reported in the plot data.

Interpretation
This map class was mapped only where it was documented by ground data or field observations. It is limited to a single, small stand.



Example of photo signature for map class H-LEVI (#48).

Map Class 49
Great Basin Wildrye Grassland (H-LECI)

Photo credits: NCPN

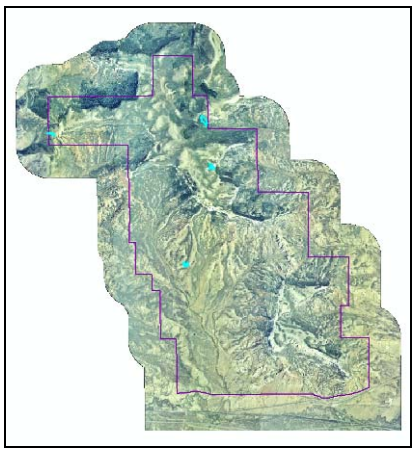
Associations
Leymus cinereus Herbaceous Vegetation

Common species
- *Artemisia tridentata* var. *vaseyana*
- *Symphoricarpos oreophilus*
- *Chrysothamnus viscidiflorus*
- *Leymus cinereus*

H-LECI Map Class Statistics

Type:	Association
Frequency:	5 total polygons
	4 polygons in FOBU
	1 polygons in the environs
Total project area:	4 hectares / 9 acres (0.1 %)
	4 hectares / 9 acres in FOBU
	0 hectares / 0 acres in the environs
Average Polygon Size:	0.7 hectares / 1.8 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

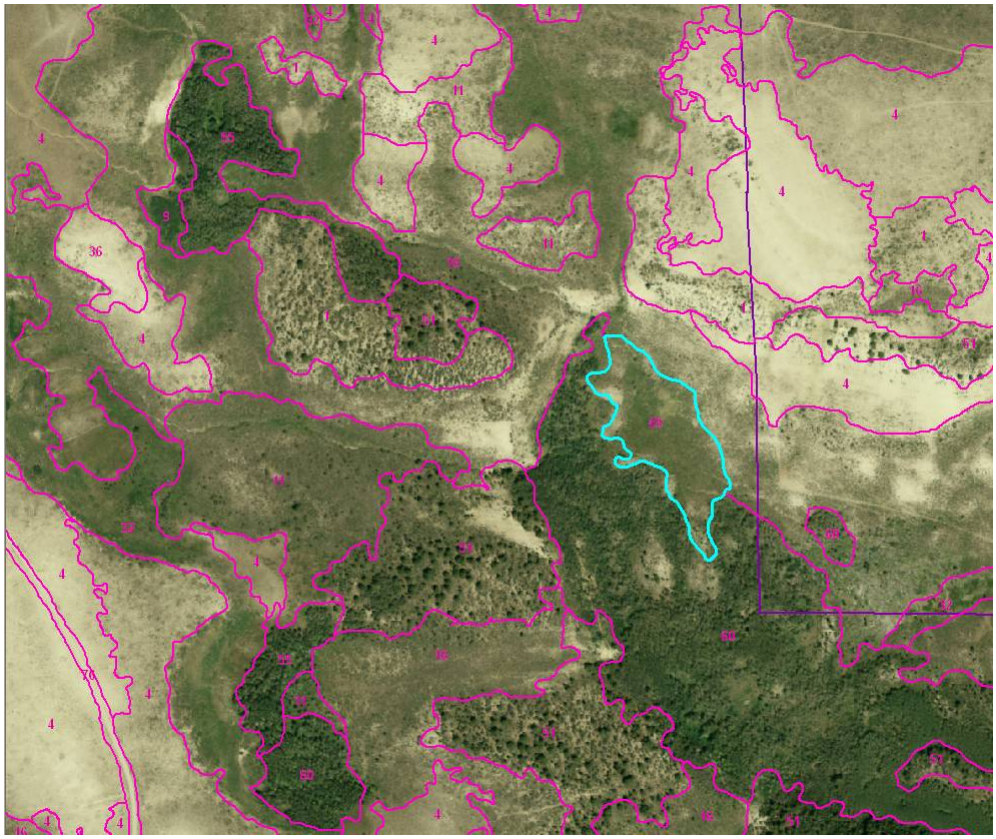
Distribution in Mapping Area



Distribution/Ecology/Composition
This community type is restricted to sheltered areas with groundwater near the surface, but which are generally not saturated throughout the growing season. Great Basin wildrye is very susceptible to grazing. It tends to disappear from heavily grazed sites or those in which the water table has been lowered beyond its rooting zone. No large stands of Great Basin wildrye remain at FOBU; only small stands (<<MMU) associated with groundwater seepage, or near the heads of tributary drainages where stream incision has not yet lowered the water table. A few stands occur on sheltered north- or east-facing slopes that also collect snow. This tall bunchgrass persists with low cover in many sagebrush stands throughout the Monument; if these stands were to experience a relatively cool burn, the cover of Great Basin wildrye is likely to increase.

Interpretation

This map class occurs in small (<minimum map unit), narrow to regular polygons. Most polygons tend to be small inclusions in other types and are generally associated with high groundwater tables or seeps. The characteristic photosignature is the stippled texture created by the large bunches of Great Basin wildrye, and ranges from light brown to dark green in color. This map class is mapped only where it was documented by ground data or field observations.



Example of photo signature for map class H-LECI (#49).

Woody Wetlands

Map Class 9
Silver Sagebrush Wet Meadow (S-ARCA)

Photo credits: NCPN

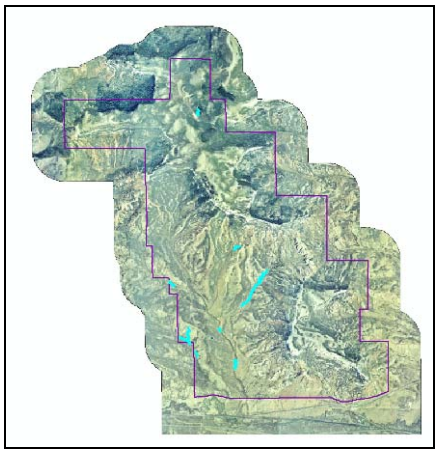
Associations
Artemisia cana / Juncus balticus Shrubland

