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Vegetation Classification and Mapping Project Report, Natural Bridges National Monument

Natural Resource Technical Report NPS/NCPN/NRTR—2008/077



ON THE COVER
Sipapu Bridge, Natural Bridges National Monument (Photograph courtesy of the National Park Service)

Vegetation Classification and Mapping Project Report, Natural Bridges National Monument

Natural Resource Report NPS/NCPN/NRTR—2008/077

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Acronyms and Abbreviations

AA	Accuracy Assessment
APFO	Aerial Photography Field Office
BLM	United States Bureau of Land Management
BOR	United States Bureau of Reclamation
CANY	Canyonlands National Park
CEGL	Community Element Code
CNHP	Colorado Natural Heritage Program
DBH	Diameter At Breast Height (4.5 feet)
DEM	Digital Elevation Model
DOQQ	Digital Orthophotograph Quarter Quadrangle
DRC	Diameter At Root Crown
e^2M	engineering-environmental Management, Incorporated
ES	Ecological System
ESRI	Environmental Systems Research Institute
FGDC	Federal Geographic Data Committee
GIS	Geographic Information System
GPS	Global Positioning System
I&M	Inventory and Monitoring Program
ITIS	Integrated Taxonomic Information System
LC/LU	Land Cover/Land Use
MMU	Minimum Mapping Unit
NABR	Natural Bridges National Monument
NAD	North American Datum
NBII	National Biological Information Infrastructure Program
NCPN	Northern Colorado Plateau Network
NPS	National Park Service
NPS FirePro	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
SCS	Soil Conservation Service
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 (NCPN) worked with the U.S. Geological Survey (USGS) and National Park Service (NPS) Vegetation Characterization Program to describe and map vegetation at Natural Bridges National Monument. This collaborative effort involved many project partners, particularly engineering-environmental Management (e^2M), the Western Region office of NatureServe, and their cooperators.

The total project mapping area is 5,378 hectares (13,290 acres), encompassing the Monument and environs. Ecologists, botanists, and photo interpreters worked together to identify plant associations for NABR and determine how best to map them using 1:12,000-scale, true color aerial photography. The team collected vegetation and environmental data from 80 vegetation classification plots and 17 observation points. No supplemental fuels data were collected during the project. Fieldwork and mapping were completed between 2003 and 2005.

Analysis of the plot data revealed 35 National Vegetation Classification plant associations or park special vegetation types within the Monument and environs. Four of these associations were added to the classification following an analysis of the accuracy assessment data in the latter stages of the project. Three unvegetated land use/land cover types were delineated, including roads and Monument facilities.

Vegetation and land use were interpreted to as detailed a level as possible from high-resolution, true color digital orthophotographs and 9” x 9” stereo pairs of 1:12,000-scale true color aerial photography flown specifically for this project. Polygons representing vegetation or land use map classes were delineated on orthophotographs and later transferred to a spatial database.

A total of 1232 map polygons representing 16 natural and semi-natural vegetation map classes were developed within the NABR mapping project area. Three land use map classes described 18 polygons within the mapping area. Average polygon size across all map classes is 4.3 ha (10.6 acres). One map class (Hanging Gardens) occurs consistently in patches smaller than the minimum mapping unit of 0.5 ha and is represented by point data.

Map accuracy was assessed within the NABR boundary only. Results from a thematic accuracy assessment of 14 vegetation map classes indicated an overall map accuracy of 86.8% (Kappa index = 85.0%). Five map classes did not meet the 80% accuracy standard, but were retained because of their relative rarity and value to Monument managers. These are described in detail in the Accuracy Assessment section of this report, along with the justification for retaining them.

Products resulting from the NABR 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 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
- land use, aerial photography flight lines, monument and project boundaries
- ground photography of vegetation plots, observation points, and accuracy assessment points in hard copy and digital formats
- 360 degree panoramic digital videos acquired at each vegetation plot
- all field data (plot, observation point, and accuracy assessment point) stored in a Microsoft Access database
- 9" x 9" 1:12,000-scale true-color stereo aerial photographs acquired for this project
- 1:12,000-scale, geo-referenced true color digital orthophotography acquired for this project (electronic and hard copy formats)
- hard copy vegetation maps
- metadata for all digital products

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

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

Acknowledgements

This project was completed through the efforts of numerous individuals and organizations. Angie Evenden, Mike Story (National Park Service) and Karl Brown (U.S. Geological Survey) provided project oversight and coordination with significant support from Jim Von Loh, Senior Biologist with engineering environmental Management and Janet Coles in her roles as ecological consultant, regional ecologist with NatureServe, and vegetation mapping coordinator with the NPS. Funding for this project was provided through the USGS-NPS National Vegetation Characterization Program, NPS FireProgram, and the Northern Colorado Plateau Inventory and Monitoring Network (NCPN).

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

Numerous individuals were involved in collecting quality photo signature, plot, observation point, and accuracy assessment field data. Appreciation for this fieldwork is extended to Travis Belote, Arne Buechling, Lisa Hahn, Gerald Manis, Amy Schwarzbach, Jim Von Loh, and Pete Williams. We are grateful to the staff of Natural Bridges National Monument for making room in the campground for field staff and for coordinating our work in the backcountry.

The geodatabase was built by Aneth Wight of NCPN with assistance from Gery Wakefield of the Southeast Utah Group. Gerald Manis was the photointerpreter for this project and developed the initial set of map classes. The preliminary vegetation classification was prepared by Karin Decker of the Colorado Natural Heritage Program and the final vegetation classification by Marion Reid and Janet Coles of NatureServe. Janet Coles developed and applied a method to test and improve the field key. Gerald Manis and Janet Coles led an effective accuracy assessment meeting. Marion created and supplied the standardized local plant association description template for this project while Janet wrote the global plant association descriptions.

Database management support and development were skillfully performed by Margaret Beer of NPS and Jack Doria with e^2M, whose preparation of an MS Access database for plot, observation point, and accuracy assessment data simplified the entry and analysis of data. Jack and Margaret assisted database users to allow analyses to proceed on schedule.

For these and other contributors to the success of the project, we are grateful for their assistance, knowledge, dedication, and support.

Introduction

Vegetation Classification and Mapping Project, Natural Bridges National Monument

The Natural Bridges National Monument (NABR) Vegetation Mapping Project was organized and coordinated by the Northern Colorado Plateau Network (NCPN) Inventory and Monitoring (I&M) Program between 2001 and 2006, with assistance from several project cooperators. The purpose of this project was to describe and map existing plant associations on 5,378 hectares (13,290 acres) within and adjacent to NABR, 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 three basic project components were vegetation classification and description, vegetation map and spatial database development, and map accuracy assessment.

In 2001, the NCPN I&M Program launched a multi-year project to complete vegetation classifications and maps for network park units. Funding was provided by the USGS-NPS Vegetation Characterization Program and the Northern Colorado Plateau Network. To support this effort, the NCPN acquired 1:12,000-scale true color aerial photography for each park unit, including NABR, in 2002. The NABR Vegetation Classification and Mapping Project was initiated at a 2003 scoping meeting with project partners, including engineering-environmental Management, Inc. (e^2M), and NatureServe. Vegetation plot and observation point data collection occurred in 2003 and 2004, and the accuracy assessment was conducted in 2004.

Project methods, results, and products are documented in this report. This introductory section describes the NPS I&M Program and the USGS-NPS Vegetation Characterization Program , as well as the NABR 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 Characterization Program

The National Vegetation Characterization 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 AA protocols and standards are applied across projects supported by this program. The National Vegetation Characterization 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 NABR. 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 seen 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 NABR vegetation mapping project is the second of the network-coordinated projects to be completed.

Vegetation Characterization 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 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 NVC is based in part on earlier vegetation classification produced by the United Nations Educational, Cultural, and Scientific Organization (UNESCO 1973, Driscoll et al. 1984). Use of a standardized classification system helps ensure data compatibility throughout the National Park Service and other agencies. The FGDC Vegetation Subcommittee works to keep this standard current and relevant (http://biology.usgs.gov/fgdc.veg/standards/vegstd.htm).

Classification systems attempt to recognize and describe repeating assemblages of plants in similar habitats. The NVC is a hierarchical system that incorporates physiognomic characters and floristic data to define seven levels of terrestrial vegetation classification. The five upper levels (class, subclass, group, subgroup, and formation) are based on physiognomic features. The two lower levels (alliance and association) are distinguished by variability in floristic composition. The physiognomic units have a broad geographic perspective and the floristic units have utility in local and site-specific applications (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 and are determined by the most abundant or diagnostic species comprising the strata 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 (NatureServe 2003a). 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.

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

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

Other Standards

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

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

Project Area Description

Location and Setting

President Theodore Roosevelt established Natural Bridges National Monument in 1908 by presidential proclamation. The Monument was created to preserve "some of the finest examples of ancient stone architecture and three natural bridges formed where meandering streams eroded canyon walls". It represents the first NPS-managed public land in Utah. NABR encompasses 3,090 ha (7,637 acres) of rugged mesa, canyon, and rim topography ranging from 1,828 to 2,012 m (6,000 to 6,600 ft) in elevation. The vegetation mapping area includes the entire Monument and 2,288 ha (5,653 acres) of adjacent public lands. The total project mapping area is 5,378 ha (13,290 acres) (NPS 2005).

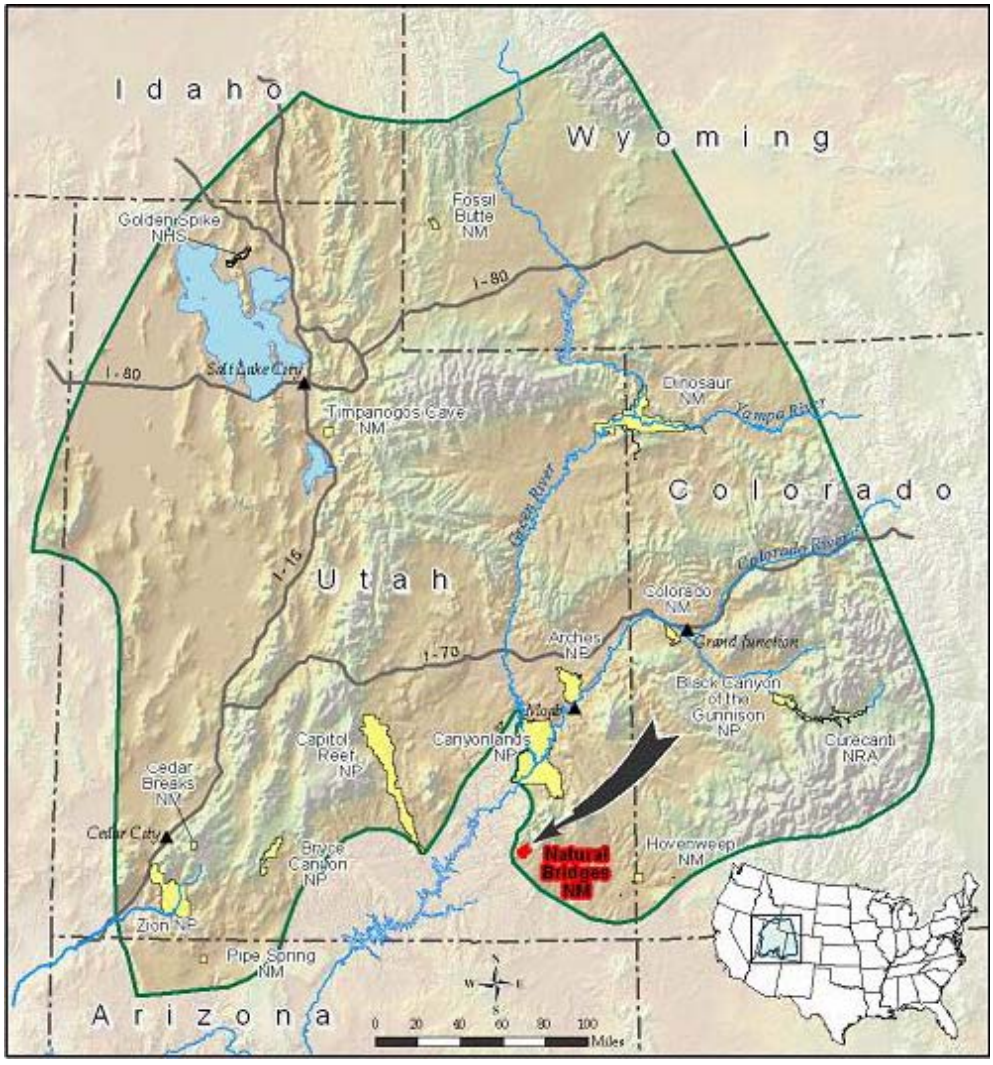


Figure 1. Location of NABR within the Northern Colorado Plateau network of parks.

NABR is located in San Juan County, UT, 193 km (120 miles) south of Moab, on the southern edge of the Northern Colorado Plateau Network (Figure 1). It is accessible via State Highway 95. Blanding, UT with a population of 3,100, is the nearest town, located 64 km (40 miles) east of the Monument. Surrounding San Juan County is sparsely populated, with a density of fewer than 0.6 people per square kilometer or 1.5 people per square mile. Approximately 100,000 people per year visit NABR to enjoy the scenery, prehistoric dwellings, and recreation opportunities. NABR is bordered by lands managed by the BLM or the State of Utah (Figure 2). The NABR vegetation mapping project area also includes rights-of-way for state highways 95 and 275.

Topography

The Monument occupies the center of the Monument uplift within the Canyon Lands Section of the Colorado Plateau physiographic province (Fenneman and Johnson 1946). The Colorado Plateau is a 33.5 million ha (130,000 mi^2) basin ringed by highlands and dissected by deep canyons (Cogan et al. 2004). Landscapes within the Monument are characterized by a rolling plateau deeply incised by White and Armstrong canyons and their tributaries. The forces of wind and water erosion combined to carve sedimentary geological layers into the present topographic character. The elevational range is moderate; the highest elevation is 2,022 m (6,635 ft.) in the northeastern corner of the mapping area, the lowest is 1,700 m (5,580 ft.) where White Canyon exits the Monument.

Climate

Records of climatic conditions have been maintained continuously at the NABR visitor center since 1965 (Western Regional Climate Center 2004). NABR is characterized by a semiarid climate, averaging 12.4 inches (31.5 cm) of precipitation annually (Figure 3). Most precipitation is in the form of afternoon showers and thunderstorms occurring from July through October (Figure 4). Total annual snowfall averages approximately 40 inches (101.6 cm) with December and January being the snowiest months.

Conditions within the Monument can change significantly during a day and between seasons. Summers are long with hot days averaging 89.1 °F (31.7 °C) and warm nights averaging 59.2 °F (15.1 °C) in July. Hot days typically approach 100 °F (38 °C) and occasionally up to 110 °F (43.3 °C). Winters are relatively mild with an average maximum temperature of 38.5 °F (3.6 °C) and an average minimum temperature of 17.5 °F (-8.1 °C) occurring in January. Cold days occasionally drop to single digits (below 0 °C).

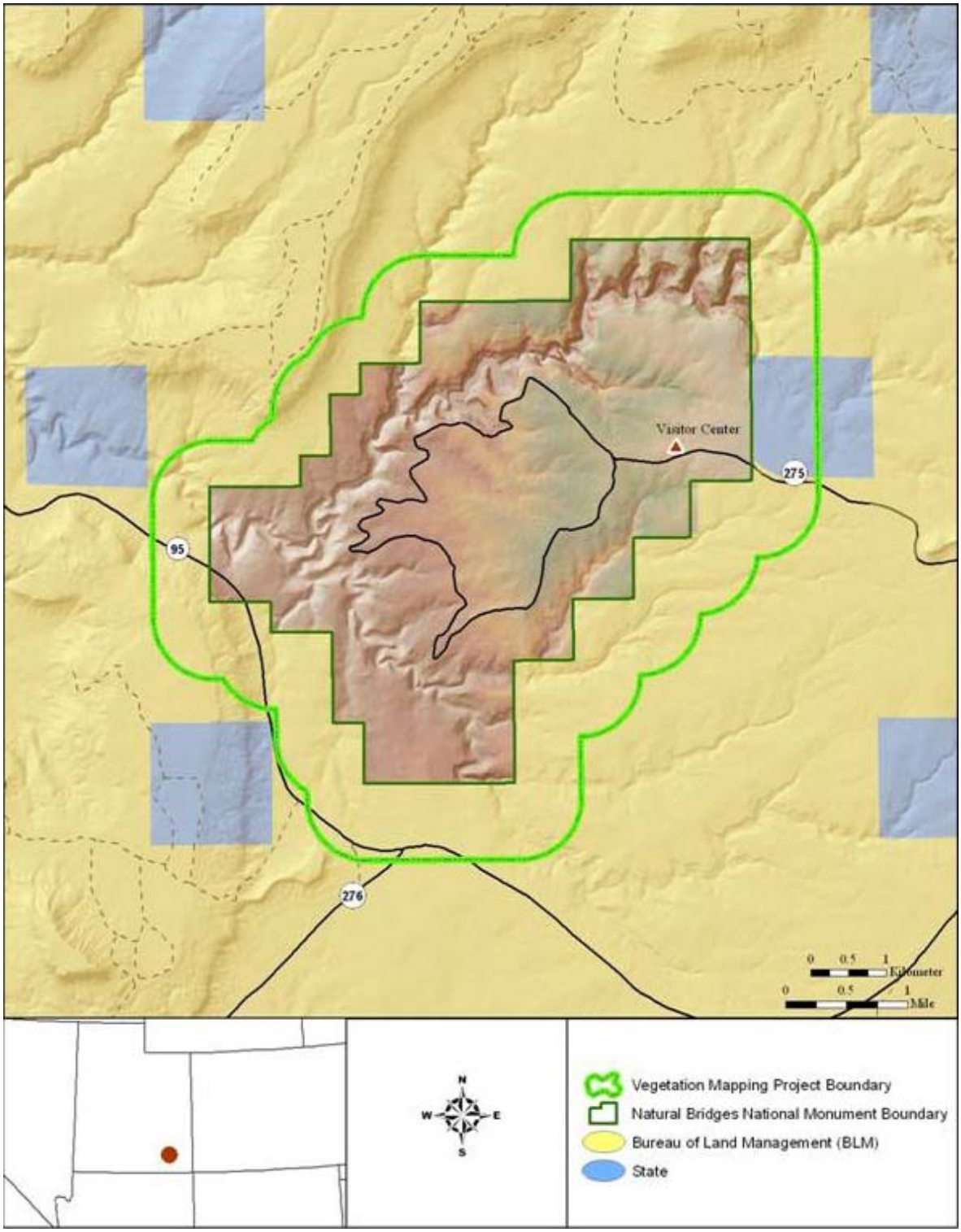


Figure 2. Map of the NABR vegetation mapping project area boundary showing adjacent land ownership.

West (1988) analyzed fossil pollen to study the effects of climate and human activities on vegetation between the prehistoric period of human settlement (around 7,000 BC) and the early 1970s. He concluded that no major climatic changes had occurred in the area since the prehistoric period, and that human activities were the major drivers of vegetation change during the period of study.

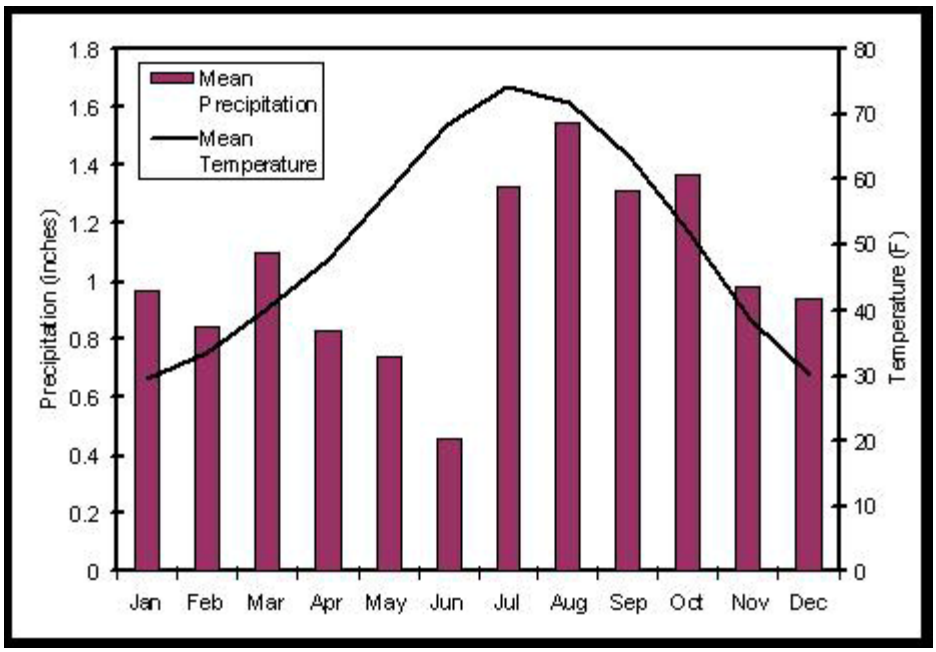


Figure 3. Climate data for NABR (Western Regional Climate Center 2004).

Plant microfossils recovered from packrat middens indicate that Engelmann spruce (Picea engelmannii), limber pine (Pinus flexilis), and Douglas-fir (Pseudotsuga menziesii) grew in the NABR region during the late Pleistocene (Mead et al. 1987), reflecting wetter and colder climatic conditions persisting until 12,000 years ago. Relict stands of Douglas-fir still occupy mesic, sheltered habitats on some canyon walls and north-facing talus slopes.

Extreme weather events are important factors in shaping the landscape at NABR. A severe regional drought has affected the area since 1998 and pine bark beetle (Ips spp.) populations increased to kill many of the drought-stressed pinyon pine trees within and around the Monument. An extreme flood event in Armstrong Canyon triggered by an intense thunderstorm in September 2005 damaged or removed much of the riparian vegetation on the canyon floor.



Figure 4. Typical convective afternoon thunderstorm forming over NABR.

Geology and Vegetation

A major reason for establishing NABR was to protect three large natural bridges formed by stream erosion in Armstrong and White Canyons and their tributaries. These bridges are cut into the massive Cedar Mesa Sandstone that covers nearly the entire Monument (Figure 5). The natural bridges were given Hopi names in 1909. “Sipapu” means “the place of emergence”, describing an entryway by which the Hopi believe their ancestors came into this world. Kachina” is named for rock art on the bridge that resembles symbols commonly used on kachina dolls. “Owachomo” means “rock mound”, in reference to a feature on the east abutment of this bridge.

The following description of the geologic history of NABR is derived from Huntoon et al. (2003). Geologic processes created the features visible within NABR over a period of about 270 million years. The bridges themselves are probably less than 30,000 years old. They are carved from Cedar Mesa Sandstone deposited as sand dunes during the early Permian, when the west coast of North America was located in central Utah. The sands were buried under tens of thousands of feet of younger sediments and solidified into a massive sandstone. Regional uplifts during the Laramide Orogeny (70 mya) and beginning again about six million years ago raised these rocks to the surface. The streams of White and Armstrong Canyons were entrenched in their courses by two million years ago when their cutting power was enhanced by the cooler and wetter climates of the Pleistocene. For this reason, the paths of these canyons through the tough Cedar Mesa sandstone meander as they would through softer rocks on flat terrain. The natural bridges are bedrock arches left when the outer edges of two meanders joined to shorten the stream channel (Figure 6).

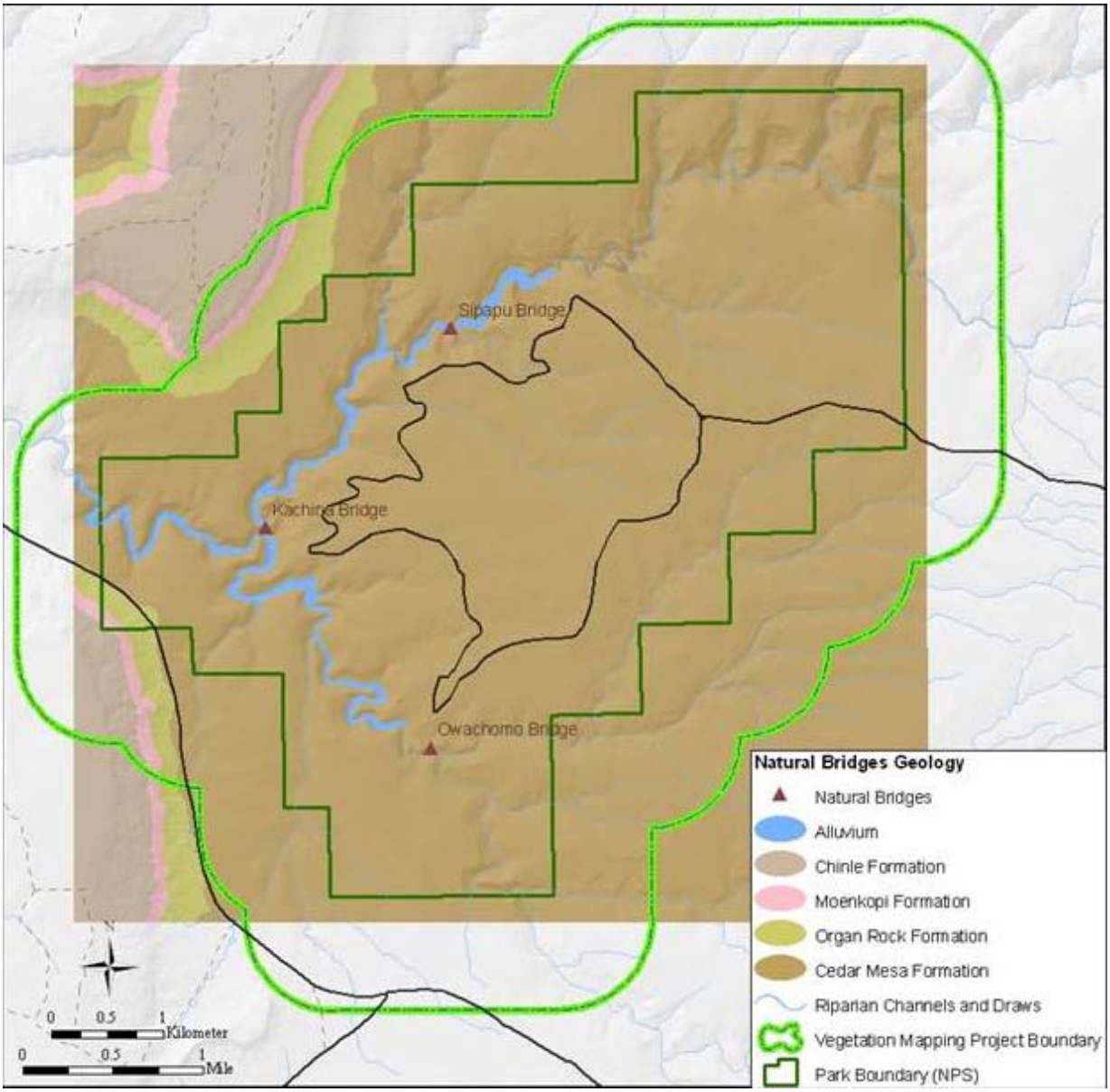


Figure 5. Bedrock geology map of NABR.

NABR lies within the Colorado Plateau Semidesert Province within the Dry Domain-Tropical / Subtropical Steppe Division (Bailey 2001). The Monument supports vegetation broadly classified as temperate or semi-desert (West 1988). Although woodlands dominate the vegetation, a variety of shrublands and a few small grasslands are also present. The distribution of vegetation is controlled by substrate (geology and soils) and to a lesser extent, aspect. The remainder of this section is a summary of the general distribution of vegetation in relation to geology across the mapping area, organized from oldest to youngest rocks.



Figure 6. How natural bridges form. The left drawing shows a stream meander entrenched in Cedar Mesa sandstone. Erosion tends to widen the meander loops at their outer edges. The right-hand drawing shows that the outer edges of two loops have cut through the rock between them, leaving a stone bridge over the new stream course.

Cedar Mesa Sandstone (Permian). This formation is the most widely exposed within the Monument (Figure 5); it supports the plateau and forms the rims and walls of the canyons, as well as the natural bridges. It is a massive, light gray sandstone. Where the sandstone is covered by deep eolian or residual soils, the vegetation consists of woodlands with a canopy of pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) (Figure 7a). Openings within the woodlands contain shrublands of Wyoming sagebrush (*Artemisia tridentata* ssp. *wyomingensis*). Thinner soils near canyon rims support a diverse wooded shrubland community. Lenses of fine-grained shale (evidence of interdunal wetlands) exposed in the canyon walls force groundwater to the surface and are the locations of hanging gardens (Figure 7b).

Five of the six plant species of special concern found within NABR are restricted to hanging gardens or perennial seeps emerging from Cedar Mesa Sandstone (Schelz and Moran 2004). These species are Rydberg thistle (*Cirsium rydbergii*), kachina daisy (*Erigeron kachinensis*), helleborine (*Epipactus gigantea*), alcove death camas (*Zigadenus vaginatus*), and alcove bog orchid (*Habenaria zothecina*). The sixth species, Monument milkvetch (*Astragalus monumentalis*), is an endemic upland plant.



Figure 7a. Pinyon-juniper woodland typical of deep the soils on top of the mesa.



Figure 7b. Hanging garden emerging from canyon wall.

Organ Rock and Triassic Moenkopi Formations (Permian). These formations are combined because they are continuous and difficult to distinguish. They form the slopes of Mossback Butte and Deer Mesa on the west side of the project area. Fallen blocks of Shinarump conglomerate modify the shale surface and provide microsites that support a diverse woodland or wooded shrubland, especially on cooler, north-facing slopes (Figure 7c). Characteristic shrubs include roundleaf buffaloberry (*Shepherdia rotundifolia*) and Utah serviceberry (*Amelanchier utahensis*). Other common species include littleleaf mountain mahogany (*Cercocarpus intricatus*), true mountain mahogany (*Cercocarpus montanus*), Mormon-tea (*Ephedra viridis*) and desert snowberry (*Symphoricarpos longiflorus)*. Scattered pinyon pine and Utah juniper are usually present except on drier slopes. Salina lyme grass (*Leymus salinus*) occurs in most stands. Steep, south-facing shale slopes support an open woodland with a sparse understory of the same species on thin soils.



Figure 7c. Diverse woodland on colluvium-covered shale slopes on the side of Mossback Butte.

Shinarump Conglomerate (Triassic). The erosion-resistant Shinarump Conglomerate (part of the Chinle) forms the caprock of buttes and benches on the margins of the mapping project area. Exposures are limited to the environs of the vegetation mapping area. These sites support pinyon-juniper woodlands with an understory of Wyoming sagebrush or black sagebrush (*Artemisia nova*) and various grasses (Figure 7d). On Deer Mesa and Mossback Butte, the woodland was chained and planted to pasture grasses, but remnants of the original woodland vegetation persist.



Figure 7d. Pinyon-juniper woodland on Shinarump Conglomerate (Mossback Butte).



Figure 7e. Grove of mature cottonwood on the floor of White Canyon.

Quaternary Alluvial Deposits. Unconsolidated stream sands and gravels are confined to narrow terraces and point bars in the bottoms of White and Armstrong Canyons and their tributaries. These deposits cover less than 1% of the mapping area and support primarily riparian vegetation. Lower terraces support Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*) woodlands and willow (*Salix* spp.) shrublands (Figure 7e). Higher terraces support woodlands of pinyon pine, Utah juniper, or Gambel oak (*Quercus gambelii*) (Figure 7f), or shrublands of sagebrush (*Artemisia tridentata* ssp. *tridentata*) and rubber rabbitbrush (*Ericameria nauseosa*). Point bars (Figure 7g) sometimes support small grasslands dominated by needle-and-thread (*Hesperostipa comata*) and Indian ricegrass (*Achnatherum hymenoides*).



Figure 7f. Gambel oak woodland on a terrace above the floor of Armstrong Canyon.



Figure 7g. Small bunchgrass grasslands occupy point bars on the floors of the main canyons.

Soils

NABR soils are derived from sandstone and shale bedrock that has been redistributed as alluvial, colluvial, or eolian deposits (Figure 8; NRCS 2003). Soil textures range from loamy sands (course) to sandy clay loams. Five soil types have been described for NABR:

Rizno-Barx-Yarts Complex. This soil complex covers 85% of the Monument. It is associated with relatively gentle slopes on upland mesas and benches. The principal vegetation types ainyon-juniper woodlands and Wyoming big sagebrush shrublands. The component soil types are susceptible to erosion; dunes, and gullies are common.

Rizno-Rock Outcrop Complex. This soil complex consists of thin soils intermixed with rock outcrops on mesas. Pinyon-juniper woodland with pockets of perennial grasses is the principal egetation type found on this complex.

Rock Outcrop - Strych - Rizno Association. This soil unit occurs on the steep sandstone walls and ledges of White, Armstrong, Deer, and Tuwa Canyons. Plant communities occurring in edrock cracks include sparse pinyon-juniper woodlands and sparbse shrublands of littleleaf mountain mahogany or spiny greasebush (*Glossopetalon spinescens* var. *meionandrum*).

Strych - Rizno - Strych, Very Steep Association. This uncommon soil unit is associated with steep, slopes near the junction of Armstrong and White Canyons. This association supports sparse pinyon-juniper woodlands with roundleaf buffaloberry and Utah serviceberry.

Wet Alluvial Land. Linear strips of this soil unit occur on drainage bottoms, where they are included in the Rock Outcrop – Strych – Rizno Association. These sandy loams are saturated for at least part of the year and support mesic plant species such as western wheatgrass (*Pascopyrum smithii*), rubber rabbitbrush, coyote willow (*Salix exigua*), and Rio Grande cottonwood.

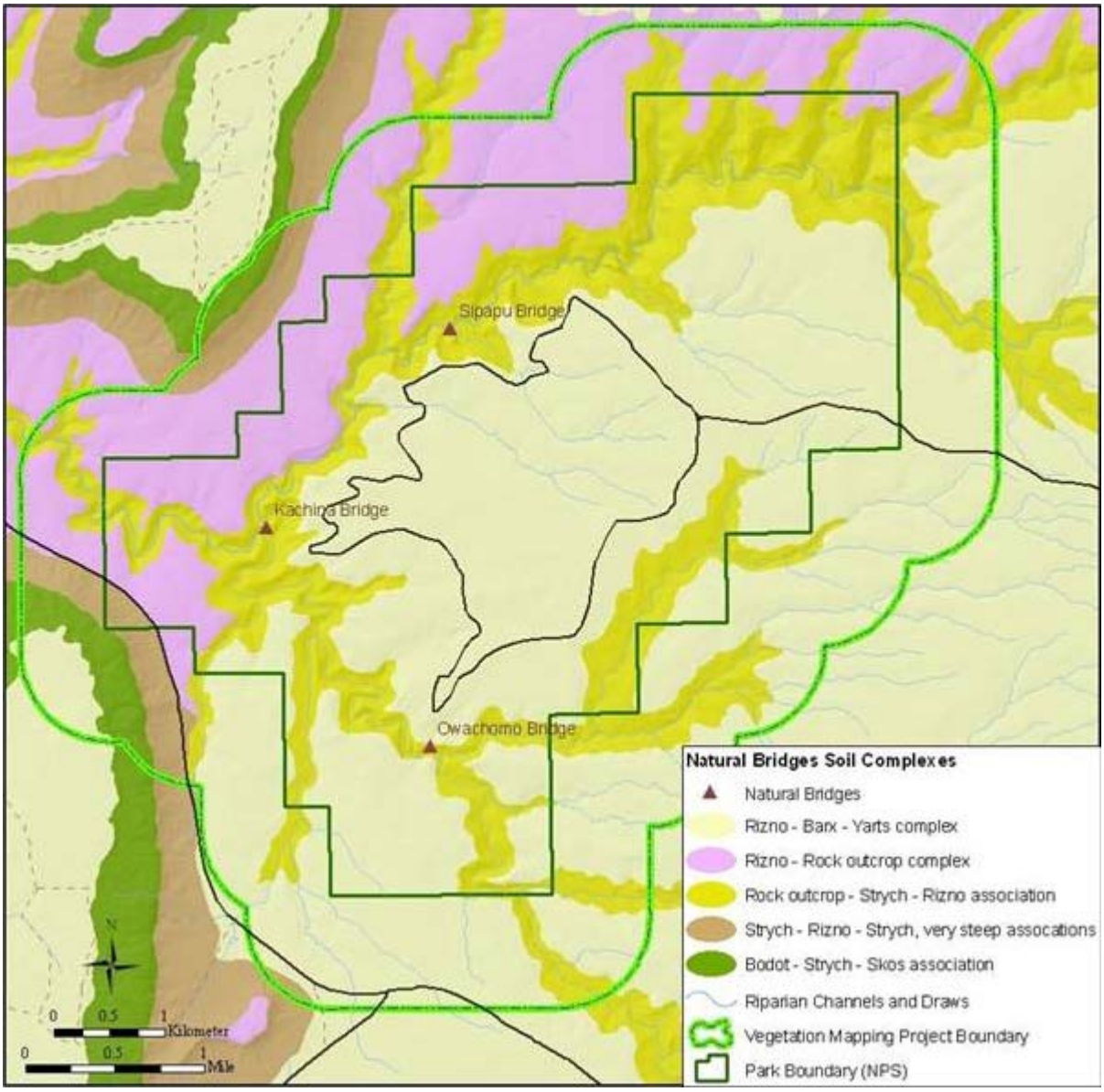


Figure 8. Soil associations within the NABR vegetation mapping project area.

Biological Soil Crusts

Biological soil crusts are well developed within NABR, particularly where thin soils overlie slickrock (Figure 9). These crusts are a complex community of cyanobacteria, green algae, lichens, mosses, microfungi, and other true bacteria (Belnap et al. 2001). The cyanobacteria and microfungi have filaments that weave through the top few millimeters of soil, creating a matrix that stabilizes and protects soil surfaces from wind and water erosion. Other services provided by biological soil crusts include fixing atmospheric nitrogen, building soil organic matter (Eldridge and Green 1994), and retaining soil moisture (Belnap et al. 2001).

On deeper soils, biological soil crusts at NABR occupy the nutrient-poor openings between tree canopies and clumps of vascular plants. They also occupy thin soils over bedrock. They are diverse in terms of species composition, often including more species than the associated vascular plant community (Rosentreter 1986 and Ponzetti et al. 1998). Where land uses such as livestock grazing have removed the crusts, decades can pass before they begin to reestablish.

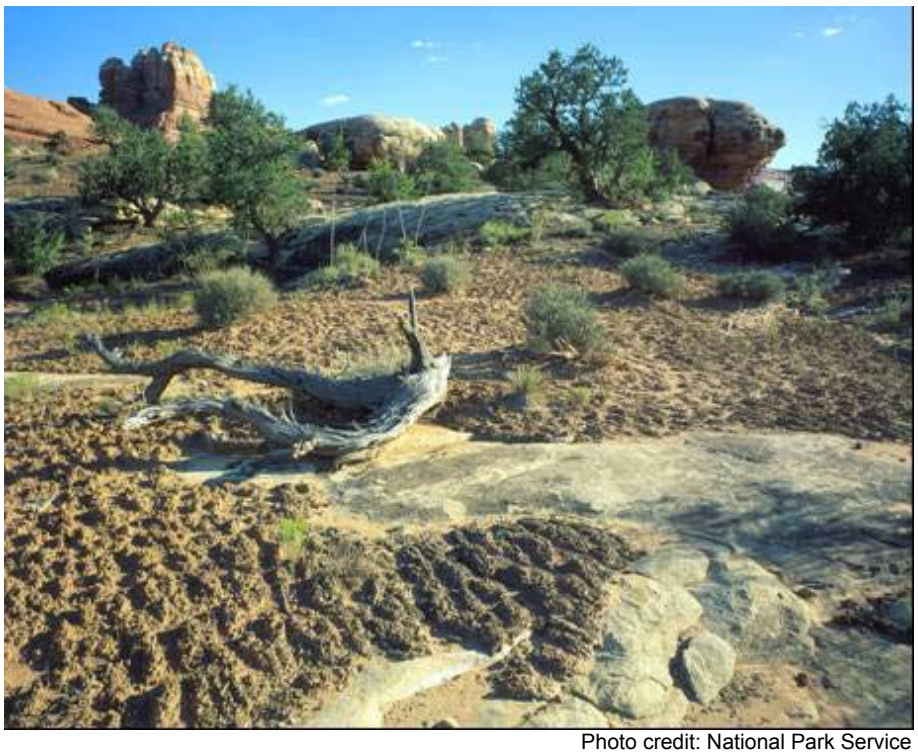


Photo credit: National Park Service

Figure 9. Example of well-developed biological soil crusts on the Colorado Plateau.

Hydrology and Water Resources

The Monument contains limited water resources in the form of intermittent streams, plunge pools, intermittently filled bedrock potholes (tinajas), seeps, and springs. Intermittent streams in Armstrong and White Canyons support stands of riparian and wetland vegetation, especially below bedrock pour-offs where plunge pools exist. Tinajas develop in solution pits formed in level exposures Cedar Mesa Sandstone. Seeps and springs with flow rates of only a few gallons per minute provide sufficient water for localized surface flows in canyon heads and moist to saturated soils where they emerge from bedding planes and joints in sandstone cliffs (Berghoff and Vana-Miller 1997). Seeps emerging from cliff faces deposit dissolved salts as the water evaporates, staining the surface white. Flow and standing water from hydrologic sources is typically ephemeral, but constitutes a significant source of water for wildlife and aquatic biota.

NABR is a plateau dissected by a canyon system consisting of White, Armstrong, Deer, and Tuwa canyons. Surface water exits NABR via White Canyon and flows toward Lake Powell in

Arizona. Surface flows are intermittent, occurring most commonly during and following precipitation events, when runoff from exposed bedrock and upland soil surfaces drains to the canyon floors. Debris lines and channel scour indicate that flash flooding periodically removes vegetation, moves boulders, incises channels and builds new terraces. One such flash flood was documented during this study, when a storm cell dropped more than 7.6 cm (3 in.) over the NABR region in a few hours on September 9, 2003. The intense rainfall resulted in water depths up to 10 m (33 ft) in the narrower canyons. Much of the vegetation growing on the canyon bottoms was damaged, washed away, or buried under sediment and/or flood debris.

Land Use

Most of the land use within the Monument consists of motorized (restricted to park roads) and passive (hiking) recreation. Current land uses outside the Monument consist primarily of maintaining transportation corridors and grazing. All land uses influence vegetation distribution and composition of the Monument to some degree. For example, exotic species are introduced along roadsides and trails, either deliberately for revegetation or accidentally by hikers. Some of the public lands abutting the Monument were chained and seeded with crested wheatgrass (*Agropyron cristatum*). These treatments occurred decades ago and the land is recovering slowly to native vegetation. Twentieth-century exploration for uranium deposits in the Shinarump Conglomerate (Chinle Formation) left mine adits, tailings, and access roads on the slopes of Deer Mesa.

Previous Vegetation Studies

NABR supports arid woodland vegetation within dissected plateau topography distributed over a 600-foot elevation range. The complex juxtaposition of topography, geology, soils, hydrology and disturbance history results in a greater diversity of vegetation than might be expected for an area of this size. The documented vascular flora of NABR includes 435 species (Welsh and Moore 1968, Malm 1987, Austin 1990, and Schelz 1999, 2000, 2001, 2002).

There are 42 known species of non-native plants within NABR (Schelz and Budalier 2000). Tamarisk (*Tamarix chinensis*) and white poplar (*Populus alba*) are woody; the other species are herbaceous perennials and or biennials (19 species) or annuals (21 species). State-listed noxious weeds found within NABR include field bindweed (*Convolvulus arvensis*), Canada thistle (*Cirsium arvense*), and perennial pepperweed (*Lepidium latifolium*)(Schelz et al. 2004). Tamarisk has been the focus of most of the Monument's weed control efforts, with the result that the species has been virtually eliminated from the Monument (Gilbert and Hendrickx 1977, Thomas et al. 1987, Kunzmann 1989), although it remains the main exotic plant species in terms of area occupied (Dewey and Andersen 2005).

Long-term vegetation monitoring began in 1987 with the establishment of permanent monitoring plots to document long-term trends and natural vegetation variability (Schelz and Moran 2004). The permanent vegetation plots at NABR were established in pinyon-juniper communities on the mesa top, Rio Grande cottonwood stands in the canyons, and in Gambel oak stands on riparian terraces. Each sample plot includes 100 permanent 0.5 x 0.5m quadrats arranged systematically along one or more transects in each plot. Frequency and cover of all vascular plant species

occurring within each quadrat are recorded annually, along with the extent of ground cover and abiotic elements, including litter, bare ground, cyanobacteria, mosses, lichens, rocks, and gravel. These data have been summarized but not analyzed (Schelz personal communication 2007).

In 1995, a revegetation project attempted to restore more than 60 sites totaling nearly 2.5 ha (6 acres) that were disturbed during a road realignment project. The sites were planted with native vegetation, and records evaluating the success of the project were maintained, including information about the collection and planting of the native vegetation, qualitative success rates for germination and growth, slides, and digital photographs (USDI 1994).

Declines and die-offs of Utah juniper in the Monument were investigated by Weber and Nelson (1991, 1994), using transect sampling to determine the cause of foliar damage to the trees. Increased moisture during the second year of the study coincided with a decrease in damaged and dying trees, suggesting a correlation with soil moisture and perhaps soil salinity. No pathogenic agents were identified as the causal agent of the decline.

Project Overview

General Approach and Timeline

The goals of this project were to inventory, describe, and map the existing vegetation at NABR and its environs. The project at NABR is part of a larger effort undertaken by the NCPN to classify and map vegetation in all network parks. As part of the network-wide coordinated effort, the NCPN developed standardized databases, mapping and reporting standards, and naming conventions to ensure that data across parks can be collated or compared.

The NCPN vegetation classification and mapping project was launched in July 2001 at a scoping meeting among network park staff, NCPN staff, and potential project cooperators. Following this meeting, NCPN prepared a multi-year, multi-park project proposal to the USGS/NPS Vegetation Characterization Program to cost-share network I&M funding with the National Vegetation Characterization Program funding to complete vegetation maps for all network parks (Evenden 2001).

NCPN negotiated interagency agreements with the USDA Aerial Photo Field Office and the USDI Bureau of Reclamation Remote Sensing and Geographic Information Group to acquire aerial photography for each park, including NABR. Aerial photography was flown during June and July 2002. NCPN contracted with engineering environmental Management (e^2M) to prepare a work plan for the NABR vegetation mapping project (Von Loh, et al. 2003). This work plan provided the framework for organizing the project, an overview of park resources, project task descriptions and timeline (Table 2), a review of legacy data, and a preliminary plant association classification.

Table 2. Timeline for NABR vegetation mapping project tasks.

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

Most of the vegetation plot and observation point data collection at NABR occurred in July 2003. No formal sampling design was created for this small park. Instead, field crews walked across every major section of the park, collecting data in distinct plant communities to achieve good spatial distribution of sample plots. The canyon bottoms received a disproportionate number of plots, as it was judged that most of the community diversity would occur there.

Field data were entered into a MS Access database developed for the project and were analyzed in the fall of 2003. Because some types were undersampled in 2003, additional vegetation plot and observation point data were collected during the 2004 field season. Both sets of data were analyzed by the Colorado Natural Heritage Program, who prepared a preliminary vegetation classification report. The final assignment of plots to associations of the National Vegetation Classification was made by NatureServe. Local and global plant association descriptions based on the classification were written in 2004-2005. An illustrated field key to NABR plant associations was developed prior to map accuracy assessment (AA) and field tested during the initial stages of the AA in 2004.

Interpretation of aerial photos and digital database development for the NABR vegetation map were completed during the fall and winter of 2003 and 2004, following completion of the vegetation classification. In preparation for mapping, the photointerpreter visited NABR in 2004 to conduct reconnaissance, obtain observation data, and develop an understanding of vegetation patterns at NABR. Map classes were defined for the project by the consulting photointerpreter, with input from NCPN and NatureServe ecologists. A traditional photo interpretation was performed, with interpreted polygons drawn initially on mylar overlays and transferred to a digital format via a scanning, orthorectification, and attribution process. Polygon attribution followed standards developed by NCPN for all park mapping projects (Evenden 2004).

A draft map and associated spatial database were completed in the summer of 2004. Accuracy assessment data collection and entry occurred late in the 2004 field season. Data were entered into the NABR project database and analyzed, with results tabulated into a contingency matrix. A meeting held with project cooperators in March 2005 determined which map classes should be retained, and which combined or eliminated because they failed to meet the 80% accuracy standard. Final revisions were made to the vegetation classification, map and spatial database during the summer of 2005. All geospatial products associated with this project are in the UTM projection, Zone 12, NAD83.

Primary Partners and Project Roles

Several agencies and organizations were involved in completing the Natural Bridges National Monument Vegetation Mapping Project. The roles of each individual are described below.

engineering-environmental Management, Inc.

- *Jim Von Loh, Senior Biologist* – developed project work plan, helped prepare agendas and compile minutes for project meetings, managed plot and AA field data collection entry, created field key, prepared association local descriptions, contributed to final report
- *Sharon Anderson, Ph.D., Plant Taxonomist* – assisted with work plan development

- *Dan Niosi, Natural Resource Specialist* – assisted with work plan development, production, and project meeting minutes
- *Janet Coles, Consulting Ecologist* – managed plot and observation point field data collection, contributed to final report
- *Gerald Manis, Consulting Photointerpreter* – delineated and attributed vegetation polygons and assisted in preparing the map accuracy assessment. Prepared the draft photointerpretation guide
- *Jack Doria, Database Programmer* – developed the MS Access (plots) database
- *Travis Belote, Staff Ecologist* – Collected and entered plot and AA point data
- *Arne Beuchling, Staff Ecologist* – Collected and entered plot and AA point data
- *Peter Williams, Consulting Field Technician* – Collected plot and observation point data
- *Karin Decker (Consulting Ecologist, Colorado Natural Heritage Program)* – Analyzed field data and prepared preliminary vegetation classification

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, report writing, final product completion, data management
- *Janet Coles, Vegetation Ecologist* – Technical editor for the final report; coordinated creation of final products, wrote final photointerpretation guide
- *Margaret Beer, Data Manager* – project database development and data management support
- *Lisa Hahn, Plant Ecologist* – plot and observation point data collection
- *Amy Schwarzbach, Plant Ecologist* – plot and observation point data collection
- *Liz Ballenger, Plant Ecologist* –plot and observation point data collection
- *Gery Wakefield, GIS Team Leader* – managed the GIS and remote sensing database construction, selected AA points and prepared maps to support the AA
- *Aneth Wight, GIS Technician* – produced geodatabase; plots database support, project metadata
- *Bruce Condie, Field Technician* – plot and observation point data collection
- *Sarah Topp, Field Technician* – plot and observation point data collection

U.S. Department of Agriculture Aerial Photo Field Office

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

USDI Bureau of Reclamation Remote Sensing and Geographic Information Group

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

NatureServe

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

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

- *Mike Story, NPS Program Leader* – Provided national level program oversight
- *Karl Brown, Ph.D., USGS Program Leader* – Provided national level program oversight
- *Tammy Hamer, Vegetation Characterization Program Biologist* – Facilitated generation of final products

Aerial Photography

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

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

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

Initial vegetation mapping project boundaries were determined prior to aerial photography acquisition. The boundary for aerial photography coverage extended slightly beyond the project mapping area boundary.

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 NABR. The photographs were flown on July 1, 2002 by the subcontractor, Blue Skies Consulting, LLC of Albuquerque, New Mexico. The photography was acquired at a nominal elevation of 6,000 ft (1,829 m) above ground level in a Cessna T210N aircraft. A Wild RC10 camera with 15.2 cm (6 in) lens was used with Kodak Aerocolor negative film. The target scale for this photography was 1:12,000 (1 in = 1,000 ft). The mission was designed such that approximately 30% sidelap occurred between flight lines and 60% overlap occurred between photos, with a minimum sun angle of 45º. The project encompassed 40.7 linear km (25.3 miles) divided among five flight lines and 38 individual photos (Figure 10). Figure 11 is an example of the 23 cm x 23 cm aerial stereo photographs for NABR. These photographs were used for photo interpretation during the mapping phase of the project, as well as by field crews during plot data collection.

The film negatives for this aerial 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 NABR and the other is retained at the NCPN offices in Moab, Utah.

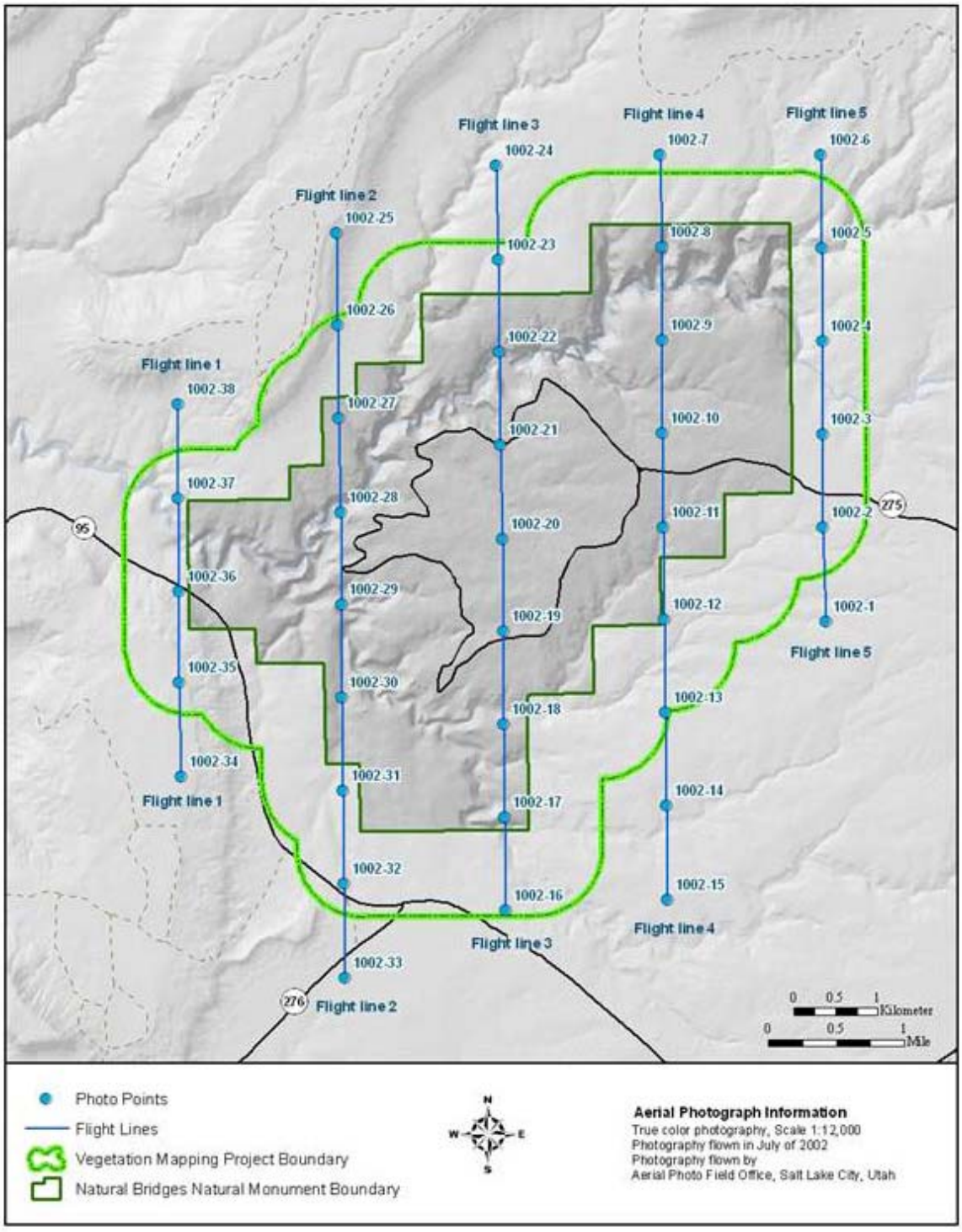


Figure 10. Flight lines for 2002 stereo aerial photograph coverage of NABR.

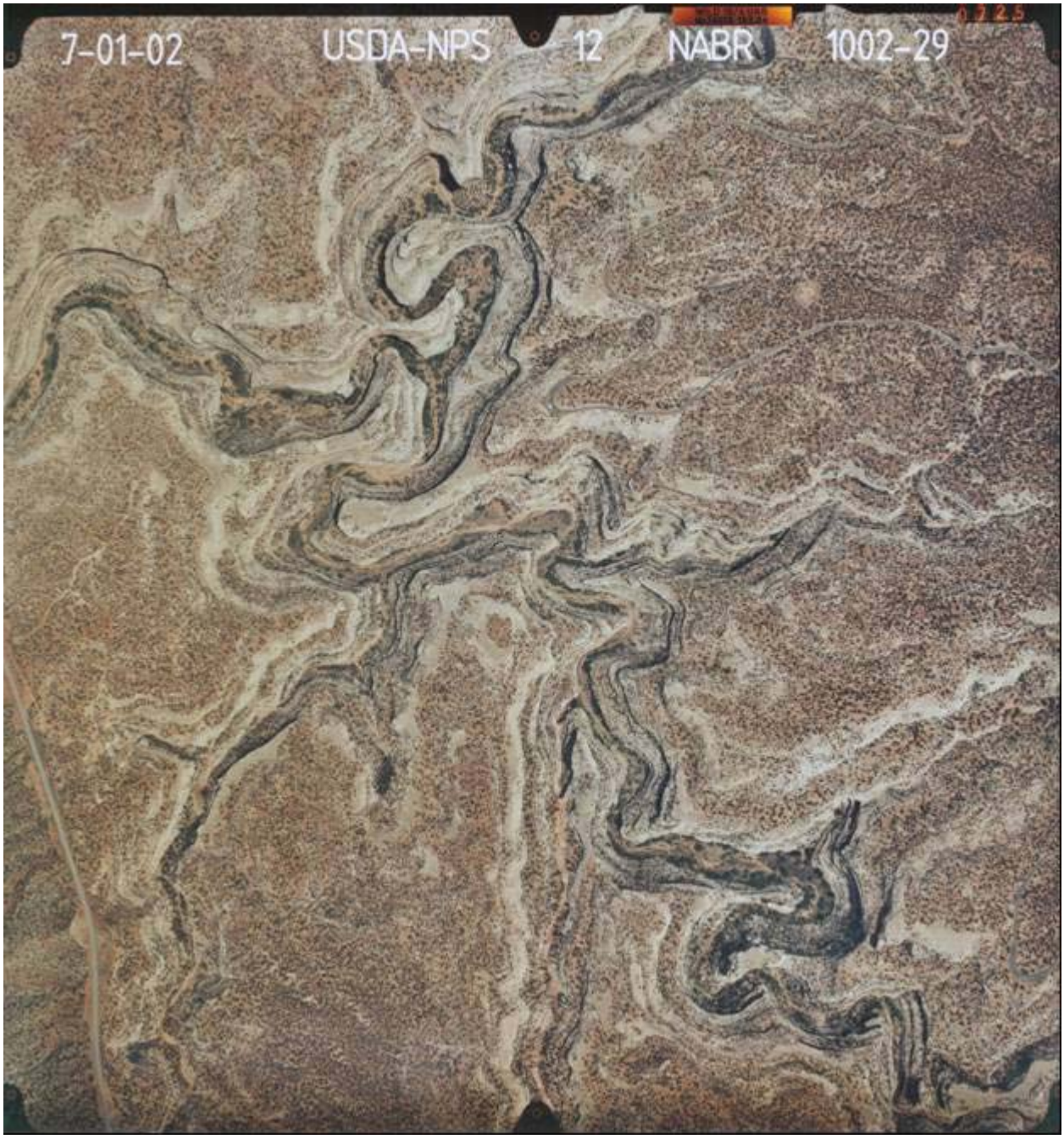


Figure 11. Example of a 9” x 9” aerial photograph taken for the NABR vegetation classification and mapping project.

Digital Orthophotos

The USDI Bureau of Reclamation Remote Sensing and Geographic Information Group (BOR) in Denver, Colorado, produced 1:12,000 scale digital orthophotography for NABR from new imagery. This work was subcontracted to Horizons Inc. of Rapid City, South Dakota. The photography was flown on June 18, 2002, at a mean above ground level elevation of 6,096 m (20,000 ft). Sidelap was approximately 30% and overlap about 60%. Airborne global positioning

system (GPS) data were collected for each exposure. A Zeiss RMK 15/23 camera with a 15.2 cm (6 in) lens was used with AGFA100 film. The project extended over 52 linear km (32 miles) divided among four flight lines and 26 individual photos (Figure 12).

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

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

Scoping Meeting

The initial project meeting was held in February 2003. At this gathering, SEUG staff met with NCPN staff, cooperators, and other interested parties to discuss the project and provide input to the project planning process. During the meeting, this group discussed resource management concerns, finalized the project mapping area boundary, developed a project schedule and identified logistic needs. Monument staff expressed interest in documenting and mapping stands of tamarisk, springs and seeps and biological soil crust conditions in vegetation plots.

Work Plan

A vegetation classification and mapping project work plan for NABR was completed early in the project timeline (Von Loh et al. 2003). It provided detailed descriptions, estimates of effort needed, and proposed timelines for each of 11 project tasks:

- planning and scoping
- aerial photography acquisition
- preliminary plant association and species list development
- field plot and observation point data collection

- aerial photo interpretation
- vegetation classification and characterization
- local and global plant association description preparation
- spatial database and map development
- plant association field key preparation
- accuracy assessment
- report and metadata compilation

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

Project Boundary and Map Extent

A uniform project boundary of approximately 0.8 km (0.5 miles) around the edge of the Monument (environs) was chosen by SEUG staff and project cooperators at the February 2003 scoping meeting (Figure 2). The total project mapping area is 5,378 hectares (13,290 acres). Of this area, 3090 ha (7,637 acres) occur with the NABR boundary and 2,288 ha (5,653 acres) are in the environs. The environs were delineated to support coordinated management on adjacent public lands administered by the BLM and the State of Utah.

Minimum Mapping Unit

With few exceptions, a standard 0.5 ha (1.2 acre) minimum mapping unit (MMU) was employed in the NABR vegetation mapping project. During project scoping, SEUG staff expressed interest in mapping several special features, all of which occupy areas smaller than the MMU. These included invasive tamarisk stands, hanging gardens, and springs and seeps. These situations were typically mapped as points based on field observations.

Ecological System Classification

The network elected to use the ecological system (ES) classification structure developed by NatureServe (Comer et al. 2003, NatureServe 2003b) as a framework for organizing and presenting plant community data. An ES is defined as a group of plant associations from two or more alliances that tend to co-exist in a given landscape due to similar ecologic processes, substrates, and/or environmental gradients. The ES classification was developed to provide larger scale classification units for application to resource management, mapping, and conservation. Current estimates are that Colorado and Utah contain more than 80 ecological systems (NatureServe Explorer 2006). This approach complements the NVC where the finer-scale association units provide a basis for interpreting larger-scale ES patterns and concepts. A description of each of these units appears in Appendix A.

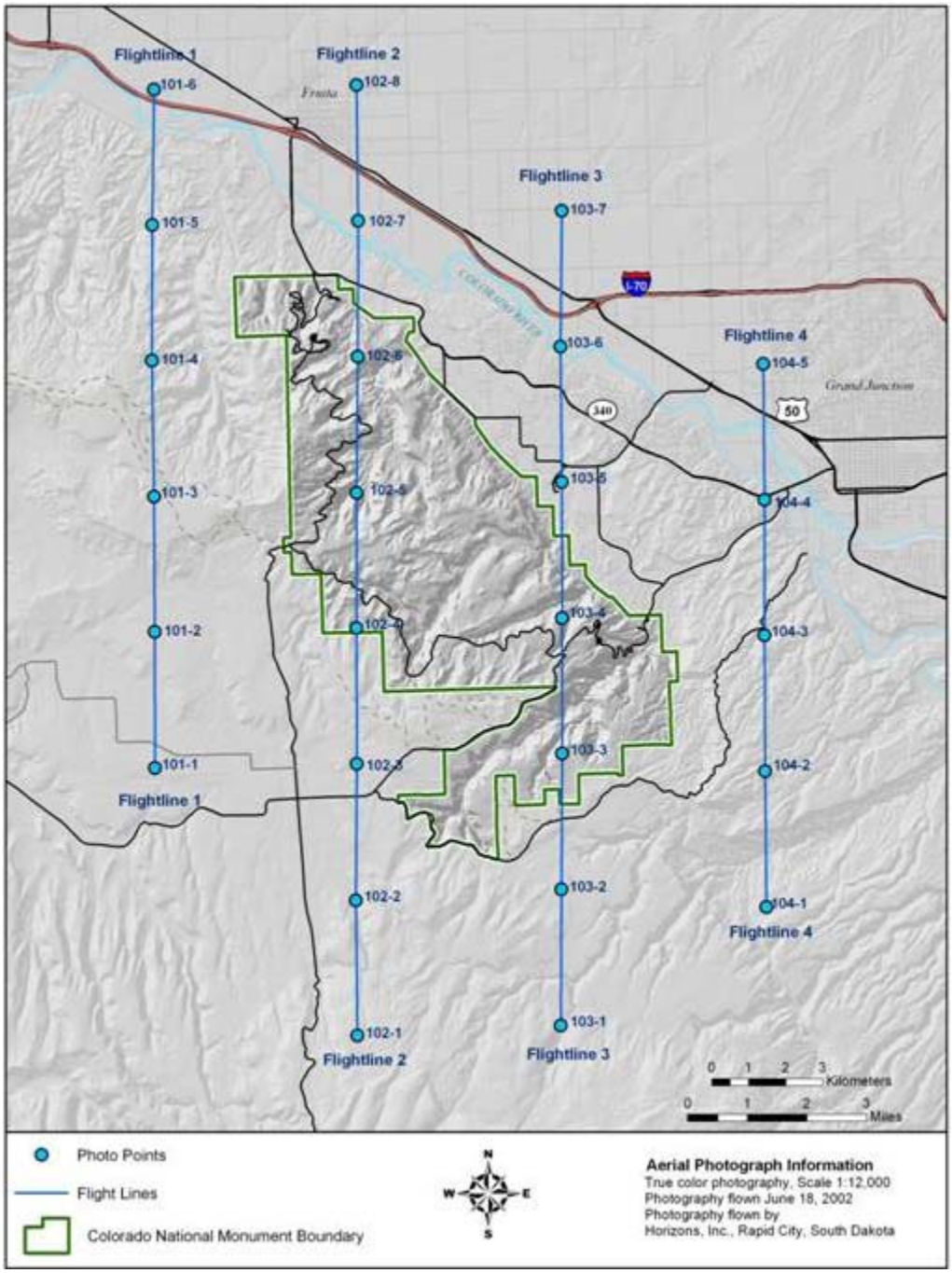


Figure 12. Flight lines for 2002 orthophotography coverage of NABR.

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

- Colorado Plateau Hanging Garden (CES304.764)
- Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)
- Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)
- Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
- Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)
- Inter-Mountain Basins Semi-Desert Grassland (CES304.787)
- Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)
- Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)
- Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)
- Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)
- Southern Rocky Mountain Ponderosa Pine Woodland (CES306.648)

Vegetation Classification and Description

Pre-Field Methods

Preliminary Classification List

A preliminary list of vegetation associations and alliances for NABR was compiled during work plan development. E^2M developed this list by selecting from NVC plant associations and alliances (NatureServe Explorer 2006) known to occur in the Northern Canyon Lands section of the Intermountain Semi-Desert and Desert Province (Bailey 2001). Previous vegetation classification work, floristic information for NABR and expert local knowledge were used to refine the list. This analysis created a preliminary list of approximately 170 plant associations for the vegetation mapping project area (Von Loh et al. 2003). This list was used to plan field work and assign provisional association names to vegetation plots and observation points.

Legacy Data Review

Existing vegetation data for NABR were reviewed for possible use in the classification. This legacy data review is documented in the NABR project work plan (Von Loh et al. 2003). Existing data from three vegetation monitoring transects within NABR did not meet the standards for classification analysis. The final vegetation classification was derived from new field data collected specifically for the NABR vegetation mapping project.

Field Methods

The primary purpose of classification plot data was to derive quantitative information documenting the composition and structure of NABR's vegetation and associated environmental conditions. These data became the basis for classifying the vegetation at the Monument. Field methods used in the NABR vegetation mapping project followed national program standards (e.g., TNC and ESRI 1994a, 1994b). The methods for conducting classification plot (also known as relevé) sampling are widely used by ecologists. 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 defined additional data fields to meet needs of network managers. Plot forms and individual data field descriptions appear in Appendix B. This section is a summary of the vegetation plot methods used at NABR.

Field Sampling Approach

The sampling area included the entire Monument as well as BLM and State of Utah lands in the environs (Figure 1). Because the project area is relatively small and accessible, the decision was made in 2002 not to use a formal modified gradient-oriented transect (gradsect) analysis to determine sampling locations. Instead, field crews used a combination of aerial photographs, biophysical information, topographic maps, and field reconnaissance to select representative plot

locations. Most areas within NABR were accessible for sampling except steep canyon walls. Field crews were led by ecologists with experience sampling plant communities on national parks and other landscapes. The list of 170 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 NABR project area. However, some common associations were sampled more often and some rare types were sampled less often. An effort was made to achieve good spatial distribution of plots across the landscape and to capture the full range of variation of each association.

The initial data collection was completed in July 2003. An analysis of these data indicated that some geographic areas (canyon rims, colluvial slopes) were under-sampled. These areas were targeted for additional sampling in April and June 2004. Eighty vegetation plots and 17 observation points were sampled in 2003 and 2004 (Figure 13).

Plot Data Collection

Field crews located classification plots subjectively within 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 at least 0.5 hectares. Plots were generally located in stands exceeding the minimum mapping unit (MMU) of 0.5 hectares. A few plots were sampled in smaller vegetation patches of distinctive or rare species aggregations, such as hanging gardens and riparian plant communities. Plot size and shape requirements were consistent with national Vegetation Characterization Program guidelines (TNC and ESRI 1994a). Plot size was determined by the physiognomy of the community being sampled (Table 3). NABR plots were typically circular, but plot shape was adjusted as needed to sample linear bands of vegetation in drainage bottoms. Plot size and shape were recorded for all NABR plots.

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

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

Location and Plot Identifiers. The bounds of each plot were marked using measuring tapes. The Universal Transverse Mercator (UTM) XY coordinates at the center of each plot were recorded (zone 12, NAD83) on 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.

NABR staff requested that the vegetation plot locations not be permanently marked. Locations were recorded on topographic maps during each field trip to avoid duplication of effort and ensure that the Monument was adequately sampled.

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

- location and plot identifiers
- environmental description
- vegetation description

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

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

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

Vegetation Description. Every vascular plant species in each plot was assigned to one of 14 physiognomic strata (Appendix 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 relating the area occupied by an individual species to the area of the entire plot. When it was not possible to identify a species in the field, plant material was collected and pressed for later identification. All plant material collected for identification was destroyed in analysis. Provisional plant association names were assigned to each plot using the preliminary association list and professional judgment.

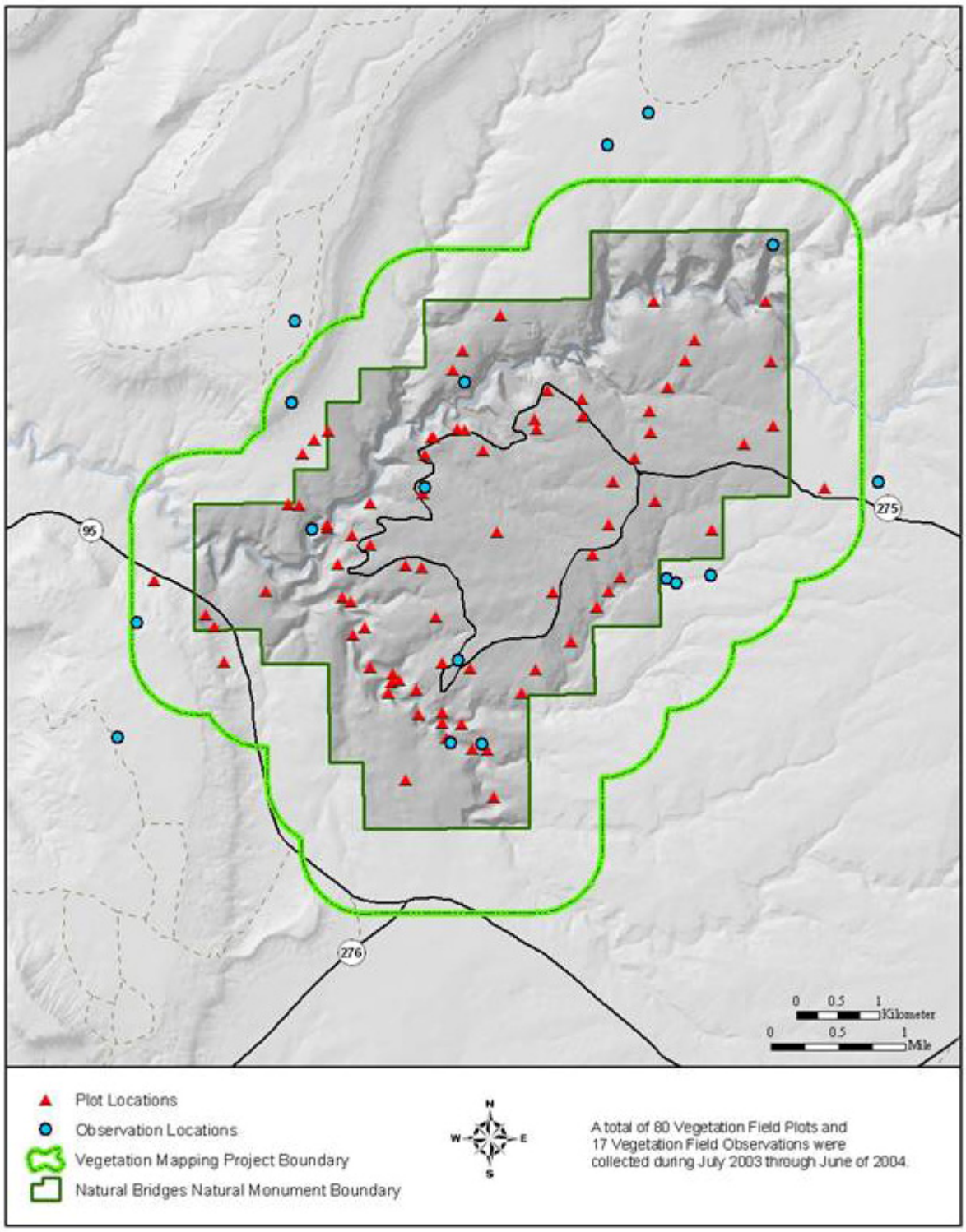


Figure 13. Vegetation plot and observation point locations in the NABR mapping project area.

Descriptive 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, andsite disturbance history. The overall character of the vegetation and features of each plot were recorded in two 35 mm color slide photographs. In most plots, a photograph was taken to document soil crusts.

Table 5. Vegetation cover and height classes used in the NABR 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

Eighty vegetation plotswere sampled within the mapping project area during the 2003 and 2004 field seasons (Figure 13). Plot data were manually entered into the NABR 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 Characterization Program by TNC (1997). The NABR database offers NCPNgreater flexibility in overall data management than does the NatureServe PLOTS database. The NCPN database was designed to accommodate all project data including plots, observation points, fuels data, and accuracy assessment points. Data standards were established by NCPN for all network vegetation mapping projects, allowing compatibility of data across network park units. Fields associated with the NABR plots database are described in Appendix C.

Each 35 mm slide associated with the project was scanned into digital format. The 769 digital images were stored in a photograph database. Of these, 29 photos document soil crust conditions. A unique identifier allows each photograph to be linked with the plots and spatial databases.

Observation Points

In addition to classification plots, field crews collected vegetation and environmental data at 17 observation points. Data collected at observation points reflected the vegetation of an undefined area around the point rather than a measured plot, and were less detailed (Appendix B). These data were intended primarily to support modeling and interpretation of the aerial imagery, but were also used to help describe plant associations. Field crews could choose to sample an observation point instead of a full classification plot when:

- the were sampling the environs
- the vegetation was highly disturbed, ecotonal, or otherwise anomalous
- cartographers requested documentation of a specific photo signature or area
- they wished to document special features or vegetation occurring in stands smaller than 0.5 ha (1.24 acres).

A thorough quality assessment and quality check (QA/QC) was performed on all plot and observation point data following entry to the plots database. Individual plot data records were reviewed with the individual field data sheets in hand. Additional QA/QC was performed using a set of queries designed to identify inconsistencies across data fields and check for missing data. NCPN technicians standardized the scientific names in the database and noted name changes on the field forms. The primary authority used for plant names for the NABR vegetation mapping project and all other NCPN I&M projects is A Utah Flora (Welsh et al. 2003). It is important to note that NatureServe, a primary project partner, follows Kartesz (1999) as its primary nomenclatural authority. As a result, nomenclature used in the body of this report follows Kartesz, whereas nomenclature in the project database follows Welsh et al. (2003). Differences between the two nomenclatural authorities are reconciled in a crosswalk table (Appendix D).

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

Classification Data Analysis

Vegetation classification was accomplished through a multivariate analysis of vegetation plot data augmented by observation point data. Species cover data were exported in list format fromthe database then imported into PC-Ord (McCune and Mefford, 1999). Midpoints of canopy cover classes were used in all data analysis procedures. Exploratory multivariate statistical analyses (summary statistics, outlier analysis, ordination by Detrended Correspondence Analysis (DCA), cluster analysis, and Indicator Species Analysis (ISA)) were used with the objectives of summarizing the compositional and structural characteristics of the plant communities and assessing possible spatial patterns related to environmental gradients.

The matrix was initially evaluated to find outliers, which potentially distort the matrix. There were no apparent outliers in the dataset. An ordination analysis (McCune and Mefford 1999) revealed four clusters of plots (Figure 14) representing

- two-needle pinyon pine – Utah juniper / mixed shrubs vegetation
- canyon bottom vegetation (cottonwood, coyote willow, big sagebrush)
- mixed mesic coniferous and deciduous vegetation (hanging garden, Douglas-fir, Gambel oak, mountain mahogany)
- grasslands (blue grama andneedle-and-thread)

Cluster analysis and indicator species analysis (Dufrêne and Legendre 1997) were used to separate plots in the four groups into vegetation associations.

Following preliminary classification, each plot was provisionally assigned an association name and the entire dataset was then examined in detail by NatureServe ecologists. NatureServe finalized the classification in a July 2004 report (Appendix E).

