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Vegetation Classification and Map

Bandelier National Monument

Natural Resource Technical Report NPS/SCPN/NRTR—2011/438



ON THE COVER

Frijoles Canyon looking northwest from Lummis Mesa; Cerro Grande is in the distance.
Photo courtesy of Amanda Kennedy

Vegetation Classification and Map

Bandelier National Monument

Natural Resource Technical Report NPS/SCPN/NRTR—2011/438

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Acronyms and abbreviations

BP	(years) before the present
BAND	Bandelier National Monument
CCC	Civilian Conservation Corps
DBH	Diameter at Breast Height (4.5 feet)
DCA	Detrended Correspondence Analysis
DEM	Digital Elevation Model
DOQQ	Digital Orthophotograph Quarter Quadrangle
ESRI	Environmental Systems Research Institute
ETM	Enhanced Thematic Mapper
FGDC	Federal Geographic Data Committee
FSO	Feature Space Optimization
GIS	Geographic Information System
GPS	Global Positioning System
I&M	Inventory and Monitoring Program
IFOV	Instantaneous Field of View
ITIS	Integrated Taxonomic Information System
LANL	Los Alamos National Laboratory
MMU	Minimum Mapping Unit
NAD	North American Datum
NDSVI	Normalized Senescent Difference Vegetation Index
NDVI	Normalized Difference Vegetation Index
NHNM	Natural Heritage New Mexico
NPS	National Park Service
NRCS	Natural Resource Conservation Service
NVC	National Vegetation Classification
NVCS	National Vegetation Classification Standard
PA	Plant Association
PCA	Principal Components Analysis
SFNF	Santa Fe National Forest
SI	Solar Index
TAS	Terrain Analysis System
TNC	The Nature Conservancy
TRMI	Topographic Relative Moisture Index
UNESCO	United Nations Education, Science, and Cultural Organization
USGS	United States Geological Survey
UNM	University of New Mexico
UTM	Universal Transverse Mercator
VCNP	Valles Caldera National Preserve

Executive Summary

We developed a vegetation classification and high-resolution vegetation map for Bandelier National Monument, New Mexico, as part of the USGS Vegetation Characterization Program, a cooperative effort by the U.S. Geological Survey (USGS) and the National Park Service Inventory & Monitoring - Vegetation Mapping Program to classify, describe, and map vegetation communities in more than 280 national park units across the United States. The classification and map for Bandelier National Monument (BAND) were based on data collected from 710 field plots between 2003 and 2007.

The vegetation communities of BAND are diverse. They range from desert shrublands and semiarid grasslands of the lowland canyons and foothills to subalpine forest and woodlands at the highest elevations. Using various multivariate statistical and tabular tools, and adhering to the guidelines of the National Vegetation Classification Standard (NVCS), we identified 95 plant associations for the park, many of them unique to the Southwest. The vegetation map was developed using a combination of automated digital processing (supervised classifications and image segmentation) and direct image interpretation of high-resolution color and color infrared aerial orthophotography in combination with satellite imagery (Landsat Thematic Mapper). The map legend is hierarchically structured with an upper Level 1 of 24 map units corresponding to the Group Level NVCS and a Level 2 composed of 55 nested map units comprised of plant associations from the vegetation classification.

The map was designed to facilitate ecologically-based natural resources management at a 1:24,000 scale with 0.5-ha minimum map unit size. Based on a provisional assessment, overall accuracy was 82.5% for Level 1 and 66.8% for Level 2. Level 1 units will likely be sufficient and most appropriate for many natural resource planning and evaluations, while Level 2 units provide added fine-scale information within major ecological groups. To support the map as a management tool, we provide an annotated map legend along with descriptions of each plant association, a corresponding diagnostic key, field forms, and a plant species list. The map was delivered in both printed form and as digital Geographic Information System (GIS) map files. The GIS format allows flexibility to update the map as new information becomes available, or as major vegetation changes, such as fire, disease or other impacts, occur in the park.

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1 Introduction

1.1 Background, scope, and products

Bandelier National Monument harbors world-renowned archeological sites in an ecologically complex landscape. The same unusual volcanic tuff cliffs and mesas that were home to the Ancestral Pueblo peoples also gave rise to diverse vegetation communities that now provide habitat and forage for a plethora of wildlife as well as exceptional recreational opportunities for park visitors. The National Park Service (NPS) has sought to manage these biological resources with the same care and attention as that given to the archeological values. Accordingly, along with comprehensive biological inventories and monitoring, a key to effective biological management is the development of a high-resolution vegetation map that can support such activities as flora and fauna habitat modeling, recreation planning, fire management, ecological research, and broad-scale facilities planning.

To meet this objective, the U.S. Geological Survey (USGS)-National Park Service (NPS) Vegetation Mapping Program and the NPS Southern Colorado Plateau Network (SCPN), in cooperation with Natural Heritage New Mexico (NHNM)[1], NatureServe[2] and the staff at Bandelier National Monument (BAND), set out to develop a vegetation map that meets or exceeds USGS-NPS standards[3], (1:24,000 scale and 0.5 ha minimum map unit size). The map was to be based on high-resolution aerial photography and satellite imagery and extensive ground sampling. The project was initiated in 2002 with field surveys of the vegetation communities beginning in the summer of 2003. The vegetation survey data was entered into a database and used to develop a park-wide vegetation classification following the National Vegetation Classification System (FGDC 1997, 2008; Grossman et al. 1998) guidelines. Then, a vegetation map was generated from the vegetation classification and associated ground control points at the 1:12,000 scale, using a combination of automated image analysis (image segmentation and supervised classifications) and direct image interpretation. Map units were designed to support ecologically-based natural resources management with an emphasis on uses for fire and wildlife management.

We provide here (1) the details on how the map was constructed, (2) an overview of the classification and ecology of the vegetation communities of the park, (3) the vegetation map with associated map unit descriptions, (4) plant community descriptions and a diagnostic key, and (5) a vouchered species list. The map is presented in both printed form and as digital Geographic Information System (GIS) map files. In addition, all field data were compiled into a relational database, and all data and reports elements have been made ready for web-based applications. Finally, we provide an accuracy assessment that reflects both user and producer confidence in the map.

1.2 The USGS-NPS Vegetation Characterization/Mapping Program

The USGS-NPS Vegetation Characterization Program is a cooperative effort by the USGS and the NPS to classify, describe, and map vegetation communities in more than 280 national park units across the United States. Consistent vegetation classification, mapping, and accuracy assessment protocols and standards are applied across projects supported by this program. The National Vegetation Mapping Program is administered by the USGS Center for Biological Informatics in cooperation with the NPS Inventory & Monitoring (I&M) Program and its Vegetation Mapping Inventory. As a result of the NPS Natural Resource Challenge (NPS 1999), significant funding became available for completing important natural resource

[1] A division of the Museum of Southwestern Biology at the University of New Mexico.

[2] The national network organization of natural heritage programs and conservation data centers. See: http://www.natureserve.org/

[3] See http://biology.usgs.gov/npsveg/standards.html.

baseline inventories in park units, including vegetation classification and mapping. This support enabled the NPS to move forward with dozens of new park unit vegetation classification and mapping projects, including the project at BAND. 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 (see: http://biology.usgs.gov/npsveg/).

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

Protocols

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

Standards

- National Vegetation Classification Standard (FGDC 1997; 2008)
- Spatial Data Transfer Standard (FGDC 1998b)
- Content Standard for Digital Geospatial Metadata (FGDC 1998a)
- United States National Map Accuracy Standards (USGS 1999);
- Integrated Taxonomic Information System (http://www.itis.gov).
- program-defined standards for map attribute accuracy and minimum mapping unit

1.3 Park environment

1.3.1 Location and cultural setting

Bandelier National Monument is located along the southern portion of the volcanic Pajarito Plateau on the southeast flank of the Jemez Mountains in north-central New Mexico (fig. 1). It is bounded on the north along the plateau by Los Alamos National Laboratory (LANL); on the northwest and west by the Jemez District of the Santa Fe National Forest (SFNF); in the northwest corner by Valles Caldera National Preserve (VCNP), and to the south by Cañada de Cochiti land grant and the Rio Grande in White Rock Canyon (fig. 2). The project area includes the park proper of 15,742 ha (33,750 ac), plus an additional 15,000 ha (33,000 ac) of buffer areas on adjacent U.S. Forest Service (USFS) lands. The project area also includes the small, isolated Tsankawi Unit (342 ha; 844 ac) about 15 km (12 mi) north of the park near the town of White Rock.

Within the park, a long elevation gradient stretches from the Rio Grande in the bottom of White Rock Canyon at 1,600 m (5,300 ft), to the summit of Cerro Grande in the Sierra de los Valles (which forms the natural boundary with Valles Caldera) at 3,109 m (10,199 ft). The long elevation gradient, in combination with the geologic, topographic, and soils diversity, provides the framework for a wide variety of ecosystem types and complex vegetation patterns.

This diverse landscape once provided a home for the Ancestral Puebloans, which was the primary reason that Bandelier National Monument was created in 1916 (i.e., to preserve and protect the high concentration of cultural resources). The monument contains approximately 2,750 recorded archeological sites that span from the Paleoindian period (10,000 years ago) to the historic period (1600 to present). The monument contains ancient hunting camps, “caveate” structures (rooms that have been carved into the soft tuff bedrock), 300-room pueblos, small farming

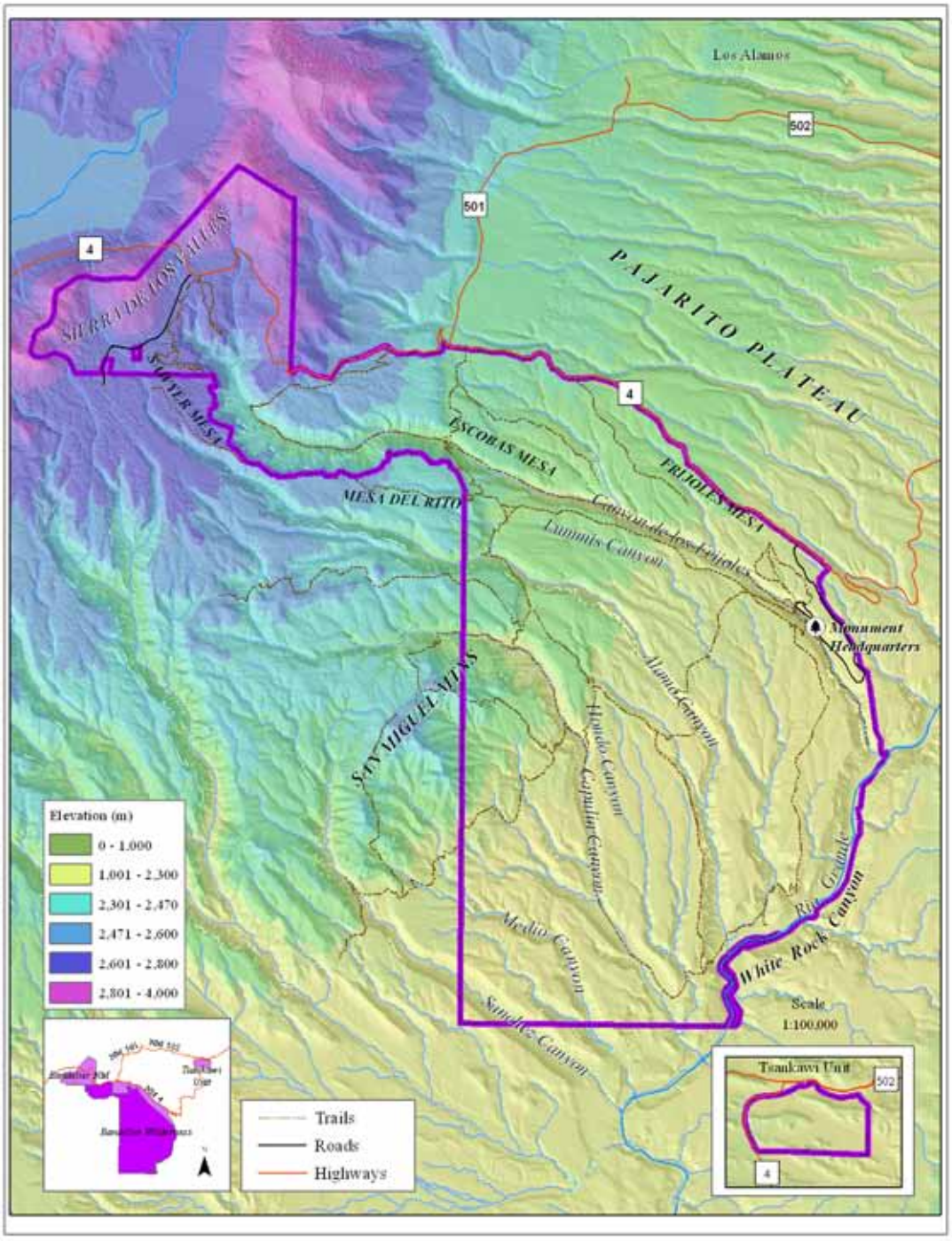


Figure 1. Bandelier National Monument (BAND) is located on the southeast flank of the Jemez Mountains on the southern portion of the volcanic Pajarito Plateau in north-central New Mexico. The figure depicts the main unit of BAND; the inset on the lower left depicts the entire monument; the inset on the lower right depicts the Tsankawi unit of the park, which was included in this vegetation mapping project.

hamlets, and the remains of historic corrals and log cabins, as well as other cultural resources. Bandelier is also home to the largest collection of Civilian Conservation Corps (CCC)-era buildings and features, most of which are preserved in the Bandelier National Monument CCC Historic District. This National Historic Landmark commemorates the accomplishments of the CCC and its contributions to the history of the NPS. The relatively high concentration of human activity in the park throughout its history also likely exerted significant influence on vegetation patterns and dynamics within the park (Allen 2002, 2004).

1.3.2 Climate

The climate of BAND is characterized by cool-to-cold, dry winters, and warm, wet (monsoonal) summers (Jacobs et al. 2002). The mean daily temperature extremes range between -10 °C and 6°C in January, and 13°C to 30 °C in June, considered, re-

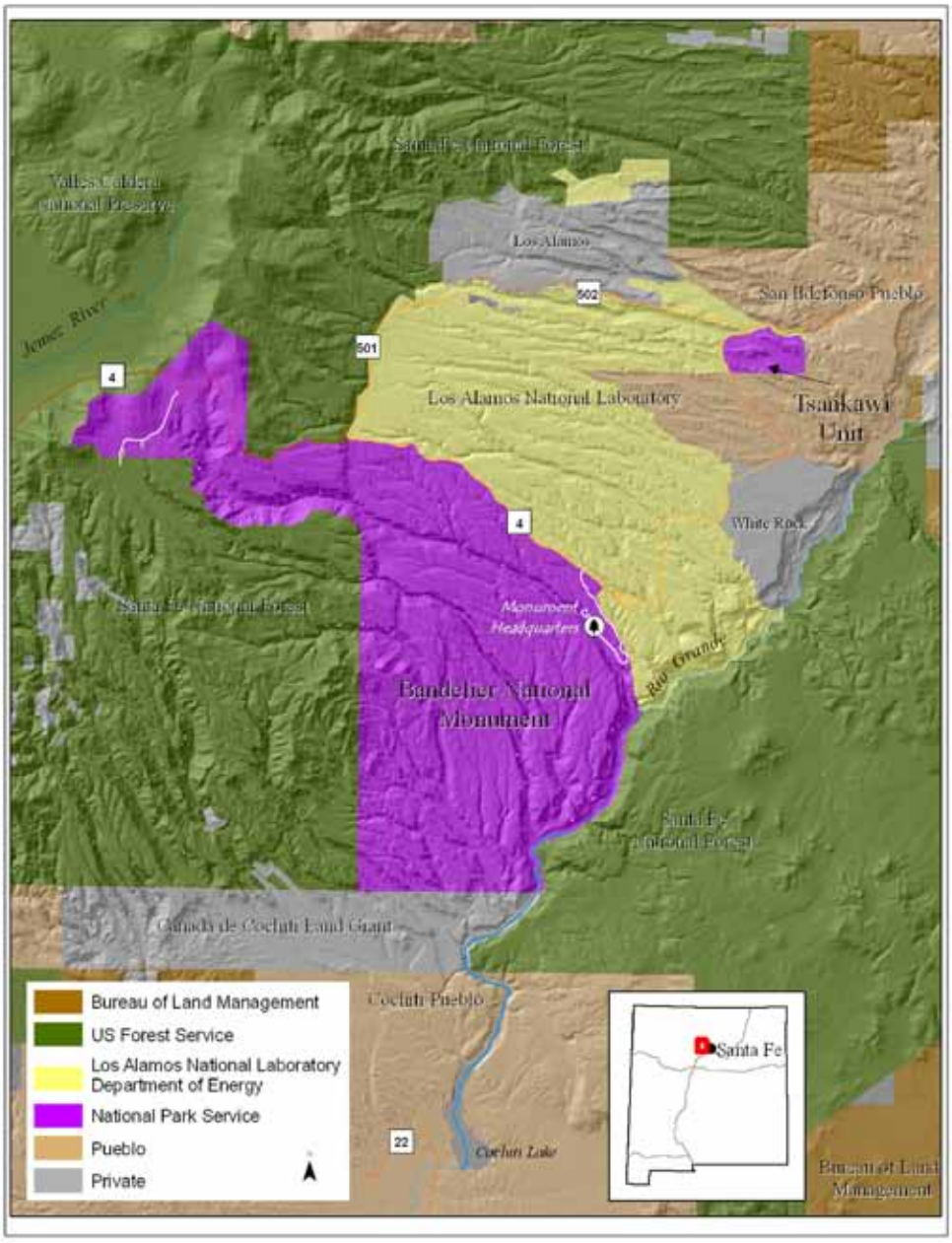


Figure 2. Bandelier National Monument is surrounded by a complex ownership pattern of federal lands, such as the Santa Fe National Forest; tribal lands, such as the Cochiti Pueblo; and local jurisdictions, such as the Los Alamos and White Rock town sites.

spectively, the coldest and warmest months of the year. The coldest recorded daily temperature at nearby Los Alamos was -27.2 °C and the warmest 35 °C.

Jacobs et al. (2002) reported that the mean annual precipitation was about 427 mm as recorded at the fire lookout tower near park headquarters (unpublished weather records for 1925-2002, on file at Bandelier National Monument). Winter precipitation was delivered principally as snow by low-pressure systems that sweep from west to east across the Southwest, coalescing with moisture from the Pacific Ocean or the Gulf of Mexico. Winter precipitation was generally followed by a seasonal dry period during the months of May and June. This dry period was defined as much by the increased potential evapotranspiration that accompanies increased day length, solar radiation, and temperatures, as by decreased precipitation. The spring dry period was usually relieved by the onset of the Mexican monsoon—this weather pattern typically delivered at least 40% of the annual precipitation during the months of July through September, and is associated mostly with short-duration, high-intensity thunderstorms. Each summer, as high pres-

sure became entrenched off the coast of Baja California, low pressure in the Southwest fed Pacific moisture across the region, fueling the development of afternoon thunderstorms. The magnitude, frequency, and tracking of individual large, intense thunderstorm cells during this period can account for large year-to-year variability in annual rainfall and between local areas.

Given the long elevational gradient within the park, precipitation and temperature will shift locally along the gradient and in response to topographic features. For example, at the lower elevations, precipitation likely dips below 400 mm with a corresponding increase in temperature between 2°C and 5°C; while at the highest elevations, precipitation may exceed 500 mm, with temperatures dipping 5°C to 10°C (USFS 1993). In addition, the canyons afford a pathway for cold air to drain from the highest elevations to the lowest, which has a significant effect, not only in shortening the relative growing season length, but also on evaporation, with an associated modulation of moisture conditions.

During the project period, 2002 through 2008, precipitation declined significantly from the long-term average (fig. 3). Based on records from nearby Los Alamos, NM, annual precipitation began declining in 1998 and bottomed out in 2003 at 252 mm, the second-lowest yearly total on record (1956 had 172 mm). The decline could be attributed to a combination of several dry winters and/or relatively weak monsoons, with severe drought conditions prevailing between the winter of 2001-02 through the summer of 2003 (fig. 4). Although rainfall conditions improved from 2004 through 2008, the 2002-03 drought had a significant impact on project planning and execution (see Project Overview below).

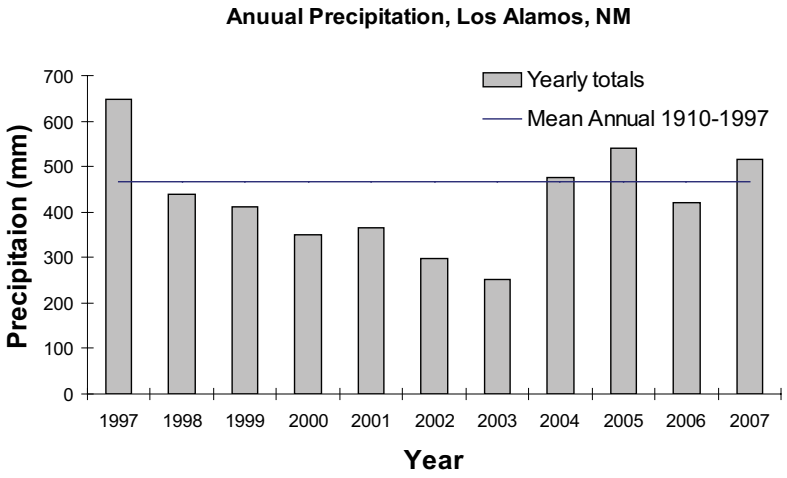


Figure 3. Trend in annual precipitation between 1997 and 2007 at Los Alamos, NM, 20 km north of Bandelier National Monument (source: Western Regional Climate Center, wrcc@dri.edu).

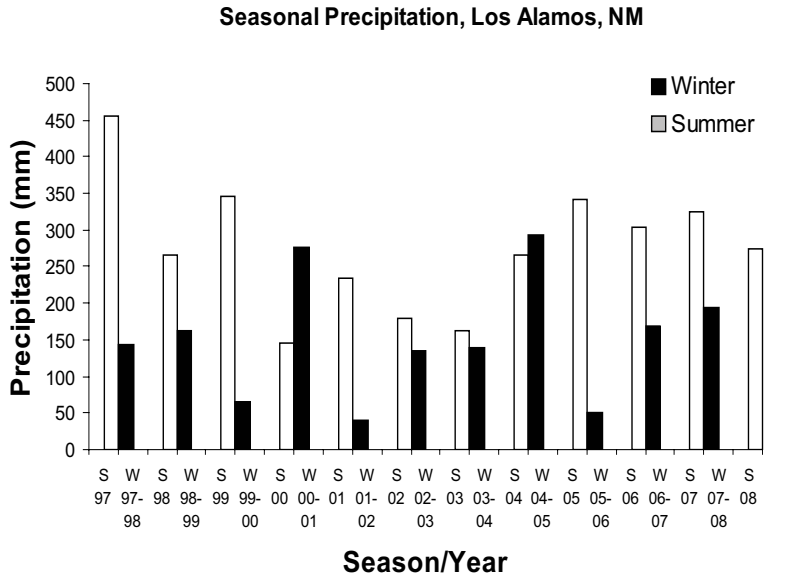


Figure 4. Seasonal precipitation trends between 1997 and 2007 at Los Alamos, NM, 20 km north of Bandelier National Monument (source: Western Regional Climate Center, wrcc@dri.edu).

1.3.3 Landscape context

1.3.3.1 Geology

The geology of the Jemez Mountains region was mapped by Smith et al. (1970), and the BAND portion of the map is utilized in Figure 5, which illustrates the general geology of BAND. However, we used recently completed draft geology maps that detail the geologic composition and structure of the park and adjacent areas at a 1:24,000 scale (Goff et al. 2002; 2005). These maps, while not yet digitized, were used to qualitatively inform the vegetation mapping process. A summary of the rock units within BAND mapped by these authors is provided in Appendix A.