Common species
- *Artemisia cana*
- *Juncus balticus*

S-ARCA Map Class Statistics

Type:	Association
Frequency:	10 total polygons 8 polygons in FOBU 2 polygons in the environs
Total project area:	8 hectares / 20 acres (0.1 %) 8 hectares / 19 acres in FOBU hectares / acres in the environs
Average Polygon Size:	0.8 hectares / 2 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

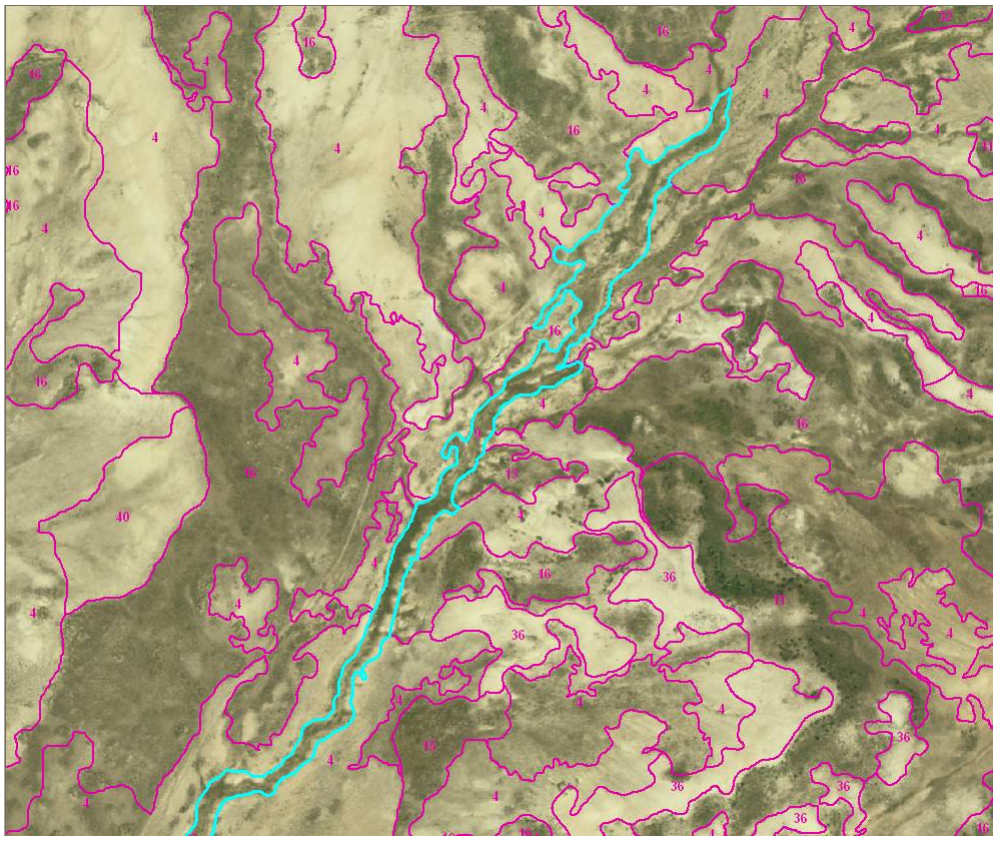
Distribution in Mapping Area



Distribution/Ecology/Composition
This is the most common shrubland in swales and minor drainages throughout the monument. Most of the documented stands are located in the Chicken Creek drainage, with a few occurrences on slump benches near The Bullpen. The community commonly occurs within a mosaic of wet meadow types, including Baltic rush or sedge stands. Exotic or disturbance-tolerant species generally dominate the herbaceous layer, including Baltic rush, Kentucky bluegrass, Canada thistle, and yellow sweetclover. Less-disturbed stands have an understory that includes tufted hairgrass, starry false Solomon's-seal, clustered field sedge, and Great Basin wildrye.

Interpretation

This map class occurs in swales and drainage bottoms and was mapped only where known to occur from ground data or field observations. The characteristic photosignature is a relatively smooth-textured (from the high shrub cover), silver green color. Most polygons are small and linear-to-elongated in shape.



Example of photo signature for map class S-ARCA (#9).

Map Class 38
Shrubby Cinquefoil Shrubland (S-DAFR)

Photo credit: NCPN

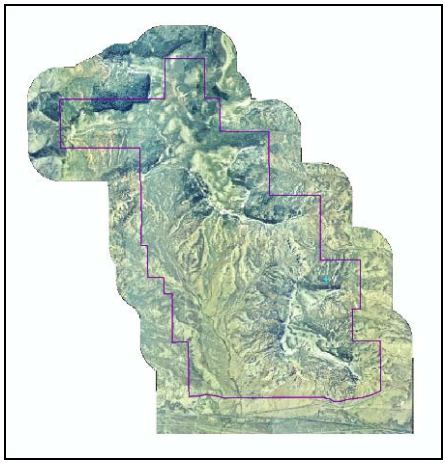
Associations
Dasiphora fruticosa ssp. *floribunda* Shrubland