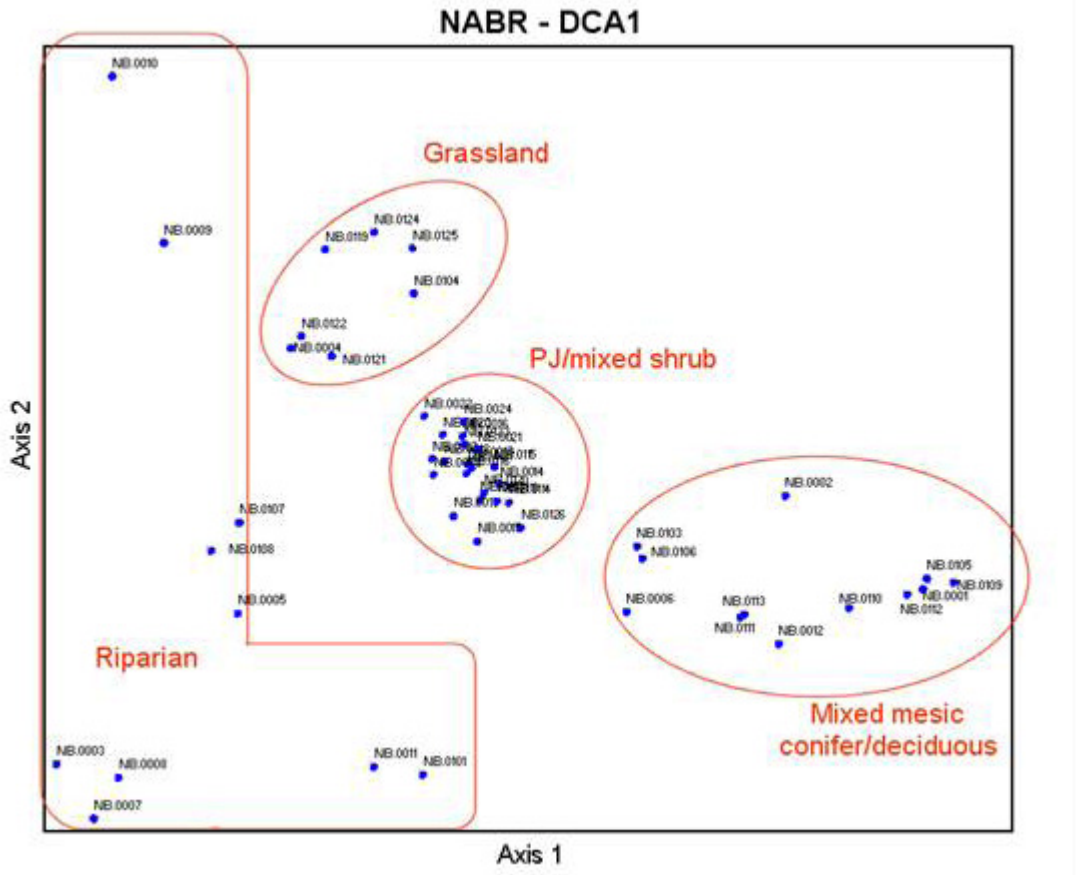


Figure 14. Detrended correspondence analysis ordination diagram for vegetation plots from NABR. Four major vegetation groups resulted from this analysis, which were then parsed using other methods to identify vegetation associations.

Classification Results

The vegetation of the NABR mapping project area classified into 35 plant associations in 17 NVC alliances and 11 ecological systems (Table 6). Two of these plant communities were described as 'park specials' because they occur as small patches or stands, are not included in the NVC, and appear to be unique to the Monument. The vegetation includes three forest, 12 woodland, nine shrubland, eight riparian/wetland, and three grassland associations. One shrubland association is dominated by non-native perennial grasses; the others describe native vegetation. Four plant associations were documented during the accuracy assessment phase.

Table 6. Plant associations identified within the NABR vegetation mapping project area*.

NVC Association	Common Name	CEGL Code†
UPLAND ASSOCIATIONS		
FORESTS		
Southern Rocky Mountain Dry Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)‡		
Pseudotsuga menziesii / Arctostaphylos patula Forest	Douglas-fir / Greenleaf Manzanita Forest	CEGL000423
Pseudotsuga menziesii / Quercus gambelii Forest	Douglas-fir / Gambel Oak Forest	CEGL000452
Pseudotsuga menziesii / Symphoricarpos oreophilus Forest	Douglas-fir / Mountain Snowberry Forest	CEGL000462
WOODLANDS		
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)		
Pinus edulis – Juniperus osteosperma / Cercocarpus intricatus Woodland	Two-needle Pinyon – Utah juniper / Curl-leaf Mountain-mahogany Woodland	CEGL000779
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)		
Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata Woodland	Two-needle Pinyon - (One-seed Juniper, Utah Juniper) / Needle-and-Thread Woodland	CEGL000797
Pinus edulis – Juniperus osteosperma / Arctostaphylos patula Woodland	Two-needle Pinyon – Utah juniper / Greenleaf Manzanita Woodland	CEGL002939
Pinus edulis – Juniperus spp. / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland	Two-needle Pinyon – Juniper / Big Sagebrush Woodland	CEGL000776
Pinus edulis – Juniperus spp. / Cercocarpus montanus – Mixed Shrub Woodland	Two-needle Pinyon –Juniper / Mountain-mahogany Mixed Shrub Woodland	CEGL000780
Pinus edulis – Juniperus osteosperma / Petradoria pumila Woodland	Two-needle Pinyon – Utah juniper / Grassy Rock Goldenrod Woodland	CEGL002332
Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland	Two-needle Pinyon - Utah Juniper / Pursh's Cliffrose Woodland	CEGL000782
Pinus edulis – Juniperus spp. / Quercus gambelii Woodland	Two-needle Pinyon – Juniper / Gambel Oak Woodland	CEGL000791
Pinus edulis – Juniperus osteosperma / Shepherdia rotundifolia Woodland	Two-needle Pinyon – Utah juniper / Roundleaf Buffaloberry Woodland	CEGL002335
Pinus edulis – Juniperus osteosperma / Sparse Understory Woodland	Two-needle Pinyon – Utah juniper / Sparse Understory	CEGL002148

Table 6. Plant associations identified within the NABR vegetation mapping project area*.

NVC Association	Common Name	CEGL Code†
Recently chained Pinus edulis – Juniperus osteosperma / Artemisia tridentata ssp. wyomingensis Woodland	N/A	Park Special
Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)		
Pinus edulis – Juniperus osteosperma / (Shepherdia rotundifolia – Amelanchier utahensis) Wooded Shrubland	Two-needle Pinyon – Utah juniper / (Roundleaf Buffaloberry – Utah Serviceberry) Woodland	CEGL002334
Southern Rocky Mountain Ponderosa Pine Woodland (CES306.648)		
Ponderosa Pine Population	N/A	Park Special
SHRUBLANDS		
Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)		
Quercus gambelii / Sparse Understory Shrubland	Gambel oak / Sparse Understory Shrubland	CEGL002337
Quercus gambelii / Symphoricarpos oreophilus Shrubland	Gambel oak / Mountain Snowberry Shrubland	CEGL001117
Quercus gambelii / Amelanchier utahensis Shrubland	Gambel Oak / Utah Serviceberry Shrubland	CEGL001110
Rocky Mountain Lower Montane-Foothill Shrubland (CES306.818)		
Amelanchier (utahensis, alnifolia) – Cercocarpus montanus Shrubland	Serviceberry – Alderleaf Mountain-mahogany Shrubland	CEGL001070
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)		
Cercocarpus intricatus Slickrock Sparse Vegetation	Littleleaf Mountain Mahogany Slickrock Sparse Vegetation	CEGL002977
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)		
Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Semi-natural Shrubland	Big Sagebrush - (Rubber Rabbitbrush) / Cheatgrass Semi-natural Shrubland	CEGL002699
Artemisia tridentata ssp. tridentata / Hesperostipa comata Colorado Plateau Shrubland	Basin Big Sagebrush / Needle-and-Thread Colorado Plateau Shrubland	CEGL002966
Artemisia tridentata ssp. wyomingensis / (Agropyron cristatum, Psathyrostachys juncea) Seeded Grasses Semi-natural Shrubland	Wyoming Big Sagebrush / Seeded Grasses Semi-natural Shrubland	CEGL002185
GRASSLANDS		
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)		
Bouteloua gracilis Herbaceous Vegetation	Blue Grama Herbaceous Vegetation	CEGL001760

Table 6. Plant associations identified within the NABR vegetation mapping project area*.

NVC Association	Common Name	CEGL Code†
Hesperostipa comata Great Basin Herbaceous Vegetation	Needle-and-Thread Great Basin Herbaceous Vegetation	CEGL001705
Pleuraphis jamesii Herbaceous Vegetation	James' Galleta Herbaceous Vegetation	CEGL001777
RIPARIAN, WETLAND AND MESIC ASSOCIATIONS		
Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.821)		
Populus angustifolia / Rosa woodsii Forest	Narrowleaf Cottonwood / Woods' Rose Forest	CEGL000653
Populus deltoides (ssp. wislizeni, ssp. monilifera) / Artemisia tridentata Woodland	Cottonwood / Basin Big Sagebrush Woodland	CEGL005966
Populus deltoides (ssp. wislizeni, ssp. monilifera) / Pascopyrum smithii Woodland	Cottonwood / Western Wheatgrass Woodland	CEGL002680
Populus deltoides (ssp. wislizeni, ssp. monilifera) / Salix exigua Woodland	Cottonwood / Coyote Willow Woodland	CEGL002685
Populus deltoides ssp. wislizeni / Acer negundo Woodland	Rio Grande Cottonwood / Box Elder Woodland	CEGL000662
Populus fremontii / Salix (ligulifolia, lutea) Woodland	Fremont Cottonwood / (Strapleaf, Yellow) Willow Woodland	CEGL004002
Salix exigua / Mesic Graminoids Shrubland	Coyote Willow / Mesic Graminoids Shrubland	CEGL001203
Colorado Plateau Hanging Garden (CES304.764)		
Aquilegia micrantha – Calamagrostis scopulorum Herbaceous Vegetation	Mancos Columbine - Ditch Reedgrass Herbaceous Vegetation	CEGL002592

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

† The CEGL code is assigned by NatureServe to track NVC associations within their databases. 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 NABR vegetation by physiognomic group. Appendix F provides detailed local and global descriptions of the 35 plant associations 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 plant associations at NABR fit into defined NVC concepts. A few associations represent local variations of NVC types, three are unique to the Monument, and two are not classified within the NVC.

Forest Associations

Forested vegetation types are uncommon within NABR and occur in small stands on mesic sites. Stands are subject to landslides, flash floods, bank scouring, and rockfall from adjacent high cliffs. Channels were generally incised up to several meters deep, except where they were controlled by bedrock. Most examples at NABR do not have the closed tree canopy that usually characterizes forest (as opposed to more open woodland) associations. The forest associations at NABR include:

- *Populus angustifolia / Rosa woodsii* Forest
- *Pseudotsuga menziesii / Arctostaphylos patula* Forest
- *Pseudotsuga menziesii* / *Quercus gambelii* Forest
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Forest

The mature narrowleaf cottonwood community occurs on sandy mid-level terraces deposited in the bottom of Armstrong Canyon. This type is rarely flooded, although a severe September 2003 flood scoured the understory of this stand, removing many of the shrubs and herbaceous species.

Douglas-fir stands are restricted to cool sites with supplemental water, such as upper canyon floors or north-facing slopes below canyon rims. Montane shrubs such as Gambel oak, mountain snowberry and serviceberry dominate the understory of most Douglas-fir communities.

Woodland Associations

Woodlands occupy two ecological situations within the Monument: deciduous woodlands growing on mesic sites in canyons or evergreen woodlands occupying xeric habitats on mesas, canyon rims, slopes, and alluvial fans. Xeric woodlands of pinyon pine and Utah juniper comprise most of the vegetation cover in NABR. The deciduous and evergreen woodland associations of NABR include:

- *Pinus edulis – Juniperus osteosperma* / *Arctostaphylos patula* Woodland
- *Pinus edulis – Juniperus* spp. */ Artemisia tridentata* (ssp. *wyomingensis, vaseyana*) Woodland
- *Pinus edulis – Juniperus osteosperma* / *Cercocarpus intricatus* Woodland

- *Pinus edulis – Juniperus* spp. */ Cercocarpus montanus* - Mixed Shrub Woodland
- *Pinus edulis – (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata* Woodland
- *Pinus edulis – Juniperus osteosperma* / *Petradoria pumila* Woodland
- *Pinus edulis – Juniperus* spp. / *Quercus gambelii* Woodland
- *Pinus edulis – Juniperus osteosperma* / *Shepherdia rotundifolia* Woodland
- *Pinus edulis – Juniperus osteosperma / (Shepherdia rotundifolia – Amelanchier utahensis*) Wooded Shrubland
- *Pinus edulis – Juniperus osteosperma* / Sparse Understory Woodland
- *Pinus ponderosa* (Ponderosa Pine) Population
- *Populus angustifolia / Rosa woodsii* Woodland
- *Populus deltoides (*ssp. *wislizenii,* ssp. *monilifera)* / *Artemisia tridentata* Woodland
- *Populus deltoides (*ssp. *wislizenii,* ssp. *monilifera)* / *Pascopyrum smithii* Woodland
- *Populus deltoides* (ssp. *wislizenii,* ssp. *monilifera*) / *Salix exigua* Woodland
- *Populus deltoides* ssp. *wislizeni / Acer negundo* Woodland
- *Populus fremontii / Salix (ligulifolia, lutea)* Woodland

Most of the xeric (pinyon-juniper) woodlands have a shrub-dominated understory. North-facing Chinle or Moenkopi shale slopes with a veneer of colluvium support open woodlands with a diverse shrub understory dominated by roundleaf buffaloberry, Utah serviceberry, Wyoming big sagebrush, and mountain mahogany. Other open woodlands occupy shallow soils and bedrock fractures on canyon rims; these stands have a diverse understory dominated by greenleaf manzanita or littleleaf mountain mahogany, sometimes with spiny greasebush. In deeper soils away from or below the rim, woodlands have an understory in which true mountain mahogany is dominant. Small stands with an undestory of Gambel oak occupy terraces in the canyons.

Deeper soils of the mesa tops support a mosaic of denser pinyon-juniper woodlands with a shrub understory that is generally sparse, sometimes sparse enough to be classified as such in the absence of other floristic identifiers. Otherwise there is generally between 5% and 20% cover by Wyoming big sagebrush, Utah serviceberry or roundleaf buffaloberry, generally with few other species present. Spatial boundaries between these associations are indistinct, however, with understory species intermingling across broad areas.

Pinyon-juniper woodlands with an herbaceous understory are uncommon in NABR. Stands with blue grama or needle-and-thread in the understory occur on the bench between Deer Canyon and Deer Mesa. Tiny stands also occur on canyon bottoms. Another rare woodland type that tends to occur on thin soils with exposed sandstone has a sparse grassy rock goldenrod understory.

A small stand of mature ponderosa pine occupies a north-facing slope in the North Fork of Tuwa Canyon. The open understory includes pinyon pine, Utah juniper, and Utah serviceberry.

Riparian woodlands are dominated by a mature, open canopy of Rio Grande cottonwood, Fremont cottonwood or a hybrid between the two. Most stands are on middle to upper terraces that are not subject to flooding in most years. The understory therefore often is dominated by upland species such as basin big sagebrush or rabbitbrush. Stands on lower terraces have a more

mesic understory that may include box elder, yellow willow, western wheatgrass or coyote willow. These stands were severely damaged by the September 2003 flood.

Shrubland Associations

Shrub-dominated associations are common but patchy within the mapping area, tending to occur where deeper soils are available. They include a mix of xeric, mesic and riparian types:

- *Amelanchier* (*utahensis, alnifolia*) – *Cercocarpus montanus* Shrubland
- *Artemisia tridentata* ssp. *tridentata / Hesperostipa comata* Shrubland
- *Artemisia tridentata* ssp. *wyomingensis / (Agropyron cristatum, Psathyrostachys juncea)* Seeded Grass Semi-natural Shrubland
- *Quercus gambelii* / Sparse Understory Shrubland
- *Quercus gambelii / Symphoricarpos oreophilus* Shrubland
- *Salix exigua* / Mesic Graminoids Shrubland

Deep soils on the mesa tops support Wyoming big sagebrush shrublands; these usually result from disturbance in pinyon-juniper / Wyoming big sagebrush woodlands. Most stands have been planted with exotic grasses and contain seedling trees. Cool, rocky canyon slopes support a mixed mountain shrubland dominated by Utah serviceberry and true mountain mahogany, with occasional green Mormon-tea, singleleaf ash, or Gambel oak shrubs.

Canyon bottoms support a diversity of shrublands. Gambel oak shrublands occur on high stream terraces, drainages and toeslopes with well-drained alluvial soils. The oak shrubs are usually tall and even-aged. The understory is controlled by a dense litter layer. Root sprouts of Gambel oak are the common understory component, although snowberry may be common in more mesic stands. Basin big sagebrush shrublands are restricted to point bars. These stands are subject to intermittent flooding, scouring and sediment deposition. They consist of dense tall shrubs with a sparse understory of native grasses. Stands represent a later stage of the needle-and-thread herbaceous vegetation association. Coyote willow / mesic graminoids shrublands occur in small patches adjacent to channels in the canyons of NABR. Stands were severely affected by the September 2003 flood; all that remained after the event were sparse stands of coyote willow. Before the flood, yellow willow was generally co-dominant and stands were dense.

Herbaceous Associations

Graminoid associations are uncommon within the mapping area, with most occurring as small patches on point bars or bedrock ledges. The only documented forb association at NABR was a hanging garden type. Herbaceous-dominated associations of NABR include:

- *Bouteloua gracilis* Herbaceous Vegetation
- *Hesperostipa comata* Great Basin Herbaceous Vegetation
- *Pleuraphis jamesii* Herbaceous Vegetation
- *Aquilegia micrantha – Calamagrostis scopulorum* Herbaceous Vegetation

Rare, small patches of grassland dominated by blue grama, galleta, needle-and-thread, or ricegrass occur in potholes on the first ledge below the main canyon rim. Small stands also occur on ridges and elevated, inactive terraces in the bottom of White Canyon.

Hanging gardens are present on canyon walls and alcoves throughout NABR, where lenses of shale create an impermeable contact zone for groundwater percolating through layers of sandstone. The seeps are notable for the associated dark green line of vegetation and the white color that remains as water evaporates and deposits a crust of salts on the otherwise pink-to-red rock face of the surrounding cliffs. Mancos columbine (Aquilegia micrantha) is the common diagnostic forb characterizing these wetland communities throughout the Colorado Plateau. Drier seeps may be dominated by little bluestem.

Field Key Preparation

An illustrated dichotomous field key to plant associations of the NABR 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, tall shrubland, shrubland, dwarf-shrubland, graminoid, or forb. The second level focuses on the dominant species' canopy cover. Brief environmental descriptions are included with the floristic descriptions to assist in identifying plant associations. To increase the utility of the key, individual plant associations are cross-referenced to map classes.

The field key was constructed from data collected during the classification phase of the mapping project and revised following accuracy assessment of the map. Because the key is based on a sample of the vegetation, it probably does not account for all associations occurring within the Monument, nor does it explain the full range of variation of all associations as they appear in the Monument.

The field key was tested by NatureServe using NABR 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.

Assessment of Global Rarity

NABR represents the dry eastern edge of the Colorado Plateau. Because water is a limiting factor, riparian and wetland plant species, although regionally common, are rare within the Monument. Plants associated with hanging gardens that occur where Cedar Mesa Sandstone overlies impervious rock layers and seeps emerge are of special concern. Few plant associations at NABR are considered globally imperiled (NatureServe Explorer 2006); however, not enough is known about the abundance or distribution of many of NABR’s associations to evaluate global rarity. As more field data are evaluated, NatureServe ecologists will develop rankings of global rarity and post them on its Explorer Web site (http://www.natureserve.org/explorer).

NatureServe and its network of state natural heritage programs indicate the rarity and degree of

imperilment of plant communities by assigning a global conservation status rank to each. The rank scale ranges from 1 to 5; a rank of 1 indicates critical imperilment due to rarity, endemism, and/or threats, while a rank of 5 indicates little or no risk of extirpation of the plant community. No plant associations within NABR are considered critically imperiled (G1). Two associations are considered imperiled (G2): *Amelanchier (utahensis, alnifolia) – Cercocarpus montanus* Shrubland and *Pinus edulis – (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata* Woodland (Figure 15). Eighteen 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 NABR are subject to change over time; drought and fire are the most likely agents of change. Because of recent regional drought and a general change over time to a warmer and drier climate, all riparian and wetland plant communities within NABR are threatened to some degree. This threat is heightened due to the introduction of non-native plant species that invade mesic habitats more readily than dry upland habitats. Flash flooding in September 2003 had an observable negative effect on riparian plant communities by eroding away sediment bars on which they had become established. Individual trees, shrubs, and small stands were injured and some were buried by sediment scouring and re-deposition.



Photo credit: NCPN

Figure 15. The globally imperiled *Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata* Woodland association at NABR.

Fuels Data Collection

Fuels data were not analyzed as part of this project and data pertinent only to fuels modeling were not collected. The plot photographs and some of the data collected for vegetation classification (see below) may be useful for fuels management.

Fuels Data

Data collected in the vegetation plots at NABR that are potentially useful for fuels modeling include stem diameter at root crown for pinyon and juniper trees and stem diameter at breast height for ponderosa pine, Gambel oak, cottonwood and Douglas-fir trees. Sampled pinyon-juniper stands were assigned to one of four age-class categories: old-growth, mature, young, or invasive.

Vegetation Mapping

Methods

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

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

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

Field Reconnaissance

Reconnaissance was conducted independently of the vegetation plot data collection in 2003. The photointerpreter visited the Monument to assign plant communities or complexes to distinct signatures on the orthophotographs. Understanding environmental drivers influencing vegetation patterns and identifying what information could be extracted from the project imagery were other important products of the reconnaissance. Field notes were written directly on paper plots of the stereo photographs; these guided the photo interpretation and mapping process.

Observation point data collected by field crews provided additional documentation of the vegetation for the photointerpreter. Seventeen observation points were collected within the NABR vegetation mapping project area (Figure 13). At each point, a subset of vegetation and environmental data was collected (Appendix B). Vegetation information was recorded only for the most abundant species present at each sampling location. Observation points varied in size, but usually approximated the minimum mapping unit (MMU) of 0.5 hectares. Observation point data were used primarily to support photointerpretation and mapping. However, a subset of these data was used to augment vegetation description in the following circumstances: 1) unique vegetation too small for a fixed-plot, 2) inaccessible areas where the vegetation could be viewed from a distance, and 3) special features occupying areas smaller than 0.5 ha (1.2 acres). Overall conditions at each observation point were documented with one or more 35mm color slide photographs. Thirty-two color slides of observation points were acquired.

Observation point data were entered into the plots database developed for this project and then subjected to a thorough quality assessment procedure. Slides were tagged with archival quality labels generated from the project database. At the time of film processing, each slide was scanned into digital format. The digital images are stored in a photo database managed by the NCPN Inventory and Monitoring Program and were available to the photointerpreter.

Map Class and Polygon Attribute Development

The goal of mapping was to identify meaningful units to represent existing vegetation and land uses for the NABR vegetation mapping project area. Map classes specific to this project were developed to characterize vegetation types within the Monument and most of the environs. Standard land-use map classes (Anderson et al. 2002) were used to map developed parts of the mapping area such as park facilities and roads.

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

In order to facilitate use of vegetation maps and mapping data across multiple parks, the NCPN adopted a convention for naming and presenting map classes. For each map class representing an NVC plant association, the NatureServe common name (e.g. Utah Juniper / Talus Mixed Shrub Woodland) was used. To facilitate tracking and management of vegetation map class information, a coding system was developed. The original map class coding system assigned a unique number to each map class. Although these numeric codes have been retained within the spatial database and map class keys (Appendix I), a complementary, five-letter alphacode system for map classes was created for all park vegetation mapping projects. Each alphacode begins with the first letter of the corresponding NVC Class (F = Forest, W = Woodland, S = Shrubland, H = Herbaceous and N = nonvascular). The subsequent four letters generally abbreviate the map class name. For example, the Pinyon-Juniper / Mixed Shrub Woodland map class is represented by the alphacode “W-PJSH”. For map classes representing coarser levels of the NVC, geologic exposures, and other non-vegetated features, generic names incorporating vegetation and landscape features were used. Geologic exposures were given the prefix G = geology and developed sites the prefix L = land cover/land use.

Photo interpretation and polygon labeling and attribution procedures were standardized for all park vegetation mapping projects (Evenden 2004). After a map class was assigned to each polygon, the polygon was assigned attributes to characterize vegetation structure (density, pattern, height; Table 7), land use and disturbance. All map polygons were assigned to a land cover / land use type (Anderson et al. 2002; Appendix H). In addition, all polygons were assigned to a corresponding level of the NVC hierarchy, with the exception of non-vegetated map classes, which were coded as ‘unclassified’ or ‘unvegetated’ in the NVC columns.

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

Category	Attribute	Description

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

NCPN photo interpretation standards defined a suite of polygon modifiers to describe altered vegetation, landforms, transportation and utilities, and other situations (Evenden 2004). Table 8 is a list of the modifiers used in the NABR project.

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

Category	Code	Name	Description
Vegetation Modifiers	a	Altered	Applies when some alteration is evident, but the type is visually indistinguishable from unaltered stands
	d	Chained	Refers to woodlands and shrublands that have been significantly altered by chaining and seeding to exotic pasture grasses. Lines left by bulldozers evident.
	r	Bare exposed rock/sandstone cliffs	Bedrock outcrops forming flat expanses, ledges, and vertical exposures of sedimentary rock
	s	Barren wash bottom	Cobble, gravel, sand and/or silt constantly rearranged during runoff from precipitation events and by wind during dry periods.
Transportation Modifiers	t	Paved road	A transportation corridor consisting of a roadbed topped by an asphalt or concrete surface. Right-of-way typically extends to the limit of the cut and fill slopes
	u	Gravel/dirt road	A transportation corridor consisting of a roadbed of imported gravel or graded native soil. Cut and fill slopes may or may not be present

Park Specials

In the scoping phase of the project, Monument staff identified several natural resource features of interest that might otherwise not have been sampled or mapped. NABR staff requested that the locations of springs and seeps (hanging gardens) and those of the exotic shrub tamarisk be noted as they were encountered. These features were documented with plots but mapped as points because they could not be seen on the aerial imagery.

Mapping

The mapping component of the NABR project used a combination of methods to interpret and delineate vegetation polygons. A trained interpreter visually examined the 9 x 9-inch photographs in stereo to identify vegetation polygons. Polygons were drawn on Mylar overlays that were later scanned, or digitally on a computer screen. Digitizing was performed using vector editing in ArcGIS. Each vegetation and land use polygon so produced was given map class and other descriptive attributes. The Monument and an area of environs surrounding it were interpreted and mapped to the same level of detail.

Spatial Database Development

Each polygon was assigned a map class number, alpha code and name, Anderson land use class, and vegetation density, pattern, and height attributes. In order to improve the utility of the map and related data, the spatial database was moved into a geodatabase format, the general structure of which is illustrated in Figure 16. This format allows text and image information to be incorporated and linked to spatial coordinates. A more detailed description of the geodatabase is provided in Appendix C.

Map Classes

Twenty map classes were developed to describe the NABR vegetation mapping project area (Table 9). Of these, 17 are vegetation map classes and 3 are non-vegetated land-use map classes. Of the 17 vegetation map classes, one is represented by points only, one is a single polygon, and three represent single NVC plant associations. The remaining 12 vegetation map classes contain multiple plant associations.

Ecological systems (Comer et al. 2003) are used to organize the vegetation map classes. They were developed by NatureServe to complement the finer-scale NVC by creating a mappable classification unit representing groups of biologic communities in similar environments and shaped by similar ecologic processes. Ecological systems typically occur in patches of tens to thousands of hectares and are expected to persist for 50 or more years. The timeframe allows successional dynamics to be integrated into the concept of each ecological system.

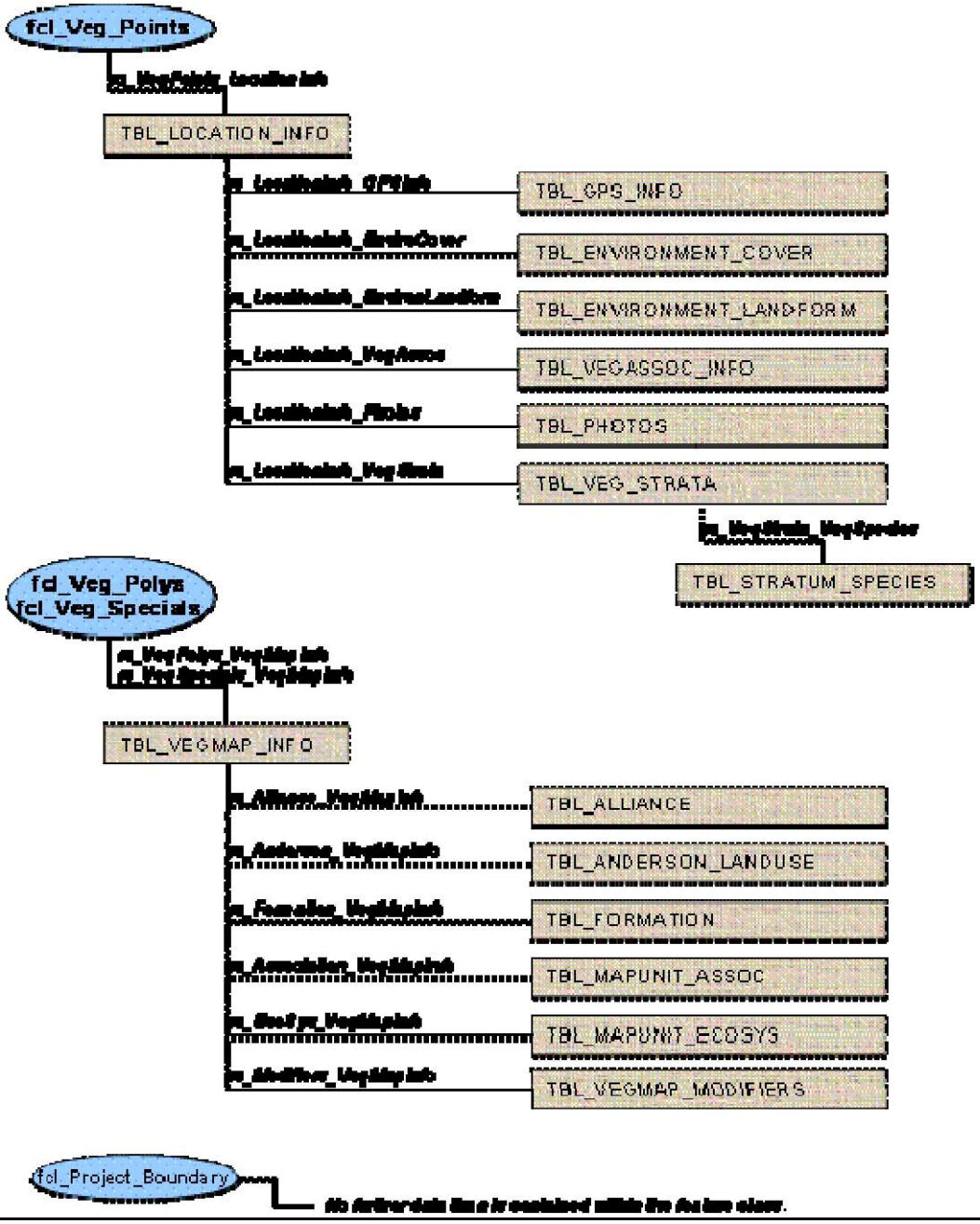


Figure 16. Structure of the NABR geodatabase.

Results

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

Table 9. Map classes used in the NABR vegetation map, with map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations. NABR vegetation map classes are arranged using the NatureServe ecological systems classification.

Map Class #	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)				
12	W-DOFI	Douglas-fir Woodland	*Pseudotsuga menziesii* / *Arctostaphylos patula* Forest *Pseudotsuga menziesii* / *Quercus gambelii* Forest *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Forest	1 to many
Southern Rocky Mountain Ponderosa Pine Woodland (CES306.648)				
14	W-PIPO	Ponderosa Pine / Pinyon-Juniper Woodland	Ponderosa Pine Stand [Park Special]	1 : 1
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)				
9	W-PJLM	Pinyon-Juniper / Littleleaf Mountain Mahogany Woodland	*Pinus edulis - Juniperus osteosperma* / *Cercocarpus intricatus* Woodland *Cercocarpus intricatus* Slickrock Sparse Vegetation *Pinus edulis - Juniperus osteosperma / Arctostaphylos patula* Woodland	1 : many
9r	C-SSV	Slickrock Sparse Vegetation	*Cercocarpus intricatus* Slickrock Sparse Vegetation *Pinus edulis - Juniperus osteosperma* / *Cercocarpus intricatus* Woodland	1 : many
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)				
15	W-PJWS	Pinyon-Juniper / Sagebrush Woodland	*Pinus edulis - Juniperus* spp. / *Artemisia tridentata* (ssp. *wyomingensis*, ssp. *vaseyana*) Woodland *Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland Recently chained *Pinus edulis – Juniperus osteosperma* / *Artemisia tridentata* ssp. *wyomingensis* Woodland [Park Special]	1 : many
16	W-PJSP	Pinyon-Juniper / Sparse Understory Woodland	*Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia* Woodland *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland	1 to many
18	W-PJNG	Pinyon-Juniper / Native Grass Woodland	*Pinus edulis* - (*Juniperus monosperma, Juniperus osteosperma*) / *Hesperostipa comata* Woodland *Pinus edulis - Juniperus osteosperma / Achnatherum hymenoides* Woodland	1 to many
Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)				
4	S-GOAK	Gambel Oak Tall Shrubland	*Quercus gambelii / Symphoricarpos oreophilus* Shrubland *Quercus gambelii /* Sparse Understory Shrubland	1 : many
Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)				
19	W-PJBB	Pinyon-Juniper / Buffaloberry-Serviceberry Woodland	*Pinus edulis - Juniperus osteosperma* / (*Shepherdia rotundifolia, Amelanchier utahensis*) Wooded Shrubland	1 : 1

Table 9. Map classes used in the NABR vegetation map, with map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations. NABR vegetation map classes are arranged using the NatureServe ecological systems classification.

Map Class #	Map Class Code	Map Class Name	Associations Assigned to Map Class	Relation
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)				
20	S-WYSB	Wyoming Sagebrush Shrubland	*Artemisia tridentata* ssp. *wyomingensis* / (*Agropyron cristatum, Psathyrostachys juncea*) Seeded Grasses Semi-natural Shrubland	1 : 1
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)				
21	H-NEED	Needle-and-Thread-Ricegrass Bunchgrass Grassland	*Hesperostipa comata* Great Basin Herbaceous Vegetation	1 : 1
22	H-GALL	Galleta – Blue Grama Grassland	*Bouteloua gracilis Herbaceous Vegetation* *Pleuraphis jamesii* Herbaceous Vegetation	1 : many
Multiple Ecological Systems: **Colorado Plateau Pinyon-Juniper Woodland (CES304.767)** **Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)** **North American Arid West Emergent Marsh (CES300.729)** **Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)**				
2	C-CABV	Canyon Bottom Vegetation	*Artemisia dracunculus* Herbaceous Vegetation [Park Special] *Artemisia tridentata ssp. tridentata / Hesperostipa comata* Shrubland *Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Semi-natural* Shrubland *Phragmites australis* Western North American Temperate Semi-natural Herbaceous Vegetation *Pinus edulis - Juniperus spp. / Quercus gambelii* Woodland *Populus angustifolia / Rosa woodsii* Forest *Populus deltoides (*ssp. *wislizeni,* ssp. *monilifera) / Artemisia tridentata* Woodland *Populus deltoides (*ssp. *wislizeni,* ssp. *monilifera) / Pascopyrum smithii* Woodland *Populus deltoides (*ssp. *wislizeni,* ssp. *monilifera) / Salix exigua* Woodland *Populus deltoides* ssp. *wislizeni / Acer negundo* Forest *Populus fremontii / Salix (ligulifolia, lutea)* Woodland *Salix exigua / Mesic Graminoids* Shrubland	1 : many
Multiple Ecological Systems: **North American Arid West Emergent Marsh (CES300.729)** **Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)**				
3	C-SCSB	Stream Channel – Sand Bar Sparse Vegetation	*Phragmites australis* Western North American Temperate Semi-natural Herbaceous Vegetation *Pinus edulis - Juniperus* spp. / *Quercus gambelii* Woodland *Populus angustifolia / Rosa woodsii Forest* *Populus deltoides (*ssp. *wislizeni,* ssp. *monilifera) / Artemisia tridentata* Woodland *Populus deltoides (*ssp. *wislizeni,* ssp. *monilifera) / Pascopyrum smithii* Woodland *Populus deltoides (*ssp. *wislizeni,* ssp. *monilifera) / Salix exigua* Woodland *Populus deltoides ssp. wislizeni / Acer negundo* Forest *Populus fremontii / Salix (ligulifolia, lutea)* Woodland *Salix exigua* / Mesic Graminoids Shrubland	1 : many

Table 9. Map classes used in the NABR vegetation map, with map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations. NABR vegetation map classes are arranged using the NatureServe ecological systems classification.

Map Class #	Map Class Code	Map Class Name	Associations Assigned to Map Class	Relation
Multiple Ecological Systems: Colorado Plateau Pinyon-Juniper Woodland (CES304.767) Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)				
17	W-PJSH	Pinyon-Juniper / Mixed Shrubs Woodland	*Pinus edulis - Juniperus osteosperma / Petradoria pumila* Woodland *Pinus edulis - Juniperus osteosperma / Arctostaphylos patula* Woodland *Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* - Mixed Shrub Woodland *Pinus edulis - Juniperus osteosperma / Amelanchier utahensis* Woodland *Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus* Woodland *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland	1 : many
Multiple Ecological Systems: Colorado Plateau Pinyon-Juniper Woodland (CES304.767) Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)				
17r	W-PJRL	Pinyon-Juniper / Mixed Shrubs Woodland Rock Ledge Complex	*Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* - Mixed Shrub Woodland *Pinus edulis - Juniperus* spp. / *Quercus gambelii* Woodland *Amelanchier (utahensis, alnifolia) - Cercocarpus montanus* Shrubland	1 : many
Mapped as Points Only, Not Polygons: Colorado Plateau Hanging Garden (CES304.764)				
1	H-HGSS	Hanging Garden	*Aquilegia micrantha – Calamagrostis scopulorum* Herbaceous Vegetation	1 : 1
Non-Vegetated (Anderson Land Use) Map Classes:				
220	L-PAFA	Park facility	NPS buildings and facilities, including housing, solar array, visitor center, parking lots, and outbuildings	N/A
226	L-ROAD	Road	Paved and dirt roads within the Monument, regardless of whether they are open to travel	N/A
320	L-QUBP	Quarry / Borrow Pit	Heavily disturbed and generally unvegetated areas adjacent to roads and parking areas	N/A

Map Class Descriptions

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

- a summary of the ecological concept of the map class. Summaries of map classes consisting of multiple plant associations include an explanation of why associations were grouped. Reference is made to the abundance of the map class within the project area
- a list of plant associations and common plant species occurring within the map class
- a qualitative description of the photographic signature along with representative samples from the orthophotography
- ground photographs
- statistics and accuracy assessment results

Map Polygons

One thousand two hundred-fifty polygons totaling 5,378 hectares (13,290 acres) were mapped at NABR. Average polygon size was 4.3 ha (10.6 acres). Lands within the Monument made up 3090 ha (7,637 acres) or 57% of the total project area. Of the total, 1,232 polygons (99%) represent natural or semi-natural vegetation map classes covering 99% of the mapping project area. Map classes representing non-vegetated roads, facilities and borrow pits account for the remaining 18 polygons (1% of polygons and area).

The polygon count includes adjacent polygons that have the same map code but different density or pattern attributes. The most common map class was Pinyon-Juniper / Mixed Shrubs Woodland (W-PJSH) with 319 polygons covering 35.4% of the mapping area. This map class also had the largest average polygon size at 6.0 ha (14.7 acres) per polygon.

Hanging gardens at NABR occupy vertical sites on cliff faces or alcoves under cliff overhangs and are generally not visible on aerial imagery. All stands within the Monument are also much smaller than the 0.5 ha MMU. This vegetation type was therefore mapped as a point layer based on observations made in the field.

Figure 17 is an example of a map of the vegetation of NABR created from the GIS spatial database. Because we used a geodatabase to store and organize spatial 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 NABR vegetation map polygons.

Table 10. Summary statistics for polygons of each map class developed for the NABR 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)							
W-DOFI	Douglas-fir Woodland	46	19	65	35.1	11.6	46.7
	Subtotal	*46*	*19*	*65*	*35.1*	*11.6*	*46.7*
Southern Rocky Mountain Ponderosa Pine Woodland (CES306.648)							
W-PIPO	Ponderosa Pine / Pinyon-Juniper Woodland	0	1	1	0	1.1	1.1
	Subtotal	*0*	*1*	*1*	*0*	*1.1*	*1.1*
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)							
W-PJWS	Pinyon-Juniper / Sagebrush Woodland	8	18	26	215.9	308.9	524.8
W-PJSP	Pinyon-Juniper / Sparse Understory Woodland	88	82	170	584.5	412.6	997.1
W-PJNG	Pinyon-Juniper / Native Grass Woodland	25	14	39	19.6	17.1	36.7
	Subtotal	*121*	*114*	*235*	*820*	*738.6*	*1558.6*
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)							
W-PJLM	Pinyon-Juniper / Littleleaf Mountain Mahogany Woodland	110	74	184	490.2	298.1	788.3
C-SSV	Slickrock Sparse Vegetation	83	55	138	385.1	152.7	537.8
	Subtotal	*193*	*129*	*322*	*875.3*	*450.8*	*1326.1*
Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)							
W-PJBB	Pinyon-Juniper / Buffaloberry-Serviceberry Woodland	2	6	8	9.9	190.1	200.0
	Subtotal	*2*	*6*	*8*	*9.9*	*190.1*	
Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)							
S-GOAK	Gambel Oak Tall Shrubland	31	1	32	9.5	0.6	10.1
	Subtotal	*31*	*1*	*32*	*9.5*	*0.6*	*10.1*
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)							
S-WYSB	Wyoming Big Sagebrush Shrubland	0	10	10	0	11.9	11.9
	Subtotal	*0*	*10*	*10*	*0*	*11.9*	*11.9*
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)							
H-NEED	Needle-and-Thread-Ricegrass Bunchgrass Grassland	22	4	26	5.8	1.3	7.1
H-GALL	Galleta – Blue Grama Grassland	3	1	4	2.6	0.1	2.7

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

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Monument	Environs	Total Area*	Monument	Environs	Total Area*
	Subtotal	*3*	*1*	*4*	*2.6*	*0.1*	*2.7*
MIXED ECOLOGICAL SYSTEMS **Colorado Plateau Pinyon-Juniper Woodland (CES304.767)** **Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)** **North American Arid West Emergent Marsh (CES300.729)** **Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)**							
C-CABV	Canyon Bottom Vegetation	73	23	96	76.6	18.8	95.4
	Subtotal	*73*	*23*	*96*	*76.6*	*18.8*	*95.4*
MIXED ECOLOGICAL SYSTEMS **North American Arid West Emergent Marsh (CES300.729)** **Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)**							
C-SCSB	Stream Channel – Sand Bar Sparse Vegetation	23	18	41	26.8	16.6	43.4
	Subtotal	*23*	*18*	*41*	*26.8*	*16.6*	*43.4*
MIXED ECOLOGICAL SYSTEMS **Colorado Plateau Pinyon-Juniper Woodland (CES304.767)** **Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)**							
W-PJSH	Pinyon-Juniper / Mixed Shrubs Woodland	189	130	319	997.7	904.5	1902.2
	Subtotal	*189*	*130*	*319*	*997.7*	*904.5*	*1902.2*
MIXED ECOLOGICAL SYSTEMS **Colorado Plateau Pinyon-Juniper Woodland (CES304.767)** **Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)**							
W-PJRL	Pinyon-Juniper / Mixed Shrubs Woodland Rock Ledge Complex	54	19	73	106.4	20.1	126.5
	Subtotal	*54*	*19*	*73*	*106.4*	*20.1*	*126.5*
MAPPED AS POINTS ONLY, NOT POLYGONS **Colorado Plateau Hanging Garden (CES304.764)**							
H-HGSS	Hanging Garden	6	0	6	N/A	N/A	N/A
	Subtotal	*6*	*0*	*6*	*N/A*	*N/A*	*N/A*
LAND USE MAP CLASSES							

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

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Monument	Environs	Total Area*	Monument	Environs	Total Area*
L-PAFA	Park facility	6	0	6	6.0	0	6.0
L-ROAD	Road	3	4	7	20.6	18.2	38.8
L-QUBP	Quarry / Borrow Pit	3	2	5	0.8	1	1.8
	Subtotal	*12*	*6*	*18*	*24.1*	*19.2*	*43.3*
	Total All Map Classes	**769**	**481**	**1250**	**2993.0**	**2385.2**	**5378.2**

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

Discussion

Mapping the parks of the Colorado Plateau, including NABR, is made more challenging by the massive, sheer cliffs that are a common feature of the Plateau. The cliffs make field access difficult, confound the generation of slope and aspect data, and create problematic shadows on the aerial and orthophotography. In addition to requiring the application of special techniques to overcome these challenges, the mapping process revealed opportunities for future improvement, which are discussed below.

Things that worked well: Field data and local descriptions of the associations provided by the ecologists were extremely important ancillary data sources used by the cartographers to delineate map classes. High-quality plot and observation point data, as well as thorough local descriptions helped provide information for direct image interpretation and modeling. Additional data collected by the project photo interpreter on field reconnaissance trips provided a stronger basis and understanding for conducting the interpretation and mapping.

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

Areas for Improvement: One area that posed difficulties for mapping in this project was shadows cast by cliffs in the project area. The shadowing affected interpretation of the canyon floors and posed difficulty in extracting derived data such as the physiognomic classes and tree densities. Photointerpretation efforts could have been better informed by collecting either additional observation points or by acquiring additional training site data within shadowed areas.

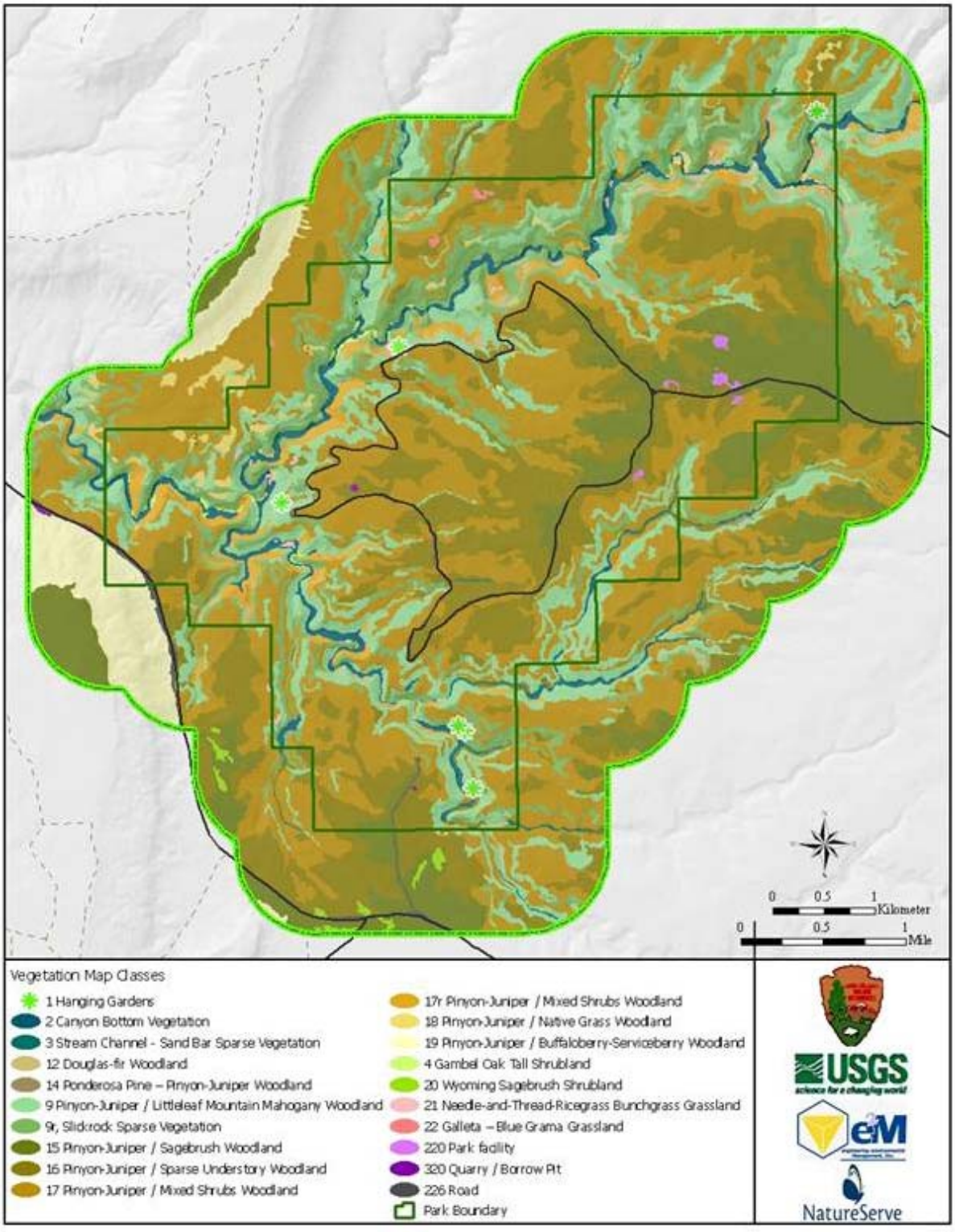


Figure 17. The NABR vegetation map based on the 20 post-accuracy assessment map classes.

Accuracy Assessment

Methods

Introduction

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

Sampling Design

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

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

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

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

Scenario D: The class is rare. It has more than five but fewer than 30 polygons and covers less than 50 ha. The recommended number of samples is five. The rationale for reducing the sample size is that the class consists of small polygons and the frequency of the polygons is low. Specifying more than five sample sites will likely result in multiple samples within the same

(small) polygon. Collecting five samples will allow accuracy to be estimated, although the estimate will not be very precise.

Scenario E: The class is very rare. It has fewer than five polygons and occupies less than 50 ha. In this case, it is recommended that the existence of the class be confirmed by a visit to each polygon. The rationale for the recommendation is that with fewer than five sample sites (assuming one site per polygon), no estimate of level of confidence can be established for the sample and the accuracy of the class can only be confirmed through a field census.

Seven map classes were excluded from the accuracy assessment. Land-use map classes (L-ROAD, L-PAFA and L-QUBP) were excluded because they are not vegetated. Map class C-SBSC (stream channels) was also excluded because many examples are unvegetated and because most polygons were smaller than the minimum mapping unit. The hanging garden map class (H-HGSS) was excluded from the AA because it consists of points based on field data and known sites; resampling would have been redundant. The single polygon containing ponderosa pine (map class W-PIPO) was excluded for the same reason. The map class describing sagebrush communities (S-WYSB) was not accuracy assessed because it occurs only in the environs. These seven classes total 70 polygons covering 103 ha (254 acres).

Accuracy assessment sampling points were selected for each map class using guidelines A–E. Three hundred-one AA points were selected for evaluation of the NABR map. A 25 m (82 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 25 m buffer worked in most situations; however, for small or linear polygons the buffer was reduced or eliminated. Isolated mesa tops, sheer cliffs, and steep talus were excluded from the AA point selection pool due to poor or dangerous access. Location (UTM) coordinates for all AA points were downloaded to GPS units for field sampling. The points and polygons were printed on paper maps with an orthophotograph background to guide the field crews.

Field Data Collection

Accuracy assessment point data were collected during the summer of 2004. Field crews used GPS receivers, digital orthophotograph plots, and topographic maps to navigate precisely to each pre-selected AA point. The crews evaluated an area approximately 5,000m^2 centered on the AA point coordinates (Appendix B). Environmental data collected in the field included elevation, slope, aspect, topographic position, landform, unvegetated surface elements, and descriptive comments. Vegetation data included leaf type and physiognomic class, as well as height and canopy cover for the dominant species in each stratum. The illustrated field key was used to identify the plant association that best described the plot. In most cases, only one plant association name was recorded. When vegetation relationships were less clear, a secondary or tertiary plant association name was also recorded. Plant associations occurring within 50 m of the AA point boundary were also recorded. One or more 35 mm color slides were taken at each AA point to provide visual documentation of the site.

The field team visited 288 AA points (Figure 18). AA point data were manually entered into the plots database and a thorough quality assessment/quality check (QA/QC) was performed on the

data prior to analysis. Nomenclature standards and other data management procedures were the same as for the classification plot data (see Vegetation Classification and Description section). Slides were converted to digital format and cataloged in the same database as the classification plot photographs.

Data Analysis

Two hundred eighty-eight AA data points were used in the data analysis. The field data were converted into a spatial data layer with coordinates and attributes. The first step in the AA analysis intersected the AA point data with the map polygon data. The primary, secondary and tertiary plant association names assigned in the field to each AA point were compared to the map class code for that polygon. If any of the three names agreed with the labeled map class for a given polygon, the point was considered correct. All other points were considered mismatches and marked incorrect.

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

In March 2005, a meeting was held among the project cooperators to review the AA results. Participants reviewed field data sheets and spatial products to analyze the AA data and to make recommendations for adjusting the final spatial database. Each AA point mismatch (disagreement between field call and polygon label) was evaluated for the type of error (true or false). Sources of "false" error include GPS position error, questionable field determinations, edge error, and inclusions (small patches of vegetation within larger map polygons). Mismatches were corrected when a false error was identified. All other mismatches were deemed true errors.

Producer's and user's accuracy were recalculated, and the group discussed whether to merge map classes in order to reach the 80% national standard for thematic accuracy. In some cases, meeting participants recommended combining certain map classes to achieve higher levels of accuracy and more meaningful vegetation map classes. In other cases, the group recommended retaining map classes with lower accuracy, discussed below. A final contingency table was produced by project cartographers (Table 11). The final spatial database was revised to reflect the final combinations of map classes.

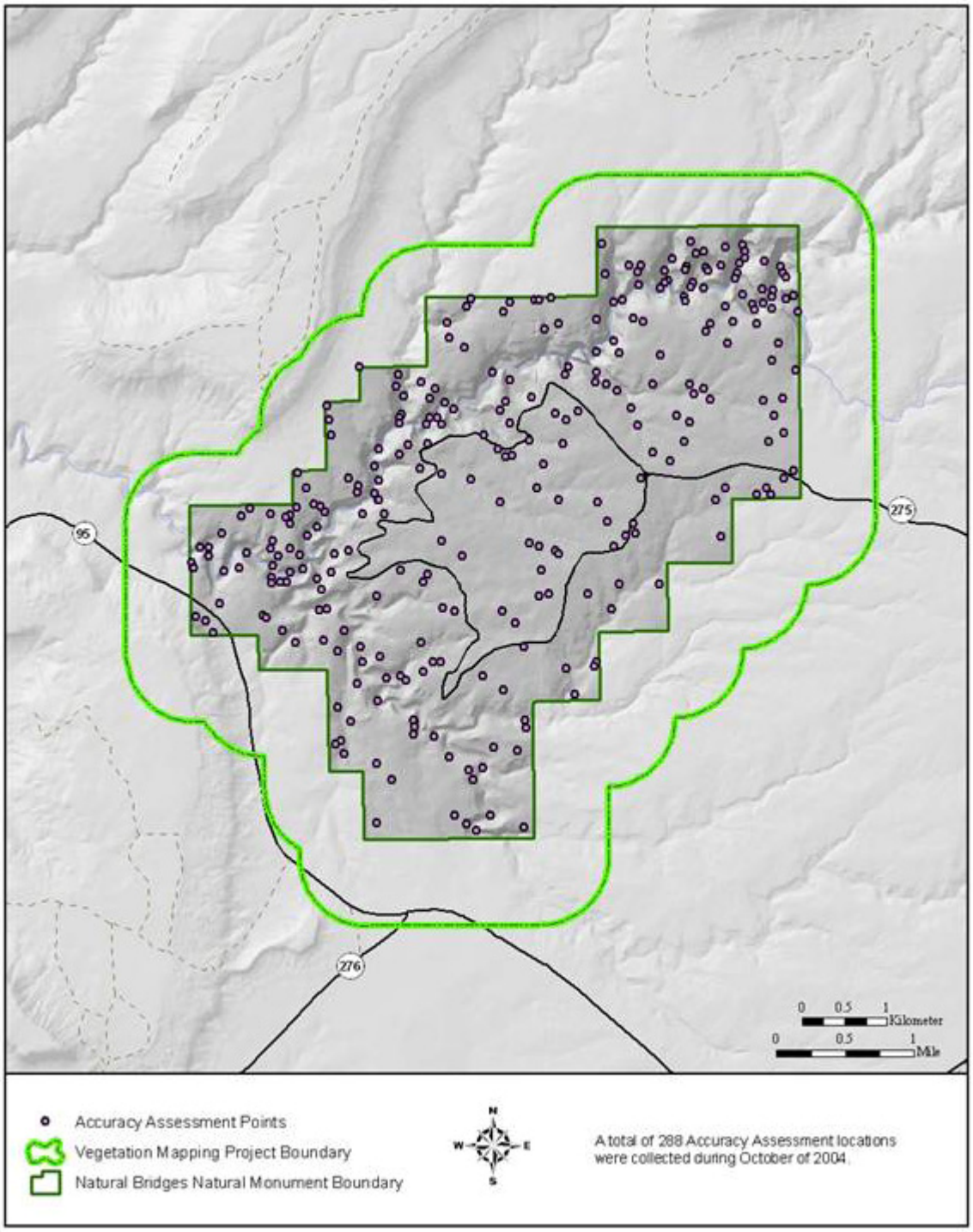


Figure 18. Location of accuracy assessment points sampled within NABR. The accuracy of the map outside of the park boundary was not assessed.

Table 11. Final contingency table for the map classes used at NABR. This table represents the map classes retained following accuracy assessment and revision. Shaded boxes indicate the number of AA points that agree with the assigned map class.

Map Data →

AA Field Call ↓		C-CABV	S-GOAK	W-PJLM	C-SSV	W-DOFI	W-PJWS	W-PJSP	W-PJSH	W-PJRL	W-PJNG	W-PJBB	H-NEED	H-GALL			90% Conf. Interval	
Map Class	**Map Code[1]**	**2**	**4**	**9**	**9r**	**12**	**15**	**16**	**17**	**17r**	**18**	**19**	**21**	**22**	**TOTAL**	**Prod's Accuracy**	**+**	**-**
C-CABV	2	27	1										1		30	90%	101%	79%
S-GOAK	4	1	12												13	92%	108%	76%
W-PJLM	9	1		42		3									46	91%	99%	83%
C-SSV	9r				37										37	100%	101%	99%
W-DOFI	12	1				16				1					18	89%	104%	74%
W-PJWS	15						14	1							15	93%	107%	79%
W-PJSP	16			2			6	33	2		1	1	1		46	72%	84%	60%
W-PJSH	17	1		3				1	31	1					37	84%	95%	72%
W-PJRL	17r			2						17					19	89%	104%	75%
W-PJNG	18										14			1	15	93%	107%	79%
W-PJBB	19			1				1	3			3			8	38%	72%	4%
H-NEED	21												2		2	100%	125%	75%
H-GALL	22													2	2	100%	125%	75%
TOTAL		**31**	**13**	**51**	**37**	**19**	**20**	**36**	**36**	**19**	**15**	**4**	**3**	**3**	**288**			
User's Accuracy		87%	92%	82%	100%	84%	70%	92%	86%	89%	93%	75%	67%	67%	**Overall Accuracy = 86.8%**			
90% Conf. Interval	+	99%	108%	92%	101%	101%	89%	101%	97%	104%	107%	123%	128%	128%	**Kappa Index = 85%**			
	-	76%	76%	73%	995	68%	51%	83%	75%	75%	79%	27%	5%	5%				

[1]Map classes 1, 3, 14, 20, 220, 226 and 320 were not 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 map class accuracy. Overall final map accuracy is 86.8% (Kappa correction = 85%). Individual map class producer's and user's accuracy values are given with their 90% confidence intervals. The width of each confidence interval is affected by sample size. Individual map class accuracy ranges from 17% to 100% Table 12 and Table 13).

Table 12. NABR vegetation map classes that met or exceeded the 80% program standard.

Map Class	Map Class #	Map Class Name	Producer's Accuracy (±90% CI)	User's Accuracy (±90% CI)
C-CABV	2	Canyon Bottom Vegetation	90% ± 11%	87% ± 12%
S-GOAK	4	Gambel Oak Tall Shrubland	92% ± 16%	92% ± 16%
W-PJLM	9	Pinyon-Juniper / Littleleaf Mountain Mahogany Woodland	91% ± 8%	82% ± 10%
C-SSV	9r	Slickrock Sparse Vegetation	100% ± 1%	100% ± 1%
W-DOFI	12	Douglas-fir Woodland	89% ± 15%	84% ± 16%
W-PJSH	17	Pinyon-Juniper / Mixed Shrubs Woodland	84% ± 12%	86% ± 11%
W-PJRL	17r	Pinyon-Juniper / Mixed Shrubs Woodland Rock Ledge Complex	89% ± 14%	89% ± 15%
W-PJNG	18	Pinyon-Juniper / Native Grass Woodland	93% ± 14%	93% ± 14%

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

Map Class	Map Class #	Map Class Name	Producer's Accuracy (±90% CI)	User's Accuracy (±90% CI)	Mostly Confused with Map Class #
W-PJWS	15	Pinyon-Juniper / Sagebrush Woodland	93%±14%	70%±19%	16
W-PJSP	16	Pinyon-Juniper / Sparse Understory Woodland	72%±14%	92%±9%	15
W-PJBB	19	Pinyon-Juniper / Buffaloberry-Serviceberry Woodland	38%±28%	75%±31%	17
H-NEED	21	Needle-and-Thread-Ricegrass Bunchgrass Grassland	100%±25%	67%±61%	16
H-GALL	22	Galleta – Blue Grama Grassland	100%±25%	67%±61%	18

As shown in Table 13, five map classes were retained in the final vegetation map for NABR, although either user's or producer's accuracy did not meet the 80% program standard. Reasons for retaining each map class are detailed below.

W-PJWS (Map Class 15) – Pinyon - Juniper / Sagebrush Woodland: Most of the confusion of this map class was with the Pinyon-Juniper / Sparse Understory Woodland map class (W-PJSP). This is because the woodlands occupying the deeper soils on top of the Cedar Mesa Sandstone

are a mosaic of stands with shrub understories (mostly *Artemisia tridentata* ssp. *wyomingensis* and/or *Shepherdia rotundifolia*) of varying cover and composition. The cutoff in shrub cover that distinguishes a sparse understory from a shrub understory (5%) is somewhat arbitrary and not apparent to the mapper.

W-PJSP (Map Class 16) – Pinyon - Juniper / Sparse Understory Woodland: Confusion in this map class was mostly with map class W-PJWS, for the same reasons as above. Both classes were retained, because to combine them would eliminate most of the mapping detail for the Cedar Mesa sandstone bench.

W-PJBB (Map Class 19) – Pinyon - Juniper / Buffaloberry - Serviceberry Woodland: This map class occurs primarily in the environs, as it is restricted to steep, rocky slopes of Moenkopi shale. The few polygons within the Monument boundary that comprised the sample population do not represent this type well. It was retained because it represents a community with high plant diversity. Confusion with the Pinyon-Juniper / Mixed Shrubs Woodland map class (W-PJSH) resulted from similarities in the mixed-shrub understory that is characteristic of both types.

H-NEED (Map Class 21) – Needle-and-Thread - Ricegrass Bunchgrass Grassland: This type was rare within the mapping area and many polygons were too small to map with high spatial precision. The one incorrect point assigned to this map class was on the margin between a woodland and a small grassy opening. The map class was retained because it represents significant vegetation diversity within the Monument.

H-GALL (Map Class 22) – Galleta - Blue Grama Grassland: This type was rare within the mapping area and many polygons were too small to map with high spatial precision. The one incorrect point assigned to this map class had marginal tree cover for a woodland and appears to be a grassy opening on the aerial photos. The map class was retained because it represents significant vegetation diversity within the Monument.

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Appendix A

Ecological Systems of Natural Bridges National Monument

Introduction

This appendix contains summary descriptions of 11 terrestrial and riparian/wetland ecological system (ES) units (NatureServe 2003b, Comer et al. 2003) occurring at Natural Bridges National Monument. Each ecological system represents one or more National Vegetation Classification (NVC) plant associations (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

CES306.823 SOUTHERN ROCKY MOUNTAIN DRY-MESIC MONTANE MIXED CONIFER FOREST AND WOODLAND

Division 306 (Rocky Mountain); Forest and Woodland

Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Montane, Lower Montane]; Forest and Woodland (Treed); Aridic; Intermediate Disturbance Interval; F-Patch/Medium Intensity; F-Landscape/Medium Intensity; Needle-Leaved Tree; RM Montane Mesic Mixed Conifer; Moderate (100–500 yrs) Persistence
Concept Summary: This is a highly variable ecological system of the 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

CES306.648 SOUTHERN ROCKY MOUNTAIN PONDEROSA PINE WOODLAND

Division 306 (Rocky Mountain); Forest and Woodland

Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Ridge/Summit/Upper Slope; Very Shallow Soil; Mineral: W/ A-Horizon <10 cm; Sand Soil Texture; Aridic; Intermediate Disturbance Interval [Periodicity/Polycyclic Disturbance]; F-Patch/Medium Intensity; Needle-Leaved Tree; Pinus ponderosa with shrubby understory.
Concept Summary: This widespread ecological system is most common throughout the Rocky Mountain cordillera, from the Greater Yellowstone region south. It is also found in the Colorado Plateau region, west into scattered locations in the Great Basin. These woodlands typically occur on dry slopes at the lower treeline/ecotone between grasslands or shrublands and more mesic coniferous forests. Elevations range from less than 1900 m in northern Wyoming to 2800 m in the New Mexico mountains. Occurrences are found on all slopes and aspects; however, moderately steep to very steep slopes or ridgetops are most common. This ecological system generally occurs on igneous, metamorphic, and sedimentary material derived soils, with characteristic features of good aeration and drainage, coarse textures, circumneutral to slightly acid pH, an abundance of mineral material, rockiness, and periods of drought during the growing season. Northern Rocky Mountain Ponderosa Pine Woodland and Savanna (CES306.030) in the eastern Cascades, Okanogan and northern Rockies regions receives winter and spring rains, and thus has a greater spring "green-up" than the drier woodlands in the central Rockies. *Pinus ponderosa* (primarily var. *scopulorum* and var. *brachyptera*) is the predominant conifer; *Pseudotsuga menziesii, Pinus edulis*, and *Juniperus* spp. may be present in the tree canopy. The understory is usually shrubby, with *Artemisia nova, Artemisia tridentata, Arctostaphylos patula, Arctostaphylos uva-ursi, Cercocarpus montanus, Purshia stansburiana, Purshia tridentata, Quercus gambelii, Symphoricarpos oreophilus, Prunus virginiana, Amelanchier alnifolia,* and *Rosa* spp. common species. *Pseudoroegneria spicata* and species of *Hesperostipa, Achnatherum, Festuca, Muhlenbergia*, and *Bouteloua* are some of the common grasses. Mixed fire regimes and ground fires of variable return intervals maintain these woodlands, depending on climate, degree of soil development, and understory density.
Range: This system is found throughout the Rocky Mountain cordillera, from northwestern Wyoming south through the Rocky Mountains of Colorado and into New Mexico. In Arizona, it occurs on the Mogollon Rim north into the Colorado Plateau region and west into scattered locations of the Great Basin.
Subnations: AZ, CO, ID?, NM, NV, UT, WY

CES304.767 COLORADO PLATEAU PINYON-JUNIPER WOODLAND
Division 304 (Inter-Mountain Basins); Forest and Woodland

Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Lower Montane]; Lowland [Foothill]; Mesa; Ridge/Summit/Upper Slope; Sedimentary Rock; Temperate [Temperate Xeric]; Aridic; *Pinus edulis, Juniperus osteosperma*
Concept Summary: This ecological system occurs in dry mountains and foothills of the Colorado Plateau region including the Western Slope of Colorado to the Wasatch Range, south to the Mogollon Rim and east into the northwestern corner of New Mexico. It is typically found at lower elevations ranging from 1,500 m to 2,440 m. These woodlands occur on warm, dry sites

on mountain slopes, mesas, plateaus, and ridges. Severe climatic events occurring during the growing season, such as frosts and drought, are thought to limit the distribution of pinyon-juniper woodlands to relatively narrow altitudinal belts on mountainsides. Soils supporting this system vary in texture ranging from stony, cobbly, gravelly sandy loams to clay loam or clay. *Pinus edulis* and/or *Juniperus osteosperma* dominate the tree canopy. In the southern portion of the Colorado Plateau in northern Arizona and northwestern New Mexico, *Juniperus monosperma* and hybrids of *Juniperus* spp may dominate or codominate the tree canopy. *Juniperus scopulorum* may codominate or replace *Juniperus osteosperma* at higher elevations. Understory layers are variable and may be dominated by shrubs, graminoids, or be absent. Associated species include *Arctostaphylos patula, Artemisia tridentata, Cercocarpus intricatus, Cercocarpus montanus, Coleogyne ramosissima, Purshia stansburiana, Purshia tridentata, Quercus gambelii, Bouteloua gracilis, Pleuraphis jamesii,* or *Poa fendleriana*. This system occurs at higher elevations than Great Basin Pinyon-Juniper Woodland (CES304.773) and Colorado Plateau shrubland systems where sympatric.
Range: Occurs on dry mountains and foothills of the Colorado Plateau region from the Western Slope of Colorado to the Wasatch Range, south to the Mogollon Rim. It is typically found at lower elevations ranging from 1,500 m–2,440 m.
Subnations: AZ, CO, NM, UT

CES306.766 COLORADO PLATEAU PINYON-JUNIPER SHRUBLAND
Division 304 (Inter-Mountain Basins); Shrubland

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

CES306.822 ROCKY MOUNTAIN LOWER MONTANE-FOOTHILL SHRUBLAND

Division 306 (Rocky Mountain); Shrubland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Lower Montane]; Lowland [Foothill]; Shrubland (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

CES306.818 ROCKY MOUNTAIN GAMBEL OAK-MIXED MONTANE SHRUBLAND

Division 306 (Rocky Mountain); Shrubland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Shrubland (Shrub-dominated); Shallow Soil; Mineral: W/ A-Horizon <10 cm; Loam Soil Texture; Sand Soil Texture; Ustic; Unconsolidated; Intermediate Disturbance Interval [Periodicity/Polycyclic Disturbance]; Broad-Leaved Deciduous Shrub

Concept Summary: This ecological system occurs in the mountains, plateaus, and foothills in the southern Rocky Mountains and Colorado Plateau including the Uinta and Wasatch ranges and the Mogollon Rim. These shrublands are most commonly found along dry foothills, lower mountain slopes, and at the edge of the western Great Plains from approximately 2,000 m to 2,900 m in elevation, and are often situated above pinyon-juniper woodlands. Substrates are variable and include soil types ranging from calcareous, heavy, fine-grained loams to sandy loams, gravelly loams, clay loams, deep alluvial sand, or coarse gravel. The vegetation is typically dominated by *Quercus gambelii* alone or codominant with *Amelanchier alnifolia, Amelanchier utahensis, Artemisia tridentata, Cercocarpus montanus, Prunus virginiana, Purshia stansburiana, Purshia tridentata, Robinia neomexicana, Symphoricarpos oreophilus,* or *Symphoricarpos rotundifolius*. There may be inclusions of other mesic montane shrublands with *Quercus gambelii* absent or as a relatively minor component. This ecological system intergrades with the lower montane-foothills shrubland system and shares many site characteristics. Density and cover of *Quercus gambelii* and *Amelanchier* spp. often increase after fire.
Range: Occurs in the mountains, plateaus, and foothills in the southern Rocky Mountains and Colorado Plateau including the Uinta and Wasatch ranges and the Mogollon Rim.
Subnations: AZ, CO, NM, UT, WY

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

Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Lowland]; Shrubland (Shrub-dominated); Toeslope/Valley Bottom; Deep Soil; Aridic; *Artemisia tridentata* ssp. *tridentata*
Concept Summary: This ecological system occurs throughout much of the western U.S., typically in broad basins between mountain ranges, plains, and foothills between 1,500 m and 2,300 m elevation. Soils are typically deep, well-drained, and non-saline. These shrublands are dominated by *Artemisia tridentata* ssp. *tridentata* and/or *Artemisia tridentata* ssp. *wyomingensis*. Scattered *Juniperus* spp., *Sarcobatus vermiculatus*, and *Atriplex* spp. may be present in some stands. *Ericameria nauseosa, Chrysothamnus viscidiflorus, Purshia tridentata*, or *Symphoricarpos oreophilus* may codominate disturbed stands. Perennial herbaceous components typically contribute less than 25% vegetative cover. Common graminoid species include *Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus, Festuca idahoensis, Hesperostipa comata, Leymus cinereus, Pleuraphis jamesii, Pascopyrum smithii, Poa secunda*, or *Pseudoroegneria spicata*.
Range: Occurs throughout much of the western U.S., typically in broad basins between mountain ranges, plains, and foothills between 1,500 m to 2,300 m elevation.
Subnations: CA, CO, ID, MT, NV, OR, UT, WA, WY

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

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Foothill, Lowland]; Herbaceous; Temperate [Temperate Xeric]; Alkaline Soil; Aridic; Graminoid
Concept Summary: This widespread ecological system occurs throughout the intermountain western U.S. on dry plains and mesas, at approximately 1,450 m to 2,320 m (4,750–7,610 ft) elevation. These grasslands occur in lowland and upland areas and may occupy swales, playas, mesa tops, plateau parks, alluvial flats, and plains, but sites are typically xeric. Substrates are often well-drained sandy or loamy-textured soils derived from sedimentary parent materials but are quite variable and may include fine-textured soils derived from igneous and metamorphic rocks. When they occur near foothill grasslands, they will be at lower elevations. The dominant perennial bunch grasses and shrubs within this system are all very drought-resistant plants. These grasslands are typically dominated or codominated by *Achnatherum hymenoides, Aristida* spp., *Bouteloua gracilis, Hesperostipa comata, Muhlenbergia* sp., or *Pleuraphis jamesii* and may include scattered shrubs and dwarf-shrubs of species of *Artemisia, Atriplex, Coleogyne, Ephedra, Gutierrezia*, or *Krascheninnikovia lanata*.
Range: Occurs throughout the Intermountain western U.S. on dry plains and mesas, at approximately 1,450 m to 2,320 m (4,750–7,610 ft) in elevation.
Subnations: AZ, CA, CO, ID, MT?, NM, NV, OR, UT, WA, WY

CES304.765 COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND
Division 304 (Inter-Mountain Basins); Barren

Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland
Diagnostic Classifiers: Montane [Lower Montane]; Lowland [Foothill]; Shrubland (Shrub-dominated); Ridge/Summit/Upper Slope; Sedimentary Rock; Temperate [Temperate Xeric]; Alkaline Soil; Aridic
Concept Summary: The distribution of this ecological system is centered on the Colorado Plateau where it is comprised of barren and sparsely vegetated landscapes (generally <10% plant cover) of steep cliff faces, narrow canyons, and open tablelands of predominantly sedimentary rocks, such as sandstone, shale, and limestone. Some eroding shale layers similar to Inter-Mountain Basins Shale Badland (CES304.789) may be interbedded between the harder rocks. The vegetation is characterized by very open tree canopy or scattered trees and shrubs with a sparse herbaceous layer. Common species include *Pinus edulis, Pinus ponderosa, Juniperus* spp., *Cercocarpus intricatus*, and other short-shrub and herbaceous species, utilizing moisture from cracks and pockets where soil accumulates.
Comments: Geographically restricted and distinct from the related, but broader Inter-Mountain

Basins Cliff and Canyon (CES304.779). Shale areas are not extensive as in shale badlands.
Range: Colorado Plateau.
Subnations: AZ, CO, NM, UT

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: Montane [Lower Montane]; Riverine / Alluvial; Mineral: W/ A-Horizon <10 cm; Unconsolidated; Short (<5 yrs) Flooding Interval; Short (50–100 yrs) Persistence
Concept Summary: This system is found throughout the Rocky Mountain and Colorado Plateau regions within a broad elevation range from approximately 900 m to 2,800 m. This system often occurs as a mosaic of multiple communities that are tree-dominated with a diverse shrub component. This system is dependent on a natural hydrologic regime, especially annual to episodic flooding. Occurrences are found within the flood zone of rivers, on islands, sand or cobble bars, and immediate stream banks. They can form large, wide occurrences on mid-channel islands in larger rivers or narrow bands on small, rocky canyon tributaries and well-drained benches. It is also typically found in backwater channels and other perennially wet but less scoured sites, such as floodplains swales and irrigation ditches. Dominant trees may include *Acer negundo, Populus angustifolia, Populus balsamifera, Populus deltoides, Populus fremontii, Pseudotsuga menziesii, Picea pungens, Salix amygdaloides,* or *Juniperus scopulorum*. Dominant shrubs include *Acer glabrum, Alnus incana, Betula occidentalis, Cornus sericea, Crataegus rivularis, Forestiera pubescens, Prunus virginiana, Rhus trilobata, Salix monticola, Salix drummondiana, Salix exigua, Salix irrorata, Salix lucida, Shepherdia argentea*, or *Symphoricarpos* spp. *Elaeagnus angustifolia* and *Tamarix* spp. are common in some stands. Generally, the upland vegetation surrounding this riparian system is different and ranges from grasslands to forests.
Range: Found throughout the Rocky Mountain and Colorado Plateau regions within a broad elevation range from approximately 900 m to 2,800 m. 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

CES304.764 COLORADO PLATEAU HANGING GARDEN

Division 304 (Inter-Mountain Basins); Herbaceous Wetland

Spatial Scale & Pattern: Small patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Diagnostic Classifiers: Montane [Montane, Lower Montane]; Cliff (Landform); Cliff (Substrate); Sedimentary Rock; Temperate [Temperate Xeric]; Seepage-Fed Sloping; Forb; Fern; Graminoid; Saturated Soil
Concept Summary: Hanging gardens in the Colorado Plateau region are surrounded by an arid environment and associated with canyon country. These highly localized environments include canyonlands with perennial water sources (seeps) forming pocketed wetlands and draping vegetation across wet cliff faces. Three main garden types exist: alcove, terrace, or windowblind. Each is determined by the nature of the geological formation and the presence or absence of joint systems. They tend to occur at all exposures of the canyon walls, but they are always shaded for much to most of each day. Temperature and humidity are relatively stable compared to the surrounding environment. Most hanging gardens are dominated by herbaceous plants, and a number of these are endemic to this region. Common species include *Adiantum capillus-veneris, Adiantum pedatum, Mimulus eastwoodiae, Mimulus guttatus, Sullivantia hapemanii, Cirsium rydbergii*, and several species of *Aquilegia*.
Range: Colorado Plateau.
Subnations: AZ, CO, NV?, UT

Appendix B

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

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 photo interpreters to help recognize aerial photo signatures. Observation points were used primarily for assisting with photo interpretation, and secondarily for supporting NVC association descriptions and documenting non-standard vegetation types. Accuracy assessment data were used primarily for testing the thematic accuracy of the vegetation map, and secondarily to support NVC association descriptions.