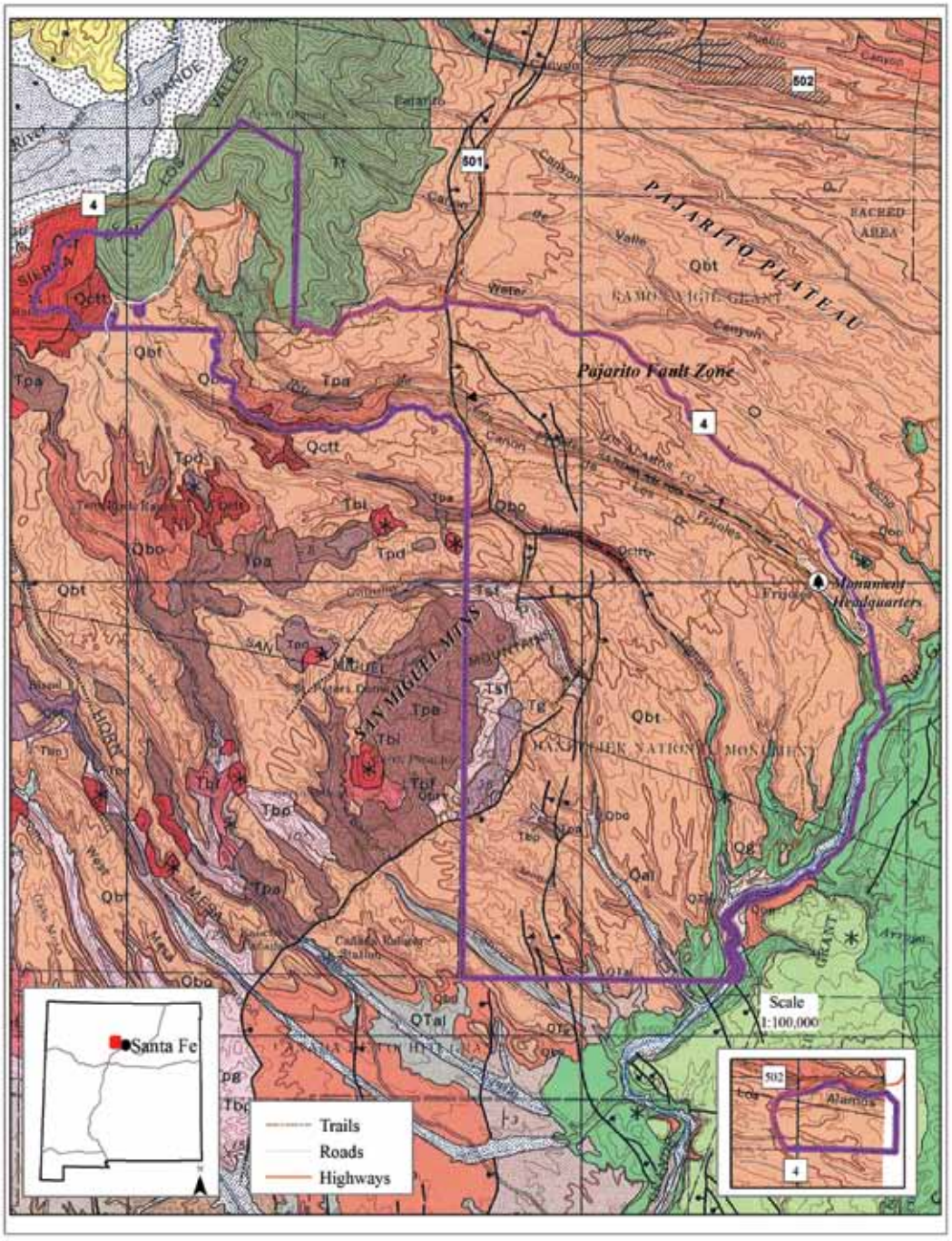


Figure 5. The general geology of Bandelier National Monument. The monument is dominated by volcanic deposits of tuff and pumice (see appendix A). The inset on the bottom right depicts the Tsankawi unit. Extracted from Smith et al. (1970).

Geology Units within Bandelier National Monument Boundaries

- Q Tal - Undifferentiated terraces and alluvium
- Qal - Alluvium
- Qbo - Lower Bandelier Tuff
- Qbt - Upper Bandelier Tuff
- Qct - Cerro Toledo Rhyolite
- Qctt - Cerro Toledo Interval
- Qg - Quaternary gravel
- Tbp - Bearhead rhyolite, Peralta Tuff member
- Tg- Tertiairy gravels
- Tpa - Two-pyroxne andesite, undivided (Paliza Canyon Formation)
- Tsf - Santa Fe Group, Miocene

Bandelier National Monument is located on the southeastern flank of the Jemez Mountains, which lie at the intersection of the Jemez lineament and the Rio Grande rift (fig. 6). The Jemez lineament is a chain of volcanic centers extending from Arizona to Colorado, and the Rio Grande rift is a crack in the earth's crust extending from the Rocky Mountains of central Colorado to Chihuahua, Mexico. This geologic interface was the site of a series of volcanic events related to tectonic movements which began some 13 million years ago, culminating in two massive explosions and leading to the formation of the Toledo and Valles Calderas at 1.61 and 1.23 million years ago, respectively (Spell and Harrison 1993). The Toledo eruption discharged an estimated 396 km^3 of rock and ash, while the Valles eruption produced about 292 km^3. By comparison, Mount Saint Helens erupted 25 km^3 and Krakatoa 18 km^3 of new material.

The Valles and Toledo eruptions cumulatively deposited the 300-meter thick Bandelier Tuff in two distinct layers that now dominate the BAND landscape as part of Pajarito Plateau (the lower Otowi and upper Tshirege members, respectively (Qbo and Qbt in appendix A and figure 5). The most recent eruption, El Cajete at 50-60,000 B.P., buried the local landscape under many meters of pumice (Qvec, Qvr), much of which was subsequently eroded and reworked, leaving pumice patches predominately on east-facing slopes and deep alluvial deposits on lower slopes (Goff et al. 1995). Along the western boundary of the park lie the San Miguel Mountains, which are comprised of older Tertiary and andesitic and rhyolitic volcanics (Tka, Tkch, Tkct, Tkhd, Tkoa, Tkpa,) along with sedimentary sandstones of the Santa Fe Group and Galisteo Formation (Tsf, Tsfb, Tsfu, and Tgs). The south-to-north trending Parajito Fault Zone ranges from the base of the San Miguel Mountains northward, distinctly separating the Pajarito Plateau from the San Miguel Mountains and the rim country to the west known as Sierra de los Valles and its associated mesas (Sawyer Mesa, Mesa del Rito). The Sierra de los Valles are made up of dacites associated with Cerro Grande (Ttcg) and Sawyer Dome (Ttcd), along with rhyolites of Rabbit Mountain (Qrd and Qrm). In contrast, the Pajarito Plateau is bounded on the east by White Rock Canyon, a deep gorge containing the Rio Grande that has extensive exposures of Tertiary mafic lava beds (Tcb, Tcba, and Tcbm).

1.3.3.2 *Terrain and watershed characteristics*

Topographically, the layered volcanic rocks of the Pajarito Plateau provide a structural control that has resulted in a series of deeply incised, southeast-trending, steep-walled canyons (Frijoles, Lum-

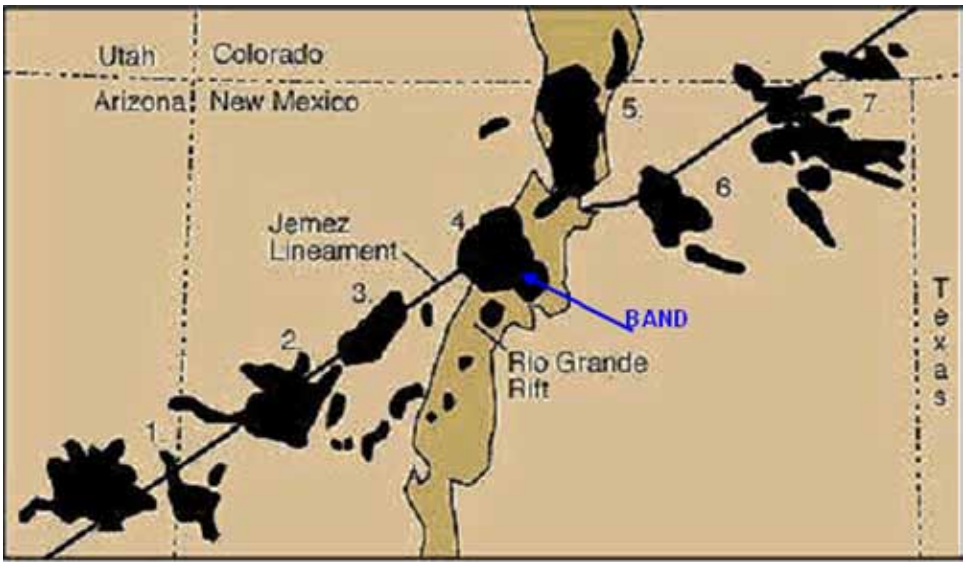


Figure 6. Geologically, Bandelier National Monument is located relative to the Miocene to Holocene volcanic fields and the Jemez lineament: 1. Springerville; 2. Zuni-Bandera; 3. Mount Taylor; 4. Jemez Mountains; 5. Taos; 6. Ocate; and 7. Raton-Clayton (from Ander et al. (1981).

mis, Alamo, Hondo, Capulin, Medio, and Sanchez), alternating with broad mesa tablelands (see figure 1). The tablelands themselves are moderately incised with small drainages that create an undulating topography of small canyons and intervening "interfluves," particularly at the lower, distal ends of the mesas. Conversely, the upper portions of the mesas are flatter and bounded by the structurally uncontrolled slopes of the San Miguel Mountains and Sierra de los Valles. Along the plateau escarpments and canyon sides, a distinctive banding of cliffs, rock outcrops, and rubble zones reflect the stratigraphy of the various members of Bandelier Tuff and other volcanic rocks. Conspicuous are the dramatic pink-to-orange cliffs of the Tshirege Member of Bandelier Tuff that can be over 250 m (820 ft) tall.

The canyon and valley bottoms can contain relatively broad floodplains (100-200 m; 325-650 ft) filled with deep sediments delivered by perennial, intermittent, and ephemeral streams. Frijoles and Alamo canyons together occupy 9,062 ha (22,392 acres) and Frijoles Canyon contains the only consistently perennial stream in the park. The smaller canyons of Hondo, Capulin, Medio, and Sanchez Canyons together account for 4,087 ha (10,099 ac) and have intermittent zones of perennial waters. These drainages join the Rio Grande within White Rock Canyon, which in turn forms the eastern boundary of the park. The Rio Grande, with its headwaters in the San Juan Mountains of southwestern Colorado, can deliver high discharges, particularly during spring snowmelt (> 140 cms, 5,000 cfs), along with significant sediment deposition. While the gorge confines the river on a broad scale, floodplain deposits on both sides of the river are up to 130 m (427 ft) across and support riparian and wetland vegetation. The Rio Grande is impounded 20 km (12.4 mi) south of the park boundary at Cochiti Lake reservoir. The reservoir began filling in 1972, and the pool at different times has extended up into White Rock Canyon through the park and into the adjacent tributary canyons some 13 km (8 mi). This has created an identifiable high-water zone as high as 30 m (98 ft) up slopes above the current Rio Grande and side canyon floodplains.

1.3.3.3 Soils

A second-order soil survey by the Natural Resources Conservation Service (NRCS) was recently completed for BAND and made available in digital form (Hibner 2009). Thirty-nine soil map units were described and delineated at a 1:24,000 scale, and generally organized in broad terrain groups and along an elevation gradient (fig. 7; appendix B). The map units were made up of various combinations of 34 soil series (and variants) from a wide variety of soil families. At the lowest elevations in White Rock Canyon and surrounding areas, a suite of units represent the bordering escarpments, mesas and plateaus along with the bottom-land floodplains of the Rio Grande and immediate tributaries (Group A). These soils are variously derived from basalt, sedimentary bedrock, or alluvium.

Group B contains the lower-elevation soils of the plateaus and mesas, which are derived from colluvium, slope alluvium, or eolian-deposit parent materials over rhyolitic Bandelier Tuff residuum (the 400s map units). This group includes the moderately developed soils (haplustalfs) of plateau tops (Canuela, Hackroy, and Nyjack series); weakly developed shoulder and backslope soils (ustorthents and ustipsamments) of the Palatka, Zacaton (south facing), and Abrojo (north facing) series; and rock outcrops. In contrast, this group also includes Armenta (413) and Adornado (408) soils derived from rhyolitic El Cajete pumice, which overlays the Bandelier Tuff. These soils are deeper (haplustolls), and have comparatively better developed, but coarser surface horizons (sandy and gravelly loams). Soils of the inter-plateau canyons and valleys (Group C) occur at similar elevations and include Navajita (402) and Piojillo (403) soils of the lower colluvial toe slopes of canyon sides, along with alluvial soils of valley floors and floodplains (Totavi (404), Espiritu/Petegral (405), and Metate

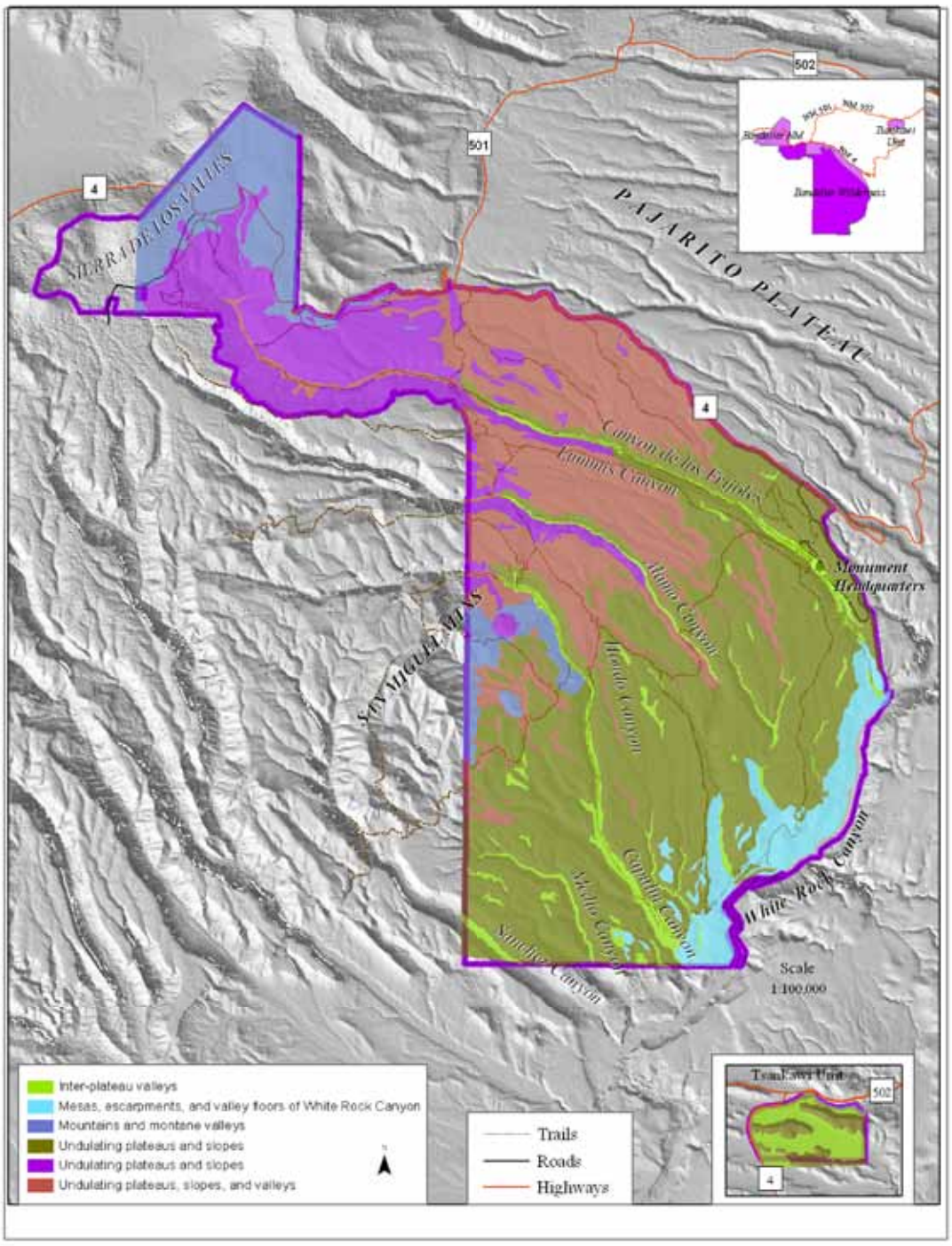


Figure 7. Generalized soil map of Bandelier National Monument derived from Hibner (2009). See Appendix B for definitions of soil groups. The inset on the lower left depicts the entire monument; the inset on the lower right depicts the Tsankawi unit of the park, which was included in this vegetation mapping project.

(414)).

The mid-elevation mesa tops and slopes of the Pajarito Plateau are represented by a similarly structured group of soil units (Group D). Rotado and Tocal soils are relatively deep Paleustalfs and Haplustalfs, respectively, which are derived from rhyolytic tuff and occupy the summits of the interfluves. The shallower Urioste (Ustorthents) and Cymery (Haplustepts), along with rock outcrop, characterize shoulders and backslopes of the canyons. El Cajete pumice soils are represented again by the Adornado series (803 and 804) on the plateau tops and the Cajete Series on the slopes. A cooler version of Metate (807) occupies the alluvial terraces of the valley bottoms.

The highest-elevation plateau soils units (Group E) typically occur above the Parajito Fault Zone at greater than 2,300 m (7,500 ft). Tschicoma (810), Hoxoh (813),

and Jemez (814) are the deeper soils of the plateau summits and summit toeslopes (Argiustolls, Haplustolls, and Haplustalfs, respectively). Shallow Cymery (811), Urioste (816), and Estaban (816, 826) soils occupy the slopes and rock outcrops.

Mountain soils lie above the plateaus (Group F), with Mapache (821, 822) and Lucito (820) occupying the lower slopes and Casey the upper slopes and summits of the Sierra de los Valles; Wauquie and Laventana (815) are andesitic soils found on the slopes of the San Miguel Mountains. Tschicoma and Tranquilar (823) soils occupy small valley footslopes and floors, respectively.

1.3.3.4 Previous vegetation classification and mapping studies

DeVelice (1983) and DeVelice et al. (1986) produced a comprehensive forest-habitat classification for northern New Mexico and southern Colorado that included the Jemez Mountains, and laid the foundation for future forest classifications in the region. Barnes (1983) produced a pinyon-juniper habitat type classification for BAND that identified three main plant associations based on detailed floristic and environmental parameters. Allen (1984) provided detailed descriptions of montane grasslands within the park. Allen also produced (1989) a 1:24,000-scale map of the major cover types in the park, based on photo-interpretation of 1981 color USFS stereo air photos and black and white orthophotography. He ground-truthed the map using 969 sample points. A decade later, Balice et al. (1997) and Balice (1998), working on behalf of LANL, produced a preliminary vegetation classification for the Los Alamos region, which has also added to the understanding of the vegetation patterns of the park. The LANL group produced a series of maps based on 30-meter LANDSAT Thematic Mapper imagery for the Los Alamos and eastern Jemez regions (Koch et al. 1997; McKown et al. 2003). They developed 30 vegetation map units that provided the context for the map unit development for the BAND vegetation classification map. At about the same time, Muldavin and Tonne (2003) and Muldavin et al. (2006) completed a vegetation classification for the adjacent Valles Caldera National Preserve. They identified 65 plant associations and developed 20 map units which were mostly associated with montane and subalpine forests and grasslands. To enhance cross-jurisdictional management, the BAND map units were developed with the goal of maintaining as much congruence as possible with other maps in the region.

1.3.3.5 Fire and drought impacts on vegetation

Historical fires and recent droughts have had a significant impact on vegetation patterns in BAND. As is typical with much of the wildland landscape of the Southwest, fire frequencies and extent at BAND significantly declined at the turn of the 19th and 20th centuries (Foxx and Potter 1984; Allen 1984; Touchan et al. 1996; Swetnam and Baisan 1996). Prior to 1894, mean fire intervals for major fires in ponderosa and mixed-conifer forest ranged from 6.5 to 22 years. After 1894, major, spatially extensive fires were absent from both the dendrochronological record and actual fire records. This was attributed to the onset of heavy grazing and fire suppression activities. Consequently, forest stands began to accumulate fine fuels and developed ladder fuels from extensive understory conifer regeneration. Conifers began to invade open montane grasslands (Allen 1984; 1989). In addition, those fires that did occur were increasingly attributed to human causes rather than lightning.

The combination of fuel accumulation and human ignitions led to three major crown-fire events at BAND since 1977, which have transformed a significant portion of the park's landscape (fig. 8). The first was the La Mesa Fire in the summer of 1977, which burned 6,354 ha (15,700 ac) on the plateaus of the central portion of the park and adjacent LANL lands. The Dome Fire occurred in the spring of 1996



Figure 8. In 2002-03, bark beetle *(Ips* sp.) and the associated fungal rot (*Ophiostoma* sp. and *Ceratocystis* sp.) killed thousands of pinyon and ponderosa pines all across the mid-elevations of Bandelier National Monument. In addition, fires, such as the 2000 Cerro Grande fire, the effects of which can be seen in the background of this photo, have had a significant impact on the vegetation of the park. Photo courtesy of Craig Allen.

and burned 6,677 ha (16,500 ac) over the western portion of the park and adjacent USFS lands. Lastly, the Cerro Grande Fire of 2000 was initiated as a prescribed fire in the upper Frijoles watershed within the park, but control was lost, and it burned some 16,909 ha (41,782 ac), mostly to the north on USFS, LANL, and private lands. Only about 494 ha (1,221 ac) burned within the park (based upon GIS coverages of the fire). All three fires had major impacts on vegetation patterns, leaving behind partially burned patches, stands of standing dead trees, and extensive open areas that are now in the process of revegetating (Foxx and Potter 1984; Foxx 1996). Of particular consequence for the vegetation classification was the introduction of exotic grasses in post-fire seeding to curb erosion (Foxx 1996). In addition, the park has conducted a series of other prescribed fires and woodland treatments that have altered stand structure and composition on a smaller scale (Jacobs et al. 2002). These have known locations and were accounted for in the mapping process.

Finally, vegetation mortality due to recent drought has also significantly affected vegetation patterns at BAND (fig. 8). Water stress from dry years, beginning in 1996 and culminating in a severe drought from 2000-2004, killed many trees and also caused dieback of shrubs and grasses at BAND. Tree mortality was caused by a combination of direct water stress, associated outbreaks of bark beetles (especially *Ips*, *Dendroctonus*, and *Scolystus* sp.), and fungal rots (*Ophiostoma* sp. and *Ceratocystis* sp.) carried by the beetles. This combination of drought and bark beetles killed trees of many species across elevational gradients in Bandelier (and throughout the Southwest), ranging from Douglas-fir and white fir at higher elevations, down through ponderosa pine, pinyon, and juniper on lower mesas (McDowell et al. 2010, Allen et al. 2010). Pinyon mortality was particularly high in the Bandelier landscape, commonly killing over 95% of the trees in a given stand (cf. Breshears et al. 2005). While overall tree mortality rates were very high at many sites in Bandelier, young trees less than five cm (2 in) in basal diameter typically survived and are expected to support recovery of local forest and woodland canopies on most sites.

2 Vegetation Classification

A consistent, ecologically-based vegetation classification is the foundation for the development of an information–rich vegetation map. Vegetation classifications are ground-based descriptions of vegetation patterns that take into account floristic composition and abundance, site characteristics, and ecological dynamics. Accordingly, for BAND, we used extensive field sampling and analysis to develop a hierarchical classification following the National Vegetation Classification Standard (FGDC 1997 & 2008). The outcome was the identification and description of a suite of plant associations that are singularly, or in combination, components of map units, depending on cartographic standards and constraints and the targeted uses of the map (see Chapter 3). Below we describe our methods for classification development and provide an overview and discussion of the BAND classification.

2.1 Classification methods

2.1.1 The National Vegetation Classification Standard

The National Vegetation Classification (NVC) is used in SCPN vegetation mapping projects (TNC and ESRI 1994a), and is based on the National Vegetation Classification Standard (NVCS) adopted by the Federal Geographic Data Committee in 1997 and updated in 2008 (FGDC 1997 & 2008). The NVC evolved from work conducted primarily by The Nature Conservancy (TNC), NatureServe, and the Natural Heritage Program network over more than two decades (Grossman et al. 1998). The structure of the NVC 1997 standard is based, in part, on an earlier international vegetation classification developed by the United Nations Educational, Cultural, and Scientific Organization (UNESCO 1973, Driscoll et al. 1984) and is presented in Table 1. Use of a standardized classification system helps to ensure data compatibility throughout the National Park Service and other agencies. In 2008, a revised standard was adopted by the FGDC that contains substantial revisions to the upper levels of the NVCS hierarchy, currently under review (table 2). A crosswalk of hierarchical levels between the two standards from FGDC (1997 & 2008) is provided in Table 3. Accordingly, because the NVSC is in transition, we provide the classification following both frameworks in this project.

The NVCS is a hierarchical system that allows for vegetation classification at multiple scales. The FGDC (1997) standard incorporates physiognomic characters and floristic data to define seven levels of terrestrial vegetation classification (table 1). The five upper levels (class, subclass, group, subgroup, and formation) are based

Table 1. The 1997 U.S. National Vegetation Classification physiognomic-floristic hierarchy for terrestrial vegetation (FGDC 1997; Grossman et al. 1998)

Level	Primary basis for classification	Example
Class	Growth form and structure of vegetation	Shrubland
Subclass	Growth form characteristics, e.g., leaf phenology	Deciduous Shrubland
Group	Leaf types, corresponding to climate	Cold-deciduous Shrubland
Formation	Additional physiognomic and environmental factors	Temperate Cold-deciduous Shrubland
Alliance Group	Regional floristically and environmentally related Alliances	Rocky Mountain Montane Deciduous Scrub
Alliance	Dominant/diagnostic species of the uppermost or dominant stratum	Mountain Mahogany (*Cercocarpus montanus*)
Plant Association	Additional dominant/diagnostic species from any stratum	Mountain Mahogany/New Mexico Muhly Shrubland (*Cercocarpus montanus*/*Muhlenbergia pauciflora* Shrubland)

Table 2. National Vegetation Classification hierarchy for terrestrial vegetation following the FGDC (2008) standard.