Common species
- *Dasiphora fruticosa* ssp. *floribunda*
- *Juncus balticus*

S-DAFR Map Class Statistics

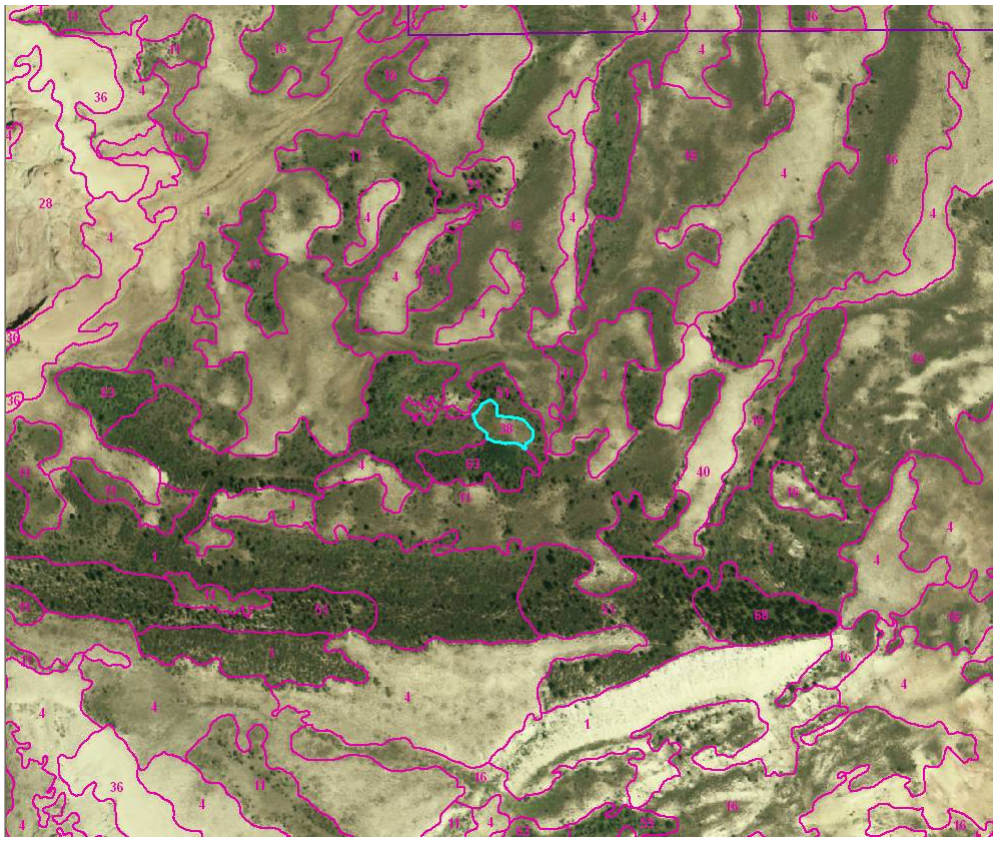
Type:	Association
Frequency:	1 total polygons 1 polygons in FOBU 0 polygons in the environs
Total project area:	0.2 hectares / 0.5 acres (<0.1 %) 0.2 hectares / 0.5 acres in FOBU 0 hectares / 0 acres in the environs
Average Polygon Size:	0.2 hectares / 0.5 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area



Distribution/Ecology/Composition
Shrubby cinquefoil is a wet meadow species that tolerates both a drop in the water table and disturbance caused by activities such as heavy grazing. A meadow community dominated by this shrub is therefore likely to be somewhat degraded in function and depauperate in composition. The documented stand was observed on a slump bench on the north slope of Fossil Butte. Shrubby cinquefoil provides about 25% cover and Baltic rush dominates the herbaceous layer.

Interpretation
This map class is restricted to one small patch mapped where it was documented by field data. It lacks a characteristic photosignature.



Example of photo signature for map class S-DAFR (#38).

Map Class 54
Narrowleaf Cottonwood Woodland (W-POAN)

Photo credits: NCPN

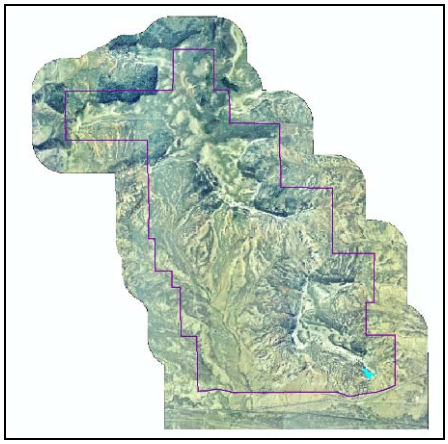
Associations
Populus angustifolia / Leymus cinereus Woodland

Common species
- *Artemisia tridentata* ssp. *tridentata*
- *Aster glaucodes*
- *Populus angustifolia*
- *Leymus cinereus*

W-POAN Map Class Statistics

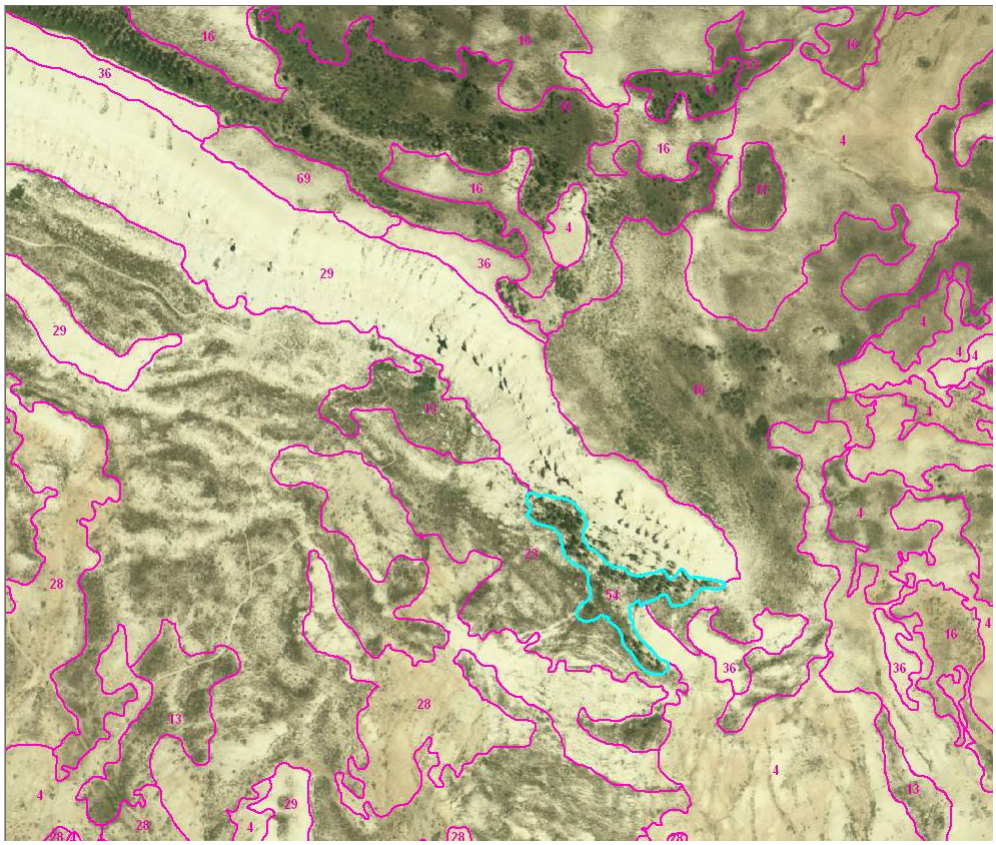
Type:	Association
Frequency:	1 total polygons
	1 polygons in FOBU
	0 polygons in the environs
Total project area:	1.2 hectares / 2.9 acres (<0.1 %)
	1.2 hectares / 2.9 acres in FOBU
	0 hectares / 0 acres in the environs
Average Polygon Size:	1.2 hectares / 2.9 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area



Distribution/Ecology/Composition
This community is restricted to a spring-fed slump topography on the southeast face of Fossil Butte. Because of natural soil movement, stands include both mature trees as well as seedlings and saplings. Although the canopy is open, the understory is somewhat sparse in cover and diverse in composition. Utah serviceberry and Great Basin wildrye are the most consistent native species. The presence of upland species including basin big sagebrush and limber pine suggest the presence of several seeps with dry areas between or recent shifts in the sites where groundwater emerges.