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

Natural Bridges National Monument
A Basic Guide for Field Work Modified for the 2003/2004 Field Seasons

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

OVERVIEW

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

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

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

The field crew will evaluate the field data, assign a preliminary vegetation type based on a list of potential vegetation types developed from the existing literature, and update the tally of vegetation types by number of plots still needed. The goal is to use your time as efficiently as possible: we are trying our best to avoid oversampling of some types and undersampling of

others. Deciding where to sample to capture the full range of diversity throughout the monument is an iterative process.

GETTING THERE

You will have a Digital Ortho Quarter Quad (DOQQ) print and a copy of the 1:12,000-scale aerial photography to guide you. You and your partner will navigate towards each selected photo-signature using your Monument road and trail map, USGS 7.5 mm. topographic map, the DOQQ, and/or GPS. The DOQQ's will have roads and trails highlighted on them to help you as well.

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

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

Along the way... look around. The goal of this field work is to sample all the different vegetation types that occur in Natural Bridges National Monument. If, on the way to one vegetation type, you see an assemblage of plants that seems unique and that is not included on the list of vegetation types, please sample if time allows. In this Monument, these undescribed vegetation types are more likely various pinyon – juniper woodland understories, riparian woodlands, or shrublands. You will be better able to recognize these undescribed vegetation types as the season progresses and you become more familiar with the vegetation types and how they can look on the ground.

ONCE THERE

Establishing a Plot

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

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

2) Using your GPS (Global Positioning System) receiver, record the UTM (Universal Transverse Mercator) coordinates in the center of the plot under the Field UTM X and Field UTM Y on the field form. Also mark and label the location of the plot on a USGS 7.5 min. topographic map and/or on an aerial photo. If you cannot obtain a GPS reading, estimate UTMs from the USGS topographic map and note on the form that you had to resort to this method. Plots may be circular, rectangular or square. Note shape and dimensions on the field form. If the plot is

rectangular or square, record the azimuth of the long side (any side if square) to help relocate the plot. It may make more sense to establish rectangular plots in linear vegetation types (e.g. riparian or ridgeline types). Standard plot sizes should be as follows:

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

Note: You can deviate from the standard plot *shapes* where that makes sense, but the total plot *area* encompassed by the boundaries should be as listed above for each major class of vegetation. For example, forested riparian vegetation may be sampled in a more linear 10 x 40 m (400 m^2) plot; herbaceous riparian or ridgeline vegetation in a 2 x 50 m (100m2) plot. You may also increase the size of the plot to the next standard size if necessary to sample the heterogeneity of the vegetation. Forests, woodlands and shrublands can be increased to 1000 m2. Please make a note on plot form.

3) Once the plot is established, it is generally a good time to fill out the **Identifiers/Locators** part of your Plot Survey Form (see the cheat sheet) and take the plot photos.

Taking photographs
Two color photos will be taken of each plot using slide film. The purpose is to obtain a good representation of the vegetation of the plot, not individual species. A piece of paper (or a chalk

board or dry erase board) should be placed in the plot, with the plot number recorded on it, so that the photo includes the plot number. Preprinted plot numbers could be printed or copied onto colored paper (white has such strong contrast as to be unreadable in the photo) and attached to the back of a clipboard. This saves having to write plot numbers in the field. Take the photograph looking across the contour if plot is steep. Record roll #, frame # and azimuth on plot form.

Data Collection

Environmental Description

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

Vegetation Description

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

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

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

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

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

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

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

Observation Point Form

When you have sampled one particular vegetation type thoroughly, but want to further define its distribution or when you encounter small but unique vegetation patches that are below the minimum mapping unit in size (<1.5 ha), record the site on an Observation Point form. This is an abbreviated Plot Survey form and usually takes about 15 minutes to fill in the data. The major difference is that an Observation Point is unbounded and includes an area roughly equal to that of the minimum mapping unit (20 m radius around the observer) or it encompasses the entirety of a small but unique vegetation patch. The data fields are the same as those on the Plot Survey form, so use the above instructions. Minor differences in the Observation Point form from the Plot Survey form include the elimination of some data fields, more general cover classes for ground cover estimates, and only the dominant or diagnostic species are recorded. Also, only one photo is taken to record the Observation Point plant community.

Accuracy Assessment Point Form

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

We hope your field season on the northern Colorado Plateau enjoyable and rewarding. Good luck!

LITERATURE CITED

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, Virginia.

The Nature Conservancy [TNC]. 1998. An environmentally-driven approach to vegetation sampling and mapping at Yosemite National Park. Report prepared for the U.S. Department of the Interior, National Biological Survey and National Park Service. The Nature Conservancy, Arlington, Virginia.

INSTRUCTIONS FOR FILLING OUT PLOT AND OBSERVATION POINT SURVEY FORMS

PLOT DESCRIPTION

Plot Code
Code indicating the specific plot within the vegetation polygon. For the 2003 field season, the codes will be in the following format "PARK ACRONYM.XXX" (i.e., "Natural Bridges National Monument = NABR.XXX"). Begin with NABR.00l and go from there. If another team is working, decide with them which plot numbers each team will use to identify the data they gather. For example, if a second team is working one week at Natural Bridges National Monument and approximately 100 plots have already been collected, they may sample plots NABR.125 through NABR.150.

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

State UT

Park Name NABR

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

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

Quad Code
Code of quadrangle map.

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

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

GPS Error
Note the error in the GPS reading off the unit.

Survey Date
Date the survey was taken; year, month, day.

Surveyors
Names of surveyors, with principal surveyor (usually the Lead Ecologist) listed first.

Directions to Plot
Precise directions to the site using a landmark (e.g., a named point on the topographic map, a major highway, using park naming conventions for roads) readily locatable on a 7.5 minute topographic or park map as the starting point. Use clear sentences that will be understandable to someone who is unfamiliar with the area and has only your directions to follow. Give distances as closely as possible to the 0.1 mile and use compass directions. Give additional directions to the plot within the site. Do not take more than a couple of minutes to fill this out.

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

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

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

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

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

ENVIRONMENTAL DESCRIPTION

Elevation
Elevation of the plot. Specify whether in feet or meters (this will depend on the units used on the GPS or on the topographic map being used). In general, we have determined that the reading you obtain from a topographic map, provided you are certain where you are, is more accurate than the average reading from the GPS unit. Thus, please attempt to estimate your elevation with the topographic map.

Slope
Measure the slope in degrees using a clinometer.

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

Topographic Position
Topographic position of the plot. Choose one:

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

HIGH SLOPE (shoulder slope, upper slope, convex creep slope). Geomorphic component that forms the uppermost inclined surface at the top of a slope. Includes the transition zone from backslope to summit. Surface is dominantly convex in profile and erosional in origin.

HIGH LEVEL (mesa). Level top of a plateau.

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

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

STEP IN SLOPE (ledge, terraeette). Level shelf interrupting a steep slope, rock wall, or cliff face.

LOWSLOPE (lower slope, foot slope, colluvial footslope). Gently inclined surface at the base of a slope. Surface profile is usually concave and transitions between midslope or backslope, and toeslope.

TOESLOPE (alluvial toeslope). Outermost gently inclined surface at base of a slope. In profile, commonly gentle and linear and characterized by alluvial deposition.

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

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

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

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

Landform

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

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

Surficial Geology

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

Natural Bridges National Monument Geology Map Units

- Quaternary Alluvium
- Eolian Sand
- Chinle Formation
- Moenkopi Formation
- Organ Rock Formation
- Cedar Mesa Formation

Cowardin System

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

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

S SEMIPERMANENTLY FLOODED - Surface water persists throughout growing season except during periods of drought. Land surface is normally saturated when water level drops below soil surface. Includes Cowardin's Intermittently Exposed and Semipermanently Flooded modifiers.

SEASONALLY FLOODED - Surface water is present for extended periods during the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is very variable, extending from saturated to a water table well below the ground surface. Includes Cowardin's Seasonal, Seasonal-Saturated, and Seasonal-Well Drained modifiers.

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

TEMPORARILY FLOODED - Surface water present for brief periods during growing season, but water table usually lies well below soil surface. Often characterizes flood-plain wetlands. Equivalent to Cowardin's Temporary modifier.

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

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

UNKNOWN - The water regime of the area is unclear. The unit is described as a non-tidal wetland.

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

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

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

Simplified Key to Soil Texture (Brewer and McCann 1982)

Al Soil does not remain in a ball when squeezed.....sand
A2 Soil remains in a ball when squeezed.....B

Bl Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you push up over your finger.
Soil makes no ribbon.....loamy sand
B2 Soil makes a ribbon; may be very short.....C

C1 Ribbon extends less than 1 inch before breaking.....D
C2 Ribbon extends 1 inch or more before breaking.....E

D1 Add excess water to small amount of soil
Soil feels at least slightly gritty.....loam or sandy loam
D2 Soil feels smooth.....silt loam

E1 Soil makes a ribbon that breaks when 1 2 inches long;
Cracks if bent into a ring.....F
E2 Soil makes a ribbon 2+ inches long; does not crack when bent into a ring..... G

Fl Add excess water to small amount of soil;
Soil feels at least slightly gritty.....sandy clay loam or clay loam
F2 Soil feels smooth.....silty clay loam or silt

G1 Add excess water to a small amount of soil;
Soil feels at least slightly gritty.....sandy clay or clay
G2 Soil feels smooth….....silty clay

Soil Drainage
The soil drainage classes are defined in terms of (l) actual moisture content (in excess of field moisture capacity) and (2) the extent of the period during which excess water is present in the plant-root zone. It is recognized that permeability, level of groundwater, and seepage are factors affecting moisture status. However, because these are not easily observed or measured in the

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

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

WELL DRAINED - The soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant part of the year. Soils are usually free from mottling in the upper 3 feet, but may be mottled below this depth. B horizons, if present, are reddish, brownish, or yellowish.

MODERATELY WELL DRAINED - The soil moisture in excess of field capacity remains for a small but significant period of the year. Soils are commonly mottled (chroma <2) in the lower B and C horizons or below a depth of 2 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.

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

POORLY DRA1NED - The soil moisture in excess of field capacity remains in all horizons for a large part of the year. The soils are usually very strongly gleyed. Except in high-chroma parent materials the B, if present and upper C horizons usually have matrix colors of low chroma. Faint mottling may occur throughout.

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

VEGETATION DESCRIPTION

Leaf Phenology

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

EVERGREEN - Greater than 75% of the total woody cover is never without green foliage.

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

MIXED EVERGREEN - COLD DECIDUOUS - Evergreen and deciduous species generally contribute 25-75% of the total woody cover. Evergreen and cold-deciduous species admixed.

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

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

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

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

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

MICROPHYLLOUS - Woody cover primarily microphyllous.

GRAMINOID - Herbaceous vegetation composed of more than 50 percent graminoid species.

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

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

Physiognomic Class Choose one:

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

Woodland: Open stands of trees with crowns not usually touching (generally forming 25-60% cover). Canopy tree cover may be less than 25% in cases where it exceeds shrub, dwarf-shrub, herb, and nonvascular cover, respectively.

Shrubland: Shrubs generally greater than 0.5 m tall with individuals or clumps overlapping to not touching (generally forming more than 25% cover, trees generally less than 25% cover). Shrub cover may be less than 25% where it exceeds tree, dwarf-shrub, herb, and nonvascular cover, respectively. Vegetation dominated by woody vines is generally treated in this class.

Dwarf-shrubland: Low-growing shrubs usually under 0.5 m tall. Individuals or clumps overlapping to not touching (generally forming more than 25% cover, trees and tall shrubs

generally less than 25% cover). Dwarf-shrub cover may be less than 25% where it exceeds tree, shrub, herb, and nonvascular cover, respectively

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

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

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

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

Trees are defined as single-stemmed woody plants, generally 5 m in height or greater at maturity and under optimal growing conditions. Shrubs are defined as multiple-stemmed woody plants generally less than 5 m in height at maturity and under optimal growing conditions.

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

Cover Scale for Strata		**Height Scale for Strata**	
T	<1%	01	<0.5 m
P	1-5%	02	0.5-1 m
1	5-15%	03	l-2 m
2	15-25%	04	2-5 m
3	25-35%	05	5-10 m
4	35-45%	06	l0-l5 m
5	45-55%	07	15-20 m
6	55-65%	08	20-35 m
7	65-75%	09	35-50 m
8	75-85%	10	>50 m
9	85-95%		
10	95+		

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

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

Other Comments
Any other comments.

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

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

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

Appendix B.2. Accuracy Assessment Field Sampling Manual

2004 Natural Bridges National Monument Accuracy Assessment Manual

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

Overview

The primary purpose of accuracy assessment (AA) fieldwork is to supply data that will test the accuracy of vegetation maps. It is also a continuation of the sampling of vegetation communities. AA data are used to:

- Verify accuracy of polygons drawn on the map (map units)
- Verify relationships between associations and mapping units
- Verify that field key works well to classify vegetation to association
- Check for classification completeness –undescribed associations not sampled during inventory
- Clarify concepts and augment descriptions of existing associations and possibly develop new associations

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

- Locational error (when it is not possible to acquire reliable UTM coordinates, the AA point data collected may look like it is in another polygon, or if the polygons are small/narrow and the GPS receiver isn't working well, it may be difficult to know which polygon is supposed to be sampled).
- Field key is difficult to use, leading the investigator to assign the point to the wrong association.
- Field key does not include all plant associations in the park, also leading to confusion in which association to assign to a point.
- Field data error- either by mis-identifying diagnostic species, or by not reading the key carefully, resulting in a bad field call when the map attribute is accurate.
- AA point falls within an ecotone, which is impossible to classify but still has to be mapped as something.
- Relationships between plant associations and map units (modeling) are flawed.
- The polygon is heterogenous, including patches of varying vegetation that are too small to map individually. The AA point may happen to fall in a part of the polygon with a different community than observed by the photo interpreter in the bigger picture.

Navigating to a Point

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

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

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

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

Along the way... Identify the mapping polygons where the target AA points are located and if possible walk through part of the polygons on the way to the points, noting polygon boundaries. Is the map polygon uniform or variable? Is the AA point representative of the polygon? Record these observations on the AA form upon arrival at the point.

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

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

describe in the comments fields the situation and be clear about what is represented within and outside the polygon targeted for sampling.

AA Point Form Instructions

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

IDENTIFIERS / LOCATORS SECTION

AA Point Code:

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

Quad Name:

Record the full name of the 7.5 minute quadrangle.

County:

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

State:

Enter state in which AA point occurs, e.g., UT.

Park Site Name:

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

Survey Date:

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

Surveyor(s):

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

AA Point Shape:

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

GPS File:

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

Field UTM X, Field UTM Y

Record the UTM easting and northing coordinates saved as a waypoint in the GPS receiver. Please double check to make sure the easting is six digits and the northing is seven digits.

In deep canyon country it can be difficult to obtain UTM coordinates (the GPS receiver has to be able to 'see' at least three satellites). If it is not possible to acquire UTM coordinates, or if the PDOP is greater than 8 (or EPE is greater than ±50m), first try to obtain a signal from a higher point nearby (but still close to) the AA point. If that fails then estimate the UTM coordinates from the digital orthophoto (NAD83), and manually enter them into the GPS receiver.

GPS Receiver:

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

GPS Error:

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

3D Differential?

3D differential is obtained when the GPS receiver can "see" a satellite that does nothing but correct the tiny errors in the positioning or clocks of other GPS satellites. This satellite broadcasts a real-time differential correction so that the location coordinates are as accurate as possible. It is in geosynchronous orbit in the southern sky, so if the southern sky is visible, one will generally be able to acquire 3D differential. This system is known as the Wide-Area Augmentation System, or WAAS. Please make sure that WAAS is always on.

GPS Receiver Comments:

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

Camera:

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

Taking Photographs:

Expose one color slide of each AA point. The purpose is to acquire a good representation that accurately captures the vegetative stand of the AA point. If the area is heterogeneous please represent this in the photo. Try to include a little sky, approximately 10% sky, for perspective. Use a chalkboard to record the point number and the direction the photo is exposed. Thus, for AA point 241, the board in the photo taken from the SE facing NW across



the point will read "NABR AA 241, NW". Take the photographs looking across the contour if the AA point is on a steep slope. In addition, a photograph log for all photos not taken at AA points will need to be maintained. It is not anticipated that crews would routinely take additional photos, however, if a crew member finds a new vegetation type not previously described it would be good to document this situation with a photograph.

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

For the photo taken at the AA point record the following: *Roll number:* record roll number (Roll numbers should be a team member's initials plus a sequential number, which are written on the film before it goes into the camera.) *Frame number:* record frame number of photo. *Photographer:* record last name of person taking photograph. *Directions/Comments:* record the direction the photos were exposed from and towards (SENW) 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 the AA point does not key well, make the best effort to fit it into one or two of the associations listed in the manual, then make detailed comments in the "Classification Comments" field to justify the selection and/or reasoning. If vegetation near the AA point does not fit the plant association key at all then create a new name using the dominant species of each 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 the AA points are randomly located within a polygon, there is no guarantee that they will land in a spot that is representative of either the polygon or of the plant associations included within the polygon's map unit. The point could easily land in a small gully or an inclusion that is too small to map, or an ecotone where trees are invading a shrubland, for instance. Because of this, it is important that the investigator pay attention not only to the vegetation within the 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 in a gully or on a rock outcrop. If the polygon is extremely large and the observer is unable to make an assessment then please use the 'unknown' field.

Fit of plant association to description in the key:

The key 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 association to the description in the key (Good, Fair, Poor). It would also be helpful to note specific suggestions on how to make the key work better. It will provide information for improving the key for the final report.

ENVIRONMENTAL DESCRIPTION SECTION

Elevation:

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

Slope:

Measure the slope in degrees using a clinometer. The degree scale is the left-hand scale when looking through the clinometer. If the slope varies at the point then estimate an average. Enter "variable" if the plot is on a landform such as a dune field. 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). Gently inclined surface at the base of a slope. Slope profile is usually concave and transitions between midslope or backslope, and toeslope.
Toeslope (alluvial toeslope). Outermost gently inclined surface at base of a slope. In profile, usually gentle, linear and characterized by alluvial deposition.
Low level (terrace). Valley floor or shoreline representing the former position of an alluvial plain, lake, or shore.

Landform:

Enter the landform that best describe the site where the AA point is located. Referring to the topo map for the landscape context may help the investigator determine what landform(s) to choose. Note that the landform choices may describe different scales, or that a landform feature can be described by more than one term. For example, the AA point may be on a ledge on the rim of a canyon. A suggested list of landforms and definitions is provided in 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 occurs. A list of geologic types is provided on a cheatsheet at the end of this document. The geology map should help, but if one is unable to decipher the geology, then provide a general description (e.g., coarse sandstone, aeolian sands or obscured by soil).

Environmental Comments:

Enter comments on the environmental setting and its effect on the vegetation. Examples include: "stunted trees due to shallow soils", "vegetation only where pockets of soil occur", or "large colluvial boulders and small rocks litter surface of soil". This field can also be used to describe site history such as fire events. This is an extremely important field for crews to document so please take the time to do a good job. Information from this field is used to prepare local descriptions of the plant communities, and to help assign AA points to associations not previously recorded in the park.

Unvegetated Surface:

This field is an ocular estimate of ground cover for the following: bedrock; litter/duff; wood (>1cm); large rocks (cobbles, boulders >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 on the form. If an unvegetated surface category is not present in the observation point area, leave the corresponding line blank.

VEGETATION DESCRIPTION SECTION

Leaf Phenology:

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

Evergreen. Greater than 75% of the total woody cover is never without green foliage. (Some tricky examples: most *Artemisia, Ephedra,* and all *Atriplex* except *A. canescens,* all *Chrysothamnus*).
Cold deciduous. Greater than 75% of the total woody cover sheds its foliage in connection with an unfavorable season mainly characterized by winter frost (tricky ones: *Sarcobatus vermiculatus, Tamarix*).
Mixed evergreen – Cold deciduous. Evergreen and deciduous species are mixed within the type and generally contribute 25-75% of the total woody cover.
Perennial. Herbaceous vegetation composed of more than 50% perennial species.
Annual. Herbaceous vegetation composed of more than 50% annual species.

Leaf Type:

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

Broad-leaved. Woody vegetation that is primarily broad-leaved (sagebrush, oak, mountain mahogany).
Needle-leaved. Woody vegetation that is primarily needle-leaved (juniper, pinyon, tamarisk).
Microphyllous. Woody cover that is primarily microphyllous (*Ephedra*).
Graminoid. Herbaceous vegetation composed of more than 50 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.

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 short saplings in addition to mature tall trees.

The remaining vegetative strata are (remember to check **with plant list for consistency):**

S1 Tall Shrub: >2 meters tall. For example, *Fraxinus anomala* and *Amelanchier utahensis.*
S2 Short Shrub: <2 meters tall. For example, *Artemisia,* all *Atriplex* except *gardneri* (which are

dwarf).
S3 Dwarf-shrub: <0.5 meters tall. For example, *Gutierrezia, Opuntia polycantha.*
H Herbaceous: All herbaceous species including graminoids, forbs, ferns, and fern allies.
H4 Tree Seedlings: Seedlings are trees with vertical stems < 1.5 m tall, but that may vary by species (e.g. does not always apply to pinyon – juniper).
N Nonvascular: This is mainly dark cyanobacteria, mosses and lichens.

Height can be used to define strata, but is not how species should be placed in strata. Species **characteristically belong to one stratum or another** (e.g., pinyon and juniper are canopy (T2), Utah serviceberry is a tall shrub (S1), sagebrush is a short shrub (S2), snakeweed is a dwarf-shrub (S3), etc.), **EVEN when unusual environmental circumstances dictate that the plants have an unusually tall** (e.g., response of some plants to fire) **or unusually short growth form**. So even if the junipers growing in cracks are only 1.5 m tall, as long as they are mature trees, they are placed in the T2 category. About the only rule regarding height should be that the tree layer is (usually) higher than the tall shrub layer that is taller than the short shrub layer, etc.

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

The third thing is how to define some of the "borderline/confusing" species. What we want to avoid is having some crew members calling *Leptodactylon* a forb and some calling it a dwarf-shrub. Same for snakeweed, *Eriogonum microthecum*, fringed sagewort, *Brickellia* and any number of other species. Consult the master plant species list when in doubt. Crew members should keep the master plant list and strata assignments updated.

Completing the Species/Strata Table:

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

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

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

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

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

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

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

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

If the point is on the border between two types… (and both types are at least MMU-size) Make two species lists, one for each type, on the back of the AA point form. These will both be entered into the database for that AA point.

NATURAL BRIDGES NATIONAL MONUMENT – AA CHEAT SHEET

LANDFORMS

alluvial fan
alluvial flat
alluvial plain
remnant
alluvial terrace
alluvium
artificial levee
backslope
badlands
bajada
ballena
ballon
basin
basin floor
bench
blowout
bluff
bolson
borrow pit
bottomland
box canyon
braided stream
break
butte
canyon
channel
cliff
climbing dune
closed depression
colluvium
crest
cuesta
debris flow
deflation basin
depression
desert pavement
dike
dip
ditch
divide
dome
drainageway
draw
dune
dune field
earthflow
eolian deposit
eolian sands
ephemeral stream
escarpment
falling dune
finger ridge
flat
flood plain
foothills
gorge
gravel pit
gulch
gully
hanging valley
hill
hillslope
hogback
hummock
interdune
interfluve
intermittent stream
island
knob
knoll
lakebed
lakeshore
landslide
ledge
levee
meander belt
mesa
mountain
natural levee
overflow channel
oxbow
pediment
perennial stream
plain
plateau
playa
point bar
pool
quarry
ravine
reef
ridge
rise
rim
rockfall
saddle
sand ramp
sand sheet
scarp
scree slope
shoulder
side slope
slope
slope alluvium
slope wash
slot canyon
stream terrace
summit
swale
talus slope
tank
terrace
terracettes
toeslope
valley
valley floor
valley side
wash (dry wash)
zibar

TOPOGRAPHIC POSITION

SEE THE ATTACHED DIAGRAM

VEGETATIVE STRATA

T1 = emergent tree
T2 = tree canopy
T3 = tree sub-canopy
S1 = tall shrub > 2m
S2 = short shrub < 2m
S3 = dwarf shrub < 0.5m
H = herbaceous
H4 = Tree seedlings
N = nonvascular other than ferns

PARK SPECIALS (keep an eye out for)

Hanging Gardens
Invasive tamarisk

PHYSIOGNOMIC CLASS

Forest: Crowns touching
Woodland: Trees>10%, crowns not touching
Shrubland: Shrubs> grass, forbs or trees
Dwarf Shrubland: Shrubland <0.5 m tall
Shrub Herbaceous: Shrubs = Forbs/grasses
Herbaceous: Grass/forbs > trees or shrubs
Wooded Herbaceous: Trees= grass/forbs
Sparsely Vegetated: Total veg<5-7%

ASPECT

Flat
Azimuth (deg.)
Variable

GPS SETTINGS

NAD1983
WAAS on

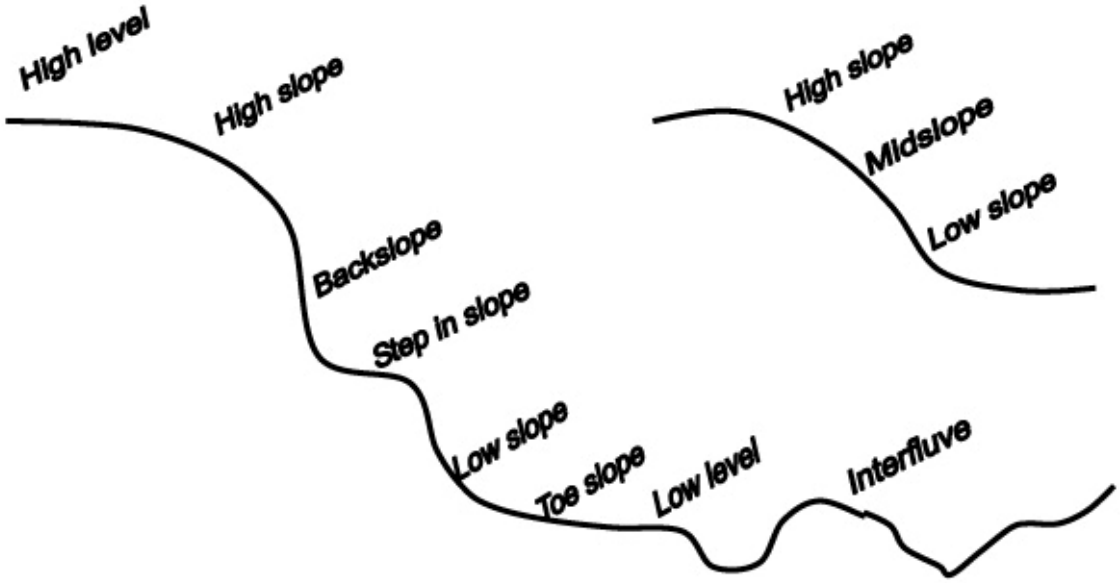
SURFICIAL GEOLOGY

Obscured by soil
Quaternary Alluvium
Chinle Formation
Moenkopi Formation
Organ Rock Formation
Cedar Mesa Formation

DISTURBANCE

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

TOPOGRAPHIC POSITION - CHEAT SHEET



CONSIDERATIONS FOR PLANNING

Planning for the day:

1. Safety and sustenance: Plenty of food, water, first-aid kit, raingear, sunscreen.
2. Field communications:
   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
   b. Communicate with the other team member(s) to make sure you aren't duplicating effort.

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

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

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

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

Communicate among teams / Topics for wrap-up meetings.

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

Materials Checklist

- Monument research permit
- Topo maps
- Monument and BLM maps for general navigation
- DOQQ photos of AA point locations
- Geology map
- Compass with adjustable declination
- Clinometer
- GPS receiver
- Extra AA batteries for walkie talkie
- Radio or walkie talkie and/or cell phone
- 35 mm camera & slide film (allow at least 2 exposures per AA point)
- Baggies for temporary storage of unknown plants, and masking tape for labeling
- Plant press & paper
- Plant Keys / Flora(s)
- Pencils / sharpies
- Forms: AA point and observation point
- Clipboard/forms holder

  Pens, pencils, pencil lead, slate board, chalk, and chalkboard eraser or supply of clean rags
- Key to the plant associations of the park
- 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 A: 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 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.

arroyo - (colloquial: southwest A.) The channel of a flat-floored, ephemeral stream, commonly with very steep to vertical banks cut in unconsolidated material; sometimes called a wash. It is usually dry but can be transformed into a temporary watercourse or short-lived torrent after heavy rain within the watershed. Where arroyos intersect zones of ground-water discharge, they are more properly classed as intermittent stream channels.

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

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

bar - A general term for a ridge-like accumulation of sand, gravel, or other alluvial material formed in the channel, along the banks, or at the mouth of a stream where a decrease in velocity induces deposition; e.g. a channel bar or a meander bar. A generic term for any of various elongate offshore ridges, banks, or mounds of sand, gravel, or other unconsolidated material submerged at least at high tide, and built up by the action of waves or currents, especially at the mouth of a river or estuary, or at a slight distance offshore from the beach.

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.

bench - (not preferred) refer to structural bench.

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 - (colloquial: western US) A landscape or large tract of steep, rough or broken land dissected by ravines and gullies and marks a sudden change in topography as from an elevated plain to lower hilly terrain, or a line of irregular cliffs at the edge of a mesa or a river (e.g., the Missouri River breaks).

breaks - (colloquial: western US) A landscape or large tract of steep, rough or broken land dissected by ravines and gullies and marks a sudden change in topography as from an elevated plain to lower hilly terrain, or a line of irregular cliffs at the edge of a mesa or a river (e.g., the Missouri River breaks).

butte - An isolated, generally flat-topped hill or mountain with relatively steep slopes and talus or precipitous cliffs and characterized by summit width that is less than the height of bounding escarpments, commonly topped by a caprock of resistant material and representing an erosion remnant carved from flat-lying rocks.

canyon - A long, deep, narrow, very steep-sided valley cut primarily in bedrock with high and precipitous walls in an area of high local relief (e.g., mountain or high plateau terrain), often with a perennial stream at the bottom; similar to but larger than a gorge. Compare - gorge, box canyon, slot canyon.

canyon bench - One of a series of relatively narrow, flat landforms occurring along a canyon wall and caused by differential erosion of alternating strong and weak horizontal strata; a type of structural bench.

canyonlands - A deeply and extensively dissected landscape composed predominantly of relatively narrow, steep-walled valleys with small flood plains or valley floors; commonly with considerable outcrops of hard bedrock on steep slopes, ledges, or cliffs, and with broader summits or interfluves than found in badlands. Sideslopes exhibit extensive erosion, active back-wearing, and relatively sparse vegetation.

channel - (a) The hollow bed where a natural body of surface water flows or may flow. The deepest or central part of the bed of a stream, containing the main current and occupied more or less continuously by water. (b) (colloquial: western US.) The bed of a single or braided watercourse that commonly is barren of vegetation and is formed of modern alluvium. Channels may be enclosed by banks or splayed across and slightly mounded above a fan surface and include bars and mounds of cobbles and stones. (c) Small, trough-like, arcuate or sinuous channels separated by small bars or ridges, caused by fluvial processes; common to flood plains and young alluvial terraces; a constituent part of bar and channel topography.

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

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*.

debris fall - The process, associated sediments (debris fall deposit) or resultant landform characterized by a rapid type of *fall* involving the relatively free, downslope movement or collapse of detached, unconsolidated material which falls freely through the air (lacks an underlying slip face); sediments have substantial proportions of both fine earth and coarse fragments; common along undercut stream banks. Compare - rock fall, soil fall, landslide.

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.

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..

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.

eolian deposit - Sand, silt or clay-sized clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sheet of sand or loess. Conventionally, primary volcanic deposits (e.g. tephra) are handled separately. Compare - loess, parna, beach sands.

eolian sands - Sand-sized, clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sand sheet. Compare - beach sands.

ephemeral stream - Generally a small stream, or upper reach of a stream, that flows only in direct response to precipitation. It receives no protracted water supply from melting snow or other sources and its channel is above the water table at all times. Compare - arroyo, intermittent stream, perennial stream.

eroded fan remnant - All, or a portion of an alluvial fan that is much more extensively eroded and dissected than a fan remnant; sometimes called an erosional fan remnant. It consists primarily of a) eroded and highly dissected sides (eroded fan-remnant sideslopes) dominated by hillslope positions (shoulder, backslope, etc.), and b) to a lesser extent an intact, relatively planar, relict alluvial fan "summit" area best described as a tread.

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.

fan - (a) A gently sloping, fan-shaped mass of detritus forming a section of a low-angle cone commonly at a place where there is a notable decrease in gradient; specifically an alluvial fan (not preferred – use alluvial fan). Compare - alluvial fan, alluvial cone. (b) A fan-shaped mass of congealed lava that formed on a steep slope by the continually changing direction of flow.

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.

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.

footslope - The hillslope profile position that forms the concave surface at the base of a hillslope. It is a transition zone between upslope sites of erosion and transport (shoulder, backslope) and downslope sites of deposition (toeslope). Compare - summit, shoulder, backslope, and toeslope.

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.

head slope - A geomorphic component of hills consisting of a laterally concave area of a hillside, especially at the head of a drainageway, resulting in converging overland water flow (e.g. sheet wash); head slopes are dominated by colluvium and slope wash sediments (e.g., slope alluvium); contour lines form concave curves. Slope complexity (downslope shape) can range from simple to complex. Headslopes are comparatively moister portions of hillslopes and tend to accumulate sediments (e.g., cummulic profiles) where they are not directly contributing materials to channel flow. Compare - side slope, nose slope, free face, interfluve, crest, base slope.

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 dependent on local convention.

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.

hoodoo - A bizarrely shaped column, pinnacle, or pillar of rock produced by differential weathering or erosion in a region of sporadically heavy rainfall. Formation is facilitated by joints and layers of varying hardness.

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.

inset fan - (colloquial; western US) The flood plain of an ephemeral stream that is confined between fan remnants, ballenas, basin-floor remnants, or closely-opposed fan toeslopes of a basin.

interdune - The relatively flat surface, whether sand-free or sand-covered, between dunes. GG

interfluve - A landform composed of the relatively undissected upland or ridge between two adjacent valleys containing streams flowing in the same general direction. An elevated area between two drainageways that sheds water to those drainageways. Compare - divide.

intermittent stream - A stream, or reach of a stream, that does not flow year-round (commonly dry for 3 or more months out of 12) and whose channel is generally below the local water table; it flows only when it receives a) base flow (i.e. solely during wet periods), or b) ground-water discharge or protracted contributions from melting snow or other erratic surface and shallow subsurface sources. Compare - ephemeral stream.

knob - (a) A rounded eminence, a small hill or mountain; especially a prominent or isolated hill with steep sides, commonly found in the Southern United States. (b) A peak or other projection from the top of a hill or mountain. Also, a boulder or group of boulders or an area of resistant rocks protruding from the side of a hill or mountain.

knoll - A small, low, rounded hill rising above adjacent landforms.

landslide - A general, encompassing term for most types of mass movement landforms and processes involving the downslope transport and outward deposition of soil and rock materials, caused by gravitational forces and which may or may not involve saturated materials. Names of landslide types generally reflect the dominant process and/or the resultant landform. The main operational categories of mass movement are *fall* (rockfall, soil fall, topple), *slide* (rotational landslide, block glide, debris slide, lateral spread), *flow* [rock fragment flow (especially rockfall avalanche), debris avalanche, debris flow (e.g., lahar), earthflow, (creep, mudflow)], and *complex landslides*.

ledge - (a) A narrow shelf or projection of rock, much longer than wide, formed on a rock wall or cliff face, as along a coast by differential wave action on softer rocks; erosion is by combined biological and chemical weathering. (b) A rocky outcrop; solid rock. (c) A shelf-like quarry exposure or natural rock outcrop. Compare - structural bench.

marsh - Periodically wet or continually flooded areas with the surface not deeply submerged. Covered dominantly with sedges, cattails, rushes, or other hydrophytic plants. Compare - salt marsh, swamp, bog, fen.

meander scar - (a) A crescent-shaped, concave or linear mark on the face of a bluff or valley wall, produced by the lateral erosion of a meandering stream which impinged upon and undercut the bluff; if it's no longer adjacent to the modern stream channel it indicates an abandoned route of the stream; (b) (not recommended - refer to oxbow) An abandoned meander, commonly filled in by deposition and vegetation, but still discernable.

meander scroll - (a) One of a series of long, parallel, close fitting, crescent-shaped ridges and troughs formed along the inner bank of a stream meander as the channel migrated laterally down-valley and toward the outer bank. Compare - meander belt, point bar. (b) (not recommended; refer to oxbow lake) - A small, elongate lake on a flood plain in a well-defined part of an abandoned stream channel.

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

open depression - A generic name for any enclosed or low area that has a surface drainage outlet whereby surface water can leave the enclosure; an area of lower ground indicated on a topographic map by contour lines forming an incomplete loop or basin indicating at least one surface exit. Compare - closed basin.

overbank deposit - Fine-grained sediments (silt and clay) deposited from suspension on a flood plain by floodwaters that cannot be contained within the stream channel.

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

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 large part of a plateau surface is near summit level.

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.

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.

ridge - A long, narrow elevation of the land, usually sharp crested with steep sides and forming an extended upland between valleys. The term is used in areas of both hill and mountain relief.

rill - A very small channel with steep sides caused by erosion and cut in unconsolidated materials by concentrated but intermittent flow of water, usually during and immediately following moderate rains or after ice/snow melt. Generally, a rill is not an obstacle to wheeled vehicles and is shallow enough to be obliterated by ordinary tillage.

rim - The border, margin, edge, or face of a landform, such as the curved brim surrounding the top part of a crater or caldera; specifically the rimrock of a plateau or canyon.

rise - (refer to lake plain) (a) A general term for a slight increase in slope and elevation of the land surface, usually with a broad summit and gently sloping sides. (b) same as (a) but the term is restricted to microfeatures in areas of very low relief such as lake plains or coastal plains.

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

rock pediment - An erosion surface of low relief, cut directly into and across bedrock and composed of either bare rock or thinly veneered pedisediment or residuum (e.g. < 1.5 m) over bedrock; it occurs along the flanks of mountain fronts, or at the base of mountains or high hills. Its surface grades to the backwearing mountain slopes or hillslopes above, and generally grades down to and merges with a lower-lying alluvial plain, piedmont slope or valley floor below.

rotational slide - The process, associated sediments (rotational landslide deposit) or resultant landforms characterized by an extremely slow to moderately rapid type of slide, composed of comparatively dry and largely soil-rock materials, portions of which remain largely intact and in which movement occurs along a well-defined, concave shear surface and resulting in a backward rotation of the displaced mass. The landform may be single, successive (repeated up and down slope), or multiple (as the number of slide components increase). Compare - rotational debris slide, rotational earth slide, rotational rock slide, translational slide, lateral spread, landslide.

rubble - An accumulation of loose angular rock fragments, commonly overlying outcropping rock; the unconsolidated equivalent of a breccia. Compare - scree, talus.

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

sand plain - (a) A sand-covered plain which may originate by deflation of sand dunes, and who's lower limit of erosion is governed by the ground-water level. Also spelled *sandplain*. (b) (not preferred - refer to *sandy* outwash plain) A small outwash plain composed chiefly of sand deposited by meltwater streams flowing from a glacier.

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

scarp slope - The relatively steeper face of a cuesta, facing in a direction opposite to the dip of the strata. Compare - dip slope.

scree - A collective term for an accumulation of coarse rock debris or a sheet of coarse debris mantling a slope. Scree is not a synonym of talus, as scree includes loose, coarse fragment material on slopes without cliffs. Compare - talus, colluvium, mass movement.

scree slope - A portion of a hillside or mountainslope mantled by scree and lacking an up-slope rockfall source.

seep - (noun) An area, generally small, where water or oil percolates slowly to the land surface. For water, it may be considered as a seepage spring, but it is used by some for flows too small to be considered as springs.

shoulder - The hillslope profile position that forms the convex, erosional surface near the top of a hillslope. If present, it comprises the transition zone from summit to backslope. Compare - summit, crest, backslope, footslope, and toeslope.

side slope - A laterally planar area of a hillside, resulting in predominantly parallel overland water flow (e.g., sheet wash); contour lines generally form straight lines. Side slopes are dominated by colluvium and slope wash

sediments. Slope complexity (downslope shape) can range from simple to complex. Compare - head slope, nose slope, free face, interfluve, crest, base slope. The slope bounding a drainageway and lying between the drainageway and the adjacent interfluve. It is generally linear along the slope width.

slide - (a) Mass movement processes, associated sediments (slide deposit) or resultant landforms (e.g., rotational, translational, and snow slide) characterized by a failure of earth, snow, or rock under shear stress along one or several surfaces that are either visible or may reasonably be inferred. The moving mass may or may not be greatly deformed, and movement may be rotational (rotational slide) or planar (translational slide). A slide can result from lateral erosion, lateral pressure, weight of overlying material, accumulation of moisture, earthquakes, expansion owing to freeze-thaw of water in cracks, regional tilting, undermining, fire, and human agencies. Compare -fall, topple, lateral spread, flow, complex landslide. (b) The track of bare rock or furrowed earth left by a slide. (c) The mass of material moved by or deposited by a slide.

slope - (also called slope gradient or gradient) The inclination of the land surface from the horizontal. Percent slope is the vertical distance divided by the horizontal distance, then multiplied by 100.

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*.

slot canyon - A long, narrow, deep and tortuous channel or drainageway with sheer rock walls eroded into sandstone or other sedimentary rocks, especially in the semi-arid western US (e.g. Colorado Plateau); subject to flash flood events; depth to width ratios exceed 10:1 over most of its length and can approach 100:1; commonly containing unique ecological communities distinct from the adjacent, drier uplands.

strath terrace - A type of stream terrace, formed as an erosional surface cut on bedrock and thinly mantled with stream deposits (alluvium).

stream - (a) A body of running water that moves under gravity to progressively lower levels, in a relatively narrow but clearly defined channel on the ground surface, in a subterranean cavern, or beneath or in a glacier. It is a mixture of water and dissolved, suspended, or entrained matter. (b) A term used in quantitative geomorphology interchangeably with channel. Compare - river.

stream terrace - One or a series of platforms in a stream valley, flanking and more or less parallel to the stream channel, originally formed near the level of the stream, and representing the remnants of an abandoned flood plain, stream bed, or valley floor produced during a former state of fluvial erosion or deposition (i.e., currently very rarely or never floods; inactive cut and fill and/or scour and fill processes). Erosional surfaces cut into bedrock and thinly mantled with stream deposits (alluvium) are called “strath terraces.” Remnants of constructional valley floors thickly mantled with alluvium are called alluvial terraces. Compare - alluvial terrace, flood-plain step, strath terrace, terrace.

structural bench - A platform-like, nearly level to gently inclined erosional surface developed on resistant strata in areas where valleys are cut in alternating strong and weak layers with an essentially horizontal attitude. Structural benches are bedrock controlled, and in contrast to stream terraces, have no geomorphic implication of former, partial erosion cycles and base-level controls, nor do they represent a stage of flood-plain development following an episode of valley trenching. Compare - pediment, ledge; see scarp.

summit - (a) The topographically highest position of a hillslope profile with a nearly level (planar or only slightly convex) surface. Compare - shoulder, backslope, footslope, and toeslope, crest. (b) A general term for the top, or highest area of a landform such as a hill, mountain, or tableland. It usually refers to a high interfluve area of relatively gentle slope that is flanked by steeper slopes, e.g., mountain fronts or tableland escarpments.

swale - (a) A shallow, open depression in unconsolidated materials which lacks a defined channel but can funnel overland or subsurface flow into a drainageway. Soils in swales tend to be more moist and thicker (cummulic) compared to surrounding soils. (b) A small, shallow, typically closed depression in an undulating ground moraine formed by uneven glacial deposition; Compare - swell-and-swale topography. (c) (not preferred; refer to interdune) A long, narrow, generally shallow, trough-like depression between two beach ridges, and aligned roughly parallel to the coastline.

tableland - A term for a broad upland with an extensive, nearly level or undulating summit area and steep side slopes descending to surrounding lowlands. Compare - plateau, mesa, cuesta.

talus - Rock fragments of any size or shape (usually coarse and angular) derived from and lying at the base of a cliff or very steep rock slope. The accumulated mass of loose broken rock formed chiefly by falling, rolling, or sliding.

talus cone - A small, steep, cone-shaped landform at the base of a cliff or escarpment, that heads in a relatively small declivity or ravine, and composed of poorly sorted rock and soil debris that has accumulated primarily by episodic rockfall or, to a lesser degree, by slope wash. Not to be confused with an *alluvial cone*; a similar feature but of fluvial origin, composed of better stratified and more sorted material, and that tapers up into a more extensive drainageway. Compare - alluvial cone, beveled base, talus slope.

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

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

terrace - A step-like surface, bordering a valley floor or shoreline, that represents the former position of a flood plain, or lake or sea shore. The term is usually applied to both the relatively flat summit surface (tread), cut or built by stream or wave action, and the steeper slope (scarp, riser), descending to a lower base level. Practically, terraces are considered to be generally flat alluvial areas above the 100 yr. flood stage.

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

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

translational slide - A category of mass movement processes, associated sediments (translational slide deposit) or resultant landforms characterized by the extremely slow to moderately rapid downslope displacement of comparatively dry soil-rock material on a surface (slip face) that is roughly parallel to the general ground surface, in contrast to falls, topples, and rotational slides. The term includes such diverse *slide* types as translational debris slides, translational earth slide, translational rock slide, block glides, and slab or flake slides. Compare - rotational slide, slide, landslide.

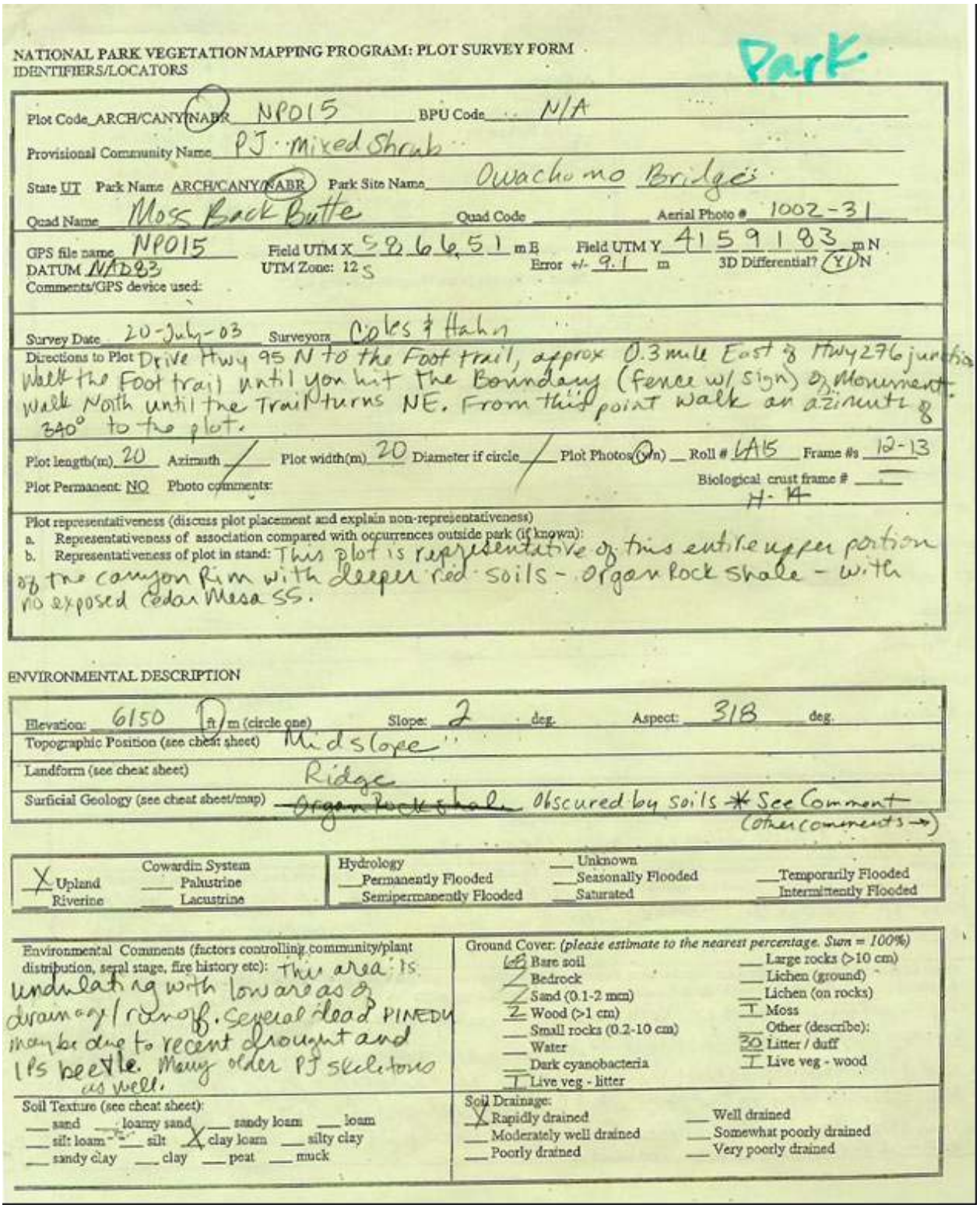
valley - An elongate, relatively large, externally drained depression of the Earth's surface that is primarily developed by stream erosion or glacial activity. Compare - basin.

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 B.3. Example of a Vegetation Plot Data Form



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

Park

Plot Code ARCH/CANY/NABR NP015 BPU Code N/A
Provisional Community Name PJ · Mixed Shrub
State UT Park Name ARCH/CANY/NABR Park Site Name Owachomo Bridge
Quad Name Moss Back Butte Quad Code Aerial Photo # 1002-31
GPS file name NP015 Field UTM X 586651 mE Field UTM Y 4159183 mN
DATUM NAD83 UTM Zone: 12 S Error +/- 9.1 m 3D Differential? (Y)N
Comments/GPS device used:
Survey Date 20-July-03 Surveyors Coles & Hahn
Directions to Plot Drive Hwy 95 N to the Foot trail, approx 0.3 mile East of Hwy 276 junction. Walk the Foot trail until you hit the Boundary (fence w/ sign) & Monument. Walk North until the Trail turns NE. From this point walk an azimuth of 340° to the plot.
Plot length(m) 20 Azimuth / Plot width(m) 20 Diameter if circle / Plot Photos (y/n) Roll # LA15 Frame #s 12-13
Plot Permanent: NO Photo comments: Biological crust frame # H-14
Plot representativeness (discuss plot placement and explain non-representativeness)
a. Representativeness of association compared with occurrences outside park (if known):
b. Representativeness of plot in stand: This plot is representative of this entire upper portion of the canyon Rim with deeper red soils - Organ Rock Shale - with no exposed Cedar Mesa SS.

ENVIRONMENTAL DESCRIPTION

Elevation: 6150 (ft) / m (circle one) Slope: 2 deg. Aspect: 318 deg.
Topographic Position (see cheat sheet) Midslope
Landform (see cheat sheet) Ridge
Surficial Geology (see cheat sheet/map) ~~Organ Rock Shale~~ Obscured by soils * See Comment (Other comments →)

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

Environmental Comments (factors controlling community/plant distribution, seral stage, fire history etc): This area is undulating with low areas of drainage/runoff. Several dead PINEDY maybe due to recent drought and IPS beetle. Many older PJ skeletons as well.

Ground Cover: (please estimate to the nearest percentage. Sum = 100%)
60 Bare soil; Bedrock; Sand (0.1-2 mm); 2 Wood (>1 cm); Small rocks (0.2-10 cm); Water; Dark cyanobacteria; 1 Live veg - litter; Large rocks (>10 cm); Lichen (ground); Lichen (on rocks); 1 Moss; Other (describe); 30 Litter / duff; 1 Live veg - wood

Soil Texture (see cheat sheet): sand; loamy sand; sandy loam; loam; silt loam; silt; X clay loam; silty clay; sandy clay; clay; peat; muck
Soil Drainage: X Rapidly drained; Moderately well drained; Poorly drained; Well drained; Somewhat poorly drained; Very poorly drained

VEGETATION DESCRIPTION

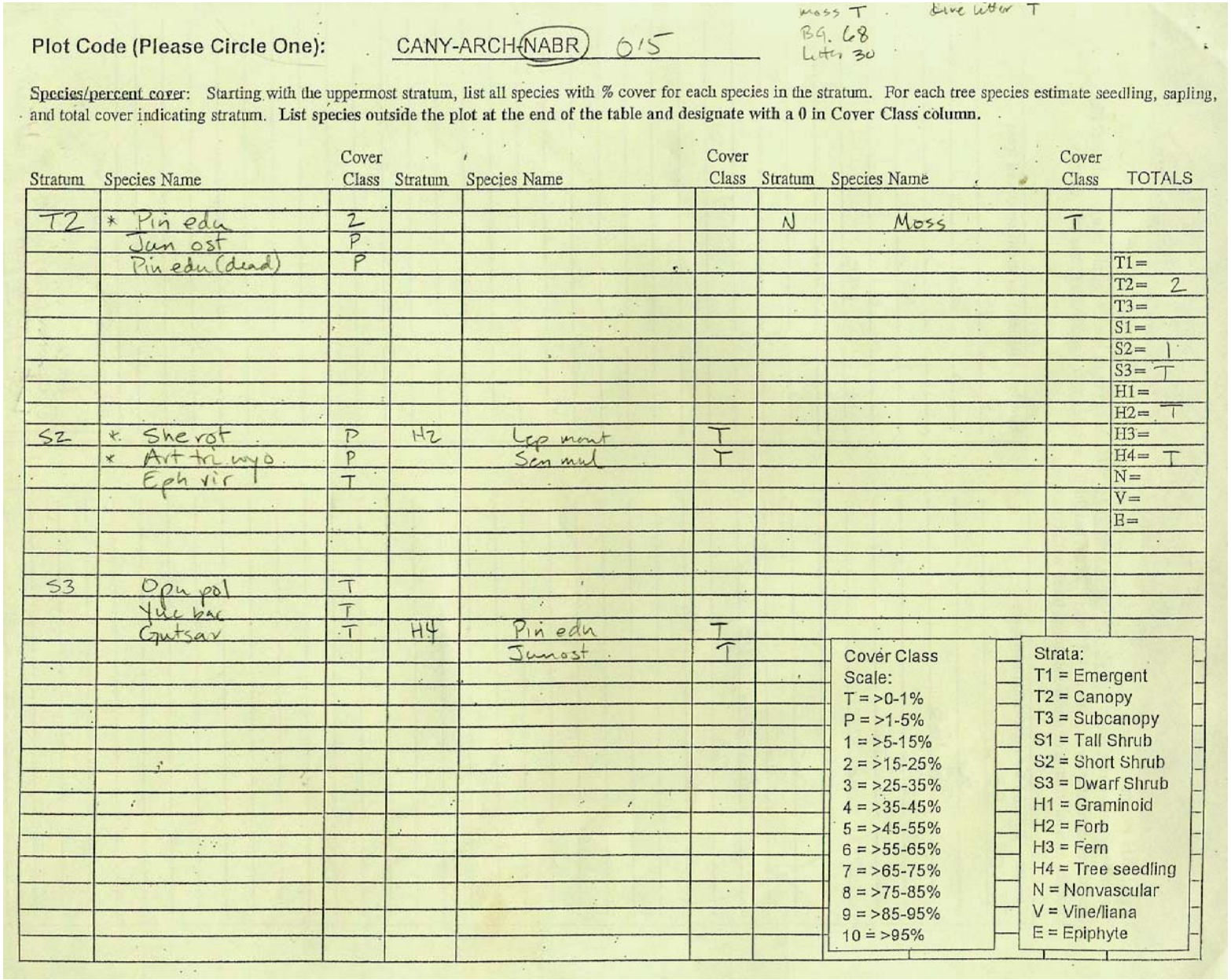
Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic Class	Height Scale for Strata	Cover Scale for Strata
Trees and Shrubs				T 0-1%
X Evergreen	___ Broad-leaved	___ Forest	01 <0.5 m	P >1-5%
___ Cold-deciduous	X Needle-leaved	X Woodland	02 0.5-1m	1 >5-15%
___ Mixed evergreen-cold-deciduous	___ Microphyllous	___ Shrubland	03 1-2 m	2 >15-25%
	___ Graminoid	___ Dwarf Shrubland	04 2-5 m	3 >25-35%
Herbs	___ Forb	___ Shrub Herbaceous	05 5-10 m	4 >35-45%
___ Annual	___ Pteridophyte	___ Herbaceous	06 10-15 m	5 >45-55%
___ Perennial	___ Non-vascular	___ Nonvascular	07 15-20 m	6 >55-65%
	___ Mixed (describe)	___ Sparsely Vegetated	08 20-35 m	7 >65-75%
			09 35 – 50 m	8 >75-85%
			10 >50 m	9 >85-95%
				10 > 95%

	Height Class	Cover Class	Dominant Species (mark Diagnostic species with *)
T1 Emergent			
T2 Canopy	04	2	Pinedu, Junost
T3 Sub-canopy			
S1 Tall shrub			
S2 Short Shrub	02	1	Sherot, Artri wyo
S3 Dwarf-shrub	01	T	Mix
Ht Herbaceous		T	
H1 Graminoids			
H2 Forbs	01	T	Mix
H3 Ferns			
H4 Tree seedlings	01	T	Pinedu, Junost
N Non-vascular			
V Vine/liana			
E Epiphyte			

Animal Use Evidence (including scat, browse, burrows, bedding sites, etc)
Few deer trails in area, no other sign.

Natural and Anthropogenic Disturbance Comments (see cheat sheet for examples; describe intensity and effect on the vegetation, also whether disturbance is current, chronic, episodic or historic) This plot is far enough off the foot trail to have no obvious disturbance. PINED are leaking pitch and several in the plot died recently.

Other Comments/Continuation from previous sections. Describe surrounding communities and how they relate to the plot. Describe distribution of biological crust components in the community. Soil packs down to a clay hard pan at approximately 5 inches. Very, very, very young dark cyano development, mostly soil cracking. Between the plot and the foot trail we have walked through PJ w/ ARTTRIW and few SHEROT, Sparse PJ, and areas like this plot - PJ w/ ARTTRI W & SHEROT. All look the same on the photos and are not very different in composition. This is an area of Cedar Mesa Sandstone with soils on top, which appear to be derived from Organ Rock Shale.



Moss T Live litter T
BG. 68
Litter 30

Plot Code (Please Circle One): CANY-ARCH-NABR 015

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

Stratum	Species Name	Cover Class	Stratum	Species Name	Cover Class	Stratum	Species Name	Cover Class	TOTALS
T2	* Pin edu	2				N	Moss	T	
	Jun ost	P							
	Pin edu (dead)	P							T1=
									T2= 2
									T3=
									S1=
									S2= 1
									S3= T
									H1=
									H2= T
S2	* Sherot	P	H2	Lep mont	T				H3=
	* Art tri wyo	P		Sen mul	T				H4= T
	Eph vir	T							N=
									V=
									E=
S3	Opu pol	T							
	Yuc bac	T							
	Gut sar	T	H4	Pin edu	T				
				Jun ost	T				

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

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

Tree DBH Form

Plot Code (Please circle one): CANY-ARCH-NABR 05 Units in cm or inches (circle one) Subplot? (Y/N) N

Record tree diameter over 5 cm at 4.5 feet (1.37 m) height for species that contribute to the tree canopy.

Separate measurements of multi-stemmed trees with commas.

Species	DBH(s) for multi-stemmed trees
JUOS	25.5
	36
	38 12.5
	14.5
	50.5
	10
	16.5
	30.5
	29.5
	14, 11.5, 10, 24.5, 9.5
	29
	44.5; 6.5, 15

Species	DBH(s) for multi-stemmed trees
PIED	15
	13.5
	30.5
	13.5
	21
	19.5
	15.5

Pinyon-juniper age classes (check one)

___Not PJ
___Old-growth (>500 years old)
1 Mature (350-500 years old, shrub layer absent)
___Young (100-350 years old)
___Invasive (<80 years old)

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

NATIONAL PARK VEGETATION MAPPING PROGRAM: OBSERVATION POINT FORM

Park

IDENTIFIERS/LOCATORS

Plot Code (Please Circle One): CANY-ARCH-NABR NOPP2 **Polygon Code:** NA

Provisional Community Name: ARTTRI - BROTEC Shrubland

State: UT **Park Name (Pleae Circle One):** Canyonlands, Arches, Natural Bridges **Park Site Name:** Owachomo Bridge

Quad Name: Moss Back Butte **Quad Code:** 1002-18 Aerial Photo

GPS File Name: NOPP2 **Field UTM X:** 587202 mE **Field UTM Y:** 4159627 mN

Please do not complete the following information when in the field: 3DGPS +/- 5 m

Corrected UTM X: mE **Corrected UTM Y:** mN **Zone:**

Observers: Colet + Hahn **Date:** 7-18-03 **Photos:** LA13 #36

ENVIRONMENTAL DESCRIPTION

Elevation: 5880 ft **Slope:** 0 deg. **Aspect:** 0 deg.

Topographic Position: Midslope/Low level

Landform: Stream terrace **Geology:** Recent alluvium

Cowardin Wetland Classification System

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

Hydrologic Regime - Non Tidal

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

Environmental Comments: This is a small patch approx 50m x 15m, with nearly solid BROTEC in understory. Area does not flood. On margins of ARTTRI shrubland, are PINEDU, FRAANO, MAHFRE, QUEGAM, POPFRE, but do not make up this community.

Unvegetated Surface (*please use cover scale below*)

- ___ Bedrock
- ___ Rocks >10 cm
- ___ Rocks 0.2-10 cm
- OT Sand
- OT ~~Other (describe)~~ Biotic crust
- 04 Bare Soil
- 04 Litter/Duff
- 01 Wood

VEGETATION DESCRIPTION

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

NATIONAL PARK VEGETATION MAPPING PROGRAM: OBSERVATION POINT FORM

Stratum	Height	Cover Class	Dominant species (mark diagnostic spp with a *)	% cover
T1: Emergent				
T2: Canopy				
T3: Sub-canopy				
S1: Tall shrub	03	03	ARTTRI T SALEX1	03 one
S2: Short shrub	01	01	OPUPOL ROSWOO	01 01
H: Herbaceous	01	03	BROTEC LAPOCC SPHPAR SENMUL TRADUB ARIDRA HETVIL	03 01 01 01 01 01 01
SPOCRY 01 SPOAIR 01 CASLIN 01 MACCAN 01 LEPMON var. spathulatum 01	Thelypodium lax. 01 DESPIN 01 POAFEN 01 ORYhym 01			
N: Non-vascular	01	01	Syntrichia Bark cyano	01 01
V: Vine/liana				
E: Epiphyte				

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

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

ACCURACY ASSESSMENT POINT FORM

IDENTIFIERS/LOCATORS

Field Point Code **NABR.AA.050** Database Point Code _____

State: CO Park Name: NABR Park Site Name WHITE CANYON

Quad Name WOODENSHOE BUTTES Quad Code _____

GPS file name _____ GPS Unit: ETREX

Field UTM X 590717 m E Field UTM Y 4164876 m N GPS Error 5.0 m

Field Photo Notes: Camera: OLYMPUS

Roll: AB14 Frame: 4 Photographer: AB Comments: E→W

Roll: " Frame: 5 Photographer: " Comments: N→S

please do not complete the following information when in the field

Corrected UTM X _____ m ECorrected UTM Y _____ m N UTMZone _____

Survey Date 12/16/04 Surveyors BUECHLING

Primary Name Veg Assoc: SALIX EXIGUA / MESIC GRAMINOIDES

Secondary Name Veg Assoc: ERICAMERIA NAUSEOSA SHRUBLAND
(NOT IN CLASSIFICATION)

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

3) _____ Other Map Unit within 50m _____

Classification Comments: THIS STAND IS DOMINATED BY ERICAMERIA NAU.

ENVIRONMENTAL DESCRIPTION

Elevation 1830 m Slope 1° Aspect 277°

Topographic Position LOW LEVEL

Landform LOW TERRACE ON CANYON BOTTOM

Environmental Comments (including hydrology):

THIS TERRACE IS INTERMITTENTLY FLOODED. SALIX OCCURS PREDOMINANTLY DIRECTLY ADJACENT TO THE WASH.

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

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

VEGETATION DESCRIPTION

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

Strata	Height Class	Cover Class	Dominant species (mark any known diagnostic species with a *)	Cover % (Actual)
T1 Emergent				
T2 Canopy	05	01	ACER NEGUNDO	5
T3 Sub-canopy				
S1 Tall shrub	04	01	* SALIX EXIGUA	4
S2 Short Shrub	03	09	ERICAMERIA NAUSEOSA	75
			SYMPHORICARPOS OREOPHILUS	4
S3 Dwarf-shrub				
H Herbaceous	03	01		
			LEPIDIUM MONTANUM	2
			BROMUS TECTORUM	2
			SPOROBOLUS ~~sp~~ airoides	<1
			STIPA HYMENOIDES	<1
N Non-vascular				
V Vine/liana				
E Epiphyte				

Appendix C

C.1. Plots Database Documentation

Background

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

Two database files are required to use NABR VegMapDB:

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

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

Entity Relationship Diagram

The primary tables and relationships from the backend file (NABR_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.

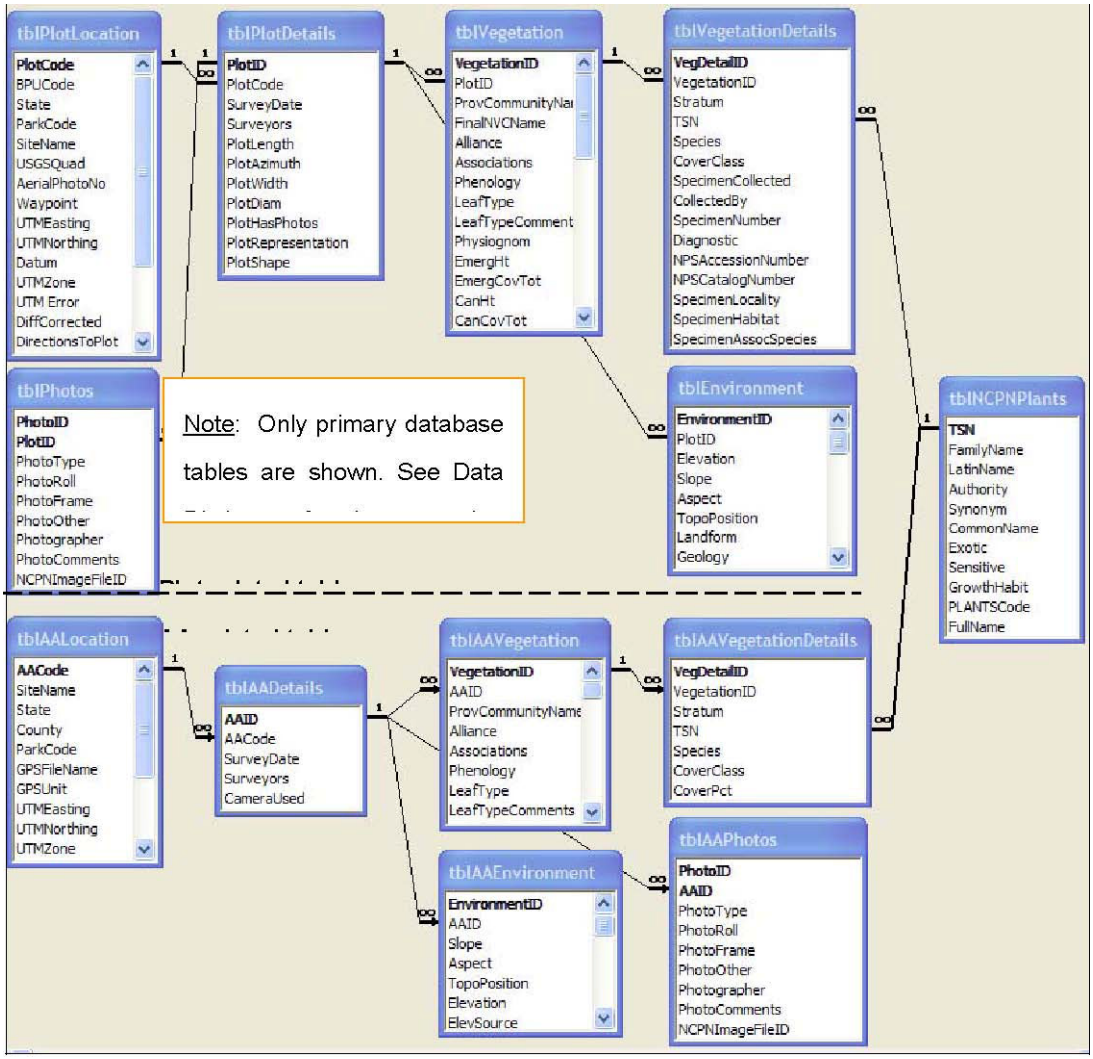


Figure 1. Entity Relationship Diagram for NABR VegMapDB.

Data Dictionary

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

Plot-related tables

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

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 and ActionYear fields.	dbText	50

Field Name	Field Description	Field Type	Field Width
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
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	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
Wood	Estimate to the nearest percentage of wood >1cm ground cover	dbText	3

Field Name	Field Description	Field Type	Field Width
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	Calculated total percent ground cover	dbInteger	2

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

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

Table Name: tblFuels
Description: Table containing details on fuels characteristics of plot.

Field Name	Field Description	Field Type	Field Width
FuelsID	Unique record ID	dbLong	4

Field Name	Field Description	Field Type	Field Width
PlotID	Foreign key; links to tblPlotDetails	dbLong	4
PPDFPhotoGuide	n/a for NABR plots	dbText	3
PJPhotoGuide	n/a for NABR plots	dbText	3
SBPhotoGuide	n/a for NABR 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 NABR plots	dbText	3
LitterNorth	n/a for NABR plots	dbText	3
LitterEast	n/a for NABR plots	dbText	3
LitterSouth	n/a for NABR plots	dbText	3
LitterWest	n/a for NABR plots	dbText	3
DuffOrigin	n/a for NABR plots	dbText	3
DuffNorth	n/a for NABR plots	dbText	3
DuffEast	n/a for NABR plots	dbText	3
DuffSouth	n/a for NABR plots	dbText	3
DuffWest	n/a for NABR plots	dbText	3
IsSubplot	Indicate if measurements are for subplot (if plot has >25 trees, one quadrant (subplot) of plot can be measured for fuels	dbBoolean	1

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

Field Name	Field Description	Field Type	Field Width
FuelsDetailID	Unique identifier for record	dbLong	4
FuelsID	Foreign key, links to tblFuels	dbLong	4
StemCount	Number of stems measured. Value will be 1 if forest species; >=1 if woodland species.	dbInteger	2
StemDiameter	diameter in cm of stem(s). If stem count =1 for a forest species, diameter represents dbh. If stem count is >1 for a woodland species, diameter represents the average diameter of all stems measured at crown base.	dbDouble	8
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
WoodlandCrownWidth	n/a for NABR plots	dbDouble	8
WoodlandCrownHeight	n/a for NABR plots	dbDouble	8
ForestCrownBaseHeight	n/a for NABR plots	dbDouble	8
ForestCrownHeight	n/a for NABR plots	dbDouble	8
CrownRatio	n/a for NABR plots	dbText	12
StructureStage	n/a for NABR plots	dbText	12
Comments	n/a for NABR plots	dbText	255

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

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

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	dbText	50
PhotoOther	Other unique identifier or reference number for digital photo or name of movie file	dbText	25
Photographer	Name of photographer	dbText	50
PhotoComments	Brief description of photo	dbText	255
NCPNImageFileID	Cross-reference for NCPN Photo Database 'ImageFileID' and 'PhotoOther'	dbText	50

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

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

Table Name: tblPlotLocation
Description: Basic and unchanging information on plot or observation point location.

Field Name	Field Description	Field Type	Field Width
PlotCode	Identifier assigned to plot by survey crew	dbText	10
BPUCode	Biophysical unit code where plot is located	dbText	10
State	State where plot is located	dbText	2
ParkCode	Park unit where plot is located	dbText	4
SiteName	Short, descriptive name of site where plot is located	dbText	100
USGSQuad	USGS quadrangle (1:24K) where plot is located	dbText	50
AerialPhotoNo	Aerial photo number corresponding to plot location	dbText	10
Waypoint	Garmin plot code	dbText	7
UTMEasting	UTM easting of plot	dbDouble	8
UTMNorthing	UTM northing of plot	dbDouble	8
Datum	Datum of UTM coordinates	dbText	10
UTMZone	UTM zone of coordinates	dbText	4
UTMError	Error, in meters, of location data (based on reading from Garmin GPS unit)	dbText	5
DiffCorrected	Indicate if coordinates have been differentially corrected	dbText	3
DirectionsTo Plot	Precise directions to plot		0
County	County where plot is located	dbText	50

Field Name	Field Description	Field Type	Field Width
GPSUnit	Manufacturer and model of GPS unit (e.g., Trimble GeoExplorer 3)	dbText	25
GPSComments	Any brief comments on GPS data collection at plot	dbText	255
InPark	Select Yes if plot is within park boundaries	dbBoolean	1
IsObservationPt	Yes if observation point	dbBoolean	1

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

Field Name	Field Description	Field Type	Field Width
VegetationID	Unique record ID	dbLong	4
PhotoID	Foreign key, links to tblPlotDetails	dbLong	4
ProvCommunityName	Community name (provisional) assigned by field crews by following naming protocols as described in field manual and training 04/04	dbText	120
FinalNVCName	Final community name, provided by NatureServe	dbText	240
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	01<.5m 02=.5-1m 03=1-2m 04=2-5m 05=5-10m 06=10-15m 07=15-20m 08=20-35m 09=35-50m 10=>50m	dbText	2
EmergCovTot	Height class of emergent stratum (classes are in tlkpHeight)	dbText	2
CanHt	Height class of canopy stratum	dbText	2
CanCovTot	Cover class of canopy stratum	dbText	50
SubHt	Height class of subcanopy stratum	dbText	2
SubCovTot	Cover class of subcanopy stratum	dbText	2
TallShHt	Height class of tall shrub stratum	dbText	2
TallShCovTot	Cover class of tall shrub stratum	dbText	2
ShrubHt	Height class of short shrub stratum	dbText	2
ShrubCovTot	Cover class of short shrub stratum	dbText	2
DwarfHt	Height class of dwarf shrub stratum	dbText	2
DwarfCovTot	Cover class of dwarf shrub stratum	dbText	2
HerbHt	Height class of herbaceous stratum (all H layers)	dbText	2
HerbCovTot	Cover class of herbaceous stratum (all H layers)	dbText	2
GramHt	Height class of graminoid stratum	dbText	2
GramCovTot	Cover class of graminoid stratum	dbText	2
ForbHt	Height class of forb stratum	dbText	2
ForbCovTot	Cover class of forb stratum	dbText	2
FernHt	Height class of fern and fern ally stratum	dbText	2
FernCovTot	Cover class of fern and fern ally stratum	dbText	2
SeedlHt	Height class of seedling stratum	dbText	2
SeedlCovTot	Cover class of seedling stratum	dbText	2
NonvasHt	Height class of nonvascular stratum	dbText	2
NonvasCovTot	Cover class of nonvascular stratum	dbText	2
VineHt	Height class of vine stratum	dbText	2

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

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

Field Name	Field Description	Field Type	Field Width
VegDetailID	Unique record ID	dbLong	4
VegetationID	Foreign key; links to tblVegetation	dbLong	4
Stratum	Strata class from tlkpStrata	dbText	2
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
Species	Latin name of species, from tblNCPNPlants	dbText	100
CoverClass	Cover class to describe species and strata (from tlkpCover)	dbText	2
SpecimenCollected	Check yes if a specimen of the species was collected	dbBoolean	1
CollectedBy	Name of person making collection	dbText	120
SpecimenNumber	Enter the collector's reference number for the specimen collected	dbText	50
Diagnostic	Check yes if the species is known to be diagnostic of the vegetation type	dbBoolean	1
NPSAccessionNumber	Accession number corresponding to all collections made under research permit; provided by park curator	dbText	50
NPSCatalogNumber	Unique reference number for individual specimen; provided by park curator	dbText	50
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 where specimen was collected, suitable for herbarium label	dbText	240

Accuracy assessment-related tables

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

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

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

Field Name	Field Description	Field Type	Field Width
EnvironmentID	Unique record identifier	dbLong	4
AAID	Foreign key; links to tblAADetails	dbLong	4
Slope	Slope of AA point measured in degrees	dbText	50
Aspect	Aspect of AA point	dbText	50
TopoPosition	Topographic position of AA point; value selected from tlkpTopography	dbText	50
Elevation	Elevation of AA point in meters as estimated from either map or GPS unit	dbLong	4
ElevSource	How elevation was derived in the field (GPS or Quad Map)	dbText	50
EnvironmentalComments	Comments on environmental setting and its effect on the vegetation; also comments on any disturbance or reproduction factors	dbMemo	0
BareSoil	Estimate to the nearest percentage of bare soil ground cover	dbText	3
Bedrock	Estimate to the nearest percentage of bedrock ground cover	dbText	3
Sand	Estimate to the nearest percentage of sand (particle size 0.1-2mm) ground cover	dbText	3
Moss	Estimate to the nearest percentage of moss ground cover	dbText	3
Other	Estimate to the nearest percentage of other type of ground cover	dbText	3
OtherPctDesc	Description of other type of ground cover if "Other" percentage field contains a value	dbText	255
Litter	Estimate to the nearest percentage of litter ground cover	dbText	3
Rocks	Estimate to the nearest percentage of rocks >10cm wide ground cover	dbText	3
Lichen	Estimate to the nearest percentage of lichen ground cover	dbText	3
Gravel	Estimate to the nearest percentage of gravel <10cm wide ground cover	dbText	3
LiveVegLitter	Estimate to the nearest percentage of live veg litter ground cover	dbText	3
LiveVegWood	Estimate to the nearest percentage of live veg wood ground cover	dbText	3
Wood	Estimate to the nearest percentage of wood >1cm ground cover	dbText	3
LichenRocks	Estimate to the nearest percentage of lichen covering rocks	dbText	3
LichenGround	Estimate to the nearest percentage of lichen covering ground	dbText	3
DarkCyanobacteria	Estimate to the nearest percentage of dark cyanobacteria ground cover	dbText	3
Water	Estimate to the nearest percentage of water ground cover	dbText	3

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

Field Name	Field Description	Field Type	Field Width
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
UTMEasting	UTM easting of point	dbText	9
UTMNorthing	UTM northing of point	dbText	10
UTMZone	UTM zone of coordinates	dbText	4
DiffCorrected	Indicate if coordinates have been differentially corrected	dbText	3
Datum	Datum of UTM coordinates	dbText	10
PDOP	Satellite Precision Dilution of Position (based on reading from Trimble GPS unit)	dbText	50
UTM Error	Error, in meters, of location data (based on reading from Garmin GPS unit)	dbText	5
InPark	Select Yes if point is within park boundaries	dbBoolean	1
GPSComments	Any brief comments on GPS data collection	dbText	255

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

Field Name	Field Description	Field Type	Field Width
PhotoID	Unique record identifier	dbLong	4
AAID	Foreign key; provides link to tblAADetails	dbLong	4
PhotoType	Type of photo being referenced	dbText	16
PhotoRoll	Reference number for film roll of photo	dbText	12
PhotoFrame	Frame number of photo within roll	dbText	50
PhotoOther	Other unique identifier or reference number for digital photo or name of movie file	dbText	25
Photographer	Name of photographer	dbText	50
PhotoComments	Brief description of photo	dbText	255
NCPNImageFileID	Cross-reference for NCPN Photo Database 'ImageFileID' and '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

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

Table Name: tblAAVegetation
Description: Overall vegetation characteristics of an AA point.