Level	Level name	Criteria	Example
Upper levels			
L1	Formation Class	Broad combinations of general dominant growth forms that are adapted to basic temperature (energy budget), moisture, and/or substrate or aquatic conditions.	Mesomorphic Shrub and Herb Vegetation (Shrubland and Grassland)
L2	Formation Subclass	Combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate or aquatic conditions.	Temperate and Boreal Shrub and Herb Vegetation (Temperate and Boreal Shrubland & Grassland)
L3	Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.	Temperate Shrub and Herb Vegetation (Temperate Shrubland & Grassland)
Mid levels			
L4	Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant taxa that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology,and disturbance regimes.	*Andropogon – Stipa – Bouteloua* Grassland & Shrubland Division (North American Great Plains Grassland & Shrubland)
L5	Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and subcontinental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	*Andropogon gerardii – Schizachyrium scoparium –Sorghastrum nutans* Grassland & Shrubland Macrogroup (Great Plains Tall Grassland & Shrubland)
L6	Group	Combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	*Andropogon gerardii – Sporobolus heterolepis* Grassland Group (Great Plains Mesic Tallgrass Prairie)
Lower levels			
L7	Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition that reflect regional to subregional climate substrates, hydrology, moisture/nutrient factors, and disturbance regimes.	*Andropogon gerardii* – (*Calamagrostis canadensis – Panicum virgatum*) Herbaceous Alliance (Wet-mesic Tallgrass Prairie)
L8	Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition that reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.	*Andropogon gerardii – Panicum virgatum – Helianthus grosseserratus* Herbaceous Vegetation (Central Wet-mesic Tallgrass Prairie)

Table 3. Comparison of revised 2008 hierarchy for natural vegetation with the 1997 hierarchy. In the 1997 version, natural and cultural vegetation were not separated until Level 4 – formation subgroup (derived from FGDC 2008).

2008 Hierarchy for vegetation classification	1997 Hierarchy for vegetation classification
Upper levels	
	Division - Vegetation vs. Non-vegetation
	Order – Tree, Shrub, Herb, Nonvascular
Level 1– Formation Class	Level 1 – Formation Class
	Level 2 - Formation Subclass
Level 2 – Formation Subclass	Level 3 – Formation Group
	Level 4 – Formation Subgroup – Natural/Cultural
Level 3 - Formation	Level 5 – Formation
Mid levels	
Level 4 – Division	
Level 5 – Macrogroup	
Level 6 – Group	
Lower levels	
Level 7 – Alliance	Level 6 – Alliance
Level 8 – Association	Level 7 – Association

on physiognomic features that vary among major vegetation groups, such as vegetation structure, life form, botanical characteristics, etc. The two lower levels (alliance and association) are distinguished by differences in floristic composition. Alliances are physiognomically distinct groups of plant associations sharing one or more differential or diagnostic species (Mueller-Dombois and Ellenberg 1974). These are commonly the dominant(s) found in the uppermost strata of the vegetation. The plant association is the fundamental unit of the classification, and following the International Botanical Congress of 1910, is defined as a community of definite floristic composition (.i.e., a repeating assemblage of species), uniform physiognomy and habitat conditions (Mueller-Dombois and Ellenberg 1974).

The 2008 NVCS revision (Version 2; FGDC 2008) has eight levels (table 2). The upper three levels, which are a reorganization of the five upper physiognomic levels from Version 1, indicate physiognomic characteristics that reflect geographically widespread (global) topographic and edaphic factors. The middle three levels are new to the NVCS hierarchy and focus on largely biogeographic and habitat factors, along very broad, regional-to-continental topographic, edaphic, and disturbance gradients. The lower two levels, alliance and association, are used in park mapping and are currently the same in Version 1 and Version 2. (In the future, substantial revisions of the alliances are expected to improve concordance through the hierarchy, but for the purposes of this report, they have not been revised.)

The NVCS provides a framework for levels of classification but does not provide descriptions of vegetation types at all levels. The actual National Vegetation Classification (NVC) is maintained in a database by NatureServe and the network of affiliated natural heritage programs and conservation data centers for use by government agencies including the NPS, along with NGOs and the public. The NVC database tracks plant communities defined in the U.S. down to the association level and provides at least initial narrative descrip-

tions of most alliances and associations. The database is available online through NatureServe Explorer (http://www.natureserve.org/explorer/), which provides public access to regularly updated versions of the NVC plant community listings and descriptions. NatureServe's documentation of alliances and associations is the most accessible national listing currently available. However, the plant community descriptions within the NVC are not complete, and projects such as the one described in this report constantly add to the documentation and listing of NVC types.

2.1.2 Field methods

Vegetation sampling was designed to capture as wide a variety of vegetation types as possible within the seasonal time frame available for field work (typically during the rainy season between July 15 to October 15 when botanical expression is at its best). The four- to six-week sampling campaigns were planned to optimize field crew efficiency while still capturing as wide a range of vegetation types as possible on any given day. Accordingly, we used a cluster sampling approach for which a series of daily routes for the sampling crews were designed in a GIS using the digital orthophotography and preliminary vegetation maps. The locations of eight to ten sampling points per route were driven by differences in vegetation, soils, and geologic pattern, plus logistics, i.e., what could be accomplished in one day's travel time by vehicle and foot by a field crew (sampling days were ten hours long to further increase daily efficiency). Routes were distributed as widely as possible throughout the study area, but the emphasis was primarily on capturing the range of variation within the park, and secondarily on adjacent USFS lands. While using the GIS was an excellent planning tool that took much of the guesswork out of plot placement, final plot locations were field-based decisions predicated on positioning the sampling point in homogenous stands of vegetation and habitat.

Field crews were composed of two to three people with a senior technician crew chief, who was responsible for botany and vegetation sampling, while the second and third members were junior technicians responsible for gathering tree and fuels data, photographs, and Global Positioning System (GPS) locations. Plots were established in large stands of vegetation representative of the typical vegetation at a site (greater than one ha). Plots were generally 400 m^2 and square, but occasionally other sizes and shapes were used to fit the structure of a community, especially along drainages where vegetation stands conform to the channel shape.

For standard plots, a list of all vascular plant species, stratified by life form (tree, shrub, subshrub, grass and forb layers) was compiled, and cover estimated for each species using a modified Domin-Krajina Scale (table 4) (Mueller-Dombois and Ellenberg 1974). Site attributes for plots, including slope percent, aspect, slope shape, surface rock type, and ground cover (percent rock, gravel, bare soil and litter) were noted, along with detailed narratives on species composition and site conditions. Within each plot, all trees were tallied in two-inch-diameter

Table 4. Modified Domin-Krajina vegetation cover scale (from Mueller-Dombois and Ellenberg 1974). Cover class is the scalar value assigned in the field; Canopy cover is the range of cover the class represents; m^2/ 400 m^2 is the actual area represented by the cover class within the 400m^2 plot; and Canopy cover midpoint is the midpoint canopy cover value used in data analysis.

Cover class	Canopy cover (%)	Canopy cover midpoint (%)	Area within m^2 per 400 m^2 plot
+0	[Undefined]	[0.001]	[Outside plot]
+	< 0.05	0.01	< 0.04
1	< 0.1	0.05	≥ 0.04 and < 0.5
2	< 1	0.5	≥ 0.5 and < 4
3	1 – 4	2.5	≥ 5 and < 20
4	5 – 10	7.5	≥ 20 and < 40
5	10 – 25	17.5	≥ 40 and < 100
6	25 – 33	29.0	≥ 100 and < 132
7	33 – 50	41.5	≥ 132 and < 200
8	50 – 75	62.5	≥ 200 and < 300
9	> 75	87.5	≥ 300

classes up to 20 in (50 cm). We measured diameter at breast height (DBH) for trees greater than 20 in in diameter. Trees below 2 in (5 cm) in diameter were broken down further into two height classes: those taller than breast height (4.5 ft; 1.37 m), and those shorter. In the first year, fuel loading sampling was conducted following standard fuels transect line sampling (Brown 1974; Lutes et al. 2006). Plot locations were recorded with a Garmin GPS Model 12 with +/- 10-m accuracy. The fuel plots of 2003 were monumented with a single rebar and tag at the start position of the three Brown transects. For each plot, at least four photos were taken in the four directions from plot center, with each photo containing a placard noting the project, sampling date and plot number. The compass direction and focal length of each shot was logged for future reference. See Appendix C for NHNM field survey handbook and examples of sampling forms.

We primarily used standard plots to support vegetation classification development, and three to five can be established in a day. For maximizing ground control for the mapping process, we employed stripped-down mapping plots (quick plots) for which only the cover of dominant species in each strata was recorded, along with a reduced set of site parameters. Anywhere from 6 to 12 of these quick plots could be established in a day, depending on logistics (all accuracy assessment plots were of this style). Lastly, we utilized simple observation points (OPs) for which we recorded GPS locations, plant association designation, and brief qualitative descriptions.

A total of 711 plots were collected for the classification and mapping portion of the project (fig. 9). Of these, 210 were standard plots, 467 were quick plots, and 34 were observation points. Of the 210 standard plots, 151 were monumented fuel plots.

We collected plant voucher specimens to confirm field identifications when necessary. These are currently housed at the University of New Mexico Herbarium. NHNM botanist Yvonne Chauvin identified specimens to the lowest level possible, given the material at hand, and assigned names according to the PLANTS database (USDA-NRCS 2009) and the Integrated Taxonomic Information System (ITIS). Qualifying specimens were accessioned with both UNM accession numbers and NPS record numbers tied to the Herbarium and NPS databases. A species list derived from the plot data is provided in Appendix D.

All vegetation and site data were entered into the Microsoft Access NHNM Ecology database and quality controlled through error checking computer routines and manual read-backs. Each record contains the comprehensive documentation of the plot location, dimensions, vegetation composition, tree stand structure, site characteristics, vegetation classification, and photo points. All plot data and associated location information and metadata were transferred to a stand-alone NPS-developed Microsoft Access relational database (PLOTS_v3_BE_ BAND.MDB). While no structural changes were made to the NPS database template, we did add selected fields that allow the tracking back of all data to the NHNM database.

2.1.3 Vegetation analysis

To develop the vegetation classification, the plot data were analyzed in a multivariate framework using cluster analysis, detrended correspondence analysis (DCA), and standard tabular comparison techniques (Becking 1957, Mueller-Dombois and Ellenberg 1974, Ludwig and Reynolds 1988, McCune and Grace 2002). These analyses were based primarily on species-level canopy cover values with some grouping at the genus level where taxonomic units were ambiguous (abundance scalar values were converted to percent cover mid-point values). The cluster analysis was computed with SAS Version 8.02 routines (SAS Institute 1989, 2001) using a flexible-beta coefficient of -0.25 to approximate Wards Minimum Variance Method. The dendrogram arrangements of plots provided an initial ordering of plots into a hierarchical

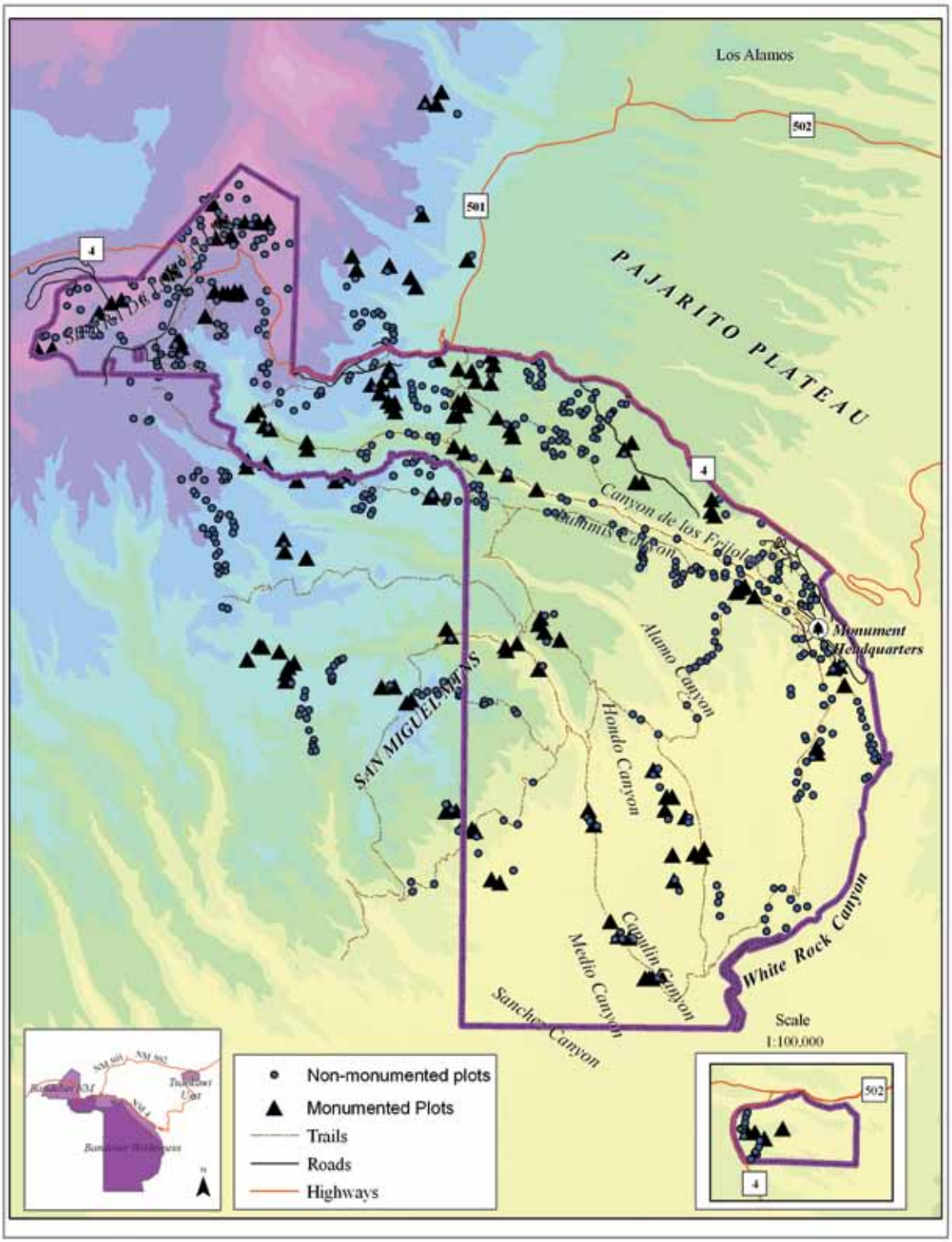


Figure 9. Distribution of vegetation plots used for classification and mapping for the Bandelier National Monument vegetation map. Of the 727 plots were collected, 151 had fuels data associated with them and were monumented with a rebar and tag.

classification that was then refined through row by column tabular sorting of species and plots using programs derived from Muldavin et al. (1990). The DCA was computed with PCORD (McCune and Mefford 1999) and was used to further interpret the grouping structures, their relationships to one another, the environment,

and the NVCS hierarchy. The DCA not only included BAND plots, but also other data available from the Jemez Mountains region (LANL, VCNP, and USFS). Along with standard site characteristic data, such as elevation, slope, aspect, landform, etc., a Solar Index (SI) was computed, using the GIS that incorporates slope, aspect and altitude, to estimate actual solar incidence at a site (values scaled from 0, no solar input to 200, the maximum). In addition, a Topographic Relative Moisture Index (TRMI), following Parker (1982), was computed that integrated slope configuration, aspect, and drainage size into an indirect measure of water availability in a given watershed.

In general, each plot was classified into an alliance, based on dominant or indicator species, and then to a particular plant association (PA), based on codominance and/or other groups of differential species. Phases of associations were assigned, as necessary, to define further the character of the plant community. Within the old NVCS (FGDC 1997), alliances were assigned to Formations following Grossman et al. (1998) and subsequent database revisions. For the new NVCS (FGDC 2008), associations were assigned to Groups based on a working classification developed by NatureServe in collaboration with government agencies and Natural Heritage network ecologists (pers. comm., M. Reid, NatureServe Senior Regional Ecologist 2008). The resulting hierarchical classification was reviewed by NatureServe ecologists responsible for maintenance and consistency of the NVCS. Because the NVCS continues to be revised to meet the new standard, not all "Groups" have been defined. Hence, we had the opportunity to propose new groups for review as part of the analysis (described below). Final summary floristic and site tables by plant association were computed and became the basis for plant association descriptions and dichotomous keys.

Vegetation plant associations were also ranked with respect to rarity on a state and global basis. The network of natural heritage programs under NatureServe evaluates the status of biological elements, either species or natural communities, using a ranking system that considers rarity, vulnerability and imperilment (Grossman et al. 1998). The ranking system is used by all network data centers, including the New Mexico Natural Heritage Program (NMNHP), as well as various government agencies and other organizations to support the planning of conservation strategies. Global ranks are based on factors such as quality, condition and viability, size, and identifiable threats that face the community. Each element is assigned a single global (G) rank to indicate its relative degree of imperilment on a five-point scale (e.g., 1 = critically imperiled because of extreme rarity, 5 = demonstrably secure). The primary criteria for ranking community elements are the number of occurrences (the number of known distinct localities) and extant acreage. Also of importance are the geographic range, trends in distribution, and the number of already protected occurrences. However, the emphasis remains on the number of occurrences, such that ranks are, in effect, an index of known biological rarity. State ranks are similar, but the evaluation is based on ranges and distributions within New Mexico (these are available from http://www.natureserve.org/explorer/).

2.2 Classification results

The long elevational gradient and topographic heterogeneity within Bandelier National Monument creates a setting for a diverse set of vegetation communities. We identified 95 plant associations (PAs) that range from riparian woodlands and herbaceous wetlands along the Rio Grande to high-elevation sub-alpine forests and montane grasslands along the rim of Sierra de los Valles. In Table 5 we present the PAs ordered by the new NVCS hierarchy, along with their classification status, number of BAND plots, and NatureServe database code. Seventy-three of the PAs were considered established or provisional types according to the NVC, i.e., they are well documented, either in the park or in the

Table 5. A hierarchical plant association classification for the Bandelier National Monument (see Table 2.2 for hierarchical level definitions). Under "Classification level and Name", Alliances and Plant associations are presented under their respective "Groups." Under "Classification status", "E" is an established plant association recognized in the National Vegetation Classification System (NVCS). "P" is a "park special" association known only from limited sampling within the park and has not yet been accepted into the NVCS; "I" is an incidental association know only from one plot or observation point and needs further confirmation within the park, or it was identified during the accuracy assessment phase of the project. The number of plots from PAs indentified only during the accuracy assessment phase of the project are in parentheses. Plots identified only to the alliance level are excluded here. "Code" is the database code, either from NatureServe (CEGL numbers) if established USNVC types or from NHNM (NPS_NHNM numbers) if not yet part of the USNVC, pending the acquisition of additional data on their distribution, composition, and environment. Map units refers to the vegetation map units in which the plant association is considered to be either a primary component (1), secondary component (2), related inclusion (Ri), or contrasting inclusion (Ci). Phases relevant to the vegetation map are listed under their plant association with references to their respective map units (the main plant association level without a phase designation is by default inclusive of the "typic" phase and other phases that were mapped implicitly).

Class: 1 Forest and Woodland

Subclass: 1.C Temperate Forest

Formation: 1.C.2 Cool Temperate Forest

Division: 1.C.2.b Western North America Cool Temperate Forest

Macrogroup: MG020. Rocky Mountain Subalpine & High Montane Forest

Group	Alliance	Association	Classification status	# of plots	NatureServe code	Map unit
G222. Rocky Mountain Subalpine & Montane Aspen Forest & Woodland Group	*Populus tremuloides* Forest Alliance	*Populus tremuloides - Acer glabrum* Forest	E	2	CEGL000563	2B
		Populus tremuloides / Festuca thurberi Forest	E	2	CEGL000585	2A, 3A
		Populus tremuloides / Thalictrum fendleri Forest	E	3	CEGL000619	2B
		Populus tremuloides / Invasive Perennial Grasses Forest	E	6	CEGL003748	2A, 2B
G218. Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest & Woodland	*Picea engelmannii* Forest Alliance (mesic-moist section)	*Picea engelmannii / Erigeron eximius* Forest	E	1	CEGL000364	1A

Macrogroup: MG022. Southern Rocky Mountain Lower Montane Forest

Group	Alliance	Association	Classification status	# of plots	NatureServe code	Map unit
G226. Southern Rocky Mountain White Fir-Douglas-fir Dry Forest Group	*Abies concolor* Forest Alliance (in part)	*Abies concolor - Pseudotsuga menziesii / Festuca thurberi - Danthonia parryi* Woodland	E	16	CEGL005350	5A, 7A
		Populus tremuloides Phase				2A, 3A, 3B
		Abies concolor / Juniperus communis Forest	E	18	CEGL000249	5B, 6A
		Populus tremuloides Phase				3B
		Abies concolor / Mahonia repens Forest	E	5	CEGL000251	5B

Group	Alliance	Association	Classification status	# of plots	NatureServe code	Map unit
		Abies concolor - Pseudotsuga menziesii / Quercus gambelii / Carex rossii Forest	E	8	CEGL005351	5B, 5C, 6A
		Abies concolor - Pseudotsuga menziesii / Carex rossii Forest	E	16	CEGL000431	5B
		Populus tremuloides Phase				3B
	Pseudotsuga menziesii Forest Alliance	*Pseudotsuga menziesii / Mahonia repens* Forest	E	2	CEGL000442	5B
		Populus tremuloides Phase				3B
		Pseudotsuga menziesii - Quercus gambelii Forest	E	17	CEGL000452	5B, 5C
G225. Southern Rocky Mountain Douglas-fir-White Fir-Blue Spruce Mesic Forest Group	*Abies concolor* Forest Alliance (in part)	*Abies concolor - Pseudotsuga menziesii / Jamesia americana - Holodiscus dumosus* Scree Woodland	E	8	CEGL000890	5B. 5C, 6C
		Populus tremuloides Phase				4B
		Abies concolor - (Pseudotsuga menziesii) / Quercus gambelii / Thalictrum fendleri Forest	E	11	CEGL005352	6A, 6B
		Abies concolor - Pseudotsuga menziesii / Thalictrum fendleri Forest	E	25	CEGL005353	6A, 6B
		Populus tremuloides Phase				4A, 4B
		Abies concolor - Pseudotsuga menziesii / Acer glabrum Forest	E	10	CEGL000240	1A, 6A, 6B
		Populus tremuloides Phase				4A, 4B
	Picea pungens Forest Alliance	*Picea pungens / Fragaria virginiana* Forest	E	3	CEGL000391	6A
G229. Southern Rocky Mountain Ponderosa Pine Savanna Group	*Pinus ponderosa* Woodland Alliance [in part]	*Pinus ponderosa / Bouteloua gracilis* Woodland	E	2	CEGL000848	7B, 8A, 8C, 17D
		Pinus ponderosa / Festuca thurberi Woodland	E	9	CEGL005373	5A, 7A
		Pinus ponderosa / Muhlenbergia montana Woodland	E	29	CEGL000862	7B
		Poa fendleriana Phase				8B, 8C, 8D
		Pinus ponderosa / poa pratensis Semi-natural Forest	I	(2)	NPS_NM016	7A
		Pinus ponderosa / Schizachyrium scoparium Woodland	E	9	CEGL002019	7B, 8D
G228. Southern Rocky Mountain Ponderosa Pine Forest and Woodland Group	*Pinus Ponderosa* Woodland Alliance [in part]	*Pinus ponderosa - Carex inops* ssp. *heliophila* Woodland	E	17	CEGL000849	7A, 7B, 8B

Table 5. *continued.* A hierarchical plant association classification for the Bandelier National Monument

Group	Alliance	Association	Classification Status	# of plots	NatureServe code	Map unit
		Pinus ponderosa - Quercus gambelii / Carex inops ssp. *heliophila* Woodland	E	29	CEGL005372	5C, 7B, 8B, 8C
		Rockland Phase				8A, 8D
		Pinus ponderosa / Quercus × *pauciloba* Woodland	E	21	CEGL000874	7B, 8A, 8C, 8D
		Pinus ponderosa / Robinia neomexicana Woodland	E	27	CEGL005374	8B
		Seeded Grasses Phase				7B
Macrogroup: MG011. Madrean Montane Forest & Woodland						
G203 Madrean Lower Montane Pine-Oak Forest & Woodland Group	*Pinus ponderosa* Woodland Alliance [in part]	*Pinus ponderosa - Quercus grisea* Woodland	I	1	CEGL000871	17D
Class: 1 Forest and Woodland						
Subclass: 1.C Temperate Forest						
Formation: 1.C.2 Cool Temperate Forest						
Division: 1.C.2.c Western North America Scrub Woodland & Shrubland						
Macrogroup: MG027. Rocky Mountain Pinyon-Juniper Woodland						
G253. Southern Rocky Mountain Pinyon-Juniper Woodland	*Pinus edulis* Woodland Alliance (in part)	*Pinus edulis* – (*Juniperus monosperma, Juniperus deppeana*) / *Bouteloua gracilis* Woodland	I	1	CEGL002151	9A
G252. Southern Rocky Mountain Juniper Woodland & Savanna	*Juniperus monosperma* Woodland Alliance (in part)	*Juniperus monosperma / Bouteloua curtipendula* Woodland	E	4	CEGL000708	9C, 9D, 11A, 11E, 11C, 11D, 11H
		Dead *Pinus edulis* Phase				9E
		Juniperus monosperma / Bouteloua eriopoda Woodland	E	7	CEGL000709	11B, 11C, 11G
		Juniperus monosperma / Bouteloua gracilis Woodland	E	36	CEGL000710	11A, 11B, 11D, 11F, 11H
		Dead *Pinus edulis* Phase				9A, 9B, 9C, 9E
		Dead *Pinus edulis* Treatment Phase				9F