Interpretation
This map class is restricted to seeps on the shoulder of Fossil Butte. The photosignature is characteristic of open cottonwood stands; the tree crowns are large, distinct, raggedly circular, medium-to-dark green spots. This map class is restricted to a single polygon mapped where it was documented by field data.



Example of photo signature for map class W-POAN (#54).

Map Class 70
Yellow Willow Shrubland (S-SALU)

Photo credits: NCPN

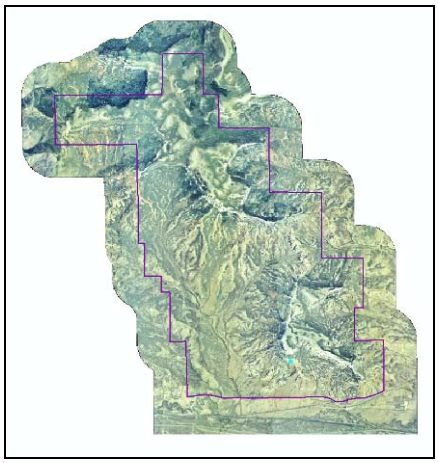
Associations
Salix lutea / Leymus cinereus Shrubland

Common species
- *Salix lutea*
- *Maianthemum stellatum*
- *Achillea millefolium*
- *Leymus cinereus*

S-SALU Map Class Statistics

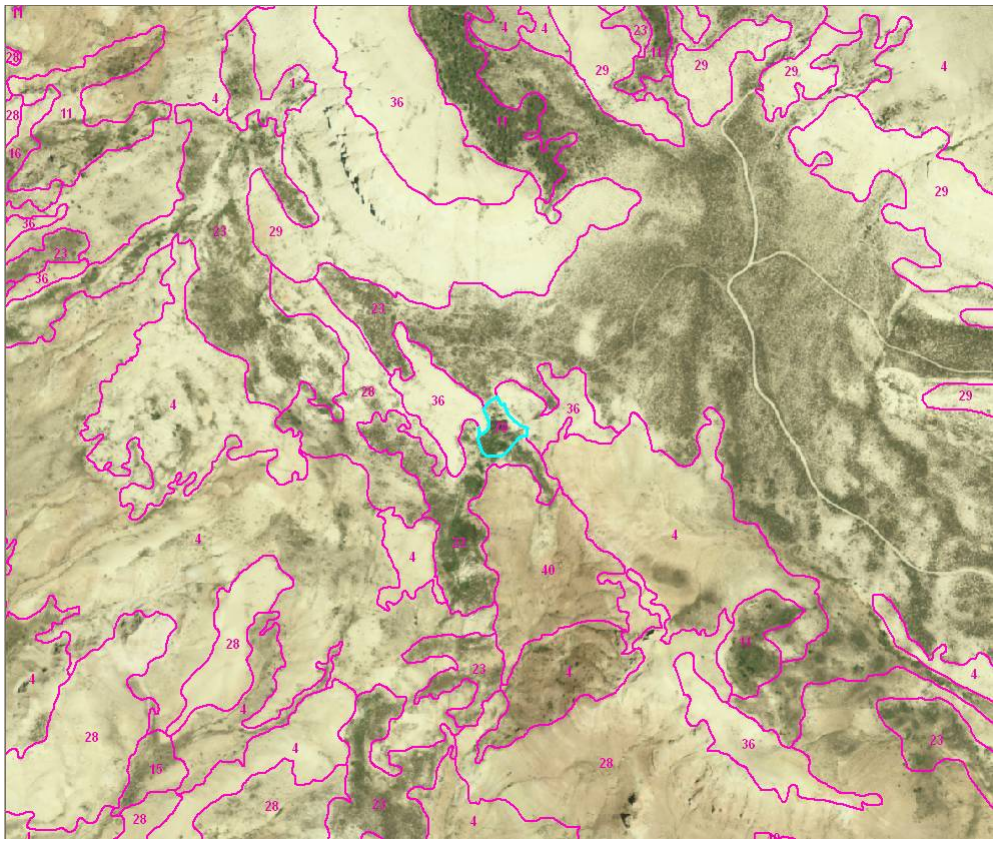
Type:	Association
Frequency:	1 total polygons
	1 polygons in FOBU
	0 polygons in the environs
Total project area:	0.2 hectares / 0.6 acres (<0.1 %)
	0.2 hectares / 0.6 acres in FOBU
	0 hectares / 0 acres in the environs
Average Polygon Size:	0.2 hectares / 0.6 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area



Distribution/Ecology/Composition
This unique community occupies a slump bench kept moist by groundwater emerging from the slopes of Fossil Butte and adjacent ridges. The small stands (<MMU) are inclusions in a Wyoming big sagebrush stand. Most are too small to map. Yellow willow forms small, dense thickets. The understory is dominated by Great Basin wildrye.

Interpretation
This map class was mapped only where known to occur from field data. As a mapping unit, it is limited to a single, small stand. Small clumps are scattered throughout the wetter slumps on the slopes of Fossil Butte.



Example of photo signature for map class S-SALU (#70).

Map Class 71
Scouler Willow Shrubland (S-SASC)

Photo credit: NCPN

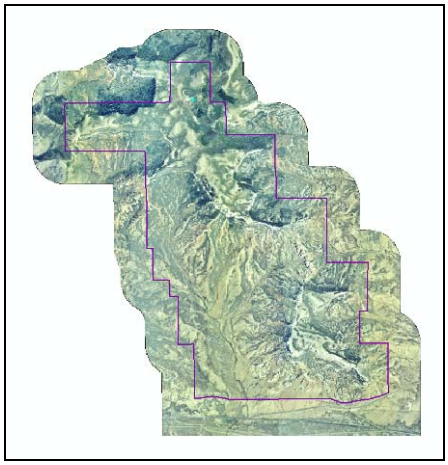
Associations
Salix scouleriana Shrubland

Common species
- *Salix scouleriana*
- *Calamagrostis canadensis*
- *Osmorhiza chilensis*
- *Symphoricarpos oreophilus*
- *Melica bulbosa*