Field Name	Field Description	Field Type	Field Width
VegetationID	Unique record identifier	dbLong	4
AAID	Foreign key; provides link to tblAADetails	dbLong	4
ProvCommunityName	Community name (provisional) assigned by field crews by following naming protocols as described in field manual and training 04/04.	dbText	120
Alliance	Alliance corresponding to provisional community name	dbText	100
Associations	Association corresponding to provisional community name	dbText	100
Phenology	Leaf phenology of the dominant stratum.	dbText	35
LeafType	Leaf form of the dominant stratum.	dbText	35
LeafTypeComments	If Leaf Type is "mixed," this field describes the multiple leaf types found in the dominant stratum.	dbText	255
Physiognom	Physiognomic class of plot (from tllkPhysiogClass)	dbText	20
EmergHt	01<.5m 02=.5-1m 03=1-2m 04=2-5m 05=5-10m 06=10-15m 07=15-20m 08=20-35m 09=35-50m 10=>50m	dbText	2
EmergCovTot	Cover class of emergent stratum	dbText	15
EmergCovPercent	[not used]	dbText	50
CanHt	Height class of canopy stratum	dbText	2
CanCovTot	Cover class of canopy stratum	dbText	15
CanCovPercent	[not used]	dbText	50
SubHt	Height class of subcanopy stratum	dbText	2
SubCovTot	Cover class of subcanopy stratum	dbText	15
SubCovPercent	[not used]	dbText	50
TallShHt	Height class of tall shrub stratum	dbText	2
TallShCovTot	Cover class of tall shrub stratum	dbText	15
TallShCovPercent	[not used]	dbText	50
ShrubHt	Height class of shrub stratum	dbText	2
ShrubCovTot	Cover class of shrub stratum	dbText	15
ShrubCovPercent	[not used]	dbText	50
DwarfHt	Height class of dwarf shrub stratum	dbText	2
DwarfCovTot	Cover class of dwarf shrub stratum	dbText	15
DwarfCovPercent	[not used]	dbText	50
HerbHt	Height class of herbaceous stratum	dbText	2
HerbCovTot	Cover class of herbaceous stratum	dbText	15
HerbCovPercent	[not used]	dbText	50
NonvasHt	Height class of nonvascular stratum	dbText	2
NonvasCovTot	Cover class of nonvascular stratum	dbText	15
NonvasCovPercent	[not used]	dbText	50
VineHt	Height class of vine stratum	dbText	2
VineTotCov	Cover class of vine stratum	dbText	15

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

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

Field Name	Field Description	Field Type	Field Width
VegDetailID	Unique record ID	dbLong	4
VegetationID	Foreign key; links to tblAAVegetation	dbLong	4
Stratum	Strata class from tllkStrata	dbText	2
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS (Integrated Taxonomic Information System)	dbDouble	8
Species	Latin names of species, from tblNCPNPlants	dbText	100
CoverClass	Cover class to describe species and strata (from tllkCover)	dbText	5
CoverPct	[not used]	dbText	5

Lookup tables

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

Field Name	Field Description	Field Type	Field Width
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
FamilyName	Family name of taxon	dbText	255
LatinName	Latin name of taxon	dbText	255
Authority	Authority of Latin name	dbText	255
Synonym	Accepted synonyms of taxon	dbText	255
CommonName	Locally accepted common name for taxon	dbText	255
Exotic	Check yes if species is exotic	dbBoolean	1

Field Name	Field Description	Field Type	Field Width
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: tlkpCover
Description: Look-up of cover classes assigned to strata in VegetationDetails.

Field Name	Field Description	Field Type	Field Width
CoverClass	T >0-1% P >1-5% 1 >5-15% 2 >15-25% etc.	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: 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	50

Table Name: tlkpLeafPhen
Description: Look-up of phenology types to describe dominant stratum (from Veg Mapping Manual 04/04).

Field Name	Field Description	Field Type	Field Width
Phenology	Leaf phenology descriptors to describe dominant stratum	dbText	40

Table Name: tlkpLeafType
Description: Look-up of leaf form of dominant stratum (from Veg Mapping Manual 04/04).

Field Name	Field Description	Field Type	Field Width
LeafType	Leaf form description of the dominant stratum	dbText	35

Table Name: tlkpParks
Description: Look-up of parks in the Northern Colorado Plateau network of I&M.

Field Name	Field Description	Field Type	Field Width
ParkCode	Four-letter abbreviation for park name	dbText	4
ParkName	Full name of park where data were collected	dbText	50

Table Name: tlkpPhotoTypes
Description: Look-up of types of photos taken during data collection.

Field Name	Field Description	Field Type	Field Width
PhotoType	Type of photo taken, associated with plot	dbText	50

Table Name: tlkpPhysiogClass
Description: Look-up of physiognomic types to describe each plot or observation point.

Field Name	Field Description	Field Type	Field Width
Physiognom	Physiognomic class used to describe plot	dbText	50

Table Name: tlkpPJAge
Description: Look-up of Pinyon-Juniper age classes.

Field Name	Field Description	Field Type	Field Width
PJAgeClass	Pinyon- Juniper age class, if plot contains either of these two species	dbText	15

Table Name: tlkpPlotShapes
Description: Look-up of shapes of plots.

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

Table Name: tlkpSoilDrainage
Description: Look-up of soil drainage classes to describe plot or observation point.

Field Name	Field Description	Field Type	Field Width
SoilDrainage	Soil drainage classes used to describe soil where plot is located	dbText	30

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

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

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

Field Name	Field Description	Field Type	Field Width
StateCode	Two-letter abbreviation for each state	dbText	2
StateName	Full name of each state in the USA	dbText	50

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

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

Table Name: tlkpStructureStages
Description: Look-up of vegetation structure stages.

Field Name	Field Description	Field Type	Field Width
StructureStage	Standard fuel model classes for forest and woodland trees indicating their position in the canopy	dbText	12

Table Name: tlkpSurveyors
Description: Look-up of names of data collection individuals for NABR 2003 field season.

Field Name	Field Description	Field Type	Field Width
SurveyorName	Full names of all surveyors who worked on data collection in NABR during the 2003 field season.	dbText	75

Table Name: tlkpTopography
Description: Look-up of topographic positions to describe where plot or observation point is located on its related landform.

Field Name	Field Description	Field Type	Field Width
TopoPosition	Topographic positions used to describe where plot or observation point is located on its related landform	dbText	50

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

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

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

Field Name	Field Description	Field Type	Field Width
TMZone	UTM zone where all NABR plots were collected	dbText	5

C.2. Geodatabase Documentation *Purshia mexicana* (D. Don) Henrickson

Background

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

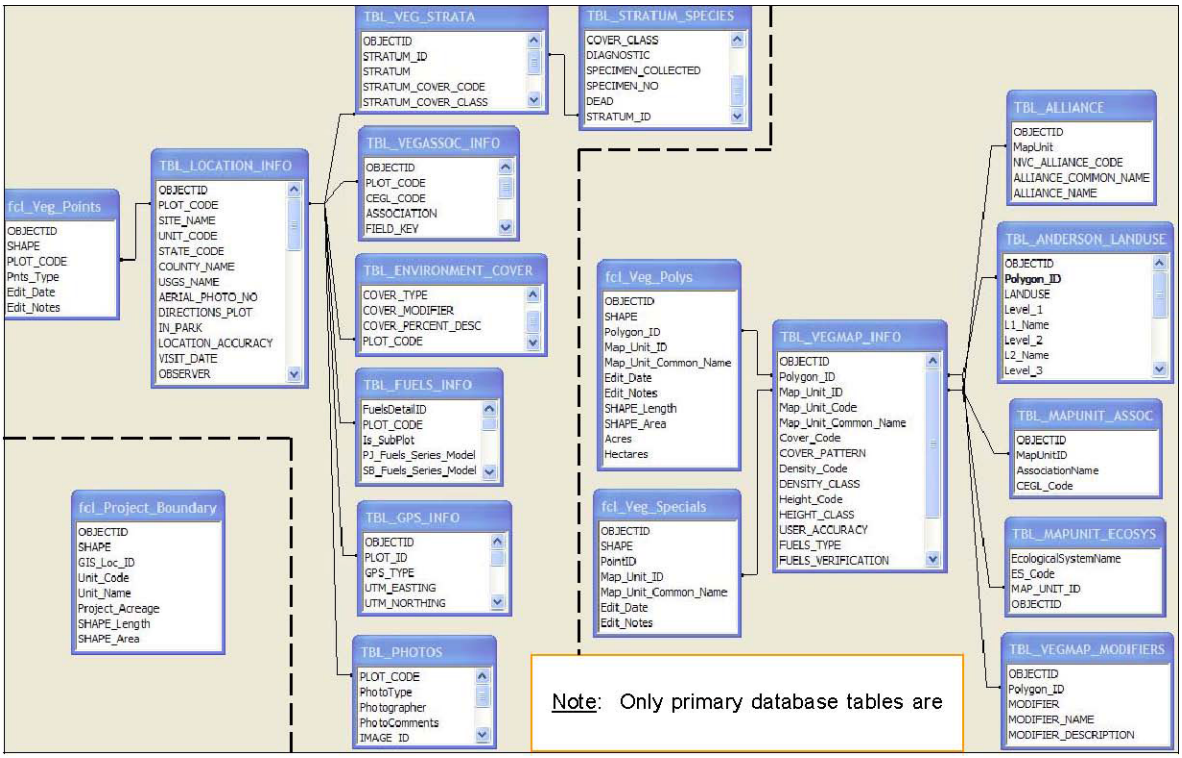


Figure 2. Entity Relationship Diagram for NABR Geodatabase

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

Field Name	Field Description	Field Type	Field Width
SHAPE	ESRI generated	dbLongBinary	0
GIS_Loc_ID	unique ID	dbText	128
Unit_Code	Four-letter park code (NABR)	dbText	10
Unit_Name	Full name of national park (Natural Bridges 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

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

Non-spatial tables

Table Name: TBL_ALLIANCE
Description: Contains the alliances for the vegetation polygons by map unit ID.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MapUnit	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	12
NVC_ALLIANCE_CODE	The NVC alliance code	dbText	20
ALLIANCE_COMMON_NAME	NVC alliance common name	dbText	250
ALLIANCE_NAME	NVC alliance latin name	dbText	250

Table Name: TBL_ANDERSON_LANDUSE
Description: Contains the Anderson Landuse classes for the vegetation polygons.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
Polygon_ID	Unique polygon code, used for relating tables (TBL_VEGMAP_INFO)	dbText	20
LANDUSE	The Anderson landuse classes of the polygon (version 1.5, January 2002)	dbDouble	8
Level_1	Anderson landuse code for level one	dbText	255
L1_Name	Anderson landuse name for level one	dbText	255
Level_2	Anderson landuse code for level two	dbText	50
L2_Name	Anderson landuse name for level two	dbText	255
Level_3	Anderson landuse code for level three	dbText	255
L3_Name	Anderson landuse name for level three	dbText	255
Level_4	Anderson landuse code for level four	dbText	255
L4_Name	Anderson landuse name for level four	dbText	255
Level_5	Anderson landuse code for level five	dbText	255
L5_Name	Anderson landuse name for level five	dbText	255
Level_6	Anderson landuse code for level six	dbText	255
L6_Name	Anderson landuse name for level six	dbText	255

Table Name: TBL_ENVIRONMENT_COVER
Description: Contains ground cover data for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
COVER_TYPE	Ground cover type	dbText	30

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

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

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

Table Name: TBL_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 Woodland 208	dbText	255

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

Field Name	Field Description	Field Type	Field Width
FuelsDetailID	Unique identifier for record	dbLong	4
PLOT_CODE	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	20
Is_SubPlot	Indicate if measurements are for subplot (if plot has >25 trees, one quadrant (subplot) of plot can be measured for fuels)	dbText	4
PJ_Fuels_Series_Model	Pinyon/Juniper Fuels series ID	dbText	6
SB_Fuels_Series_Model	Sagebrush Fuels series ID	dbText	6
PJ_Age_Class	If plot contains pinyon and/or juniper, enter value that best describes the age class of the stand	dbText	50
StemCount	Number of stems measured. Value will be 1 if forest species; >=1 if woodland species.	dbInteger	2
StemDiameter	Diameter in cm of stem(s). If stem count =1 for a forest species, diameter represents dbh. If stem count is >1 for a woodland species, diameter represents the average diameter of all stems measured at crown base.	dbDouble	8
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
Species	Species name	dbText	250
WoodlandCrownWidth	In PJ woodlands, the width of the tree crown at its widest point, in meters to the nearest half-meter	dbDouble	8

Field Name	Field Description	Field Type	Field Width
WoodlandCrownHeight	In PJ woodlands, distance from the ground to the top of the living tree crown, in meters to the nearest half-meter	dbDouble	8
ForestCrownBaseHeight	In Douglas-fir, ponderosa pine, or other tall tree woodlands, the distance from the ground to the base of the living tree crown, exclusive of dead or single branches, in meters to the nearest half-meter	dbDouble	8
ForestCrownHeight	Same as for woodlands, but for real trees	dbDouble	8
CrownRatio	The ratio of crown height to total tree height.	dbText	12
StructureStage	Describes the place of the tree in the canopy - emergent above the canopy, main canopy, sub canopy, sapling, seedling	dbText	12
Comments	General comments regarding the fuels at a specific plot.	dbText	255

Table Name: TBL_GPS_INFO
Description: Contains information about the GPS unit and accuracies of data collected for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
PLOT_ID	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	20
GPS_TYPE	Manufacturer and model of GPS unit (e.g., Garmin Etrex)	dbText	30
UTM_EASTING	UTM easting of plot	dbDouble	8
UTM_NORTHING	UTM northing of plot	dbDouble	8
UTM_ZONE	UTM zone of coordinates	dbText	3
DATUM	Datum of UTM coordinates (NAD83)	dbText	10
GPS_ERROR	Error, in meters, of location data (based on reading from Garmin GPS unit)	dbText	5
DIFF_CORRECTED	Indicates if coordinates have been differentially corrected (from Garmin screen)	dbText	3
GPS_COMMENTS	Any brief comments on GPS data collection at plot.	dbText	255
GPS_QUALITY	Indicates the quality of the GPS unit used (recreational, mapping grade)	dbText	35
PDOP	Positional Dilution Of Precision reading (from Garmin screen)	dbText	30
ERROR_RANGE	General error range, in meters, of the type of GPS unit used.	dbText	20

Table Name: TBL_LOCATION_INFO
Description: Contains data about the location of the point and general observations about the area for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
PLOT_CODE	Unique Plot code, used for relating tables and feature class (fcl_Veg_Points)	dbText	20
SITE_NAME	General Site name given by field crew	dbText	255
UNIT_CODE	4 letter park code (NABR)	dbText	10
STATE_CODE	State (Utah)	dbText	2

Field Name	Field Description	Field Type	Field Width
COUNTY_NAME	County where plot is located (San Juan County)	dbText	100
USGS_NAME	USGS 1:24k Topo Name	dbText	100
AERIAL_PHOTO_NO	9X9 photo name on which the point most directly falls	dbText	30
DIRECTIONS_PLOT	Directions to the location of the plot	dbText	255
IN_PARK	Indicates if the point was inside or outside the park boundary (only applicable to Plots and Observation points, all AA pts inside park)	dbBoolean	1
LOCATION_ACCURACY	Indicates general range of locational error of the point coordinates.	dbText	45
VISIT_DATE	Date the location was visited	dbText	10
OBSERVER	The names of the field crew member(s) observing the site.	dbText	50
PLOT_WIDTH	The width of the point	dbText	3
PLOT_LENGTH	The length of the point	dbText	3
PLOT_DIAMETER	The diameter of the point	dbText	5
PLOT_AZIMUTH	The azimuth of the point	dbText	5
PLOT_SHAPE	The shape of the area observed as a point	dbText	20
REPRESENTATIVENESS	The representativeness of the vegetation	dbText	255
ASPECT	Aspect of plot	dbText	50
ELEVATION	Elevation of plot in meters, created from 10 meter DEMs	dbDouble	8
SLOPE	Slope of plot measured in degrees	dbText	15
TOPO_POSITION	Topographic position of plot	dbText	50
SOIL_TEXTURE	Assessment of average soil texture from sample taken a few inches below the surface	dbText	50
COWARDIN_SYSTEM	If the plot is in a wetland system, select term that best describes its hydrology (Upland, Palustrine, Riverine, Lacustrine)	dbText	50
HYDROLOGY	Describes hydrology of plot	dbText	50
GEOLOGY	Geologic substrate influencing the plant community	dbText	50
SOIL_DRAINAGE	Soil drainage class based on actual moisture content and extent period	dbText	30
ENV_COMMENTS	Comments on environmental setting and its effect on the vegetation; also comments on any disturbance or reproduction factors	dbText	255
ANIMAL_USE_COMMENTS	Comments on evidence of use by non-domestic animals in plot area	dbText	255
DISTURBANCE_COMMENTS	Comments on evidence of natural or anthropogenic disturbance in plot area, severity and effects on vegetation	dbText	255
LANDSCAPE_COMMENTS	Description of landscape context of plot, including any important landscape features influencing the community	dbText	255
OTHER_COMMENTS	Other general comments	dbText	255
SOIL_TAXON_DESC	Field used for either identifying soils keyed, or to describe if large rocks or outcrops are present on the surface	dbText	255

Field Name	Field Description	Field Type	Field Width
ALLIANCE	Alliance corresponding to provisional community name	dbText	100
PROVISIONAL_COMM_NAME	Community name (provisional) assigned by field crews by following naming protocols as described in field manual and training (2004).	dbText	200
PHENOLOGY	Leaf phenology of the dominant stratum. Field is blank for non-vascular plots	dbText	200
LEAF_TYPE	Leaf form of the dominant stratum.	dbText	100
LEAF_TYPE_COMMENTS	If Leaf Type is "mixed," this field describes the multiple leaf types found in the dominant stratum.	dbText	255
PHYSIOGNOMIC_NAME	Physiognomic class of plot	dbTex	100
PLANT_SPECIES_COMMENTS	Comments about the plant species observed.	dbText	200

Table Name: TBL_MAPUNIT_ASSOC
Description: Contains association data for the vegetation polygons by map unit ID.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MapUnitID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	20
CEGL_Code	NVC association code	dbText	18
AssociationName	The NVC Association name	dbText	250
AssociationCommonName	The NVC Association Common name	dbText	250

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

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

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

Field Name	Field Description	Field Type	Field Width
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	Path to photos	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" if a specimen of the species was collected.	dbInteger	2
SPECIMEN_NO	Collector's reference number for the specimen	dbText	10
DEAD	Percent coverof 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	12

Table Name: TBL_VEGASSOC_INFO
Description: Contains association data for AA points in the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
PLOT_CODE	Unique Plot code, used for relating tables (only AA points)	dbText	128
CEGL_CODE	CEGL (association) code	dbText	10
ASSOCIATION	Vegetation association assigned in the field.	dbText	100
FIELD_KEY	Name was chosen from field key	dbInteger	2
NEW_NAME	When no name really fits from the field key, the surveyor will create a new name.	dbInteger	2
POST_FIELD_NAME	Name assigned post field during AA analysis, based on species lists and comments fields.	dbInteger	2
ASSOC_RANK	Rank of vegetation association (primary, secondary, tertiary)	dbText	50
OTHER_ASSOC_50M	Other associations noted in a 50meter band beyond the plot boundary	dbText	200

Table Name: TBL_VEGMAP_INFO
Description: Contains map unit level data for each vegetation map unit polygon.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
Polygon_ID	Unique polygon code, used for relating tables and feature classes (fcl_Veg_polys)	dbText	30
Map_Unit_ID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10
Map_Unit_Code	NCPN code (X-NABR)	dbText	10
Map_Unit_Common_Name	The name of the map unit (or map class)	dbText	250
Cover_Code	Cover pattern value class code	dbText	1
COVER_PATTERN	Describes the pattern of vegetation within a polygon (Homogenous (default), Clumped / Bunched, Linear, Gradational / Transitional, Regularly Alternating).	dbText	100
Density_Code	Density value code	dbText	1
DENSITY_CLASS	Density of Forest/Woodland vegetation, and density for sagebrush communities per polygon.	dbText	100
Height_Code	Height class value code	dbText	1
HEIGHT_CLASS	Vegetation height classes assigned to each polygon of forest/woodland and/or shrubland types	dbText	100
USER_ACCURACY	User's accuracy of the map class	dbText	3
FUELS_TYPE	Fuels vegetation types	dbText	50
FUELS_VERIFICATION	Fuels verification	dbText	255
VEGMAP_COMMENTS	Any comments about the 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:/NABR/Vegetation/MapClassDescriptions/MU4.pdf)	dbText	250

Table Name: TBL_VEGMAP_MODIFIERS
Description: Contains modifiers for the vegetation map unit polygons.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
Polygon_ID	Unique polygon code, used for relating tables (TBL_VEGMAP_INFO)	dbText	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

Two hundred-forty plant species representing 54 families were noted during plot, observation point and accuracy assessment point data collection at Natural Bridges National Monument (NABR). The Northern Colorado Plateau Network uses three taxonomic authorities for vascular plants: Welsh et al. 2003 as the nomenclatural authority for Utah parks, Weber and Whittmann 2001 for Colorado parks, and Dorn and Lichvar 1984 for the single park in Wyoming; the NABR vegetation mapping project database reflects scientific names as assigned by Welsh. These names are crosswalked to Kartesz 1999, which is the nomenclatural authority used by NatureServe for the National Vegetation Classification. Scientific and common names used by NatureServe are presented in this crosswalk; these names are used throughout the NABR vegetation mapping report and in the individual association descriptions in Appendix F. The taxonomic serial number (TSN) assigned by the Integrated Taxonomic Information System (ITIS) is provided for each species.

VASCULAR PLANTS

Family	Scientific Name (Welch et al. 2003)	Scientific Name (Kartez 1999)	Common Name (NatureServe)	TSN
Aceraceae	*Acer negundo* L.	*Acer negundo*	Box-elder	28749
Agavaceae	*Yucca angustissima* Engelm. ex Trel.	*Yucca angustissima*	Fineleaf Yucca	43131
	Yucca baccata Torr.	*Yucca baccata*	Banana Yucca	43134
	Yucca harrimaniae Trel.	*Yucca harrimaniae*	Spanish Bayonet	43144
	Yucca L.	*Yucca*	Yucca	43116
Anacardiaceae	*Rhus aromatica* Ait.	*Rhus aromatica*	Fragrant Sumac	28779
	Rhus aromatica var. *simplicifolia* (Greene) Cronq.	*Rhus trilobata* var. *simplicifolia*	Singleleaf Sumac	539585
	Rhus aromatica var. *trilobata* (Nutt.) Gray ex. S. Wats.	*Rhus trilobata* var. *trilobata*	Skunkbush	539586
Apiaceae	*Cymopterus purpureus* S. Wats.	*Cymopterus purpureus*	Purple Spring-parsley	29654
	Cymopterus Raf.	*Cymopterus*	Spring-parsley	29625
	Lomatium parryi (S. Wats.) J.F. Macbr.	*Lomatium parryi*	Utah Desert-parsley	29735
	Lomatium Raf.	*Lomatium*	Desert-parsley	29677
Apocynaceae	*Apocynum cannabinum* L.	*Apocynum cannabinum*	Indian-hemp	30157
Asclepiadaceae	*Asclepias cryptoceras* S. Wats.	*Asclepias cryptoceras*	Humboldt Milkweed	30257
	Asclepias L.	*Asclepias*	Milkweed	30240
Asteraceae	*Antennaria* Gaertn.	*Antennaria*	Pussytoes	36716
	Artemisia bigelovii Gray	*Artemisia bigelovii*	Bigelow Sagebrush	35452
	Artemisia campestris L.	*Artemisia campestris*	Pacific Wormwood	183748
	Artemisia dracunculus L.	*Artemisia dracunculus*	Dragon Wormwood	35462
	Artemisia frigida Willd.	*Artemisia frigida*	Fringed Sagebrush	35465
	Artemisia ludoviciana Nutt.	*Artemisia ludoviciana*	White Sagebrush	35474
	Artemisia nova A. Nels.	*Artemisia nova*	Black Sagebrush	500971
	Artemisia tridentata Nutt.	*Artemisia tridentata*	Basin Big Sagebrush	35498

Family	Scientific Name (Welch et al. 2003)	Scientific Name (Kartez 1999)	Common Name (NatureServe)	*TSN*
	Artemisia tridentata ssp. *tridentata* Nutt.	*Artemisia tridentata* ssp. *tridentata*	Basin Big Sagebrush	35499
	Artemisia tridentata ssp. *wyomingensis* Beetle & Young	*Artemisia tridentata* ssp. *wyomingensis*	Wyoming Big Sagebrush	183741
	Aster L.	*Aster*	Aster	35510
	Brickellia Ell.	*Brickellia*	Brickelbush	36859
	Brickellia longifolia S. Wats.	*Brickellia longifolia*	Longleaf Brickelbush	36885
	Brickellia microphylla (Nutt.) Gray	*Brickellia microphylla*	Littleleaf Brickelbush	36886
	Chaenactis stevioides Hook. & Arn.	*Chaenactis stevioides*	Broad-flower Pincushion	36998
	Chaetopappa ericoides (Torr.) Nesom	*Chaetopappa ericoides*	Rose-heath	501376
	Chrysopsis villosa (Pursh) Nutt. ex DC.	*Heterotheca villosa*	Hairy Goldenaster	510984
	Chrysothamnus linifolius Greene	*Chrysothamnus linifolius*	Spearleaf Rabbitbrush	37054
	Chrysothamnus nauseosus (Pallas ex Pursh) Britt.	*Ericameria nauseosa*	Rubber Rabbitbrush	37055
	Chrysothamnus Nutt.	*Chrysothamnus*	Rabbitbrush	37048
	Chrysothamnus viscidiflorus (Hook.) Nutt.	*Chrysothamnus viscidiflorus*	Green Rabbitbrush	37090
	Chrysothamnus viscidiflorus ssp. *viscidiflorus* (Hook.) Nutt.	*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*	Green Rabbitbrush	37091
	Chrysothamnus viscidiflorus var. *stenophyllus* (Gray) Hall	*Chrysothamnus viscidiflorus* var. *stenophyllus*	Green Rabbitbrush	566624
	Cirsium calcareum (M.E. Jones) Woot. & Standl.	*Cirsium calcareum*	Cainville Thistle	36346
	Cirsium P. Mill.	*Cirsium*	Thistle	36334
	Erigeron utahensis var. *sparsifolius* (Eastw.) Cronq.	*Erigeron utahensis* var. *sparsifolius*	Utah Fleabane	527970
	Gaillardia pinnatifida Torr.	*Gaillardia pinnatifida*	Red-dome Blanket-flower	37409
	Gutierrezia Lag.	*Gutierrezia*	Snakeweed	37478
	Gutierrezia microcephala (DC.) Gray	*Gutierrezia microcephala*	Small-head Snakeweed	37482
	Gutierrezia sarothrae (Pursh) Britt. & Rusby	*Gutierrezia sarothrae*	Snakeweed	37483
	Haplopappus acaulis (Nutt.) Gray	*Stenotus acaulis*	Stemless Mock Goldenweed	37499
	Haplopappus armerioides (Nutt.) Gray	*Stenotus armerioides*	Skyline Goldenweed	37506

Family	Scientific Name (Welch et al. 2003)	Scientific Name (Kartez 1999)	Common Name (NatureServe)	*TSN*
	Hymenopappus filifolius Hook.	*Hymenopappus filifolius*	Fineleaf Woollywhite	37766
	Hymenopappus L'Hér.	*Hymenopappus*	Woollywhite	37763
	Hymenoxys acaulis (Pursh) Parker	*Tetraneuris acaulis* var. *acaulis*	Arizona Bitterweed	514991
	Hymenoxys acaulis var. *arizonica* (Greene) Parker	*Tetraneuris acaulis* var. *arizonica*	Arizona Four-nerve daisy	536275
	Hymenoxys acaulis var. *ivesiana* (Greene) Parker	*Tetraneuris ivesiana*	Ives' Four-nerve-daisy	536278
	Lactuca serriola L.	*Lactuca serriola*	Prickly Lettuce	36608
	Machaeranthera canescens (Pursh) Gray	*Machaeranthera canescens*	Hoary Tansy-aster	37984
	Machaeranthera grindelioides (Nutt.) Shinners	*Machaeranthera grindelioides*	Rayless Tansy-aster	37992
	Machaeranthera grindelioides var. *grindelioides* (Nutt.) Shinners	*Machaeranthera grindelioides* var. *grindelioides*	Rayless Tansy-aster	529072
	Machaeranthera Nees	*Machaeranthera*	Tansy-aster	37970
	Petradoria pumila (Nutt.) Greene	*Petradoria pumila*	Grassy Rock-goldenrod	38233
	Senecio integerrimus Nutt.	*Senecio integerrimus*	Lamb-tongue Ragwort	36148
	Senecio L.	*Senecio*	Ragwort	36084
	Senecio multilobatus Torr. & Gray ex Gray	*Packera multilobata*	Lobeleaf Groundsel	36161
	Solidago canadensis L.	*Solidago canadensis*	Canada Goldenrod	36224
	Solidago gigantea Ait.	*Solidago gigantea*	Giant Goldenrod	36259
	Solidago L.	*Solidago*	Goldenrod	36223
	Solidago velutina DC.	*Solidago velutina*	Three-nerve Goldenrod	505290
	Taraxacum officinale G.H. Weber ex Wiggers	*Taraxacum officinale*	Common Dandelion	36213
	Townsendia Hook.	*Townsendia*	Townsend-daisy	38536
	Townsendia incana Nutt.	*Townsendia incana*	Hoary Townsend-daisy	38549
	Tragopogon dubius Scop.	*Tragopogon dubius*	Meadow Goat's-beard	38564
Berberidaceae	*Mahonia fremontii* (Torr.) Fedde	*Mahonia fremontii*	Desert Oregon-grape	195033
	Mahonia repens (Lindl.) G. Don	*Mahonia repens*	Creeping Oregon-grape	195045

Family	Scientific Name (Welch et al. 2003)	Scientific Name (Kartez 1999)	Common Name (NatureServe)	*TSN*
Boraginaceae	*Cryptantha crassisepala* var. *elachantha* I.M. Johnston	*Cryptantha crassisepala* var. *elachantha*	Thick-sepal Cat's-eye	527560
	Cryptantha flava (A. Nels.) Payson	*Cryptantha flava*	Plateau Yellow Cat's-eye	31770
	Cryptantha flavoculata (A. Nels.) Payson	*Cryptantha flavoculata*	Rough-seed Cat's-eye	31809
	Cryptantha Lehm. ex G. Don	*Cryptantha*	Cat's-eye	31765
	Lappula occidentalis (S. Wats.) Greene	*Lappula occidentalis*	Flat-spine Sheepburr	503329
	Tiquilia latior (I.M. Johnston) A. Richards.	*Tiquilia latior*	Matted Crinklemat	505519
Brassicaceae	*Arabis* L.	*Arabis*	Rockcress	22671
	Descurainia pinnata (Walt.) Britt.	*Descurainia pinnata*	Western Tansy-mustard	22826
	Draba cuneifolia Nutt. ex Torr. & Gray	*Draba cuneifolia*	Wedgeleaf Whitlow-grass	22874
	Lepidium alyssoides var. *eastwoodiae* (Woot.) Rollins	*Lepidium alyssoides* var. *eastwoodiae*	Mesa Pepperwort	531291
	Lepidium L.	*Lepidium*	Pepperwort	22953
	Lepidium montanum Nutt.	*Lepidium montanum*	Mountain Pepperwort	503381
	Lepidium montanum var. *jonesii* (Rydb.) C.L. Hitchc.	*Lepidium montanum* var. *jonesii*	Jones' Pepperwort	528731
	Lesquerella S. Wats.	*Lesquerella*	Bladderpod	23162
	Physaria acutifolia Rydb.	*Physaria acutifolia*	Sharpleaf Twinpod	23270
	Physaria ludoviciana (Nuttall) O'Kane & Al-Shehbaz	*Lesquerella ludoviciana*	Louisiana Bladderpod	-9
	Physaria rectipes (Woot. & Stan.) O'Kane & Al-Shehbaz	*Lesquerella rectipes*	Straight Bladderpod	-14
	Stanleya pinnata (Pursh) Britt.	*Stanleya pinnata*	Golden Prince's-plume	23329
	Streptanthella longirostris (S. Wats.) Rydb.	*Streptanthella longirostris*	Long-beak Fiddle-mustard	23333
	Streptanthus cordatus Nutt.	*Streptanthus cordatus*	Heartleaf Jewelflower	23348
	Thelypodium integrifolium (Nutt.) Endl. ex Walp.	*Thelypodium integrifolium*	Entireleaf Thelypody	23398
	Thelypodium laxiflorum Al-Shehbaz	*Thelypodium laxiflorum*	Loose-flower Thelypody	23404
Cactaceae	*Echinocereus triglochidiatus* Engelm.	*Echinocereus triglochidiatus*	King-cup Cactus	19815
	Opuntia erinacea Engelm. & Bigelow ex Engelm.	*Opuntia erinacea*	Oldman Cactus	19705

Family	Scientific Name (Welch et al. 2003)	Scientific Name (Kartez 1999)	Common Name (NatureServe)	*TSN*
	Opuntia fragilis (Nutt.) Haw.	*Opuntia fragilis*	Brittle Prickly-pear	19707
	Opuntia P. Mill.	*Opuntia*	Prickly-pear	19686
	Opuntia phaeacantha Engelm.	*Opuntia phaeacantha*	Tulip Prickly-pear	19724
	Opuntia polyacantha Haw.	*Opuntia polyacantha*	Panhandle Prickly-pear	19726
	Sclerocactus whipplei (Engelm. & Bigelow) Britt. & Rose	*Sclerocactus whipplei*	Whipple's Fishhook Cactus	19765
	Sclerocactus whipplei var. *roseus* (Clover) L. Benson	*Sclerocactus parviflorus* ssp. *parviflorus*	Small-flower Fishhook Cactus	540500
Caprifoliaceae	*Symphoricarpos longiflorus* Gray	*Symphoricarpos longiflorus*	Desert Snowberry	35334
	Symphoricarpos oreophilus Gray	*Symphoricarpos oreophilus*	Mountain Snowberry	35338
Caryophyllaceae	*Arenaria fendleri* Gray	*Arenaria fendleri*	Fendler's Sandwort	20245
	Silene antirrhina L.	*Silene antirrhina*	Sleepy Catchfly	20045
Celastraceae	*Pachyistima myrsinites* (Pursh) Raf.	*Paxistima myrsinites*	Oregon Boxleaf	504149
Chenopodiaceae	*Atriplex canescens* (Pursh) Nutt.	*Atriplex canescens*	Fourwing Saltbush	20518
	Atriplex confertifolia (Torr. & Frém.) S. Wats.	*Atriplex confertifolia*	Shadscale	20519
	Krascheninnikovia lanata (Pursh) A.D.J. Meeuse & Smit	*Krascheninnikovia lanata*	Winter-fat	503290
	Salsola tragus L.	*Salsola tragus*	Prickly Russian-thistle	520950
Cornaceae	*Cornus sericea* L.	*Cornus sericea*	Red-osier Dogwood	501637
Crossosomataceae	*Glossopetalon spinescens* Gray	*Glossopetalon spinescens*	Spiny Greasebush	502808
	Glossopetalon spinescens var. *meionandrum* (Koehne) Trel.	*Glossopetalon spinescens* var. *meionandrum*	Spiny Greasebush	528253
Cupressaceae	*Juniperus osteosperma* (Torr.) Little	*Juniperus osteosperma*	Utah Juniper	194859
	Juniperus scopulorum Sarg.	*Juniperus scopulorum*	Rocky Mountain Juniper	194872
Cyperaceae	*Carex aurea* Nutt.	*Carex aurea*	Golden-fruit Sedge	39445
	Carex geyeri Boott	*Carex geyeri*	Geyer's Sedge	39613
	Carex L.	*Carex*	Sedge	39369
	Carex rossii Boott	*Carex rossii*	Ross' Sedge	39786

Family	Scientific Name (Welch et al. 2003)	Scientific Name (Kartez 1999)	Common Name (NatureServe)	*TSN*
Elaeagnaceae	*Shepherdia rotundifolia* Parry	*Shepherdia rotundifolia*	Roundleaf Buffaloberry	27780
Ephedraceae	*Ephedra viridis* Coville	*Ephedra viridis*	Mormon-tea	502319
Equisetaceae	*Equisetum arvense* L.	*Equisetum arvense*	Field Horsetail	17152
	Equisetum hyemale L.	*Equisetum hyemale*	Common Scouring-rush	17154
	Equisetum L.	*Equisetum*	Horsetail	17148
	Equisetum laevigatum A. Braun	*Equisetum laevigatum*	Smooth Horsetail	17156
Ericaceae	*Arctostaphylos patula* Greene	*Arctostaphylos patula*	Greenleaf Manzanita	23512
	Arctostaphylos patula ssp. *platyphylla* (Gray) P.V. Wells	*Arctostaphylos patula*	Greenleaf Manzanita	23514
Euphorbiaceae	*Euphorbia fendleri* Torr. & Gray	*Chamaesyce fendleri*	Fendler's Sandmat	28069
Fabaceae	*Astragalus* L.	*Astragalus*	Milk-vetch	25392
	Astragalus mollissimus Torr.	*Astragalus mollissimus*	Woolly Milk-vetch	25589
	Lupinus L.	*Lupinus*	Lupine	25916
	Medicago lupulina L.	*Medicago lupulina*	Black Medic	503721
	Medicago sativa L.	*Medicago sativa*	Alfalfa	183623
	Melilotus albus Medikus	*Melilotus officinalis*	Sweetclover	26149
	Melilotus officinalis (L.) Lam.	*Melilotus officinalis*	Sweetclover	26150
Fagaceae	*Quercus gambelii* Nutt.	*Quercus gambelii*	Gambel Oak	19337
Gentianaceae	*Swertia radiata* (Kellogg) Kuntze	*Frasera speciosa*	Monument Plant	30120
Grossulariaceae	*Ribes* L.	*Ribes*	Gooseberry	24448
Juncaceae	*Juncus arcticus* Willd.	*Juncus balticus* var. *montanus*	Baltic Rush	39222
	Juncus longistylis Torr.	*Juncus longistylis*	Long-styled Rush	503256
Lamiaceae	*Hedeoma drummondii* Benth.	*Hedeoma drummondii*	Drummond's False Pennyroyal	32512
Liliaceae	*Allium* L.	*Allium*	Garlic, Onion, Wild Leek	42634
	Calochortus nuttallii Torr. & Gray	*Calochortus nuttallii*	Sego-lily	42863

Family	Scientific Name (Welch et al. 2003)	Scientific Name (Kartez 1999)	Common Name (NatureServe)	*TSN*
	Smilacina stellata (L.) Desf.	*Maianthemum stellatum*	Starflower False Solomon's-seal	43038
	Zigadenus elegans Pursh	*Zigadenus elegans*	Mountain Deathcamas	43158
	Zigadenus vaginatus (Rydb.) J.F. Macbr.	*Zigadenus vaginatus*	Sheathed Deathcamas	505802
Linaceae	*Linum* L.	*Linum*	Flax	29201
	Linum subteres (Trel.) Winkl.	*Linum subteres*	Sprucemont Flax	29224
Loasaceae	*Mentzelia* L.	*Mentzelia*	Blazingstar	202469
Malvaceae	*Sphaeralcea coccinea* (Nutt.) Rydb.	*Sphaeralcea coccinea*	Scarlet Globemallow	21920
	Sphaeralcea parvifolia A. Nels.	*Sphaeralcea parvifolia*	Small-leaf Globemallow	21953
Nyctaginaceae	*Mirabilis multiflora* (Torr.) Gray	*Mirabilis multiflora*	Colorado Four-o'clock	19654
Oleaceae	*Fraxinus anomala* Torr. ex S. Wats.	*Fraxinus anomala*	Singleleaf Ash	32937
Onagraceae	*Calylophus lavandulifolius* (Torr. & Gray) Raven	*Calylophus lavandulifolius*	Lavender-leaf Sundrops	501160
	Oenothera longissima Rydb.	*Oenothera longissima*	Long-stem Evening-primrose	27428
Orchidaceae	*Epipactis gigantea* Dougl. ex Hook.	*Epipactis gigantea*	Giant Helleborine	43481
	Habenaria zothecina Higgins & Welsh	*Platanthera zothecina*	Alcove Bog Orchid	514389
Pinaceae	*Pinus edulis* Engelm.	*Pinus edulis*	Two-needle Pinyon	183336
	Pinus ponderosa P. & C. Lawson	*Pinus ponderosa*	Ponderosa Pine	183365
	Pseudotsuga menziesii (Mirbel) Franco	*Pseudotsuga menziesii*	Douglas-fir	183424
Plantaginaceae	*Plantago patagonica* Jacq.	*Plantago patagonica*	Woolly Plantain	32907
Poaceae	*Agropyron cristatum* (L.) Gaertn.	*Agropyron cristatum*	Crested Wheatgrass	182478
	Agropyron Gaertn.	*Agropyron*	Wheatgrass	40353
	Agrostis exarata Trin.	*Agrostis exarata*	Spiked Bentgrass	40412
	Aristida purpurea Nutt.	*Aristida purpurea*	Purple Three-awn	41429
	Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths	*Bouteloua gracilis*	Blue Grama	41493
	Bromus inermis Leyss.	*Bromus inermis*	Smooth Brome	40502

Family	Scientific Name (Welch et al. 2003)	Scientific Name (Kartez 1999)	Common Name (NatureServe)	*TSN*
	Bromus japonicus Thunb. ex Murr.	*Bromus japonicus*	Japanese Brome	40479
	Bromus tectorum L.	*Bromus tectorum*	Cheatgrass	40524
	Calamagrostis scopulorum M.E. Jones	*Calamagrostis scopulorum*	Ditch Reedgrass	40566
	Elymus canadensis L.	*Elymus canadensis*	Nodding Wild Rye	40683
	Elymus elymoides (Raf.) Swezey	*Elymus elymoides*	Bottlebrush	502264
	Elymus salinus M.E. Jones	*Leymus salinus*	Salinas Lyme Grass	512841
	Elymus smithii (Rydb.) Gould	*Pascopyrum smithii*	Western Wheatgrass	512844
	Elymus spicatus (Pursh) Gould	*Pseudoroegneria spicata*	Bluebunch Wheatgrass	512845
	Elymus trachycaulus (Link) Gould ex Shinners	*Elymus trachycaulus*	Slender Wild Rye	502282
	Festuca octoflora Walt.	*Vulpia octoflora*	Eight-flower Six-weeks Grass	513551
	Festuca ovina L.	*Festuca ovina*	Sheep Fescue	40804
	Hilaria jamesii (Torr.) Benth.	*Pleuraphis jamesii*	James' Galleta	41768
	Hordeum jubatum L.	*Hordeum jubatum*	Foxtail Barley	40871
	Muhlenbergia pungens Thurb.	*Muhlenbergia pungens*	Sandhill Muhly	41934
	Muhlenbergia Schreb.	*Muhlenbergia*	Muhly	41883
	Oryzopsis micrantha (Trin. & Rupr.) Thurb.	*Piptatherum micranthum*	Little-seed Mountain Ricegrass	41989
	Panicum acuminatum Sw.	*Dichanthelium acuminatum*	Tapered Rosette Grass	518203
	Phalaris arundinacea L.	*Phalaris arundinacea*	Reed Canarygrass	41335
	Phragmites australis (Cav.) Trin. ex Steud.	*Phragmites australis*	Common Reed	41072
	Poa fendleriana (Steud.) Vasey	*Poa fendleriana*	Muttongrass	504467
	Poa L.	*Poa*	Bluegrass	41074
	Poa pratensis L.	*Poa pratensis*	Kentucky Bluegrass	41088
	Schizachyrium scoparium (Michx.) Nash	*Schizachyrium scoparium*	Little Bluestem	42076
	Sporobolus airoides (Torr.) Torr.	*Sporobolus airoides*	Alkali Sacaton	42128

Family	Scientific Name (Welch et al. 2003)	Scientific Name (Kartez 1999)	Common Name (NatureServe)	*TSN*
	Sporobolus cryptandrus (Torr.) Gray	*Sporobolus cryptandrus*	Sand Dropseed	42132
	Stipa comata Trin. & Rupr.	*Hesperostipa comata*	Needle-and-thread	42172
	Stipa coronata Thurb.	*Achnatherum coronatum*	Giant Needlegrass	42173
	Stipa hymenoides Roemer & J.A. Schultes	*Achnatherum hymenoides*	Indian Ricegrass	522063
	Stipa speciosa Trin. & Rupr.	*Achnatherum speciosum*	Desert Needlegrass	42194
Polemoniaceae	*Gilia inconspicua* (Sm.) Sweet	*Gilia inconspicua*	Shy Gilia	31127
	Gilia Ruiz & Pavón	*Gilia*	Gilia, Gily-flower	31075
	Ipomopsis aggregata (Pursh) V. Grant	*Ipomopsis aggregata*	Scarlet Skyrocket	31192
	Ipomopsis roseata (Rydb.) V. Grant	*Ipomopsis roseata*	Rosy Skyrocket	31218
	Leptodactylon pungens (Torr.) Torr. ex Nutt.	*Leptodactylon pungens*	Granite Prickly-phlox	31233
	Phlox pulvinata (Wherry) Cronq.	*Phlox pulvinata*	Cushion Phlox	30980
Polygonaceae	*Eriogonum alatum* Torr.	*Eriogonum alatum*	Winged Wild Buckwheat	21057
	Eriogonum Michx.	*Eriogonum*	Wild Buckwheat	21054
	Eriogonum microthecum Nutt.	*Eriogonum microthecum*	Slender Wild Buckwheat	21192
	Eriogonum microthecum var. *simpsonii* (Benth.) Reveal	*Eriogonum microthecum* var. *simpsonii*	Simpson's Buckwheat	195533
Pteridaceae	*Adiantum capillus-veneris* L.	*Adiantum capillus-veneris*	Southern Maidenhair	17308
Ranunculaceae	*Aquilegia micrantha* Eastw.	*Aquilegia micrantha*	Mancos Columbine	18743
	Clematis L.	*Clematis*	Leatherflower, Virgin's-bower	18685
	Clematis ligusticifolia Nutt.	*Clematis ligusticifolia*	Deciduous Traveler's-joy	18702
	Delphinium L.	*Delphinium*	Larkspur	18457
Rhamnaceae	*Rhamnus* L.	*Rhamnus*	Buckthorn	28561
Rosaceae	*Amelanchier utahensis* Koehne	*Amelanchier utahensis*	Utah Serviceberry	25121
	Cercocarpus intricatus S. Wats.	*Cercocarpus intricatus*	Littleleaf Mountain-mahogany	25133
	Cercocarpus montanus Raf.	*Cercocarpus montanus*	Mountain-mahogany	25136

Family	Scientific Name (Welch et al. 2003)	Scientific Name (Kartez 1999)	Common Name (NatureServe)	*TSN*
	Holodiscus dumosus (Nutt. ex Hook.) Heller	*Holodiscus dumosus*	Glandular Oceanspray	25178
	Prunus virginiana L.	*Prunus virginiana*	Choke Cherry	24806
	Purshia mexicana (D. Don) Henrickson	*Purshia mexicana*	Mexican Cliffrose	195899
	Rosa woodsii Lindl.	*Rosa woodsii*	Woods' Rose	24847
Rubiaceae	*Galium* L.	*Galium*	Bedstraw	34796
	Galium multiflorum Kellogg	*Galium multiflorum*	Many-flower Bedstraw	34892
	Galium multiflorum var. *coloradoense* (W. Wight) Cronq.	*Galium coloradoense*	Colorado Bedstraw	535620
Salicaceae	*Populus angustifolia* James	*Populus angustifolia*	Narrowleaf Cottonwood	22452
	Populus fremontii S. Wats.	*Populus fremontii, Populus deltoides*	Fremont Cottonwood	22459
	Salix eriocephala Michaux	*Salix eriocephala*	Missouri Willow	22528
	Salix exigua Nutt.	*Salix exigua*	Coyote Willow	22529
Santalaceae	*Comandra umbellata* (L.) Nutt.	*Comandra umbellata*	Bastard Toadflax	501614
Scrophulariaceae	*Castilleja chromosa* A. Nels.	*Castilleja applegatei* ssp. *martinii*	Wavyleaf Indian-paintbrush	33102
	Castilleja linariifolia Benth.	*Castilleja linariifolia*	Wyoming Indian-paintbrush	33138
	Castilleja lineata Greene	*Castilleja lineata*	Marsh-meadow Indian-paintbrush	33139
	Castilleja Mutis ex L. f.	*Castilleja*	Indian-paintbrush	33049
	Castilleja scabrida Eastw.	*Castilleja scabrida*	Rough Indian-paintbrush	33165
	Cordylanthus Nutt. ex Benth.	*Cordylanthus*	Bird's-beak	33537
	Pedicularis centranthera Gray	*Pedicularis centranthera*	Dwarf Lousewort	33367
	Penstemon comarrhenus Gray	*Penstemon comarrhenus*	Dusty Beardtongue	33854
	Penstemon Schmidel	*Penstemon*	Beardtongue	33665
	Penstemon utahensis Eastw.	*Penstemon utahensis*	Utah Firecracker	33785
Tamaricaceae	*Tamarix chinensis* Lour.	*Tamarix chinensis*	Chinese Tamarisk	22308
Ulmaceae	*Celtis reticulata* Torr.	*Celtis laevigata* var. *reticulata*	Netleaf Hackberry	19045

Family	Scientific Name (Welch et al. 2003)	Scientific Name (Kartez 1999)	Common Name (NatureServe)	*TSN*
Viscaceae	*Arceuthobium divaricatum* Engelm.	*Arceuthobium divaricatum*	Pinyon Dwarf-mistletoe	27891

NON-VASCULAR PLANTS

Family	Scientific Name (Welch et al. 2003)	Scientific Name (Kartez 1999)	Common Name (NatureServe)	*TSN*
Catillariaceae	*Toninia* A. Massal.	*Toninia*	Bruised Lichen	190205
Collemataceae	*Collema* Wigg.	*Collema*	Jelly Lichen	191331
Psoraceae	*Psora* Hoffm.	*Psora*	Scale Lichen	190026
Teloschistaceae	*Fulgensia* Massal. and De Not.	*Fulgensia*	Sulphur Lichen	191759

Appendix E

Field Plot Crosswalk to NVC Associations

Plots, observation points and accuracy assessment (AA) points are assigned to National Vegetation Classification associations based on their composition and structure as they were recorded in the field. Four associations in the table below were documented only during accuracy assessment (Plot codes in the rightmost column contain the letters “AA”). Accuracy assessment points assigned to associations already described from plots or observation points are not included in this table. Element codes are used by NatureServe and state Natural Heritage Programs to track nomenclature and status of rare plants, rare animals, and communities (“elements”). Nomenclature used by the NVC follows Kartesz (1999).

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland	CEGL001070	2	NABR.0062, NABR.0103
Aquilegia micrantha - Calamagrostis scopulorum Herbaceous Vegetation	CEGL002592	5	NABR.0006,NABR.0012, NABR.0111, NABR.0113, NABR.9003
Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Semi-natural Shrubland	CEGL002699	1	NABR_AA.163
Artemisia tridentata ssp. tridentata / Hesperostipa comata Shrubland	CEGL002966	3	NABR.0107, NABR.0108, NABR.9002
Artemisia tridentata ssp. wyomingensis / (Agropyron cristatum, Psathyrostachys juncea) Seeded Grasses Semi-natural Shrubland	CEGL002185	3	NABR.9006, NABR.9103, NABR.9106
Bouteloua gracilis Herbaceous Vegetation	CEGL001760	2	NABR.0119, NABR.0124
Cercocarpus intricatus Slickrock Sparse Vegetation	CEGL002977	5	NABR_AA.010, NABR_AA.067, NABR_AA.246, NABR_AA.250, NABR_AA.266
Hesperostipa comata Great Basin Herbaceous Vegetation	CEGL001705	6	NABR.0004, NABR.0104, NABR.0121, NABR.0122, NABR.9101, NABR.9104
Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis) Wooded Shrubland	CEGL002334	6	NABR.0013, NABR.0067, NABR.0068, NABR.0069, NABR.9004, NABR.9059
Pinus edulis - Juniperus osteosperma / Arctostaphylos patula Woodland	CEGL002939	1	NABR.0016
Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland	CEGL000779	7	NABR.0021, NABR.0063, NABR.0114, NABR.0115, NABR.0117, NABR.0301, NABR.0306
Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata Woodland	CEGL000797	12	NABR.0102, NABR.0307, NABR_AA.033, NABR_AA.157, NABR_AA.158, NABR_AA.173, NABR_AA.175, NABR_AA.179, NABR_AA.180, NABR_AA.182, NABR_AA.198, NABR_AA.199
Pinus edulis - Juniperus osteosperma / Petradoria pumila Woodland	CEGL002332	1	NABR.0123
Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland	CEGL000782	4	NABR_AA.154, NABR_AA.161, NABR_AA.165, NABR_AA.284
Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia Woodland	CEGL002335	2	NABR.0017, NABR.9072

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plot, Observation Point, and AA Point Assignments
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	CEGL002148	25	NABR.0018, NABR.0020, NABR.0022, NABR.0023, NABR.0024, NABR.0053, NABR.0054, NABR.0055, NABR.0056, NABR.0057, NABR.0061, NABR.0064, NABR.0065, NABR.0066, NABR.0116, NABR.0118, NABR.0120, NABR.0126, NABR.0300, NABR.0302, NABR.0308, NABR.0309, NABR.0312, NABR.9071, NABR.9102
Pinus edulis - Juniperus spp. / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland	CEGL000776	8	NABR.0015, NABR.0019, NABR.0052, NABR.0060, NABR.0303, NABR.0305, NABR.0310, NABR.9005
Pinus edulis - Juniperus spp. / Cercocarpus montanus - Mixed Shrub Woodland	CEGL000780	4	NABR.0014, NABR.0106, NABR.0304, NABR.0311
Pinus edulis - Juniperus spp. / Quercus gambelii Woodland	CEGL000791	1	NABR.0313
Pleuraphis jamesii Herbaceous Vegetation	CEGL000777	1	NABR.0125
Ponderosa Pine Population	Park Special	1	NABR.9058
Populus angustifolia / Rosa woodsii Forest	CEGL000653	1	NABR.0011
Populus deltoides (ssp. wislizeni, ssp. monilifera) / Artemisia tridentata Woodland	CEGL005966	1	NABR.0005
Populus deltoides (ssp. wislizeni, ssp. monilifera) / Pascopyrum smithii Woodland	CEGL002680	1	NABR.0010
Populus deltoides (ssp. wislizeni, ssp. monilifera) / Salix exigua Woodland	CEGL002685	3	NABR.0007, NABR.0008, NABR.0009
Populus deltoides ssp. wislizeni / Acer negundo Woodland	CEGL002336	1	NABR.0101
Populus fremontii / Salix (ligulifolia, lutea) Woodland	CEGL004002	1	NABR.9070
Pseudotsuga menziesii / Arctostaphylos patula Forest	CEGL000423	1	NABR.0110
Pseudotsuga menziesii / Quercus gambelii Forest	CEGL000452	1	NABR.0112
Pseudotsuga menziesii / Symphoricarpos oreophilus Forest	CEGL000462	1	NABR.0002
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Recently chained Pinus edulis – Juniperus osteosperma / Artemisia tridentata ssp. wyomingensis Woodland	Park Special	1	NABR.9105
Salix exigua / Mesic Graminoids Shrubland	CEGL001203	1	NABR.0003

Appendix F

Plant Association Descriptions for Natural Bridges National Monument

The Natural Bridges National Monument (NABR) vegetation mapping project identified 33 National Vegetation Classification (NVC) plant associations and two park special vegetation types representing 17 vegetation alliances. Detailed vegetation descriptions are essential for recognizing floristic vegetation types (association and alliance levels of the NVC) in the field. Local and global descriptions "*provide specific information on the geographical distribution, level of acceptable physiognomic and compositional variation, and the key ecological process and environmental / abiotic factors that are associated with a type*" (Grossman et al. 1998). The two levels of vegetation descriptions are valuable for comparing each association as it appears in the park with the global range of variation for that association.

The following report was prepared by NatureServe to provide local and global descriptions for each plant association found at NABR. 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.

By convention, the broadleaf cottonwood at NABR is defined as Populus deltoides ssp. wislizeni. However, in one case, *Populus fremontii / Salix (ligulifolia, lutea)* Woodland, a different species was retained as a convenience. This association has been documented from nearby Canyonlands NP, where the conventional name for the broadleaf cottonwood is *Populus fremontii*. It is likely that in both parks, most or all of the broadleaf cottonwoods may actually be a hybrid of *P. fremontii* and *P. deltoides* ssp. *wislizeni*. Therefore, the non-standard name was retained for this association, instead of creating a parallel name based on the convention of *P. deltoides* ssp. *wislizeni* for NABR.

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 / Arctostaphylos patula Forest
Douglas-fir / Greenleaf Manzanita Forest

CODE	CEGL000423
PHYSIOGNOMIC CLASS	Forest (I)
PHYSIOGNOMIC SUBCLASS	Evergreen forest (I.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen forest (I.A.8.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen forest (I.A.8.N.)
FORMATION	Conical-crowned temperate or subpolar needle-leaved evergreen forest (I.A.8.N.c.)
ALLIANCE	PSEUDOTSUGA MENZIESII FOREST ALLIANCE (A.157) Douglas-fir Forest Alliance

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

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This minor woodland association has been reported from the mountains and plateaus of southern Utah. Elevation ranges from 1829-2653 m (6000-8700 feet). Sites are steep mid to lower slopes, on all aspects except south. Soils are typically loam or sandy loam derived from sandstone or limestone. This association is characterized by a typically open tree canopy (about 30% cover) that is dominated or codominated by *Pseudotsuga menziesii*, usually with *Pinus ponderosa* present to codominant. Scattered *Pinus flexilis* and *Juniperus scopulorum* trees may also be present. *Arctostaphylos patula* dominates the moderate to sparse shrub layer with *Mahonia repens* a common associate. Others shrub species present may include *Acer glabrum, Amelanchier utahensis, Ceanothus* spp., *Cercocarpus ledifolius, Cercocarpus montanus, Purshia tridentata, Quercus gambelii*, and *Symphoricarpos oreophilus*. The sparse herbaceous layer (<20% cover) is primarily composed of graminoids, such as *Carex rossii, Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Elymus elymoides, Leymus salinus, Poa fendleriana*, and *Pseudoroegneria spicata*. Forbs are sparse and may include *Achillea millefolium, Astragalus miser, Clematis columbiana, Eriogonum racemosum,* and *Hymenoxys richardsonii*.

DISTRIBUTION

Natural Bridges National Monument

This association occurs in canyons and was sampled in White Canyon, just below the rim, near Sipapu Bridge.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

This forest association was observed at a single site below the rim of White Canyon. The site is a northwest-facing steep slope at 1829 m elevation. The unvegetated surface has moderate cover of litter, large rocks, and bedrock. The soil is a rapidly drained loamy sand derived from Cedar Mesa sandstone.

Globally

This minor woodland association has been reported from the mountains and plateaus of southern Utah. Elevation ranges from 1829-2653 m (6000-8700 feet). Sites are steep mid to lower slopes, often with eastern, northern or western aspects. Soils are typically loam or sandy loam. Parent materials are usually sandstone or limestone.

VEGETATION DESCRIPTION

Natural Bridges National Monument

This Douglas-fir / greenleaf manzanita forest association is rare, occupying ledges near the canyon rims. The total vegetation cover is greater than 50% in this moderately vegetated stand. This forest association is characterized by an open tree canopy, typically 10-15 m tall, of *Pseudotsuga menziesii* trees that range in cover from 25 to 35%. A subcanopy of scattered *Juniperus scopulorum* and *Pinus edulis* trees, typically 5-10 m tall, is present. The shrub layer is diverse and is dominated by *Arctostaphylos patula, Amelanchier utahensis, Quercus gambelii*, and *Rhus trilobata*. The herbaceous layer is diverse but totals less than 5% cover. The most conspicuous herbaceous species include *Piptatherum micranthum, Achnatherum coronatum* (= *Stipa coronata*), *Cirsium calcareum, Frasera speciosa*, and *Heterotheca villosa*. Seedling Pseudotsuga menziesii, Pinus edulis, and Juniperus scopulorum provide up to 5% cover.

Globally
This association is characterized by a typically open tree canopy (about 30% cover) that is dominated or codominated by *Pseudotsuga menziesii*, usually with *Pinus ponderosa* present to codominant. Scattered *Pinus flexilis* and *Juniperus scopulorum* trees may also be present. *Arctostaphylos patula* dominates the moderate to sparse shrub layer with *Mahonia repens* a common associate. Others shrub species present may include *Acer glabrum, Amelanchier utahensis, Ceanothus* spp., *Cercocarpus ledifolius, Cercocarpus montanus, Purshia tridentata, Quercus gambelii*, and *Symphoricarpos oreophilus*. The sparse herbaceous layer (<20% cover) is primarily composed of graminoids, such as *Carex rossii, Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Elymus elymoides, Leymus salinus, Poa fendleriana*, and *Pseudoroegneria spicata*. Forbs are sparse and may include *Achillea millefolium, Astragalus miser, Clematis columbiana, Eriogonum racemosum*, and *Hymenoxys richardsonii*.

MOST ABUNDANT SPECIES
Natural Bridges National Monument

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*
Tall shrub/sapling	*Arctostaphylos patula*

Global

Stratum	Species
Tree canopy	*Pinus ponderosa, Pseudotsuga menziesii*
Tall shrub/sapling	*Arctostaphylos patula*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G4 (23-Feb-1994).

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
This *Pseudotsuga menziesii* woodland is typically codominated by *Pinus ponderosa* and occurs at the lower elevation range of *Pseudotsuga menziesii* woodlands (Youngblood and Mauk 1985). *Pinus ponderosa* and Pseudotsuga menziesii codominate the tree canopy, often with *Pinus ponderosa* more abundant (Youngblood and Mauk 1985). This association is very similar to the more xeric *Pinus ponderosa / Arctostaphylos patula* Woodland (CEGL000842), which may occur nearby, but this

association is less xeric with *Pseudotsuga menziesii* dominating/codominating the tree canopy and the presence of mesophytic understory species such as *Acer glabrum* and *Clematis columbiana* (Graybosch and Buchanan 1983). More study is needed to clarify where to separate transition stands.

CLASSIFICATION CONFIDENCE: 2 – Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: This association occurs on north-facing canyon walls where the shrubs tend to be patchy, often in a mosaic with pinyon-juniper woodland types.
Natural Bridges National Monument Plots: The description is based on 2003 field data (one plot: NABR.0110).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Graybosch and Buchanan 1983, Roberts et al. 1992, Western Ecology Working Group n.d., Youngblood and Mauk 1985

Pseudotsuga menziesii / Quercus gambelii Forest
Douglas-fir / Gambel Oak Forest

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

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

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This forest association occurs on mountains and plateaus from Colorado to Trans-Pecos Texas, west into Arizona and Utah. Elevation ranges from 1229 to 2870 m (4030-9400 feet). Stands are found along drainages, lower and middle slopes, steep upper slopes and ridge tops. Aspects are variable. This forest occurs as both a non-obligate riparian community on the outer margins of riparian areas in desert canyons and steep draws, and as an upland forest forming extensive stands on typically north-facing hill slopes (southern aspects at higher elevations). Soils vary, but are often shallow and rocky ranging from sandy loams to clay. The vegetation is characterized by a relatively sparse to moderately dense evergreen tree canopy dominated by *Pseudotsuga menziesii* sometimes with scattered large *Pinus ponderosa, Pinus strobiformis, Pinus edulis*, or *Juniperus* spp. (especially on drier sites). *Abies concolor* is typically not present. *Quercus gambelii* dominates both the subcanopy (tree form, if present) and the moderately dense tall-shrub layer that consists of dense clumps of oak. *Quercus gambelii* must have at least 5% cover, but there is frequently over 25%. At higher elevations, the *Quercus gambelii* are more tree-like and *Symphoricarpos oreophilus* will be present with significant cover in the short-shrub layer. At lower elevations, scattered *Pinus edulis, Juniperus osteosperma,* or *Juniperus deppeana* are often present. The herbaceous layer is generally sparse and composed of mostly graminoids with scattered forbs, but can be moderately dense and diverse. Many other species are associated such as *Amelanchier* spp., *Holodiscus dumosus, Mahonia repens, Paxistima myrsinites, Robinia neomexicana, Rosa woodsii, Carex* spp.,

Festuca arizonica, Muhlenbergia virescens, Poa fendleriana, Lathyrus lanszwertii var. *leucanthus, Thalictrum fendleri,* and *Vicia americana*. The shrub layer has equal or greater cover than graminoids.

DISTRIBUTION

Natural Bridges National Monument
This association is distributed in canyons and was sampled in White Canyon and below the canyon rim north of the Sipapu Bridge trailhead parking lot.

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

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument
This forest association was observed on a canyon wall, growing from a cliff covered by large boulders. The site is a steep, northwest-facing slope at 1841 m elevation. The unvegetated surface has high cover of litter and low to moderate cover of large rocks and bedrock. Soils are a rapidly drained sandy loam derived from Cedar Mesa sandstone and covered by large blocks of rock that have accumulated against the cliff.

Globally
This forest association occurs on mountains and plateaus at elevation ranges from 1229 to 2870 m (4030-9400 feet). Stands are found along drainages, gentle to moderate lower and middle slopes, steep upper slopes and ridge tops. Aspects are variable. This forest occurs as both a non-obligate riparian community on the outer margins of riparian areas in desert canyons and steep draws, and as an upland forest forming extensive stands on typically north-facing hill slopes (southern aspects at higher elevations). Soils vary but are often shallow and rocky, ranging from sandy loams to clay. The surface is generally largely covered with a thin layer of litter. Parent materials include alluvium, fractured limestone, sandstone, granite, basalt, andesite and even slickrock.

This forest association was sampled once next to an intermittently flooded drainage at the head of a canyon. The site is moderately steep (12 degrees), oriented to the north, and lies at 1229 m elevation. Most of the unvegetated surface is covered by large rocks with low cover of litter and bare soil. The soil is a rapidly drained loamy sand.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This Douglas-fir / Gambel oak forest association is rare within the monument, occupying ledges on the canyon walls. The total vegetation cover exceeds 150%. This association is characterized by a moderately closed tree canopy and subcanopy, typically 10-15 m tall (canopy) and 2-5 m tall (subcanopy). The dominant tree species are *Pseudotsuga menziesii* (35% cover) and *Quercus gambelii* (50% cover). The shrub layer may approach 40% cover and is dominated by *Amelanchier utahensis, Paxistima myrsinites,* and *Shepherdia rotundifolia*. The herbaceous layer is sparse, less than 1% cover, and includes scattered individuals of *Piptatherum micranthum* and *Packera multilobata* (= *Senecio multilobatus*). Seedling *Quercus gambelii* and *Prunus virginiana* shrubs provide up to 25% cover. The vine *Clematis ligusticifolia* provides sparse cover.

Globally
This association is characterized by a relatively sparse to moderately dense evergreen tree canopy dominated by *Pseudotsuga menziesii*, sometimes with scattered large *Pinus ponderosa, Pinus strobiformis, Pinus edulis,* or *Juniperus* spp. (especially on drier sites). *Abies concolor* is typically not

present. *Quercus gambelii* dominates both the subcanopy (tree form, if present) and the moderately dense tall-shrub layer that often consists of dense clumps of oak. *Quercus gambelii* must have at least 5% cover, but there is frequently over 25%. At higher elevations, the *Quercus gambelii* are more tree-like, and *Symphoricarpos oreophilus* will be present with significant cover in the short-shrub layer. At lower elevations, scattered *Pinus edulis, Juniperus osteosperma*, or *Juniperus deppeana* are often present. Other common shrub species, depending on geographic location, may include *Acer glabrum, Arctostaphylos patula, Amelanchier* spp., *Cercocarpus montanus, Holodiscus dumosus, Mahonia repens, Paxistima myrsinites, Prunus virginiana, Ribes cereum, Robinia neomexicana*, and *Rosa woodsii*. The generally sparse herbaceous layer is composed of mostly graminoids with scattered forbs but ranges to moderately dense and diverse. Associated graminoids may include *Bromus* spp., *Carex rossii, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Muhlenbergia virescens,* and *Poa fendleriana*. Common forbs include *Achillea millefolium, Lathyrus lanszwertii* var. *leucanthus, Thalictrum fendleri*, and *Vicia americana*. The shrub layer has equal or greater cover than graminoids. This open conifer forest transitions to *Quercus gambelii* woodlands in drier sites and at lower elevations.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

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

Global

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

OTHER NOTEWORTHY SPECIES

Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Natural Bridges National Monument
Data are not available.

Globally
Within the Habitat Type literature there are four phases mentioned: Festuca arizonica phase, Holodiscus dumosus phase, *Muhlenbergia virescens* phase (all defined by having at least 5% cover of both *Quercus gambelii* and the nominal species), and *Quercus gambelii* (typic) phase by a undeveloped herbaceous layer (Alexander et al. 1984b, Alexander et al. 1987, DeVelice et al. 1986, Fitzhugh et al. 1987, Johnston 1987, Larson and Moir 1987, Muldavin et al. 1996, Stuever and Hayden 1997b). There are 3 similar USNVC *Pseudotsuga menziesii* associations that use these phase species as the nominal species. These phases represent "intermediate" vegetation. Review of these associations is needed to clarify relationships between associations.

CLASSIFICATION CONFIDENCE: 2 – Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: Occurs on cool, north-facing canyon walls where bedrock ledges and rockfall have created steep slopes. Small groups of trees are present, arranged linearly.
Natural Bridges National Monument Plots: Plots: The description is based on 2003 field data (1 plot: NABR.0112).
Local Description Authors: A. Buechling, mod. J. Von Loh and J. Coles
Global Description Authors: K.A. Schulz, mod. J. Drake

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

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 feet). 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

Natural Bridges National Monument
This rare association was sampled on a point bar approximately 3500 m upstream of Sipapu Bridge in White Canyon.

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 & Washington.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument
This association was found at a single site on a point bar on the floor of White Canyon. The site has a gentle slope, occurs at 1814 m elevation, and is oriented to a northern aspect. The unvegetated surface has high cover of litter and low exposure of bare soil and cover of downed wood. The soils are rapidly drained sandy loams derived from alluvium.

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 feet). 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 silt loam 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

Natural Bridges National Monument
This Douglas-fir / mountain snowberry forest association is rare within the monument. The total vegetation cover does not exceed 80% in the one sampled stand. This forest association is characterized by an open tree canopy, typically 15-20 m tall, of *Pseudotsuga menziesii* that ranges in cover from 15 to 20% and a short-shrub canopy of *Symphoricarpos oreophilus* that ranges in cover from 5 to 15%. Smaller Juniperus osteosperma and *Pseudotsuga menziesii* are scattered throughout the subcanopy and seedling layers. The shrub layer is well-developed and has relatively high cover; *Symphoricarpos oreophilus* dominates the shrub layer, but *Acer negundo, Amelanchier utahensis, Mahonia fremontii, Chrysothamnus linifolius,* and *Quercus gambelii* also have measurable cover. The herbaceous layer is sparse, and only the bunchgrass *Piptatherum micranthum* with the forb *Antennaria* sp. are notable. Cryptogam cover is moderate, with moss providing from 5 to 15% cover.

Globally
This forest association 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* is present and usually dominates the sparse to moderately dense short-shrub layer. Shrub associates vary depending on location 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, including *Bromus* spp., *Carex geyeri, Carex rossii, Festuca idahoensis, Leucopoa kingii, Koeleria macrantha,* and *Poa fendleriana.* Common forbs include *Achillea millefolium, Arnica cordifolia, Artemisia frigida, Thalictrum fendleri,* and *Vicia americana.*

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*
Short shrub/sapling	*Chrysothamnus linifolius, Symphoricarpos oreophilus*
Herb (field)	*Piptatherum micranthum*

Global

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*
Short shrub/sapling	*Symphoricarpos oreophilus*

OTHER NOTEWORTHY SPECIES

Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION COMMENTS

Natural Bridges 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

Natural Bridges National Monument Inventory Notes: This stand occupies an area of about 1.0 ha on a point bar on the canyon floor.
Natural Bridges National Monument Plots: The description is based on 2003 field data (1 plot: NABR.0002).
Local Description Authors: A Buechling, mod. J. Von Loh and J. Coles
Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles

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, Western Ecology Working Group n.d., Williams and Lillybridge 1983, Williams and Lillybridge 1985, Williams et al. 1990b, Wright et al. 1979, Youngblood and Mauk 1985

Populus angustifolia / Rosa woodsii Forest
Narrowleaf Cottonwood / Woods' Rose Forest

CODE	CEGL000653
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 ANGUSTIFOLIA TEMPORARILY FLOODED FOREST ALLIANCE (A.310) Narrowleaf Cottonwood Temporarily Flooded Forest Alliance

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

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This deciduous riparian forest occurs on stream terraces and adjacent floodplains in the La Sal and Abajo mountains in southeastern Utah, the west slope of the Wasatch Range in central Utah, in western Wyoming, and in various mountain ranges in Nevada. It may also occur in Colorado. Elevation ranges from 1780-2300 m. Substrates are moderately well-drained alluvial soils derived from sandstone or other sedimentary rock. The community is one of the drier *Populus angustifolia* plant associations. This association has a closed upper tree canopy that is dominated by *Populus angustifolia*. Other tree species may include *Quercus gambelii, Populus tremuloides*, and an occasional *Juniperus osteosperma* or other upland tree species. *Prunus virginiana* and *Salix bebbiana* may form a tall-shrub layer, especially streamside. A dense short-shrub layer dominated by *Rosa woodsii* or *Rosa nutkana* is diagnostic of this type. *Symphoricarpos oreophilus* is often present and occasionally codominant. *Rhus trilobata, Mahonia repens*, or *Cornus sericea* are present in some stands. The vine *Clematis ligusticifolia* is abundant in some stands. The herbaceous layer is generally sparse but may be denser in openings where the introduced grasses *Poa pratensis* and *Agrostis stolonifera* and the native *Elymus glaucus* are dominant. Common native forbs include *Maianthemum stellatum, Thalictrum fendleri, Osmorhiza berteroi* (= *Osmorhiza chilensis*), *Geranium richardsonii*, and *Galium boreale*. The introduced forb *Taraxacum officinale* is often also present. The dense short-shrub layer dominated by *Rosa* spp. separates this association from other *Populus angustifolia* riparian forests. If present, *Cornus sericea* is always a minor component.

DISTRIBUTION

Natural Bridges National Monument

This association is distributed as a single stand in the canyon bottom downstream of Owachomo Bridge.

Globally

This riparian forest occurs locally in the LaSal and Abajo mountains in southeastern Utah, on the western slope of the Wasatch Range in central Utah, in western Wyoming, and in various mountain ranges in Nevada. This association may also occur in Colorado.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This forest association was observed on canyon bottoms on stream banks and low terraces. The site is moderately steep (23 degrees), occurs at 1780 m elevation, and is oriented to an eastern aspect. The unvegetated surface has high cover of litter and sparse exposure of bare soil. Parent materials are Cedar Mesa sandstones that have eroded and are deposited as new alluvium. Soils are moderately well-drained and texturally are loamy sand.

Globally

This deciduous riparian forest occurs on stream terraces and adjacent floodplains in isolated mountains and tablelands of the Colorado Plateau, the west slope of the Wasatch Range in Wyoming, and in various mountain ranges in Nevada. It may also occur on the western slope of the southern Rocky Mountains. Elevation ranges from 1780-2300 m. Substrates are moderately well-drained alluvial soils derived from sandstone or other sedimentary rock.

VEGETATION DESCRIPTION

Natural Bridges National Monument

This narrowleaf cottonwood / Woods' rose forest association is rare, known from one stand within the monument. The total vegetation cover exceeds 100% in this densely vegetated stand. This stand is characterized by an open tree canopy and subcanopy, typically 2-10 m tall, of *Populus angustifolia* with 40% cover in the canopy and 10% cover in the subcanopy, and a short-shrub layer of *Rosa woodsii* that has 20% cover. *Acer negundo* is also present in the subcanopy layer. The shrub layer is relatively diverse and provides moderate cover, including *Amelanchier utahensis, Rhus trilobata,* and *Salix exigua*. There is no herbaceous layer, but the most obvious herbaceous species include *Pascopyrum smithii, Artemisia ludoviciana, Heterotheca villosa, Solidago gigantea,* and *Equisetum hyemale.* Scattered *Populus angustifolia* seedlings provide sparse cover.