Group	Alliance	Association	Classification status	# of plots	NatureServe code	Map unit
		Juniperus monosperma / *Hesperostipa neomexicana* Woodland	I	(1)	CEGL000722	11A
		Juniperus monosperma / *Quercus* × *pauciloba* Woodland	E	33	CEGL000721	11A, 11B, 11C, 11D, 11E, 11F
		Dead *Pinus edulis* Phase				9A, 9B, 9C, 9D, 9E, 10A
		Juniperus monosperma / *Rhus trilobata* Woodland	I	2	NPS_NM010	9A, 11D
		Juniperus monosperma / Rockland Woodland	E	5	CEGL005369	11C, 11D, 11E
		Dead *Pinus edulis* Phase				9C, 9D, 9E, 10A
		Juniperus monosperma / Sparse Understory Woodland	E	21	CEGL005368	
		Dead *Pinus edulis* Loamy Phase				9A
		Dead *Pinus edulis* Stony Phase				9B, 11C
		Dead *Pinus edulis* Treatment Phase				9F
		Loamy Phase				11A
		Pumice Phase				11G
		Stony Phase				11B, 11F
		Juniperus monosperma / *Artemisia tridentata* Woodland	E	2	CEGL000706	11C, 14A

Class: 1. Forest and Woodland

Subclass: 1.C Temperate Forest

Formation: 1.C.1 Warm Temperate Forest

Division: 1.C.1.c Madrean Forest

MG010. Madrean Lowland Evergreen Woodland

G200. Madrean Pinyon-Juniper Woodland	*Juniperus deppeana* Woodland Alliance	*Juniperus deppeana* / *Bouteloua gracilis* Woodland	I	(2)	CEGL000693	10A
		Juniperus deppeana - *Quercus* x *pauciloba* Woodland, Dead *Pinus edulis* Phase	E	4	CEGL005370	10A

Table 5. *continued.* A hierarchical plant association classification for the Bandelier National Monument

Group	Alliance	Association	Class-ification status	# of plots	NatureServe code	Map unit
		Juniperus deppeana / Sparse Woodland, Dead *Pinus edulis* Phase	I	2	NPS_NM009	10A
		Juniperus deppeana / Ruderal Herbs Vegetation Woodland, Dead *Pinus edulis* Phase	I	2	NPS_NM008	10A
Class: 1 Forest and Woodland						
Subclass: 1.C Temperate Forest						
Formation: 1.C.3 Temperate Flooded & Swamp Forest						
Division: 1.C.3.c Western North America Flooded & Swamp Forest						
Macrogroup: MG034. Rocky Mountain and Great Basin Flooded & Swamp Forest						
G[*][1]. Rocky Mountain Subalpine-Montane Riparian Forest and Woodland	*Abies concolor* Forest Alliance (in part)	*Abies concolor - Acer negundo / Alnus incana* ssp. *tenuifolia* Forest	E	5	CEGL005367	17A, 17B 17C
	Acer negundo Forest Alliance	*Acer negundo - Alnus oblongifolia* Forest	E	2	CEGL005383	17A
		Acer negundo - Alnus incana ssp. *tenuifolia* Forest	E	3	CEGL005940	17A, 17B, 17C
		Acer negundo / Eleocharis palustris Forest	I	1	NPS_NM001	17A
		Acer negundo / Prunus virginiana Forest	I	1	CEGL000628	17A
		Acer negundo / Salix irrorata Forest	P	2	NPS_NM003	17A
	Pinus ponderosa Forest Alliance (in part)	*Pinus ponderosa / Forestiera pubescens* Woodland	E	13	CEGL005384	
		Typic Phase				8C, 17C, 17D
		Acer negundo Phase				17B, 17C
		Populus angustifolia Phase				17B, 17C
	Populus angustifolia Forest Alliance	*Populus angustifolia - Acer negundo / Forestiera pubescens* Forest	P	3	NPS_NM020	17A, 17C,17E
		Populus angustifolia / Fallugia paradoxa Forest	P	2	NPS_NM021	17A, 17D
G[*]. Rocky Mountain Subalpine-Montane Riparian Shrubland	*Alnus incana* ssp. *tenuifolia* Shrubland Alliance	*Alnus incana* / Mesic Graminoids Shrubland	I	1	CEGL001148	17A

[1] [*] indicates that the Group designation is provisional and not currently included in the NVCS.

Group	Alliance	Association	Classification status	# of plots	NatureServe code	Map unit
Class: 1 Forest and Woodland						
Subclass: 1.C Temperate Forest						
Formation: 1.C.3 Temperate Flooded & Swamp Forest						
Division: 1.C.3.d Western North America Warm Temperate Flooded & Swamp Forest						
Macrogroup: MG036. Warm Desert Riparian, Flooded & Swamp Forest						
G[*]. Southwest Lowland Riparian Woodland & Shrubland	*Elaeagnus angustifolia* Semi-natural Woodland Alliance	*Elaeagnus angustifolia / Bromus tectorum* Semi-natural Woodland	I	1	NPS_NM005	18B
	Populus deltoides Forest Alliance	*Populus deltoides* ssp. *wislizeni / Salix irrorata* Forest	E	1	CEGL005993	18A
	Salix exigua Shrubland Alliance	*Salix exigua* / Mesic Graminoids Shrubland	I	1	CEGL001203	18A, 18B
	Salix amygdaloides Temporarily Flooded Woodland Alliance	*Salix amygdaloides / Salix exigua* Woodland	E	1	CEGL000948	18A
	Tamarix chinensis Semi-natural Shrubland Alliance	*Tamarix chinensis / Forestiera pubescens* Semi-natural Shrubland	P	1	NPS_NM030	18B
		Tamarix chinensis - Salix exigua Semi-natural Shrubland	I	1	NPS_NM031	18A, 18B
		Tamarix chinensis / Sparse Undergrowth Semi-natural Shrubland	I	1	NPS_NM032	18B
	Juniperus monosperma Woodland Alliance (in part)	*Juniperus monosperma / Forestiera pubescens* Woodland	E	11	CEGL005371	11H, 17D, 17E
		Dead *Pinus edulis* Phase				9E
	Fallugia paradoxa Shrubland Alliance (in part)	*Fallugia paradoxa* Colorado Plateau Desert Wash Shrubland	E	5	CEGL002357	17D, 17E, 18C
	Forestiera pubescens Shrubland Alliance (in part)	*Forestiera pubescens* / Ruderal Herbs Shrubland	P	4	NPS_NM032	18C
Class: 2 Shrubland & Grassland						
Subclass: 2.C Temperate & Boreal Shrubland & Grassland						
Formation: 2.C.1 Temperate Grassland, Meadow & Shrubland						
Division: 2.C.1.a Vancouverian & Rocky Mountain Grassland & Shrubland						
Macrogroup: MG049 Southern Rocky Mountain Montane Shrubland & Grassland						

Table 5. *continued.* A hierarchical plant association classification for the Bandelier National Monument

Group	Alliance	Association	Classification status	# of plots	NatureServe code	Map unit
G277 Southern Rocky Mountain Gambel Oak-Mixed [Mesic] Montane Shrubland Group	*Ceanothus fendleri* Shrubland Alliance	*Ceanothus fendleri / Muhlenbergia montana* Shrubland	E	6	CEGL005376	12A, 12C, 12D
	Jamesia americana Shrubland Alliance	*Jamesia americana* - (*Physocarpus monogynus, Holodiscus dumosa*) Rock Outcrop Shrubland	E	3	CEGL002783	12C
	Quercus gambelii Woodland Alliance	*Quercus gambelii - Robinia neomexicana / Carex inops* ssp. *heliophila* Shrubland	E	66	CEGL005379	5C, 12C, 13C, 24C
		Seeded Grasses Phase				12A, 12D
		Quercus gambelii - Robinia neomexicana / Muhlenbergia montana Shrubland	E	11	CEGL005380	12A, 12D, 13A
	Robinia neomexicana Shrubland Alliance	*Robinia neomexicana / Carex inops* ssp. *heliophila* Shrubland	E	22	CEGL005375	12A, 12C, 12D
		Ruderal Herbs Phase				12B
G276. Southern Rocky Mountain Cercocarpus-Mixed [Dry] Foothill Shrubland Group	*Cercocarpus montanus* Shrubland Alliance	*Cercocarpus montanus / Bouteloua curtipendula* Shrubland	I	(1)	CEGL001086	13A
	Quercus x pauciloba Shrubland Alliance	*Quercus x pauciloba / Bouteloua curtipendula* Shrubland	E	12	CEGL005378	13A, 13B
		Quercus x pauciloba / Cercocarpus montanus Shrubland	E	7	CEGL001118	13A, 13C
	Fallugia paradoxa Shrubland Alliance (in part)	*Fallugia paradoxa - Brickellia* spp. - (*Holodiscus dumosus*) Scree Shrubland	E	2	CEGL003496	13C, 14A
		Fallugia paradoxa / Ruderal Herbs Shrubland	I	3	NPS_NM006	12A, 12B, 13A, 15B, 16A
	Rhus trilobata Shrubland Alliance	*Rhus trilobata* Rocky Mountain Shrub Herbaceous Vegetation	I	1	CEGL002910	13C
G268. Southern Rocky Mountain Montane-Subalpine Grassland	*Muhlenbergia montana* Herbaceous Alliance	*Rosa woodsii / Muhlenbergia montana* Shrub Herbaceous Vegetation	I	1	NPS_NM011	15B
		Muhlenbergia montana - Seeded Grasses Herbaceous Vegetation	P	4	NPS_NM012	15B
		Muhlenbergia montana - Schizachyrium scoparium Herbaceous Vegetation	E	6	CEGL005381	15B
		Muhlenbergia montana Herbaceous Vegetation	E	4	CEGL001646	15C
	Poa pratensis Herbaceous Alliance	*Poa pratensis - Taraxacum officinale* Semi-natural Herbaceous Vegetation	P	6	NPS_NM019	15A, 15C

Group	Alliance	Association	Classification status	# of plots	NatureServe code	Map unit
		Carex praegracilis Phase				19A
		Poa pratensis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation	E	5	CEGL005265	15C
	Festuca thurberi Herbaceous Alliance	*Festuca thurberi - (Lathyrus lanszwertii* var. *leucanthus, Potentilla* spp.) Herbaceous Vegetation	E	5	CEGL001630	15A
		Festuca thurberi - Danthonia parryi / Potentilla hippiana Herbaceous Vegetation	E	7	CEGL005377	15A, 24B
Class: 2 Shrubland & Grassland						
Subclass: 2.C Temperate & Boreal Shrubland & Grassland						
Formation: 2.C.1 Temperate Grassland, Meadow & Shrubland						
Division: 2.C.1.b Great Plains Grassland & Shrubland						
Macrogroup: MG052 Great Plains Sand Grassland & Shrubland						
G069 Great Plains Sand Shrubland	*Artemisia filifolia* Shrubland Alliance	*Artemisia filifolia / Bouteloua eriopoda* Shrubland	E	1	CEGL001077	14A
Macrogroup: MG053 Great Plains Shortgrass Prairie & Shrubland						
G [*] Southwest Plains-Mesa Grassland	*Bouteloua gracilis* Herbaceous Alliance	*Gutierrezia sarothrae / Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation	E	7	CEGL005382	13A, 13C, 15B, 16A, 16C, 16D, 16B
	Bouteloua curtipendula Herbaceous Alliance	*Bouteloua curtipendula - Bothriochloa barbinodis* Herbaceous Vegetation	E	1	CEGL001590	24D
	Bouteloua eriopoda Herbaceous Alliance	*Bouteloua eriopoda - Bouteloua gracilis* Herbaceous Vegetation	E	4	CEGL001747	16B, 16C, 16D
		Ruderal Forbs Phase				24A
		Bouteloua eriopoda - Bouteloua curtipendula Herbaceous Vegetation	E	3	CEGL001747	14A,16C, 16D
	Elymus x pseudorepens Herbaceous Alliance	*Elymus x pseudorepens - Bromus carinatus* Semi-natural Herbaceous	P	6	NPS_NM004	15B, 16A, 24B
	Pascopyrum smithii Herbaceous Alliance	*Pascopyrum smithii* / Ruderal Herbaceous Vegetation	P	4	NPS_NM045	15B, 16A,16B
	Schizachyrium scoparium Herbaceous Alliance	*Schizachyrium scoparium - Koeleria macrantha* Herbaceous Vegetation	P	3	NPS_NM028	15B
G [*] Southwest Ruderal Disturbance Herbaceous Vegetation	Ruderal Herbaceous Vegetation Alliance	Ruderal Post-fire Herbaceous Vegetation	I	9	NPS_NM025	12B, 13B, 16A, 24A, 24B, 24C

Table 5. *continued*. A hierarchical plant association classification for the Bandelier National Monument

Group	Alliance	Association	Class-ification status	# of plots	NatureServe code	Map unit
		Ruderal Flood Zone Herbaceous Vegetation	I	1	NPS_NM026	20A, 24D
		Ruderal Disturbance Herbaceous Vegetation	I	4	NPS_NM027	24E
Class: 2 Shrubland & Grassland						
Subclass: 2.C Temperate & Boreal Shrubland & Grassland						
Formation: 2.C.5 Temperate & Boreal Freshwater Marsh						
Division: 2.C.5.b Western North America Freshwater Marsh						
MG073. Western North America Freshwater Marsh						
G [*]. Southern Rocky Mountain Montane-Subalpine Emergent Wetland	*Calamagrostis canadensis* Seasonally Flooded Herbaceous Herbaceous Alliance	*Calamagrostis canadensis* Western Herbaceous Vegetation	I	1	CEGL001559	19A
	Juncus balticus Herbaceous Alliance	*Juncus balticus* Herbaceous Vegetation	E	3	CEGL001838	19A
MG076 Warm Desert Freshwater Shrubland, Meadow & Marsh						
G [*] North American Arid West Emergent Wetland	*Eleocharis palustris* Herbaceous Alliance	*Eleocharis palustris - Carex praegracilis - Berula erecta* Herbaceous Vegetation	E	1	CEGL002634	20A
Class: 6 Lithomorphic Vegetation (Nonvascular & Sparse Vascular Rock Vegetation)						
Subclass: 6.B Mediterranean, Temperate, & Boreal Nonvascular & Sparse Vegetation						
Formation: 6.B.2 Temperate & Boreal Cliff, Scree, & Rock Vegetation						
Division: 6.B.2.b Western North America Temperate Cliff, Scree and other Rock Vegetation						
MG113. Rocky Mountain Cliff, Scree, & Other Rock Vegetation						
G[*]. Rocky Mountain Cliff, Canyon & Massive Bedrock		Sparse Vegetation / Boulder Rockland	I	4	NPS_NM013	5C, 8B, 8C, 8D, 9C, 9D, 9E, 11C, 11D, 11E, 12C, 13C, 16D, 21A
		Sparse Vegetation / Scree	I	2	NPS_NM014	5C, 14A, 16C, 21B
		Sparse Vegetation / Recent Alluvial Deposits	I	-	NPS_NM049	18C, 20A, 23A

region, and have been entered in the NVC database and assigned a NatureServe database code. Another 23 have limited documentation within and outside the park, and are hence, considered "Park Specials", which need further documentation before being included officially in the NVC. For several PAs, we have recognized phases that are reflective of variants in floristic composition from the typical or central concept of an association ("Typic Phase"). While phases are not tracked in the NVC at the national level, they can be important for mapping purposes within a park, or they may later be elevated to PA status. For the established and provisional associations, we provide detailed descriptions of floristic composition site characteristics along with diagnostic keys in Appendices C and D (summary data supporting the classification and description of each plant association is provided in an Electronic Addendum available at http://biology.usgs.gov/npsveg/products/parkname.html). Lastly, we have cross-walked each PA to the map units in which they are either a primary or secondary component or related inclusion, or a contrasting inclusion (see Chapter 3 for a description of map unit structure and Table 9).

2.2.1 Classification overview

In this section we summarize the information on composition, structure, and environments of vegetation communities within the park in the context of the new NVCS hierarchy. We focus on the middle tiers of the hierarchy (Division, Macrogroup, and Group), with brief summaries of plant association (PA) composition and distribution (see Table 2).

2.2.1.1 Western North America Cool Temperate Forest

Rocky Mountain Subalpine & High Montane Forests Macrogroup. This macrogroup is part of the Western North America Cool Temperate Forest Division and includes forested plant associations of the highest elevations in BAND (generally greater than 2,750 m (9,000 ft), although they can extend down to 2,275 m (7,500 ft)). These very cold forests have also been referred to as Rocky Mountain Subalpine Conifer Forest (Brown et al. 1998; Dick-Peddie 1993; Thompson et al. 1996). In BAND, the macrogroup contains the conifer-dominated Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland and the broadleaf deciduous-dominated Rocky Mountain Subalpine & Montane Aspen Forest & Woodland.

The Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland is represented by small patches of the *Picea engelmannii* / *Erigeron eximius* PA (Engelmann spruce/Forest Fleabane) that are found along the north-facing upper slopes and ridgelines of the caldera rim along the Sierra de los Valles. While typically *P. engelmannii* dominates, *Abies lasiocarpa* var. *arizonica* (corkbark fir) can be an occasional codominant. Both species are widely distributed throughout the mountains of the western United States and Canada, but in BAND, and in the Jemez Mountains as whole, they are approaching their southern limit (*A. lasiocarpa* var. *arizonica* is known only from the Southwest). Of the two trees, Engelmann spruce is the longer-lived species, and in general reaches maturity between 250 and 300 years, with individuals known to live as long as 500 to 600 years. *Abies concolor* (white fir), *Pseudotsuga menziesii* (Douglas-fir), *Pinus strobiformis* (Southwestern white pine), or *Pinus flexilis* (limber pine) may also be present in stands as mature individuals, but they are considered successional following fire and other disturbances and do not dominate, nor do they have significant reproduction (Moir and Ludwig 1979). *Populus tremuloides* (quaking aspen) can be a significant codominant seral species and, hence, we have identified a phase to the association where it exceeds 25% of the relative tree cover.

These forests form dense, closed canopies with shady understories, but because of the mesic conditions, the *Picea engelmannii* / *Erigeron eximius* PA develops a rich herbaceous layer that often exceeds 30% cover,



Figure 10. The Rocky Mountain Aspen Group is dominated by the broadleaf and cold-deciduous *Populus tremuloides* (quaking aspen). While conifers can be part of a stand, as shown here in this representative of the *Populus tremuloides* / *Thalictrum fendleri* PA in the Scooter Peak vicinity, they do not exceed 25% relative cover (photo: Jonathan Coop).

while shrub cover is minimal. *Erigeron eximius* (forest fleabane) is usually the dominant forb, but it is the overall rich complement of mesic forbs that is characteristic, e.g., *Fragaria vesca* (strawberry), *Viola canadensis* (Canadian white violet), *Bromus ciliatus* (fringed brome), and *Galium boreale* (northern bedstraw). This association is widely distributed in the Southwest and in the southern Rocky Mountains (Moir and Ludwig 1979; DeVelice et al. 1986; Fitzhugh et al. 1987; Muldavin et al. 1996).

The Rocky Mountain Subalpine & Montane Aspen Forest & Woodland is dominated by the broadleaf and cold-deciduous *Populus tremuloides* (quaking aspen), with conifers making up less than 25% of the relative canopy cover of the stand, and includes six associations that represent a variety of habitats (fig.10). *The Populus tremuloides* / *Thalictrum fendleri* PA (Quaking Aspen / Meadow Rue) occurs in mesic sites of mid-elevational to lower slopes and is characterized by closed canopies of aspen. The understory typically has a luxuriant herbaceous cover represented by a wide variety of mesic forbs and grasses. These types of stands are often referred to as aspen meadows or glades (Allen 1984). In contrast, the *Populus tremuloides - Acer glabrum* PA (Quaking Aspen - Rocky Mountain Maple Forest) and *Populus tremuloides* / *Quercus gambelii* PA (Quaking Aspen - Gambel Oak) are shrub-dominated and typically associated with rockier sites, with the *Populus tremuloides - Acer glabrum* PA typically found in the coldest sites (canyon covers and lower slopes). Particularly rocky and unstable scree slopes may support the *Populus tremuloides* / *Scree* (Quaking Aspen – Scree Forest), which also has a shrub component, but overall cover in the tree and shrub canopies is low. The *Populus tremuloides* / *Festuca thurberi* PA (Quaking Aspen / Thurber's Fescue Forest) has a grassy understory dominated by tall bunch grasses such as *Festuca thurberi* or *Danthonia parryi* (Parry's Danthonia) and is typically found in or adjacent to montane grasslands (see Southern Rocky Mountain Montane-Subalpine Grassland below). Allen (1984, 1989) provided stand structure and soils evidence that indicates that aspens likely invaded montane grasslands with the suppression of natural fire over the past 75 to 100 years, and Karmarkova et al. (1988) pointed out that understory composition also suggests this. Although relatively uncommon, this association has been reported elsewhere in Colorado (Hess and Alexander 1986; Karmarkova et al. 1988).

While it may be invasive in montane grasslands, *Populus tremuloides* is a major successional species following fire in spruce-fir and mixed conifer forests (see Southern Rocky Mountain Lower Montane Forest below). Aspen is a clonal species that most commonly reproduces by root sprouting. Following fires (and other disturbances such as logging), aspens can vigorously resprout and can come to dominate a site for decades, even centuries (Bradley et al. 1992). Aspen regeneration is particularly strong on severely burned sites, but may be controlled to some degree by preferential elk and deer browsing in those areas (Allen

1989; Bailey and Witham 2002). Although some aspen forests are known to be self-perpetuating, conifers will typically regain a site in the absence of fire and with adequate conifer seed sources (DeVelice et al. 1986).

Southern Rocky Mountain Lower Montane Forest Macrogroup. This macrogroup represents cool-temperate forest communities that generally lie at mid elevations between 2,130 and 2,750 m (7,000 and 9,000 ft), but may extend downslope along drainages to 1,800 m (6,000 ft), or upslope on warmer exposures to over 3,000 m (9,850 ft). The upper end of this elevation zone (above 2,300 m; 7,000 ft) is represented by two mixed-conifer groups reflecting the moisture gradient within the zone: Southern Rocky Mountain Dry-Mesic and the Southern Rocky Mountain Aspen-Douglas-fir-White Fir-Blue Spruce Mesic Forest. These forests are typically codominated by a combination of mid-elevation conifers: *Pseudotsuga menziesii*, *Abies concolor*, *Picea pungens*, *Pinus ponderosa* (ponderosa pine), *P. strobiformis*, or *P. flexilis* (the mixed conifer zone, as a whole, is also referred to as the Rocky Mountain Upper Montane Conifer Forest by Brown et al. 1998; Dick-Peddie 1993; Thompson et al. 1996).

The Southern Rocky Mountain White Fir-Douglas-fir Dry Forest is represented by seven associations that generally occur on mid-elevational to upper slopes and ridgelines with greater solar exposure (solar input). The drier conditions often lead to sparse understories dominated by scattered sedges, grasses, and forbs [e.g., *Pseudotsuga menziesii* / *Carex rossii* (Douglas-fir / Beaked Sedge Forest), *Abies concolor* / *Mahonia repens* (White Fir / Creeping Barberry Forest), *Pseudotsuga menziesii* / *Mahonia repens (*Douglas-fir / Creeping Barberry Forest PAs)]. The sparse understory may result from a combination of dense overstory canopies and dry shallow soils (fig. 11). Alternatively, shrub cover can be significant along with scattered herbs (e.g., *Pseudotsuga menziesii* / *Juniperus communis* (Douglas-fir / Common Juniper), *Abies concolor* / *Juniperus communis* (White Fir / Common Juniper Forest), *Pseudotsuga menziesii* - *Quercus gambelii* (Douglas-fir-Gambel Oak), or *Abies concolor* - *Quercus gambelii* / *Carex rossii* (White Fir - Gambel Oak / Ross' Sedge) PAs). On some upper slopes and ridge sites, the *Abies concolor* / *Festuca thurberi* - *Danthonia parryi* PA is prevalent with luxurious grassy understories. As with the *P. tremuloides* / *Festuca thurberi* PA, stands of this association are often found near or adjacent to montane grasslands, and may represent invaded grassland sites (per Allen 1989).



Figure 11. The sparse understory of this example of the *Pseudotsuga menziesii* / *Mahonia repens* Forest on Cerro Grande is common among associations of the Southern Rocky Mountain Dry-Mesic Mixed Conifer Forest Group. Sparse understory may result from a combination of dense overstory canopies and dry shallow soils. Other sites of the group can have extensive grass cover (photo: Charlie Jackson).