S-SASC Map Class Statistics

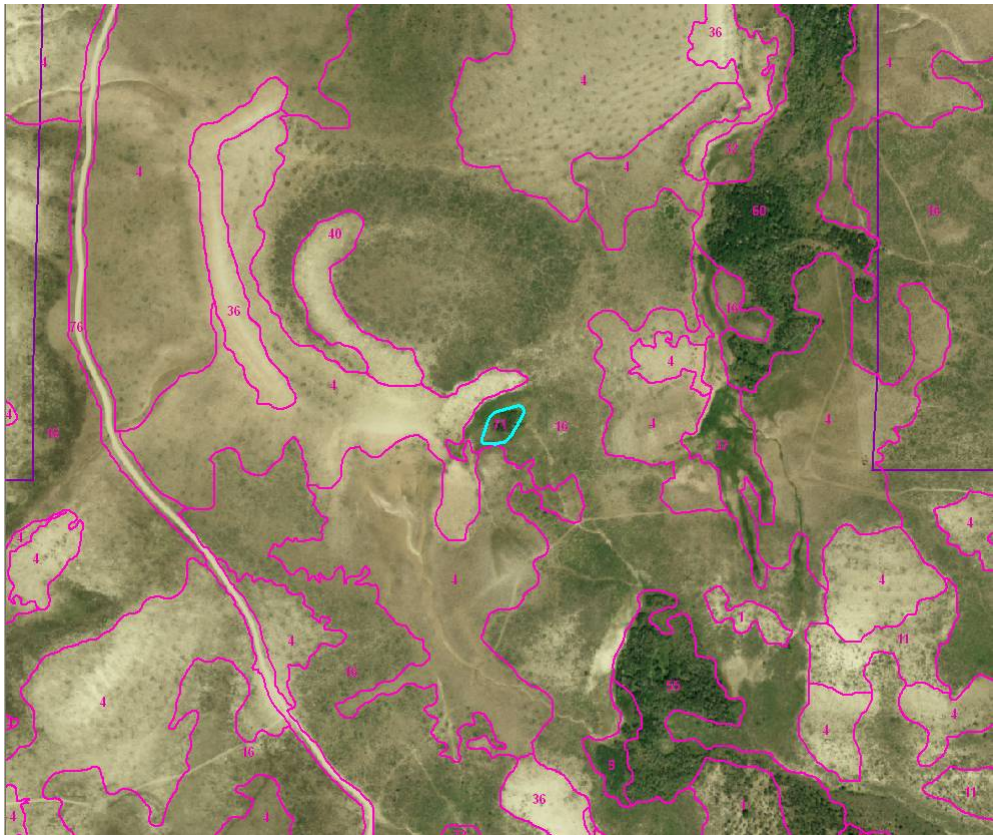
Type:	Association
Frequency:	1 total polygons
	1 polygons in FOBU
	0 polygons in the environs
Total project area:	0.1 hectares / 0.4 acres (<0.1 %)
	0.1 hectares / 0.4 acres in FOBU
	0 hectares / 0 acres in the environs
Average Polygon Size:	0.1 hectares / 0.4 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area



Distribution/Ecology/Composition
The single stand of this community documented from FOBU is located immediately below The Bullpen summit. It occupies a slump bench at the site of a spring that keeps the slope moist and unstable. The community is a near monoculture of Scouler willow clumps with a dense herbaceous understory dominated by bluejoint reedgrass. Quaking aspen occurs near the margins of the stand.

Interpretation
This map class was mapped only where it was documented by ground data or field observations. It is limited to a single, small stand.



Example of photo signature for map class S-SASC (#71).

Herbaceous Wetlands

Map Class 32
Wet Meadow Herbaceous (H-JUBA)

Photo credits: NCPN

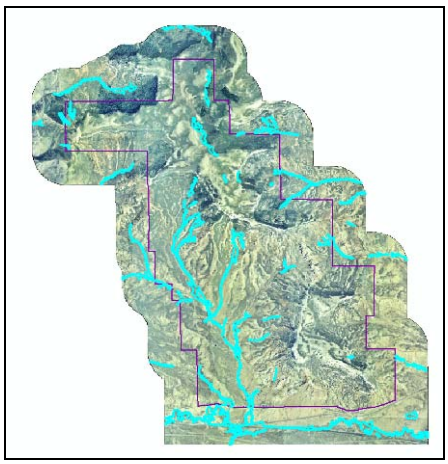
Associations
Carex nebrascensis Herbaceous Vegetation
Juncus balticus Herbaceous Vegetation

Common species
- *Artemisia cana*
- *Juncus balticus*
- *Carex nebrascensis*
- *Hordeum brachyantherum*

H-JUBA Map Class Statistics

Type:	Complex
Frequency:	74 total polygons
	32 polygons in FOBU
	42 polygons in the environs
Total project area:	189 hectares / 467 acres (3 %)
	85 hectares / 209 acres in FOBU
	104 hectares / 258 acres in the environs
Average Polygon Size:	2.6 hectares / 6.3 acres
Producer's accuracy:	82% ± 23%
User's accuracy:	100%