Globally

This deciduous riparian forest is one of the drier *Populus angustifolia* plant associations. This association has a closed upper tree canopy that is dominated by *Populus angustifolia*. Other tree species may include *Quercus gambelii, Populus tremuloides*, and an occasional *Juniperus osteosperma* or other upland tree species. *Prunus virginiana* and *Salix bebbiana* may form a tall-shrub layer, especially streamside. A dense short-shrub layer dominated by *Rosa woodsii* or *Rosa nutkana* is diagnostic of this type. *Symphoricarpos oreophilus* is often present and occasionally codominant. *Rhus trilobata, Mahonia repens*, or *Cornus sericea* are present in some stands. The vine *Clematis ligusticifolia* is abundant in some stands. The herbaceous layer is generally sparse but may be denser in openings where the introduced grasses *Poa pratensis* and *Agrostis stolonifera* and the native *Elymus glaucus* are dominant. Common native forbs include *Maianthemum stellatum, Thalictrum fendleri, Osmorhiza berteroi* (= *Osmorhiza chilensis*), *Geranium richardsonii,* and *Galium boreale.* The introduced forb *Taraxacum officinale* is often also present. The dense short-shrub layer dominated by *Rosa* spp. separates this association from other *Populus angustifolia* riparian forests. If present, *Cornus sericea* is always a minor component.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	**Species**
Tree canopy	*Populus angustifolia*
Tree subcanopy	*Populus angustifolia*

Global

Stratum	**Species**
Tree canopy	*Populus angustifolia*
Short shrub/sapling	*Rosa woodsii*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G2G3 (27-Dec-1999). This riparian woodland association is rare and has only been described from 5 stands in three mountain ranges in Utah. There are over 20 occurrences estimated for this type range wide. Although this association appears stable, the condition of high quality occurrences is extremely threatened. Development, heavy recreation use, expansion and maintenance of roads and railroads, improper grazing, and modification of the hydrologic processes threaten this community with the introduction of non-native species, accelerated erosion, and damage to native vegetation. Hydrologically modified streams may lack the processes necessary to regenerate the *Populus angustifolia* tree canopy. Additional survey is needed to determine if it occurs in Colorado and elsewhere in Utah.

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
Compare this association with *Populus angustifolia / Cornus sericea* Woodland (CEGL002664).

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: This is the only major patch of *Populus angustifolia* observed in the canyon. The canyon is oriented north to south at this location.
Natural Bridges National Monument Plots: The description is based on 2003 field data (one plot: NABR.0011).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: J. Nachlinger, mod. K.A. Schulz and J. Coles

REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Jones 1992b, Jones and Ogle 2000, Manning and Padgett 1992, Manning and Padgett 1995, NVNHP 2003, Nachlinger and Reese 1996, Padgett and Manning 1988, Padgett et al. 1988b, Padgett et al. 1989, Western Ecology Working Group n.d.

Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata Woodland
Two-needle Pinyon - (One-seed Juniper, Utah Juniper) / Needle-and-Thread Woodland

CODE	CEGL000797
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

Southern Rocky Mountain Pinyon-Juniper Woodland (CES306.835)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association is known from western and south-central Colorado and eastern Utah. Stands occur on a variety of sites from flat or gentle lower slopes, benches, mesa tops to steep colluvial slopes to montane alluvial fans. Parent materials are frequently sandstone or shale. This woodland is characterized by the dominance or codominance of *Pinus edulis* in an open evergreen tree canopy. *Juniperus osteosperma* or *Juniperus monosperma* may codominate some stands, and *Juniperus scopulorum* may also be present. The sparse to moderately dense herbaceous layer is dominated by the perennial bunchgrass *Hesperostipa comata* (= *Stipa comata*), with *Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Koeleria macrantha, Bouteloua gracilis, Pleuraphis jamesii* (= Hilaria jamesii), and Pascopyrum smithii often present to common. Forb cover is generally sparse but may include *Heterotheca villosa, Hymenoxys* spp., *Artemisia dracunculus* (= *Artemisia dracunculoides*), *Oxytropis lambertii, Castilleja* sp., *Eriogonum jamesii*, and *Sphaeralcea coccinea*. Scattered shrubs and dwarf-shrubs may also be present, such as *Cercocarpus montanus, Quercus gambelii, Atriplex canescens, Artemisia frigida, Ephedra viridis*, or *Gutierrezia sarothrae*. *Opuntia polyacantha* and *Yucca glauca* are often present. Diagnostic of this woodland association is the dominance or codominance of *Pinus edulis* in the tree canopy and a *Hesperostipa comata*-dominated herbaceous layer.

DISTRIBUTION

Natural Bridges National Monument

This association is scattered in small patches throughout the monument. It was sampled on the bench between Deer Canyon and Deer Mesa, as well as the floor of White Canyon. It often occurs in patches in a matrix of woodlands with a sparse understory or a scattered shrub understory.

Globally

This association is known from four counties (Montrose, San Miguel, Mesa, and Saguache) in western portion of Colorado (Isaacson 1967, P. Lyon pers. comm.). It also occurs in southeastern Utah.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This woodland association occurs on shallow to moderately deep sandy soils on mesas and benches, as well as on canyon floors throughout the monument. Sites are flat to gently sloping (0- to 14-degree slopes), occur between 1796 and 1849 m elevation, and tend to be oriented to south or west aspects. Bare ground and litter cover most of the unvegetated surface, and biological soil crusts often have high cover in areas that have been protected from grazing. Soils are well-drained to rapidly drained clay loams and sandy loams derived from eolian or alluvial deposits.

Globally

This woodland association occurs on slopes, benches and ridges with coarse-sandy, sometimes rocky soils. Elevations range between 1490 and 2156 m (4900-7070 feet); slopes are level to steep and may be oriented to any aspect. The unvegetated soil surface may be rocky, gravelly, or mostly bare ground, or biological soil crusts can have high cover in areas that have been protected from grazing. The sandy or silty soils are generally derived from sandstone, less often from shale, alluvial or eolian deposits.

VEGETATION DESCRIPTION

Natural Bridges National Monument

This woodland association is uncommon within the park and usually occurs in relatively small stands. Total vegetation cover ranges between 20 and 30%. The open canopy consists of both *Pinus edulis* and *Juniperus osteosperma* trees with between 5 and 15% cover. The understory rarely exceeds 15% cover

and is dominated or codominated by the tall bunchgrass *Hesperostipa comata*. Shrubs are scattered throughout the community but are too sparse to constitute a layer; common species include *Ephedra viridis, Mahonia fremontii, Symphoricarpos oreophilus,* and *Gutierrezia sarothrae*. The herbaceous layer is diverse and will often include significant cover of *Achnatherum hymenoides, Pleuraphis jamesii,* and *Bouteloua gracilis*. Forbs are rare; only *Tiquilia latior* and *Petradoria pumila* were recorded in the ten sampled stands. Cryptogams do not exceed 5% cover.

Globally
This woodland association occurs on sandy, sometimes rocky soils in the northern Colorado Plateau. Total vegetation cover ranges between 10% to at least 70%. This woodland association is characterized by an open to somewhat closed canopy, typically 2-5 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees, and an understory dominated by the bunchgrass *Hesperostipa comata*. Scattered shrubs, such as *Ephedra viridis* and *Chrysothamnus viscidiflorus*, are present but do not form a layer. The herbaceous layer is diverse and provides up to 15% cover. *Achnatherum hymenoides* may be codominant with *Hesperostipa comata*, and *Pleuraphis jamesii* or *Bouteloua gracilis* may be present with low cover. Forbs are more diverse but contribute little cover and may include *Hymenoxys richardsonii, Sphaeralcea coccinea*, and *Mirabilis multiflora*. Cryptobiotic crusts are present in some stands.

MOST ABUNDANT SPECIES
Natural Bridges National Monument

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

Global

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

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G2? (14-Nov-1997). This is a rare, regionally endemic association. It is poorly known, with only five documented locations from four counties (Montrose, San Miguel, Mesa, and Saguache) in the western portion of Colorado (CONHP 1997). None of these stands are protected. There is some uncertainty about the accuracy of this rank (the actual rank may be lower) because both Isaacson (1967) and Colorado Natural Heritage Program field investigators (P. Lyons pers. comm.) suggest it may be more widespread on the western slope of Colorado and may extend into Utah. This association occurs in a relatively common environmental setting, being found on flat or gently inclining slopes or benches of sandstone origin (CONHP 1997). Existing stands have been degraded by overgrazing, non-native species invasion, and possibly fire suppression. As of 2006, this association has been found regularly in national park units in southern and eastern Utah, as well as western Colorado. However, stands tend to be small, isolated, and affected by grazing.

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
Juniperus monosperma-codominated stands are restricted to south-central Colorado.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: Several stands experience light to moderate grazing.
Natural Bridges National Monument Plots: The description is based on 2003 field data (2 plots: NABR.0102, NABR.0307) and the 2004 accuracy assessment (10 plots: NABR_AA.033, NABR_AA.157, NABR_AA.158, NABR_AA.173, NABR_AA.175, NABR_AA.179, NABR_AA.180, NABR_AA.182, NABR_AA.198, NABR_AA.199).
Local Description Authors: J. Coles
Global Description Authors: D. Clark, mod. J. Coles and K.A. Schulz

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

Pinus edulis - Juniperus osteosperma / Arctostaphylos patula Woodland
Two-needle Pinyon - Utah Juniper / Greenleaf Manzanita Woodland

CODE	CEGL002939
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This association is found on the Colorado Plateau of southern Utah on flat to gently sloping sites between 1707 and 2103 m (5600-6900 feet) elevation. Slope aspects tend toward western and southern. Soils are loamy sands, sandy loams, and clay loams and are rapidly drained. The unvegetated surface has moderate cover of bare soil and varying cover of cryptogams, litter, and small and large rocks. This woodland association has a short (2-10 m), open tree canopy (10-30% cover). *Pinus edulis* and *Juniperus osteosperma* are the most abundant tree species, each of which typically has from 5-25% cover. The shrub layer has moderate cover (5-30%) and can be fairly diverse. *Arctostaphylos patula* dominates the shrub layer with 5-30% cover. Other common shrubs include *Amelanchier utahensis, Cercocarpus intricatus, Eriogonum microthecum, Opuntia* spp., *Quercus gambelii,* and *Shepherdia rotundifolia*. The herbaceous layer has sparse to low cover and low to moderate species diversity. It may contain *Achnatherum hymenoides, Muhlenbergia pungens,* and *Poa fendleriana, Comandra umbellata, Penstemon eatonii,* and *Lepidium montanum*.

DISTRIBUTION
Natural Bridges National Monument
This association was sampled on the rim of upper White Canyon, northeast of the park's sewage disposal ponds.

Globally
This association occurs in southern Utah.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument
This woodland association was observed on the rim of White Canyon. The sampled site is on a gentle slope at 2006 m elevation. The unvegetated surface has high cover of cryptogams and moderate exposure of bare soil. Litter cover is low. Parent materials are Cedar Mesa sandstone, occurring both as bedrock exposures and as pockets of soil and rocks. Soils are a rapidly drained sandy loam filling cracks and potholes in the sandstone.

Globally
This association occurs on flat to gently sloping sites between 1707 and 2103 m elevation. Slope aspects tend toward western and southern. Parent materials are typically sandstone, although some sites are on shale. Soils are loamy sands, sandy loams, and clay loams and are rapidly drained. The unvegetated surface has moderate cover of bare soil and varying cover of cryptogams, litter, and small and large rocks.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This pinyon-juniper / greenleaf manzanita woodland association is rarely found along canyon rims. The total vegetation cover typically ranges from 10 to 25% in these stands, but some sparser tree-dominated stands from extremely dry, rocky sites are included in this woodland association as a best fit. This woodland association is characterized by an open tree canopy, typically 2-5 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees that range in cover from 1 to 5% each, and a sparse shrub layer dominated by the short shrub *Arctostaphylos patula*. Other shrubs that occur in the community include *Amelanchier utahensis, Ephedra viridis, Mahonia fremontii,* and *Opuntia polyacantha*. The herbaceous layer is sparse and includes trace amounts of *Comandra umbellata, Eriogonum alatum, Stenotus acaulis* (= *Haplopappus acaulis*), *Stenotus armerioides* (= Haplopappus armerioides), *Hymenopappus filifolius, Lepidium montanum, Pedicularis centranthera, Petradoria pumila,* and *Solidago velutina* (= *Solidago sparsiflora*). Seedling *Pinus edulis* and *Juniperus osteosperma* also occur in trace amounts. Cryptogam cover is high, from 45 to 60%.

Globally
This association typically has an open tree canopy (10-30% cover) that is 2-10 m tall, but some sparse, tree-dominated stands from extremely dry, rocky sites in the Colorado Plateau are included as a best fit. The dominant trees are *Pinus edulis* and *Juniperus osteosperma,* each of which typically has from 5-25% cover. The shrub layer has moderate cover (5-30%) and can have high species diversity. *Arctostaphylos patula* has 5-30% cover and dominates the shrub layer. Other common shrubs include *Amelanchier utahensis, Cercocarpus intricatus, Eriogonum microthecum, Opuntia* spp., *Quercus gambelii*, and *Shepherdia rotundifolia*. The herbaceous layer has low cover and low to moderate species diversity. It may contain the graminoids *Achnatherum hymenoides, Muhlenbergia pungens*, and *Poa fendleriana* and the forbs *Comandra umbellata, Penstemon eatonii*, and *Lepidium montanum*. A few stands observed on canyon rims in southeastern Utah are much sparser than average with total vegetation cover of 5-25% and total tree cover of 2-10%.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Arctostaphylos patula*

Global

Stratum	**Species**
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Arctostaphylos patula*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (14-Aug-2001).

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands may be similar to open Arctostaphylos patula shrublands with scattered pinyon and juniper trees but is considered to be a variation of the woodland type because of the ecological values of the trees.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: Sites are associated with canyon rims. A great diversity of shrub and woodland types occupy canyon rims at Natural Bridges; this type is the only one with *Pinus edulis, Juniperus osteosperma* and *Arctostaphylos patula* as dominants.
Natural Bridges National Monument Plots: The description is based on one 2003 field plot: NABR.0016.
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: J. Drake, mod. K.A. Schulz

REFERENCES: Cogan et al. 2004, Western Ecology Working Group n.d.

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

CODE	CEGL000799
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)
Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association occurs on dry sandstone ridge tops, mesa edges, outcrops, colluvial slopes, slickrock hills, benches and knolls at moderate elevations of 1484 to 2470 m (4870-8100 feet) on the Colorado Plateau and in extreme northwestern Colorado, adjacent Utah, and possibly Wyoming. South and southwest aspects are common, and slopes can be variable in steepness. Exposed bedrock and large rock may cover over 50% of the stand, with vegetation growing in the cracks. These sandstone-derived soils are generally poorly developed, coarse-textured and skeletal. Bare soil is common. The vegetation is characterized by a short (2-10 m), open tree canopy (10-25% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*, and by the dominance of *Cercocarpus intricatus* in the relatively sparse short-shrub layer (5-25% cover). *Pinus edulis* and *Juniperus osteosperma* vary in cover between 1 and 15%, though higher covers are possible. The shrubs *Amelanchier utahensis, Arctostaphylos patula, Gutierrezia sarothrae, Mahonia fremontii, Quercus gambelii,* or *Yucca* spp. are often present in many stands. Herbaceous cover is sparse (<5% cover) and is composed of scattered forbs and grasses such as species of *Cryptantha, Penstemon,* and *Opuntia, Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Bouteloua gracilis, Elymus elymoides, Pleuraphis jamesii,* and *Poa fendleriana.*

DISTRIBUTION

Natural Bridges National Monument

This association is distributed on canyon rims and slickrock slopes with patchy soil accumulation and was sampled south of the park loop road, in a draw near the picnic area, north of the campground, on the rim of the north branch of Tuwa Canyon, and near Kachina Bridge. A diversity of shrubland and woodland associations occur on the canyon rims at the monument. This association is distinguishable because *Cercocarpus intricatus* is often a codominant shrub.

Globally

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

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This woodland association was observed on canyon rims and slopes with bedrock exposures and thin soils. The sites are on gentle to moderate slopes between 1812 and 1931 m elevation. The unvegetated surface has low to moderate cover of litter and extensive exposures of bare soil and bedrock. Cryptogamic crusts have sparse to moderate cover. Soils are rapidly drained to well-drained sandy loams, silt loams, and sands derived from local sandstones and shales.

Globally
This woodland association occurs on dry, sandstone ridge tops, mesa edges, outcrops, colluvial slopes, slickrock hills, benches and knolls at moderate elevations (1484 -2470 m) on the Colorado Plateau and in extreme northwestern Colorado, adjacent Utah, and possibly Wyoming. South and southwest aspects are common, and slopes can vary from gentle to steep. Exposed bedrock and large rock may cover over 50% of the stand, with vegetation growing in soil that has collected in joints and cracks. These sandstone-derived soils are generally poorly developed, coarse-textured and skeletal. Soils are rapidly drained sandy loams, sands, or silt loams derived from colluvium derived from a variety of parent materials, including Carmel Formation, Cedar Mesa sandstone, Chinle Formation, Dakota Formation, Kayenta Formation, Morrison Formation, Navajo Formation, or Wingate Formation. Bare soil is common.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This sparse pinyon-juniper / littleleaf mountain-mahogany woodland association is common on the canyon rims and adjacent upper canyon walls. The total vegetation cover typically ranges from 10 to 60% in these stands, but some sparser tree-dominated stands from extremely dry, rocky sites are included in this woodland association as a best fit. This woodland association is characterized by a very open to open tree canopy, typically 1-5 m tall, of *Pinus edulis* and *Juniperus osteosperma* that range in cover from 1 to 15% and 1 to 5%, respectively. The diverse shrub layer is dominated by *Cercocarpus intricatus* that ranges in cover from 1 to 5% and is usually accompanied by *Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus, Fraxinus anomala* and *Mahonia fremontii*. Scattered forbs and grasses are generally present and include *Petradoria pumila, Stenotus armerioides* (= *Haplopappus armerioides*), *Cryptantha flava, Arenaria fendleri, Eriogonum alatum,* and *Hymenopappus filifolius*. Scattered seedlings of *Pinus edulis* and *Juniperus osteosperma* provide sparse cover. The nonvascular layer may cover up to 40% and is composed primarily of dark cyanobacteria and ground lichens.

Globally
The association is characterized by an open tree canopy (10-25% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*, and by the dominance of *Cercocarpus intricatus* in the relatively sparse short-shrub layer (5-25% cover). The tree canopy may be between 2 and 10 m tall; *Pinus edulis* and *Juniperus osteosperma* vary in cover between 1 and 15%, with some stands having up to 25% cover of *Pinus edulis*. Some stands may have an occasional emergent *Pinus ponderosa, Pseudotsuga menziesii,* or *Juniperus scopulorum* tree. Additionally, some sparse (<10% total cover), tree-dominated stands from extremely dry, rocky sites in the Colorado Plateau are included in this woodland association as a best fit. The shrub layer represents the mesic end of the pinyon-juniper / mixed shrub understory communities found on slickrock exposures. *Amelanchier utahensis, Arctostaphylos patula, Gutierrezia sarothrae, Mahonia fremontii, Quercus gambelii* (low cover), or *Yucca* spp. are often present in many stands. A variety of other shrubs and dwarf-shrubs may be present depending on location, including *Artemisia bigelovii, Brickellia microphylla, Cercocarpus montanus, Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Ephedra viridis, Eriogonum corymbosum, Fendlerella utahensis, Fraxinus anomala, Glossopetalon spinescens* var. *meionandrum, Holodiscus dumosus, Philadelphus microphyllus, Purshia stansburiana, Quercus turbinella,* or *Shepherdia rotundifolia*. *Coleogyne ramosissima* is typically absent. Herbaceous cover is sparse (<5% cover) and is composed of scattered forbs and grasses, such as species of *Cryptantha, Penstemon,* and *Opuntia, Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Bouteloua gracilis, Elymus elymoides, Pleuraphis jamesii,* and *Poa fendleriana*.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*

Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Cercocarpus intricatus*

Global

Stratum	**Species**
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Cercocarpus intricatus*
Herb (field)	*Achnatherum hymenoides, Elymus elymoides, Poa fendleriana*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G3 (30-Dec-2000). The plant association is limited to a small geographic area and is documented from a narrow elevational band on sandstone substrates in extreme northwestern Colorado and possibly adjacent Utah. There are 11 documented stands in Colorado with size ranging from 4-450 acres. Although most occurrences are considered in good to excellent condition, those in excellent condition tend to be small. Grazing and woodcutting are the primary threats where stands are accessible.

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
Compare this association with *Juniperus osteosperma / Cercocarpus intricatus* Woodland (CEGL000733) which is very similar, but lacks *Pinus edulis*. On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands may be similar to open *Cercocarpus intricatus* shrublands with scattered pinyon and juniper trees but is considered to be a variation of the woodland type because of the ecological values of the trees.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: Scattered *Pinus edulis* mortality is attributed to drought and bark beetle damage.
Natural Bridges National Monument Plots: The description is based on 2003 and 2004 field data (7 plots: NABR.0021, NABR.0063, NABR.0114, NABR.0115, NABR.0117, NABR.0301, NABR.0306).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: A.E. Black, mod. K.A. Schulz, J. Drake, J. Coles

REFERENCES: Baker 1983b, Baker 1983c, Baker 1984a, Baker and Kennedy 1985, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Cogan et al. 2004, Driscoll et al. 1984, Western Ecology Working Group n.d., Zimmerman 1978

***Pinus edulis - Juniperus osteosperma / Petradoria pumila* Woodland**
Two-needle Pinyon - Utah Juniper / Grassy Rock-goldenrod Woodland

CODE	CEGL002332
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is found in eastern Utah and western Colorado on upper topographic positions between 1841 and 2195 m (6050-7200 feet) elevation. It occurs on level to gently sloping sites on any aspect with thin soils over sandstone or shale bedrock. Litter, bedrock, and bare soil are the most common components of the ground cover. This woodland association has a short, open tree canopy dominated by evergreen tree species. Total vegetation cover is relatively sparse to moderate. The dominant tree species are *Pinus edulis* and *Juniperus osteosperma*; either species can have cover between 1 and 25%. The shrub layer is absent to moderate and has low diversity. *Ephedra viridis, Gutierrezia sarothrae,* and succulents, such as *Echinocereus triglochidiatus, Opuntia erinacea, Opuntia fragilis,* and *Yucca harrimaniae,* are the most common species. The herbaceous layer has low cover, as well, but tends to have greater diversity. Common grasses, such as *Achnatherum hymenoides, Bromus tectorum, Elymus elymoides,* and *Poa fendleriana,* provide sparse cover. The forb *Petradoria pumila* is the most abundant herbaceous species and is characteristic of this association. Other forbs include *Arenaria fendleri, Descurainia pinnata, Eriogonum alatum, Heterotheca villosa, Streptanthus cordatus,* and *Tetraneuris acaulis*.

DISTRIBUTION

Natural Bridges National Monument

This association was sampled on small benches near the rim of Deer Flat.

Globally

This association is found in western Colorado and eastern Utah.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This woodland association was observed from a single site within the monument. It occurs on a ledgy canyon rim, where bedrock is thinly mantled with soil. The site is on a gentle slope at 1841 m elevation with a northwestern aspect. The unvegetated surface has low cover of litter, bedrock, and cryptogams and high exposure of bare soil. The parent material is Cedar Mesa sandstone. The soil is a rapidly drained sandy loam.

Globally

This association is found on canyon rims, mesa tops, and interfluves between 1841 and 2195 m elevation. It occurs on level to gently sloping sites and on any aspect. Soils are thin and usually well- to rapidly drained over sandstone or shale bedrock. Litter, bedrock, and bare soil are the most common components of the ground cover.

VEGETATION DESCRIPTION

Natural Bridges National Monument

This pinyon-juniper / grassy rock-goldenrod woodland association is rarely encountered within the monument. The total vegetation cover ranges from 10 to 30% in these sparsely to moderately vegetated stands. This woodland association is characterized by an open tree canopy, typically 2-5 m tall, of *Pinus*

edulis and *Juniperus osteosperma* that range in cover from 5 to 15% and 1 to 5%, respectively, and the forb *Petradoria pumila* that ranges in cover from 1 to 5%. There is no shrub layer and the only shrub with measurable cover is *Ephedra viridis. Cryptogam* cover is moderate, between 10 and 30%.

Globally
This woodland association has a short, open tree canopy dominated by evergreen tree species. Total vegetation cover is moderate to sparse, including some tree-dominated stands with <10% total vegetation cover as a best fit. The dominant tree species are *Pinus edulis* and *Juniperus osteosperma* which range between 2 and 10 m tall, and either species can have cover between 1 and 25% in the tree canopy. The shrub layer is absent to moderate and has low diversity. *Ephedra viridis, Gutierrezia sarothrae*, and succulents, such as *Echinocereus triglochidiatus, Opuntia erinacea, Opuntia fragilis*, and *Yucca harrimaniae*, are the most common species. The herbaceous layer has low cover, as well, but tends to have greater diversity. Common grasses, such as *Achnatherum hymenoides, Bromus tectorum, Elymus elymoides*, and *Poa fendleriana*, provide sparse cover. The forb *Petradoria pumila* is the most abundant herbaceous species and is characteristic of this association. Other forbs that may be present include *Arenaria fendleri, Descurainia pinnata, Eriogonum alatum, Heterotheca villosa, Streptanthus cordatus*, and *Tetraneuris acaulis*.

MOST ABUNDANT SPECIES
Natural Bridges National Monument

Stratum	**Species**
Tree canopy	*Juniperus osteosperma, Pinus edulis*

Global

Stratum	**Species**
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Herb (field)	*Petradoria pumila*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

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

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands are considered to be a variation of the woodland type because of the ecological values of the trees.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: This association occurs predominantly on thin soils and exposed bedrock where small benches or ledges occur.

Natural Bridges National Monument Plots: The description is based on 2003 field data (1 plot: NABR.0123).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: J. Drake, mod. K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland
Two-needle Pinyon - Utah Juniper / Stansbury's Cliffrose Woodland

CODE	CEGL000782
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This woodland association is known from the Colorado Plateau of southern Utah and Colorado south to central Arizona. It occurs on dry sites on canyon rims, ridges and slopes. Elevations range from 1400 to 2165 m. Stands typically occur on gentle to moderately steep slopes on all aspects. The soils are generally shallow and rocky, ranging from sand to clay loam in texture. Rock outcrop and bare soil are common. Parent materials include sandstone and shale. The vegetation is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. *Purshia stansburiana* dominates or codominates the sparse to moderately dense short-shrub layer, often with *Artemisia tridentata* in the northern part of its range. *Cercocarpus montanus* and *Purshia tridentata* are scarce or absent. Other shrubs may be present, including *Amelanchier utahensis, Arctostaphylos patula, Chamaebatiaria millefolium, Ephedra viridis, Gutierrezia sarothrae, Quercus gambelii* (<5% cover), or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (<5% cover) with scattered perennial forbs.

DISTRIBUTION
Natural Bridges National Monument
This association is scattered and limited to specific sites in the monument, including slickrock exposures near the east entrance and the southern boundary.

Globally
This woodland association occurs in the Colorado Plateau region of central Arizona, western New Mexico, southwestern Colorado, and southern Utah.

ENVIRONMENTAL DESCRIPTION
Natural Bridges National Monument
This woodland association occurs in scattered sites around the margins of the monument, in shallow washes as well as on fractured Cedar Mesa slickrock. Stands occur on gentle slopes (not exceeding 3 degrees) with a west aspect between 1871 and 2013 m elevation. Bare soil (60-70%) and litter (10-20%) cover most of the unvegetated surface. Soils are shallow, rapidly drained sandy loams derived from Cedar Mesa sandstone and eolian silt deposits.

Globally
This woodland occurs on the Colorado Plateau of southern Utah and Colorado south to central Arizona, on dry canyon rims, ridges, hills, benches, mesas and occasionally in intermittent drainages. Elevations range from 1400 to 2165 m (4600-7100 feet). Stands typically occur on gentle to moderately steep slopes on all aspects, but range from flat to steep slopes (0-30%). Soils are generally shallow and rocky, ranging in texture from sand in most stands to clay loam or sandy clay. Exposed sandstone or limestone bedrock and bare soil have high cover, and woody plants are generally rooted in cracks and joints in bedrock. A minority of stands may also occur on shale slopes covered by sandstone colluvium. Parent materials are variable and include sandstones and shale of the Moab Tongue of the Curtis Formation, Kayenta Formation, Moenkopi Formation, Morrison Formation, Cedar Mesa sandstone and eolian silt deposits.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This woodland association is locally common within the park, especially around the margins. Total vegetation cover is about 20% in these sparsely vegetated stands. The canopy is open (around 10% cover); *Pinus edulis* and *Juniperus osteosperma* trees are codominant. *Purshia stansburiana* is the dominant species in a scattered shrub layer with around 5% cover. Other shrubs are generally present with lesser cover, including *Artemisia tridentata* ssp. *wyomingensis, Ephedra viridis, Amelanchier utahensis*, and *Artemisia bigelovii*. Sparse, scattered forbs may be present, never with more than trace cover, including *Lepidium montanum, Packera multilobata* (= *Senecio multilobatus*), *Cryptantha flava*, and *Petradoria pumila*.

Globally
This woodland association is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. *Purshia stansburiana* dominates or codominates the sparse to moderately dense short-shrub layer, often with *Artemisia tridentata* in the northern part of its range. Total vegetation cover can vary from 12% to more than 65%, with tree canopy sometimes falling below 10% cover in very open stands. *Cercocarpus montanus* and *Purshia tridentata* are scarce or absent. Other shrubs may be present, including *Amelanchier utahensis, Arctostaphylos patula, Artemisia bigelovii, Artemisia nova, Artemisia tridentata, Chamaebatiaria millefolium, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Fraxinus anomala, Gutierrezia sarothrae, Quercus gambelii* (<5% cover), *Rhus trilobata, Shepherdia rotundifolia, Symphoricarpos longiflorus*, or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Aristida purpurea, Bouteloua curtipendula, Bouteloua gracilis, Bouteloua hirsuta, Elymus elymoides, Hesperostipa comata, Hesperostipa neomexicana, Koeleria macrantha, Poa fendleriana, Pleuraphis jamesii*, and *Schizachyrium scoparium*. Forbs may include *Artemisia ludoviciana, Artemisia frigida, Calliandra humilis, Descurainia pinnata, Eriogonum ovalifolium, Lappula occidentalis, Oenothera pallida*, and *Penstemon linarioides*.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	**Species**
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Purshia stansburiana*

Global

Stratum	**Species**
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Purshia stansburiana*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Bromus tectorum, Descurainia pinnata, Erodium cicutarium

CONSERVATION STATUS RANK
Global Rank & Reasons: G4? (1-Feb-1996).

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
The global name of this association was changed on 2001-09-04 because of a taxonomic change of the nominal species. *Purshia mexicana* var. *stansburiana* (Torr.) Welsh is now recognized as *Purshia stansburiana* (Torr.) Henrickson (Kartesz 1999). *Purshia mexicana* (D. Don) Henrickson, a closely related species, occurs in Chihuahua, Durango and Zacateca, Mexico, and possibly extreme southern Arizona, and is not known to be present in this association (Cronquist et al. 1997).

This association appears to be part of a continuum of Colorado Plateau woodland communities growing on fractured sandstone. Stands where *Purshia stansburiana* is the dominant understory shrub are less common than those in which it is a component of a mixed shrub understory that includes *Cercocarpus montanus, Amelanchier utahensis*, and Cercocarpus intricatus in mesic stands, or *Coleogyne ramosissima* and *Yucca* spp. in xeric stands. An analysis of the woodland data from four parks (Colorado, Arches, Natural Bridges, Canyonlands) confirmed that *Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland (CEGL000782) is a valid association but not always easy to distinguish from more mixed-shrub woodlands in the field.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: This association occurs in small stands scattered on the margins of the monument. It is not clear why *Purshia stansburiana* dominates these stands and yet is minor or absent from other woodlands on shallow soils.
Natural Bridges National Monument Plots: The description is based on field data collected in 2004 during accuracy assessment (4 plots: NABR_AA.154, NABR_AA.161, NABR_AA.165, NABR_AA.284).
Local Description Authors: J. Coles
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: BIA 1979, Baker 1980a, Baker 1984a, Bourgeron and Engelking 1994, Britton and Wright 1983, CONHP unpubl. data 2003, Cogan et al. 2004, Cronquist et al. 1997, Driscoll et al. 1984, Isaacson 1967, Kartesz 1999, Larson and Moir 1987, Moir and Carleton 1987, Northcutt 1978, Stuever and Hayden 1997a, USFS 1982, USFS 1985c, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia Woodland
Two-needle Pinyon - Utah Juniper / Roundleaf Buffaloberry Woodland

CODE	CEGL002335
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)

ALLIANCE	PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association occurs in two distinct situations: At Natural Bridges National Monument and Capitol Reef National Park, stands of this type occupy rolling uplands on eolian, alluvial or residual red sandy silt soils, often in a mosaic with *Pinus edulis - Juniperus* spp. / *Artemisia tridentata* (ssp. *wyomingensis*, ssp. *vaseyana*) Woodland (CEGL000776) and *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland (CEGL002148). In addition, at Capitol Reef and Canyonlands national parks, stands occur on warm, dry, moderately steep lower slopes where sandstone colluvium overlies slopes of Chinle or Organ Rock shales. Elevations range from 1445 to 2273 m (4740-7460 feet). Soils vary depending on substrate, including sandy loams, sandy clays, and silt loams. This woodland association is locally common in the Colorado Plateau of southern Utah. Total vegetation cover ranges between 15 and 80%. *Juniperus osteosperma* and Pinus edulis form a canopy 2-5 m tall and with 10-60% cover. The understory is characterized by a shrub layer dominated by *Shepherdia rotundifolia*. Other shrubs present may include *Artemisia tridentata* ssp. *wyomingensis*, *Mahonia fremontii*, *Artemisia nova*, and *Gutierrezia sarothrae*. Herbaceous species generally have low total cover and vary from site to site. Cryptobiotic soils may have significant cover in sites derived from loess.

DISTRIBUTION

Natural Bridges National Monument

This association is distributed primarily at the higher elevations within the monument, on undulating uplands adjacent to the monument loop road and north of the sewage disposal pond.

Globally

This association has been documented from southern Utah. It may also occur in northern New Mexico within the range of *Shepherdia rotundifolia*.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This woodland association was observed on undulating topography with small ravines. Sites are gentle to moderately steep (2- to 15-degree slopes), occur between 1883 and 1991 m elevation, and are oriented to western and northwestern aspects. The unvegetated surface has low to moderate cover of litter and moderate to high cover of bare soil. The parent material is Cedar Mesa sandstone and eolian loess derived from Chinle and Organ Rock shales. Soils are rapidly drained silt loam.

Globally

This association occurs in two distinct situations: (1) At Natural Bridges National Monument and Capitol Reef National Park, stands of this type occupy rolling uplands on eolian, alluvial or residual red sandy silt soils, often in a mosaic with *Pinus edulis - Juniperus* spp. / *Artemisia tridentata* (ssp. *wyomingensis*, ssp. *vaseyana*) Woodland (CEGL000776) and *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland (CEGL002148). (2) In addition, at Capitol Reef and Canyonlands national parks, stands occur on warm, dry, moderately steep lower slopes where sandstone colluvium overlies slopes of Chinle or Organ Rock shales. Elevations range from 1445 to 2273 m (4740-7460 feet). Because this is a relatively xeric woodland, bare soil and rocks may cover up to 70% of the unvegetated surface. Soils vary depending on substrate, including sandy loams, sandy clays, and silt loams.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This pinyon-juniper / roundleaf buffaloberry woodland association is uncommon, occupying deep, fine-textured soils away from the canyon rims within the monument. The total vegetation cover ranges from 15 to 60% in these sparsely to moderately vegetated stands. This woodland association is characterized by an open tree canopy, typically 2-5 m tall, of *Juniperus osteosperma* and *Pinus edulis* trees that range in cover from 5 to 25% and 5 to 15%, respectively. The characteristic tall shrub *Shepherdia rotundifolia* provides low cover of 5 to 15%. No other shrub has more than 5% cover, but *Gutierrezia sarothrae* is consistently at low cover. Herbaceous species are present with trace cover but without consistent species. Cryptogam cover is usually low but can be as high as 35%.

Globally
This woodland association is locally common in the Colorado Plateau of southern Utah. Total vegetation cover ranges between 15 and 80%. *Juniperus osteosperma* and *Pinus edulis* form a canopy 2-5 m tall and with 10-60% cover. The understory is characterized by a shrub layer dominated by *Shepherdia rotundifolia*. Other shrubs present may include *Artemisia tridentata* ssp. *wyomingensis, Mahonia fremontii, Artemisia nova,* and *Gutierrezia sarothrae*. Herbaceous species generally have low total cover and vary from site to site. Cryptobiotic soils may have significant cover in sites derived from loess.

MOST ABUNDANT SPECIES
Natural Bridges National Monument

Stratum	**Species**
Tree canopy	*Juniperus osteosperma, Pinus edulis*

Global

Stratum	**Species**
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Shepherdia rotundifolia*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jan-2005).

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: Undulating topography with deep, fine-textured soils and erosion channels are common to this type. The understory must have at least 5% cover of *Shepherdia rotundifolia* and less than 5% cover of any other shrub or grass species.
Natural Bridges National Monument Plots: The description is based on 2003 field data (one plot: NABR.0017 and one observation point: NABR.9072).
Local Description Authors: J. Von Loh, mod. J. Coles

Global Description Authors: J. Coles

REFERENCES: Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland
Two-needle Pinyon - Utah Juniper / Sparse Understory Woodland

CODE	CEGL002148
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516)
	Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Great Basin Pinyon-Juniper Woodland (CES304.773)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This variable woodland association is widespread in parts of western Colorado and eastern Utah. It is found most commonly on mid- to upper slopes, though other topographic positions are possible. It has been sampled at elevations between 1354 and 2389 m and on all aspects. At higher elevations, it tends toward southwestern aspects. Sites range from flat to moderately steep. The ground has variable amounts of litter and often has moderate to high amounts of gravel, rocks, and exposed bedrock. Cryptogamic cover is usually low to moderate, but some sites have up to 55-65% cover. Soils are always rapidly drained to moderately well-drained. Parent materials are also highly variable and can be sandstones, shales, or limestones. The lack of an understory may be due to high rock cover, low soil moisture, or a closed evergreen canopy of pinyon and juniper. This widespread association occurs as relatively sparse to moderately vegetated stands with total vegetation cover ranging from 10-75%. Sparsely vegetated stands (<10% total vegetation cover) composed of only trees are included as a best fit in this woodland association in extremely dry, rocky portions of the Colorado Plateau. The tree canopy is dominated by *Pinus edulis* and *Juniperus osteosperma*. Both typically range from 1-35% cover with some stands having canopy cover by one species up to 50%. The tree canopy is short, usually 2-10 m tall, and open to moderately closed. *Fraxinus anomala* has been observed in the canopy of some stands but always at no more than 5% cover. Several shrub species are commonly found in this association, but they occur as widely scattered individuals or an open shrub stratum. Scattered small *Pinus edulis* and *Juniperus osteosperma* are found along with shrubs such as *Amelanchier utahensis, Artemisia tridentata* ssp. *wyomingensis, Cercocarpus montanus, Ephedra viridis, Eriogonum microthecum, Shepherdia rotundifolia,* and *Opuntia* spp. The herbaceous layer is low in cover (<5%) and usually low in diversity. *Achnatherum hymenoides, Bouteloua gracilis, Bromus tectorum, Poa fendleriana,* and *Pleuraphis jamesii* are common graminoids. Forbs are not abundant, but typical species include *Descurainia pinnata, Cryptantha* spp., and *Tetraneuris acaulis.*

DISTRIBUTION

Natural Bridges National Monument

This association occurs commonly throughout the upland areas of the monument.

Globally

This association is known to occur in western Colorado and eastern Utah.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This woodland association was observed on the undulating surfaces of mesas, plateaus and benches. Sites are flat to moderately steep (0- to 11-degree slopes), occur between 1870 and 1997 m elevation, and include all aspects. The unvegetated surface has low to moderate cover of litter and low to high exposure of bare soil. Cryptogam cover is variable but can be as high as 65%. Parent materials are Cedar Mesa sandstone and Organ Rock shale that have eroded and been redistributed by wind and water. Soils are rapidly drained to moderately well-drained silt loams and sandy loams.

Globally

his woodland association is found most commonly on mid- to upper slopes, though other topographic positions are possible, such as valley floors, plateaus, colluvial slopes, hills, canyon rims, canyon sides, mesas, plains, and benches.. It has been sampled at elevations between 1354 and 2389 m and on all aspects. At higher elevations, such as in Black Canyon of the Gunnison National Park it tends toward southwestern aspects. Sites range from flat to moderately steep (0-25 degrees). The ground has variable amounts of litter and often has moderate to high amounts of gravel, rocks, and exposed bedrock. Cryptogamic cover is usually low to moderate, but some sites have up to 55-65% cover. Soils vary in texture and can be loamy sand, silts, loams or silty clay but are always rapidly drained to moderately well-drained. Parent materials are also highly variable and can be sandstones, shales, limestones, among others.

VEGETATION DESCRIPTION

Natural Bridges National Monument

This pinyon-juniper woodland association is widely distributed throughout the monument. The total vegetation cover ranges from 1 to 55% in these sparsely to moderately vegetated stands. This woodland association is characterized by an open canopy, typically 2-5 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees that range in cover from <1 to 25% and 1 to 35%, respectively. The understory lacks a developed shrub or herbaceous layer but usually contains a number of species with low cover. Scattered shrubs may include *Amelanchier utahensis, Shepherdia rotundifolia, Artemisia tridentata* ssp. *wyomingensis, Ephedra viridis, Mahonia fremontii, Symphoricarpos longiflorus, Yucca harrimaniae*, and *Gutierrezia sarothrae*. The herbaceous layer is low in diversity and is sparse, often much less than 5% total cover. Typical herbaceous species include *Petradoria pumila, Hymenopappus filifolius, Tetraneuris acaulis* (= *Hymenoxys acaulis*), *Senecio integerrimus*, and *Pleuraphis jamesii*. *Pinus edulis* and *Juniperus osteosperma* seedlings are sometimes present. The parasite *Arceuthobium divaricatum* is present in one stand. Cryptogam cover is variable, with many stands having very little, but occasionally cover can be as high as 65%.

Globally

This widespread pinyon-juniper woodland association occurs as relatively sparse to moderately vegetated stands with total vegetation cover ranging from 10-75%. Sparsely vegetated stands (<10% total vegetation cover) composed of only trees are included as a best fit in this woodland association in extremely dry, rocky portions of the Colorado Plateau. The tree canopy is dominated by *Pinus edulis* and *Juniperus osteosperma*. Both typically range from 1-35% cover with some stands having canopy cover by one species up to 50%. The tree canopy is short, usually 2-10 m tall, and open to moderately closed. *Fraxinus anomala* has been observed in the canopy of some stands at Colorado National Monument but always at no more than 5% cover. Several shrub species are commonly found in this association, but they occur as widely scattered individuals or an open shrub stratum. Scattered small Pinus edulis and *Juniperus osteosperma* are found along with shrubs such as *Amelanchier utahensis, Artemisia bigelovii, Artemisia tridentata* ssp. *wyomingensis, Cercocarpus montanus, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra viridis, Eriogonum microthecum, Gutierrezia sarothrae, Shepherdia rotundifolia, Symphoricarpos longiflorus*, and *Opuntia* spp., usually *Opuntia fragilis* or *Opuntia polyacantha*. The

herbaceous layer is low in cover (<5%) and usually low in diversity. *Achnatherum hymenoides, Bouteloua gracilis, Bromus tectorum, Poa fendleriana,* and *Pleuraphis jamesii* are common graminoids. Forbs are not abundant, but typical species include *Descurainia pinnata, Cryptantha* spp., and *Tetraneuris acaulis.*

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma*

Global

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*

OTHER NOTEWORTHY SPECIES

Natural Bridges National Monument
Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (15-Dec-2004).

CLASSIFICATION COMMENTS

Natural Bridges National Monument
Data are not available.

Globally
Environmental and physiognomic variability within this association is high. There are few consistent understory species across all parks, but that is part of the concept of this type. The general sparseness of the understory is one of the main diagnostic features. Because of the wide range of circumstances that result in a sparse understory, a lot of variability in the floristic components of the understory is allowed. It is possible that this type will be split into several associations based on environmental factors, since floristic factors are not diagnostic. On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%, and they are considered a variation of the woodland type because of the ecological values of the trees.

CLASSIFICATION CONFIDENCE: 1 – Strong

ELEMENT SOURCES

Natural Bridges National Monument Inventory Notes: This association occupies a variety of substrates from eolian deposits to exposed bedrock. The woodland may be stunted and have sparse to low canopy cover or may be quite tall with moderate canopy cover. Neither shrub nor herbaceous layers have more than 5% cover.
Natural Bridges National Monument Plots: The description is based on 2003 and 2004 field data (23 plots: NABR.0018, NABR.0020, NABR.0022, NABR.0023, NABR.0024, NABR.0053, NABR.0054, NABR.0055, NABR.0056, NABR.0057, NABR.0061, NABR.0064, NABR.0065, NABR.0066, NABR.0116, NABR.0118, NABR.0120, NABR.0126, NABR.0300, NABR.0302, NABR.0308, NABR.0309, NABR.0312; and 2 observation points: NABR.9071, NABR.9102).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: J. Drake, mod. J. Coles and K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Pinus edulis - Juniperus spp. / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland
Two-needle Pinyon - Juniper species / (Wyoming Big Sagebrush, Mountain Big Sagebrush) Woodland

CODE	CEGL000776
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Southern Rocky Mountain Pinyon-Juniper Woodland (CES306.835)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This broadly defined woodland association is common in the Colorado Plateau but also occurs on dry foothills and mesas from north-central New Mexico and southern Colorado west to the eastern Mojave Desert, in extreme northwestern Colorado and adjacent Utah. Elevations range from 1465 to 2500 m (4800-8200 feet). Stands occur most often on flat to gentle slopes on all aspects. The soils are generally poorly developed, moderately deep to deep, well-drained to rapidly drained loams and sands. Ground cover is variable; bare soil is common, but bedrock, litter, and large or small rocks can also be abundant on some sites. Parent material includes sandstone and shale. The vegetation is characterized by a typically open tree canopy (10-30% cover but ranges up to 50% cover) that is codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus osteosperma* is common from northwestern New Mexico west and north into Arizona and Utah. *Juniperus scopulorum* is more common in higher elevation stands. *Artemisia tridentata* (either ssp. *vaseyana* or ssp. *wyomingensis* depending on location) strongly dominates the sparse to moderately dense short-shrub layer (10-35% cover). *Purshia stansburiana* is typically absent or scarce. Other shrubs present may include *Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus, Ephedra viridis, Gutierrezia sarothrae, Quercus gambelii* (typically <5% cover), or species of *Yucca* and *Opuntia*. Herbaceous cover is variable but generally sparse and dominated by graminoids (<5% cover) with scattered forbs.

DISTRIBUTION

Natural Bridges National Monument

This association was sampled near Owachomo Bridge, near the monument entrance, north of the Visitor Center, west of Tuwa Canyon, and along the loop road.

Globally

This woodland association is common on the Colorado Plateau, occurring from north-central New Mexico and southern Colorado west to the Mogollon Rim of Arizona and the eastern Mojave Desert, and in extreme northwestern Colorado and adjacent Utah.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This woodland association was observed growing on undulating eolian deposits of ridges, mesas, and hillsides. Sites are typically flat or on gentle slopes, occur between 1875 and 2026 m elevation, and include southwest to northwest aspects. The unvegetated surface has low to moderate cover of litter and moderate to high exposure of bare soil. Cryptogam cover is sparse. Downed wood may have as much as 10% cover. Parent materials are fine-textured sediments of eolian origin. Soils are rapidly drained to moderately well-drained silt loams, clay loams, and sandy loams.

Globally
This broadly defined woodland association occurs on dry foothills and mesas across much of the Colorado Plateau and adjacent areas. Elevations range from 1459 to 2502 m. Stands occur most often on flat to gentle slopes but can be found on moderate to moderately steep slopes on all aspects. The soils are often deep, generally poorly developed, skeletal, moderately well-drained to rapidly drained loams and sands. Ground cover varies; bare soil is common, but bedrock, litter, and large or small rocks can also be abundant on some sites. Parent material includes sandstone and shale.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This pinyon-juniper / Wyoming big sagebrush woodland association is uncommon within the monument, occurring on mesa tops, hill slopes, and ridges. The total vegetation cover ranges from 8 to 60% in these stands, including some sparse, tree-dominated stands from extremely dry, rocky sites placed into this woodland association as a best fit. This woodland association is characterized by an open canopy, typically 2-10 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees that range in cover from 1 to 25% and 1 to 45%, respectively, and by the short shrub *Artemisia tridentata* ssp. *wyomingensis* that ranges in cover from 1 to 15%. *Shepherdia rotundifolia* and *Ephedra viridis* are consistently present with 1-5% cover. A diversity of herbaceous species is usually present, but there is little consistency among plots, and total herbaceous cover is rarely more than 2%. Cryptogam cover is variable, with some stands having little, others as much as 15%.

Globally
This woodland is characterized by a typically open tree canopy (usually 10-30% cover but ranges up to 50% cover) that ranges from 2 to 10 m tall in most stands. The tree canopy is codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus osteosperma* is common in stands reported from northwestern New Mexico, western Colorado, Arizona and Utah. *Juniperus scopulorum* is more common in higher elevation stands. *Artemisia tridentata* strongly dominates the relatively sparse to moderately dense short-shrub layer (10-35% cover); either ssp. *vaseyana* or ssp. *wyomingensis* may be present, with ssp. vaseyana being more characteristic of higher elevations or more mesic conditions. *Purshia stansburiana* is typically absent or scarce. Other shrubs present may include *Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus, Ephedra viridis, Gutierrezia sarothrae, Quercus gambelii* (typically <5% cover), or species of *Yucca* and *Opuntia*. Herbaceous cover is variable but is generally sparse and dominated by graminoids (<5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Bouteloua gracilis, Carex filifolia, Hesperostipa comata, Koeleria macrantha, Muhlenbergia torreyi, Pascopyrum smithii, Pleuraphis jamesii,* and *Poa fendleriana*. Forbs include species of *Cryptantha, Eriogonum, Penstemon,* and *Phlox*. Cryptogram cover tends to be low, but some stands may have moderate cover.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Shepherdia rotundifolia*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*

Global

Stratum	**Species**
Tree canopy	*Juniperus monosperma, Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

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

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands may be similar to open *Artemisia tridentata* shrublands with scattered pinyon and juniper trees but is considered to be a variation of the woodland type because of the ecological values of the trees.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: This is predominantly a community of deep undulating eolian deposits somewhat dissected by small drainages and narrow erosional channels. It supports stands of *Pinus edulis* and *Juniperus osteosperma* trees where *Artemisia tridentata* ssp. *wyomingensis* has persisted in the understory.
Natural Bridges National Monument Plots: The description is based on 2003 and 2004 field data (7 plots: NABR.0015, NABR.0019, NABR.0052, NABR.0060, NABR.0303, NABR.0305, NABR.0310, and 1 observation point: NABR.9005).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles

REFERENCES: Bourgeron and Engelking 1994, Bunting 1987, CONHP unpubl. data 2003, Cogan et al. 2004, Dick-Peddie 1993, Driscoll et al. 1984, Erdman 1970, Everett 1987, Heinze et al. 1962, Isaacson 1967, Jameson et al. 1962, Johnston 1987, Larson and Moir 1987, Mason et al. 1967, Moir and Carleton 1987, NVNHP 2003, Stuever and Hayden 1997a, Tiedemann 1978, USFS 1983a, USFS 1985a, USFS 1985e, Warren et al. 1982, Western Ecology Working Group n.d., Wright et al. 1979

Pinus edulis - Juniperus spp. / Cercocarpus montanus - Mixed Shrubs Woodland
Two-needle Pinyon - Juniper species / Mountain-mahogany - Mixed Shrubs Woodland

CODE	CEGL000780
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)

ALLIANCE — PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516)
Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Southern Rocky Mountain Pinyon-Juniper Woodland (CES306.835)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This broadly defined woodland association is common on the Colorado Plateau, occurring on sheltered colluvial slopes, sandstone hogbacks, dry foothills and mesas from north-central New Mexico and southern Colorado west to the Mogollon Rim of Arizona, and in western Colorado and adjacent Utah. It can be found on any slope position, though lower slopes are less common. Elevations range from 1472 to 2480 m (4830-8135 feet). Stands occur on gentle to steep slopes on all aspects. The soils are variable but generally shallow, poorly developed and skeletal, ranging from clayey marl to loamy sands. The unvegetated surface is characterized by bedrock, large and small rocks, and/or bare soil with little litter. Sandstone or shale are the most common parent materials. This association is characterized by an open to moderately dense tree canopy (10-60% cover) dominated by a combination of *Pinus edulis* and *Juniperus* spp. with a shrub layer dominated by *Cercocarpus montanus*. The tree canopy averages 2-5 m tall, but some stands may be as tall as 10 m. *Pinus edulis* and *Juniperus* spp. codominate in most stands, but sometimes one may be more prevalent than the other. The species of *Juniperus* varies with geography and elevation and includes *Juniperus deppeana, Juniperus monosperma, Juniperus osteosperma,* and *Juniperus scopulorum*. The total shrub cover may range from sparse to moderate. *Cercocarpus montanus* is the dominant shrub with up to 35% cover. It typically occurs as a short shrub but can be a tall shrub on some sites. Other shrubs may be present, including *Amelanchier* spp., *Artemisia bigelovii, Artemisia tridentata, Ephedra viridis, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Fendlera rupicola, Garrya ovata, Mahonia* spp., *Nolina microcarpa, Quercus gambelii, Quercus grisea, Rhus trilobata,* or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, and generally dominated by graminoids (>5% cover) with scattered forbs. Extremely open stands of this association, usually occurring on fractured slickrock exposures, may have as little as 5% total vegetation cover and an upper canopy only 2 m tall.

DISTRIBUTION

Natural Bridges National Monument

This association is best developed on sandstone ledges near the rims of the major canyons and their tributaries. It was sampled at the old entrance/White Canyon overlook, 1.2 km north of The Shoe in Armstrong Canyon, near Horse Collar Ruin, and just north of Tuwa Canyon.

Globally

This widespread woodland association is found from southern Colorado and north-central New Mexico to the Mogollon Rim of Arizona, north across the Colorado Plateau into western Colorado and adjacent Utah.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This woodland association was observed on canyon rims and upper slopes with exposed bedrock or mantled by talus. Sites are relatively gentle to steep (6- to 35-degree slopes) and between 1762 and 1937 m elevation. The unvegetated surface has low cover of litter and low to high exposure of bare soil. Some sites have moderate cover of large and small rocks. Cryptogams may be sparse to moderate in cover. Parent materials are Cedar Mesa sandstones that have weathered to form thin soils or broken into rocks and boulders onto talus slopes. Patches of Organ Rock shale overlie the Cedar Mesa sandstone on some sites. Soils are rapidly drained sandy loams and silt loams.

Globally
This broadly defined woodland association is common on the Colorado Plateau, occurring on sheltered colluvial slopes, sandstone hogbacks, dry foothills and mesas. It can be found on any slope position (upper, middle, or lower), though lower slopes are the least common. Elevations range from 1472 to 2480 m (4830-8135 feet). Stands occur on gentle to steep (3- to 36-degree) slopes on all aspects. The soils are variable but generally shallow, poorly developed and skeletal, ranging from clayey marl to loamy sands. The unvegetated surface is characterized by bedrock, large and small rocks, and/or bare soil. Litter has low cover. Parent materials are often sandstone or shale, but others are possible.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This pinyon-juniper / mountain-mahogany woodland association is uncommon, occupying small patches on canyon rims and talus slopes in the monument. The total vegetation cover ranges from 10 to 125% in these sparsely to densely vegetated stands. This woodland association is characterized by an open tree canopy, typically 2-5 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees that range in cover from 1 to 25% and 1 to 15%, respectively. The characteristic tall shrub *Cercocarpus montanus* ranges in cover from 1 to 35%. The shrub layer is somewhat diverse and provides low to moderate cover. Additional tall shrubs present include *Amelanchier utahensis* and *Fraxinus anomala*. Short and dwarf-shrubs, including succulents, have relatively low diversity and provide low cover, including *Ephedra viridis, Glossopetalon spinescens* var. *meionandrum* (= *Forsellesia meionandra*), and *Mahonia fremontii*. Graminoids provide sparse cover and include the bunch grasses *Achnatherum hymenoides* and *Leymus salinus*. Forbs are diverse but provide sparse cover, including *Stenotus armerioides* (= *Haplopappus armerioides*), *Machaeranthera grindelioides, Petradoria pumila*, and *Packera multilobata* (= *Senecio multilobatus*). *Pinus edulis* and *Juniperus osteosperma* seedlings are scattered in most stands. Cryptogams can provide up to 35% cover.

Globally
This association is characterized by an open to moderately dense tree canopy (10-60% cover) dominated by a combination of *Pinus edulis* and *Juniperus* spp. The canopy averages 2-5 m tall, but some stands may be as tall as 10 m. *Pinus edulis* and *Juniperus* spp. codominate in most stands, but sometimes one may be more prevalent than the other. *Pinus edulis* and *Juniperus* spp. are also present as smaller individuals in the shrub and field strata. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus deppeana* is common in southern New Mexico, and *Juniperus osteosperma* is common from northwestern New Mexico west into Arizona and north into western Colorado and Utah. *Juniperus scopulorum* is more common in higher elevation stands. The total shrub cover may range from sparse to moderate. *Cercocarpus montanus* is the dominant shrub with 1-35% cover. It typically occurs as a short shrub <2 m tall but can be a tall shrub (2-5 m) on some sites. Other shrubs may be present, including *Amelanchier* spp., *Artemisia bigelovii, Artemisia tridentata, Ephedra viridis, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Fendlera rupicola, Fraxinus anomala, Garrya ovata, Mahonia* spp., *Nolina microcarpa, Purshia stansburiana, Quercus gambelii* (<5% cover), *Quercus grisea, Rhus trilobata, Symphoricarpos oreophilus*, or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, and generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Andropogon gerardii, Aristida purpurea, Bouteloua curtipendula, Bouteloua gracilis, Bouteloua hirsuta, Carex rossii, Hesperostipa comata, Koeleria macrantha, Leymus salinus* (= *Elymus salinus*), *Muhlenbergia pauciflora, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana, Pseudoroegneria spicata*, and *Schizachyrium scoparium.* Common forbs include species of *Chamaesyce, Cryptantha, Eriogonum, Machaeranthera, Packera, Penstemon, Petradoria, Phlox*, and *Tetraneuris*. Extremely open stands of this association occurring on

exposed and fractured slickrock may have as little as 5% total vegetation cover and an upper canopy only 2 m tall. Biological soil crusts are patchy but may contribute up to 27% cover and are generally well-developed.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Cercocarpus montanus*
Short shrub/sapling	*Ephedra viridis*

Global

Stratum	Species
Tree canopy	*Juniperus monosperma, Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Cercocarpus montanus*

OTHER NOTEWORTHY SPECIES

Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Natural Bridges National Monument
Data are not available.

Globally
This is a widely distributed and variable association, found throughout much of the Colorado Plateau, edges of the Colorado Rockies and south into New Mexico. On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands may be similar to open Cercocarpus montanus shrublands with scattered pinyon and juniper trees but is considered to be a variation of the woodland type because of the ecological values of the trees.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Natural Bridges National Monument Inventory Notes: Stands are recognizable by the dominance or codominance of *Cercocarpus montanus* in the shrub layer. Many other shrubs may be present to codominant. If *Cercocarpus intricatus* is present, it has less than 5% cover.
Natural Bridges National Monument Plots: The description is based on 2003 and 2004 field data (4 plots: NABR.0014, NABR.0106, NABR.0304, NABR.0311).
Local Description Authors: A. Buechling, mod. J. Von Loh and J. Coles
Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles

REFERENCES: Baker 1983b, Baker 1984a, Baker and Kennedy 1985, Bourgeron and Engelking 1994, Bradley et al. 1992, CONHP unpubl. data 2003, Cogan et al. 2004, Driscoll et al. 1984, Erdman 1962, Erdman 1969, Hess and Wasser 1982, Isaacson 1967, Johnston 1987, Kennedy 1983a, Larson and Moir 1987, Marr et al. 1979, Medina 1986, Moir 1963, Moir and Carleton 1987, Moir and Ludwig 1979, Pase

and Lindenmuth 1971, Stuever and Hayden 1997a, USFS 1981a, USFS 1981b, USFS 1983a, USFS 1985d, USFS 1985e, USFS 1985g, Vories 1974, Western Ecology Working Group n.d., Wright et al. 1979

Pinus edulis - Juniperus spp. / Quercus gambelii Woodland
Two-needle Pinyon - Juniper species / Gambel Oak Woodland

CODE	CEGL000791
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Southern Rocky Mountain Pinyon-Juniper Woodland (CES306.835)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This widespread woodland association is known from the Colorado Plateau and southern Rocky Mountains, occurring from south-central Colorado to south-central New Mexico, west along the Mogollon Rim of Arizona, and north into Utah and western Colorado. Elevations normally range from 1509-2665 m but may be higher in stands in southern New Mexico. Sites are variable but generally are relatively mesic. Stands occur on flat to moderate slopes along drainages and on mesa tops, and on moderate to steep, rocky slopes of foothills, mountains and canyons, especially in draws where soil moisture is concentrated, or on northern aspects or where shaded by upper canyon walls. The soils are variable and range from deep to shallow, silty clay to sandy loam, and often gravelly. Litter from *Quercus gambelii* and other shrubs is often extensive (over 50% cover). The vegetation is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus deppeana* is common in southern New Mexico, and *Juniperus osteosperma* is common in northwestern New Mexico, northern Arizona and in Utah. *Juniperus scopulorum* is more common in higher elevation stands. An occasional *Pinus ponderosa* tree may be present in some stands. *Quercus gambelii* dominates the often patchy, moderately dense tall-shrub layer with at least 5% cover, but often over 25% cover. *Amelanchier utahensis, Cercocarpus montanus, Symphoricarpos oreophilus*, or species of *Yucca* and *Opuntia* are common shrub associates. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include Achnatherum hymenoides (= *Oryzopsis hymenoides*), *Bouteloua gracilis, Carex geyeri, Carex rossii, Elymus elymoides, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Poa fendleriana*, and *Schizachyrium scoparium*.

DISTRIBUTION

Natural Bridges National Monument

This association was sampled on the canyon floor near Owachomo Bridge.

Globally

This woodland association occurs in foothills and mesas from southern Colorado to south-central New Mexico, west along the Mogollon Rim of Arizona, and north into Utah and western Colorado.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This woodland association was observed at a single site on an old river terrace. The slope of the one occurrence is gentle (6 degrees), lies at 1797 m elevation, and is oriented to the northwest. The unvegetated surface cover is high for litter and low for bare soil and cover by downed wood. Parent material is Cedar Mesa sandstone, and the soil is a rapidly drained sandy loam.

Globally

This widespread woodland association is known from the Colorado Plateau and southern Rocky Mountains, occurring from south-central Colorado to south-central New Mexico, west along the Mogollon Rim of Arizona, and north into Utah and western Colorado. Elevations normally range from 1509-2665 m but may be higher in stands in southern New Mexico. Sites are variable but generally are relatively mesic. Stands occur on flat to moderate slopes along drainages and on mesa tops, and on moderate to steep, sometimes rocky slopes of foothills, mountains and canyons, especially in draws where soil moisture is concentrated, or on northern aspects or where shaded by upper canyon walls. Stands are less common on hot south-facing slopes, unless they are located in a moisture-concentrating gully. Soils are variable and range from deep to shallow, silty clay to sandy loam, and are often gravelly or rocky. Litter from Quercus gambelii and other shrubs is often extensive (over 50% cover). Parent materials include alluvial, colluvial or eolian deposits derived from sandstone, shale, limestone and rhyolite.

VEGETATION DESCRIPTION

Natural Bridges National Monument

This pinyon-juniper / Gambel oak woodland association is rarely found on canyon floors within the monument. The total vegetation cover ranges from 35 to 75% in these moderately to densely vegetated stands. This woodland association is characterized by an open tree canopy, typically 2-5 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees that range in cover from 5 to 15% and 1 to 5%, respectively; and the tall shrub *Quercus gambelii* that is 2-5 m tall and ranges from 25 to 35% cover. The remainder of the shrub layer is diverse in terms of composition but provides low cover. *Amelanchier utahensis* and *Symphoricarpos oreophilus* are the only shrubs that occur with more than 1% cover. The herbaceous layer provides less than 5% cover. A number of graminoids occur with low cover, of which *Poa fendleriana* is the dominant. The most conspicuous forb is *Pedicularis centranthera*. *Pinus edulis* seedlings provide sparse cover, and cryptogam cover is also sparse.

Globally

This widespread association is characterized by an open to moderately dense tree canopy (10-70% cover) codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus deppeana* is common in southern New Mexico, and *Juniperus osteosperma* is common in northwestern New Mexico, northern Arizona and in Utah. *Juniperus scopulorum* is more common in higher elevation stands. An occasional *Pinus ponderosa* tree may be present is some stands. *Quercus gambelii* dominates the often patchy, moderately dense tall-shrub layer with at least 5% cover, but often with more than 25% cover. *Amelanchier utahensis, Cercocarpus montanus, Symphoricarpos oreophilus,* or species of *Yucca* and *Opuntia* are common shrub associates. Other shrubs, depending on geography, may include *Artemisia tridentata, Artemisia nova, Arctostaphylos patula, Cercocarpus ledifolius, Ephedra viridis, Fendlera rupicola, Gutierrezia sarothrae, Garrya* spp., *Mahonia fremontii, Ptelea trifoliata, Prunus* spp., *Quercus X pauciloba, Robinia neomexicana,* or *Rosa* spp. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Bouteloua gracilis, Carex geyeri, Carex rossii, Elymus elymoides, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Poa fendleriana,* and *Schizachyrium scoparium*. Common forbs may include *Artemisia frigida, Balsamorhiza sagittata, Geranium caespitosum, Lepidium montanum, Machaeranthera grindelioides, Packera neomexicana, Thalictrum fendleri, Tetraneuris acaulis,* or *Vicia*

americana.

MOST ABUNDANT SPECIES
Natural Bridges National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*

Global

Stratum	Species
Tree canopy	*Juniperus monosperma, Juniperus osteosperma, Juniperus scopulorum, Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis, Quercus gambelii*
Tall shrub/sapling	*Cercocarpus montanus*
Short shrub/sapling	*Symphoricarpos oreophilus*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

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

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: Sites are associated with more mesic, deeper soils on an old stream terrace adjacent to a cliff.
Natural Bridges National Monument Plots: The description is based on 2003 field data (one plot: NABR.0313).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Bassett 1987, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Cogan et al. 2004, Driscoll et al. 1984, Harmon 1980, Hess and Wasser 1982, Holm 1927, Isaacson 1967, Johnston 1987, Kallender 1959, Larson and Moir 1987, Marr et al. 1973b, Muldavin et al. 1994a, Muldavin et al. 2000b, Steinhoff 1978, Stuever and Hayden 1997a, Vories 1974, Warren et al. 1982, Western Ecology Working Group n.d., Wright 1972, Wright et al. 1979

Populus deltoides (ssp. wislizeni, ssp. monilifera) / Artemisia tridentata Woodland (Rio Grande Cottonwood, Plains Cottonwood) / Basin Big Sagebrush Woodland

CODE	CEGL005966
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)

FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*POPULUS DELTOIDES* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.636) Eastern Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): North American Warm Desert Lower Montane Riparian Woodland and Shrubland (CES302.748)
North American Warm Desert Riparian Woodland and Shrubland (CES302.753)
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This mature riparian forest association is found in the San Juan River drainage in northwestern New Mexico and adjacent southeastern Utah. It is probably present in northeastern Arizona. It occurs along low-gradient rivers of wide lowland valleys at elevations from 1640 to 1840 m (5375-6025 feet). Stands are located on high terraces well above the active channel (discharge ratio >5), and flooding is infrequent (50- to 100-year recurrence intervals). Soils have coarse loamy profiles throughout and are mostly young and undeveloped Entisols, although Inceptisols can occur on higher terraces where soil development has not been disrupted by flooding. Mature *Populus deltoides* canopies are generally open, with *Juniperus scopulorum, Elaeagnus angustifolia*, and *Salix amygdaloides* in the subcanopy. The shrub layer is dominated by *Artemisia tridentata* with other upland species associates such as *Ericameria nauseosa* (= *Chrysothamnus nauseosus*) and *Rhus trilobata*. The presence of *Artemisia*, a common dominant from surrounding desert uplands, in these floodplain gallery forests is an indicator of infrequent flooding, perhaps because of regulated stream flows, or because the channel is actively cutting down or away from the forest. Grasses can be well-represented to abundant and are typically dominated by upland species, such as *Sporobolus cryptandrus* and *Achnatherum hymenoides* (= *Oryzopsis hymenoides*). Although a relatively dry type, some wetland indicator species still occasionally occur, such as *Schoenoplectus pungens* (= *Scirpus pungens*), *Distichlis spicata*, and *Muhlenbergia asperifolia*. Forbs are very scattered and low in diversity. As a keystone species, the reproduction of *Populus deltoides* after flooding (and sufficient subsequent base flows) is critical to the sustainability of this community.

DISTRIBUTION

Natural Bridges National Monument

This association occurs on high terraces on the floor of Armstrong Canyon, approximately 1500 m southeast of Owachomo Bridge.

Globally

This association is found in the San Juan River drainage in northwestern New Mexico, in adjacent southeastern Utah and is probably present in northeastern Arizona.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This woodland association was observed on high terraces in canyon bottoms. A single site was sampled. The site is on a gentle slope at 1799 m elevation. The unvegetated surface has high cover of litter and low cover of downed wood. Parent materials are colluvial Organ Rock and Moenkopi sediments that have deposited as new alluvium. Soils are a rapidly drained sandy loam derived from alluvium.

Globally

This mature riparian forest association is characteristic of high terraces along low-gradient rivers in

northwestern New Mexico, adjacent southeastern Utah and probably northeastern Arizona. It occurs in wide lowland valleys at elevations from 1640 to 1840 m (5375-6025 feet). Stands are located on terraces well above the active channel (discharge ratio >5). The water table is usually at least 3 m below ground surface, and flooding is infrequent to absent (minimum 50- to 100-year recurrence intervals). Soils have coarse loamy profiles throughout and are mostly young and undeveloped Entisols (Aquic and Typic Ustifluvents). Inceptisols can occur on higher terraces where soil development has not been disrupted by flooding (Fluventic Ustochrept).

VEGETATION DESCRIPTION

Natural Bridges National Monument

This Rio Grande cottonwood / Basin Big Sagebrush woodland association is rare, occupying terraces in canyons in the monument. The total vegetation cover exceeds 100% in this densely vegetated stand. This association is characterized by a tree canopy, typically 10-15 m tall, of *Populus deltoides* ssp. *wislizeni* trees with 40% cover. The shrub layer totals about 30% cover and is dominated by *Ericameria nauseosa* and *Artemisia tridentata* ssp. *tridentata*. There are scattered *Pinus edulis* and *Juniperus osteosperma* trees in the sparse subcanopy. The herbaceous layer is dominated by *Bromus tectorum* with 20% cover. Other herbaceous species present include *Poa fendleriana, Artemisia ludoviciana,* and *Heterotheca villosa*. The vine *Clematis ligusticifolia* provides sparse cover.

Globally

Mature Populus deltoides canopies are generally open (ranging between 30 and 60% cover) and from 10-20 m high, sometimes with a sparse subcanopy of *Juniperus scopulorum, Juniperus osteosperma, Elaeagnus angustifolia, Celtis laevigata* var. *reticulata,* and *Salix amygdaloides*. The shrub layer is dominated by *Artemisia tridentata* with other upland species such as *Ericameria nauseosa* (= *Chrysothamnus nauseosus*) and *Rhus trilobata*. Grasses can be well-represented to abundant and are typically dominated by upland species, such as *Sporobolus cryptandrus* and *Achnatherum hymenoides* (= *Oryzopsis hymenoides*). Although a relatively dry type, some wetland indicator species still occasionally occur, such as *Schoenoplectus pungens* (= *Scirpus pungens*), *Distichlis spicata,* and *Muhlenbergia asperifolia*. Forbs are very scattered and low in diversity (16 species), of which 75% (12 species) are native.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	Species
Tree canopy	*Populus deltoides* ssp. *wislizeni*
Tall shrub/sapling	*Ericameria nauseosa*
Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*

Global

Stratum	Species
Tree canopy	*Populus deltoides* ssp. *monilifera*, *Populus deltoides* ssp. *wislizeni*
Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*

OTHER NOTEWORTHY SPECIES

Natural Bridges National Monument

Bromus tectorum

Globally

Bromus tectorum, Tamarix chinensis

CONSERVATION STATUS RANK

Global Rank & Reasons: G2G3 (28-Sep-2004). This association has likely undergone significant declines in the San Juan River basin as a result of impoundments and subsequent river regulation along with

agricultural conversion and urban development. It requires low-gradient floodplain habitats in which natural hydrological processes are operational to ensure reproduction and maintenance of Populus deltoides and other key wetland species. Conditions such as these are now rare in river basins of the Southwest. Many extant occurrences are approaching senescence and loss without replacement due to the lack of natural floods. Others are declining because minimum in-stream base flows are not being maintained. In addition, many occurrences are significantly invaded by alien species. The rank of G2G3 was assigned with limited information; further documentation is desirable. However, the expectation is that this rank will be upheld and may be trending towards a rank of G2.

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
This type, although it lacks significant wetland indicators other than cottonwood, is often found in a mosaic with wetter forested and shrub wetland types than occur on lower floodplain terraces. It is ecologically similar to Populus deltoides / Ericameria nauseosa Forest (CEGL005969), but Artemisia tridentata has significantly higher cover than Ericameria nauseosa. Dick-Peddie (1993) refers to a Populus fremontii / Chrysothamnus nauseosus / Mesic Grass - Forb type as part of his Floodplain-Plains Riparian group, which may also be related.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: The site is elevated 2-3 m above the existing channel. Flooding is probably rare unless during exceptional events, such as occurred in the fall of 2003.
Natural Bridges National Monument Plots: The description is based on 2003 field data (one plot: NABR.0005).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: E. Muldavin et al., mod. J. Coles

REFERENCES: Dick-Peddie 1993, Muldavin et al. 2000a, Western Ecology Working Group n.d.

Populus deltoides (ssp. wislizeni, ssp. monilifera) / Pascopyrum smithii Woodland
(Rio Grande Cottonwood, Plains Cottonwood) / Western Wheatgrass Woodland

CODE	CEGL002680
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*POPULUS DELTOIDES* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.636) Eastern Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): Western Great Plains Wooded Draw and Ravine (CES303.680)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This association represents riparian woodlands on the Great Plains of eastern Wyoming, southeastern Utah and possibly eastern Montana, the western Dakotas and Nebraska. Stands have been documented in Wyoming from 1143 to 1387 m (3750-4550 feet) elevation, primarily along small streams (<50 feet

wide), on alluvial soils in a range of textural classes. The vegetation is simple in structure. *Populus deltoides* dominates a tree overstory that may consist of scattered large trees in old stands or of denser, small or -medium-sized trees in younger stands. Scattered shrubs may be present. The herbaceous undergrowth is composed of short or mid-height grasses and forbs; *Pascopyrum smithii* contributes as much canopy cover to the undergrowth as does any other native species. As with other *Populus deltoides* woodlands, stands of this association generally are early- to mid-seral; *Populus deltoides* seedlings become established on bare sediment bars laid down by flood waters, and trees in the even-aged overstory are not replaced by younger cottonwoods as they age and die. Several different *Populus deltoides* associations share a number of plant species in the herbaceous undergrowth (including *Pascopyrum smithii*), and this association contains the woodlands in which *Pascopyrum smithii* contributes at least as much cover as does any other native graminoid.

DISTRIBUTION

Natural Bridges National Monument
This association occurs in canyon bottoms on stream terraces and was sampled 200 m south of The Shoe.

Globally
This association has been described from eastern Wyoming, at elevations below about 1829 m (6000 feet). That range encompasses 23,279 square miles. A single stand was described from Natural Bridges National Monument in southeastern Utah. The possible extent of the range in eastern Montana, the western Dakotas and northwestern Nebraska, if any, is not included in this estimate.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument
This woodland association was observed on a low stream terrace in the canyon bottom. The one sampled site is on a gentle slope at 1761 m elevation. The unvegetated surface has high cover of litter. The soil is a rapidly drained loamy sand derived from alluvium.

Globally
Stands have been documented in Wyoming from 1143 to 1387 m (3750-4550 feet) elevation, primarily along small streams (<50 feet wide) (Jones 1998a, 1998b, Jones and Walford 1995). One site has been reported from the Colorado Plateau of southeast Utah, on a canyon floor at 1761 m (5777 feet). Soils where stands of this association grow are derived from alluvium and cover a range of textural classes. Plots in eastern Wyoming (Jones and Walford 1995), though, showed that genetic soil horizons beneath stands of this association belong to a broad range of textural classes, and clays are the most common.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This cottonwood / western wheatgrass woodland association is rare, occupying stream terraces within the monument. The total vegetation cover exceeds 100% in this densely vegetated stand. This woodland association is characterized by a clumped tree canopy (20% cover) and subcanopy (10% cover), typically 5-10 m tall (canopy) and 2-5 m tall (subcanopy), of P*opulus X acuminata* trees. There may be scattered shrubs of *Chrysothamnus linifolius, Opuntia polyacantha*, and *Yucca* spp., but no developed shrub layer. The herbaceous layer is overwhelmingly dominated by *Pascopyrum smithii*, sometimes with scattered individuals or small patches of *Achnatherum hymenoides, Hesperostipa comata*, or *Juncus balticus*. Forbs are sparse but diverse.

Globally
The vegetation is simple in structure. *Populus deltoides* or *Populus X acuminata* dominate a tree overstory that may consist of scattered large trees in old stands or of denser, small or -medium-sized trees in younger stands. Scattered shrubs may be present. The herbaceous undergrowth is composed of short or mid-height grasses and forbs; *Pascopyrum smithii* contributes as much canopy cover to the undergrowth

as does any other native species. *Populus* dominates the overstory and often is the only tree, but *Salix amygdaloides* is present in some stands and may dominate small areas. *Pascopyrum smithii* is as common as any other native graminoid, but other species may contribute substantial cover, chief among them Distichlis spicata (on fine-textured soils), *Sporobolus cryptandrus* (on sandy soils), *Koeleria macrantha*, and *Elymus lanceolatus* (Jones and Walford 1995). In many stands, the undergrowth is codominated or dominated by exotic grasses, principally *Bromus tectorum*, *Bromus commutatus*, and *Poa pratensis*. Shrubs generally contribute only trace cover, but *Artemisia cana* ssp. *cana* may be present in more than trace amounts. Several different *Populus deltoides* associations share a number of plant species in the herbaceous undergrowth (including *Pascopyrum smithii*), and this association contains the woodlands in which *Pascopyrum smithii* contributes at least as much cover as does any other native graminoid.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	**Species**
Tree canopy	*Populus* x *acuminata*
Tree subcanopy	*Populus* x *acuminata*
Herb (field)	*Pascopyrum smithii*

Global

Stratum	**Species**
Tree canopy	*Populus deltoides* ssp. *monilifera*, *Populus deltoides* ssp. *wislizeni*
Tree subcanopy	*Populus* x *acuminata*
Herb (field)	*Distichlis spicata*, *Pascopyrum smithii*, *Sporobolus cryptandrus*

OTHER NOTEWORTHY SPECIES

Natural Bridges National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (27-Sep-2004). The G3 rank is based on (1) the assumption that this association occurs only in riparian zones on the Great Plains of eastern Wyoming and Montana and, perhaps, the western Dakotas and northwestern Nebraska, (2) the assumption that occurrences larger than a few hundred square meters are uncommon, and (3) the knowledge that occurrences of this association are highly susceptible to changes in flood regime and to invasion by exotics.