In contrast, plant associations of Southern Rocky Mountain Douglas-fir-White Fir-Blue Spruce Mesic Forest have richer and more luxurious understories, often dominated by mesic shrubs and/or graminoids and forbs (fig. 12). For example, the *Abies concolor* / *Thalictrum fendleri* (White Fir / Meadow Rue) PA or the *Picea pungens* / *Fragaria vesca* (Blue Spruce / Woodland Strawberry) PA have upwards of 40 forb



Figure 12. The Southern Rocky Mountain Mesic [Moist] Mixed Conifer Forest Group typically has a rich and luxurious understory often dominated by mesic shrubs and/or graminoids and forbs. Shown here is an example of a *Picea pungens* / *Fragaria vesca* Forest from the lower slopes of Rabbit Mountain at about 2,750 m (9,000 ft) (photo: Jonathan Coop).

species and 15 graminoids that are known from the associations. In addition to *Thalictrum fendleri* or *Fragaria virginiana* (Virginia Strawberry), stands can include such mesic species as *Geranium richardsonii* (Richardson's geranium), *Erigeron eximius* (spruce-fir fleabane), *Osmorhiza depauperata* (bluntseed sweetroot), *Galium aparine* (stickywilly), *Bromus ciliatus* (fringed brome), and *Carex siccata* (dryspike sedge), among others. Other associations of the group can have a strong component of mesic shrubs as well (sometimes with a reduced herbaceous layer due to shading). These include the *Abies concolor* / *Jamesia americana* (White Fir / Cliffbush), *Abies concolor - Quercus gambelii* / *Thalictrum fendleri* (White Fir - Gambel Oak / Fendler's Meadow-rue), and *Abies concolor - Pseudotsuga menziesii* / *Acer glabrum* (White Fir - Douglas-fir / Rocky Mountain Maple) PAs. Other prevalent shrubs include *Holodiscus dumosus* (rockspirea), *Ribes leptanthum* (trumpet gooseberry), *Ribes montigenum* (gooseberry currant), and *Symphoricarpos oreophilus* (whortleleaf snowberry).

Among these mixed-conifer associations, which tree species will dominate on a site is a function of site conditions and disturbance history (particularly fire). Cooler, more mesic sites tend to be dominated by *A. concolor* and *P. pungens*, two species that are extremely shade tolerant, but intolerant of fire In contrast, *Pseudotsuga* is less shade tolerant, but has a greater fire resistance and drought tolerance. Hence, it tends to be favored over *A. concolor* and *P. pungens* on drier sites with the potential for higher fire frequency. In addition, although less shade tolerant than *A. concolor*, *Pseudotsuga* is the longer lived of the two, which may be partly responsible for the dynamic balance between the two species in stands. But, with the cessation of natural fire during the 20th century, both *A. concolor* and *P. pungens* have become more prevalent, sometimes dominating sites that would normally support *Pseudotsuga* or even pines (*P. ponderosa* or *P. flexilis*) over the long term. *P. ponderosa*, with its shade intolerance and the highest fire resistance of the group, is typically an early successional species following fire in the mixed conifer forests. Later, as the pines mature, *Pseudotsuga* will replace *P. ponderosa* in the canopy. Sometimes, however, they become established at the same time and codominate the regenerating forest. Without fire and with adequate seed sources, *A. concolor* and *P. pungens* will eventually replace both *Pseudotsuga* and *P. ponderosa*, particularly on the more mesic sites (where fire is less likely). *P. flexilis* or *P. strobiformis* are found scattered throughout the mixed conifer zone, but they seldom dominate, except on very dry, rocky sites. *Populus tremuloides* is also a common component in these forests, particularly on sites that have been burned or logged. Where it exceeds 25% of the canopy cover, *P. tremuloides* phases are indicated as part of a given association.

At lower elevations, the mixed-conifer forest groups give way to the Southern Rocky Mountain Ponderosa Pine Forest & Woodland and Southern Rocky Mountain Ponderosa Pine Savanna groups, and the

Madrean Lower Montane Pine-Oak Forest Group (a member of the Madrean Montane Forest & Woodland Macrogroup). Here, *P. ponderosa* is the clear dominant and other tall conifers are uncommon or absent. However, low-statured conifers, such as *Pinus edulis* (pinyon pine), *Juniperus monosperma* (oneseed juniper), *J. scopulorum* (Rocky Mountain juniper), or *J. deppeana* (alligator juniper) may be common in the understory, along with oaks such as *Quercus gambelii* and *Q. grisea* (gray oak).

The Southern Rocky Mountain Ponderosa Pine Forest & Woodland Group is represented by five associations with moderately open to closed canopies (25 to 75% cover). Of these associations, three are characteristically shrubby with sparse herbaceous layers, or they may lack shrubs as well (fig. 13). The *Pinus ponderosa - Quercus gambelii / Carex inops* ssp. *heliophila* (Ponderosa Pine - Gambel Oak / Sun Sedge), *Pinus ponderosa - Quercus gambelii* (Ponderosa Pine - Gambel Oak), and *Pinus ponderosa / Robinia neomexicana* (Ponderosa Pine / New Mexico Locust) PAs are dominated by their respective deciduous shrubs and tend to be found at higher elevations or in more mesic conditions. Other relatively mesic deciduous shrubs that may be present include *Ribes leptanthum* (trumpet gooseberry), *Rosa woodsii* (wood rose), *Ptelea trifoliata* (common hoptree), and *Rubus idaeus* (red raspberry). The herbaceous layers are low to moderate in cover and characterized by cool-season graminoids such as *Poa fendleriana* (mutton bluegrass), *Koeleria macrantha* (June grass), *Elymus elymoides* (bottlebrush squirreltail), *Bromus ciliatus*, and *Carex inops* ssp. *heliophila*. The *Pinus ponderosa - Carex inops* ssp. *heliophila* (Ponderosa Pine - Gambel Oak / Sun Sedge) PA is similar in composition and elevation range but lacks a significant shrub component.

In contrast, the *Pinus ponderosa* / *Quercus* × *pauciloba* (Ponderosa Pine / Wavyleaf Oak) and *Pinus ponderosa - Quercus grisea* (Ponderosa Pine - Gray Oak) PAs are dominated by semi-deciduous or evergreen oaks (*Q.* x *pauciloba* and *Q. grisea*, respectively), and are generally found at lower elevations below 7,500 ft (2,275 m), often on rocky or shallow soils. The *Pinus ponderosa - Quercus grisea* PA is an edge-of-range representative of Madrean Lower Montane Pine-Oak Forest Group, which becomes more prevalent in the southern New Mexico and Arizona mountains and into the Sierra Madre of Mexico. In keeping with its warm-temperate affinity, it is found at the lowest elevation of the ponderosa pine zone (1,660 m; 5,450 ft).



Figure 13. The sparse understories of scattered graminoids in this example of a *Pinus ponderosa - Quercus gambelii / Carex inops* ssp. *heliophila* Forest along the Boundary Peak Trail are typical of the Southern Rocky Mountain Ponderosa Pine Woodland Group (photo: Jonathan Coop).

Intermixed among the woodland and forest associations are five grass-dominated associations of the Southern Rocky Mountain Ponderosa Pine Savanna Group. Overall, these are very open to open canopied woodland savannas (10-30% cover) with an understory that is typically dominated by bunch grasses with covers commonly between 5 and 30% and as high as 60%; shrubs are scattered or absent (fig. 14). The *Pinus ponderosa* / *Festuca thurberi* PA is found at the highest elevations (above



Figure 14. Grasses dominate the associations of the Southern Rocky Mountain Ponderosa Pine Savanna Group as shown in this example of *Pinus ponderosa* / *Muhlenbergia montana* Forest on Escobas Mesa. Most commonly, stands of these associations are found on undulating mesa tops (photo: Amanda Kennedy).

2,740 m; 9,000 ft) in the Sierra de los Valles, often at the edge of, or within, subalpine and montane grasslands (see Southern Rocky Mountain Montane-Subalpine Grassland below). Hence, this association shares, along with *F. thurberi,* herbaceous elements with those grasslands, such as *Danthonia parryi, Iris missouriensis* (Rocky Mountain iris), *Campanula rotundifolia* (bluebell bellflower), *Arenaria fendleri* (Fendler's sandwort), and *Potentilla hippiana* (woolly cinquefoil), as well as forest species such as *Pseudocymopterus montanus* (alpine false springparsley), *Senecio eremophilus* (ragwort), *and Vicia americana* (American vetch).

Further down the elevation gradient (1,890-2,500 m; 6,190-8,210 ft), the *Pinus ponderosa / Muhlenbergia montana* (Ponderosa Pine / Mountain Muhly) PA occurs along lower mountain slopes and upper ends of the plateaus and mesas. Besides *M. montana,* stands are characterized by a suite of montane grasses such as *Koeleria macrantha, Poa fendleriana, Elymus elymoides, Festuca arizonica* (Arizona fescue), and *Blepharoneuron tricholepis* (pine dropseed). Somewhat further down slope along the mesa tops are the *Pinus ponderosa* / *Schizachyrium scoparium* (Ponderosa Pine / Little Bluestem) and *Pinus ponderosa* / *Bouteloua gracilis* (Ponderosa Pine / Blue Grama) PAs. The graminoid component of these associations has strong affinities with the Great Plains grasslands, as reflected not only in the dominance of *S. scoparium* and *B. gracilis*, but also in the presence of forbs such as *Dalea candida* (white prairie clover), *Heterotheca villosa* (hairy golden-aster), *Liatris punctata* (dotted gayfeather), and *Psoralidium tenuiflorum* (slimflower scurfpea). These associations typically occur from about 2,300 m (7,500 ft) down to 1,770 m (5,800 ft), where stands are often inter-fingered with Rocky Mountain Pinyon-Juniper Woodland. In particular, at the lower elevations, ponderosa savanna can occur on patches of deep pumice soils (with their relatively favorable moisture conditions) in the matrix of finer textured soils derived from Bandelier Tuff that support the surrounding pinyon-juniper woodlands.

In addition to soils, terrain and climatic factors, fire has played an important role in shaping the structure and composition of ponderosa pine forest and woodland associations. Because *P. ponderosa* is highly fire tolerant (Bradley et al. 1992) and drought tolerant, it often occupies sites that are drier and have higher natural fire frequencies than those of the mixed conifer zone (DeVelice et al. 1986; Allen and Peet 1990; Touchan et al. 1996). In the past, low-intensity fires would burn through ponderosa pine stands every 8 to 15 years, removing competing understory vegetation and woody debris (Weaver 1951; Cooper 1960; Mehl 1992; Swetnam and Baisan 1996; Touchan et al. 1996). Savanna woodlands, with their high grass cover, were likely to have the most frequent ground fires, while forests, which tended to occur on steeper, rocky slopes with less "fine fuels," had fire return intervals that were likely longer.

After fires, shade-intolerant seedlings can become established in open areas,

usually in pulses correlated to favorable precipitation years (Mast et al. 1997; Mast el al. 1998; Savage et al. 1995). The other conifers (*A. concolor*, *Pseudotsuga*, etc.) are less drought- and fire-tolerant and at a disadvantage on these sites. As a result, they either fail to become established or are removed by subsequent surface fire, leading to forest stands dominated by *P. ponderosa* (with even-aged tree groups embedded in the stands depending on recruitment pulses). Without fire, other conifers can come to codominate stands with *P. ponderosa*, expanding the distribution of mixed-conifer forests. At the other end of the spectrum, *P. ponderosa* has been shown to have invaded adjacent grasslands where fires have been suppressed (Allen 1984, 1989). Hence, some stands of the various savanna associations may be considered invasive depending on edaphic conditions and disturbance history.

2.2.1.2 Western North America Scrub Woodland and Shrubland

Rocky Mountain-Colorado Plateau Pinyon-Juniper Woodland Macrogroup. Pinyon-juniper woodlands dominate the mesas and foothills of BAND and are represented by two groups: Southern Rocky Mountain Pinyon-Juniper Woodland and Southern Rocky Mountain Juniper Woodland and Savanna. With the die-off of 95% or more of *P. edulis* during the extreme drought of 2002-03, most of the landscape is now effectively Southern Rocky Mountain Juniper Woodland and Savanna dominated by *J. monosperma* (and a limited amount of Madrean Lowland Evergreen Woodland dominated by *J. deppeana*; see below). While *J. monosperma* is now the dominant, *P. edulis* is still present as seedlings and saplings in the mid to upper elevation stands (and occasionally as remnant mature individuals). Hence, much of the zone would still be considered *P. edulis* habitat type sensu Daubenmire (1966, 1976) and Layser and Schubert (1979), but for our purposes, we report only plant associations that reflect the actual vegetation as sampled (per NPS guidelines of TNC and ESRI 1994). We do, however, acknowledge the P. *edulis* habitat types by indicating a Dead *P. edulis* Phase where appropriate (this is particularly important in the mapping process since we delineated the die-off zone of *P. edulis* because it is a significant management issue for BAND). Arid conditions can also stress the junipers; dead skeletons of oneseed junipers are often conspicuous at lower elevation fringes, probably because of a 1950's drought-induced die-off (Betancourt 1993).

The Southern Rocky Mountain Juniper Woodland and Savanna Group is represented by nine PAs. Four of them are savanna types characterized by open to very open canopies (10 to 60%) of *J. monosperma* and grassy inter-canopy spaces dominated by *Bouteloua* sp. or *Hesperostipa neomexicana* bunch grasses with covers between 5 and 50% (i.e., the *Juniperus monosperma* / *Bouteloua gracilis* (Oneseed Juniper / Blue Grama), *Juniperus monosperma* / *Bouteloua eriopoda* (Oneseed Juniper / Black Grama), *Juniperus monosperma* / *Bouteloua curtipendula* (Oneseed Juniper / Sideoats Grama) PAs, and the *Juniperus monosperma* / *Hesperostipa neomexicana* (Oneseed Juniper / New Mexico feathergrass) PA). While *Bouteloua* sp. or *H. neomexicana* dominate, other common grasses include *Bouteloua hirsuta* (hairy grama), *Hesperostipa comata* (needle-and-thread grass), *Pleuraphis jamesii* (galleta), and *Sporobolus contractus* (spike dropseed). Other forest-related species, such as *Piptatherum micranthum* (littleseed ricegrass), *Poa fendleriana, Koeleria macrantha,* and *Elymus elymoides* are common in the shady understory of individual trees. Shrubs in these associations are scattered and seldom exceed 5% total cover. Most stands of these associations are found on undulating mesa tops, swales, or foothill slopes at elevations between 1,660 and 2,20 m (5,400 and 7,000 ft) (fig. 15). Also common in these environments is the *Juniperus monosperma* / Sparse (Oneseed Juniper / Sparse Undergrowth) PA, where shrubs or herbs are scattered and seldom exceed 1% cover (we further differentiated stony,



Figure 15. The Southern Rocky Mountain Juniper Woodland and Savanna Group is diverse, with a mixture of shrub- or grass-dominated associations. The example of *Juniperus monosperma* / *Bouteloua gracilis* woodland shown here from near Corral Hill on Lummis Mesa is typical of the grassy savanna-like associations of the group (photo: Amanda Kennedy).



Figure 16. The *Juniperus monosperma* / *Quercus* × *pauciloba* Woodland is typical of the shrub-dominated associations of the Southern Rocky Mountain Juniper Woodland and Savanna Group. This example from along the Tyuonyi Trail on Frijoles Mesa shows the rocky substrate often associated with the type along mesa edges and slopes (photo: Jonathan Coop).

loamy, and pumice phases to reflect the different substrate characteristics within the type and associated differences in site potential).

In contrast to the savanna associations, the *Juniperus monosperma* / *Quercus ×pauciloba* (Oneseed Juniper / Wavyleaf Oak) PA is dominated by shrubs (up to 50% cover) and mostly found on moderate to steep mountain and canyon slopes, or on rocky or shallow soils of mesa tops between 1,850 and 2,120 m (6,000 and 7,000 ft) (fig. 16). Along with *Quercus ×pauciloba*, *Cercocarpus montanus* (mountain mahogany) often codominates and may reflect a post-fire successional response. While grass composition can be similar to the savanna types, more montane species predominate (*Poa fendleriana*, *Koeleria macrantha*, *Muhlenbergia montana*, and *Elymus elymoides*), and cover seldom exceeds 10%. Along the lower canyon slopes and in the canyon bottoms, the *Juniperus monosperma* / *Rhus trilobata* (Oneseed Juniper / Skunkbush Sumac) PA is often found where shrubs are well represented by species that are indicative of the mesic canyon bottom environment: *Rhus trilobata*, *Fallugia paradoxa* (Apache plume), *Philadelphus microphyllus* (littleleaf mockorange), and *Ptelea trifoliata*. Out on the steeper and rockier slopes, we have identified a *Juniperus monosperma* / Rockland PA where total shrub and herbaceous cover falls below 5%.

We described another shrub-dominated association, *Juniperus monosperma* / *Artemisia tridentata* (Oneseed Juniper / Big Sagebrush Woodland), from lower canyon slopes and terraces below 1,700 m (6,000 ft). This is a common association of the Colorado Plateau to the west of BAND, but it is a minor element of the park's pinyon-juniper woodlands.

The Dead *P. edulis* Phase we identified, which reflects the codominance of *P. edulis* in the stands prior to the die-off of 2002-03, ranges between 1,800 m (6,000 ft) and 2,130 m (7,000 ft). Accordingly, the *Juni-*

perus monosperma / *Bouteloua eriopoda* and *Juniperus monosperma* / *Bouteloua curtipendula* PAs generally lie at lower elevations and lack the phase. There are occasional stands where mature *P. edulis* are still living and dominate, and we have accordingly identified *Pinus edulis - Juniperus monosperma* / *Bouteloua gracilis* (Pinyon Pine - Oneseed Juniper / Blue Grama Woodland) and *Pinus edulis - Juniperus monosperma* / *Quercus ×pauciloba* (Pinyon Pine - Oneseed Juniper / Wavyleaf Oak) PAs that correspond to the dominant *J. monosperma* associations of the park. These *P. edulis* associations belong to the Southern Rocky Mountain Pinyon-Juniper Woodland Group.

These juniper associations are part of the Juniper Series of Layser and Schubert (1979), and the *Juniperus monosperma* Association within the Pinyon-Juniper Series of Brown et al. (1979) described for the Southwest in general. Later, Larson and Moir (1987) identified several specific oneseed juniper associations for southern New Mexico, and Dick-Peddie (1993) identified a Oneseed Juniper Series with eight associations (Dick-Peddie (1993) referred to it as an ecotonal type of vegetation between dense woodlands and true grasslands). For BAND, Barnes (1983) was the first to describe the *Juniperus monosperma* / *Bouteloua curtipendula* and *Pinus edulis - Juniperus monosperma* / *Bouteloua gracilis* PAs as "habitat types." In addition, she described a *Pinus edulis - Juniperus monosperma* / *Muhlenbergia montana* PA which is similar to our *Pinus edulis - Juniperus monosperma* / *Quercus ×pauciloba* PA, except that it lacks the oak component. McKown et al. (2003) also recognized *B. eriopoda, B. gracilis, A. tridentata*, and sparse pinyon-juniper map units for the eastern Jemez region. All of the associations have been described elsewhere in New Mexico (Anderson et al. 1998; pers. comm., USFS, W. Robbie, Region 3 soil scientist, personal communication, Terrestrial Ecosystem Survey, unpublished data).

Fire is an important disturbance factor in pinyon-juniper woodlands, and most recently, Romme et al. (2009) provided an overview of fire's role in the dynamics and structuring of western U.S. pinyon-juniper woodlands. They recognized the "savanna woodlands" as a separate element with a specific fire regime of high-frequency, low-intensity surface fires. The shrub-dominated associations described here would be considered part of their "wooded shrubland", with a mixed fire regime of crown and surface fires of moderate to high intensity and frequency. They also described a "persistent woodland" with limited surface fuels that would have either low-frequency, high-intensity crown fires, or none, depending on canopy density. The closest analogue to this type of woodland in BAND would be the *Juniperus monosperma* / Sparse and *Juniperus monosperma* / Rockland PAs.



Figure 17. Bandelier National Monument lies at the northern edge of the distribution of the Madrean Juniper Woodland and Savanna Group. Shown here is an example of *Juniperus deppeana* / *Quercus x pauciloba* Woodland along the Boundary Peak Trail on the west side of the park at about 2,280 m (7,500 ft). This stand captures both the shrubby element of *Quercus* x *pauciloba* and the grassy component of *Bouteloua eriopoda* (photo: Charlie Jackson).



Figure 18. The Rocky Mountain Subalpine-Montane Riparian Shrubland Group is represented by the *Alnus incana* ssp. *tenuifolia* / *Agrostis gigantea* Semi-natural Shrubland shown here growing along west Upper Frijoles Creek at about 2,300 m (7,650 ft). Sites are typically along rocky, confined reaches of moderate-gradient mountain streams (photo: Yvonne Chauvin).

2.2.1.3 *Warm Temperate Madrean Forest and Woodland*

Madrean Lowland Evergreen Woodland Macrogroup. This is a minor macrogroup on BAND and is characterized by associations with affinities to the Madrean Floristic Region (Takhtajan 1986), i.e., species found more commonly in the mountains of southern New Mexico and Arizona on into the Sierra Madre of Mexico. We identified two associations dominated by *J. deppeana* that belong to the Madrean Juniper Woodland and Savanna Group of this macrogroup: *Juniperus deppeana* / *Quercus* x *pauciloba* (Alligator Juniper / Wavyleaf Oak) and *Juniperus deppeana* / Sparse Woodland (Alligator Juniper / Sparse) PAs (fig. 17). They are known at elevations from about 2,050 to 2,450 m (6,750 to 8,000 ft) in the southwestern portion of the park. While these associations have not been described elsewhere, similar ones have been identified in southern New Mexico, Arizona, west Texas, and Mexico (Anderson et al. 1998; Muldavin et al. 2009).



Figure 19. *Acer negundo* is a common dominant of Rocky Mountain Subalpine-Montane Riparian forests in Bandelier National Monument. This stand of *Acer negundo* / *Salix irrorata* Forest was located in Lower Frijoles Canyon where *Populus angustifolia* is also a common element of the riparian zone. Understories are often rich in wetland obligate shrubs and herbs (photo: Jonathan Coop).

2.2.1.4 Western North America Flooded and Swamp Forest and Shrubland

Rocky Mountain and Great Basin Flooded and Swamp Forest and Shrubland Macrogroup. These montane riparian forests, woodlands, and shrublands occur along perennial stream channels of moderate gradient (1 to 5%) within the major canyons of BAND. Elevations range between 1,650 and 2,350 m (5,400 and 7,700 ft). They are dominated by various admixtures of broadleaf and coniferous trees species and have been separated into two groups. The Rocky Mountain Subalpine-Montane Riparian Shrubland Group is represented by the *Alnus incana* ssp. *tenuifolia* / *Agrostis gigantea* (Thinleaf Alder / Redtop Shrubland) Semi-natural Shrubland PA that occurs along rocky, often confined stream reaches at the upper elevations (fig. 18). Where streams are less confined and there are small floodplains, tall broadleaf riparian tree species become more prevalent and the Rocky

Mountain Subalpine-Montane Riparian Forest Group dominates. For this group, we described six associations dominated by *Acer negundo* (box elder) and two by *Populus angustifolia* (narrowleaf cottonwood) with various combinations of shrub or graminoid-dominated understories (fig. 19). In addition, we described two association codominated by conifers and broadleaf trees. The *Abies concolor - Acer negundo* / *Alnus incana* ssp. *tenuifolia* (Box elder / Thinleaf Alder) PA occurs at the upper end of the elevational gradient, while the *Pinus ponderosa* / *Forestiera pubescens* (Ponderosa Pine / New Mexico Olive) PA occurs at the lower. For the latter, we identified *Acer negundo* and *Populus angustifolia* phases where the two species codominate with *P. ponderosa*. Six out of the ten associations have not been described elsewhere and are considered as either provisional or special park associations.



Figure 20. The Southwest Lowland Riparian Woodland and Shrubland Group is represented by both *Populus deltoides* and willow-dominated stands such as in this example of the *Salix amygdaloides - Salix exigua* Shrubland association along the Rio Grande in White Rock Canyon (photo: Elizabeth Milford).

2.2.1.5 Western North America Warm Temperate Flooded and Swamp Forest

Warm Desert Riparian, Flooded & Swamp Forest and Shrubland Macrogroup. These are lower-elevation deciduous riparian forests, woodlands, and shrublands that occur in the large canyon-bottom floodplains or along the Rio Grande floodplain within White Rock Canyon. Stands are occur between 1,630 and 1,700 m (5,350 and 5,550 ft) on alluvial bars and terraces adjacent to low-gradient channels (1 to 2%). We have identified ten associations that belong to a Southwest Lowland Riparian Woodland and Shrubland Group (fig. 20). The *Populus deltoides* / *Salix irrorata* (Plains Cottonwood / Bluestem Willow) PA is dominated by the native *Populus deltoides* var. *wislizeni* (Rio Grande cottonwood) as well as by native shrubs in the understory, such as *Salix irrorata*, *Forestiera pubescens* and *Rhus trilobata*. Similarly, two associations are dominated by native shrubs: *Salix exigua* / Mesic Graminoids (Coyote Willow / Mesic Graminoids) and *Salix amygdaloides - Salix exigua* (Peachleaf Willow - Coyote Willow) PAs. These are especially prevalent on side bars along the Rio Grande. Also intermixed



Figure 21. The Southwest Lowland Desert Wash (Arroyo) Riparian Woodland and Shrubland Group occurs along ephemeral stream channels of the larger canyon bottoms. This is an example of the *Fallugia paradoxa* / Dry Wash Shrubland along lower Lummis Canyon near its confluence with the Rio Grande (photo: Teri Neville).