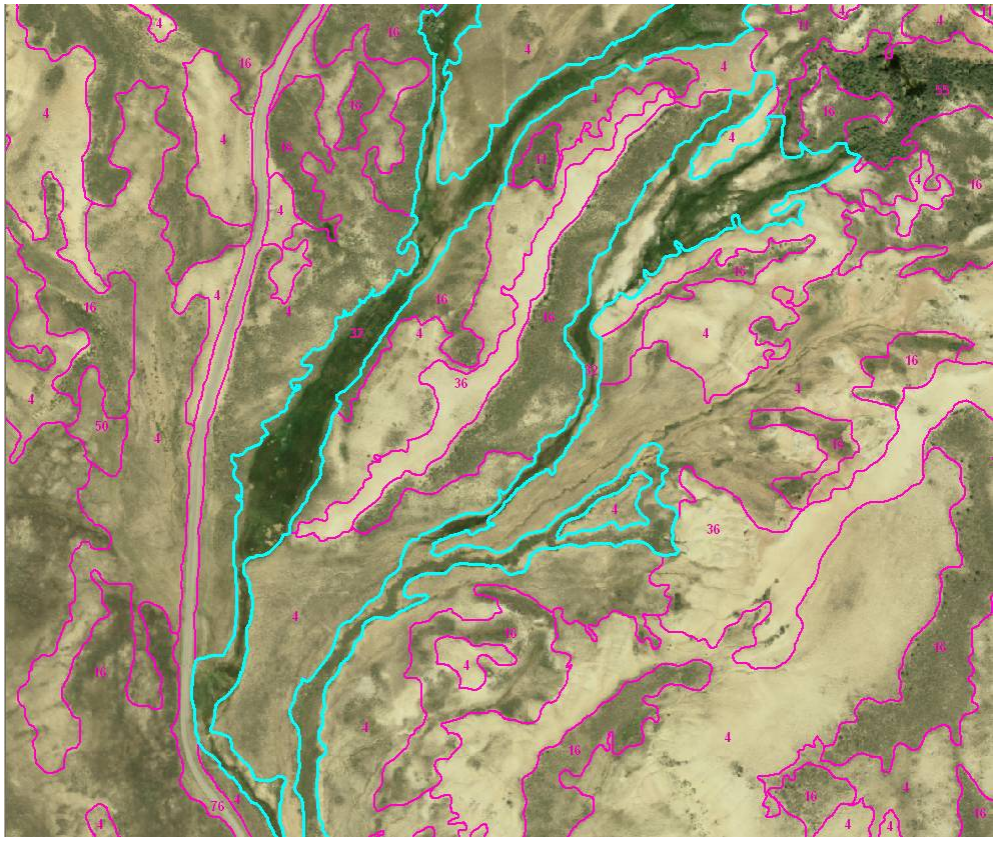
Distribution in Mapping Area



Distribution/Ecology/Composition
This is the most common vegetation community in swales and minor drainages throughout the monument. Baltic rush is tolerant of both a drop in the water table and heavy surface disturbance by historic grazing. If dominant, it usually marks the location of degraded wetland communities. Stands at FOBU occupy the bottoms of swales and drainages, as well as slopes below springs. Small inclusions of silver sagebrush (*Artemisia cana*) shrublands (too small to pull out separately) may be mixed in with stands of rush and sedge.

Interpretation

This map class was delineated along all major and minor creeks and drainages in the monument, including Smallpox Creek, Chicken Creek, Twin Creek, Morgan Canyon, and several unnamed drainages. It occurs in the wettest portions of drainages, swales, and bottomlands in the monument and environs. The photosignature is a characteristically very dark green color, and the polygons are generally long, narrow, and smooth-textured.



Example of photo signature for map class H-JUBA (#32).

Map Class 39
Marsh Spikerush Wetland (H-ELPA)

Photo credit: NCPN

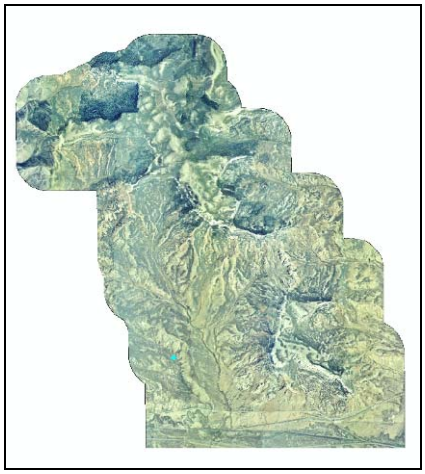
Associations
Eleocharis palustris Herbaceous Vegetation

Common species
- *Eleocharis palustris*

H-ELPA Map Class Statistics

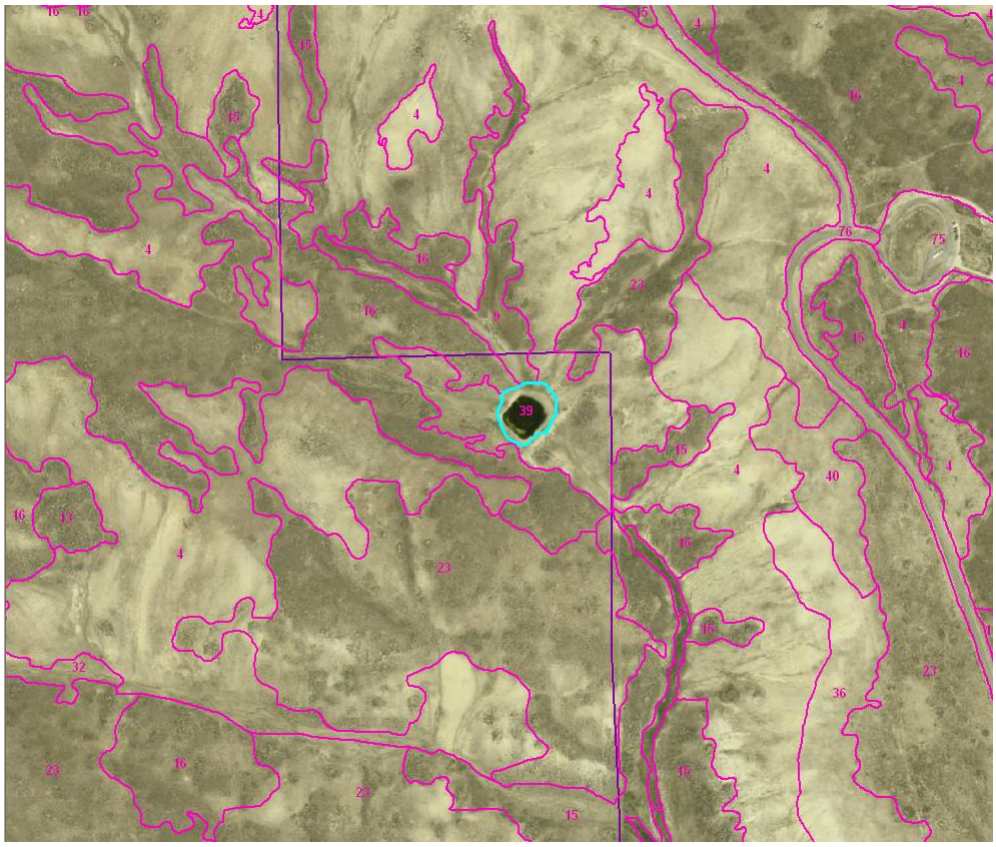
Type:	Association
Frequency:	1 total polygons
	0 polygons in FOBU
	1 polygons in the environs
Total project area:	0.4 hectares / 1 acres (<0.1 %)
	0 hectares / 0 acres in FOBU
	0.4 hectares / 1 acres in the environs
Average Polygon Size:	0.4 hectares / 1 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area



Distribution/Ecology/Composition
This rare type is restricted to ponded areas near springs (stock ponds or beaver impoundments) where there is water at the surface for most or all of the growing season. The known examples are very small (<MMU).