CLASSIFICATION COMMENTS

Natural Bridges National Monument

Data are not available.

Globally

The dominance or codominance of *Pascopyrum smithii* in the undergrowth sets this association apart from other *Populus deltoides* ssp. *monilifera* associations in which *Pascopyrum smithii* usually is present but other species dominate. In some studies, *Populus deltoides* vegetation types have been named in which the undergrowth is composed predominantly or entirely of exotic grasses (e.g., *Populus deltoides / Poa pratensis* community in eastern Wyoming (Jones and Walford 1995), *Populus deltoides / Bromus inermis* community in eastern Wyoming (Jones and Walford 1995) and eastern Colorado (Carsey et al. 2003a)), and these vegetation types may represent stands of this association (CEGL002680) with highly altered species composition. This association is a broader type containing *Populus deltoides - (Salix amygdaloides) / Salix (exigua, interior)* Woodland (CEGL000659), but the description of that association

shows that *Populus deltoides* (ssp. *wislizeni*, ssp. *monilifera*) / *Pascopyrum smithii* Woodland (CEGL002680) actually has the narrower range in plant species composition and the smaller geographic range.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: The sampled site is on a stream terrace approximately 1 m above the active channel. The terrace is under a bedrock overhang.
Natural Bridges National Monument Plots: The description is based on 2003 field data (one plot: NABR.0010).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: G.P Jones, mod. G. Kittel and J. Coles

REFERENCES: Carsey et al. 2003a, Driscoll et al. 1984, Friedman et al. 1997, Jones 1992b, Jones 1998a, Jones 1998b, Jones and Walford 1995, Kittel et al. 1999a, Western Ecology Working Group n.d., Wyoming CBM Clearinghouse 2003

Populus deltoides (ssp. wislizeni, ssp. monilifera) / Salix exigua Woodland
(Rio Grande Cottonwood, Plains Cottonwood) / Coyote Willow Woodland

CODE	CEGL002685
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*POPULUS DELTOIDES* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.636) Eastern Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): Western Great Plains Floodplain (CES303.678)
Northwestern Great Plains Canyon (CES303.658)
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)
North American Warm Desert Lower Montane Riparian Woodland and Shrubland (CES302.748)
Western Great Plains Riparian (CES303.956)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This is a lowland riparian association known from the Rio Grande, Pecos and Canadian river drainages of central and eastern New Mexico and probably elsewhere in northern New Mexico. It also occurs in the Great Plains of Colorado, North Dakota, Nebraska, Oklahoma, South Dakota, and Texas, and in the Colorado Plateau of Utah and Colorado. This association occurs in wide river corridors that have low-gradient and primarily sandy/gravelly beds (becoming cobbly with increasing gradients). Elevations range from 1380-1980 m (4525-6500 feet). The type is most often found proximal to perennial rivers on low sidebars and stream banks near stream bankfull levels (discharge ratios close to 1). Occasionally, it can be found within the active channel or nearby. Because of its low position, the type is flooded frequently (average recurrence interval is 5 years). Most soils are young and undeveloped Entisols, and soils within the active channel are classified as riverwash. Soils tend to be well-drained sands with mixtures of cobbles and gravels throughout the profile. Most soils tend to be moist or wet within 1 m, at least during seasonal high water. In some soils, moisture indicators are found at greater depths. This association is

dominated by relatively young stands of *Populus deltoides* that form open to moderately open overstories (25-50 % cover) with thickets of Salix exigua in the understory. *Baccharis salicina* is often well-represented to abundant and may codominate. Herbaceous cover is abundant, particularly among graminoids, and numerous (23) native wetland indicators can be present, such as *Schoenoplectus pungens* (= *Scirpus pungens*), *Scirpus microcarpus, Eleocharis palustris, Juncus balticus, Juncus longistylis, Juncus tenuis, Glyceria striata, Carex aquatilis, Carex oreocharis, Carex scoparia, Carex stipata, Equisetum arvense,* and *Equisetum laevigatum*. Overall herbaceous diversity is high (90 species) and still predominantly native in composition (66 species or 73%).

DISTRIBUTION

Natural Bridges National Monument
This was sampled in Tuwa Canyon 80 meters east of the confluence with Armstrong Canyon and in two places in Armstrong Canyon, between Owachomo and Kachina bridges, and south of The Shoe.

Globally
This association is found in the Rio Grande, Pecos and Canadian river drainages of central and eastern New Mexico and probably elsewhere in northern New Mexico. It also occurs in the Great Plains of Colorado, North Dakota, Nebraska, Oklahoma, South Dakota, and Texas, as well as the Colorado Plateau of Colorado and Utah.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument
This woodland association was observed on low riparian terraces within the canyons of the monument. The sites occur on level to gentle slopes between 1536 and 1799 m elevation. The unvegetated surface has high cover of litter and low to moderate exposure of bare soil. The soils are rapidly drained loamy sands and sandy loams derived from alluvium.

Globally
This community occurs in wide river corridors that have low-gradient and primarily sandy/gravelly beds (becoming cobbly with increasing gradients). Elevations range from 1380 to 1980 m (4525-6500 feet). The type is most often found proximal to perennial rivers on low sidebars and stream banks near stream bankfull levels (discharge ratios close to 1). Occasionally, it can be found within the active channel or nearby, or at the base of pour-offs in slickrock canyons. Because of its low position, the type is flooded frequently (average recurrence interval 5 years). Most soils are young and undeveloped Entisols, and soils within the active channel are classified as riverwash. Soils tend to be well-drained sands with mixtures of cobbles and gravels throughout the profile. Most soils tend to be moist or wet within 1 m, at least during seasonal high water. In some soils, moisture indicators are found at greater depths.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This Rio Grande cottonwood / coyote willow woodland association is rare, occupying terraces on canyon bottoms in the monument. The total vegetation cover ranges from 55 to 150% in these moderately to densely vegetated stands. This forest association is characterized by an open to closed tree canopy, typically 10-15 m tall, of *Populus deltoides* ssp. *wislizeni* or *Populus X acuminata* trees that range in cover from 5 to 25% and 45 to 55%, respectively, and the tall shrub *Salix exigua* that ranges in cover from 1 to 65%. Scattered *Populus deltoides* ssp. *wislizeni* or *Populus X acuminata* trees, typically 2-5 m tall, occur in the subcanopy. The shrub layer is overwhelmingly dominated by *Salix exigua*, except in situations where the community is becoming isolated from the water table, where *Salix exigua* shares dominance with upland shrubs such as *Ericameria nauseosa*. The herbaceous layer typically has less than 5% cover, except in the stand that is drying out, where *Bromus tectorum* provides 40% cover. Other graminoids present include *Juncus balticus, Pascopyrum smithii*, and *Poa pratensis*. Characteristic forbs include *Artemisia dracunculus, Artemisia ludoviciana, Castilleja linariifolia, Heterotheca villosa,* and *Solidago gigantea*.

Globally
This type is dominated by relatively young stands of *Populus deltoides* that form open to moderately open overstories (10-50% cover) with thickets of *Salix exigua* in the understory. Stands in the Colorado Plateau may include *Populus X acuminata* in the canopy. *Baccharis salicina* is often well-represented to abundant and may codominate with *Salix* in some parts of the range. Herbaceous cover is abundant, particularly among graminoids, and numerous (23) native wetland indicators can be present, such as *Schoenoplectus pungens* (= *Scirpus pungens*), *Scirpus microcarpus, Eleocharis palustris, Juncus balticus, Juncus longistylis, Juncus tenuis, Glyceria striata, Carex aquatilis, Carex oreocharis, Carex scoparia, Carex stipata, Equisetum arvense,* and *Equisetum laevigatum*. Invasive exotic species can also be prevalent, such as *Agrostis gigantea, Agrostis stolonifera, Poa pratensis,* and *Melilotus officinalis*. Overall herbaceous diversity is high (90 species) and still predominantly native in composition (66 species or 73%).

MOST ABUNDANT SPECIES
Natural Bridges National Monument

Stratum	**Species**
Tree canopy	*Populus deltoides* ssp. *wislizeni*, *Populus* x *acuminata*

Global

Stratum	**Species**
Tree canopy	*Populus deltoides* ssp. *wislizeni*
Tall shrub/sapling	*Salix exigua*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Bromus tectorum

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G3 (1-Dec-2000). This lowland riparian association is restricted to scattered stands along the Rio Grande and Pecos rivers (and their tributaries) in New Mexico, where plants, particularly trees and shrubs, have access to an active ground water table. The number of high-quality occurrences is not likely to exceed 25 in number, because as with many riparian zone communities in the Southwest, impacts over the past 150 years from livestock use, agricultural conversion, urbanization, recreational use, exotic tree and shrub invasion, and the alteration of hydrological regimes have led to extensive fragmentation and loss of this community. Viable occurrences are mostly found along unregulated rivers where periodic flooding and sustained maintenance flows lead to successful reproduction and establishment of native riparian species. In the Southwest, such unregulated rivers are few, hence this community still is threatened, and declines continue, suggesting a rank of G3. Should declines continue the rank might need to be raised to G2.

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
Initially developing on exposed depositional sandbars, this mid-successional community type depends on periodic flooding for maintenance and growth, even when well-established. As sediments and debris become trapped among the woody stems, the bar becomes more stable. In this community type, the

cottonwoods overtop the shrubby willows. Because the willows are limited to lower riverside bars or cutoff channels, the community type eventually changes as the trees develop into mature forests on higher terraces without the willow understory. Historically, when cottonwoods eventually died from old age or were removed in high-energy flood events, they were replaced by new, young trees. For this cycle to occur under regulated conditions, flows should mimic the natural flood regime as closely as possible.

Hink and Ohmart (1984) describe a cottonwood/coyote willow mapping unit with four structural sub-types for the middle Rio Grande. Dick-Peddie (1993) refers to a *Populus fremontii / Salix exigua* / Mesic Grass - Forb vegetation type as part of a Floodplains-Plains Riparian group that is probably inclusive of this type. This association is similar to *Populus deltoides - (Salix amygdaloides) / Salix (exigua, interior)* Woodland (CEGL000659) reported from the Great Plains states.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: Periodic floods will impact these stands. Evidence of drought stress was also observed.
Natural Bridges National Monument Plots: The description is based on 2003 field data (three plots: NABR.0007, NABR.0008, NABR.0009).
Local Description Authors: A. Buechling, mod. J. Von Loh and J. Coles
Global Description Authors: E. Muldavin et al., mod. J. Coles

REFERENCES: CONHP Ecology Team 2001, Dick-Peddie 1993, Hink and Ohmart 1984, Muldavin et al. 2000a, Western Ecology Working Group n.d.

Populus deltoides ssp. wislizeni / Acer negundo Woodland
Rio Grande Cottonwood / Box-elder Woodland

CODE	CEGL002336
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*POPULUS DELTOIDES* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.636) Eastern Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): North American Warm Desert Lower Montane Riparian Woodland and Shrubland (CES302.748)
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This association is described from occurrences on narrow alluvial terraces in the canyons of the Yampa and Green rivers in northwestern Colorado and occurs farther south in southeastern Utah. Stands occupy wet areas of slot canyons and the rocky or sandy banks of the main channels. Soils are sandy and derived from alluvium, and may have large rocks scattered over the ground surface. The canopy consists of *Populus deltoides* ssp. *wislizeni* with between 40 and 55% cover, with a subcanopy dominated by *Acer negundo* with a cover of 10 to 45%. Other trees in the subcanopy may include *Juniperus osteosperma* and *Celtis laevigata* var. *reticulata*. Clumps of *Rhus trilobata, Fraxinus anomala*, or *Amelanchier utahensis*

range from 15 to 30% cover, and there may be scattered individuals of *Chrysothamnus viscidiflorus, Krascheninnikovia lanata,* and *Opuntia polyacantha*. *Bromus tectorum* dominates the herbaceous layer with 10 to 20% cover. Other herbaceous species present may include *Elymus repens, Leymus cinereus, Sporobolus airoides, Distichlis spicata,* and *Lepidium latifolium*.

DISTRIBUTION

Natural Bridges National Monument
This association is limited to high alluvial terraces within White Canyon and was sampled 0.3 mile upstream from Kachina Bridge.

Globally
This association is currently only described from the canyons of the Yampa and Green rivers in Dinosaur National Monument in northwestern Colorado and from Natural Bridges National Monument in Utah. It is likely to occur elsewhere in the southwestern U.S. No other distributional information is available.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument
This woodland association was observed on a broad stream terrace on the floor of White Canyon. The site is at 1729 m elevation. The unvegetated surface has high cover of litter and moderate exposure of sand. Downed wood is abundant. The soil is a rapidly drained loamy sand derived from alluvium.

Globally
This association occurs on flat to moderately sloping alluvial terraces within broad river floodplains, or in narrow slot canyon where alluvial terrace development is extensive enough to support cottonwoods. Reported elevation ranges from 1650 to 1730 m, aspect is variable, and nonvegetated ground cover is primarily organic litter with some large rock. Sandy loam soils derived from alluvium comprise the primary substrates. Downed wood can be abundant.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This Rio Grande cottonwood / box-elder woodland association is rare, occupying stream terraces in canyon bottoms within the monument. The total vegetation cover exceeds 100% in this densely vegetated stand. This forest association is characterized by a tree canopy, typically 10-15 m tall, of *Populus deltoides* ssp. *wislizeni* (50% cover) and *Acer negundo* (10% cover) trees. The shrub layer provides 30% cover and is dominated by *Fraxinus anomala, Rhus aromatica,* and *Amelanchier utahensis*. The herbaceous layer is diverse in composition but provides sparse cover by individuals of *Achnatherum hymenoides, Hesperostipa comata, Piptatherum micranthum, Heterotheca villosa, Machaeranthera canescens, Packera multilobata* (= *Senecio multilobatus*), and *Thelypodium integrifolium*. The vine *Clematis ligusticifolia* contributes 40% cover. Seedlings of *Pinus edulis* provide sparse cover.

Globally
The total vegetation cover often exceeds 100%. This riparian association is characterized by a tree canopy, typically 10-20 m tall, of *Populus deltoides* ssp. *wislizeni* and a subcanopy of *Acer negundo* trees. In some locations *Celtis laevigata* var. *reticulata* may also be important in the subcanopy. Typically, there is an abundant shrub layer of species typical to dry riparian terraces, such as *Fraxinus anomala, Rhus trilobata,* and *Amelanchier utahensis*; occasionally *Pinus edulis* or *Juniperus osteosperma* saplings or seedling occur in the shrub layer. There is no developed short-shrub layer, but scattered shrubs less than 1 m high might include *Chrysothamnus viscidiflorus, Krascheninnikovia lanata,* and *Opuntia polyacantha*. The herbaceous layer is diverse in composition but usually has sparse cover; species can include *Achnatherum hymenoides, Hesperostipa comata, Leymus cinereus, Sporobolus airoides, Distichlis spicata, Piptatherum micranthum, Heterotheca villosa, Machaeranthera canescens, Packera multilobata,* and *Thelypodium integrifolium*. The vine *Clematis ligusticifolia* can have high cover in some

stands. Exotic species can be abundant, including *Bromus tectorum, Elymus repens,* and *Lepidium latifolium.*

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	Species
Tree canopy	*Acer negundo, Populus deltoides* ssp. *wislizeni*
Tall shrub/sapling	*Fraxinus anomala*
Herb (field)	*Clematis ligusticifolia*

Global

Stratum	Species
Tree canopy	*Populus deltoides* ssp. *wislizeni*
Tree subcanopy	*Acer negundo*
Tall shrub/sapling	*Amelanchier utahensis, Fraxinus anomala, Rhus trilobata*
Herb (field)	*Clematis ligusticifolia*

OTHER NOTEWORTHY SPECIES

Natural Bridges National Monument
Data are not available.

Globally
Bromus tectorum, Elymus repens, Lepidium latifolium

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jan-2005).

CLASSIFICATION COMMENTS

Natural Bridges National Monument
Data are not available.

Globally
This association has only been described from Dinosaur and Natural Bridges national monuments. Until further inventory is completed, global information is scanty.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: he sampled stand represents one of the larger patches of *Populus deltoides* ssp. *wislizeni* in the canyon. The terrace is wide and flat, allowing for the establishment of a large stand of *Populus deltoides* ssp. *wislizeni*.
Natural Bridges National Monument Plots: The description is based on 2003 field data (one plot: NABR.0101).
Local Description Authors: A. Buechling, mod. J. Von Loh and J. Coles
Global Description Authors: J. Coles, mod. M.S. Reid

REFERENCES: Western Ecology Working Group n.d.

Populus fremontii / Salix (ligulifolia, lutea) Woodland
Fremont Cottonwood / (Strapleaf, Yellow) Willow Woodland

CODE	CEGL004002
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	POPULUS FREMONTII TEMPORARILY FLOODED WOODLAND ALLIANCE (A.644) Fremont Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)
North American Warm Desert Lower Montane Riparian Woodland and Shrubland (CES302.748)
North American Warm Desert Riparian Woodland and Shrubland (CES302.753)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
No data available.

DISTRIBUTION
Natural Bridges National Monument
This association is known from one occurrence in the North Fork of Tuwa Canyon.

Globally
This riparian woodland has only been reported from three locations in two National Park Service units on the Colorado Plateau (Utah).

ENVIRONMENTAL DESCRIPTION
Natural Bridges National Monument
This woodland association was observed on a narrow stream terrace at approximately 1910 m elevation. The unvegetated surface has high cover of bare ground and sand with scattered large rocks. The soil is a rapidly drained loamy sand derived from alluvium. Trickling water and small pools are present throughout the sampled stand, suggesting a high water table is available throughout the growing season.

Globally
No data available.

VEGETATION DESCRIPTION
Natural Bridges National Monument
This cottonwood woodland association is rare within the Monument, occupying stream terraces in canyon bottoms. Total vegetation cover approaches 100%. The canopy is open, consisting of mature of *Populus fremontii* trees not exceeding 15% cover. The shrub layer is dense, providing more than 50% cover and is dominated by *Salix lutea*, with lesser cover by *Ericameria nauseosa*. The herbaceous layer is a monoculture of *Juncus balticus* providing 30-50% cover.

Globally
No data available

MOST ABUNDANT SPECIES
Natural Bridges National Monument

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

Global
No data available

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
No data available

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR. There is insufficient information at this time to rank this association. It is currently known only from three occurrences. Because of the generally degraded condition of riparian systems in the Western United States and the requirement of this association for frequent flooding (suggests intact hydrologic system), it is unlikely to be common anywhere in the Colorado Plateau. This association is therefore is unlikely to receive a global rank higher than G3.

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
This association has been reported from two NPS units within the northern Colorado Plateau: Canyonlands National Park and Natural Bridges National Monument. It is likely to occur elsewhere where the ranges of the diagnostic species overlap (primarily the northern Colorado Plateau).

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: The sampled stand represents one of the larger patches of *Populus deltoides* ssp. *wislizeni* in the canyon. The terrace is wide and flat, allowing for the establishment of a large population of *Populus deltoides* ssp. *wislizeni* trees.
Natural Bridges National Monument Plots: The description is based on 2003 field data (one observation point: NABR.9070).
Local Description Authors: J. Coles
Global Description Authors: N/A

Artemisia tridentata ssp. tridentata / Hesperostipa comata Shrubland
Basin Big Sagebrush / Needle-and-Thread Shrubland

CODE	CEGL002966
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA TRIDENTATA* (SSP. *TRIDENTATA*, SSP. *XERICENSIS*) SHRUBLAND

ALLIANCE (A.830)
(Basin Big Sagebrush, Foothill Big Sagebrush) Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)
Inter-Mountain Basins Big Sagebrush Steppe (CES304.778)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This shrubland association occurs in small to large patches on point bars, stream terraces, valley floors and alluvial fans in the interior western U.S. and possibly British Columbia, Canada. Slopes are generally gentle but can range up to 20% in steeper tributary drainages. Elevations range from 1220 to 2000 m at any aspect. Soils are sandy loams or loamy sands derived from alluvium. Although associated with drainages and floodplains, this community occurs in sites that rarely flood. Total vegetation cover tends to be somewhat sparse, as many examples have had their herbaceous cover reduced by grazing; undisturbed examples have total vegetation cover up to 90%. The dominant shrub is *Artemisia tridentata* ssp. *tridentata*. Others occurring as scattered individuals include *Ericameria nauseosa, Chrysothamnus viscidiflorus, Ephedra viridis, Krascheninnikovia lanata, Opuntia polyacantha,* and *Atriplex canescens*. The understory is dominated or codominated by the native bunchgrass *Hesperostipa comata*. Common herbaceous associates include *Achnatherum hymenoides, Bouteloua gracilis, Poa secunda, Sporobolus cryptandrus*, and *Sphaeralcea coccinea*. Moss and cryptogamic crusts may have significant cover in sites that have not experienced recent grazing.

DISTRIBUTION

Natural Bridges National Monument

This association is rare and was sampled on point bars or stream terraces in Armstrong Canyon. It is likely, however, that all stands within the monument were destroyed by a significant flood in September 2003.

Globally

This shrubland association occurs in the interior western U.S. from Washington to Montana south to Utah and Nevada. It may also occur in Oregon, California, and British Columbia, Canada.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This shrubland association is limited to canyons on point bars and high stream terraces. Sites are nearly level to gentle (level to 2-degree slopes) and occur between 1756 and 1768 m elevation. The unvegetated surface has high cover of litter and low cover of bare soil and downed wood. The soil is generally a poorly developed, rapidly drained sandy loam derived from sandy alluvium.

Globally

This shrubland association occurs in small to large patches on point bars, stream terraces, valley floors and alluvial fans in the interior western U.S. and British Columbia, Canada. Slopes are generally gentle but can range up to 20% in steeper tributary drainages. Elevations range from 1220 to 2000 m (4000-6580 feet), and stands may be oriented to any aspect. Soils are sandy loams or loamy sands derived from alluvium. Although associated with drainages and floodplains, this community occurs in sites that rarely flood.

VEGETATION DESCRIPTION

Natural Bridges National Monument

The total vegetation cover ranges from 60 to 90% in these densely vegetated stands. This shrubland association is characterized by 1- to 2-m tall *Artemisia tridentata* ssp. *tridentata* (45-55% cover) and *Opuntia polyacantha* (5-25% cover). Other shrubs occur with much lower cover (less than 10% each) and

include *Atriplex canescens* and *Ephedra viridis*. The herbaceous layer is typically characterized by *Hesperostipa comata, Achnatherum hymenoides, Vulpia octoflora,* and *Bromus tectorum*, each ranging in cover from 1 to 25%. Forbs are sparse in cover, but diverse in composition, including *Heterotheca villosa, Lepidium montanum, Lesquerella sp., Machaeranthera canescens, Packera multilobata* (= *Senecio multilobatus*), and *Sphaeralcea parvifolia*. Cryptogam cover is sparse, typically less than 1%. Scattered (up to 1% cover) *Juniperus osteosperma* seedlings may be present.

Globally
Total vegetation cover tends to be somewhat sparse in this association (10-40%), as many examples have had their herbaceous cover reduced by grazing; undisturbed examples have total vegetation cover up to 90%. Cover of the dominant shrub *Artemisia tridentata* ssp. *tridentata* ranges from 5 to 55% in this association. *Ericameria nauseosa, Chrysothamnus viscidiflorus, Ephedra viridis, Krascheninnikovia lanata, Opuntia polyacantha*, and *Atriplex canescens* also frequently occur as scattered individuals in the shrub layer. The understory cover totals between 5 and 40% and is dominated or codominated by the native bunchgrass *Hesperostipa comata*. Common herbaceous associates include *Achnatherum hymenoides, Bouteloua gracilis, Poa secunda, Sporobolus cryptandrus,* and *Sphaeralcea coccinea*. Moss and cryptogamic crusts may have significant cover in sites that have not experienced recent grazing.

MOST ABUNDANT SPECIES
Natural Bridges National Monument

Stratum	**Species**
Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Opuntia polyacantha*
Herb (field)	*Achnatherum hymenoides, Hesperostipa comata*

Global

Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Achnatherum hymenoides, Hesperostipa comata*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Bromus tectorum

Globally
Bromus tectorum

CONSERVATION STATUS RANK
Global Rank & Reasons: G4? (4-Dec-2001).

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
Of the references for this association, Daubenmire (1970), Hironaka et al. (1983), and Caicco and Wellner (1983f, 1983k) clearly reference *Artemisia tridentata* ssp. *tridentata / Stipa comata* vegetation type. All the others (Poulton 1955, Tueller et al. 1966, Blackburn 1967, Blackburn et al. 1968c, 1971, McLean 1970, Tueller and Blackburn 1974, DeVelice and Lesica 1993) do not provide information as to the subspecies of *Artemisia tridentata*. However, it is likely, based on habitat data, photos, and descriptions, that these studies were working with *Artemisia tridentata* ssp. *tridentata / Stipa comata* vegetation types.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: This basin big sagebrush shrubland association is rare within the monument, restricted to larger point bars and terraces in canyon bottoms.
Natural Bridges National Monument Plots: The description is based on 2003 field data (two plots: NABR.0107, NABR.0108, and one observation point: NABR.9002).
Local Description Authors: A. Buechling, mod. J. Von Loh and J. Coles
Global Description Authors: J. Coles

REFERENCES: 1967, Blackburn et al. 1968c, Blackburn et al. 1971, CONHP unpubl. data 2003, Caicco and Wellner 1983f, Caicco and Wellner 1983k, Daubenmire 1970, DeVelice and Lesica 1993, Hironaka et al. 1983, Kagan et al. 2004, MTNHP 2002b, McLean 1970, NVNHP 2003, Poulton 1955, Tueller and Blackburn 1974, Tueller et al. 1966, Western Ecology Working Group n.d.

Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Semi-natural Shrubland
Basin Big Sagebrush - (Rubber Rabbitbrush) / Cheatgrass Semi-natural Shrubland

CODE	CEGL002699
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA TRIDENTATA* SHRUBLAND ALLIANCE (A.829) Basin Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)
Inter-Mountain Basins Semi-Desert Shrub-Steppe (CES304.788)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This association is common throughout the Colorado Plateau, occurring in small to moderate-sized patches on alluvial terraces, floodplains, and point bars. *Artemisia tridentata* ssp. *tridentata* shrubs are always present, often with a lesser component of *Ericameria nauseosa, Atriplex canescens,* or *Chrysothamnus viscidiflorus*. *Bromus tectorum* dominates the occasionally sparse herbaceous layer, frequently accompanied by other weedy exotic or annual grasses and forbs. Individuals or small patches of native grasses and forbs may occur, including *Leymus cinereus, Achnatherum hymenoides,* and *Sporobolus cryptandrus*.

DISTRIBUTION
Natural Bridges National Monument
This association is known only from one site on the floor of White Canyon. Most stands were destroyed by flooding in 2003.

Globally
This association is widespread in southern Utah and western Colorado.

ENVIRONMENTAL DESCRIPTION
Natural Bridges National Monument
This association occurs on a level alluvial terrace on the floor of White Canyon. Elevation is 1759 m. The soil is a rapidly drained sandy loam derived from alluvium. Leaf litter and bare soil cover most of the unvegetated surface.

Globally
This association occurs on alluvial terraces, flats and fans or valley floors throughout the Colorado Plateau. Most stands occur below 2000 m (6560 feet) on level to gently sloping sites. Soils are variable and include sandy loams, silt loams, and clay loams, depending on the size of the stream and the geology of the watershed. Cryptobiotic soil crusts are often extensive.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This shrubland association is dominated by *Artemisia tridentata* ssp. *wyomingensis* with 10% cover. Other associated shrubs include *Ericameria nauseosa, Atriplex canescens,* and *Ephedra viridis*. The exotic annual grass *Bromus tectorum* occurs in the understory with at least 15% cover in most years with normal precipitation. *Hesperostipa comata* is the only other herbaceous species present.

Globally
This association is widespread on floodplains and terraces within the Colorado Plateau that have been subject to grazing. *Artemisia tridentata* ssp. *tridentata* is always present with cover ranging between 10 and 70% and up to 2 m in height. *Ericameria nauseosa* is not always present, but is likely to be present in the vicinity. Other shrubs that occur in this community consistently include *Atriplex canescens, Chrysothamnus viscidiflorus,* and *Sarcobatus vermiculatus*. In some stands there may be scattered individuals of *Pinus edulis* or *Juniperus osteosperma*. The herbaceous layer reflects a long history of disturbance and is dominated by exotic annual species, especially *Bromus tectorum*. Other common herbaceous species include *Erodium cicutarium, Lappula occidentalis,* and *Sisymbrium altissimum*. Because it is dominated by annual species, the total herbaceous cover varies depending on seasonal precipitation. Remnant native herbaceous vegetation may include scattered individuals or patches of *Achnatherum hymenoides* and *Oenothera caespitosa*.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	Species
Short shrub/sapling	*Ericameria nauseosa*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*, *Atriplex canescens*
Herb (field)	*Bromus tectorum*

Global

Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Bromus tectorum*

OTHER NOTEWORTHY SPECIES

Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (14-Aug-2001).

CLASSIFICATION COMMENTS

Natural Bridges National Monument
Data are not available.

Globally
This semi-natural association is likely much more widespread across the western U.S. but is not often sampled.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: This association is now rare in the park, occurring only on a few lowland terrace sites.
Natural Bridges National Monument Plots: The description is based on field data collected in 2004 during accuracy assessment (1 plot: NABR_AA.163).
Local Description Authors: J. Coles
Global Description Authors: J. Coles

REFERENCES: Cogan et al. 2004, Western Ecology Working Group n.d.

Artemisia tridentata ssp. wyomingensis / (Agropyron cristatum, Psathyrostachys juncea) Seeded Grasses Semi-natural Shrubland
Wyoming Big Sagebrush / (Crested Wheatgrass, Russian Wildrye) Seeded Grasses Semi-natural Shrubland

CODE	CEGL002185
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	*ARTEMISIA TRIDENTATA* SSP. *WYOMINGENSIS* SHRUBLAND ALLIANCE (A.832) Wyoming Big Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This shrubland association has been observed in western Colorado and eastern Utah, though it is very likely to be more widespread in the western U.S. It occurs on generally level topography that has been or is currently disturbed by land-management activities such as chaining or heavy grazing. Stands have been observed at mid-elevations, though more data are likely to expand this range. The unvegetated surfaces is generally dominated by litter and bare soil. Dead shrubs can be abundant due to past land-treatment activities. Soils are poorly drained to moderately well-drained sandy loams or loamy sands derived from sandy eolian deposits. There is a short (1-2 m) open shrub canopy dominated by *Artemisia tridentata* ssp. *wyomingensis* with other shrubs contributing low cover. Common associates are *Artemisia dracunculus, Artemisia frigida, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae,* and *Opuntia* spp. Scattered short to medium-tall *Pinus edulis* and *Juniperus osteosperma* trees may be present. The herbaceous stratum has sparse to low cover and is characterized by seeded exotic species, especially *Agropyron cristatum* or *Psathyrostachys juncea*. *Bromus tectorum* is another common exotic species. Native species, which may have been seeded or migrated from nearby seed sources, include *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Elymus elymoides, Hesperostipa comata, Poa fendleriana, Sporobolus cryptandrus,* and *Vulpia octoflora*. Nonvascular component is usually poor due to the disturbance of these sites.

DISTRIBUTION
Natural Bridges National Monument

This association occurs in the environs of the park project area; specifically on BLM lands on Deer Flat, on the bench between Deer Canyon and Deer Flat and near the park entrance.

Globally
This association has been observed in western Colorado and eastern Utah, though it is very likely to occur elsewhere in the western U.S. Psathyrostachys juncea is particularly prevalent in northwestern Colorado, as a local seed-producer specialized in this species for revegetation of degraded rangelands.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument
This shrubland association occurs on deep, sandy to loamy soils of level sites on benches and plateaus.

Globally
This association is found on generally level topography such as mesa tops, benches, and plateau. Sites can be flat to gently sloping on any aspect. Observed sites in western Colorado have been at mid-elevations (2024-2128 m), though a wider range is certain as more data are available. The unvegetated surfaces is generally dominated by litter and bare soil. Dead shrubs can be abundant due to past land-treatment activities. Soils are poorly drained to moderately well-drained sandy loams or loamy sands. Most observed sites have been on eolian deposits derived from sandstone.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This association is characterized by a shrub canopy of *Artemisia tridentata* ssp. *wyomingensis* providing between 15 and 50% cover, usually with a lesser component of *Ericameria nauseosa* and *Gutierrezia sarothrae*. The herbaceous layer is dominated by the exotic bunchgrass *Agropyron cristatum*, with between 1 and 25% cover. Native grasses, which may have been seeded or may have invaded from adjacent undisturbed stands, include *Pleuraphis jamesii, Vulpia octoflora, Hesperostipa comata*, and *Achnatherum hymenoides*. Forbs are scattered throughout the stands; the most conspicuous species are *Sphaeralcea coccinea* and *Lepidium montanum*. Most examples contain scattered individual trees of *Juniperus osteosperma* and *Pinus edulis*. The nonvascular component is generally poorly developed because of the chronic disturbance of grazing; most sites have a low cover of moss.

Globally
This shrubland has sparse to moderate total vegetation cover with an open short-shrub canopy. The dominant species in the shrub stratum is *Artemisia tridentata* ssp. *wyomingensis* which may have between 4 and 50% cover. *Artemisia dracunculus, Artemisia frigida, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae*, and *Opuntia* spp. are common associates with low cover. Short to medium-tall trees, typically *Juniperus osteosperma* or *Pinus edulis*, may be scattered throughout stands of this association. The herbaceous stratum is dominated by exotic species that have been seeded at some time in the past, most commonly *Agropyron cristatum* or *Psathyrostachys juncea* with 1-25% cover. *Bromus tectorum* is another common exotic species. Native species, which may have been seeded or migrated from nearby seed sources, include *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Elymus elymoides, Hesperostipa comata, Poa fendleriana, Sporobolus cryptandrus*, and *Vulpia octoflora*. Nonvascular component is usually poor due to the disturbance of these sites.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	Species
Tall shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Achnatherum hymenoides*, *Agropyron cristatum*, *Hesperostipa comata*

Global

Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Agropyron cristatum*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Agropyron cristatum

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: GNA (ruderal) (6-Jan-2005).

CLASSIFICATION COMMENTS
Natural Bridges National Monument

Globally
This association appears to be widespread among national parks on the Colorado Plateau.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: Data are not available.
Natural Bridges National Monument Plots: The description is based on 2003 field data (3 observation points: NABR.9006, NABR.9103, NABR.9106).
Local Description Authors: J. Coles
Global Description Authors: J. Drake

REFERENCES: Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis) Wooded Shrubland

Two-needle Pinyon - Utah Juniper / (Roundleaf Buffaloberry, Utah Serviceberry) Wooded Shrubland

CODE	CEGL002334
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Extremely xeromorphic evergreen shrubland with a sparse tree layer (III.A.5.N.e.)
ALLIANCE	*PINUS EDULIS - JUNIPERUS OSTEOSPERMA* WOODED SHRUBLAND ALLIANCE (A.2649) Two-needle Pinyon - Utah Juniper Wooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This wooded shrubland association occurs on the slopes of mesas, buttes and plateaus in southern Utah. The typical occurrence is located on the lower and middle sections of a shale slope that is overlain by rockfall from the sandstone or conglomerate that caps the landform. Most sites are moderately steep to steep (up to 85% slope), occur between 1422 and 2348 m (4665-7700 feet) elevation, and are oriented to

cooler north to northeastern aspects. A smaller number of occurrences, usually at higher elevations, occupy west-facing slopes. The unvegetated surface has sparse to low cover of litter and low to high exposure of bare soil, gravel and large rocks. Large rocks cover up to 40% of the ground surface. Parent materials are typically shales of the Moenkopi, Chinle, Cutler or Carmel formations, modified by colluvial fragments of overlying conglomerate or sandstones. Soils are rapidly drained silt loams, sandy loams and clay loams. The vegetation is characterized by a sparse to moderately closed canopy (5-30%) of *Pinus edulis*, often accompanied by *Juniperus osteosperma*. In rare cases on barren shales, the tree element is nearly absent. The shrub layer is mixed, but *Amelanchier utahensis* or *Shepherdia rotundifolia* are present (usually both). Other shrubs often present include *Cercocarpus montanus, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Gutierrezia sarothrae, Symphoricarpos longiflorus,* and *Mahonia fremontii*. The herbaceous layer is moderate to high in terms of species diversity and typically provides sparse to moderate cover. Common graminoids include *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Leymus salinus,* and *Pleuraphis jamesii.* Forbs that are occasionally present include *Cryptantha flava, Machaeranthera grindelioides, Penstemon utahensis, Phlox austromontana, Lepidium montanum, Stanleya pinnata, Streptanthella longirostris,* and *Tetraneuris acaulis.*

DISTRIBUTION

Natural Bridges National Monument

This association is restricted to the environs of the project area, occurring on the north-facing slopes of the Moss Back / Red House Cliffs adjacent to Highway 95. It may also occur on east-facing Moenkopi slopes of Deer Flat.

Globally

This association is known from the Colorado Plateau of southern and eastern Utah. It may also occur in similar habitats in Arizona and western Colorado; however, Shepherdia rotundifolia is somewhat rare east of the LaSal Mountains.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This wooded shrubland association was observed on rockfall slopes below the cliffs of a large butte. Sites are moderately steep (19-29 degrees), occur between 1836 and 1879 m elevation, and are oriented to north to northeastern aspects. The unvegetated surface has sparse to low cover of litter and low to high exposure of bare soil. Large rocks cover up to 30% of the ground surface. Parent materials are derived from Moenkopi shales modified by small to large fragments of Shinarump conglomerate. Soils are rapidly drained silt loams and clay loams.

Globally

This common northern Colorado Plateau wooded shrubland association occurs on the slopes of mesas, buttes and plateaus in southern Utah. The typical occurrence is located on the lower and middle sections of a shale slope that is overlain by rockfall from the sandstone or conglomerate that caps the landform. Most sites are moderately steep to steep (up to 85% slope), occur between 1422 and 2348 m (4665-7700 feet) elevation, and are oriented to cooler north to northeastern aspects. A smaller number of occurrences, usually at higher elevations, occupy west-facing slopes. The unvegetated surface has sparse to low cover of litter and low to high exposure of bare soil, gravel and large rocks. Large rocks cover up to 40% of the ground surface. Parent materials are typically shales of the Moenkopi, Chinle, Cutler or Carmel formations, modified by colluvial fragments of overlying conglomerate or sandstones. Soils are rapidly drained silt loams, sandy loams and clay loams.

VEGETATION DESCRIPTION

Natural Bridges National Monument

This pinyon-juniper / Utah serviceberry - roundleaf buffaloberry wooded shrubland association is limited in distribution, occupying the slopes of a butte on the southwest side of the project area. The total vegetation cover ranges from 5 to 90% in these stands. This woodland association is characterized by an open canopy, typically 2-5 m tall, of *Juniperus osteosperma* and *Pinus edulis* trees that range in cover from 1 to 25% and 0 to 15%, respectively. Either or both of the characteristic tall shrubs Amelanchier utahensis and *Shepherdia rotundifolia* may be present (usually both), with cover of 0 to 5% and 1 to 15%, respectively. The shrub layer also includes *Ephedra viridis, Symphoricarpos longiflorus, Mahonia fremontii,* and sapling *Pinus edulis*. The herbaceous layer is relatively diverse and typically provides sparse cover. The most common graminoids present include *Achnatherum hymenoides, Bromus tectorum*, and *Pseudoroegneria spicata*. Forbs include *Arabis* sp., *Tetraneuris acaulis* (= *Hymenoxys acaulis*), *Lepidium montanum*, and *Physaria acutifolia*. Constant downslope soil movement tends to keep the nonvascular cover low.

Globally
This mesic wooded shrubland association is consistent and predictable in its unique habitat in the eastern Colorado Plateau. Total cover varies from 15% to nearly 50%. The vegetation is characterized by a sparse to moderately closed canopy (5-30%) of *Pinus edulis*, often accompanied by *Juniperus osteosperma*. In a minority of stands with little colluvial rock cover, the trees may be too sparse to be considered a layer, and the community will appear to be a shrubland with very scattered pinyon and juniper. The shrub layer is variable but often has higher total cover than the tree layer. The shrub layer is mixed, but *Amelanchier utahensis* or *Shepherdia rotundifolia* are present (usually both). Other shrubs often present include *Cercocarpus montanus, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Gutierrezia sarothrae, Symphoricarpos longiflorus*, and *Mahonia fremontii*. The herbaceous layer is moderate to high in terms of species diversity and typically provides sparse to moderate cover. Common graminoids include *Achnatherum hymenoides, Bouteloua gracilis, Bromus tectorum, Hesperostipa comata, Leymus salinus,* and *Pleuraphis jamesii*. Forbs that are occasionally present include *Cryptantha flava, Machaeranthera grindelioides, Penstemon utahensis, Phlox austromontana, Lepidium montanum, Stanleya pinnata, Streptanthella longirostris, Stenotus armerioides* (= *Haplopappus armerioides*), and *Tetraneuris acaulis*. Constant downslope soil movement tends to keep the nonvascular cover low.

MOST ABUNDANT SPECIES
Natural Bridges National Monument

Stratum	**Species**
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Cercocarpus montanus*
Short shrub/sapling	*Shepherdia rotundifolia*

Global

Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Shepherdia rotundifolia*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK
Global Rank & Reasons: G3G4 (11-Jan-2006). The range of the principal shrub species only overlaps in southeastern Utah, so this association is likely to be common only within a relatively narrow range. Stands may cover many hectares, covering the sides of entire mesas or canyon walls.

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
Although this association is now well-documented from several sites, there are two closely related associations: *Pinus edulis - Juniperus osteosperma / Amelanchier utahensis* Woodland (CEGL002329) and *Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia* Woodland (CEGL002335). With better information for all three associations, it may be necessary to lump or split them differently than they are now. This association is one of a series of related Colorado Plateau types that occur on shale slopes covered by sandstone colluvium. It is distinct from others in that it has a developed (albeit sparse) canopy of pinyon and sometimes juniper trees and usually contains *Shepherdia rotundifolia*. Because of the patchy nature of these colluvial slope communities, not every vegetation plot taken in this association will contain all the named species.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: Community is restricted to north-facing, rocky slopes of Moenkopi shale below eroding outcrops of Shinarump conglomerate. Some stands included in this association are very open shrublands on bare shale and do not have a tree canopy. What is diagnostic at Natural Bridges National Monument is the underlying shale geology, the presence of large surface rock, the north aspect and the presence of either or both *Amelanchier utahensis* and *Shepherdia rotundifolia*.
Natural Bridges National Monument Plots: The description is based on 2003 and 2004 field data (four plots: NABR.0013, NABR.0067, NABR.0068, NABR.0069 and two observation points: NABR.9004, NABR.9059).
Local Description Authors: A. Buechling, mod. J. Von Loh and J. Coles
Global Description Authors: J. Coles

REFERENCES: Western Ecology Working Group n.d.

Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland
(Utah Serviceberry, Saskatoon Serviceberry) - Mountain-mahogany Shrubland

CODE	CEGL001070
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*AMELANCHIER UTAHENSIS* SHRUBLAND ALLIANCE (A.916) Utah Serviceberry Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

The description for this association is based on information from Colorado and Utah; its characteristics in Nevada are unknown and will be described when more information becomes available. This plant association is found on moderate to steeply sloping colluvial slopes, canyons, ridges and in alcoves. Sites may be oriented to any aspect. Elevation ranges between 1586 and 2595 m (5200-8500 feet). Relative to other mixed mountain shrub types, it is found on the driest sites with the least soil development and relatively low diversity. Soils range from shallow to deep but are generally always rocky with a high cover of surface rock. The vegetation is characterized by a more open shrub layer and a sparse understory relative to other mixed mountain shrub types. Total vegetation cover often does not exceed 50%. *Amelanchier utahensis* and *Cercocarpus montanus* are the dominants of as many as 16 shrub species in this association. Typical associated shrub species include *Artemisia bigelovii, Artemisia tridentata, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Purshia tridentata, Rhus trilobata, Fraxinus anomala*, and *Tetradymia canescens*. *Symphoricarpos oreophilus* can dominate the lower shrub layer, which may also include *Brickellia microphylla, Eriogonum microthecum, Gutierrezia sarothrae, Mahonia repens*, and *Paxistima myrsinites*. Succulents such as *Opuntia* spp. or *Yucca* spp. may also have minor cover. If *Quercus gambelii* is present, cover is low (<5%). Scattered trees of *Juniperus osteosperma, Juniperus scopulorum*, or *Pinus edulis* may be present in some stands. *Achnatherum hymenoides* (= *Oryzopsis hymenoides*) is the most common species in the diverse herbaceous layer. Other graminoid species may include *Poa fendleriana, Koeleria macrantha, Achnatherum lettermanii, Pseudoroegneria spicata, Elymus lanceolatus, Hesperostipa comata*, and *Leymus salinus*. Forb species may include *Arenaria fendleri, Chaenactis douglasii, Cryptantha flava, 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

Natural Bridges National Monument
This association was sampled along the Sipapu Bridge Trail and below Horse Collar Ruin in White Canyon.

Globally
This association is documented from stands in western Colorado and eastern Utah. It has been reported from Nevada and is likely to occur in xeric areas of mixed mountain shrubland throughout the plateaus and foothills of Colorado and in higher elevations of the Colorado Plateau, western Rocky Mountains and Intermountain West.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument
This shrubland association was observed on talus slopes on middle canyon walls. The documented sites are steep (average 36-degree slope), occur between 1762 and 1822 m elevation, and are on north-facing aspects. The unvegetated surface has high cover of litter and rocks. Downed wood has up to 5% cover. The substrate is talus derived from Cedar Mesa sandstone. Soils are well-drained sandy loams occupying the crevices between sandstone blocks.

Globally
The description for this association is based on information from Colorado and Utah; its characteristics in Nevada are unknown and will be described when more information becomes available. This plant association is found on moderate to steeply sloping colluvial slopes, canyons, ridges and in alcoves. Sites may be oriented to any aspect. Elevations range between 1586 and 2500 m (5200-8200 feet). Relative to other mixed mountain shrub types, it is found on the driest sites with the least soil development and relatively low diversity. Exposed ground is moderate to extensive, averaging 40%. Soils range from shallow to deep but are generally always rocky with a high cover of surface rock.

VEGETATION DESCRIPTION

Natural Bridges National Monument

This Utah serviceberry - mountain-mahogany shrubland association is rare, occupying north-facing, rocky canyon walls in the monument. Total vegetation cover ranges from 20 to 45%, depending on the amount of soil available between rocks in the talus. This shrubland association is characterized by a somewhat closed tall-shrub canopy, typically 2-5 m tall, of *Amelanchier utahensis* that ranges in cover from 1 to 25% and *Cercocarpus montanus* that ranges in cover from 5 to 35%. *Ephedra viridis* is also consistently present, although with cover usually less than 5%. The herbaceous layer is sparse, less than 5% cover, but consistently includes *Achnatherum hymenoides*. Other herbaceous species may include *Petradoria pumila, Galium coloradoense,* or *Leymus salinus.* Cryptogam cover is sparse and consists mostly of mosses. Scattered stunted *Juniperus osteosperma* and *Pinus edulis* trees occur throughout the type, with a total cover less than 10%.

Globally

The vegetation is characterized by a more open shrub layer and a sparse understory relative to other mixed mountain shrub types. Total vegetation cover often does not exceed 50%. *Amelanchier utahensis* and *Cercocarpus montanus* are the dominants of as many as 16 shrub species in this association. Typical shrub species include *Artemisia bigelovii, Artemisia tridentata, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Purshia tridentata, Rhus trilobata, Fraxinus anomala,* and *Tetradymia canescens*. *Symphoricarpos oreophilus* can dominate the lower shrub layer, which may also include *Brickellia microphylla, Eriogonum microthecum, Gutierrezia sarothrae, Mahonia repens,* and *Paxistima myrsinites*. Succulents such as *Opuntia* spp. or *Yucca* spp. may also have minor cover. *Achnatherum hymenoides* (= *Oryzopsis hymenoides*) is the most common species in the diverse herbaceous layer. Other graminoid species may include *Poa fendleriana, Koeleria macrantha, Achnatherum lettermanii, Pseudoroegneria spicata, Elymus lanceolatus, Hesperostipa comata,* and *Leymus salinus*. Forb species may include *Arenaria fendleri, Chaenactis douglasii, Cryptantha flava, Balsamorhiza sagittata, Eriogonum umbellatum, Galium coloradoense, Heterotheca villosa, Lepidium montanum, Lithospermum ruderale, Petradoria pumila, Phlox longifolia, Physaria acutifolia, Senecio integerrimus, Sphaeralcea coccinea, Stanleya pinnata, Stenotus acaulis,* and *Streptanthella longirostris*. Disturbed sites may have high cover of *Bromus tectorum*.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Cercocarpus montanus*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Petradoria pumila*

Global

Tall shrub/sapling	*Amelanchier utahensis*
Tall shrub/sapling	*Cercocarpus montanus*

OTHER NOTEWORTHY SPECIES

Natural Bridges National Monument

Data are not available.

Globally

Bromus tectorum

CONSERVATION STATUS RANK
Global Rank & Reasons: G2? (18-May-2001). This association is well-known only from a small area in Colorado, and very few occurrences have been documented. It also occurs in Utah and Nevada, but no information is available on its conservation status in those states. Very little is known about the larger scale abiotic factors that contribute to the distribution. The global rank should be at least a G3 based on the numbers of sites documented at Dinosaur and Colorado national monuments.

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: This association is rare at Natural Bridges National Monument, as it is restricted to steep, north-facing rockfall and talus with deep soil beneath. Shrub density increases with more northerly aspect and deeper soils.
Natural Bridges National Monument Plots: The description is based on 2004 field data (two plots: NABR.0062, NABR.0103).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: L. Tasker, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data, CONHP unpubl. data 2003, Driscoll et al. 1984, NVNHP 2003, Tiedemann 1978, Vories 1974, Western Ecology Working Group n.d.

Quercus gambelii / Amelanchier utahensis Shrubland
Gambel Oak / Utah Serviceberry Shrubland

CODE	CEGL001110
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*QUERCUS GAMBELII* SHRUBLAND ALLIANCE (A.920) Gambel Oak Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This mixed mountain shrubland occurs in southern Utah and western Colorado. Stands occur in canyons, or on mesas, benches, plateaus, ridges, foothills scarps and mountains. Elevation ranges from 1525 to 2700 m (5000-8860 feet). Slopes are gentle to steep (1-100%) and may be oriented to any aspect. Soil are generally deep, well-developed and are derived from a variety of sources, including sandstones, shales and metamorphic rocks. The vegetation is characterized by a sparse to dense (10-100+% cover) tall-shrub layer (2-5 m tall) codominated by *Quercus gambelii* and *Amelanchier utahensis*. Common shrub associates include *Artemisia tridentata* and *Symphoricarpos oreophilus*. *Cercocarpus montanus* is absent or poorly represented (<5% cover). Other shrubs and dwarf-shrubs present with low cover may include *Chrysothamnus viscidiflorus, Ephedra viridis, Gutierrezia sarothrae, Mahonia repens, Opuntia* spp., *Purshia tridentata*, and *Prunus virginiana*. Graminoids, such as *Pascopyrum smithii, Achnatherum*

hymenoides, Carex geyeri, Hesperostipa comata, or *Poa fendleriana,* dominate the sparse herbaceous layer (<10% total cover). Common forbs include *Achillea millefolium, Artemisia ludoviciana, Allium acuminatum, Comandra umbellata, Erigeron speciosus, Lathyrus lanszwertii, Balsamorhiza sagittata, Packera multilobata, Phlox austromontana, Thalictrum fendleri,* or *Vicia americana.* Occasionally, scattered individual trees are present in the overstory, including *Pinus edulis, Pseudotsuga menziesii,* or *Juniperus osteosperma*.

DISTRIBUTION

Natural Bridges National Monument

This association was sampled only once, in White Canyon. It is likely to be rare in the monument, as well as in the general vicinity, as Gambel oak is generally restricted to stream bottoms.

Globally

This montane shrubland occurs in southern Utah and western Colorado. It occurs in small scattered patches on Dry Bench in Capitol Reef National Park, and on high alluvial terraces in the canyons of Natural Bridges National Monument. It is one of the most abundant and widespread shrubland types in Black Canyon of the Gunnison National Park and Curecanti National Recreation Area.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This tall shrubland association occurs on the floor of White Canyon, on a high terrace out of reach of even severe flooding. The slope of the sampled site is gentle (5 degrees); the plot is at 1705 m elevation and is oriented to a northwestern aspect. Bare soil covers most of the unvegetated surface (60%), with the remainder covered by litter. The soil is a rapidly drained loamy sand derived from alluvium.

Globally

This mountain shrubland occurs in southern Utah and western Colorado. Elevation ranges from 1525 to 2700 m (5000-8860 feet). Stands occur in canyons or on mesas, benches, plateaus, ridges, foothills scarps and mountains. Slopes are gentle to steep (1-100%) and may be oriented to any aspect. Soil are generally deep, well-developed and are derived from a variety of sources, including sandstones, shales and metamorphic rocks.

VEGETATION DESCRIPTION

Natural Bridges National Monument

This Gambel oak / Utah serviceberry tall shrubland is rare within the park. Total vegetation cover is about 30%. The community is characterized by an open canopy, typically 1-5 m tall, of the tall shrubs *Quercus gambelii* and *Amelanchier utahensis* with about 10% cover each. Other shrubs include *Ericameria nauseosa* (= *Chrysothamnus nauseosus*), *Ephedra viridis, Atriplex canescens, Mahonia fremontii,* and *Fraxinus anomala*. The herbaceous layer includes only 1-2% cover of the grasses *Bromus tectorum, Hesperostipa comata,* and *Poa fendleriana.*

Globally

This association is characterized by a sparse to dense (10-100+% cover) tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii* and codominated by *Amelanchier utahensis*. Sparse stands tend to occur in areas that have burned recently. Common associates include *Artemisia tridentata* and *Symphoricarpos oreophilus*. *Cercocarpus montanus* is absent or poorly represented (<5% cover). Other shrubs and dwarf-shrubs present with low cover may include *Chrysothamnus viscidiflorus, Ephedra viridis, Gutierrezia sarothrae, Mahonia repens, Opuntia* spp., *Purshia tridentata,* and *Prunus virginiana*. Graminoids, such as *Pascopyrum smithii, Achnatherum hymenoides, Carex geyeri, Hesperostipa comata,* or *Poa fendleriana,* dominate the sparse herbaceous layer (<10% total cover). Common forbs include *Achillea millefolium, Artemisia ludoviciana, Allium acuminatum, Comandra umbellata, Erigeron*

speciosus, Lathyrus lanszwertii, Balsamorhiza sagittata, Packera multilobata, Phlox austromontana, Thalictrum fendleri, or *Vicia americana. Occasionally,* tree species are present in the overstory, including *Pinus edulis, Pseudotsuga menziesii,* or *Juniperus osteosperma.*

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis, Quercus gambelii*
Short shrub/sapling	*Ericameria nauseosa*
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Poa fendleriana*

Global

Tall shrub/sapling	*Amelanchier utahensis, Quercus gambelii*

OTHER NOTEWORTHY SPECIES

Natural Bridges National Monument
Bromus tectorum

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G3G5 (23-Feb-1994).

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
This plant association is similar to other montane Gambel oak shrublands except for the codominance of *Amelanchier utahensis* with only minor amounts (<10% or 5% cover, respectively) of *Artemisia tridentata* or *Cercocarpus montanus*.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: This point occurs in a transitional area between riparian and upland communities. This point is heterogeneous. Flooding limits vegetation densities downslope of the point. Oak densities increase upslope of the creek on the upper terrace.
Natural Bridges National Monument Plots: The description is based on field data collected in 2004 during accuracy assessment (1 plot: NABR_AA.194).
Local Description Authors: J. Coles
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Carmichael et al. 1978, Cedar Creek Associates, Inc. 1987, Clary 1992, Cogan et al. 2004, Crane 1982, Driscoll et al. 1984, Muldavin et al. 1998b, Western Ecology Working Group n.d.

Quercus gambelii / Sparse Understory Shrubland
Gambel Oak / Sparse Understory Shrubland

CODE	CEGL002337
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*QUERCUS GAMBELII* SHRUBLAND ALLIANCE (A.920) Gambel Oak Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association occurs on flat to gently sloping, usually narrow high terraces in canyons of the Colorado Plateau. The terraces are usually at least 3 m above bankfull stage and rarely, if ever, flood. Elevations range from 1220 to 1840 m (4000-6035 feet). The substrate is a fine sandy alluvium, and oak leaf litter generally covers nearly all the unvegetated surface. The canopy consists of even-aged *Quercus gambelii* stems 5-15 m high with 50-80% canopy closure. The understory consists primarily of oak sprouts less than 0.5 m tall. Scattered individuals of other woody species may occur throughout stands, including *Juniperus scopulorum, Ericameria nauseosa, Rhus trilobata,* and *Acer negundo*. Herbaceous species are usually sparse because of the dense shade cast by the relatively closed canopy but may include *Piptatherum micranthum, Maianthemum stellatum, Stanleya pinnata,* and *Clematis ligusticifolia*.

DISTRIBUTION

Natural Bridges National Monument

This association is rare within the monument. It was sampled at the confluence of Burch and White canyons and at the east end of The Shoe in Armstrong Canyon.

Globally

This association has been documented in the Colorado Plateau of eastern Utah. It has been observed at Mesa Verde National Park (not sampled) and in the Front Range foothills of eastern Colorado as well (Castlewood Canyon State Park). It is likely to occur sporadically anywhere high alluvial terraces develop within the range of *Quercus gambelii*.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This tall shrubland association was observed on high terraces in the bottoms of deep canyons. Sites are gentle (0- to 4-degree slopes), occur at 1841 m elevation, and are oriented to western aspects. The unvegetated surface has high cover of litter. Soils are rapidly drained silt loams and sandy loams derived from sandy alluvium.

Globally

This association occurs on flat to gently sloping, usually narrow high terraces in canyons of the Colorado Plateau. The terraces are usually at least 3 m above bankfull stage and rarely, if ever, flood. Elevations range from 1220 to 1840 m (4000-6035 feet). The substrate is a fine sandy alluvium, and the soils may have a dark surface horizon with a relatively high percentage of organic matter. Oak leaf litter generally covers nearly all the unvegetated surface, although wood litter from fallen branches and trunks may be significant in some older stands.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This Gambel oak tall shrubland is rare within the monument. The total vegetation cover ranges from 80 to 120% in these densely vegetated stands. This shrubland association is characterized by a closed canopy, typically 2-10 m tall, of the tall shrub *Quercus gambelii* that ranges in cover from 80 to 100%. Scattered individuals of *Populus fremontii* and *Pinus edulis* trees contribute low cover to the canopy. The herbaceous layer is dominated by oak sprouts. Scattered herbaceous species include *Bromus tectorum, Maianthemum stellatum, Piptatherum micranthum,* and *Poa fendleriana*.

Globally
Stands of this community usually take the form of a dwarf-woodland, with the canopy high enough that it is possible to walk upright through a stand. Stands usually consist of a single clone of *Quercus gambelii* with roughly even-aged stems 8-20 cm in diameter, 5-15 m tall, and with 50 to 80% canopy closure. The understory consists primarily of oak sprouts less than 0.5 m tall. Scattered individuals of other woody species may occur throughout stands, including *Juniperus scopulorum, Ericameria nauseosa, Rhus trilobata,* and *Acer negundo*. Herbaceous species are usually sparse because of the dense shade cast by the relatively closed canopy but may include *Piptatherum micranthum, Maianthemum stellatum, Stanleya pinnata,* and *Clematis ligusticifolia*. Exotic annual grass *Bromus tectorum* is common in some stands.

MOST ABUNDANT SPECIES
Natural Bridges National Monument

Stratum	**Species**
Tree canopy	*Populus fremontii, Quercus gambelii*
Tall shrub/sapling	*Fraxinus anomala*
Short shrub/sapling	*Yucca baccata*

Global

Tree canopy	*Quercus gambelii*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (12-Jan-2005).

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
This association is distinguished from other Gambel oak associations occurring in the Colorado Plateau by its position on level, abandoned alluvial terraces and the lack of a developed understory.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: This association is established on high terraces that rarely flood. Trees are even-aged clones tall enough to walk under. The understory is almost entirely Gambel oak root sprouts.
Natural Bridges National Monument Plots: The description is based on 2003 field data (two plots:

NABR.0001, NABR.0109).
Local Description Authors: A. Buechling, mod. J. Von Loh and J. Coles
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Western Ecology Working Group n.d.

Quercus gambelii / Symphoricarpos oreophilus Shrubland
Gambel Oak / Mountain Snowberry Shrubland

CODE	CEGL001117
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*QUERCUS GAMBELII* SHRUBLAND ALLIANCE (A.920) Gambel Oak Shrubland Alliance

ECOLOGICAL SYSTEM(S): Madrean Lower Montane Pine-Oak Forest and Woodland (CES305.796)
Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)
Southwestern Great Plains Canyon (CES303.664)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This plant association is found in foothills, plateaus and mountains from western Texas to southern and western Colorado and throughout Utah, and likely occurs in northern Arizona. It is a mesic upland and non-obligate riparian community. Some stands appear to be transitional between riparian areas and drier upland communities such as *Artemisia* spp. It occurs on cool, moist sites, such as along drainages in canyons and steep draws in more xeric areas, and as a mesic upland shrubland forming extensive stands on cooler northern slopes. Substrates are typically deep, well-drained sandy loam to clay loam derived from alluvium or colluvium. The vegetation is characterized by an open to closed, typically tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii*. The understory is composed of a short-shrub layer that is dominated by *Symphoricarpos oreophilus* or a closely related local *Symphoricarpos* species such as *Symphoricarpos rotundifolius* or *Symphoricarpos palmeri*. Other mesic shrubs may be present, including *Amelanchier* spp., *Prunus virginiana*, *Robinia neomexicana*, and *Brickellia* sp. In some stands, the *Quercus gambelii* develop into small trees that form a tree canopy. These "woodlands" are included in this association because their floristic composition is identical to the tall shrublands. In other stands the oak is mostly less than 2 m tall, forming a short-shrub layer. The herbaceous layer is sparse to moderately dense, depending on density of woody canopy, and is often dominated by graminoids, such as species of *Achnatherum, Bromus*, *Elymus, Poa*, and *Koeleria*. Common forbs include *Vicia americana, Thalictrum fendleri*, and *Achillea millefolium*. Occasionally, scattered trees are present.

DISTRIBUTION

Natural Bridges National Monument

This association was observed in Armstrong Canyon approximately on mile upstream from Kachina Bridge.

Globally

This shrubland association is reported from foothills, plateaus and mountains of western Texas to southern and western Colorado and Utah, and likely occurs in Arizona.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This shrubland association was observed at a single site on a high terrace in a canyon. The site is a gentle slope at 1753 m elevation, oriented to the northwest. The unvegetated surface has high cover of litter. Downed wood is relatively common. Soils are rapidly drained loamy sands derived from alluvium.

Globally

This plant association is found in foothills, plateaus and mountains from western Texas to southern and

western Colorado and throughout Utah. It likely occurs in northern Arizona. Elevation ranges from 1750-2745 m (6000-8600 feet). It is a mesic upland and non-obligate riparian community. Some stands appear to be transitional between riparian areas and drier upland communities such as *Artemisia* spp. It occurs on cool, moist sites, such as along drainages in canyons and steep draws in more xeric areas, and as a mesic upland shrubland forming extensive stands on cooler slopes. Substrates are typically deep, well-drained sandy loam to clay loam derived from alluvium or colluvium.

VEGETATION DESCRIPTION

Natural Bridges National Monument

This Gambel oak shrubland association is rare within the monument. It is distributed on high terraces in the canyon bottoms. The total vegetation cover ranges from 90 to 110% in this densely vegetated stand. This woodland association is characterized by a tree canopy, typically 2-5 m tall, of *Quercus gambelii* trees that range in cover from 75 to 85%, and low cover, from 1 to 5%, of the shrub *Symphoricarpos oreophilus*. *Quercus gambelii* sprouts are common, providing 5 to 15% cover. Additional shrubs include *Chrysothamnus viscidiflorus* and *Ericameria nauseosa*. The liana *Clematis ligusticifolia* provides low cover. Herbaceous species are scattered and total less than 1% cover.

Globally

The vegetation is characterized by an open to closed, tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii*. The understory is composed of a short-shrub layer that is dominated by *Symphoricarpos oreophilus* or a closely related local *Symphoricarpos* species such as *Symphoricarpos rotundifolius* or *Symphoricarpos palmeri.* Other mesic shrubs may be present, including *Amelanchier* spp., *Artemisia tridentata, Prunus virginiana, Purshia tridentata, Robinia neomexicana, Ericameria nauseosa,* and *Brickellia* sp. In some stands, the *Quercus gambelii* develop into small trees that form a tree canopy. These "woodlands" are included in this association because their floristic composition is identical to the tall shrublands. In other stands the oak is mostly less than 2 m tall, forming a short-shrub layer. The herbaceous layer is sparse to moderately dense, depending on density of woody canopy, and is often dominated by graminoids, such as species of *Achnatherum, Bromus, Elymus, Poa*, and *Koeleria macrantha*. Common forbs include *Vicia americana, Balsamorhiza sagittata, Thalictrum fendleri, Clematis ligusticifolia,* and *Achillea millefolium*. Occasionally, tree species are present in the overstory, including *Pinus ponderosa, Juniperus scopulorum*, and *Pseudotsuga menziesii*. Introduced graminoids such as *Bromus inermis* and *Poa pratensis* are often common in stands that have been disturbed by heavy livestock grazing.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	**Species**
Tree canopy	*Quercus gambelii*
Tall shrub/sapling	*Symphoricarpos oreophilus*

Global

Tall shrub/sapling	*Quercus gambelii*
Tall shrub/sapling	*Symphoricarpos oreophilus*

OTHER NOTEWORTHY SPECIES

Natural Bridges National Monument

Data are not available.

Globally

Data are not available.

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

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
This plant association is similar to other montane Gambel oak shrublands except for the codominance of *Symphoricarpos oreophilus* with only minor amounts (<10% cover) of *Amelanchier utahensis, Artemisia tridentata*, or *Cercocarpus montanus*.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: This plot typifies oak stands in Armstrong and White canyons, growing at the base of sandstone cliffs on alluvium that receives more moisture than other Gambel oak stands on the canyon floor further from the cliffs.
Natural Bridges National Monument Plots: The description is based on 2003 field data (one plot: NABR.0105).
Local Description Authors: A. Buechling, mod. J. Von Loh and J. Coles
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Baker 1982b, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Clary 1992, Cogan et al. 2004, Crane 1982, Driscoll et al. 1984, Erdman 1962, Hess and Wasser 1982, Hoffman and Alexander 1980, Hoffman and Alexander 1983, Johnston 1987, Kittel et al. 1994, Kittel et al. 1999a, Kittel et al. 1999b, Komarkova et al. 1988a, Muldavin 1994, Muldavin and Mehlhop 1992, Muldavin et al. 1994a, Muldavin et al. 1998b, Muldavin et al. 2000b, Soil Conservation Service 1978, Western Ecology Working Group n.d., Wright et al. 1979

Salix exigua / Mesic Graminoids Shrubland
Coyote Willow / Mesic Graminoids Shrubland

CODE	CEGL001203
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d.)
ALLIANCE	*SALIX (EXIGUA, INTERIOR)* TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.947) (Coyote Willow, Sandbar Willow) Temporarily Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)
Western Great Plains Floodplain (CES303.678)
Northwestern Great Plains Canyon (CES303.658)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY
Globally
This riparian association is found primarily in the central Great Plains but also occurs in parts of the Rocky Mountains and Intermountain semi-desert regions. It generally occurs along backwater channels and other perennially wet but less scoured sites such as floodplain swales and irrigation ditches. The vegetation is characterized by the dominance of Salix exigua in a moderately dense tall-shrub canopy

with a dense herbaceous layer dominated by graminoids. Other common shrubs include saplings of *Populus deltoides* or *Salix amygdaloides, Salix eriocephala, Salix lutea,* and *Amorpha fruticosa*. Tall perennial grasses can appear to codominate the stand when *Spartina pectinata, Panicum virgatum* or other tall grasses are present. Other mesic graminoids, such as *Carex* spp., *Eleocharis* spp., *Juncus* spp., *Pascopyrum smithii, Schoenoplectus pungens* (= *Scirpus pungens*), and *Sphenopholis obtusata*, may be present. Common forb species include *Bidens* spp., *Lobelia siphilitica, Lycopus americanus, Lythrum alatum, Polygonum* spp., and X*anthium strumarium*. Diagnostic features of this association include the nearly pure stands of *Salix exigua* shrubs, with a dense herbaceous layer of at least 30% cover of mesic graminoids.

DISTRIBUTION

Natural Bridges National Monument
This association is rare in the monument. It was sampled at the confluence of Armstrong and Tuwa canyons.

Globally
This association is found primarily in the central Great Plains, but also parts of the Rocky Mountains and Intermountain Semi-desert regions, ranging from Wyoming west to possibly Idaho, south to Utah, and east to Oklahoma.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument
This tall-shrub association was observed in canyon bottoms on floodplains with sufficient sediment deposition. The site is on a gentle slope at 1787 m elevation and is oriented to the east. The unvegetated surface is mostly litter with low exposure of bare soil. Downed wood is sparse. The soil is a poorly drained loamy sand derived from alluvium.

Globally
This riparian association is found along alluvial terraces of backwater channels and other perennially wet but less scoured sites such as floodplain swales and irrigation ditches. It is found at elevations from 937 to 2700 m (3075-9100 feet). This community is found on sandbars, islands, and shorelines of stream channels and braided rivers in Nebraska (Steinauer and Rolfsmeier 2000). Stands usually occur within 1 m vertical distance of the stream channel on point bars, low floodplains, terraces and along overflow channels. It can also occur away from the stream channel in mesic swales or along the margins of beaver ponds and seeps. Sites are usually relatively flat, though rarely they can have moderate or moderately steep slopes. Soils are derived from alluvium and are quite variable in development, ranging from thin (<1 m) and skeletal with depth (10-50% cobbles) to well-developed Mollisols (Kittel et al. 1999a). Textures are typically loamy sands interspersed with layers of silty clays and alternating with coarse sands. Upper layers (10-30 cm) often have 25-30% organic matter (Kittel et al. 1999a), and organic litter covers most of the unvegetated ground surface.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This shrub willow association is rare in canyon bottoms within the monument. The total vegetation cover ranges from 20 to 80% in this moderately to densely vegetated stand. This shrubland association is characterized by a closed tall-shrub canopy, typically 1-2 m tall, of *Salix exigua* and *Salix lutea* that range in cover from 35 to 45% and 15 to 25%, respectively. There are few other shrubs present. The herbaceous layer is diverse, contains several non-natives, and is dominated by graminoids. Graminoids present include *Bromus tectorum, Elymus canadensis, Pascopyrum smithii* (= *Elymus smithii*), *Elymus trachycaulus, Juncus balticus, Phragmites australis*, and *Poa pratensis*. Forbs provide sparse cover and include *Castilleja linariifolia* and *Apocynum cannabinum*.

Globally
This association is characterized by the dominance of *Salix exigua* in the moderately dense tall-shrub canopy with a dense herbaceous layer dominated by graminoids. Others common shrubs may include saplings of *Populus deltoides, Salix amygdaloides, Salix bebbiana, Salix eriocephala, Salix geyeriana, Salix lucida* ssp. *lasiandra* (= *Salix lasiandra*), *Salix lutea, Salix monticola, Salix planifolia, Amorpha fruticosa*, or *Rosa woodsii*. Tall perennial grasses can appear to codominate the stand when *Spartina pectinata, Sorghastrum nutans, Panicum virgatum*, or other tall grasses are present. Mesic graminoids dominate the diverse understory and include *Carex pellita* (= *Carex lanuginosa*), *Carex nebrascensis, Carex rostrata, Deschampsia caespitosa, Eleocharis palustris, Elymus canadensis, Equisetum* spp., *Glyceria* spp., *Juncus balticus, Juncus longistylis, Juncus tenuis, Juncus torreyi, Luzula parviflora, Pascopyrum smithii, Polygonum* spp., *Schoenoplectus americanus, Schoenoplectus pungens* (= *Scirpus pungens*), *Sphenopholis obtusata*, and others. The sparse forb cover may include *Lobelia siphilitica, Bidens* spp., *Geum macrophyllum, Lycopus americanus, Lythrum alatum, Mentha arvensis, Typha angustifolia, Veronica americana*, and *Xanthium strumarium*. *Agrostis stolonifera, Bromus inermis, Melilotus* spp., *Poa pratensis*, or *Phleum pratense*, and other introduced forage species may be present to abundant in disturbed stands of this community. Diagnostic features of this association include the nearly pure stands of *Salix exigua* shrubs, with a dense ground layer of at least 30% cover of graminoids.

MOST ABUNDANT SPECIES
Natural Bridges National Monument

Stratum	**Species**
Tall shrub/sapling	*Salix exigua*

Global

Tall shrub/sapling	*Salix exigua*
Herb (field)	*Pascopyrum smithii, Poa pratensis, Schoenoplectus americanus, Sorghastrum nutans*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G5 (7-Apr-1998).

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
This broadly defined plant association occupies a rather large range and currently includes *Salix exigua* shrublands with herbaceous layers dominated by the introduced mesic, perennial, sod-grass *Poa pratensis*. Classification review of descriptions from the western part of its range need further review to determine if the type should be split. In addition, western stands may all belong to *Salix exigua* sensu stricto, and Great Plains stands may belong to either *Salix exigua* or *Salix interior* (or intermediates). *Salix interior* is an entirely Great Plains and eastward species (Kartesz 1999). In Nebraska, this community intergrades and is a successional stage that appears after both Riverine Sand Flats - Bars Sparse Vegetation (CEGL002049) and *Salix exigua* Temporarily Flooded Shrubland (CEGL001197), which is more frequently disturbed and lacks many of the more mesic herbaceous species.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: Soils are shallow on top of boulders or bedrock throughout the site occupied by this stand. Other small stands or patches are likely to occur in canyon bottoms. This association more typically occurs as understory to Fremont cottonwood.
Natural Bridges National Monument Plots: The description is based on 2003 field data (1 plot: NABR.0003).
Local Description Authors: A. Buechling, mod. J. Von Loh and J. Coles
Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles

REFERENCES: Bourgeron and Engelking 1994, Butler et al. 2002, CONHP unpubl. data 2003, Carsey et al. 2003a, Cogan et al. 2004, Cooper and Cottrell 1990, Driscoll et al. 1984, Hansen et al. 1995, Hoagland 1998c, Hoagland 2000, IDCDC 2005, Jones 1992b, Jones and Walford 1995, Kittel 1994, Kittel and Lederer 1993, Kittel et al. 1996, Kittel et al. 1999a, Lauver et al. 1999, Padgett et al. 1988b, Padgett et al. 1989, Steinauer and Rolfsmeier 2000, Walford et al. 2001, Western Ecology Working Group n.d.

Hesperostipa comata Great Basin Herbaceous Vegetation
Needle-and-Thread Great Basin Herbaceous Vegetation

CODE	CEGL001705
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d.)
ALLIANCE	*HESPEROSTIPA COMATA* BUNCH HERBACEOUS ALLIANCE (A.1270) Needle-and-Thread Bunch Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This grassland occurs on the Great Basin and Colorado Plateau east to the lower slopes of the southern Rocky Mountains. Stands are found on plains, gentle hill slopes, knolls and bluffs, mesa tops, and plateau parks. Substrates are variable and include sand, cobbles, clay loams and silty clay. This association is characterized by a relatively sparse to moderate herbaceous layer (10-40% cover) that is strongly dominated by the cool-season bunchgrass *Hesperostipa comata*. Low cover of other grasses, such as *Achnatherum hymenoides, A. lettermanii, Aristida purpurea, Elymus elymoides, Pleuraphis jamesii, Poa fendleriana,* or *Sporobolus cryptandrus,* may be present. However, *Bouteloua eriopoda* is not present. Forb cover ranges from sparse to moderate and may be diverse. Associated species may include species of *Artemisia, Balsamorhiza, Cirsium, Gilia, Hymenopappus, Lappula, Machaeranthera,* and *Vicia*. Scattered shrubs and dwarf-shrubs may be present with less than 5% total cover. The widespread introduced annual grass *Bromus tectorum* often contributes significant cover in disturbed stands. Some stands have high cover of cryptogams on the soil.

DISTRIBUTION
Natural Bridges National Monument
This association is narrowly distributed on the bench west of Deer Canyon and on the floor of Armstrong Canyon.

Globally
This grassland is found in the Colorado Plateau and Great Basin in Colorado and Utah and will probably occur in adjacent states.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument
This grassland association occurs on point bars and terraces on canyon floors as well as on upland benches. Sites are nearly flat or gently sloping, between 1751 and 1872 m elevation. The unvegetated surface has high exposure of bare soil and moderate cover of litter. Cryptogam cover is typically sparse; however, one stand contained 30% moss cover. Soils are rapidly drained loamy sands and silt loams derived from sandy eolian and alluvial deposits.

Globally
This grassland occurs on the Colorado Plateau and Great Basin. Elevation ranges from 1250-2320 m. Stands are found on point bars, stream terraces, in sand-filled potholes in slickrock washes and on plains, gentle hill slopes, knolls and bluffs, mesa tops, and plateau parks. Substrates are variable and include sand, cobbles, clay loams and silty clay derived from eolian or alluvial deposits. Fires may be important in maintaining these grasslands by reducing woody cover, but burning during the growing season could also damage the *Hesperostipa comata* plants.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This needle-and-thread grassland is rare and is distributed in small stands and patches in canyon bottoms and on ridges. In the upland, patches of this grassland are interspersed with pinyon-juniper stands; in canyon bottoms, with cottonwood stands or *Artemisia tridentata* ssp. *tridentata* shrublands. The total vegetation cover ranges from 5 to 35%. The association is characterized by the bunchgrass Hesperostipa comata that ranges in cover from 5 to 25%, nearly always with 1-5% cover of *Achnatherum hymenoides. Pleuraphis jamesii, Sporobolus cryptandrus,* or *Sporobolus airoides* may also be present with less than 5% cover. Forbs are sparse in cover and variable in composition but often include scattered *Hymenopappus filifolius* and *Calochortus nuttallii*. Shrubs present may include *Ephedra viridis, Ericameria nauseosa, Mahonia fremontii, Eriogonum microthecum, Gutierrezia sarothrae,* and *Opuntia polyacantha*. Stands on upland benches have scattered seedlings of *Pinus edulis*. The nonvascular layer ranges in cover from 1% to nearly 30% and tends to be dominated by mosses.