Figure 22. Stands dominated by shrubby *Quercus gambelii* and *Robinia neomexicana* typify the Southern Rocky Mountain Gambel Oak-Mixed Upper Montane Shrubland Group on Bandelier National Monument. This site in a small canyon on Escobas Mesa was burned in the 1977 La Mesa fire and reflects the high density of *Q. gambelii* scrub that persists following fire, particularly on slopes (photo: Jonathan Coop).

among native shrublands, we identified four invasive exotic shrubland associations dominated by either *Tamarix ramosissima* (saltcedar) or *Elaeagnus angustifolia* (Russian olive). Most occurrences of these associations are within the inundation zone of Cochiti Reservoir, either in White Rock Canyon or at the mouths of tributaries to the Rio Grande, and have been flooded as part of the reservoir pool for extended periods since 1972. Hence, the understories of these associations tend to be weedy and often dominated by the exotic grass, *Bromus tectorum* (cheatgrass).

Two associations occur along ephemeral stream channels of the larger canyon bottoms (fig. 21). The *Juniperus monosperma* / *Forestiera pubescens* (Oneseed juniper / New Mexico Olive) is a previously undescribed open woodland association common along channels around 1,975 m (6,500 ft). Channel gradients are moderate (1 to 10%) and stands can extend up into the steeper, confined canyons; they are sometimes associated with springs. The *Fallugia paradoxa* / Dry Wash Shrubland (Apache Plume / Arroyo Shrubland) PA also occurs along the lower dry wash channels (below 1,830 m; 6,000 ft) on gravelly alluvial terraces. This is a common association in New Mexico.

2.2.1.6 Vancouverian and Rocky Mountain Grassland and Shrubland

This is a diverse array of 37 upland shrubland and grassland associations distributed among three macrogroups.

Southern Rocky Mountain Montane Shrubland and Grassland Macrogroup. The Southern Rocky Mountain Gambel Oak-Mixed [Mesic] Montane Shrubland Group occurs at higher elevations (1,900 to 2,900 m; 6,200 to 9,500 ft) and is represented by five associations (fig.22). Four of the five are dominated by either *Q. gambelii* and/or *Robinia neomexicana* and are, in most cases, successional shrublands following fire in mixed conifer and ponderosa forests. That is, for those forests that originally had oak understories (e.g., *Pinus ponderosa - Quercus gambelii / Carex inops* ssp. *heliophila, Abies concolor - Quercus gambelii / Thalictrum fendleri Forest,* etc.), the *Quercus gambelii / Robinia neomexicana / Carex inops* ssp. *heliophila* or *Quercus gambelii - Robinia neomexicana / Muhlenbergia montana* are the post-fire successional correlates. Similarly, the *Robinia neomexicana / Carex inops* ssp. *heliophila* PA is likely successional to non-oak forest associations, such as the *Pinus ponderosa / Carex inops* ssp. *heliophila* or *Abies concolor / Mahonia repens* PAs, among others. Where sites were artificially seeded with grasses following fires and grasses are still abundant (>10% cover), we have indicated a Seeded Grasses Phase. McKown et al. (2003) also recognized *Q. gambelii* and/or *Robinia neomexicana* cover types for the eastern Jemez Mountains region. *Ceanothus fendleri / Muhlenbergia montana* shrublands also occur, whose successional status is less clear, i.e., they may follow fire in upper-elevation pinyon-juniper or *P. ponderosa* woodlands, or perhaps they

are quasi-stable shrublands on rocky sites within grasslands.

As a result of the extensive fires in the park since 1977, *Q. gambelii* shrublands have likely become more widely distributed on both slopes and rockier mesa tops sites. There are sites where *Q. gambelii*, a strongly clonal species, may have dominated and persisted for long periods with or without fire--precluding the establishment of trees (particularly on steep rocky slopes). Similarly, the *Jamesia americana* (*Physocarpus monogynus*, *Holodiscus dumosus*) PA may also be successional to mesic-moist associations, such as the *Abies concolor* / *Jamesia americana* or *Abies concolor - Pseudotsuga menziesii* / *Acer glabrum* PAs, but it also can occur on unstable scree slopes that may never have been forested.

At lower elevations of 1,659 to 2,500 m (5,400 to 8,150 ft), the Southern Rocky Mountain Cercocarpus-Mixed [Dry] Foothill Shrubland Group becomes more prevalent, intermixed with pinyon-juniper woodlands and grasslands. The two plant associations in this group are dominated by the semi-deciduous *Q.* x *pauciloba:* the *Quercus* x *pauciloba* / *Bouteloua curtipendula* and *Quercus* x *pauciloba - Cercocarpus montanus* PAs (fig. 23). As with *Q. gambelii* and forest associations, these may be successional to *Juniperus monosperma* / *Quercus* x *pauciloba* Woodland following fires, or they may occur on rocky, often unstable slopes which are unfavorable to trees regardless of fire. At the lowest elevations (<2,065 m; 6,800 ft), are shrublands dominated by *Fallugia paradoxa*. These either occur on rocky slopes (*Fallugia paradoxa* / Rockland PA), or on disturbed mesa top sites (*Fallugia paradoxa* / Ruderal Herbs PA). Lastly, at lower elevations there are occasional stands dominated by *Rhus trilobata* along with a mixture of lower montane shrubs and grasses (*Rhus trilobata* Rocky Mountain Shrub Herbaceous Vegetation PA).

Within this macrogroup, grasslands are represented by the Southern Rocky Mountain Montane-Subalpine Grassland Group. The higher elevations (>2,700 m; 8,800 ft) of the Sierra de los Valles are dominated by *Festuca thurberi* and *Danthonia parryi* grassland associations (fig. 24). These tall bunch-grass grasslands are conspicuous on the southern aspects of mountain tops, upper slopes, and, occasionally, forest openings. Along with the dominant grasses, forbs can be common and diverse. *Potentilla hippiana* is the typical dominant, along with other open-meadow species, such as *Achillea millefolium*, *Iris missouriensis, Campanula rotundifolia, Erigeron formosissimus* and *Arenaria fendleri*. These are also referred to as Montane Grassland by McKown et al. (2003). With the cessation of fire, there is evidence that conifers have invaded several sites, creating high montane savannas (Allen 1984). *Poa pratensis*-dominated grasslands are also prevalent and may represent the legacy of historic livestock grazing.

At mid elevations (2,125 to 2,425 m; 7,000 to 8,500 ft), along the lower mountain slopes and upper mesas, *Muhlenbergia*



Figure 23. The *Quercus* × *pauciloba* / *Bouteloua curtipendula* Shrubland shown here from lower Escobas Mesa is representative of the Rocky Mountain Lower Montane-Foothill Shrubland Group on Bandelier National Monument. Stands often occur on rocky sites on the shoulders of mesas or on canyon slopes (photo: Jonathan Coop).



Figure 24. The Southern Rocky Mountain Montane-Subalpine Grassland Group occurs at elevations generally above 2,700 m (8,850 ft) and is typified by *Festuca thurberi*- and *Danthonia parryi*-dominated grassland associations. This stand of *Festuca thurberi* / *Potentilla hippiana* Herbaceous Vegetation was located along the lower slopes of Scooter Peak in an area that may have been historically logged (photo: Jonathan Coop).



Figure 25. Intermixed among pinyon and juniper woodlands are open grasslands dominated by *Bouteloua* sp. that are elements of the Southwest Plains/Mesa Grassland. This is a stand of *Bouteloua gracilis* / *Gutierrezia sarothrae* Dwarf-shrub Herbaceous Vegetation that occurred on lower Escobas Mesa at about 2,000 m (6,600 ft). Soils are deeper and finer textured in comparison to sites where oaks and other tall shrubs dominate (photo: Amanda Kennedy).

montana-dominated associations become more prevalent. In addition, Great Plains species, such as *B. gracilis* and *Schizachyrium scoparium*, can also be common, and even codominant. These grasslands are often associated with post-fire landscapes that were once dominated by mixed-conifer, and ponderosa pine forest stands (e.g., the *Pinus ponderosa* / *Muhlenbergia montana* PAs) may include grasses that were artificially seeded after fires (e.g., *Bromus inermis* (smooth brome), *Pascopyrum smithii* (western wheatgrass), *Festuca idahoensis* (Idaho fescue) and *Elymus pseudorepens* (false quackgrass). These associations fall within the Submontane Grassland described by McKown et al. (2003).

2.2.1.7 Great Plains Grassland and Shrubland

BAND lies just to the east of the Great Plains proper, and hence supports scattered stands of grassland and shrubland that are common to that biome and that we have segregated into two macrogroups as follows:

Great Plains Shortgrass Prairie and Shrubland Macrogroup. On BAND, this macrogroup is represented by associations belonging to a proposed Southwest Plains-Mesa Grassland Group (fig. 25). These grasslands are mainly dominated by short to medium-tall bunch grasses (e.g., *Bouteloua gracilis, B. eriopoda, B. curtipendula, and Schizachyrium scoparium*) and occur at elevations between 1,650 and 2,300 m (5,400 and 7,500 ft). They are often interspersed among *J. monosperma* woodlands (e.g., *Juniperus monosperma* / *Bouteloua gracilis*, *Juniperus monosperma, Bouteloua eriopoda,* and *Juniperus monosperma* / *Bouteloua curtipendula* PAs) and have many species in common. The *Bouteloua gracilis*/*Gutierrezia sarothrae* PA, and *Bouteloua eriopoda - Bouteloua gracilis* PA are mostly associated with swales or depressions (vegas) on mesa tops, or occasionally with alluvial terraces in canyon bottoms. In contrast, the *Bouteloua eriopoda - Bouteloua curtipendula* Herbaceous Vegetation is found mostly on rocky canyon slopes.

The *Schizachyrium scoparium - Koeleria macrantha* PA occurs at the upper-elevation end and is associated with post-fire woodlands or forest sites. In addition, we have placed in this group two associations that represent post-fire, artificially seeded grasslands: the *Elymus x pseudorepens - Bromus carinatus* (California brome) Semi-natural Herbaceous Vegetation PA and the *Pascopyrum smithii* / Ruderal Herbaceous Vegetation PA. Similarly, McKown et al. (2003) identified a *Bromus carinatus- Elymus trachycaulus* (slender wheatgrass) cover type to represent post-fire seeded landscapes. We also included the *Bouteloua curtipendula - Bothriochloa barbinodis* PA, which occurs in the high-water flood zone of Cochiti Reservoir and is dominated by ruderal, weedy species.

Early successional vegetation that follows disturbance can be a heterogeneous mix of annual and short-lived perennial species that can be diverse but variable from site to site. Accordingly, we designated a special Southwest Plains-Mesa Ruderal Disturbance Vegetation Group with generalized associations that reflect fire, flooding and other disturbances.

Great Plains Sand Grassland and Shrubland Macrogroup. This is a minor macrogroup on BAND and is represented by an isolated occurrence within White Rock Canyon of *Artemisia filifolia* / *Bouteloua eriopoda* (Sandsage/ Black Grama) Shrubland, which belongs within the Great Plains Sand Shrubland Group.

2.2.1.8 Western North America Freshwater Marsh

This macrogroup is limited in distribution on BAND and is represented at upper elevations by wet meadows and herbaceous wetlands belonging to the Southern Rocky Mountain Montane-Subalpine Emergent Wetland Group. They are associated with springs, seeps, and swales, and are dominated by facultative or obligate wetland species, such as *Juncus arcticus* (arctic rush) and *Calamagrostis canadensis* (bluejoint),



Figure 26. The Southern Rocky Mountain Montane-Subalpine Persistent Emergent Wetland Group is limited in extent on Bandelier National Monument. It occurs in high-elevation spring areas and swales such this one at the foot of Scooter Peak where the *Juncus arcticus - Poa pratensis* Semi-natural Herbaceous Vegetation Wetland is the dominant association (photo: Yvonne Chauvin).

along with *Carex pellita*, *Carex microptera*, *Ranunculus cardiophyllus*, and *Mentha arvensis Berula erecta* (cutleaf waterparsnip) (fig. 26).

2.2.1.9 Western North American Warm Desert Freshwater Marsh

This macrogroup has a limited distribution at lower elevations along the Rio Grande and immediate tributaries within White Rock Canyon. It is represented by the *Eleocharis palustris - Carex praegracilis - Berula erecta* Herbaceous Vegetation PA that is part of a proposed North American Arid West Emergent Marsh Group. This association is found interspersed among lowland riparian shrublands and woodlands.

2.3 Classification discussion

Daubenmire (1974) suggested that plant communities integrate all impinging environmental conditions and hence, the classification and description of plant associations provides a framework for under-

standing the ecological composition and structure of a given landscape. Accordingly, plant associations are used in the mapping process to define map unit components—providing the information linkage between a vegetation community's spatial distribution and its ecology. The outcome is that by grouping land areas based on the ability to support similar associations, general management observations and recommendations can be made for each grouping. In addition, resource managers have found that the classification of vegetation into plant associations has provided insight and the ability to predict vegetation changes in response to various disturbance processes.

Yet, the development of a vegetation classification is an incremental process of successive approximation (Shimwell 1971). In particular, on BAND, we suggest that further work is needed in describing edge-of-range associations from the Colorado Plateau, Great Plains, and Chihuahuan Desert. Among the dominant Rocky Mountain forest and woodlands, more work is needed on delineating understory patterns and species distributions with respect to further defining the "Group" level of the classification and revising the alliances within the new FGDC (2008) NVCS hierarchy.

3 Bandelier National Monument Vegetation Map

3.1 Mapping process overview

The vegetation map for Bandelier National Monument (BAND) was developed using a combined strategy of automated digital image classification and direct analog image interpretation of aerial photography and satellite imagery. Initially, the aerial photography and satellite imagery were processed and entered into a GIS along with ancillary spatial layers. A working map legend of ecologically-based vegetation map units was developed using the vegetation classification described in Chapter 2 as the foundation. The intent was to develop map units that targeted the plant association level wherever possible within the constraints of image quality, information content, and resolution. With the provisional legend and ground-control points provided by the field-plot data (the same data used to develop the vegetation classification), a series of automated image segmentation and supervised image classifications were conducted, followed by fine-scale map refinement using direct image interpretation and manual editing. The outcome was a vegetation map composed of a suite of map units defined by plant associations and represented by sets of mapped polygons with similar spectral and site characteristics.

The key mapping standards of the National Vegetation Mapping Program (http://biology.usgs.gov/npsveg/), call for spatial data to be provided with a horizontal positional accuracy meeting National Map Accuracy Standards at the 1:24,000 scale, i.e., each well-defined object in the spatial database must be within 1/50-of-an-inch display scale or 12.2 m (40 ft) of its actual location. In addition, each vegetation map class (unit) should meet or exceed 80% accuracy at the 90%-confidence level, and the minimum mapping unit (MMU) should be 0.5 ha (1.24 ac). Details of the accuracy assessment for the BAND vegetation map are provided in Chapter 4.

3.2 Mapping methods

3.2.1 Data sources and processing

3.2.1.1 Aerial photography

Aerial photography was the foundation imagery for the vegetation map. Originally, 1:12,000 natural-color photography from the year 2000 was available, but it was rejected because it predated the major die-off of *Pinus edulis* in 2002 and 2003 and was low in contrast. A second flight in 2003 had poor color balance and incomplete coverage. Finally, between June 11 & 19, 2004, 107 stereo-paired natural-color air photos at a 1:12,000 scale were acquired over the park and surrounding area. The hard-copy photos were scanned into a three-band (one band each representing visible red, visible green, and visible blue wavelengths) digital file at 900 dpi resolution. These were then imported into ERDAS Imagine (v.8.6).

The image files were orthorectifed using the 1-m spatial resolution 1996 USGS Digital Orthophoto Quarter Quads (DOQQs) as the horizontal control. The 10-m spatial resolution USGS Digital Elevation Model (DEM) was used as the vertical control. At least nine ground-control points were used to tie each photo frame to the vertical and horizontal control. These were then used to solve the collinear equations that provided the transformation equation, which converted each photo into a planimetric image. The photos were rectified into a Universal Transverse Mercator (UTM) projection, Zone 13, 1927 North American Datum (NAD), Clarke 1866 Spheroid, with an original spatial resolution of 0.5 m.

The individual orthophotos were then mosaicked together. Each photo had a parabolic color adjustment applied to it to subdue hot spots and dark corners. The edges were also cut off and the boundaries of the adjoining photos were feathered together over a 30-pixel overlap. The resulting orthophoto mosaic was further color adjusted. Although the original 0.5-m spatial resolution provided good detail of surface features, it was more detailed than

needed for the level of classification that was being attempted and the size of the image file made it difficult to use. Therefore, for classification, the orthophoto was resampled to a 2-m spatial resolution—reducing its overall file size by a factor of 16, without substantially reducing the detail. The 0.5-m resolution file was retained and used to support the subsequent photo-interpretation corrections to the automated classification.

3.2.1.2 Satellite imagery

To complement the digital aerial photography, we used two multi-spectral satellite Landsat Enhanced Thematic Mapper+ (ETM+) images. Multi-spectral satellite imagery records different reflectances of the variable natural radiation of surface materials, such as rocks, plants, soils, and water, over the Instantaneous Field of View (IFOV)—an area of approximately 98 x 98 ft (30 x 30 m). Variations in plant reflection and absorption due to biochemical composition produce distinct spectral "signatures" (Lillesand and Kiefer 1987). These signatures provide a quantitative measure of reflectance at specific wavelengths, which can be analyzed statistically to develop a vegetation map of spectrally similar plant communities.

The advantages and disadvantages of using Landsat imagery are almost the opposite of using air photos. While ETM+ spatial resolution (30 m pixels) is much coarser than that of the air photo, and individual plants can not be resolved, ETM+ spectral resolution extends to the near- and mid-infrared wavelengths, which are important regions for differentiating vegetation and the underlying soil reflectance responses (table 6). Each band represents a specific range of light wavelengths and suite of spectral responses. ETM+ bands 2, 3, 4, and 5 are particularly useful for vegetation, while bands 3, 5, and 7 are responsive to variations in surface geology. Surface geology and soil discrimination are important in developing mapping units of the sparse vegetation communities that occur in the study area. ETM+ band 6 records surface temperature and can be an indirect measure of moisture content. It can be important for discriminating between different plant and soil types; however, it was not used because it has a much coarser spatial resolution (200 x 200 ft; 60 x 60 m).

Another advantage of ETM+ imagery is that its stable sensor platform makes it relatively easy to geometrically correct imagery to a known coordinate system of a base map. The height of the sensor above the earth (466 mi; 705 km for Landsat) negates most parallax problems commonly found in aerial photography (parallax is the apparent change in position of stationary objects affected by the viewing angle, creating greater distortions at greater distances from the center of an aerial photo). In addition, satellite data generally do not have the radiometric problems of air photos, such as hot spots, dark edges, or different contrasts for each photo due to sun-angle changes during overflights .

Table 6. Landsat Enhanced Thematic Mapper Plus (ETM+) spectral band descriptions (Jensen 2004).

Landsat band	Wavelength (μm)	Surface response
Band 1	Visible Blue (0.45-0.52)	Absorption by most materials except saline or sandy soils
Band 2	Visible Green (0.52-0.6)	Minor green vegetation reflectance peak
Band 3	Visible Red (0.63-0.69)	Green vegetation absorption, but senescent vegetation reflectance and iron-stained soils reflect in these wavelengths
Band 4	Near-Infrared (0.76-0.9)	Green vegetation reflectance peak
Band 5	Mid-Infrared (1.55-1.75)	Woody vegetation has less reflectance than herbaceous vegetation due to shadowing
Band 7	Mid-Infrared (2.08-2.35)	Hydrated vegetation, wet soil, and clayey soils have strong absorption features in these wavelengths

We used two available ETM+ scenes—one from November 6, 1999 and the other from June 4, 2001—that had been used in the adjacent mapping project at the Valles Caldera National Preserve (Muldavin and Tonne 2003). These multi-temporal scenes capture the seasonal vegetation changes of deciduous shrub leaf-out, forb emergence, and transition from cool-to warm-season grasses. In addition, the two dates bracket the before and after of the May 2000 Cerro Grande fire. Although the ETM+ images were already geocorrected, they were re-rectified to the orthophoto mosaic. This was to ensure the images overlaid each other directly. The ETM+ images were sampled to a 20-m spatial resolution and projected into the orthophoto mosaic's projection.

Using the ETM+ spectral bands, we computed four vegetation indices to enhance various vegetation or ecosystem characteristics. These were the Normalized Difference Senescent Vegetation Index (NDSVI) [Eq. 1], the Normalized Difference Vegetation Index (NDVI) [Eq. 2], a moisture index [Eq. 3], and a canopy structure index [Eq. 4] computed as follows:

NDSVI = ((Band 7 – Band 3) / (Band 7 + Band 3) + 1) ∗100 (Equation 1)

NDVI = ((Band 4 – Band 3) / (Band 4 + Band 3) + 1) ∗ 100 (Equation 2)

Moisture index = ((Band 5 – Band 7) / (Band 5 + Band 7) + 1) ∗ 100 (Equation 3)

Structure index = ((Band 4 – Band 5) / (Band 4 + Band 5) + 1) ∗ 100 (Equation 4)

Band ratios, in general, are designed to divide a reflectance peak against an absorption low to distinguish unique surface features. Due to the potential differences between image data ranges, the difference between bands is normalized against the total data range of the image bands. The adding of "1" and multiplying by "100" in each equation takes the original result, which would be a positive or negative fractional value centered around 0, and turns it into a positive integer value centered around 100.

The NDSVI enhances the spectral characteristics of senescent vegetation (specifically grasses), which have a relatively low reflectance response in the red wavelengths (Band 3) and a high reflectance in the mid-infrared wavelengths (Band 7). The NDVI emphasizes vigorous green plant growth by comparing a strong chlorophyll reflectance in the near-infrared wavelengths (Band 4) against chlorophyll absorption in the visible red wavelengths (Band 3). The moisture index compares relatively high reflectance values in the shorter wavelengths of the mid-infrared (Band 5) against strong absorption at the longer wavelengths of the mid-infrared (Band 7) caused by water molecules found in soil and vegetation. Similarly, the structure index enhances shadowing and leaf water content in plants.

All of the source and derived layers were then compiled into a single image re-sampled to a 2-m spatial resolution. This resulted in a final image with 20 image bands, as listed in Table 7, available for the classification process. Given that there are 20 bands, it is likely that some are highly correlated with one another. To reduce information duplication, maximize differences within the data, and improve interpretability, a principal components analysis (PCA) was computed on the compiled image file. The results of a PCA reorganize the data using a covariance matrix into components (output as image bands of the new PCA image) into images of highly related surface responses. The first component enhances the largest overall surface response found in the data (in this case it was soil brightness) and the next component enhances the next largest response pattern (again in this case, moist higher-altitude forest), and so on for all 20 resulting components. The

Table 7. Landsat Thematic Mapper bands and derivatives compiled into the image used to classify vegetation.

Image bands	Band description
Band 1	November 6 1999 Landsat Visible Blue
Band 2	November 6 1999 Landsat Visible Green
Band 3	November 6 1999 Landsat Visible Red
Band 4	November 6 1999 Landsat Near-Infrared
Band 5	November 6 1999 Landsat Mid-Infrared
Band 6	November 6 1999 Landsat Mid-Infrared
Band 7	June 4 2001 Landsat Visible Blue
Band 8	June 4 2001 Landsat Visible Green
Band 9	June 4 2001 Landsat Visible Red
Band 10	June 4 2001 Landsat Near-Infrared
Band 11	June 4 2001 Landsat Mid-Infrared
Band 12	June 4 2001 Landsat Mid-Infrared
Band 13	November 6 1999 NSVDI
Band 14	November 6 1999 NDVI
Band 15	November 6 1999 Moisture
Band 16	November 6 1999 Structure
Band 17	June 4 2001 NDSVI
Band 18	June 4 2001 NDVI
Band 19	June 4 2001 Moisture
Band 20	June 4 2001 Structure

last components usually represent the least amount of data variance and are mostly noisy. By using the PCA images, the follow-on classification process can concentrate on the few significant component images rather than always having to use all 20 bands of image data.

3.2.1.3 Digital elevation models, associated derived indices, and other spatial data layers

A 10-m spatial resolution USGS Digital Elevation Model (DEM) was used in conjunction with ground data to help discriminate between vegetation types based on elevation gradients and terrain. Using ArcGIS 9.2 (ESRI 2008), we computed simple slope in degrees and a curvature index as first-order derivative of slope. Curvature was used to interpret the geomorphic and terrain relationships with respect to moisture availability for plants (e.g., aridic convex hillslopes and ridges versus mesic concave footslopes and valleys). A complementary hydrological flow accumulation index was created which models the amount of area that drains into each pixel to differentiate more drier sites that shed water (low flow accumulation) from more mesic and riparian sites (high flow accumulation).