Interpretation
This map class was mapped only where it was documented by ground data or field observations. It is limited to a single, small polygon surrounding a stock pond in the environs. One other stand in a beaver impoundment was documented within FOBU but was too small and indistinct to pull out from the surrounding quaking aspen stand.



Example of photo signature for map class H-ELPA (#39).

Map Class 42
Meadow Barley Grassland (H-HOBR)

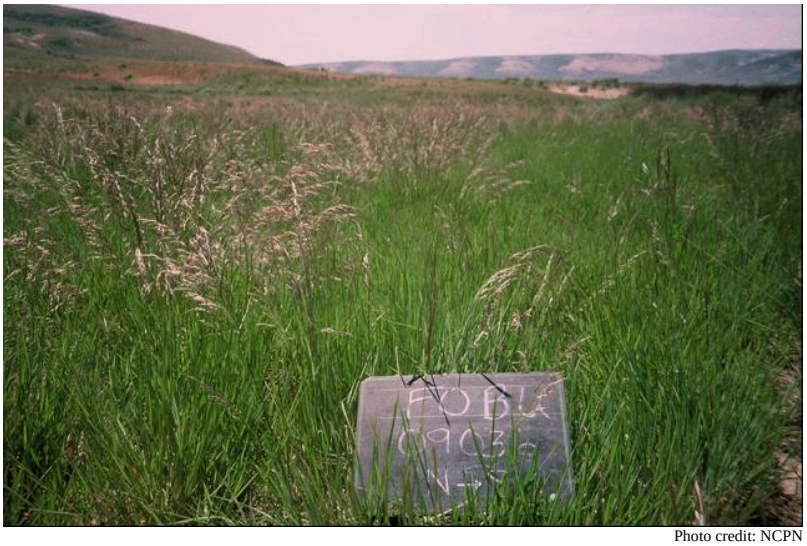


Photo credit: NCPN

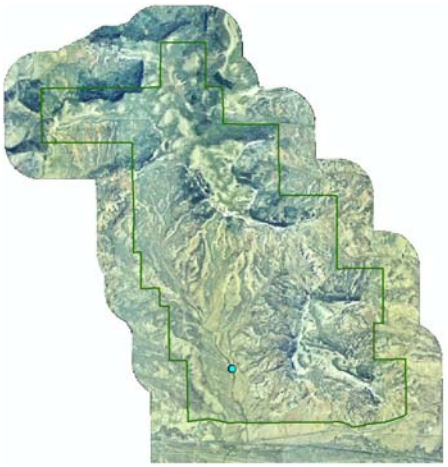
Associations
Hordeum brachyantherum Herbaceous Vegetation

Common species
- *Hordeum brachyantherum*
- *Potentilla anserina*
- *Deschampsia caespitosa*

H-HOBR Map Class Statistics

Type:	Association
Frequency:	1 point, no polygons
Total project area:	N/A
Average Polygon Size:	N/A
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area



Distribution/Ecology/Composition
Only one known small stand (planted) in Chicken Creek drainage.

Interpretation
This map class exists as a single plot in a stand too small to map as its own polygon. Its signature is indistinct from that of the wet meadow herbaceous (map class #32) community that surrounds it.

Map Class 50
Western Wheatgrass Grassland (H-PASM)

Photo credits: NCPN

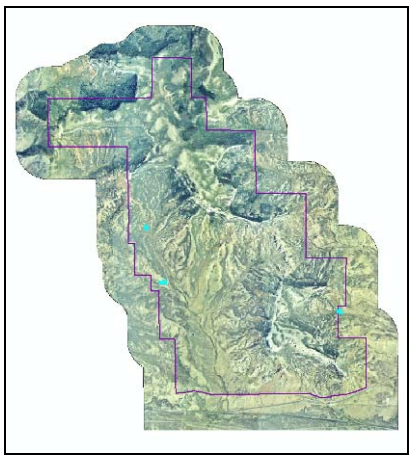
Associations
Pascopyrum smithii Herbaceous Vegetation

Common species
- *Pascopyrum smithii*
- *Iva axillaris*
- *Juncus balticus*

H-PASM Map Class Statistics

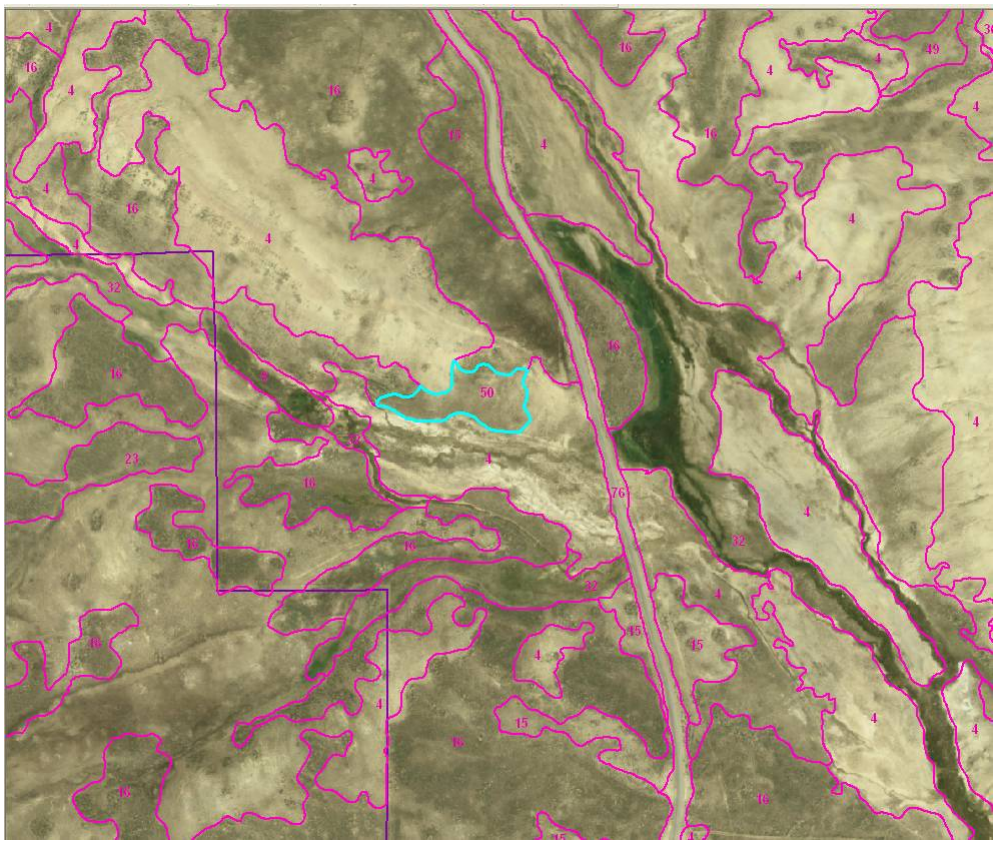
Type:	Association
Frequency:	5 total polygons 4 polygons in FOBU 1 polygons in the environs
Total project area:	2 hectares / 5 acres (<0.1 %) 1 hectares / 3 acres in FOBU 1 hectares / 2 acres in the environs
Average Polygon Size:	0.4 hectares / 1 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