Globally
This association is characterized by a relatively sparse to moderate herbaceous layer (10-40% cover) that is strongly dominated by the cool-season bunchgrass *Hesperostipa comata,* but may also include stands with less than 10% total vegetation cover. Low cover of other grasses, such as *Achnatherum hymenoides, A. lettermanii, Aristida purpurea, Elymus elymoides, Pleuraphis jamesii, Poa fendleriana,* or *Sporobolus cryptandrus,* may be present. *Bouteloua eriopoda* is not present. Forb cover ranges from sparse to moderate and may be diverse. Associated species include *Artemisia campestris, Artemisia dracunculus, Artemisia ludoviciana, Balsamorhiza sagittata, Cirsium arizonicum, Cryptantha crassisepala, Hymenopappus filifolius, Machaeranthera canescens, Sphaeralcea coccinea, Vicia americana,* and species of *Antennaria, Astragalus, Eriogonum, Gilia,* and *Lappula*. Scattered shrubs and dwarf-shrubs may present with less than 5% total cover. *Artemisia tridentata* ssp. *vaseyana, Chrysothamnus viscidiflorus, Ericameria nauseosa, Opuntia polyacantha, Gutierrezia sarothrae,* and *Symphoricarpos oreophilus* have been reported from this grassland. The widespread introduced annual grass *Bromus tectorum* often contributes significant cover in disturbed stands. Several other exotic species like *Salsola kali, Bassia scoparia* (= *Kochia scoparia*), *Poa pratensis,* and *Sisymbrium altissimum* may be present to abundant. Some stands have high cover of cryptogams on the soil including *Collema tenax, Tortula ruralis, Buellia papillata,* and *Fulgensia bracteata* (Kleiner and Harper 1977).

MOST ABUNDANT SPECIES
Natural Bridges National Monument

Stratum	Species
Herb (field)	*Achnatherum hymenoides*, *Hesperostipa comata*

Global

Herb (field)	*Hesperostipa comata*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Cirsium arizonicum

CONSERVATION STATUS RANK
Global Rank & Reasons: G2G4 (23-Feb-1994).

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
This association is composed of relatively pure Hesperostipa comata grasslands in the Intermountain West. The similar associations are distinguished by the codominance by other grass species or a shrub layer.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: This association occurs in small stands and as patches. One habitat is sandy point bars in the canyon bottoms, the other is openings within pinyon-juniper woodlands.
Natural Bridges National Monument Plots: The description is based on 2003 field data (four plots: NABR.0004, NABR.0104, NABR.0121, NABR.0122, and two observation points: NABR.9101, NABR.9104).
Local Description Authors: A. Buechling, mod. J. Von Loh and J. Coles
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Cogan et al. 2004, Coles pers. comm., Daubenmire 1970, Driscoll et al. 1984, FEIS 1998, Kleiner 1968, Kleiner 1983, Kleiner and Harper 1977, Thilenius et al. 1995, Western Ecology Working Group n.d.

Bouteloua gracilis Herbaceous Vegetation
Blue Grama Herbaceous Vegetation

CODE	CEGL001760
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Short sod temperate or subpolar grassland (V.A.5.N.e.)
ALLIANCE	*BOUTELOUA GRACILIS* HERBACEOUS ALLIANCE (A.1282) Blue Grama Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Grassland (CES304.787)
Western Great Plains Foothill and Piedmont Grassland (CES303.817)
Western Great Plains Shortgrass Prairie (CES303.672)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This minor plant association is reported from Arizona, Colorado, New Mexico, Utah and Wyoming. Sites are flat to gently sloping and include plains, plateaus and montane meadows. Substrates are variable and range from coarse-textured soils derived from sand, gravel, granite or cinder to silty clay loam prairie soils. The vegetation is characterized by a moderate to dense (25-80% cover) herbaceous layer that is strongly dominated by the warm-season, perennial shortgrass *Bouteloua gracilis*. Associated grasses are *Bouteloua curtipendula, Elymus elymoides, Muhlenbergia* spp., *Pascopyrum smithii, Pleuraphis jamesii* (= *Hilaria jamesii*), *Sporobolus cryptandrus*, and the introduced annual grass *Bromus tectorum*. Forb cover is sparse. Scattered *Ericameria nauseosa* shrubs and an occasional *Pinus edulis, Juniperus* spp., or *Pinus ponderosa* tree (in montane stands) may be present.

DISTRIBUTION

Natural Bridges National Monument

This association is rare and was sampled between Horse Collar Ruin and the slopes of Deer Flat and east of lower Deer Canyon. The first large ledge below the main canyon rim supports potholes with tiny grasslands.

Globally

This minor plant association occurs in Arizona, Colorado, New Mexico, Utah and Wyoming.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This grassland association was observed on the crest of a small ridge and on a bench of a larger ridge. Sites are gentle (2-degree slope), occur at 1881 and 1930 m elevation, and are oriented to the northwest. The unvegetated surface has high exposure of bare ground and moderate cover of litter. Cryptogamic cover is sparse, less than 5%. Soils are rapidly drained silt loams derived from Chinle shale.

Globally

This minor plant association is reported from Arizona, Colorado, New Mexico, Utah and Wyoming. Elevation ranges from 1660-2705 m (5420-8875 feet). Sites are flat to moderately sloping and include plains, plateaus and montane meadows and parks. Substrates are variable and range from coarse-textured soils derived from sand, gravel, granite or cinder to silty clay loam prairie soils. Montane Bouteloua gracilis-dominated grasslands included in this association are typically the result of heavy grazing by wildlife and/or livestock that select out less grazing-tolerant mid grasses.

VEGETATION DESCRIPTION

Natural Bridges National Monument

This blue grama grassland association is rare, occupying a few openings in extensive pinyon-juniper woodland stands. The total vegetation cover ranges from 15 to 25% in these moderately vegetated stands. This herbaceous layer is characterized by a moderate cover of *Bouteloua gracilis* that ranges in cover from 15 to 25%. Other grasses providing sparse cover include *Achnatherum hymenoides, Vulpia octoflora* (= *Festuca octoflora*), and *Hesperostipa comata*. Forbs are relatively diverse but also provide only sparse cover, including *Chaetopappa ericoides, Delphinium* sp., *Hymenopappus filifolius, Plantago patagonica, Packera multilobata* (= *Senecio multilobatus*), and *Sphaeralcea coccinea*. Scattered shrubs and tree seedlings may provide up to 5% cover; *Ephedra viridis, Gutierrezia sarothrae, Opuntia polyacantha*, and

Juniperus osteosperma are typical. Cryptogam cover is low, typically less than 5%, and is provided by mosses, lichens, and dark cyanobacteria.

Globally
This association is characterized by a moderate to dense (10-80% cover) herbaceous layer that is strongly dominated by the warm-season, perennial shortgrass *Bouteloua gracilis*. Associated grasses are *Achnatherum hymenoides, Bouteloua curtipendula, Elymus elymoides, Koeleria macrantha, Muhlenbergia montana, Muhlenbergia richardsonis, Muhlenbergia torreyi, Pascopyrum smithii, Pleuraphis jamesii* (= *Hilaria jamesii*), *Sporobolus cryptandrus*, and the introduced annual grass *Bromus tectorum*. Forb cover is sparse. Associated forbs include *Artemisia carruthii, Artemisia dracunculus, Eriogonum* spp., and *Sphaeralcea coccinea*. Scattered *Ericameria nauseosa* shrubs and an occasional *Juniperus* spp., *Pinus edulis*, or *Pinus ponderosa* tree (in montane stands) may be present.

MOST ABUNDANT SPECIES
Natural Bridges National Monument

Stratum	Species
Short shrub/sapling	*Gutierrezia sarothrae*
Herb (field)	*Bouteloua gracilis*

Global

Herb (field)	*Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: G4Q (23-Feb-1994).

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
This is a low-confidence association. There are many other associations in the *Bouteloua gracilis* Herbaceous Alliance (A.1282). This association often represents degraded montane grasslands and *Bouteloua gracilis*-dominated grasslands that lack other diagnostic species. *Bouteloua gracilis* is often able to persist after other species are eliminated because it is an extremely drought- and grazing-tolerant species.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: Understory vegetation in the surrounding pinyon-juniper stand is sparse and less dense than within *Bouteloua gracilis* Herbaceous Vegetation (CEGL001760). High cover of litter from *Bouteloua gracilis* may reflect drought stress at this site.
Natural Bridges National Monument Plots: The description is based on 2003 field data (two plots: NABR.0119, NABR.0124).
Local Description Authors: A. Buechling, mod. J. Von Loh and J. Coles

Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, Bradley et al. 1992, CONHP unpubl. data 2003, Driscoll et al. 1984, Dwyer and Pieper 1967, Fisser 1970, Fisser et al. 1965, Hansen et al. 2004a, Hansen et al. 2004c, Muldavin et al. 2000b, Pieper 1968, Western Ecology Working Group n.d., Williams 1961, Zimmerman 1967

Pleuraphis jamesii Herbaceous Vegetation
James' Galleta Herbaceous Vegetation

CODE	CEGL001777
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Short sod temperate or subpolar grassland (V.A.5.N.e.)
ALLIANCE	*PLEURAPHIS JAMESII* HERBACEOUS ALLIANCE (A.1287) James' Galleta Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This widespread grassland association is found on alluvial flats, plateau parks, mesas and plains in the Colorado Plateau and elsewhere in the southwestern U.S. Landforms vary from mesa tops and slopes to basin floors. Stands may be small woodland parks or more extensive grasslands. Soils in bottomland stands tend to be fine-textured; however, stands occur on a variety of substrates. Vegetation is characterized by a relatively sparse to moderately dense perennial herbaceous layer that is strongly dominated by the bunchgrass *Pleuraphis jamesii*. Other grasses, such as *Achnatherum hymenoides, Bouteloua eriopoda, Bouteloua gracilis, Hesperostipa comata, Muhlenbergia porteri, Sporobolus airoides, or Sporobolus cryptandrus*, may be present. Forb cover is usually sparse and includes species of *Plantago, Gilia, Lappula*, and prickly pear cacti (*Opuntia* spp.). Many species of shrubs and dwarf-shrubs may be present; however, they are not dense enough to form a shrub layer. Some stands have high cover of cryptogams on the soil surface.

DISTRIBUTION

Natural Bridges National Monument

The only sampled stand of this association occurs in a pothole in the slickrock on the first large ledge below the rim of White Canyon.

Globally

This widespread grassland association is found on alluvial flats, plateau parks and plains in the Colorado Plateau and elsewhere in the southwestern U.S.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This grassland association was observed on a ledge below the canyon rim. The site is on a gentle, northwest-facing slope at 1927 m elevation. The unvegetated surface has high cover of bare soil, moderate cover of litter, and sparse cover of cryptogams, mostly moss. Soils are rapidly drained silt loams.

Globally

This widespread association is found on a variety of sites, including alluvial flats, toe slopes, valley floors, benches, hillsides, washes, colluvial slopes, plateau parks, mesas and plains in the Colorado

Plateau and elsewhere in the southwestern U.S. Elevation ranges from 1220-1930 m, with a few sites on the western edge of the southern Rocky Mountains extending to 2400 m. Landforms vary from mesa tops and slopes to basin floors. Sites are flat to moderately steep. Stands may be small woodland parks or more extensive on the plains. Soils are variable. In bottomland stands, soils tend to be fine-textured; however, stands also occur on sandy loams derived from sandstone, remnant lava flow, basaltic cobbles, black or red cinders, or alluvium derived from Pleistocene river cobbles, sandstone, sand, or clay soils.

VEGETATION DESCRIPTION

Natural Bridges National Monument

This association is very rare, occurring as a few small patches within the monument. The total cover in the one sample is 20%. This association is characterized by the short bunchgrass *Pleuraphis jamesii* at about 20% cover. Additional sparse herbaceous cover is provided by forbs, including *Chaetopappa ericoides, Cryptantha* sp., *Lappula occidentalis, Lepidium montanum*, and *Plantago patagonica*. Shrubs are present but total less than 5% cover, including *Ephedra viridis, Gutierrezia sarothrae*, and *Opuntia polyacantha*. Cryptogam cover is usually sparse.

Globally

This association is characterized by a sparse to moderately dense perennial herbaceous layer (5-60% cover) that is strongly dominated by the warm-season bunchgrass *Pleuraphis jamesii*. Low cover of other grasses, such as *Aristida* spp., *Achnatherum hymenoides, Bouteloua eriopoda, Bouteloua gracilis, Hesperostipa comata, Muhlenbergia porteri, Sporobolus airoides*, or *Sporobolus cryptandrus*, may be present. Forb cover is usually sparse and includes *Cymopterus newberryi, Phacelia crenulata, Plantago patagonica, Sphaeralcea parvifolia*, and *Townsendia annua* along with species of *Gilia, Lappula, Zinnia*, and prickly-pear cacti (*Opuntia* spp.). Many species of shrubs may be present, but they are not abundant enough to form a shrub layer. Woody species may include *Artemisia filifolia, Atriplex canescens, Atriplex confertifolia, Brickellia oblongifolia, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Fallugia paradoxa, Gutierrezia* spp., *Krascheninnikovia lanata, Tetradymia* spp., and occasional *Juniperus* spp. trees. The widespread introduced annual grass *Bromus tectorum* and several other exotic species, such as *Salsola kali, Bassia scoparia* (= *Kochia scoparia*), and *Sisymbrium altissimum*, may be present to abundant, especially on disturbed sites. Some stands have high cover of cryptogams, including *Collema tenax, Tortula ruralis, Buellia papillata*, and *Fulgensia bracteata*.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	**Species**
Short shrub/sapling	*Ephedra viridis*
Herb (field)	*Pleuraphis jamesii*

Global

Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Natural Bridges National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G2G4 (23-Feb-1994).

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
This association is defined by the dominance of Pleuraphis jamesii in the graminoid layer without codominance of other grass species or the presence of a shrub layer.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: Some patches of *Bouteloua gracilis* are present nearby as understory to pinyon-juniper woodland.
Natural Bridges National Monument Plots: The description is based on 2003 field data (one plot: NABR.0125).
Local Description Authors: A. Buechling, mod. J. Von Loh and J. Coles
Global Description Authors: K.A. Schulz, mod. J. Coles

REFERENCES: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Cannon 1960, Cogan et al. 2004, Collins 1984, Driscoll et al. 1984, Francis 1986, Francis and Aldon 1983, Hansen et al. 2004b, Helm 1981, Kleiner 1968, Kleiner 1983, Kleiner and Harper 1972, Kleiner and Harper 1977, Marr et al. 1973a, NVNHP 2003, Nichol 1937, Stewart et al. 1940, USFS 1937, Utah Environmental and Agricultural Consultants 1973, Von Loh et al. 2002, Weaver and Albertson 1956, West et al. 1972, Western Ecology Working Group n.d.

Aquilegia micrantha - Calamagrostis scopulorum Herbaceous Vegetation
Mancos Columbine - Ditch Reedgrass Herbaceous Vegetation

CODE	CEGL002592
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial forb vegetation (V.B.)
PHYSIOGNOMIC GROUP	Temperate or subpolar perennial forb vegetation (V.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar perennial forb vegetation (V.B.2.N.)
FORMATION	Saturated temperate perennial forb vegetation (V.B.2.N.f.)
ALLIANCE	*AQUILEGIA MICRANTHA* SATURATED HANGING GARDEN HERBACEOUS ALLIANCE (A.2506) Mancos Columbine Saturated Hanging Garden Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Hanging Garden (CES304.764)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This association is confined to seeps emerging from sandstone cliffs in the Colorado Plateau and lower elevation canyons in adjacent southern Rocky Mountains where it may occur on metamorphic substrates. Elevations are below 2000 m. Aspect is not important in determining the distribution of this association. Instead, seeps will tend to occur on the side of the canyon where gravity and hydrology combine to force groundwater out. The unvegetated surface often has high cover of bare soil, sometimes coated with a white calcareous crust or bedrock. For the most part, soils are derived from dissolution of sandstone grains and fragments from adjacent slopes and ledges and are saturated year-round from water seeping between sedimentary rock layers. In the case of a stand in the Black Canyon of the Gunnison, a north-facing alcove with a seep and overhanging ledge is cut into Black Canyon schist and gneiss. Total vegetation cover ranges from 20 to 75% and is characterized by clumps of *Calamagrostis scopulorum* and *Aquilegia micrantha*. In drier gardens, *Schizachyrium scoparium* may be dominant. Other herbaceous species occurring frequently in this association include *Zigadenus vaginatus, Epipactis gigantea,*

Platanthera zothecina, Cirsium ownbeyi, Petrophyton caespitosum, Dodecatheon pulchellum, Clematis ligusticifolia, Solidago nana, Pellaea glabella, Zigadenus elegans, and *Solidago velutina*. There is no developed shrub or tree layer, but most occurrences include scattered woody plants such as *Pinus edulis, Amelanchier utahensis, Prunus virginiana, Paxistima myrsinites, Cercocarpus intricatus, Glossopetalon spinescens* var. *meionandrum, Betula occidentalis, Brickellia* sp., *Ericameria* sp., *Symphoricarpos rotundifolius, Holodiscus dumosus,* and *Rhus trilobata.*

DISTRIBUTION

Natural Bridges National Monument

This association is scattered within the canyon system and was sampled on ledges and in alcoves in Armstrong and White canyons and at a site 200 m northwest of the Kachina Bridge Trailhead. Many examples of this association are inaccessible because of steep, dangerous cliffs above and below.

Globally

This association has been documented from the Colorado Plateau and Uinta Basin of western Colorado and eastern Utah. It may also occur at Zion National Park (Malanson 1980, 1982), although it was not documented there during a recent (2003) NPS vegetation mapping effort.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument

This herbaceous association was observed in alcoves and on ledges in canyons where seeps and springs are present. Occurrences documented in the monument are on gentle to moderately steep (2- to 37-degree) slopes between 1793 and 1841 m elevation. The unvegetated surface often has high cover of bare soil (sometimes coated with a white calcareous crust) or litter, with a low cover of mosses and lichens. The substrate is always Cedar Mesa sandstone, and the seeps occur where thin lenses of clay intercept groundwater moving through the sandstone forcing it to the surface. Soils are poorly drained and range from sandy loam to silt loam. For the most part, soils are derived from dissolution of sandstone grains and fragments from adjacent sandstone slopes and ledges.

Globally

This hanging garden association occurs on ledges and in crevices and alcoves in near-vertical sandstone canyon walls in southeastern Utah and northwestern Colorado and in Black Canyon on the Gunnison metamorphic substrate in west-central Colorado. Elevations are below 2000 m. Sandy soils that accumulate in the cliff crevices or at the bases of canyon alcoves are saturated year-round from water seeping between sedimentary rock layers or in the case of Black Canyon, a north-facing alcove with a seep and overhanging ledge is cut into Black Canyon schist and gneiss. Aspect is not important in determining the distribution of this association. Instead, seeps will tend to occur on the side of the canyon where gravity and hydrology combine to force water out. The unvegetated surface often has high cover of bare soil, sometimes coated with a white calcareous crust or bedrock. For the most part, soils are derived from dissolution of sandstone grains and fragments from adjacent slopes and ledges.

VEGETATION DESCRIPTION

Natural Bridges National Monument

This association is confined to seeps emerging from sandstone cliffs. Total vegetation cover ranges from 25 to 75% and is characterized by *Calamagrostis scopulorum* and *Aquilegia micrantha* that range in cover from 3 to 40% each. In drier gardens, *Schizachyrium scoparium* may be dominant. Other herbaceous species occurring frequently in this association include *Zigadenus vaginatus, Juncus balticus, Platanthera zothecina* (= *Habenaria zothecina*), *Heterotheca villosa, Zigadenus elegans,* and *Solidago velutina* (= *Solidago sparsiflora*). There is no developed shrub or tree layer, but most occurrences include scattered *Pinus edulis, Amelanchier utahensis, Prunus virginiana,* and *Paxistima myrsinites*. Mosses provide the bulk of the nonvascular cover.

Globally
This association is confined to seeps emerging from sandstone cliffs in the Colorado Plateau. Total vegetation cover ranges from 20 to 75% and is characterized by clumps of *Calamagrostis scopulorum* and *Aquilegia micrantha*. In drier gardens, *Schizachyrium scoparium* may be dominant. Other herbaceous species occurring frequently in this association include *Zigadenus vaginatus, Epipactis gigantea, Platanthera zothecina, Cirsium ownbeyi, Petrophyton caespitosum, Dodecatheon pulchellum, Clematis ligusticifolia, Solidago nana, Pellaea glabella, Zigadenus elegans*, and *Solidago velutina*. There is no developed shrub or tree layer, but most occurrences include scattered woody plants such as *Pinus edulis, Amelanchier utahensis, Prunus virginiana, Paxistima myrsinites, Cercocarpus intricatus, Glossopetalon spinescens* var. *meionandrum, Betula occidentalis, Brickellia* sp., *Ericameria* sp., *Symphoricarpos rotundifolius, Holodiscus dumosus*, and *Rhus trilobata*.

MOST ABUNDANT SPECIES
Natural Bridges National Monument

Stratum	**Species**
Herb (field)	*Aquilegia micrantha, Cirsium calcareum, Zigadenus elegans, Zigadenus vaginatus*
Herb (field)	*Calamagrostis scopulorum, Dichanthelium acuminatum*

Global

Herb (field)	*Aquilegia micrantha*
Herb (field)	*Calamagrostis scopulorum*

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Zigadenus vaginatus

Globally
Carex curatorum, Cirsium ownbeyi, Epipactis gigantea, Platanthera zothecina, Zigadenus vaginatus

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (7-Apr-2005).

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
This association is part of a complex of herbaceous communities collectively known as "hanging gardens." Few systematic studies of these communities have been completed (e.g., Welsh and Toft 1981, Welsh 1989, Fowler 1995), and even fewer quantitative data are available, partly because stands can be difficult or dangerous to access. The National Park Service is undertaking systematic surveys of vegetation, particularly spring and seep communities, throughout the Colorado Plateau (Evenden pers. comm. 2005). As more data become available, the various hanging garden associations should be revisited. John Spence, botanist at Glen Canyon National Recreation Area, is reported to be in the process of publishing a comprehensive study and classification of hanging gardens in the Colorado Plateau (J. Spence pers. comm. 2005).

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: *Mimulus eastwoodiae* does not occur in these

hanging gardens. Dense moss cover is present in the most mesic stands. Seeps and springs emerge where lenses of shale (representing interdunal wetlands) have eroded to form alcoves. After several years of drought, few of these seeps have surface water (drips).
Natural Bridges National Monument Plots: The description is based on 2003 field data (4 plots: NABR.0006, NABR.0012, NABR.0111, NABR.0113, and 1 observation points: NABR.9003).
Local Description Authors: A. Buechling, mod. J. Von Loh and J. Coles
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Evenden pers. comm., Fowler 1995, Malanson 1980, Malanson 1982, Spence pers. comm., Welsh 1989, Welsh and Toft 1981, Western Ecology Working Group n.d.

Cercocarpus intricatus Slickrock Sparse Vegetation
Littleleaf Mountain-mahogany Slickrock Sparse Vegetation

CODE	CEGL002977
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII)
PHYSIOGNOMIC SUBCLASS	Consolidated rock sparse vegetation (VII.A.)
PHYSIOGNOMIC GROUP	Sparsely vegetated pavement (VII.A.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural sparsely vegetated pavement (VII.A.2.N.)
FORMATION	Pavement with sparse vascular vegetation (VII.A.2.N.a.)
ALLIANCE	*CERCOCARPUS INTRICATUS* SPARSELY VEGETATED ALLIANCE (A.2543) Littleleaf Mountain-mahogany Sparsely Vegetated Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Cliff and Canyon (CES304.779)
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This sparse shrubland association is restricted to exposures of massive sandstones such as on the Colorado Plateau. Elevations range between 1412 and 2348 m (4630-7700 feet), while slopes and aspects vary widely. The density of the vegetation is limited by the availability of crevices and shallow depressions where sandy soil collects and plants can root. Most of the surface is sandstone, sometimes nearly covered by lichens. Total vegetation cover is less than 15% and often less than 5%. *Cercocarpus intricatus* is dominant or codominant, with lesser cover by other shrubs such as *Amelanchier utahensis, Arctostaphylos patula, Artemisia bigelovii, Cercocarpus montanus, Glossopetalon spinescens* var. *meionandrum* (= *Forsellesia meionandra*), or *Ephedra viridis*. The herbaceous layer is diverse, variable and low in cover. Occasional dwarfed individuals (often only 1-1.5 m tall) of *Pinus edulis* of *Juniperus osteosperma* may occur.

DISTRIBUTION
Natural Bridges National Monument
This association is scattered throughout the southern half of the park. It was sampled on the rim of White Canyon, in the southwestern part of the monument and between Kachina and Owachomo bridges.

Globally
This association has been described from National Park Service units in southern and eastern Utah and western Colorado with extensive exposures of massive sandstones.

ENVIRONMENTAL DESCRIPTION
Natural Bridges National Monument
This sparse shrubland association occurs on mesa tops, ledges and slopes of exposed Cedar Mesa sandstone near canyon rims. Sites are level to moderately sloping (0- to 32-degree slopes) and occur

between 1830 and 1998 m elevation. The unvegetated surface is typically 80 to 90% bedrock exposure. Soils are rapidly drained fine sands derived from Cedar Mesa sandstone and some eolian silts.

Globally
This sparse shrubland association is restricted to exposures of massive sandstones such as the Navajo, Weber, Cedar Mesa, White Rim, Kayenta and Wingate formations on the Colorado Plateau. Elevations range between 1412 and 2348 m (4630-7700 feet), slopes range from level to vertical, and all aspects are possible. The vegetation roots in crevices where sandy soil collects. Up to 99% of the surface is exposed bedrock or rock and gravel from fractured bedrock, sometimes nearly covered by lichens.

VEGETATION DESCRIPTION

Natural Bridges National Monument
This littleleaf mountain-mahogany sparse shrub association is rare in the park and is limited to the most extreme sandstone exposures with little soil confined to cracks and shallow potholes in the bedrock. Total vegetation cover rarely exceeds 30% and is characterized by scattered clumps and patches of *Cercocarpus intricatus* with up to 20% cover. *Pinus edulis* and *Juniperus osteosperma* trees may be scattered throughout the community but do not constitute a stratum. Associated shrubs include *Yucca* sp. and *Ephedra viridis*. The herbaceous layer is nearly absent from most stands, providing sparse cover in a few; the common species are *Achnatherum hymenoides* and *Petradoria pumila*.

Globally
This Cercocarpus intricatus sparse shrub association is restricted to exposures of sandstone. Germination sites for vascular plant species are limited to cracks and small depressions in the bedrock where soil collects. Total vegetation cover is less than 20% and often is 5% or less. Cercocarpus intricatus is dominant or codominant, with between 1 and 20% cover. Most stands contain other shrubs as well, including *Amelanchier utahensis, Arctostaphylos patula, Artemisia bigelovii, Cercocarpus montanus, Glossopetalon spinescens* var. *meionandrum* (= *Forsellesia meionandra*), or *Ephedra viridis*. The herbaceous layer is diverse, variable and low in cover. Occasional dwarfed individuals (often only 1-1.5 m tall) of *Pinus edulis* of *Juniperus osteosperma* may occur. Colorful lichens may cover much of the surface of the exposed bedrock.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	Species
Short shrub/sapling	*Cercocarpus intricatus, Ephedra viridis*

Global

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

OTHER NOTEWORTHY SPECIES

Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (22-Jan-2002).

CLASSIFICATION COMMENTS

Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: This is a minor type at Natural Bridges NM; most of the slickrock communities are dominated by *Pinus edulis, Juniperus osteosperma,* and a mix of shrubs, of which *Cercocarpus intricatus* is a member. Stands dominated by *Cercocarpus intricatus* are rare, tend to be small, and occur in a matrix of slickrock pinyon-juniper woodlands.
Natural Bridges National Monument Plots: The description is based on field data collected in 2004 during accuracy assessment (5 plots: NABR_AA.010, NABR_AA.067, NABR_AA.246, NABR_AA.250, NABR_AA.266).
Local Description Authors: J. Coles
Global Description Authors: J. Coles

REFERENCES: Cogan et al. 2004, Western Ecology Working Group n.d.

Ponderosa Pine Population

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
	Not Applicable

ECOLOGICAL SYSTEM(S): Southern Rocky Mountain Ponderosa Pine Woodland (CES306.032)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
Data are not available.

DISTRIBUTION
Natural Bridges National Monument
This community is restricted to a single stand in the North Fork of Tuwa Canyon.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION
Natural Bridges National Monument
This woodland association occupies north-facing lower canyon walls and toe slopes. Slopes do not exceed 5%, and soils are deep and sandy. The elevation at the sample site is 1925 m.

Globally
Data are not available.

VEGETATION DESCRIPTION

Natural Bridges National Monument
In this type, scattered mature *Pinus ponderosa* emerge trees above a relatively dense canopy of *Pinus edulis* and *Juniperus osteosperma*. Total vegetation cover is approximately 35%. Shrubs present include scattered or patchy *Amelanchier utahensis, Quercus gambelii*, and *Shepherdia rotundifolia*. Common herbaceous species include conspicuous forbs such as *Senecio integerrimus* and *Hymenopappus filifolius*.

Globally
Data are not available.

MOST ABUNDANT SPECIES
Natural Bridges National Monument

Stratum	**Species**
Tree canopy	*Pinus ponderosa, Pinus edulis, Juniperus osteosperma*
Tall shrub/sapling	*Amelanchier utahensis, Quercus gambelii*
Short shrub/sapling	*Ericameria nauseosa, Shepherdia rotundifolia*
Herb (field)	*Senecio integerrimus, Hymenopappus filifolius*

Global
Data are not available.

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
None.

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: Not applicable

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: The ponderosa pine trees are an isolated population, possibly relict from cooler climates, persisting in a shaded canyon.
Natural Bridges National Monument Plots and Observation Points: The description is based on 2003 field data (1 plot: NABR.9058).
Local Description Author(s): J. Coles
Global Description Authors: N/A

REFERENCES: Data are not available.

Recently Chained *Pinus edulis – Juniperus osteosperma / Artemisia tridentata* ssp. *wyomingensis* Woodland

Recently chained Two-needle Pinyon – Utah Juniper / Wyoming Big Sagebrush Woodland

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable
	Not Applicable

ECOLOGICAL SYSTEM(S): Not assigned

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally
Data are not available.

DISTRIBUTION

Natural Bridges National Monument
This community is restricted to mesa tops in the environs of the mapping project area.

Globally
Data are not available.

ENVIRONMENTAL DESCRIPTION

Natural Bridges National Monument
This woodland association occurs on deep soils of the mesa tops, in areas modified for livestock forage. A ship's anchor chain dragged between two bulldozers tears trees and shrubs from the ground. The area is then seeded to exotic forage grasses. The remains of dead trees and shrubs remain on the soil surface, and much bare ground is apparent. Biological soil crusts are generally destroyed, either by the initial disturbance or by grazing livestock. Soils are rapidly drained and sandy.

Globally
Data are not available.

VEGETATION DESCRIPTION

Natural Bridges National Monument
Total vegetation cover and composition vary, depending on how long ago the disturbance occurred. Most stands within the mapping project area are in some stage of recovery. Young trees are generally present and shrubs are increasing in density. Patches of remnant native bunchgrasses occur in most stands. Stands may be dominated by exotic grasses such as Agropyron cristatum or by shrubs, especially *Artemisia tridentata* ssp. *wyomingensis*, *Atriplex confertifolia* and *Chrysothamnus viscidiflorus*. Native herbaceous species range from sparse to common and may include *Achnatherum hymenoides* and *Hesperostipa comata*.

Globally
Data are not available.

MOST ABUNDANT SPECIES

Natural Bridges National Monument

Stratum	**Species**
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Agropyron cristatum*
Herb (field)	*Machaeranthera canescens*

Global
Data are not available.

OTHER NOTEWORTHY SPECIES
Natural Bridges National Monument
Bromus tectorum

Globally
Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS
Natural Bridges National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: Not applicable

ELEMENT SOURCES
Natural Bridges National Monument Inventory Notes: The community will eventually return to an approximately natural condition if left undisturbed. Dates of the original chaining are not available, but probably occurred within the past 20 years.
Natural Bridges National Monument Plots and Observation Points: The description is based on 2003 field data (1 observation point: NABR.9105).
Local Description Author: J. Coles
Global Description Authors: N/A

REFERENCES: Data are not available.

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Appendix G

ILLUSTRATED KEY TO THE PLANT ASSOCIATIONS OF NATURAL BRIDGES NATIONAL MONUMENT

The vegetation of Natural Bridges National Monument was sampled during the summer of 2003 under the US Geological Survey and National Park Service Vegetation Mapping Program. This dichotomous key, illustrated with images taken during the sampling effort, has been prepared to assist in the field identification of 35 plant associations described for Natural Bridges National Monument. The key is designed to work using one or more dominant species with environmental characteristics. Because of natural variation within plant associations, observers may need to try more than one of the physiognomic keys. In ecotones (areas where plant associations mix), it may be difficult to determine a definitive association name. This illustrated key also allows the user to crosswalk plant associations directly to the Natural Bridges National Monument vegetation map. Each map class may contain more than one plant association.

HOW TO USE THE KEY:

The key approaches plant association identification at two levels. The first level is physiognomic (forest, woodland, tall shrubland, shrubland, dwarf-shrubland, graminoid, or forb). The second level allows identification to plant association based on the dominant species, and to a lesser extent, habitat characteristics. Photographs demonstrating variation within vegetation types are shown below association names.

It is possible that in using this key, you will have difficulty arriving at an association that describes your community. There are several possible reasons for this, 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 10% (tree layer) or 5% (shrub or herbaceous layers), it is ignored. The exception is in very sparse communities (see #3).

2. You can follow a key to a certain point, but you clearly have something not described in the key. This is to be expected – very likely you have an association that was not found during the sampling phase of the project. In this case, simply record "Unclassified pinyon-juniper (or whatever type of vegetation you have) association". Be sure to note the dominant species and their cover.

3. Communities that are sparsely vegetated (i.e., < 10% 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.

KEY I
A Key to the Major Physiognomic Groups of Natural Bridges National Monument

1a Vegetation woody or appearing woody, consisting primarily of trees, shrubs, or shrub-like herbs; total vegetation cover may be sparse to dense **(2)**

1b Vegetation consisting primarily of grasses, grass-like herbs (sedge, scouring-rush), or broadleaf herbs (forbs); total vegetation cover may be sparse to dense. Although some woody species may be present, they have low relative cover and are not dominant. Characteristic genera include *Achnatherum, Aquilegia, Bouteloua, Carex, Hesperostipa, Juncus, Mimulus,* and *Pleuraphis* - **Key IV**




Photo credits: NCPN

2a (1) Forest or woodland vegetation; characteristic genera include *Acer, Juniperus, Pinus, Populus, Pseudotsuga* - **Key II**. For woodlands with a canopy of *Quercus gambelii*, see **Key III**




Photo credits: NCPN

2b Tall, short, or dwarf-shrub vegetation; canopies may interlock but are more commonly less dense. Some trees may be present with low relative cover. Characteristic genera

include: *Amelanchier, Artemisia, Cercocarpus, Ericameria, Quercus, Rosa, Salix* - **Key III**





Photo credits: NCPN

KEY II
A Key to the Forest and Woodland Associations of Natural Bridges National Monument

1a Forests and woodlands with a canopy dominated by the genus *Populus*, usually growing on stream banks, stream terraces, and/or cold air canyons **(2)** [*Note: many of these riparian stands were severely affected by flooding during 2003 and may not retain all characteristics described in this key*.]

1b Forests and woodlands with canopies dominated by *Juniperus, Pinus*, and/or *Pseudotsuga*, often with scattered young trees or shrubs present in the open ground between tree canopies **(7)**

2a (1) Deciduous riparian forests and woodlands with a canopy dominated by Populus angustifolia trees with an understory of *Rosa woodsii* shrubs or by P*opulus x acuminata* with an understory of *Pascopyrum smithii* **(3)**

2b Deciduous riparian forests and woodlands with canopies dominated by *Populus deltoides* ssp. *wislizeni*, typically with understories of *Acer negundo, Ericameria nauseosa*, or *Salix* spp. **(4)**

3a (2) Deciduous riparian stands with a tree canopy dominated by mature *Populus angustifolia* with an understory of *Rosa woodsii* shrubs. Stands occur on middle riparian terraces that rarely flood – **Populus angustifolia / Rosa woodsii Forest (Narrowleaf Cottonwood / Woods' Rose Forest) [Map Class 2]**



Photo credits: NCPN

3b Deciduous riparian woodlands with a canopy dominated by *Populus deltoides* ssp. *wislizeni* or *P. x acuminata* trees with an understory of *Pascopyrum smithii* and growing on lower riparian terraces that experience regular flooding – **Populus deltoides (ssp. wislizeni, ssp. monilifera) / Pascopyrum smithii Woodland (Plains, Rio Grande Cottonwood / Western Wheatgrass Woodland) [Map Class 2]**

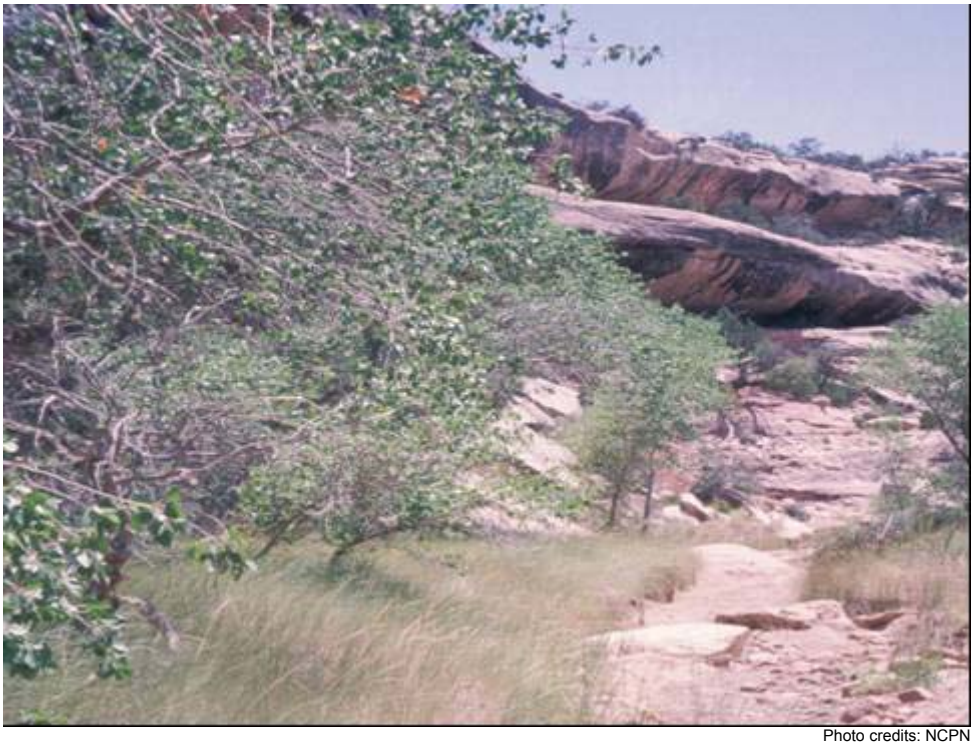


Photo credits: NCPN

4a (2) Deciduous riparian woodlands with a canopy dominated by *Populus deltoides* ssp. *wislizeni* trees and an understory dominated by *Ericameria nauseosa* and *Artemisia tridentata* ssp. *tridentata* shrubs. Stands are on high terraces that rarely flood – **Populus deltoides (ssp. wislizeni, ssp. monilifera) / Artemisia tridentata Woodland (Plains, Rio Grande Cottonwood / Basin Big Sagebrush Woodland) [Map Class 2]**

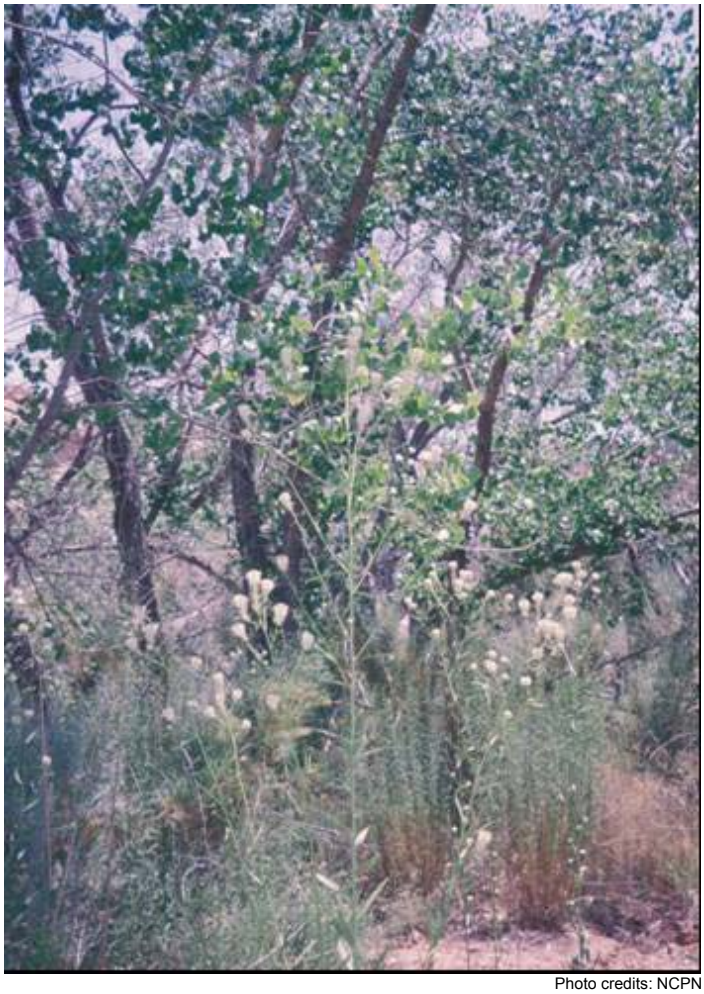


Photo credits: NCPN

4b Deciduous riparian forests with a canopy dominated by *Populus deltoides* ssp. *wislizeni* trees with a subcanopy of *Acer negundo* or an understory dominated by *Salix* spp. **(5)**

5a (4) Deciduous riparian forests with a canopy dominated by *Populus deltoides* ssp. *wislizeni* trees and a subcanopy of *Acer negundo*. Additional understory shrubs include *Amelanchier utahensis, Fraxinus anomala,* and/or *Rhus trilobata*. Stands on middle riparian terraces that rarely flood – **Populus deltoides ssp. wislizeni / Acer negundo Woodland (Rio Grande Cottonwood / Box-elder Woodland) [Map Class 2]**



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5b Deciduous riparian forests with a canopy dominated by *Populus deltoides* ssp. *wislizeni* and an understory consisting primarily of *Salix exigua* or *Salix lutea* (*ligulifolia*) **(6)**

6a (5) Deciduous woodlands with a canopy dominated by *Populus deltoides* ssp. *wislizeni* and an understory of *Salix lutea* (*ligulifolia*) shrubs; growing on lower terraces that flood regularly – **Populus fremontii / Salix (ligulifolia, lutea) Woodland (Fremont Cottonwood / (Strapleaf, Yellow) Willow Woodland) [Map Class 2]**



Photo credits: NCPN

6b Deciduous riparian forests with a canopy dominated by *Populus deltoides* ssp. *wislizeni* trees and an understory of *Salix exigua* shrubs; growing on lower riparian terraces that regularly flood – **Populus deltoides (ssp. wislizeni, ssp. monilifera) / Salix exigua Woodland (Plains, Rio Grande Cottonwood / Coyote Willow Woodland) [Map Class 2]**

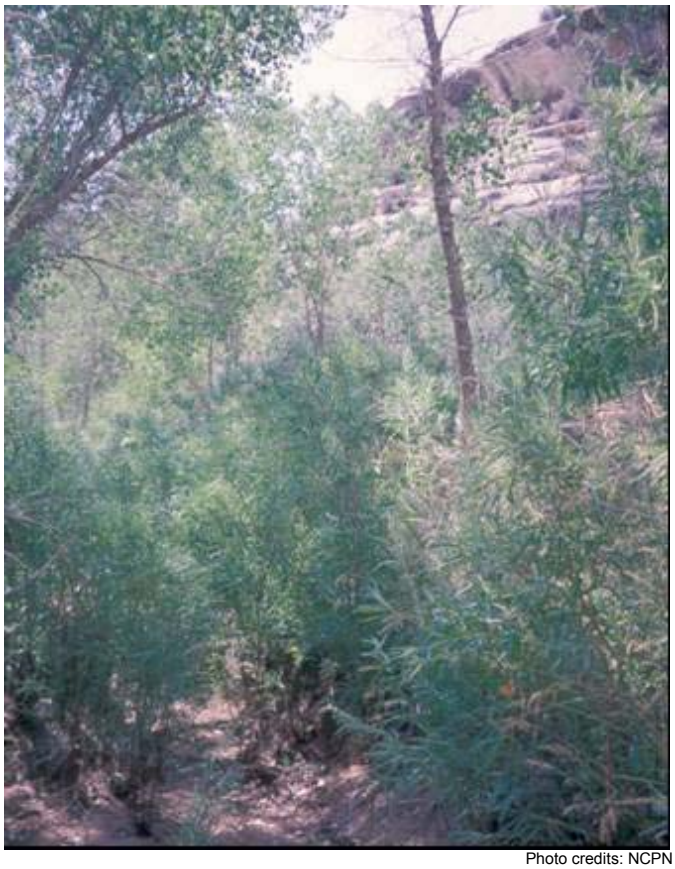


Photo credits: NCPN

7a (1) Upland coniferous forests with a canopy dominated by *Pseudotsuga menziesii*, growing on north-facing canyon walls or in cold-air drainages **(8)**

7b Upland coniferous woodlands with a canopy dominated by *Pinus edulis* and/or *Juniperus osteosperma* trees (in one case, *Pinus ponderosa* trees). Substrates include mesas, slopes, canyons, and bedrock exposures **(10)**

8a (7) Woodlands with a canopy dominated by *Pseudotsuga menziesii* trees; the shrub understory dominated by *Arctostaphylos patula* or *Symphoricarpos oreophilus* (often with *Chrysothamnus linifolius* and/or *Mahonia fremontii*) **(9)**

8b Douglas-fir woodlands with a tall shrub understory of *Quercus gambelii*, often with a subcanopy of *Juniperus scopulorum* and/or *Pinus edulis*. Stands occupy cool north-facing canyon walls – **Pseudotsuga menziesii / Quercus gambelii Forest (Douglas-fir / Gambel Oak Forest) [Map Class 12]**



Photo credits: NCPN

9a (8) Douglas fir woodlands with a shrub understory that includes *Arctostaphylos patula*. Stands grow on north-facing canyon walls where the shrubs are patchy in distribution and occur in canopy openings – **Pseudotsuga menziesii / Arctostaphylos patula Forest (Douglas-fir / Greenleaf Manzanita Forest) [Map Class 12]**



Photo credits: NCPN

9b Douglas-fir woodlands, with a shrub understory in which *Symphoricarpos oreophilus* is conspicuous to co-dominant (sometimes also with *Chrysothamnus linifolius* or *Mahonia fremontii* – **Pseudotsuga menziesii / Symphoricarpos oreophilus Forest (Douglas-fir / Mountain Snowberry Forest) [Map Class 12]**



Photo credits: NCPN

10a (7) Pinyon-juniper woodlands occurring near canyon rims with exposed bedrock and shallow soils concentrated in rock fractures **(11)**

10b Pinyon-juniper woodlands occurring on level to rolling uplands with deeper soils, steep north-facing slopes, riparian terraces, or on ledges below canyon rims **(14)**

11a (10) Pinyon-juniper woodlands with an understory characterized by relatively abundant *Arctostaphylos patula*; commonly occurs near canyon rims – **Pinus edulis – Juniperus osteosperma / Arctostaphylos patula Woodland (Two-needle Pinyon – Utah Juniper / Greenleaf Manzanita Woodland) [Map Class 17]**



Photo credits: NCPN

11b Pinyon-juniper woodlands occurring on this soils near canyon rims with an understory characterized by the genera *Cercocarpus* or *Purshia* **(12)**

12a (11) Pinyon-juniper woodlands near canyon rims with an understory of mixed, shrubs among which *Purshia stansburiana* is dominant - **Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland (Two-Needle Pinyon - Utah Juniper /Pursh's Cliffrose Woodland) [Map Class 17].**

NO PHOTO AVAILABLE

12b Pinyon-juniper woodlands occurring on this soils near canyon rims with an understory characterized and usually dominated by the genus *Cercocarpus* **(13)**

13a (12) Pinyon-juniper woodlands with an understory of mixed, shrubs among which *Cercocarpus intricatus* is conspicuous to co-dominant. Stands may have very low cover of Pinus edulis and *Juniperus osteosperma* tree and *Cercocarpus intricatus* cover may be as low as 3% – **Pinus edulis – Juniperus osteosperma / Cercocarpus intricatus Woodland (Two-needle Pinyon – Utah Juniper / Greenleaf Manzanita Woodland) [Map Class 9, 17]**



Photo credits: NCPN

13a (cont'd) Extremely sparse communities (<5% total cover) consisting primarily of scattered Cercocarpus intricatus shrubs with occasional stunted *Pinus edulis* and/or *Juniperus osteosperma* trees occupying otherwise barren slickrock canyon walls and rims - **Cercocarpus intricatus Slickrock Sparse Vegetation (Littleleaf Mountain Mahogany Slickrock Sparse Vegetation) [Map Class 9r]**



Photo credits: NCPN

13b Pinyon-juniper woodlands with an understory of relatively abundant *Cercocarpus montanus*; if *Cercocarpus intricatus* is present it is with very low cover. Stands typically occupy canyon rims and areas where canyon rims have broken down – **Pinus edulis – Juniperus spp. / Cercocarpus montanus – Mixed Shrubs Woodland (Two-needle Pinyon – Juniper / Mountain Mahogany - Mixed Shrubs Woodland) [Map Class 17]**





Photo credits: NCPN

14a (10) Pinyon-juniper woodlands with a predominantly herbaceous or sparse understory stratum **(15)**

14b Pinyon-juniper woodlands with a predominantly shrub understory stratum **(17)**

15a (14) Pinyon-juniper woodlands with a sparse understory (<5% cover of shrubs and herbaceous species); occurring on eolian or residual reddish soils throughout the park – **Pinus edulis – Juniperus osteosperma / Sparse Understory Woodland (Two-needle Pinyon – Utah Juniper / Sparse Understory Woodland) [Map Class 16]**



Photo credits: NCPN

15b Pinyon-juniper woodlands with an understory characterized by *Petradoria pumila* or *Hesperostipa comata* **(16)**

16a (15) Pinyon-juniper woodlands with significant cover of non-vascular species and *Petradoria pumila* in the understory; large shrubs and grasses provide less than 1% cover – **Pinus edulis – Juniperus osteosperma / Petradoria pumila Woodland (Two-needle Pinyon – Utah Juniper / Grassy Rockgoldenrod – Cushion Plant Woodland) [Map Class 17]**



Photo credits: NCPN

16b Pinyon-juniper woodlands with significant cover of *Hesperostipa comata* in the understory; shrubs may be present, but with less than 1% cover – **Pinus edulis – (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata Woodland (One-needle, Two-needle Pinyon – Utah Juniper / Needle and Thread Grass Woodland) [Map Class 18]**



Photo credits: NCPN

17a (14) Pinyon-juniper woodlands with scattered *Artemisia tridentata* ssp. *wyomingensis* present in the understory (>5%). Stands occur in a mosaic with *Pinus edulis* - *Juniperus osteosperma / Shepherdia rotundifolia* stands; ecotones are common; associated with deep, eolian or residual reddish soils – **Pinus edulis – Juniperus spp. / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland (Two-needle Pinyon – Juniper / (Wyoming, Mountain) Big Sagebrush Woodland) [Map Class 15]**



Photo credits: NCPN

17b Pinyon-juniper woodlands with *Quercus gambelii*, *Shepherdia rotundifolia*, or *Amelanchier utahensis* dominant in the understory **(18)**

18a (17) Pinyon-juniper woodlands with significant cover of *Quercus gambelii* in the understory (*Pinus ponderosa* trees are rarely associated with this type in deep canyons) – **Pinus edulis – Juniperus spp. / Quercus gambelii Woodland (Two-needle Pinyon – Juniper / Gambel Oak Woodland) [Map Class 2]**



Photo credits: NCPN

18b Pinyon-juniper woodlands with *Shepherdia rotundifolia* or *Amelanchier utahensis* dominant or co-dominant in the understory **(19)**

19a (18) Pinyon-juniper woodlands on deep soils of mesa tops with a scattered shrub understory dominated by Shepherdia rotundifolia. *Artemisia tridentata* ssp. *wyomingensis* may be present with <5% cover. This type occurs in a landscape mosaic with stands of *Pinus edulis* - *Juniperus osteosperma / Artemisia tridentata* ssp. *wyomingensis* and *Pinus edulis* - *Juniperus osteosperma* / Sparse Understory – **Pinus edulis – Juniperus osteosperma / Shepherdia rotundifolia Woodland (Two-needle Pinyon – Utah Juniper / Roundleaf Buffaloberry Woodland) [Map Class 15, 16]**



Photo credits: NCPN

19b Pinyon-juniper woodlands with *Shepherdia rotundifolia* and/or *Amelanchier utahensis* present in the understory; tree cover may be sparse; associated only with steep, north-facing slopes underlain by Chinle or Moenkopi shales and with a significant layer of broken sandstone colluvium – **Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis) Wooded Shrubland (Two-needle Pinyon - Utah Juniper / (Roundleaf Buffaloberry, Utah Serviceberry) Wooded Shrubland) [Map Class 19]**

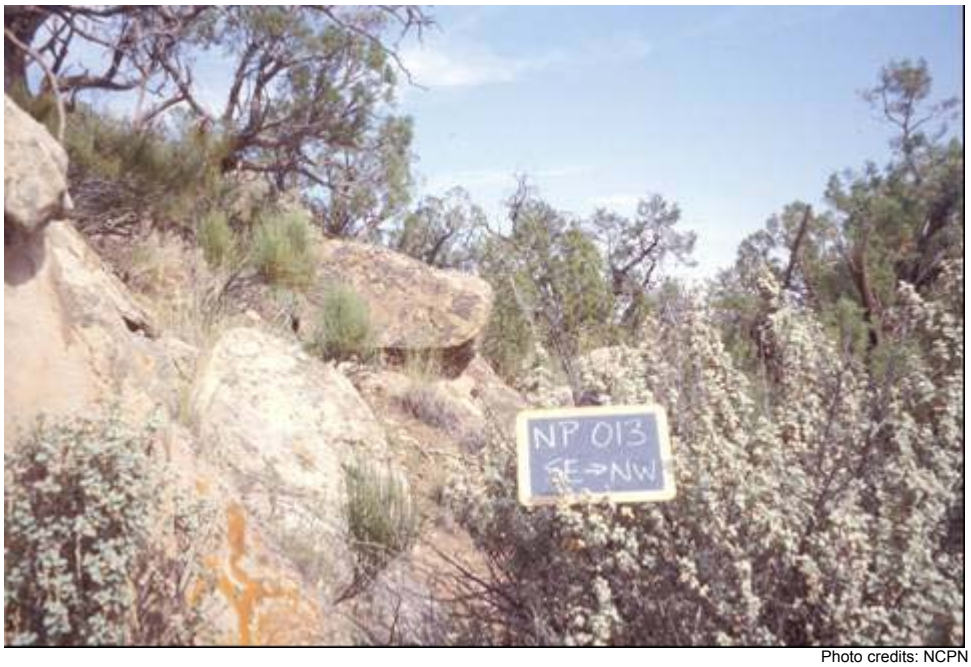


Photo credits: NCPN

KEY III
A Key to the Shrubland and Wooded Shrubland Associations of Natural Bridges National Monument

1a Tall shrublands dominated by *Salix exigua*, often co-dominant with *Salix lutea*, growing on stream banks, saturated point bars, and active stream terraces; a graminoid stratum is typically present, relatively diverse, and may include *Juncus* spp. Many stands were damaged or destroyed by floods in 2003 – **Salix exigua / Mesic Graminoids Shrubland (Coyote Willow / Mesic Graminoids Shrubland) [Map Class 2]**



Photo credits: NCPN

1b Shrublands dominated by shrubs characteristic of upland communities, including *Artemisia*, *Amelanchier*, *Cercocarpus*, and *Quercus* growing on mesa tops, drainage terraces, flats, or slopes **(2)**

2a (1) Tall shrublands containing scattered pinyon and/or juniper trees, so that they appear to be wooded shrublands. The shrub layer is dominated by *Amelanchier utahensis* and/or *Cercocarpus montanus* on north-facing rockfall or talus slopes, or extremely sparse communities (<5% total cover) consisting of scattered *Cercocarpus intricatus* shrubs growing directly out of slickrock on canyon walls and rims **(3)**

2b Tall shrublands or woodlands dominated by *Quercus gambelii*, *Artemisia tridentata*, and/or *Symphoricarpos oreophilus* growing on mesa tops, canyon bottoms, elevated stream terraces, and/or on rocky, mesic slopes **(5)**

3a (2) Tall shrublands containing scattered pinyon and/or juniper trees, so that they appear to be wooded shrublands. The shrub layer is dominated by *Amelanchier utahensis* and/or *Cercocarpus montanus* on north-facing rockfall or talus slopes **(4)**

3b Extremely sparse communities (<5% total cover) consisting of scattered *Cercocarpus intricatus* shrubs with occasional stunted *Pinus edulis* and/or *Juniperus osteosperma* trees occupying otherwise barren slickrock canyon walls and rims - **Cercocarpus intricatus Slickrock Sparse Vegetation (Littleleaf Mountain Mahogany Slickrock Sparse Vegetation) [Map Class 9r]**



Photo credits: NCPN

4a (3) Tall shrublands of *Amelanchier utahensis* and/or *Cercocarpus montanus* growing on rocky, north-facing slopes in canyons; scattered *Pinus edulis* and *Juniperus osteosperma* trees may be present. Tree cover is less than 10%; if >10%, see Key II – **Amelanchier utahensis – Cercocarpus montanus Shrubland (Utah Serviceberry – Alderleaf Mountain Mahogany Shrubland) [Map Class 17r]**



Photo credits: NCPN

4b Woodlands or open wooded shrublands or woodlands of *Pinus edulis* and *Juniperus osteosperma* trees with a mixed shrub understory in which *Shepherdia rotundifolia* and/or *Amelanchier utahensis* is dominant. *Artemisia tridentata, Ephedra viridis,* and *Cercocarpus montanus* may also be present,. This type is restricted to steep, north-facing slopes underlain by Chinle or Moenkopi shales with significant sandstone colluvium – **Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis) Wooded Shrubland (Two-needle Pinyon - Utah Juniper / (Roundleaf Buffaloberry, Utah Serviceberry) Wooded Shrubland [Map Class 19]**



Photo credits: NCPN

5a (2) Upland shrublands dominated by woody species of *Artemisia*; either *A. tridentata* ssp. *tridentata* on upper stream terraces or *A. tridentata* ssp. *wyomingensis* on deep soils of mesa tops **(6)**

5b Tall shrublands or woodlands dominated by *Quercus gambelii*, sometimes with *Amelanchier utahensis* and/or *Symphoricarpos oreophilus*, growing on rocky, mesic slopes **(8)**

6a(5) Tall shrublands of canyon bottom terraces dominated by *Artemisia tridentata* ssp. *tridentata* with a graminoid dominated understory of either *Bromus tectorum* or native grasses, among which *Hesperostipa comata* is prominent **(7)**

6b Short shrublands dominated by *Artemisia tridentata* ssp. *wyomingensis*, usually located on mesa tops as openings in pinyon-juniper woodlands. The understory may be sparse, or it may reflect a history of manipulation, being dominated by *Agropyron cristatum*. Most examples are in the park environs, except for a few small stands near the old entrance on the south side of the Monument - **Artemisia tridentata ssp. wyomingensis / (Agropyron cristatum, Psathyrostachys juncea) Semi-natural Shrubland (Wyoming Big Sagebrush / (Crested Wheatgrass, Russian Wildrye) Semi-natural Shrubland) [Map Class 20]**



Photo credits: NCPN

7a (6) Tall shrublands of canyon bottom terraces dominated by *Artemisia tridentata* ssp. *tridentata* with an understory dominated by *Bromus tectorum*. *Ericameria nauseosa* and other upland shrubs are frequently present – **Artemisia tridentata -**

(Ericameria nauseosa) / Bromus tectorum Semi-natural Shrubland (Basin Big Sagebrush – (Rubber Rabbitbrush) / Cheatgrass Semi-natural Shrubland) [Map Class 2]



Photo credits: NCPN

7b Tall shrublands of canyon bottom terraces dominated by *Artemisia tridentata* ssp. tridentata with an understory dominated by *Hesperostipa comata*; other native bunchgrasses are usually present, but if *Bromus tectorum* is present, it is with relatively low cover - **Artemisia tridentata (ssp. tridentata, ssp. xericensis) / Hesperostipa comata Shrubland (Basin Big Sagebrush / Needle-and-Thread Grass Shrubland) [Map Class 2]**



Photo credits: NCPN

8a (5) Tall shrublands or woodlands dominated by even-aged clones of *Quercus gambelii* with an understory consisting primarly of oak sprouts with few other woody or herbaceous species. Stands are on upper riparian terraces that rarely flood, although they may be eroded by flash flooding – **Quercus gambelii / Sparse Understory Shrubland (Gambel Oak / Sparse Understory Shrubland) [Map Class 4]**

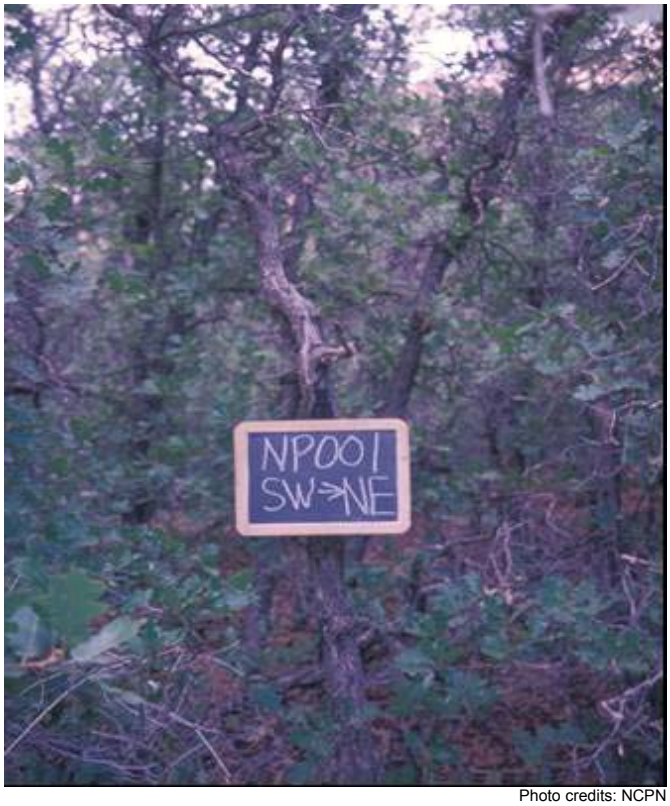


Photo credits: NCPN

8b Tall shrublands or woodlands dominated by *Quercus gambelii* with an understory that includes other shrubs, such as Amelanchier utahensis or *Symphoricarpos oreophilus* shrubs **(9)**

9a (8) Open tall shrublands or woodlands with a canopy co-dominated by *Quercus gambelii* and *Amelanchier utahensis*. The understory is variable, but may include scattered *Ericameria nauseosa* and *Ephedra viridis*. The herbaceous layer is typically sparse; *Poa fendleriana* is the only consistent species - **Quercus gambelii / Amelanchier utahensis Shrubland (Gambel Oak / Utah Serviceberry Shrubland) [Map Class 4]**

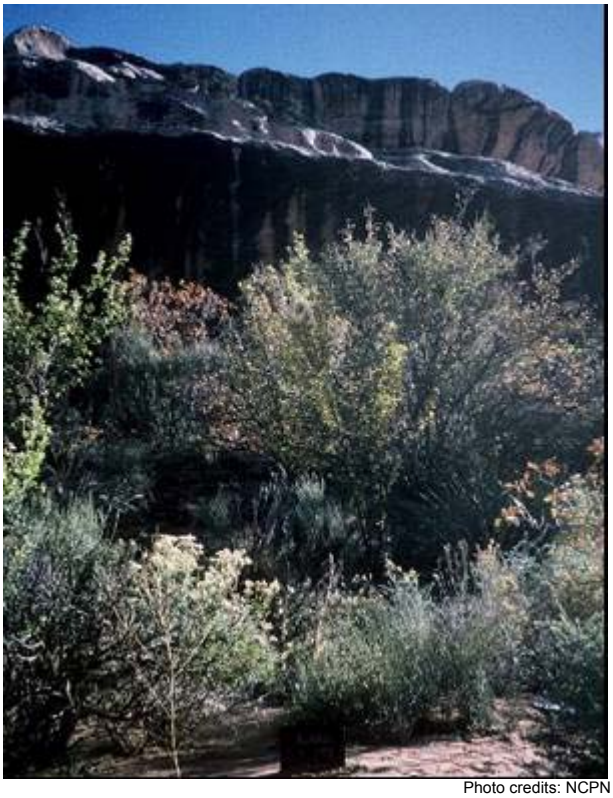


Photo credits: NCPN

9b Shrublands or woodlands with a canopy dominated by *Quercus gambelii*. The understory includes *Symphoricarpos oreophilus*; stands are located on high stream terraces that rarely flood and are more mesic than sites supporting the *Quercus gambelii* / Sparse Understory association – **Quercus gambelii / Symphoricarpos oreophilus Shrubland (Gambel Oak / Mountain Snowberry Shrubland) [Map Class 4]**



Photo credits: NCPN

KEY IV
A Key to the Herbaceous Associations of Natural Bridges National Monument

1a Perennially moist hanging gardens or seeps emerging in alcoves and on cliff faces. Characteristic and usually dominant species include *Aquilegia micrantha, Mimulus eastwoodiae, Adiantum capillus-veneris,* and *Calamagrostis scopulorum*. Mesic woody species such as *Amelanchier utahensis, Cercocarpus intricatus* and *Fraxinus anomala* are often present around the margins of the seep or on wet talus below an alcove - **Aquilegia micrantha – Mimulus eastwoodiae Herbaceous Vegetation (Mancos Columbine – Eastwood Monkeyflower Herbaceous Vegetation) [Map Class 1]**



Photo credits: NCPN

1b Herbaceous ssociation of mesic to xeric sites characterized by the grasses *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata,* and/or *Pleuraphis jamesii* **(2)**

2a (1) Grasslands occurring on sandy point bars in canyon bottoms dominated by *Hesperostipa comata; Achnatherum hymenoides* may be present to co-dominant – **Hesperostipa comata Great Basin Herbaceous Vegetation (Needle-and-Thread Grass Great Basin Herbaceous Vegetation) [Map Class 22]**



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2b Upland grasslands characterized by *Bouteloua gracilis* and/or *Pleuraphis jamesii* occurring primarily in potholes on rocky ledges below canyon rims, but also on the Cedar Mesa bench in the northwestern part of the Monument **(3)**

3a (2) Upland grasslands dominated by *Bouteloua gracilis*, generally with at least 15% cover – **Bouteloua gracilis Herbaceous Vegetation (Blue Grama Herbaceous Vegetation) [Map Class 22]**


Photo credits: NCPN

3b Herbaceous association of xeric grasslands characterized by *Pleuraphis jamesii* at generally >10% cover – **Pleuraphis jamesii Herbaceous Vegetation (James' Galleta Herbaceous Vegetation) [Map Class 22]**



Photo credits: NCPN

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Appendix H

Modified Anderson Land Use-Land Cover Classification

This classification was used to attribute polygons in the environs mapped around Colorado National Monument.

Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
1.0 Water	1.1 Open Water	1.11 Stream/river			
		1.12 Canal/ditch	1.121 Lined canal/ditch		
			1.122 Unlined canal/ditch		
		1.13 Lake/pond			
		1.14 Reservoir			
		1.15 Bay/estuary			
		1.16 Sea/ocean			
	1.2 Perennial Ice/Snow	1.21 Snowfield			
		1.22 Glacier			
2.0 Developed	2.1 Residential	2.11 Single-family residential			
		2.12 Multi-family residential			
	2.2 Non-residential Developed	2.21 Commercial/Light Industry	2.211 Major Retail		
			2.212 Mixed/Minor Retail and Services		
			2.213 Office		
			2.214 Light industry		
		2.22 Heavy Industry	2.221 Petro-chemical Refinery		
		2.23 Communications and Utilities			
		2.24 Institutional	2.241 Schools		
			2.242 Cemeteries		
		2.25 Agricultural Business	2.251 Aquiculture		
			2.252 Confined feeding		
		2.26 Transportation	2.261 Airport		
		2.27 Entertainment/ Recreation	2.271 Golf Course		
			2.272 Urban Parks		
	2.3 Mixed Urban				
3.0 Bare	3.1 Transitional				
	3.2 Quarries/Strip mines/Gravel pits				
	3.3 Bare Rock/Sand				
	3.4 Flats				

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 loose all their leaves for a specific season of the year

4.122 Evergreen Shrub land - areas where 75% or more of the land cover can be determined to be shrubs that keep their leaves year round.

4.123 Mixed Shrub land - areas dominated by shrubs where neither deciduous nor evergreen species represent more than 75% of the land cover

4.124 Desert Scrub - land areas predominantly in arid and semi-arid portions of the southwestern U.S. Existing vegetation is sparse and often covers only 5-25% of the land. Example species include sagebrush, creosote, saltbush, black greasewood, and cactus.

4.13 Planted/Cultivated Woody (Orchards/Vineyards/Groves) - areas containing plantings of evenly spaced trees, shrubs, bushes, or other cultivated climbing plants usually supported and arranged evenly in rows. Includes orchards, groves, vineyards, cranberry bogs, berry vines, and hops. Includes tree plantations planted for the production of fruit, nuts, Christmas tree farms, and commercial tree nurseries. Exclude pine plantations and other lumber or pulp wood plantings that will be classified as Forest.

4.131 Irrigated Planted/Cultivated Woody - orchards, groves, or vineyards where a visible irrigation system is in place to supply water

4.14 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 open bogs.

Appendix J

Map Class Descriptions for Natural Bridges National Monument

Introduction

This document provides a visual guide and description of the map classes for the Natural Bridges National Monument Vegetation Mapping Project. Seventeen vegetation and 3 land use map classes were delineated and defined as part of the mapping project. Each of the vegetation map classes associated with this project is documented by:

- ground photographs
- a list of component NVC associations and ecological systems
- common plant species
- examples of each map class signature taken from the ortho imagery with delineated polygons
- descriptions of the photo signature
- a description of the ecology and distribution of the map class throughout the mapping area
- polygon statistics report (polygon number, size, area and proportion)
- accuracy assessment results for each map class

One vegetation map class (#1, H-HGSS) is associated only with point data and documents springs, seeps and hanging gardens. Because it occurs primarily on vertical canyon walls, no photo signature is available, so this map class receives an abbreviated description.

This key does not attempt to show all variations within each vegetation map class; only the most common or significant representations are included. These should be sufficient to give the user a feel for the imagery and an understanding of the relationships between the vegetation classification and mapping.



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Map Class 1
Hanging Gardens
(H-HGSS)



Photo credit: NPS

H-HGSS Map Class Statistics

Type	Point
Frequency	6 total project points
	6 points in NABR
	0 points in environs
Area	Total project area = N/A
Average Size	N/A
Proportion	N/A
Accuracy	100% (mapped only where known from plot data.)

Ecological System

Colorado Plateau Hanging Garden (CES304.764)

Association

Aquilegia micrantha - *Calamagrostis scopulorum* Herbaceous Vegetation [CEGL002592]

Common species

Aquilegia micrantha	*Calamagrostis scopulorum*
Cirsium calcareum	*Zigadenus elegans*
Schizachyrium scoparium	*Zigadenus vaginatus*

Distribution/Ecology/Composition

The best examples of this association are restricted to alcoves formed in the massive Cedar Mesa Sandstone. Less-well-developed examples occupy seeping cracks in cliff faces. Groundwater moving through the sandstone becomes concentrated by lenses of impermeable shale within the sandstone. Where these lenses are exposed in canyon walls, water emerges with a steady, year-round flow. Over time, alcoves form as water dissolves the calcareous cement holding the sandstone together. Hanging gardens occur in every major canyon within NABR and in many of the tributary canyons.

The availability of water throughout the growing season supports a unique assemblage of plants within the alcove and in the saturated talus downslope known as a hanging garden. Many species are endemic to the Colorado Plateau and are not found outside of hanging gardens. Characteristic species at NABR include *Calamagrostis scopulorum* and *Aquilegia micrantha*; both are usually present and have significant cover. *Cirsium calcareum, Adiantum capillus-veneris, Zigadenus* spp., and *Epipactis gigantea* are other endemic species that are often present. Common plants growing around the margins of the garden may include *Amelanchier utahensis, Prunus virginiana, Quercus gambelii, Cercocarpus intricatus, Pinus edulis,* and *Juniperus* spp. Although vegetation is dense within the gardens (usually exceeding 100%), examples are usually long and narrow; they may extend for more than 100m along a horizontal crack, but may be no more than 1 or 2m wide in most places.

Interpretation

This type was not interpreted; because it occurs on near-vertical cliff faces or beneath cliff overhangs, most examples are invisible on the aerial imagery. Instead, this type is documented by point data derived from the plots database.

Map Class 2
Canyon Bottom Vegetation
(C-CABV)


Photo credit: NPS


Photo credit: NPS

C-CABV Map Class Statistics

Type	Complex
Frequency	Total project polygons = 96 polygons in NABR = 73 polygons in environs = 23
Area	Total project area = 95.4 hectares / 236 acres Hectares 76.6 / acres 189.3 in NABR hectares18.8 / 46.4 acres in environs
Average Size	Total project polygons = 1.1 hectares / 2.6 acres 1.0 hectares / 2.6 acres in NABR .82 hectares / 2.0 acres in environs
Proportion	1.8% of total project mapping area 2.6% of NABR portion of mapping area .008% of environs portion of mapping area
Accuracy (NABR only)	Producer: 90% ± 11% User: 87% ± 11%

Ecological Systems

Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)
North American Arid West Emergent Marsh (CES300.729)
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

Associations

Artemisia dracunculus Herbaceous Vegetation [Park Special]
Artemisia tridentata ssp. *tridentata / Hesperostipa comata* Shrubland [CEGL002966]
Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Semi-natural Shrubland [CEGL002699]
Phragmites australis Western North American Temperate Semi-natural Herbaceous Vegetation [CEGL001475]
Pinus edulis - Juniperus spp. */ Quercus gambelii* Woodland [CEGL000791]
Populus angustifolia / Rosa woodsii Forest [CEGL000653]

Populus deltoides (ssp. *wislizeni,* ssp. *monilifera*) */ Artemisia tridentata* Woodland [CEGL005966]
Populus deltoides (ssp. *wislizeni,* ssp. *monilifera) / Pascopyrum smithii* Woodland [CEGL002680]
Populus deltoides (ssp. *wislizeni, ssp. monilifera*) */ Salix exigua* Woodland [CEGL002685]
Populus deltoides ssp. *wislizeni / Acer negundo* Forest [CEGL002336]
Populus fremontii / Salix (ligulifolia, lutea) Woodland [CEGL004002]
Salix exigua / Mesic Graminoids Shrubland [CEGL001203]

Common species

Pinus edulis	*Juniperus osteosperma*
Quercus gambelii	*Artemisia tridentata* ssp. *tridentata*
Populus deltoides ssp. *wislizeni*	*Salix exigua*
Ericameria nauseosa	*Hesperostipa comata*

Distribution/Ecology/Composition

This map class includes a complex of upland and mesic woodlands and shrubland communities common to the floors of White, Armstrong, and Deer canyons. Although the communities are often distinct on the aerial photographs, they occur in a mosaic of polygons that are too small to map. The prevalence of shadows in some parts of the canyons also makes it difficult to map the bottoms accurately. At the accuracy assessment meeting the participants decided to combine all the canyon bottom map classes except Oak Tall Shrubland (#4, S-GOAK) into a single map class.

The canyon bottoms consist of a single active channel and a series of terraces. Point bars and the lowest terraces flood frequently, but are stable enough to support perennial vegetation that depends on a high water table. Communities found in these situations tend to have coyote willow and mesic herbaceous species as dominants. Middle and higher terraces are isolated from the water table and flood less often. The mesic species in these communities are relict (e.g., mature cottonwood trees with no seedlings), with upland species such as basin big sagebrush and needle-and-thread grass dominating the understory.

Interpretation

Polygons of map class C-CABV tend to be long, narrow and sinuous, as they follow the winding bottom of major canyons. The vegetation appears as a patchy, unevenly rough-textured medium green produced by tree and shrub crowns. Basin big sagebrush patches are a smooth gray, and herbaceous communities are a smooth light brown color. They can be distinguished from polygons of map class S-GOAK (#4) because the oak polygons have a solid, uniform texture and dark green color.



Example of the photo signature for map class C-CABV (#2).