The warmth of the site also has important ecological implications for vegetation pattern, and traditionally has been interpreted in terms of lapse rates (intrinsic decreases in temperature with elevation) and solar energy input (solar insolation) as functions of aspect and slope, among others. Here, we use elevation directly as the surrogate for lapse rate. In addition to a simple aspect (azimuth) layer, solar radiation measured in watts/m^2 was computed using an ArcGIS 9.2 tool based on a model of Fu and Rich (2002). The model estimates the amount of solar radiation hitting the surface over the course of a year, as a function of latitude, aspect, slope, time, and solar energy transmission through the atmosphere. For this project, an average solar radiation value was calculated for the year using an hourly time steps. The solar radiation model provides an indication of the actual warmth of a site which is not provided by aspect and slope alone, but it is not corrected for absorbance and re-radiation or reflection from other surfaces (and these can be important ecologically).

In addition to the aspect layer above, a geomorphometric TRMI was created for BAND and the surrounding terrain using a 10-m DEM downloaded from the USGS Seamless website. Based on Parker (1982), the TRMI is an index of mesoscale moisture availability in mountainous terrain ranging from 0 (xeric) to 60 (mesic). The four primary topographic attributes of slope, aspect, configuration, and topographic position are assigned scalar values with aspect and topographic position receiving double weight. The slope, aspect, and configuration layers were generated and reclassified using ArcGIS. Topographic position was reclassified in ArcGIS from a

specific catchment area analysis carried out with the stand-alone Terrain Analysis System (TAS). The geomorphometric TRMI was then improved using a topographic position of continuous scalar gradation (0 to 20), rather than the field-adapted values of 0 (ridge top), 5 (upper slope), 10 (middle slope), 15 (lower slope), and 20 (valley bottom). The TRMI is easily recorded in the field and is decomposable and intuitively comprehensible in its geospatial expression. Its reproducibility as a geomorphometric application makes it a valuable tool for ecological analysis and mapping in the mountainous landscapes.

3.2.1.4 Geographic Information System (GIS) structure and software

All imagery and other spatial data layers were compiled into a geodatabase and GIS using ArcGIS 9.2 (ESRI 2008). To support the mapping process, we acquired a standard set of relevant spatial data layers (e.g. roads, building, topographic maps, etc.). We also imported the recently completed soil survey map of Hibner (2009) provided by Natural Resources Conservation Service (NRCS), color infra-red aerial orthorectified photography from 2005, and recent images of the geology maps of the area.

3.2.2 Vegetation map units and legend development

The development of map units (map classes) and construction of a map legend is an iterative process that integrates the ecological vegetation classification units (plant associations, alliances, etc.) described above with their spatial distribution as determined by the quality of the remote sensing imagery and on-the-ground reconnaissance work. Following NPS guidelines, our goal was to develop map units that correspond to the plant association level of the national classification, but this was contingent on being able to discern differences in the available imagery at that level using various remote sensing techniques.

Initially, we used simple stereo aerial photo interpretation to develop a working legend of plausible map units based on the true color and infrared photography, and ground-control sample points. While some units were defined by single plant associations and were relatively simple, others were either structured or unstructured complexes of plant associations. Structured complexes are composed of two or more plant associations that either form fine-scale patterns, not separable at the scale of mapping (i.e., below the minimum map unit size of 0.5 ha), or they are not separable spectrally, but the spatial organization of the associations within the unit are understood to some degree. For example, the *Pinus ponderosa* / *Muhlenbergia montana* and *Pinus ponderosa/Bouteloua gracilis* savanna associations are difficult to discern based on spectral differences between their respective grass dominants, but we know the former occurs at higher elevations than the latter. Therefore, both are primary components of a Ponderosa Pine Savanna structured complex map unit.

In unstructured complexes, however, the environmental/spatial relationships among spectrally similar associations are poorly understood. In our case, closed-canopied, mixed-conifer forest may be composed of several plant associations with different understory compositions that may not be discernable through the tree canopies in the imagery. These associations may also have subtle environmental differences that have not been well defined qualitatively (e.g., the White Fir-Douglas-fir Mesic Dry Forest composed of the *Abies concolor - (Pseudotsuga menziesii)* / *Quercus gambelii* / *Carex rossii, Abies concolor* / *Juniperus communis, Abies concolor* / *Mahonia repens*, and *Pseudotsuga menziesii* / *Mahonia repens* associations).

We hierarchically structured the legend into two tiers: a basic lower Level 2 composed of simple map units or complexes as defined by plant associations, and an upper Level 1, which groups the Level 2 map units more or less following the Group level of the NVCS as currently imple-

mented by NatureServe and the Ecological Society of America National Vegetation Panel (FGDC 2008). The Level 1 grouping allows the map to be comparable at regional scales to other mapping efforts, such as Gap and Landfire (Keane et al 2002; Prior-Magee 2007). On occasion, specific phases of plant associations are identified within Level 2 map units. Phases were used primarily to identify successional patterns or further refine broadly defined plant associations for mapping purposes (e.g. among mixed-conifer and aspen forests, dead *Pinus edulis*).

For each map unit, the most predominant associations are identified as Primary Components of the unit (collectively greater than 50% of the aerial extent of the unit), while associations known to be less common from ground reconnaissance are designated as Secondary Components (collectively <50% of the area). In addition, those associations estimated to occupy less than 10% of the area of unit are designated as inclusions. These can be Related Inclusions that are floristically similar to the primary and secondary components, but relatively rare (and usually not found in other map units), or they can be Contrasting Inclusions of very different associations that are known to occur at levels below the scale of mapping and that are typically major components of other map units.

At the other end of the scale, individual polygons were further annotated with attributes, such as canopy closure and structure, condition, shrub cover, and geological substrate (table 8). In particular, those polygons in the pinyon-juniper and ponderosa pine zones were annotated where indications of the 2002-03 die-off of either *Pinus edulis* or *P. ponderosa* were present (based on interpreting actual standing dead trees and gray needle cast patches in the imagery; we estimate that the threshold for designating die-off was evidence that at least 25% of the stands were affected). Sites that were severely burned were classified into a set of specific post-fire map units (e.g., in the 2000 Cerro Grande and 1996 Dome fires).

The hierarchical working legend formed the foundation for subsequent image analysis and classification. Based on the results of the image analysis and subsequent heads-up screen editing, the legend was further refined, both by lumping and splitting the draft units. The map went through several iterations as ground data was gathered through the years and new imagery was acquired. Specifically, the massive die-off of pinyon pine in 2002-03 required the reassessment of map units and significant revision of polygon delineations, based on updated photography.

3.2.3 Image analysis and map development

3.2.3.1 Base map development

To efficiently develop a base map with a vector polygon structure (versus raster/pixel), per NPS specifications, we employed eCognition's (v. 4) object-oriented classification software (Definiens, http://earth.definiens.com/). This software uses an image segmentation technique to delineate the imagery into objects (polygons) of similar color, contrast, and shape. The advantage of this approach is that these objects will preserve edge boundaries of detailed surface features such as roads, cliffs, and drainages—features that would be lost or misclassified in a more traditional pixel-based classification. The initial base map layers were developed using the 2 m resolution color aerial orthophotos, since they had the highest spatial resolution. Because of the 2-m resolution, the aerial photo mosaic exceeded the software capacity (a 2-gigabyte limit). Therefore, the image was portioned into five separate analysis regions. The regions were designed on their shared physiography: Eastside, Westside, Riverside, USFS, and Tsankawi sub-units.

In this automated polygon delineation framework, the level of detail is controlled by a unitless scale parameter that considers each polygon object based on its homogeneity of color and shape. The scale parameter determines the maximum allowable heterogeneity for the resulting im-

Table 8. Polygon modifiers for the Bandelier National Monument vegetation map.

Modifier	Code	Category	Description
CCMD		Tree canopy cover %	
	0	0	No trees or shrubs
	1	1- 10	Scattered trees
	2	10-25	Sparse stand
	3	25-60	Open stand
	4	> 60	Closed stand
CDMD		Large tree %	
	L	>50 %	Mostly large trees, low density
	H	<50%	Mostly small trees, high density
	U		Undetermined
COMD		Condition	
	a	Normal	Natural
	b	Fire	Fire evident within last 20 years
	c	Pinyon die-off	
	d	Logging	
	g	Tall conifer die-off	Ponderosa pine, White fir, and Douglas fir
	m	Tank	Stock tanks
	t	Treatment/Thinning	
	y	Younger reproduction	Ponderosa pine saplings and poles predominate
SHMD		Shrub cover	
	0	0	No shrubs
	1	1- 10	Scattered shrubs
	2	10-25	Sparse shrubland
	3	25-60	Shrubland
	4	> 60	Dense shrubland
GEOMD		Surface geology	
	A	Andesite volcanics	TK (Keres Group) TP, Tpha, Tpoa
	B	Middle Member Bandelier Tuff	Qbt
	L	Lava	Tsfb
	P	Pumice	Qvec
	Q	Terrace/alluvium deposits	Qt, Qaf, Qoal, Qaf
	R	Rhyolite/dacite volcanics	Tpd, Tphd, Tte, Ttcg, Ttsd, Qrm
	S	Sandstone	Tgs, Tsfu, Tsf
	T	Upper Member Bandelier Tuff	Qbt
	U	Undetermined	

age objects (polygons). In heterogeneous data, the resulting objects for a given scale parameter are smaller than in more homogeneous data. By modifying the value in the "scale parameter" control, you can vary the size of the polygons. The smaller the scale parameter, the more detail is represented and the more the image is segmented into polygon objects, with a scale factor of "1" theoretically representing individual pixels

of the original photography base. In this project, the scale parameter varied from 75 to 125 from region to region of analysis. The scale parameter is also dependent on the weighting of the shape and color factors. As the natural-color air photos provided very good spatial detail but very little spectral content, the color factor was given the most weight, at 0.9, as compared to the shape factor of 0.1. The shape subfactors of smoothness and compactness were weighted equally (0.5).

Raw polygons (image primitives) were classified into vegetation map units (map classes) using all the previously described image layers in a procedure similar to supervised pixel-based classification methods. A set of sample polygons for each map unit was extracted, based on classified field data points and image interpretation. Polygons were also selected to represent the range of variation of a particular map unit in terms of image characteristics. Once all of the sample polygons have been assigned to their respective map units, feature statistics are gathered on each map unit. In eCognition, with three aerial photo layers, six topographic layers, and 20 PCA image layers, several hundred possible feature statistics could be used to discriminate among units (map classes). The feature types are from three major categories – individual layer values, polygon shape, and layer value texture; these in turn can be further subdivided by mean, standard deviation, relationship to neighboring polygons, etc. Given this model complexity and the potential complexity of a vegetation pattern, eCognition provides the Feature Space Optimization (FSO) tool to help in the decision-making process. The FSO tool uses a multivariate methodology similar to step-wise regression or canonical discriminate analysis. Using all features (variables), the feature that provides the most discrimination among map units is extracted first, along with a measure of the amount of class separability it provides. The next most discriminating features are added feature by feature with the amount of class separability listed for each new combination. Under most situations, a point is reached where additional features do not add to the class separation and, in fact, can cause over-specification of the model leading to idiosyncratic, often confusing, results, which can detract from the class separability. Therefore, by evaluating the FSO response curve, the most effective features can be chosen from the hundreds of possible choices and then used in the follow-on classification.

Once the optimal feature set has been chosen, a nearest-neighbor classification routine is run to generate an initial classified vegetation map. This is evaluated for overall coherency, and if needed, additional sample polygons are added to improve the classification (the statistics from the polygons are collected and then re-run again). This iterative process continues until the classification of polygons more or less stabilizes. The software also allows for hierarchical classification in which the user can classify the area according to a basic set of classes, then further divide those classes into more detail and continue until all land-cover types are covered. The advantage is that classes that may have very similar responses at a detailed level would have been already separated at a higher level and thereby cut down the chance of miss-classification. For example, initially Burned and Non-Burned classes were separated. The Burned area was set aside and not classified again but the Non-Burned area was further divided into Forested and Non-Forested areas that were further analyzed separately, and so on. There are separate layers at each division, which are then integrated at the end and exported as a shapefile for further heads-up editing in ArcGis 9.2.

3.2.4 Final map classification and ancillary layers

The image object maps were imported as a feature dataset polygon layer in ESRI ArcGIS (v. 9.2) and a topology built. Using auxiliary layers, such as the Relative Topographic Moisture Index (TRMI), solar indices, and the field-data points, the poly-

gons were individually checked and annotated, and boundaries modified as necessary. Polygons less than 2,500 sq mi were eliminated by merging them with contiguous polygons sharing the longest border (except thin linear features such as riparian zones and cliffs -- these were maintained for individual manual evaluation). Through this process, map units were evaluated for coherence and the legend modified accordingly.

3.3 Mapping results

3.3.1 Vegetation map and map legend

The vegetation map for Bandelier National Monument is presented in Figure 27, along with an abbreviated legend in Table 9. In Figure 27, we present only Level 1 map units at a reduced scale of about 1:15,000 for ease of interpretation in the report. We also produced a 1:24:000-scale map representing all of the Level 2 units (fig. 28), which is available as both a PDF and shape file for GIS use at http://biology.usgs.gov/npsveg/products/parkname.html. Twenty-five Level 1 units correspond to the Group level of the NVCS, plus four land-cover units that reflect sparse vegetation, urban and built-up land, water, and recently burned or otherwise disturbed areas. At Level 2, there are 58 vegetation units and 13 land-cover units. The Level 2 units are further defined by one or more plant associations per the Bandelier Vegetation Classification in Table 5 and each is identified as either a primary or secondary component, or a related or contrasting inclusion.

Each map unit is defined in terms of component plant associations—primary components, secondary components, related inclusions and contrasting inclusions (see section 3.2.2 above). The Level 2 map units are further cross-referenced by a map symbol in the vegetation classification table (table 8). While some units are more heterogeneous than others, the attempt was made to keep the map units as monophyletic as possible, that is, to minimize the overlap of associations from one unit to the next. The map-unit name reflects the primary component associations of the unit. A complete annotated legend with summary descriptions of the units, distribution maps, aerial photo examples of map unit polygons, and representative photos is provided in Appendix G.

3.4 Mapping discussion

The land-use history, as well as fire and disease, have shaped much of the vegetation pattern of BAND and posed a specific set of challenges in map unit design and the mapping itself. For example, portions of the high-elevation forests (Level 1 units 1-6) of the park had been selectively logged prior to the creation of the park, resulting in a patchwork of stand structures and species mixes. In these sites, aspens are often abundant, but seldom dominant. In addition, fires may have played a role in creating heterogeneous stands. Hence, mapping either pure conifer or pure aspen stands above the minimum map unit size of 0.5 has become problematic. Our approach was to map a mixed-confer-aspen unit (4) where either conifers or aspens ranged between 25% and 75% *relative* cover. This restricts units 3 and 5 to either 75% or more aspen or conifers, respectively. The choice of these ranges was driven primarily by the capacity to differentiate larger, more homogenous patches from one another (aspen vs. conifers). Whether these are the good ecological ranges remains to be tested (e.g., what are the ecological implications of differing canopy-cover thresholds?).

The bark beetle outbreak of 2002-03 posed special problems with respect to both classification and mapping. Initially, the near total die-off of pinyon limited the use of available aerial photography at the beginning of the project in 2002. We postponed the actual mapping until 2004 imagery was flown for the park. Then the challenge became how to identify the now dead pinyon-dominated woodland zone and separate it from the true juniper zone where pinyon was never dominant. The.

2 m resolution 2004 orthorectified imagery proved too coarse to detect the die-off either visually or analytically. We resorted to direct stereo air photo interpretation of skeletons and needle fall and annotated each polygon individually.

Then there was the issue of what to name the dead pinyon zone. Since a requirement of an NPS mapping project is to map actual vegetation, how should this zone be represented on the map? Upon consultation with park personnel, it became clear that knowing explicitly where this zone occurred was important for management and research (pers. com. Dr. Craig Allen). In addition, the die-off was not total; pinyons that were less than 5 cm usually survived the infestation. Hence, most stands have a cohort of young and healthy replacement trees. Accordingly, our solution was to create a suite of Level 2 (Pinyon)-Juniper units explicitly as members of Level 1 Southern Rocky Mountain Pinyon-Oneseed Juniper Woodland and Madrean Pinyon-Juniper Woodland Groups, with the parenthetical reference implying the presence of young pinyons, but not their dominance (we estimated that relative pinyon cover was probably at least 25% in these stands before the die-off and that many of the pinyons were open grown, that is, not growing in among individual junipers). Similarly, with respect to ponderosa pine die-off, we also maintained the ponderosa pine units (7 and 8), but annotated individual polygons where we detected die-off. This resulted in an analytically simpler map, rather than one with separate layers for disease, die-off, and other impacts.

As with the conifer die-off, addressing the multiple landscape-scale fires over the past several decades was not simple. Classifying and mapping vegetation after recent fires are necessarily generalized because vegetation is rapidly changing and often weedy, even within the scope of a single mapping project. Accordingly, for the most recent fires (Cerro Grande and Dome), we created broad post-fire map units reflecting the major forest vegetation zones (see fig. 24). For the earlier La Mesa fire, which occurred mostly in the ponderosa pine belt, vegetation patterns had stabilized somewhat and we identified several explicit grassland and shrubland associations that occur in post-fire areas. Yet, the compositions were variable as a result of artificial grass seeding after the fire, which we identified with either “seeded grasses” added to the association name, or as a phase. With respect to the map units, we do not specifically refer to the La Mesa fire in, name but imply it through the plant-association names and in the map-unit descriptions.

In addition to the basic map-unit structure, there were modifiers for tree and shrub canopy cover, condition (die-off, logging, treatments, etc.), and geological substrate, which were applied to individual polygons. These modifiers were estimated through aerial photo interpretation and have not been explicitly ground-truthed. Their purpose was to help guide the mapping of vegetation pattern, not to replace detailed maps of these attributes. Hence, they must be at best considered provisional and their use corroborated with additional data. For example, while the assignment of geological substrate was aided by recently completed geological and soils maps, the assignment for any given polygon was based on the judgment of the vegetation mapper as it related to vegetation pattern in the current imagery. Our purpose was to better inform our models of vegetation distribution, not to replace the current soils or geological maps.

Overall, the combination of the annotated legend (Appendix G) and the detailed floristic and site descriptions of individual plant associations (Appendix F) provide for a vegetation map that is rich in ecological information and one that can serve multiple purposes in the management of the park and the broader network of parks.

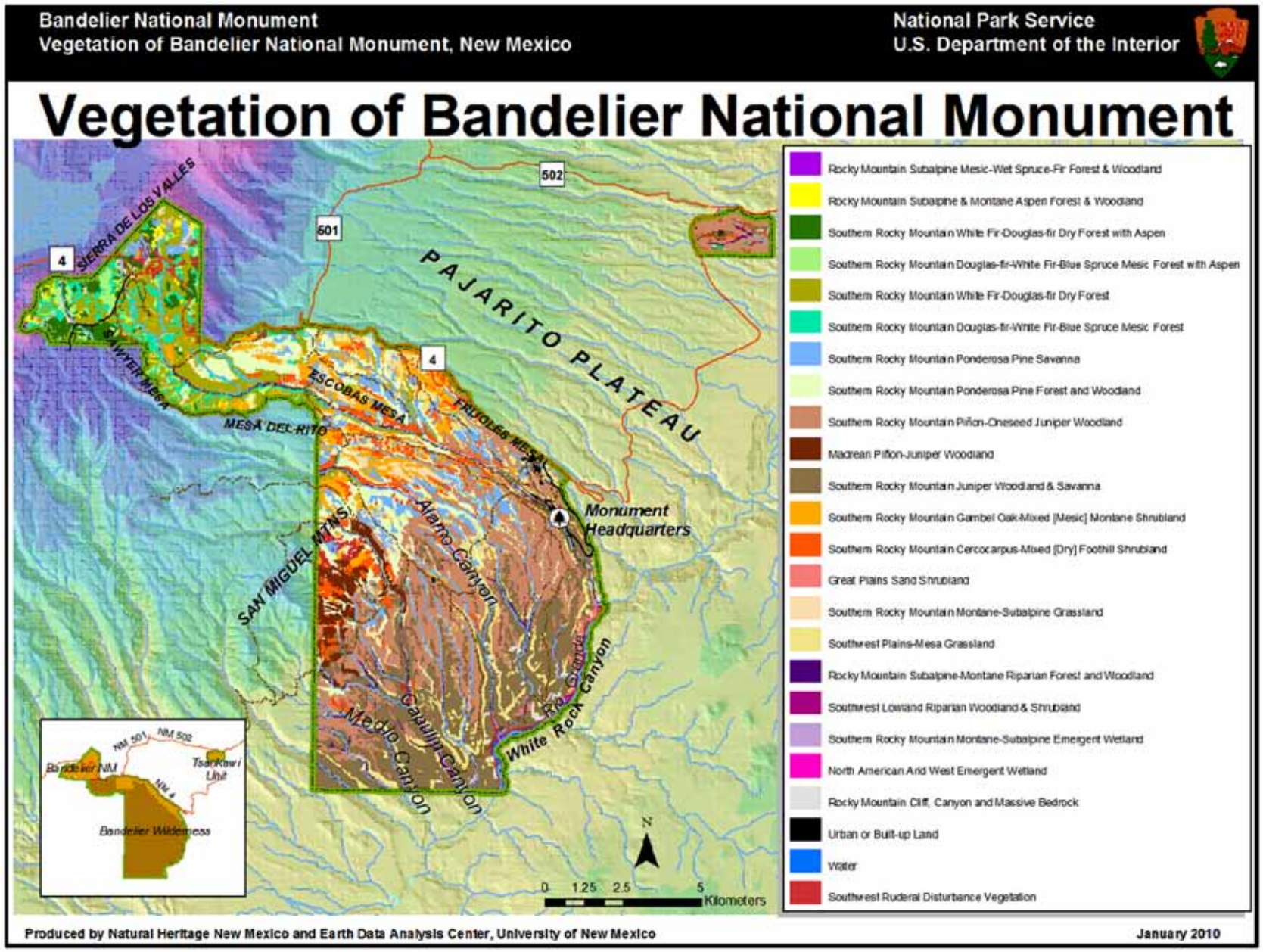


Figure 27. A vegetation map of Bandelier National Monument based on 2004, 1:12,000 color aerial photography. This map portrays Level 1 units at a scale reduced from 1:24,000 to approximately 1:150,000. See Table 9 and Appendix G for legend details. For the full scale 1:24,000 map see: http://biology.usgs.gov/npsveg/products/parkname.html.

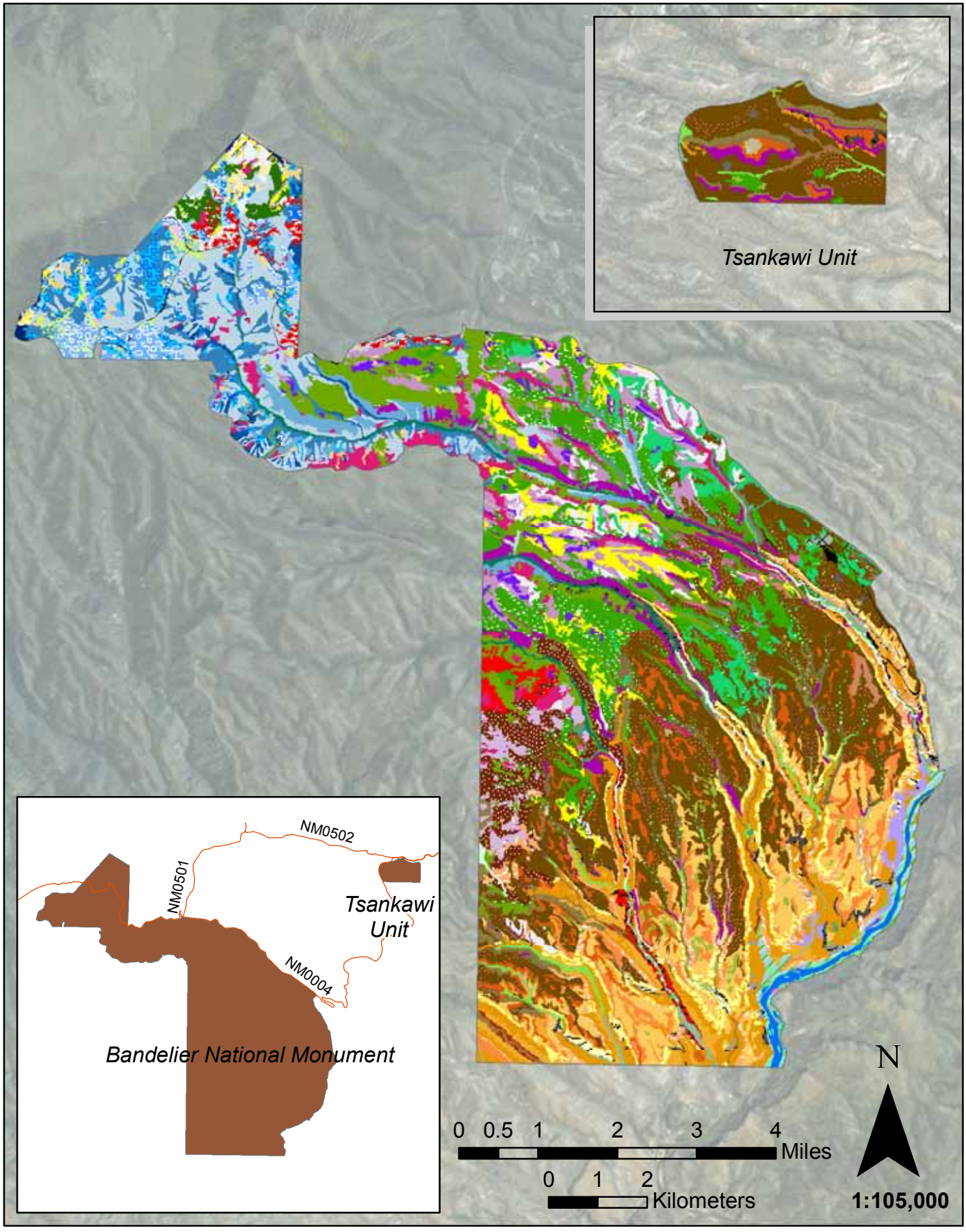

Tsankawi Unit
NM0502
NM0501
Tsankawi Unit
NM0004
Bandelier National Monument
N
0 0.5 1 2 3 4
Miles
0 1 2
Kilometers
1:105,000



Figure 28. A vegetation map of Bandelier National Monument based on 2004, 1:12,000 color aerial photography. This map portrays Level 2 units at a scale reduced from 1:24,000 to approximately 1:105,000. See Table 9 and Appendix G for legend details. For the full scale 1:24,000 map see: http://biology.usgs.gov/npsveg/products/parkname.html.