Distribution in Mapping Area



Distribution/Ecology/Composition
This type tends to occur in narrow strips (< MMU) in or near the bottoms of swales and intermittent drainages. Western wheatgrass may not be indigenous to FOBU and may have been introduced as a forage and reclamation species that has become naturalized within the monument. Even where it does not form grassland communities, it is a common understory element in basin big sagebrush shrublands.

Interpretation
This map class was mapped only where it was documented by ground data or field observations. It is limited to three small stands.



Example of photo signature for map class H-PASM (#50).

Map Class 53
Kentucky Bluegrass Meadow (H-POPR)

Photo credit: NCPN

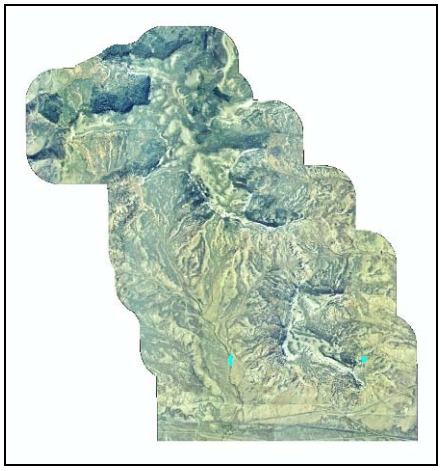
Associations
Poa pratensis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation

Common species
- *Poa pratensis*
- *Juncus balticus*

H-POPR Map Class Statistics

Type:	Association
Frequency:	2 total polygons
	2 polygons in FOBU
	0 polygons in the environs
Total project area:	1 hectares / 3 acres (<0.1 %)
	1 hectares / 3 acres in FOBU
	0 hectares / 0 acres in the environs
Average Polygon Size:	0.6 hectares / 1.4 acres
Producer's accuracy:	N/A
User's accuracy:	N/A

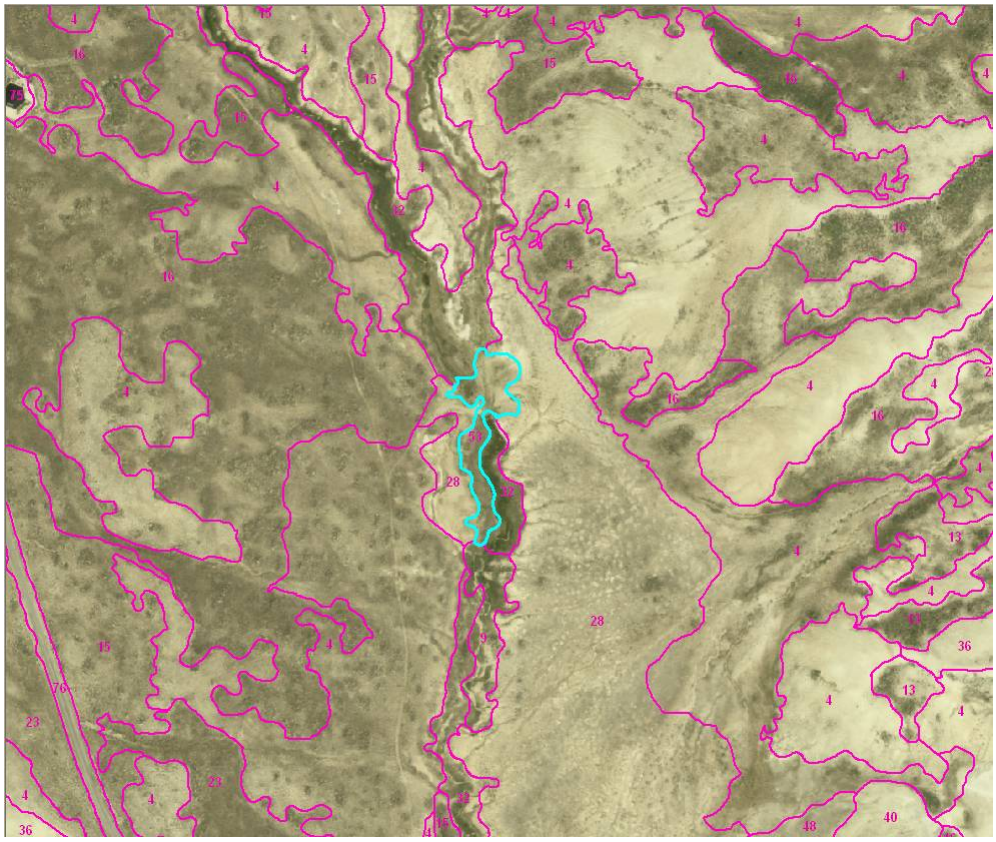
Distribution in Mapping Area



Distribution/Ecology/Composition
One stand of this type occurs in a mosaic of other communities commonly occurring in drainage bottoms. The other stand is on a dry lower slope with shallow clay soils within a stand of alkali sagebrush. The potential exists for Kentucky bluegrass to become a much more widespread type following a burn, as it is a common element of most sagebrush shrublands and this exotic rhizomatous grass responds vigorously to fire.

Interpretation

This map class was delineated only where it was documented by ground data or field observations. The two polygons of this map class are small and narrow, occupying mesic swales on gentle to moderate slopes. The signature is a smooth-textured, brownish green color.



Example of photo signature for map class H-POPR (#53).

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.

NPS 174/102082, May 2010

National Park Service
U.S. Department of the Interior

Natural Resource Program Center
1201 Oakridge Drive, Suite 150
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