Map Class 3
Stream Channel - Sand Bar Sparse Vegetation (C-SCSB)

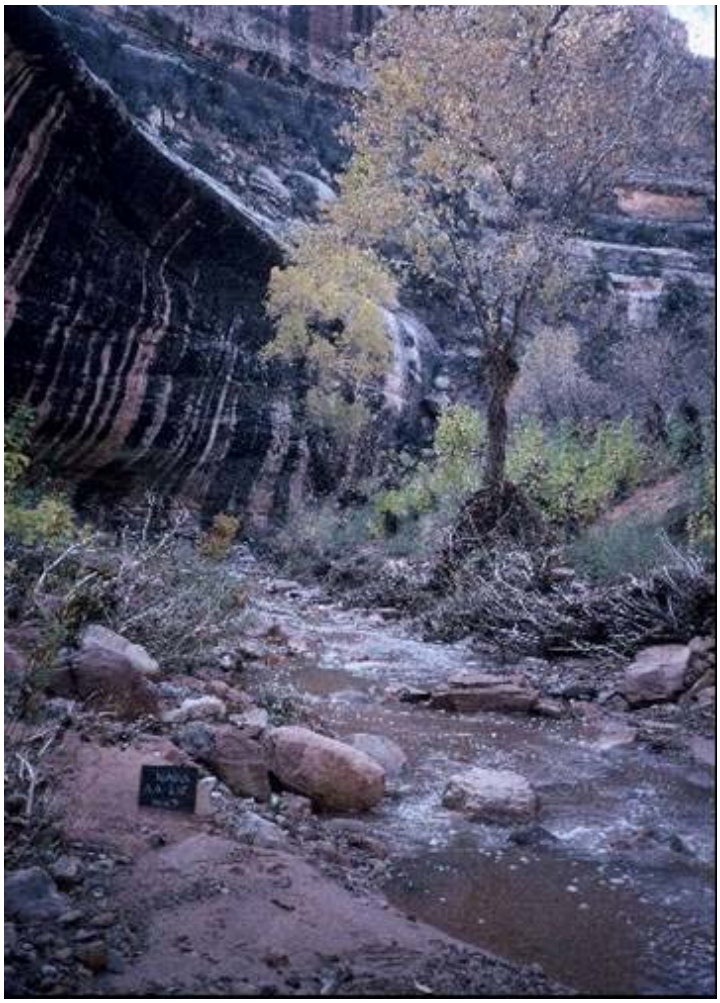


Photo credit: NPS

C-SCSB Map Class Statistics

Type	Complex
Frequency	Total project polygons = 41 polygons in NABR = 23 polygons in environs = 18
Area	Total project area = 43.4 hectares / 107.3 acres 26.8 hectares / 66.3 acres in NABR 16.6 hectares / 41.0 acres in environs
Average Size	Total project polygons = 1.06 hectares / 2.62 acres 1.2 hectares / 2.9 acres in NABR .9 hectares / 2.3 acres in environs
Proportion	0.8 % of total project mapping area .9% of NABR portion of mapping area .007% of environs portion of mapping area
Accuracy	Not accuracy assessed

Ecological System

North American Arid West Emergent Marsh (CES300.729)
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

Associations

Phragmites australis Western North America Temperate Semi-natural Herbaceous Vegetation [CEGL001475]
Populus angustifolia / Rosa woodsii Forest [CEGL000653]
Populus deltoides (ssp. *wislizeni,* ssp. *monilifera*) */ Artemisia tridentata* Woodland [CEGL005966]
Populus deltoides (ssp. *wislizeni,* ssp. *monilifera*) */ Pascopyrum smithii* Woodland [CEGL002680]
Populus deltoides (ssp. *wislizeni,* ssp. *monilifera*) */ Salix exigua* Woodland [CEGL002685]
Populus deltoides ssp. *wislizeni / Acer negundo* Forest [CEGL002336]
Populus fremontii / Salix (ligulifolia, lutea) Woodland [CEGL004002]
Salix exigua / Mesic Graminoids Shrubland [CEGL001203]

Common species

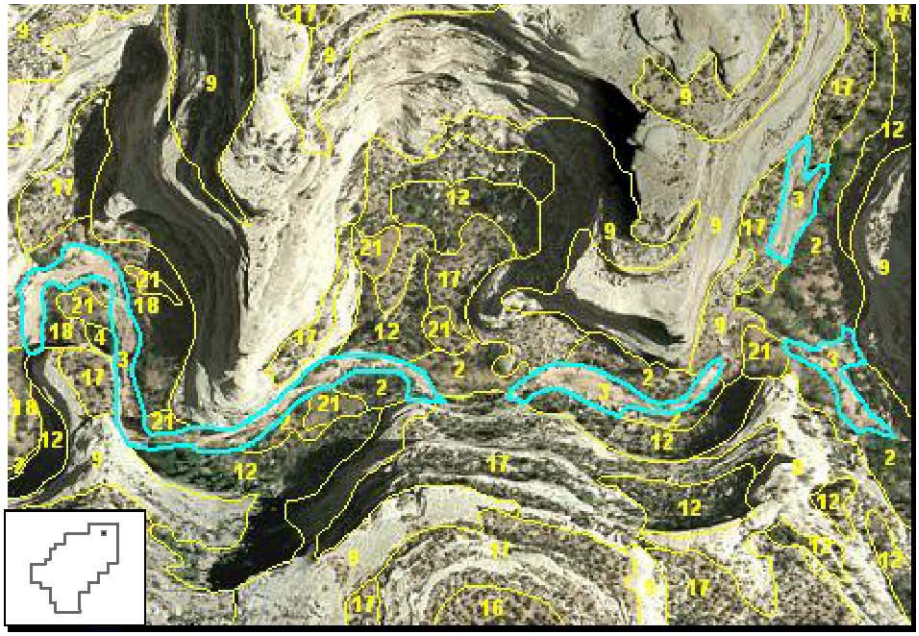
Populus deltoides ssp. *wislizeni*
Pinus edulis
Quercus gambelii
Salix lutea
Salix exigua

Distribution/Ecology/Composition

This map class is intended to describe mostly unvegetated stream channels and lower terraces. Polygons will contain scattered riparian plants or patches of poorly developed riparian communities. These areas are disturbed frequently by flash flooding or are scoured to bedrock.

Interpretation

This map class consists of linear, sinuous polygons occupying canyon floors. The signature is a light gray or light tan indicating unvegetated slickrock or alluvium. Vegetation appears as small, scattered irregular dark streaks or patches.



Example of the photo signature for map class C-SCSB (#3).

Map Class 4
Gambel Oak Tall Shrubland
(S-GOAK)



Photo credit: NPS

S-GOAK Map Class Statistics

Type	Alliance
Frequency	Total project polygons = 32 polygons in NABR = 31 polygons in environs = 1
Area	Total project area = 10.1 hectares / 24.9 acres 9.5 hectares / 23.4 acres in 0.6 hectares / 1.5 acres in environs
Average Size	Total project polygons = 0.3 hectares / 0.8 acres 0.3 hectares / 0.8 acres in NABR 0.6 hectares / 1.5 acres in environs
Proportion	0.2% of total project mapping area 0.3% of NABR portion of mapping area .0002% of environs portion of mapping area
Accuracy (NABR only)	Producer: 92% ± 16% User: 92% ± 16%

Ecological System

Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818)

Associations

Quercus gambelii / Amelanchier utahensis Shrubland [CEGL001110]
Quercus gambelii / Symphoricarpos oreophilus Shrubland [CEGL001117]
Quercus gambelii / Sparse Understory Shrubland [CEGL002337]

Common species

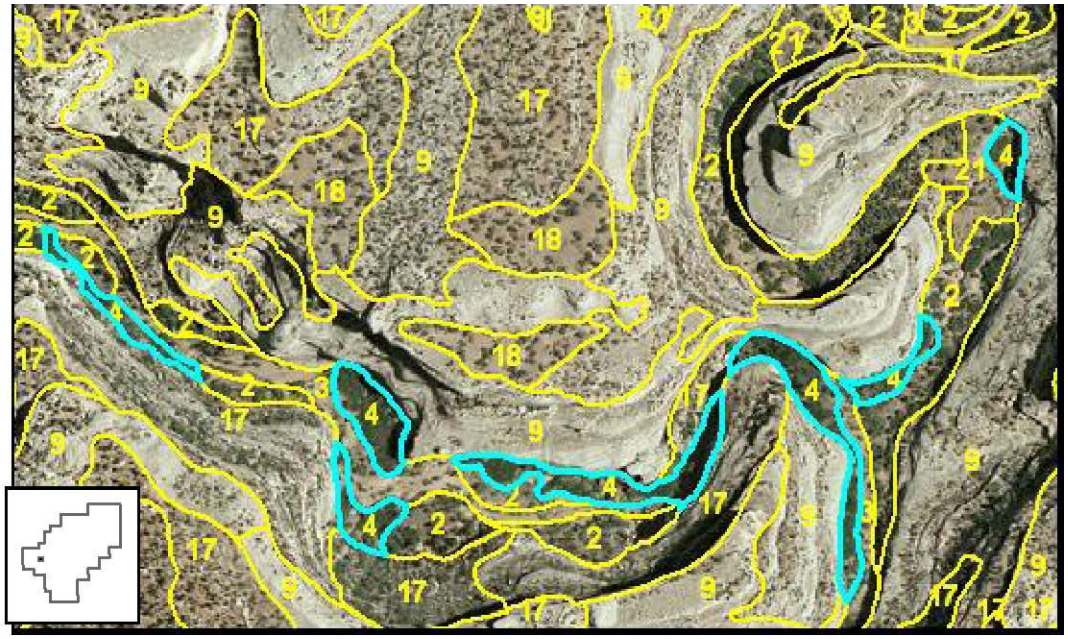
Quercus gambelii
Symphoricarpos oreophilus

Distribution/Ecology/Composition

The Gambel Oak Tall Shrubland map class is restricted to canyon bottoms, but is relatively common within that zone. Stands are scattered on high terraces that are above even the highest flood levels. The substrate is a sandy alluvium. Gambel oak grows as a tall shrubland or low woodland of evenly-spaced, uniform-diameter clonal single stems, usually forming a closed canopy. The understory has sparse to moderate cover, consisting of various shrubs and forbs such as *Amelanchier utahensis*, *Symphoricarpos oreophilus*, and *Clematis ligusticifolia*. Small oak clones appear as inclusions within the C-CABV map class.

Interpretation

This map class occurs in small patches and linear polygons. The Gambel oak canopy appears as a slightly textured but otherwise uniform dark green. Polygons containing multiple oak clones may have small openings of light tan sand/grassland separating them. Adjacent polygons are most commonly C-SSV on canyon walls or C-CABV on canyon floors.



Example of the photo signature for map class S-GOAK (#4).

Map Class 9
Pinyon-Juniper / Littleleaf Mountain Mahogany Woodland (W-PJLM)



Photo credit: NPS

W-PJLM Map Class Statistics

Type	Complex
Frequency	Total project polygons = 184 polygons in NABR = 110 polygons in environs = 74
Area	Total project area = 788.3 hectares / 1,947.9 acres 490.2 hectares / 1,211.4 acres in NABR 298.1 hectares / 736.5 acres in environs
Average Size	Total project polygons = 4.3 hectares / 10.6 acres 4.5 hectares / 11.0 acres in NABR 4.0 hectares / 9.9 acres in environs
Proportion	14.7 % of total project mapping area 16.4% of NABR portion of mapping area .125% of environs portion of mapping area
Accuracy (NABR only)	Producer: 91% ± 8% User: 82% ± 10%

Ecological System

Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

Associations

Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland [CEGL000779]
Cercocarpus intricatus Slickrock Sparse Vegetation [CEGL002977]
Pinus edulis - Juniperus osteosperma / Arctostaphylos patula Woodland [CEGL002939]

Common species

Pinus edulis	*Juniperus osteosperma*
Cercocarpus intricatus	*Fraxinus anomala*
Glossopetalon meionandrum	*Arctostaphylos patula*

Distribution/Ecology/Composition

The Pinyon-Juniper / Littleleaf Mountain Mahogany Woodland map class (W-PJLM) is common within the Monument. Most occurrences occupy level to gently sloping sites near canyon rims. A few occurrences below the rim occupy drier sandstone ledges. Sandstone outcrops cover 10% to 75% of the ground, and plants root in thin, patchy soils and bedrock joints. Stands are often open, with a mixed shrub layer contributing as much or sometimes more cover than the scattered two-needle pinyon and Utah juniper trees. The diverse shrub layer is dominated by *Cercocarpus intricatus* that ranges in cover from 1 to 5% and is usually accompanied by *Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus, Fraxinus anomala* and *Mahonia fremontii*. Scattered forbs and grasses are generally present and include *Petradoria pumila, Stenotus armerioides, Cryptantha flava, Arenaria fendleri,* and *Hymenopappus filifolius*.

Interpretation

The trees of the W-PJLM map class appear as medium dark green dots of varying diameters with a coarse texture, distributed in a slightly clumped pattern throughout the polygon on a background of tan soils. Small stripes or patches of light gray sandstone are common within the polygon. Polygons tend to be broadly linear and somewhat sinuous, as they follow the shape of the canyon rim. Adjacent polygons tend to be of map classes C-SSV (more bedrock exposure) and W-PJSH (deeper soils).



Example of the photo signature for map class W-PJLM (#9).

Map Class 9r
Slickrock Sparse Vegetation
(C-SSV)

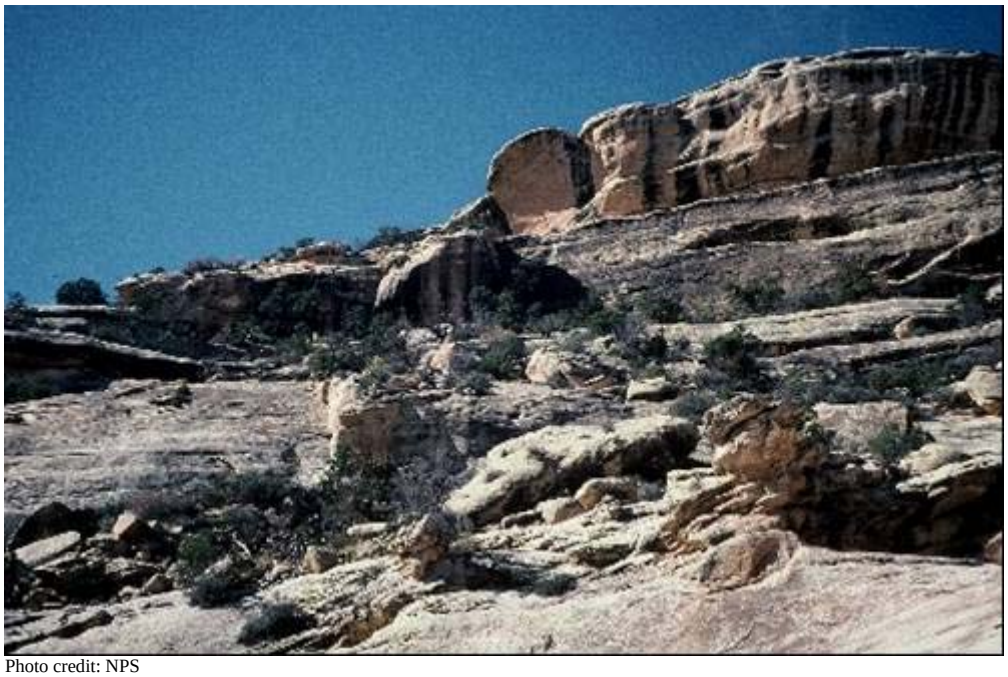


Photo credit: NPS

C-SSV Map Class Statistics

Type	Mosaic
Frequency	Total project polygons = 138 polygons in NABR = 83 polygons in environs = 55
Area	Total project area = 537.8 hectares / 1,328.8 acres 385.1 hectares / 951.6 acres in NABR 152.7 hectares / 377.2 acres in environs
Average Size	Total project polygons = 3.9 hectares / 9.6 acres 4.6 hectares / 11.5 acres in NABR 2.8 hectares / 6.9 acres in environs
Proportion	9.9% of total project mapping area 12.9% of NABR portion of mapping area .06% of environs portion of mapping area
Accuracy (NABR only)	Producer: 100% ±1 User: 100% ± 1%

Ecological System

Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

Associations

Cercocarpus intricatus Slickrock Sparse Vegetation [CEGL002977]
Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland [CEGL000779]

Common species

Pinus edulis *Juniperus osteosperma*

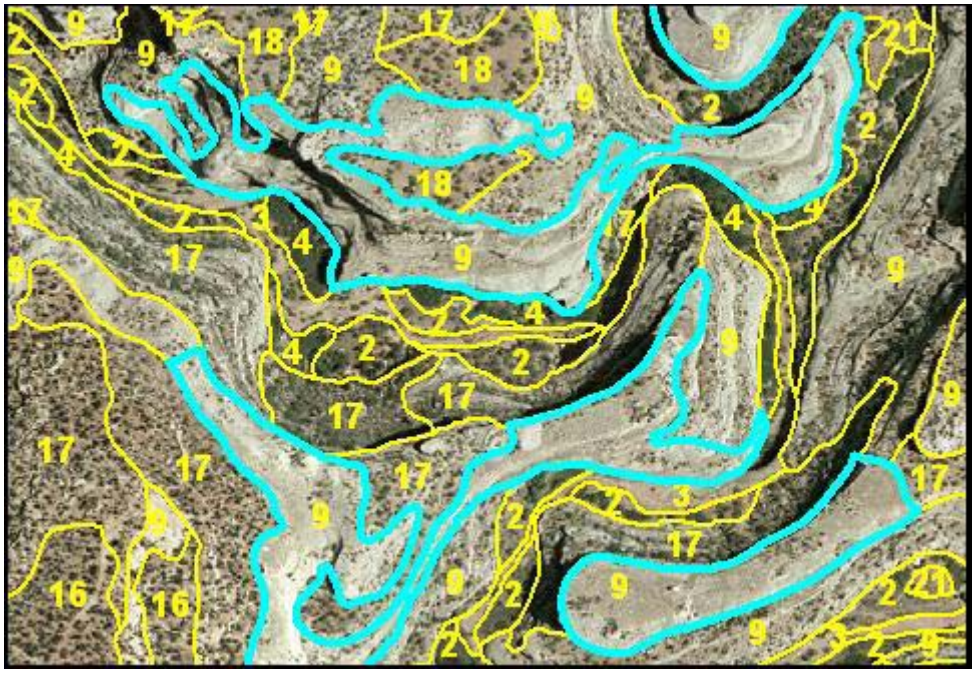
Cercocarpus intricatus

Distribution/Ecology/Composition

The Slickrock Sparse Vegetation map class is limited to barren sandstone exposures with little soil confined to cracks, ledges, and shallow potholes in the bedrock. Total vegetation cover rarely exceeds 10% and is characterized by scattered clumps and plants of *Cercocarpus intricatus. Pinus edulis* and *Juniperus osteosperma* trees may be scattered throughout the community. Associated shrubs include *Yucca* sp. and *Ephedra viridis.* The few herbaceous species present include *Achnatherum hymenoides* and *Petradoria pumila*.

Interpretation

The dominant signature of map class C-SSV is the light gray of exposed Cedar Mesa Sandstone. The scattered, sparse vegetation appears as dark green speckles for the trees and shrubs and gray-tan smudges for the pockets of soil. Adjacent polygons are most commonly of the W-PJSH and W-PJLM map classes.



Example of the photo signature for map class C-SSV (#9r).

Map Class 12
Douglas-fir Woodland
(W-DOFI)



Photo credit: NPS

W-DOFI Map Class Statistics

Type	Alliance
Frequency	Total project polygons = 65 polygons in NABR = 46 polygons in environs = 19
Area	Total project area = 46.7 hectares / 115.3 acres 35.1hectares / 86.7 acres in NABR 11.6 hectares / 28.6 acres in environs
Average Size	Total project polygons = .72 hectares / 1.8 acres .76 hectares / 1.89 acres in NABR .61 hectares / 1.5 acres in environs
Proportion	.87% of total project mapping area 1.17% of NABR portion of mapping area .005% of environs portion of mapping area
Accuracy (NABR only)	Producer: 89% ±15% User: 84% ±17%

Ecological System

Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)

Associations

Pseudotsuga menziesii / Arctostaphylos patula Forest [CEGL000423]
Pseudotsuga menziesii / Quercus gambelii Forest [CEGL000452]
Pseudotsuga menziesii / Symphoricarpos oreophilus Forest [CEGL000462]

Common species

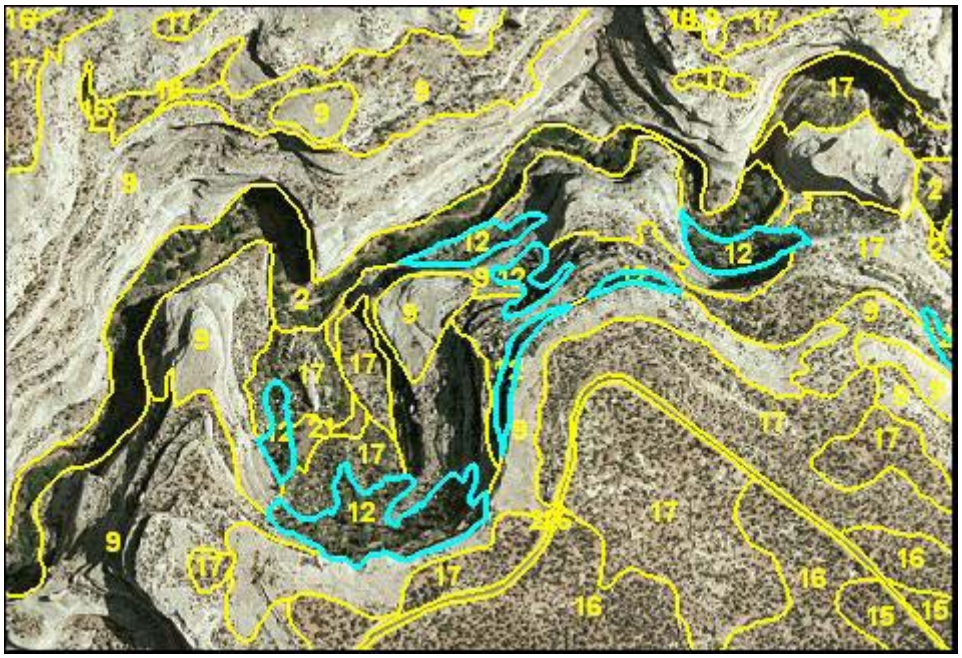
Pseudotsuga menziesii	*Quercus gambelii*
Arctostaphylos patula	*Symphoricarpos oreophilus*

Distribution/Ecology/Composition

The Douglas-fir Woodland map class is uncommon; it is restricted to north-facing canyon walls and canyon bottoms in the upper reaches of White and Armstrong canyons. Douglas-fir requires relatively mesic conditions that exist only in these shaded sites. The canopy in these stands is open because most trees are rooted in cracks in the bedrock. The understory is dominated by shrub species that are similarly mesic and scattered. The most common species include *Quercus gambelii, Amelanchier utahensis, Symphoricarpos oreophilus,* and *Arctostaphylos patula*. Herbaceous species contribute little cover in these stands. Total vegetation cover is higher than in most other vegetation types within the Monument.

Interpretation

Polygons of the Douglas-fir Woodland map class are small and irregular or linear and sinuous, following the shape of the canyon walls. The general signature of this map class is dark, because of shadows and because of the relatively dense vegetation. The narrow, pyramidal crowns of mature Douglas-fir are visible. Adjacent polygons are usually mapped as W-PJLM, W-PJRL, or C-SSV, and scattered Douglas-fir trees may occur within these map classes.



Example of the photo signature for map class W-DOFI (#12).

Map Class 14
Ponderosa Pine / Pinyon-Juniper Woodland (W-PIPO)

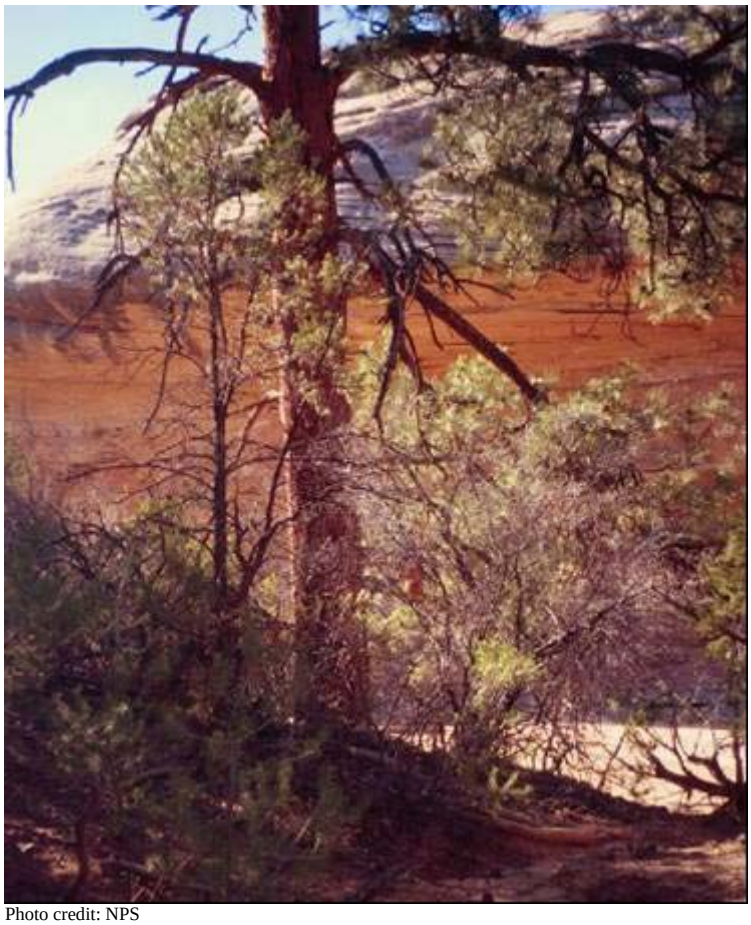


Photo credit: NPS

W-PIPO Map Class Statistics

Type	Alliance
Frequency	Total project polygons = 1 polygons in NABR = 0 polygon in environs= 1
Area	Total project area = 1.1 hectares / 2.7 acres
Average Size	Total project polygons = 1.1 hectares / 2.7 acres
Proportion	.02% of total project mapping area .02% of environs portion of mapping area
Accuracy	Not accuracy assessed

Ecological System

Southern Rocky Mountain Ponderosa Pine Woodland (CES306.648)

Association

Ponderosa Pine Stand [Park Special]

Common species

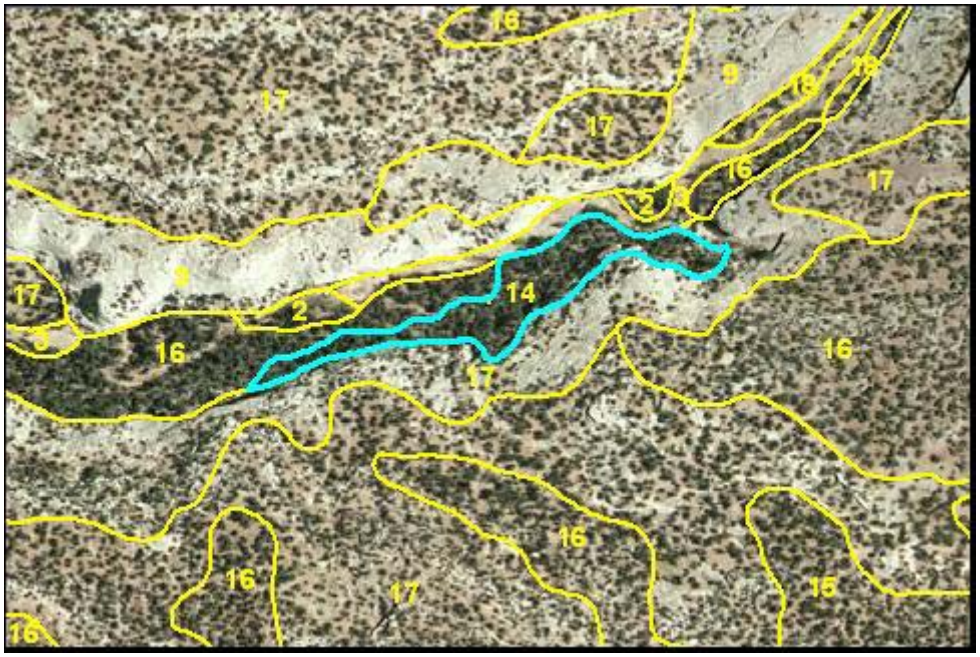
Pinus ponderosa	*Pinus edulis*
Juniperus osteosperma	*Amelanchier utahensis*

Distribution/Ecology/Composition

The Ponderosa Pine / Pinyon-Juniper Woodland map class represents a relict population of ponderosa pine that persists in a sheltered canyon bottom just east of the Monument boundary. The pines emerge above a regularly-spaced canopy of two-needle pinyon and Utah juniper that form a relatively dense woodland on the canyon floor. Utah serviceberry is the dominant shrub understory species; no other shrub or herbaceous species has more than trace cover.

Interpretation

The single polygon of this map class was defined from ground data. Rounded crowns of ponderosa pine are visible, scattered throughout the irregularly linear polygon. The dominant signature is that of the irregular dark crowns of pinyon, juniper and Utah serviceberry that constitute the majority of the vegetation. Adjacent polygons are in the C-CABV and W-PJSP map classes.



Example of the photo signature for map class W-PIPO (#14).

Map Class 15
Pinyon-Juniper Sagebrush Woodland
(W-PJWS)



Photo credit: NPS

Intact Pinyon-Juniper / Sagebrush Woodland (Map Class 15).



Photo credit: NPS

Chained Pinyon-Juniper / Sagebrush Woodland (Map Class 15, “d” modifier.

W-PJWS Map Class Statistics (15 and 15d)

Type	Complex
Frequency	Total project polygons = 26 polygons in NABR = 8 polygons in environs = 18
Area	Total project area = 524.8 hectares / 1,296.8 acres 215.9 hectares / 533.5 acres in NABR 308.9hectares / 763.3 acres in environs
Average Size	Total project polygons = 20.2 hectares / 49.9 acres 26.9hectares / 66.7 acres in NABR 17.2 hectares / 42.4 acres in environs
Proportion	9.8% of total project mapping area 7.2% of NABR portion of mapping area .13% of environs portion of mapping area
Accuracy (NABR only)	Producer: 93% ±14% User: 70% ±19%

Ecological System

Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

Associations

Pinus edulis - Juniperus spp. / *Artemisia tridentata* (ssp. *wyomingensis*, ssp. *vaseyana*) Woodland [CEGL000776]
Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland [CEGL000782]
Recently chained *Pinus edulis – Juniperus osteosperma / Artemisia tridentate* ssp. *wyomingensis* Woodland [Park Special – map class 15d]

Common species

Pinus edulis	*Juniperus osteosperma*
Artemisia tridentata ssp. *wyomingensis*	*Agropyron cristatum* (15d)

Distribution/Ecology/Composition

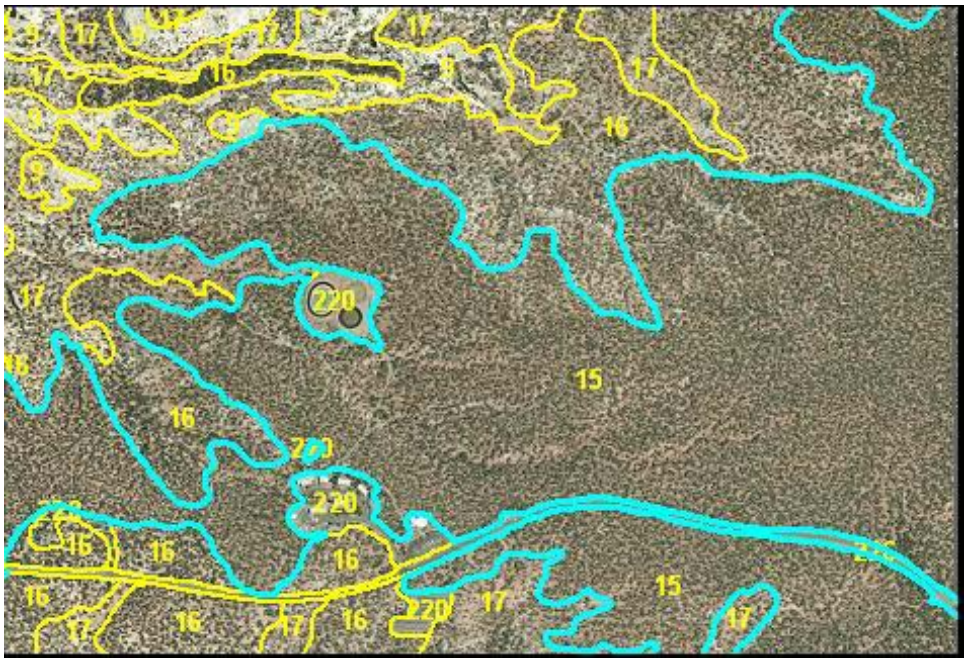
Deep soils on the rolling mesa top support a mosaic of three woodland communities: Pinyon-Juniper / Sparse Understory Woodland, Pinyon-Juniper / Roundleaf Buffaloberry Woodland and Pinyon-Juniper / Sagebrush Woodland. The boundaries among the three are rarely distinct, and most stands have relatively low shrub cover in the understory. In map class W-PJWS, stands tend to have large-crowned trees that are widely spaced with mostly bare ground between them. Shrubs tend to cluster between tree crowns or around the tree dripline where they get extra moisture but also plenty of light. Shrub cover is often less than 10%; associated species include *Purshia tridentata* and *Shepherdia rotundifolia*. Herbaceous species provide only trace cover.

The vegetation in all polygons of the chained form of this map class has been manipulated to increase forage available for cattle. This form is recognizable by the presence of uprooted and shattered trees as well as by the presence of seeded forage grasses such as *Agropyron cristatum*. Depending on how long ago the chaining occurred, the vegetation may range from a shrubby grassland of sagebrush and planted grasses to an open pinyon-juniper woodland with an understory of sagebrush, native and planted and grasses. Stands of this map class on Deer Mesa also contain black sagebrush.

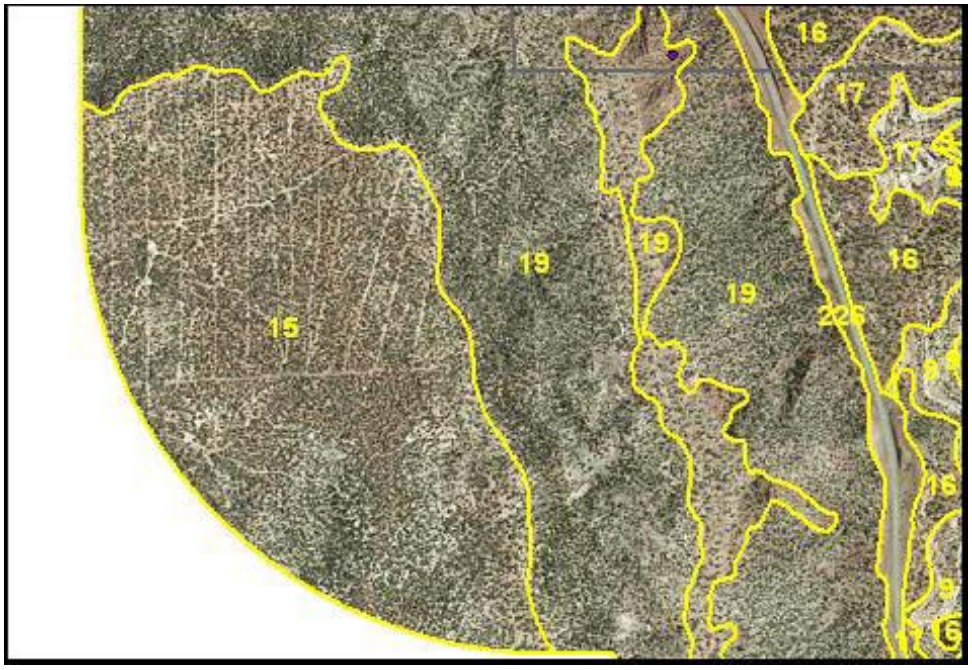
Interpretation

Polygons of the W-PJWS map class tend to be large. They are distinguished from adjacent polygons of map class W-PJSP by the denser tree canopy signature. In a few polygons in the southern half of the mapping area, the density of Wyoming sagebrush in high enough that it makes a slightly rough, patchy blue-gray signature visible between the dark green tree crowns.

All polygons of the chained version of this map class are in the environs. Lines left by the machinery during chaining are visible. Otherwise, the signature is similar to that of map class W-PJWS. Polygons tend to be relatively large, with regular edges.



Example of the photo signature for map class W-PJWS (#15).



Example of the photo signature for the chained version map class W-PJWS (#15d).

Map Class 16
Pinyon-Juniper / Sparse Understory Woodland (W-PJSP)



Photo credit: NPS

W-PJSP Map Class Statistics

Type	Complex
Frequency	Total project polygons = 170 polygons in NABR = 88 polygons in environs = 82
Area	Total project area = 997.1hectares / 2,463.9 acres 584.5 hectares / 1,444.4 acres in NABR 412.6 hectares / 1,019.6 acres in environs
Average Size	Total project polygons = 5.9 hectares / 14.5 acres 6.6 hectares / 16.4 acres in NABR 5.0 hectares / 12.4 acres in environs
Proportion	18.5% of total project mapping area 19.5% of NABR portion of mapping area .17% of environs portion of mapping area
Accuracy (NABR only)	Producer: 72% ±12% User: 92% ±9%

Ecological System
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

Associations
Pinus edulis - Juniperus osteosperma / Shepherdia rotundifolia Woodland [CEGL002335]
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland [CEGL002148]

Common species

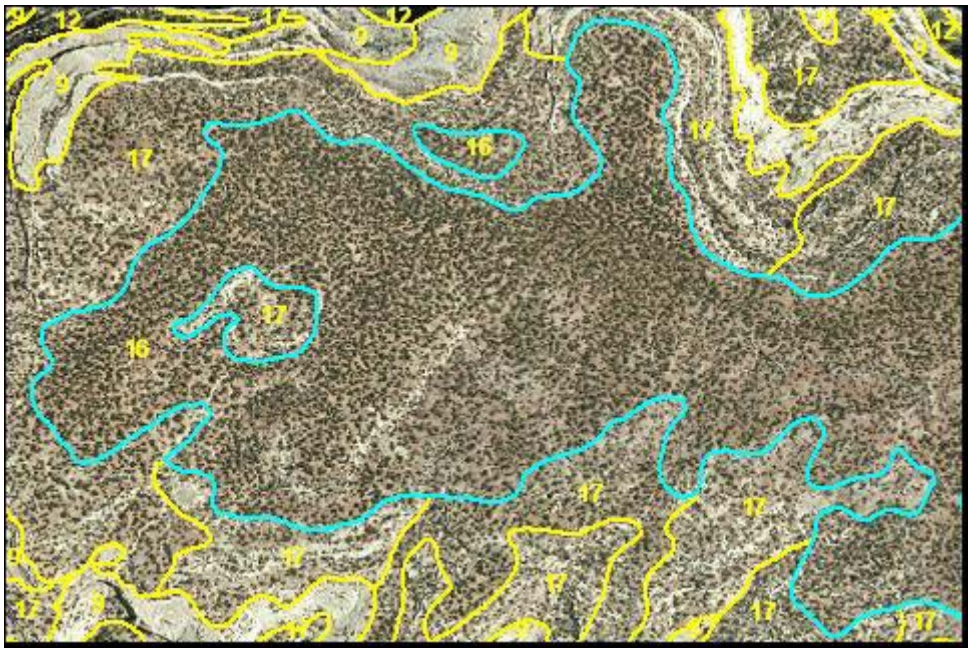
Pinus edulis *Juniperus osteosperma*

Distribution/Ecology/Composition

The Pinyon-Juniper / Sparse Understory map class covers most of the top of the Cedar Mesa plateau within the mapping area. It represents a mature to old-growth pinyon-juniper woodland with little growing in the understory other than a well-developed biological soil crust and scattered shrubs of *Shepherdia rotundifolia, Artemisia tridentata* ssp. *wyomingensis,* or *Amelanchier utahensis* (in small gullies) totaling less than 5% cover and usually less than 1%.

Interpretation

The W-PJSP map class forms large polygons on the mesa top. The signature has the regularly-spaced rounded speckles of tree crowns against a tan-colored background of bare soil. Tree crowns are larger than in adjacent polygons of map class W-PJSH, and spaced further apart than in map class W-PJWS.



Example of the photo signature for map class W-PJSP (#16).

Map Class 17
Pinyon-Juniper / Mixed Shrubs Woodland
(W-PJSH)

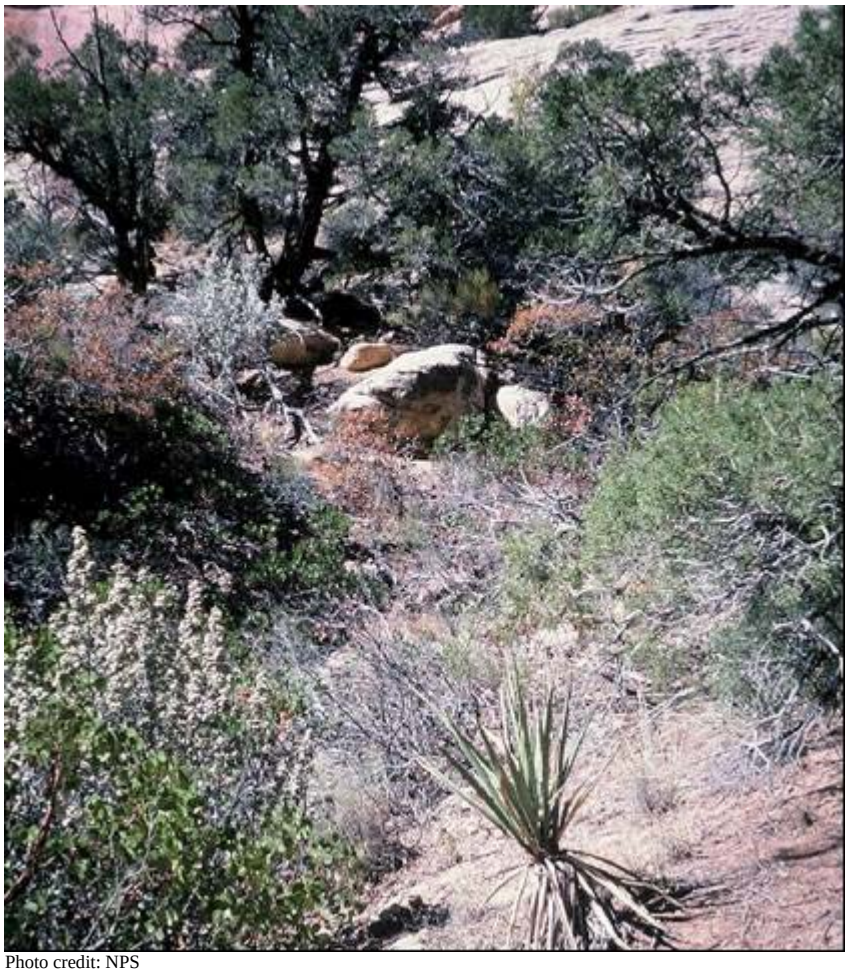


Photo credit: NPS

W-PJSH Map Class Statistics

Type	Complex
Frequency	Total project polygons = 319 polygons in NABR = 189 polygons in environs = 130
Area	Total project area = 1,902.2 hectares / 4,700.4 acres 997.7 hectares / 2,465.3 acres in NABR 904.5 hectares / 2,235.1 acres in environs
Average Size	Total project polygons = 5.9 hectares / 14.7 acres 5.3 hectares / 13.0 acres in NABR 6.9 hectares / 17.2 acres in environs
Proportion	35.4% of total project mapping area 33.3% of NABR portion of mapping area .38% of environs portion of mapping area
Accuracy (NABR only)	Producer: 84% ±11% User: 86% ±11%

Ecological System

Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765)

Associations

Pinus edulis - Juniperus osteosperma / Petradoria pumila Woodland [CEGL002332]
Pinus edulis - Juniperus osteosperma / Arctostaphylos patula Woodland [CEGL002939]
Pinus edulis - Juniperus spp. / *Cercocarpus montanus* - Mixed Shrub Woodland [CEGL000780]
Pinus edulis - Juniperus osteosperma / Amelanchier utahensis Woodland [CEGL002329]
Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland [CEGL000779]
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland [CEGL002148]

Common species

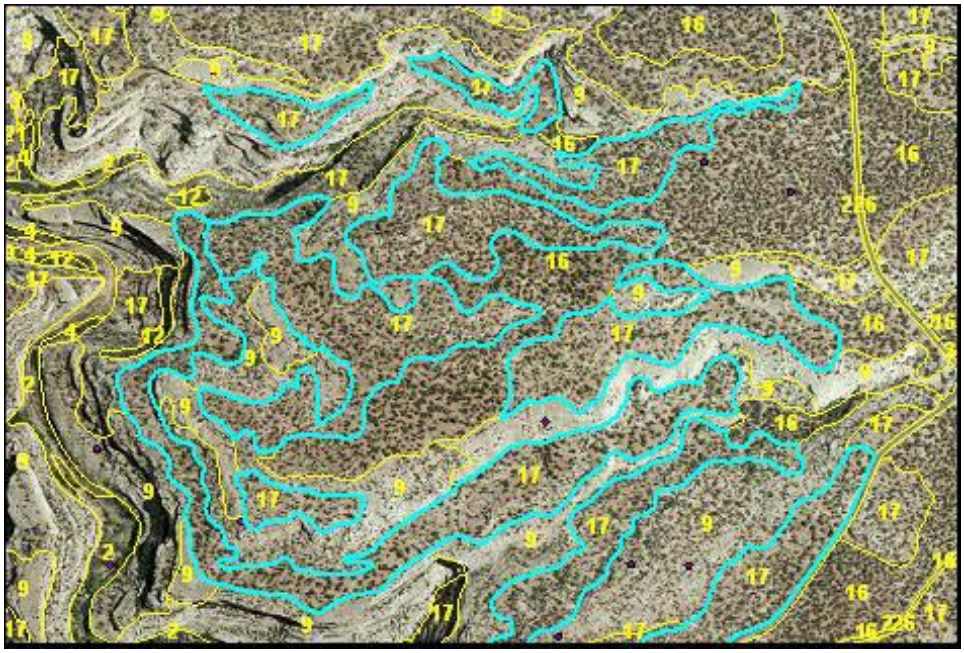
Pinus edulis	*Juniperus osteosperma*
Cercocarpus montanus	*Cercocarpus intricatus*
Arctostaphylos patula	*Glossopetalon meionandrum*

Distribution/Ecology/Composition

The Pinyon-Juniper / Mixed Shrubs Woodland map class is widespread within the mapping area, occupying a belt of thin soils near canyon rims. Outcrops of Cedar Mesa sandstone occupy 10-25% of the area. Plants are rooted in the thin soils; trees tend to be dwarfed and shrub cover may equal or exceed that of the pinyon and juniper. The shrub layer is diverse; many stands include six or more species, and the most common species are *Cercocarpus intricatus, Cercocarpus montanus, Amelanchier utahensis, Mahonia fremontii, Fraxinus anomala, Arctostaphylos patula, Glossopetalon meionandrum, Ephedra viridis,* and *Yucca* spp. *Petradoria pumila* and *Lepidium montanum* are the most consistent herbaceous species present.

Interpretation

The dark green dots representing pinyon and juniper trees in the W-PJSH map class are smaller, more irregular and sparser than in adjacent polygons of W-PJWS and W-PJSP map classes, and a little bigger and denser than in adjacent polygons of the W-PJLM map class. Small areas of light gray sandstone are evident within the woodland area. Polygons tend to be large and broadly linear, as they follow the canyon rims.



Example of the photo signature for map class W-PJSH (#17).

Map Class 17r
Pinyon-Juniper / Mixed Shrubs Woodland Rock Ledge Complex (W-PJRL)

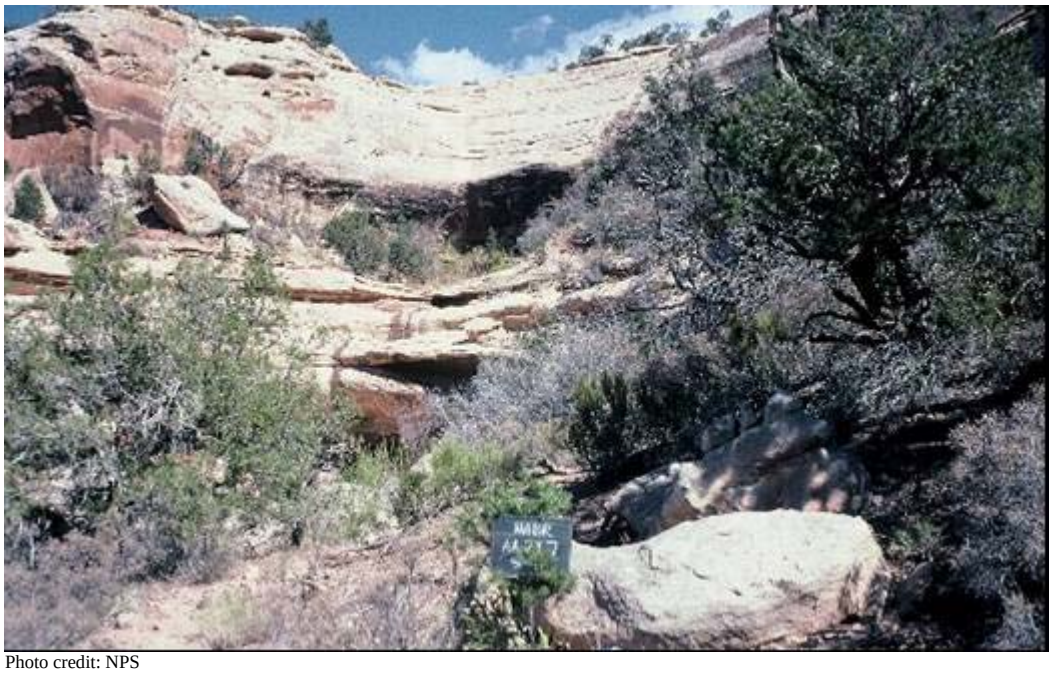


Photo credit: NPS

W-PJRL Map Class Statistics

Type	Complex
Frequency	Total project polygons = 73 polygons in NABR = 54 polygons in environs = 19
Area	Total project area = 126.5 hectares / 312.5 acres 106.4 hectares / 262.8 acres in NABR 20.1hectares / 49.7 acres in environs
Average Size	Total project polygons = 1.7 hectares / 4.3 acres 1.9 hectares / 4.9 acres in NABR 1.1 hectares / 2.6 acres in environs
Proportion	2.4% of total project mapping area 3.6% of NABR portion of mapping area .008% of environs portion of mapping area
Accuracy (NABR only)	Producer: 89% ±15% User: 89% ±15%

Ecological System

Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)

Associations

Pinus edulis - Juniperus spp. / *Cercocarpus montanus* - Mixed Shrub Woodland [CEGL000780]
Pinus edulis - Juniperus spp. / *Quercus gambelii* Woodland [CEGL000791]
Amelanchier (utahensis, alnifolia) - Cercocarpus montanus Shrubland [CEGL001070]

Common species

Pinus edulis
Cercocarpus montanus
Amelanchier utahensis
Juniperus osteosperma
Quercus gambelii
Fraxinus anomala

Distribution/Ecology/Composition

This map class is similar in composition to the W-PJSH map class, but is restricted to north facing ledges and slopes below the canyon rim. The vegetation contains higher cover by more mesic species such as *Quercus gambelii* and *Amelanchier utahensis* in addition to the shrubs found on the rim above.

Interpretation

Polygons of the W-PJRL map class are small to medium in size and have the sinuous shape of the canyon walls. Pinyon and juniper trees and large shrubs appear as small dark green dots or clumps of varying diameters with a coarse texture. The overall signature is fairly dark, partly from shadowing and partly from the relatively dense vegetation. Adjacent polygons are most often mapped as W-PJLM.



Example of the photo signature for map class W-PJRL (#17r).

Map Class 18
Pinyon-Juniper / Native Grass Woodland
(W-PJNG)



Photo credit: NPS

W-PJNG Map Class Statistics

Type	Complex
Frequency	Total project polygons = 39 polygons in NABR = 25 polygons in environs = 14
Area	Total project area = 36.7 hectares / 90.7 acres 19.6 hectares / 48.4 acres in NABR 17.1 hectares / 42.4 acres in environs
Average Size	Total project polygons = .9 hectares / 2.3 acres .8 hectares / 1.9 acres in NABR 1.2 hectares / 3.0 acres in environs
Proportion	.7% of total project mapping area .7% of NABR portion of mapping area .007% of environs portion of mapping area
Accuracy (NABR only)	Producer: 93% ±14% User: 93% ±14%

Ecological System

Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

Associations

Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata Woodland [CEGL000797]

Pinus edulis - Juniperus osteosperma / Achnatherum hymenoides Woodland [CEGL002364]

Common species

Pinus edulis *Juniperus osteosperma*

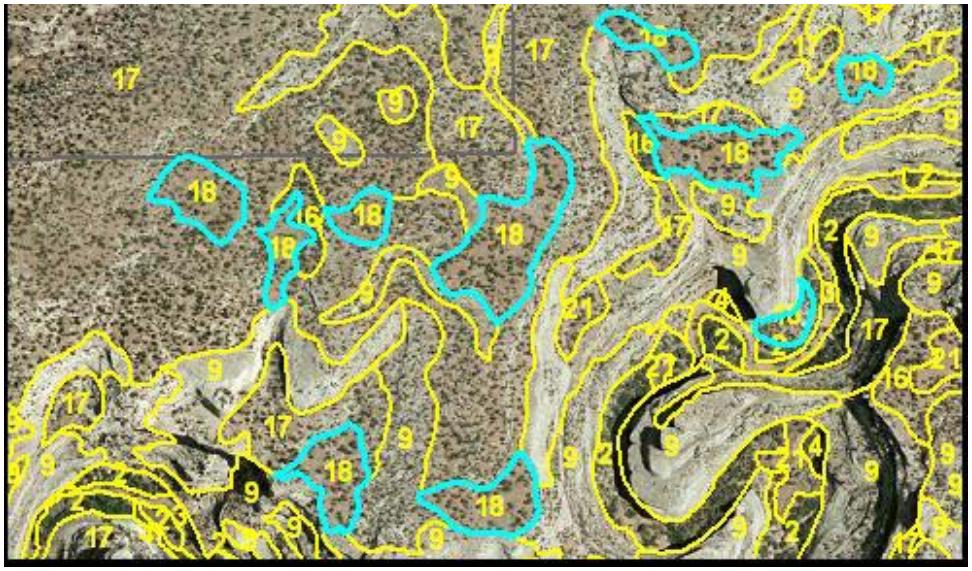
Cercocarpus montanus *Bouteloua gracilis*

Distribution/Ecology/Composition

This map class is made up of small stands of pinyon-juniper woodland with a native grass understory on deep soils on the bench between Deer Mesa and Deer Canyon. The tree canopy is relatively open, with the native grasses *Achnatherum hymenoides, Hesperostipa comata, Pleuraphis jamesii* and *Bouteloua gracilis* occupying the open spaces between tree crowns. Shrubs are absent or have only sparse cover.

Interpretation

The W-PJNG map class is difficult to distinguish from adjacent stands mapped as W-PJWS and W-PJSP; most were mapped from plot data. The tan signature of the soil surface often has a grayish cast absent from adjacent woodlands, and stands are more open.



Example of the photo signature for map class W-PJNG (#18).

Map Class 19
Pinyon-Juniper / Buffaloberry-Serviceberry Woodland (W-PJBB)



Photo credit: NPS

W-PJBB Map Class Statistics

Type	Association
Frequency	Total project polygons = 8 polygons in NABR = 2 polygons in environs = 6
Area	Total project area = 200.0 hectares / 494.1 acres 9.9 hectares / 24.4 acres in NABR 190.1 hectares / 469.7 acres in environs
Average Size	Total project polygons = 25.0 hectares / 61.8 acres 4.9 hectares / 12.2 acres in NABR 31.7 hectares / 78.3 acres in environs
Proportion	3.7% of total project mapping area .33% of NABR portion of mapping area .08% of environs portion of mapping area
Accuracy (NABR only)	Producer: 17% ±33% User: 50% ±83%

Ecological System

Colorado Plateau Pinyon-Juniper Shrubland (CES304.766)

Association

Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis) Wooded Shrubland [CEGL002334]

Common species

Pinus edulis *Juniperus osteosperma*

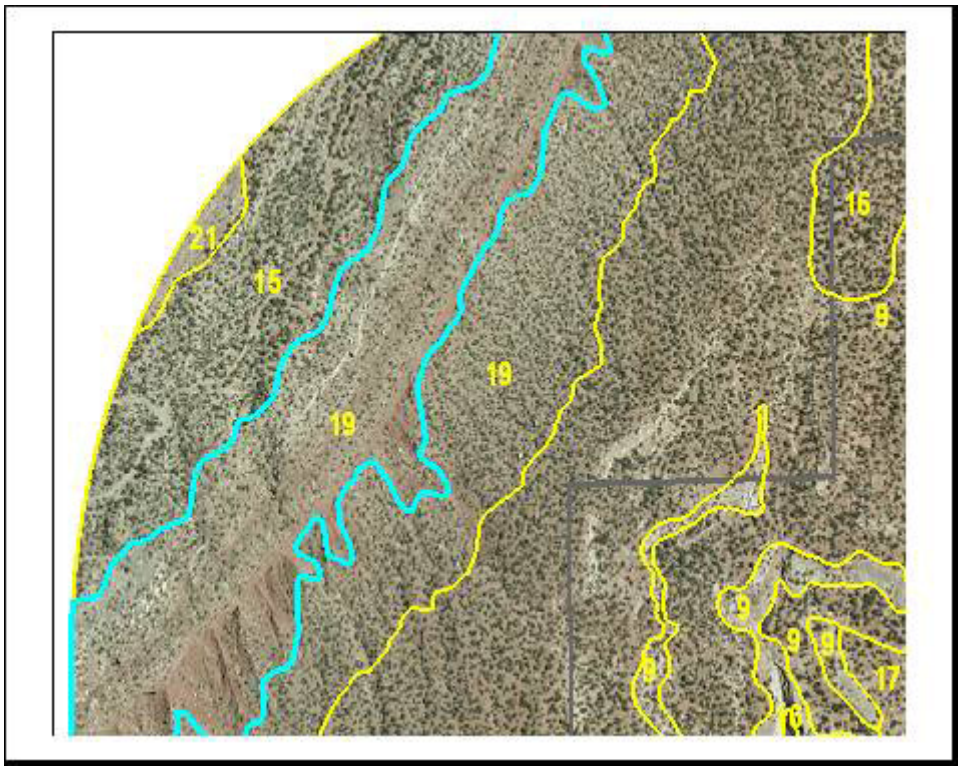
Amelanchier utahensis — *Shepherdia rotundifolia*
Cercocarpus montanus — *Leymus salinus*

Distribution/Ecology/Composition

The Pinyon-Juniper / Buffaloberry-Serviceberry Woodland map class is restricted to north-facing slopes of Moenkopi / Organ Rock shale. Blocks of Shinarump sandstone lying on the shale slopes create stable, mesic microhabitats in which trees and shrubs can become established. This map class is among the most floristically diverse; many stands include six or more shrub species, among which *Amelanchier utahensis* and *Shepherdia rotundifolia* are conspicuous to co-dominant. Other shrubs commonly present include *Cercocarpus montanus*, *Mahonia fremontii* and *Fraxinus anomala*. *Stanleya pinnata* and *Leymus salinus* are the most consistent of a variety of forbs present. Pinyon and juniper form an open to dense canopy. Very open stands on steep, unstable slopes are given the modifier "r".

Interpretation

The W-PJBB map class occurs on mesa slopes on the margins of the mapping project area. The irregular green speckles representing pinyon and juniper trees are smaller than those in adjacent polygons on deeper soils. Stands with the modifier "r" are on the steepest slopes adjacent to polygons of map class 19. Polygons are large and regular. Adjacent polygons are mapped as other woodland types.



Typical photo signature for regular (R) and sparse (L) examples of map class W-PJBB (#19).

Map Class 20
Wyoming Sagebrush Shrubland
(S-WYSB)



Photo credit: NPS

S-WYSB Map Class Statistics

Type	Association
Frequency	Total project polygons = 10 polygons in environs = 10
Area	Total project area = 11.9 hectares / 29.4 acres 11.9 hectares / 29.4 acres in environs
Average Size	Total project polygons = 1.2 hectares / 2.9 acres 1.2 hectares / 2.9 acres in environs
Proportion	0.22% of total project mapping area 0.22% of environs portion of mapping area
Accuracy	Not accuracy assessed

Ecological System

Inter-Mountain Basins Big Sagebrush Shrubland (CES304.777)

Association

Artemisia tridentata ssp. wyomingensis / (Agropyron cristatum, Psathyrostachys juncea)
Seeded Grasses Semi-natural Shrubland [CEGL002185]

Common species

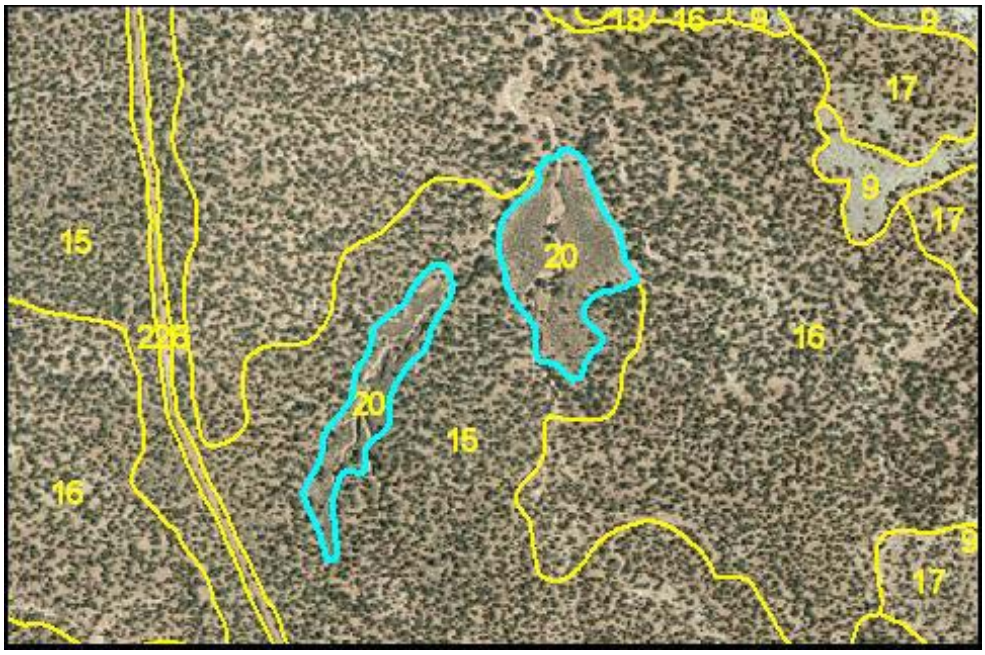
Artemisia tridentata ssp. wyomingensis *Agropyron cristatum*

Distribution/Ecology/Composition

This map class occurs on level sites in the environs of the mapping project area, as small openings within stands of the Pinyon-Juniper / Sagebrush map class. Stands may represent areas where the woodland was disturbed by fire or flash flooding, allowing shrubs to dominate the community. Sampled stands have seeded pasture grasses (*Agropyron cristatum*) in the understory; stands with native grasses may also exist but were not sampled.

Interpretation

The S-WYSB map class occurs in small regular to elongated polygons typically located in the environs south and west of the Monument boundary. The signature is a medium gray-green with a medium, regular pebbly texture. The few invading juniper trees appear as clumped, small, dark green round speckles. Adjacent polygons are most commonly mapped as W-PJWS.



Example of the photo signature for map class S-WYSB (#20).

Map Class 21
Needle-and-Thread-Ricegrass Bunchgrass Grassland (H-NEED)



Photo credit: NPS

H-NEED Map Class Statistics

Type	Association
Frequency	Total project polygons = 26 polygons in NABR = 22 polygons in environs = 4
Area	Total project area = 7.1 hectares / 17.6 acres 5.8 hectares / 14.4 acres in NABR 1.3 hectares / 3.2 acres in environs
Average Size	Total project polygons = .27 hectares / .68 acres .26 hectares / .65 acres in NABR .32 hectares / .79 acres in environs
Proportion	.13% of total project mapping area .19% of NABR portion of mapping area .0005% of environs portion of mapping area
Accuracy (NABR only)	Producer: 100% ±25% User: 67% ±61%

Ecological System
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

Association
Hesperostipa comata Great Basin Herbaceous Vegetation [CEGL001705]

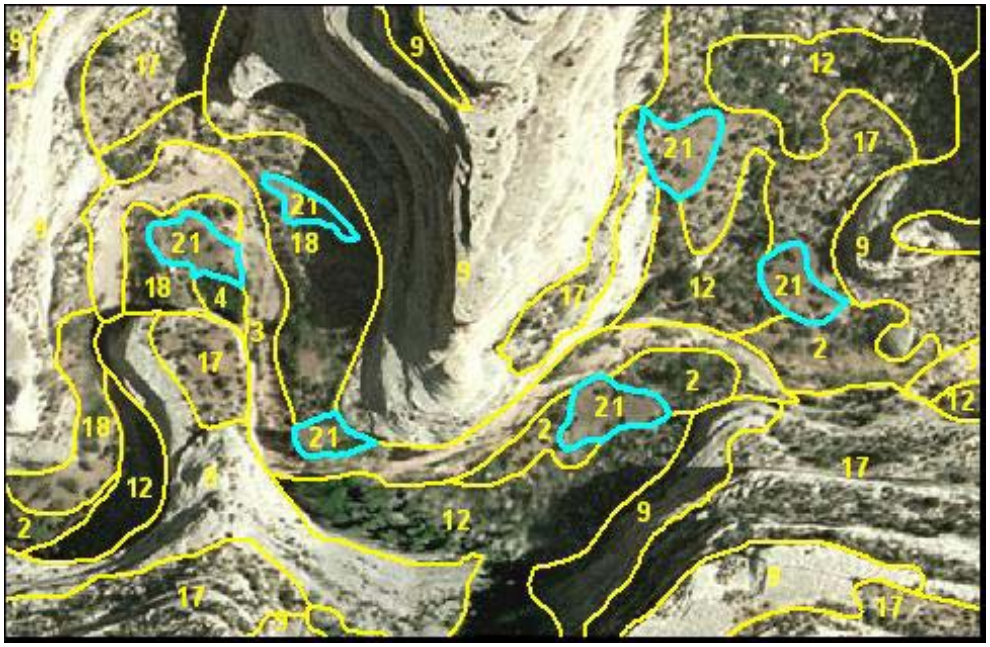
Common species
Achnatherum hymenoides *Hesperostipa comata*

Distribution/Ecology/Composition

The Needle-and-Thread-Ricegrass map class is restricted primarily to point bars and upper riparian terraces on canyon floors. A few stands occur on the mesa top in openings within the matrix-forming pinyon-juniper woodland. Soils are sandy and often have a well-developed biological soil crust. Stands are open, with between 10 and 20% cover by *Hesperostipa comata*, ften mixed with *Achnatherum hymenoides*. Scattered shrubs may also be present.

Interpretation

This map class occurs in very small, irregular or rounded polygons. Most polygons are smaller than the project minimum mapping unit size (0.5 ha), but were mapped because of their distinctive signature. The signature is a light tan, often with darker specks of shrub or tree vegetation around the margins. Adjacent polygons are mostly mapped as C-CABV, W-PJSP, or S-GOAK.



Example of the photo signature for map class H-NEED (#21).

Map Class 22
Galleta – Blue Grama Grassland
(H-GALL)


Photo credit: NPS

H-GALL Map Class Statistics

Type	Complex
Frequency	Total project polygons = 4 polygons in NABR = 3 polygons in environs = 1
Area	Total project area = 2.7 hectares / 6.7 acres 2.6 hectares / 6.5 acres in NABR .08 hectares / .20 acres in environs
Average Size	Total project polygons = .68 hectares / 1.67 acres .88 hectares / 2.16 acres in NABR .08 hectares / .20 acres in environs
Proportion	.05% of total project mapping area .09% of NABR portion of mapping area <.0001% of environs portion of mapping area
Accuracy (NABR only)	Producer: 100% ±25% User: 67% ±61%

Ecological System

Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

Associations

Bouteloua gracilis Herbaceous Vegetation [CEGL001760]
Pleuraphis jamesii Herbaceous Vegetation [CEGL001777]

Common species

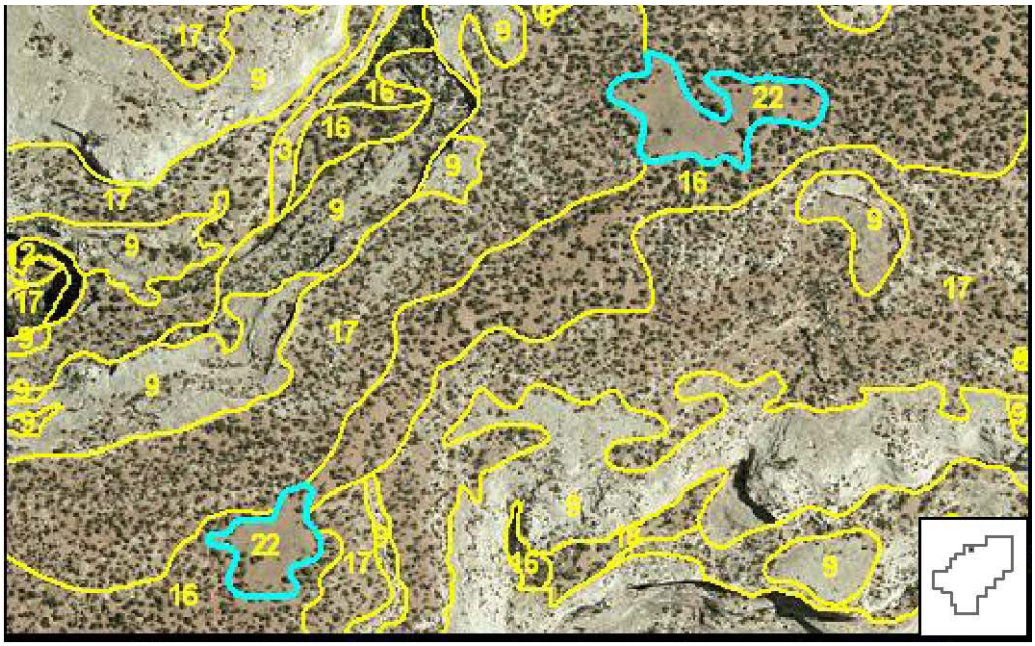
Bouteloua gracilis *Pleuraphis jamesii*

Distribution/Ecology/Composition

The Galleta-Blue Grama Grassland map class is rare within the mapping area; it is restricted to pockets of soil near and on ledges just below the canyon rim. It usually occurs as openings in pinyon-juniper woodlands with some grass in the understory. Stands are dominated by either *Pleuraphis jamesii* or *Bouteloua gracilis*; associated species include scattered small shrubs of *Gutierrezia sarothrae* and *Ephedra viridis.*

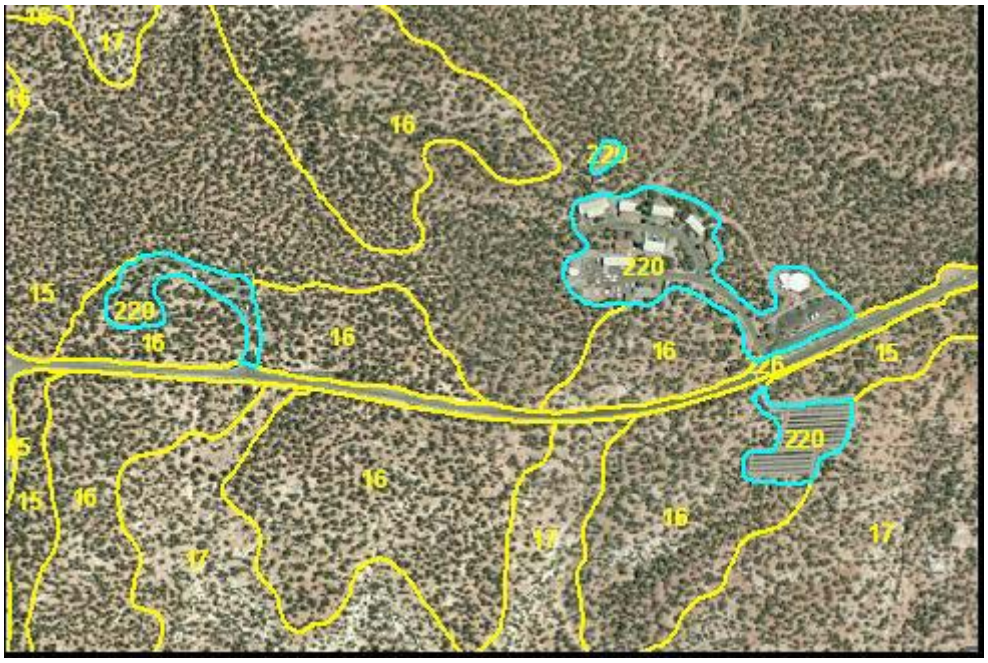
Interpretation

The H-GALL map class appears as tan areas with a grayish cast and a smooth texture. Polygons are generally small and irregular. Adjacent polygons are commonly mapped as W-PJNG, W-PJLM, and W-PJSP.



Example of the photo signature for map class H-GALL (#22).

Map Class 220
Monument Facilities
(L-PAFA)



Example of the photo signature for map class L-PAFA (#220).

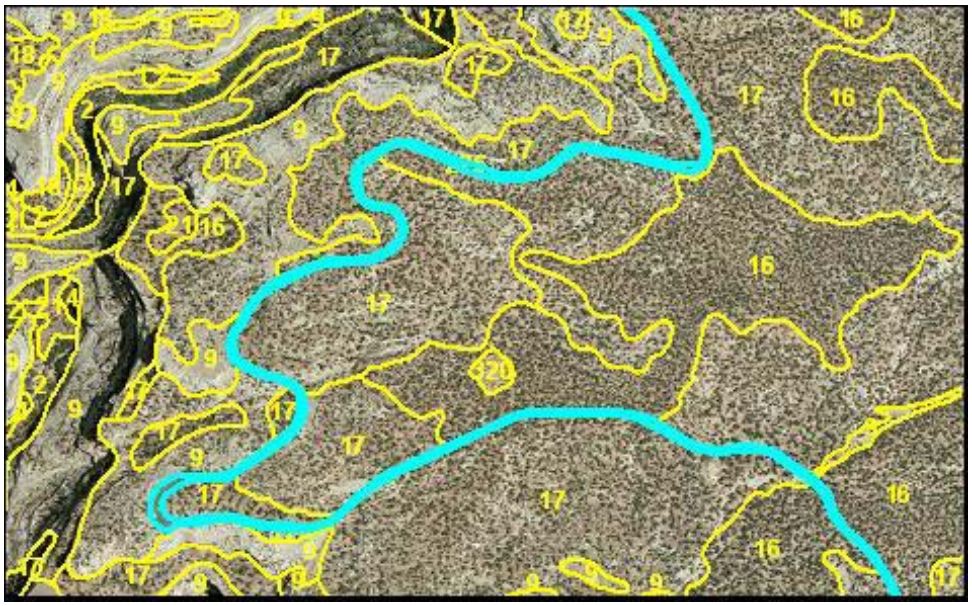
L-PAFA Map Class Statistics

Type	Land Use
Frequency	Total project polygons = 6 polygons in NABR = 6
Area	Total project area = 6.0 hectares / 14.8 acres 6.0 hectares / 14.8 acres in NABR
Average Size	Total project polygons = 1.0 hectares / 1.67 acres 1.0 hectares / 1.67 acres in NABR
Proportion	0.05% of total project mapping area 0.05% of NABR portion of mapping area
Accuracy	Not accuracy assessed

Description:

This map class consists of NPS buildings and other facilities (water tanks, sewage ponds, solar array) with associated access roads, parking areas and immediate developed and undeveloped land. The signature combines regularly-shaped structures and natural vegetation.

Map Class 226
Roads
(L-Road)



Example of the photo signature for map class L-ROAD (#226).

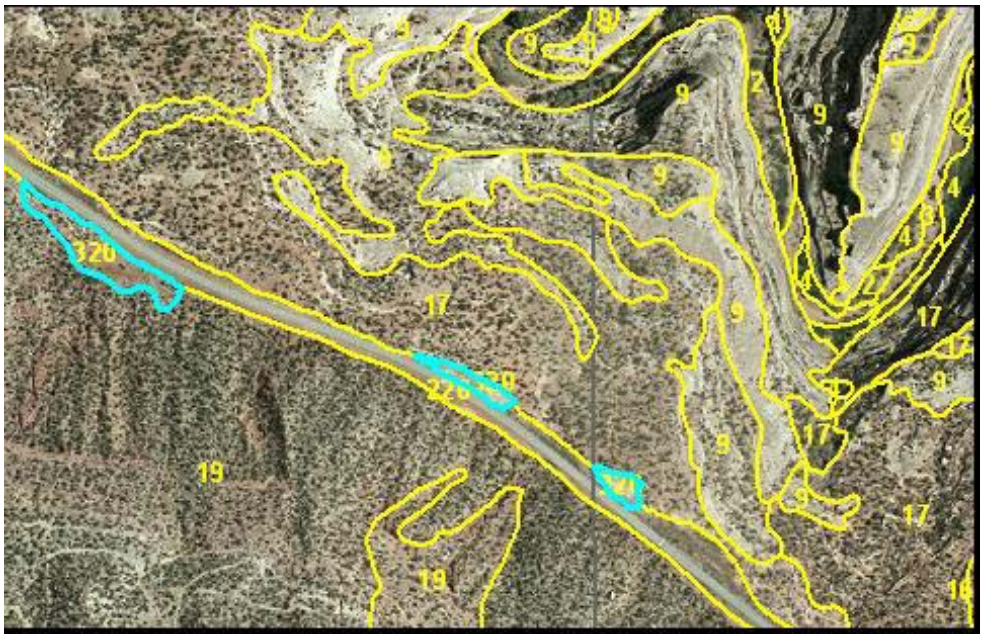
L-ROAD Map Class Statistics

Type	Land Use
Frequency	Total project polygons = 7
	polygons in NABR = 3
	polygons in environs = 4
Area	Total project area = 38.7 hectares / 95.7 acres
	20.6 hectares / 50.9 acres in NABR
	18.2 hectares / 44.9 acres in environs
Average Size	Total project polygons = 5.5 hectares / 13.7 acres
	6.7 hectares / 16.9 acres in NABR
	4.5 hectares / 11.2 acres in environs
Proportion	0.72% of total project mapping area
	0.69% of NABR portion of mapping area
	0.008% of environs portion of mapping area
Accuracy	Not accuracy assessed

Description:

This map class includes all types of road, including paved park roads, state highways, and dirt access roads. It also includes adjacent related features such as pullouts, ditches, shoulders and road cuts. The typical photo signature is long, sinuous polygons with smooth texture indicating pavement or graded dirt.

Map Class 320
Quarry / Borrow Pit
(L-QUBP)



Example of the photo signature for map class L-QUBP (#320).

L-QUBP Map Class Statistics

Type	Land Use
Frequency	Total project polygons = 5 polygons in NABR = 3 polygons in environs = 2
Area	Total project area = 1.8 hectares / 4.4 acres 0.75 hectares / 1.86 acres in NABR 1.0 hectares / 2.5 acres in environs
Average Size	Total project polygons = .35 hectares / .88 acres 0.25 hectares / .62 acres in NABR 0.51 hectares / 1.26 acres in environs
Proportion	0.03% of total project mapping area 0.69% of NABR portion of mapping area 0.0004% of environs portion of mapping area
Accuracy	Not accuracy assessed

Description

This map class consists of areas where gravel and/or soil were excavated, usually adjacent to roads and parking areas. Sometimes these areas are planted with exotic species such as sweet clover (*Melilotus* spp.). The signature is that of largely unvegetated, tan-colored soil.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior

Natural Resource Program Center

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