Table 9. A hierarchical legend for the Bandelier National Monument Vegetation Map composed of two nested levels, L1 and L2, along with the component associations that make up each unit. Under "Type" each association is designated either as a primary (1) or secondary (2) component, related inclusion (Ri), or contrasting inclusion (Ci). The number of polygons representing the level 2 map unit on the map is indicated, along with the total area in hectares and acres.

Map unit					# of	Area	
L1	L2	Map unit name	Association	Type	polygons	(ha)	(ac)
1		Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest & Woodland					
	A	Engelmann Spruce/Sprucefir Fleabane Mesic-Wet Forest			7	12	30
			Picea engelmannii / Erigeron eximius Forest	1			
			Abies concolor - Pseudotsuga menziesii / Thalictrum fendleri Forest	Ci			
			Abies concolor - Pseudotsuga menziesii / Acer glabrum Forest	Ci			
2		Rocky Mountain Subalpine & Montane Aspen Forest & Woodland					
	A	Quaking Aspen/Thurber's Fescue Upper Montane Woodland			20	35	87
			Populus tremuloides / Festuca thurberi Forest	1			
			Populus tremuloides / Invasive Perennial Grasses Forest	2			
			Abies concolor - Pseudotsuga menziesii / Festuca thurberi - Danthonia parryi Woodland, *Populus tremuloides* Phase	Ci			
	B	Quaking Aspen/Fendler's Meadowrue Mesic-Wet Forest			29	42	103
			Populus tremuloides / Thalictrum fendleri Forest	1			
			Populus tremuloides / Acer glabrum Forest	2			
			Populus tremuloides / Invasive Perennial Grasses Forest	Ri			
3		Southern Rocky Mountain White Fir-Douglas-fir Dry Forest with Aspen					
	A	White Fir-Douglas-fir-Aspen/Thurber's Fescue Forest Upper Montane Woodland			21	67	166
			Abies concolor - Pseudotsuga menziesii / Festuca thurberi - Danthonia parryi Woodland, *Populus tremuloides* Phase	1			
			Populus tremuloides / Festuca thurberi Forest	Ci			
	B	White Fir-Douglas-fir-Aspen/Common Juniper/Deer Sedge Dry-Mesic Forest			63	235	580
			Abies concolor / Juniperus communis Forest, *Populus tremuloides* Phase	1			
			Abies concolor - Pseudotsuga menziesii / Carex rossii Forest, *Populus tremuloides* Phase	1			

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Pseudotsuga menziesii / Mahonia repens Forest, *Populus tremuloides* Phase	Ri			
			Abies concolor - Pseudotsuga menziesii/ Festuca thurberi - Danthonia parryi Woodland, *Populus tremuloides* Phase	Ci			
4		Southern Rocky Mountain Douglas-fir-White Fir-Blue Spruce Mesic Forest with Aspen					
	A	White Fir-Douglas-fir-Aspen/Fendler's Meadowrue Mesic-Wet Forest			75	192	475
			Abies concolor - (*Pseudotsuga menziesii*) / *Thalictrum fendleri* Forest, *Populus tremuloides* Phase	1			
			Abies concolor - Pseudotsuga menziesii / Acer glabrum Forest, *Populus tremuloides* Phase	Ci			
	B	White Fir-Douglas-fir-Aspen/Rocky Mountain Maple Canyon Forest			13	24	58
			Abies concolor - Pseudotsuga menziesii / Acer glabrum Forest, *Populus tremuloides* Phase	1			
			Abies concolor - Pseudotsuga menziesii / Jamesia americana - Holodiscus dumosus Scree Woodland, *Populus tremuloides* Phase	2			
			Abies concolor - (*Pseudotsuga menziesii*) / *Thalictrum fendleri* Forest, *Populus tremuloides* Phase	Ci			
5		Southern Rocky Mountain White Fir-Douglas-fir Dry Forest					
	A	White Fir-Douglas-fir/Thurber's Fescue Upper Montane Woodland Savanna			27	58	144
			Abies concolor - Pseudotsuga menziesii/ Festuca thurberi - Danthonia parryi Woodland	1			
			Pinus ponderosa / Festuca thurberi Woodland	Ci			
	B	White Fir-Douglas-fir/Common Juniper-Gambel Oak/Deer Sedge Dry-Mesic Forest			205	735	1,817
			Abies concolor / Juniperus communis Forest	1			
			Abies concolor - (*Pseudotsuga menziesii*) / *Quercus gambelii / Carex rossii* Forest	1			
			Abies concolor - Pseudotsuga menziesii / Carex rossii Forest	1			
			Abies concolor / Mahonia repens Forest	2			

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Pseudotsuga menziesii / Mahonia repens Forest	2			
			Pseudotsuga menziesii - Quercus gambelii Forest	2			
			Abies concolor - Pseudotsuga menziesii / Jamesia americana - Holodiscus dumosus Scree Woodland	Ci			
			Abies concolor - (*Pseudotsuga menziesii*) / *Thalictrum fendleri* Forest	Ci			
	C	White Fir-Douglas-fir-Gambel Oak Canyon Forest			72	212	523
			Pseudotsuga menziesii - Quercus gambelii Forest	1			
			Sparse Vegetation / Boulder Rockland	2			
			Abies concolor - Pseudotsuga menziesii / Jamesia americana - Holodiscus dumosus Scree Woodland	2			
			Sparse Vegetation / Scree	Ri			
			Abies concolor - (*Pseudotsuga menziesii*) / *Quercus gambelii / Carex rossii* Forest	Ri			
			Pinus ponderosa - Quercus gambelii / Carex inops ssp. *heliophila* Woodland	Ci			
			Quercus gambelii / Robinia neomexicana / Carex inops ssp. *heliophila* Shrubland	Ci			
6		Southern Rocky Mountain Douglas-fir-White Fir-Blue Spruce Mesic Forest					
	A	White Fir-Douglas-fir/Fendler's Meadowrue Mesic-Wet Forest			131	370	915
			Abies concolor - (*Pseudotsuga menziesii*) / *Thalictrum fendleri* Forest	1			
			Abies concolor - (*Pseudotsuga menziesii*) / *Quercus gambelii / Thalictrum fendleri* Forest	2			
			Picea pungens / Fragaria virginiana Forest	2			
			Abies concolor - Pseudotsuga menziesii / Acer glabrum Forest	Ci			
			Abies concolor / Juniperus communis Forest	Ci			
			Abies concolor - (*Pseudotsuga menziesii*) / *Quercus gambelii / Carex rossii* Forest	Ci			
	B	White Fir-Douglas-fir/Rocky Mountain Maple Canyon Forest			29	69	171
			Abies concolor - Pseudotsuga menziesii / Acer glabrum Forest	1			
			Abies concolor - (*Pseudotsuga menziesii*) / *Jamesia americana - Holodiscus dumosus* Scree Woodland	2			

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Abies concolor - (*Pseudotsuga menziesii)* / *Thalictrum fendleri* Forest	Ci			
			Abies concolor - (*Pseudotsuga menziesii)* / *Quercus gambelii* / *Thalictrum fendleri* Forest	Ci			
7		Southern Rocky Mountain Ponderosa Pine Savanna					
	A	Ponderosa Pine/Thurber's Fescue Upper Montane Woodland			22	74	184
			Pinus ponderosa / *Festuca thurberi* Woodland	1			
			Pinus ponderosa / *Poa pratensis* Woodland	Ri			
			Abies concolor - *Pseudotsuga menziesii* / *Festuca thurberi* - *Danthonia parryi* Woodland	Ci			
			Pinus ponderosa / *Carex inops* ssp. *heliophila* Woodland	Ci			
	B	Ponderosa Pine/Mountain Muhly-Blue Grama Mesa Woodland			197	689	1,704
			Pinus ponderosa / *Muhlenbergia montana* Woodland	1			
			Pinus ponderosa / *Bouteloua gracilis* Woodland	1			
			Pinus ponderosa / *Schizachyrium scoparium* Woodland	2			
			Pinus ponderosa / *Robinia neomexicana* Woodland, Seeded Grasses Phase	2			
			Pinus ponderosa / *Carex inops* ssp. *heliophila* Woodland	Ci			
			Pinus ponderosa / *Quercus* x *pauciloba* Woodland	Ci			
			Pinus ponderosa - *Quercus gambelii* / *Carex inops* ssp. *heliophila* Woodland	Ci			
8		Southern Rocky Mountain Ponderosa Pine Forest and Woodland					
	A	Ponderosa Pine/Wavyleaf Oak Mesa Woodland			87	345	852
			Pinus ponderosa / *Quercus* x *pauciloba* Woodland	1			
			Pinus ponderosa - *Quercus gambelii* / *Carex inops* ssp. *heliophila* Woodland, Rockland Phase	Ci			
			Pinus ponderosa / *Bouteloua gracilis* Woodland	Ci			
	B	Ponderosa Pine-Gambel Oak/Deer Sedge Woodland			220	680	1,681
			Pinus ponderosa - *Quercus gambelii* / *Carex inops* ssp. *heliophila* Woodland	1			
			Pinus ponderosa / *Carex inops* ssp. *heliophila* Woodland	1			

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Pinus ponderosa / *Muhlenbergia montana* Woodland, Poa fendleriana Phase	2			
			Pinus ponderosa / *Robinia neomexicana* Woodland	Ri			
			Sparse Vegetation / Boulder Rockland	Ci			
	C	Ponderosa Pine Ravine Woodland			57	223	551
			Pinus ponderosa / *Quercus* x *pauciloba* Woodland	1			
			Pinus ponderosa / *Forestiera pubescens* Forest, Typic Phase	1			
			Pinus ponderosa / *Bouteloua gracilis* Woodland	2			
			Pinus ponderosa / *Muhlenbergia montana* Woodland, Poa fendleriana Phase	2			
			Pinus ponderosa - *Quercus gambelii* / *Carex inops* ssp. *heliophila* Woodland	2			
			Sparse Vegetation / Boulder Rockland	Ri			
	D	Ponderosa Pine Canyon Woodland			52	131	323
			Pinus ponderosa / *Quercus* x *pauciloba* Woodland	1			
			Pinus ponderosa / *Carex inops* ssp. *heliophila* Woodland, Rockland Phase	2			
			Sparse Vegetation / Boulder Rockland	2			
			Pinus ponderosa / *Schizachyrium scoparium* Woodland	Ri			
			Pinus ponderosa / *Muhlenbergia montana* Woodland, Poa fendleriana Phase	Ci			
9		Southern Rocky Mountain Pinyon-Oneseed Juniper Woodland					
	A	(Pinyon) Oneseed Juniper/Grama Grass Mesa Woodland			344	1,491	3,685
			Juniperus monosperma / *Bouteloua gracilis* Woodland, Dead *Pinus edulis* Phase	1			
			Juniperus monosperma / Sparse Woodland, Dead *Pinus edulis* Loamy Phase	2			
			Pinus edulis - (*Juniperus monosperma*) / *Bouteloua gracilis* Woodland	2			
			Juniperus monosperma / *Rhus trilobata* Woodland	Ci			
			Juniperus monosperma / *Quercus* x *pauciloba* Woodland, Dead *Pinus edulis* Phase	Ci			

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
	B	(Pinyon) Oneseed Juniper/Wavyleaf Oak Mesa Woodland			231	821	2,028
			Juniperus monosperma / *Quercus* x *pauciloba* Woodland, Dead *Pinus edulis* Phase	1			
			Juniperus monosperma / Sparse Woodland, Dead *Pinus edulis* Stony Phase	2			
			Juniperus monosperma / *Bouteloua gracilis* Woodland, Dead *Pinus edulis* Phase	Ci			
	C	(Pinyon) Oneseed Juniper/Wavyleaf Oak-Grama Grass Canyon Woodland			65	184	456
			Juniperus monosperma / *Quercus* x *pauciloba* Woodland, Dead *Pinus edulis* Phase	1			
			Juniperus monosperma / *Bouteloua gracilis* Woodland, Dead *Pinus edulis* Phase	2			
			Juniperus monosperma / *Bouteloua curtipendula* Woodland	Ci			
			Juniperus monosperma / Rockland Woodland, Dead *Pinus edulis* Phase	Ci			
			Sparse Vegetation / Boulder Rockland	Ci			
	D	(Pinyon) Oneseed Juniper/Rockland Canyon Woodland			69	190	469
			Juniperus monosperma / Rockland Woodland, Dead *Pinus edulis* Phase	1			
			Juniperus monosperma / *Quercus* x *pauciloba* Woodland, Dead *Pinus edulis* Phase	2			
			Sparse Vegetation / Boulder Rockland	2			
			Juniperus monosperma / *Bouteloua curtipendula* Woodland	Ci			
	E	(Pinyon) Oneseed Juniper Ravine Woodland			26	41	101
			Juniperus monosperma / *Quercus* x *pauciloba* Woodland, Dead *Pinus edulis* Phase	1			
			Juniperus monosperma / *Bouteloua curtipendula* Woodland, Dead *Pinus edulis* Phase	1			
			Juniperus monosperma / Rockland Woodland, Dead *Pinus edulis* Phase	1			
			Juniperus monosperma / *Forestiera pubescens* Woodland, Dead *Pinus edulis* Phase	2			

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Sparse Vegetation / Boulder Rockland	2			
			Juniperus monosperma / *Bouteloua gracilis* Woodland, Dead *Pinus edulis* Phase	Ci			
	F	(Pinyon) Oneseed Juniper/Treatment Woodland			3	29	72
			Juniperus monosperma / *Bouteloua gracilis* Woodland, Treatment Phase	1			
			Juniperus monosperma / Sparse Woodland, Treatment Phase	2			
10		Madrean Pinyon-Juniper Woodland					
	A	(Pinyon) Alligator Juniper/Wavyleaf Oak Woodland			64	301	744
			Juniperus deppeana / *Quercus* x *pauciloba* Woodland, Dead *Pinus edulis* Phase	1			
			Juniperus deppeana / Sparse Woodland, Dead *Pinus edulis* Phase	2			
			Juniperus deppeana / *Bouteloua gracilis* Woodland, Dead *Pinus edulis* Phase	Ri			
			Juniperus deppeana / Ruderal Herbs Vegetation Woodland, Dead *Pinus edulis* Phase	Ri			
			Juniperus monosperma / Rockland Woodland, Dead *Pinus edulis* Phase	Ci			
11		Southern Rocky Mountain Juniper Woodland & Savanna					
	A	Oneseed Juniper/Blue Grama Mesa Woodland			121	606	1,498
			Juniperus monosperma / *Bouteloua gracilis* Woodland	1			
			Juniperus monosperma / Sparse Woodland, Loamy Phase	2			
			Juniperus monosperma / *Hesperostipa neomexicana* Woodland	Ci			
			Juniperus monosperma / *Bouteloua curtipendula* Woodland	Ci			
			Juniperus monosperma / *Quercus* x *pauciloba* Woodland	Ci			
	B	Oneseed Juniper/Black Grama–Blue Grama Mesa Woodland			68	278	688
			Juniperus monosperma / *Bouteloua eriopoda* Woodland	1			
			Juniperus monosperma / *Bouteloua gracilis* Woodland	1			
			Juniperus monosperma / *Quercus* x *pauciloba* Woodland	Ri			

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Juniperus monosperma / Sparse Woodland, Stony Phase	Ri			
	C	Oneseed Juniper/Black Grama Canyon Woodland			120	634	1,567
			Juniperus monosperma / *Bouteloua eriopoda* Woodland	1			
			Juniperus monosperma / *Bouteloua curtipendula* Woodland	2			
			Juniperus monosperma / Sparse Woodland, Stony Phase	2			
			Juniperus monosperma / Rockland Woodland	Ri			
			Juniperus monosperma / *Artemisia tridentata* Woodland	Ri			
			Juniperus monosperma / *Quercus* x *pauciloba* Woodland	Ci			
			Sparse Vegetation / Rockland	Ci			
	D	Oneseed Juniper/Wavyleaf Oak-Grama Grass Canyon Woodland			13	54	134
			Juniperus monosperma / *Quercus* x *pauciloba* Woodland	1			
			Juniperus monosperma / *Bouteloua gracilis* Woodland	1			
			Juniperus monosperma / *Bouteloua curtipendula* Woodland	2			
			Juniperus monosperma / *Rhus trilobata* Woodland	2			
			Juniperus monosperma / Rockland Woodland	Ci			
			Sparse Vegetation / Rockland	Ci			
	E	Oneseed Juniper/Rockland Canyon Woodland			109	366	905
			Juniperus monosperma / Rockland Woodland	1			
			Juniperus monosperma / *Quercus* x *pauciloba* Woodland	2			
			Sparse Vegetation / Rockland	2			
			Juniperus monosperma / *Bouteloua curtipendula* Woodland	Ci			
	F	Oneseed Juniper/Wavyleaf Oak/Sparse Rockland Mesa Woodland			143	373	921
			Juniperus monosperma / *Quercus* x *pauciloba* Woodland	1			
			Juniperus monosperma / Sparse Woodland, Stony Phase	2			
			Juniperus monosperma / *Bouteloua gracilis* Woodland	Ci			
	G	Oneseed Juniper/Sparse Canyon Woodland			55	199	491
			Juniperus monosperma / Sparse Woodland, Pumice Phase	1			
			Juniperus monosperma / *Bouteloua eripopoda* Woodland	Ci			

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
	H	Oneseed Juniper/Grama Grass Valley Bottom Woodland			13	33	82
			Juniperus monosperma / *Bouteloua curtipendula* Woodland	1			
			Juniperus monosperma / *Bouteloua gracilis* Woodland	2			
			Juniperus monosperma / *Forestiera pubescens* Woodland	Ci			
12		Southern Rocky Mountain Gambel Oak-Mixed [Mesic] Montane Shrubland					
	A	*Fendler Ceanothus*-New Mexico Locust Montane Mesa Shrubland			111	367	906
			Ceanothus fendleri / *Muhlenbergia montana* Shrubland	1			
			Robinia neomexicana / *Carex inops* ssp. *heliophila* Shrubland	1			
			Fallugia paradoxa / Ruderal Herbs Shrubland	Ci			
			Quercus gambelii / *Robinia neomexicana* / *Muhlenbergia montana* Shrubland	Ci			
			Quercus gambelii / *Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland, Seeded Grasses Phase	Ci			
	B	Apache Plume-New Mexico Locust Mesa Shrubland			22	42	104
			Fallugia paradoxa / Ruderal Herbs Shrubland	1			
			Robinia neomexicana / *Carex inops* ssp. *heliophila* Shrubland, Ruderal Herbs Phase	1			
			Ruderal Post-fire Herbaceous Vegetation	2			
	C	Gambel Oak/New Mexico Locust Canyon Shrubland			174	352	870
			Quercus gambelii / *Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland	1			
			Jamesia americana (*Physocarpus monogynus*, *Holodiscus dumosa*) Rock Outcrop Shrubland	2			
			Sparse Vegetation / Boulder Rockland	2			
			Robinia neomexicana / *Carex inops* ssp. *heliophila* Shrubland	Ci			
			Ceanothus fendleri / *Muhlenbergia montana* Shrubland	Ci			
	D	Gambel Oak/New Mexico Locust-Mountain Muhly Mesa Shrubland			49	102	253
			Quercus gambelii - Robinia neomexicana / *Muhlenbergia montana* Shrubland	1			

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Quercus gambelii / *Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland, Seeded Grasses Phase	2			
			Ceanothus fendleri / *Muhlenbergia montana* Shrubland	Ci			
			Robinia neomexicana / *Carex inops* ssp. *heliophila* Shrubland	Ci			
13		Southern Rocky Mountain Cercocarpus-Mixed [Dry] Foothill Shrubland					
	A	Wavyleaf Oak/Sideoats Grama Mesa Shrubland			101	254	629
			Quercus x *pauciloba* / *Bouteloua curtipendula* Shrubland	1			
			Cercocarpus montanus / *Bouteloua curtipendula* Shrubland	Ri			
			Quercus x *pauciloba* / Cercocarpus montanus Shrubland	Ci			
			Quercus gambelii / *Robinia neomexicana* / *Muhlenbergia montana* Shrubland	Ci			
			Fallugia paradoxa / Ruderal Herbs Shrubland	Ci			
			Gutierrezia sarothrae / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation	Ci			
	B	Wavyleaf Oak/Ruderal Foothill Shrubland			36	117	289
			Quercus x *pauciloba* / *Bouteloua curtipendula* Shrubland	1			
			Ruderal Post-fire Herbaceous Vegetation	2			
	C	Wavyleaf Oak-Mountain Mahogany/Rockland Canyon Shrubland			115	341	843
			Quercus x *pauciloba* - Cercocarpus montanus Shrubland	1			
			Rhus trilobata / *Bouteloua curtipendula* Shrubland	2			
			Sparse Vegetation / Boulder Rockland	2			
			Quercus gambelii / *Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland	Ci			
			Gutierrezia sarothrae / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation	Ci			
			Fallugia paradoxa - *Brickellia* spp. - (*Holodiscus dumosus*) Scree Shrubland	Ci			
14		Great Plains Sand Shrubland					
	A	Sand Sagebrush/Talus Canyon Shrubland			11	66	163
			Artemisia filifolia / *Bouteloua eriopoda* Shrubland	1			

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Sparse Vegetation / Scree	1			
			Fallugia paradoxa - *Brickellia* spp. - (*Holodiscus dumosus*) Scree Shrubland	2			
			Juniperus monosperma / *Artemisia tridentata* Woodland	Ri			
			Bouteloua eriopoda - *Bouteloua curtipendula* Herbaceous Vegetation	Ci			
15		Southern Rocky Mountain Montane-Subalpine Grassland					
	A	Thurber's Fescue-Parry's Danthonia Upper Montane Grassland			40	61	150
			Festuca thurberi - *Danthonia parryi* / *Potentilla hippiana* Herbaceous Vegetation	1			
			Festuca thurberi / *Potentilla hippiana* Herbaceous Vegetation	1			
			Poa pratensis / *Taraxacum officinale* Semi-natural Herbaceous Vegetation	Ci			
	B	Mountain Muhly-Little Bluestem Lower Montane Grassland			81	290	716
			Muhlenbergia montana - *Schizachyrium scoparium* Herbaceous Vegetation	1			
			Muhlenbergia montana - Seeded Grasses Herbaceous Vegetation	1			
			Schizachyrium scoparium - *Koeleria macrantha* Herbaceous Vegetation	2			
			Elymus x *pseudorepens* - *Bromus carinatus* Semi-natural Herbaceous Vegetation	2			
			Muhlenbergia montana / Rosa woodsii Herbaceous Vegetation	2			
			Fallugia paradoxa / Ruderal Herbs Shrubland	Ci			
			Pascopyrum smithii / Ruderal Herbaceous Vegetation	Ci			
			Gutierrezia sarothrae / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation	Ci			
	C	Lower Montane Valley Bottom Grassland			32	45	112
			Poa pratensis / *Taraxacum officinale* Semi-natural Herbaceous Vegetation	1			

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Poa pratensis - (*Pascopyrum smithii*) Semi-natural Herbaceous Vegetation	2			
			Muhlenbergia montana Herbaceous Vegetation	Ri			
16		Southwest Plains-Mesa Grassland					
	A	Western Wheatgrass-Ruderal Herbs Mesa Grassland			70	283	699
			Pascopyrum smithii / Ruderal Herbaceous Vegetation	1			
			Ruderal Post-fire Herbaceous Vegetation	1			
			Elymus x *pseudorepens* - *Bromus carinatus* Semi-natural Herbaceous Vegetation	Ri			
			Gutierrezia sarothrae / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation	Ci			
			Fallugia paradoxa / Ruderal Herbs Shrubland	Ci			
	B	Blue Grama-Black Grama Mesa Grassland			56	73	181
			Gutierrezia sarothrae / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation	1			
			Bouteloua eriopoda - *Bouteloua gracilis* Herbaceous Vegetation	2			
			Pascopyrum smithii / *Ruderal* Herbaceous Vegetation	Ci			
	C	Grama Grass/Talus Grassland			27	49	122
			Bouteloua eriopoda - *Bouteloua curtipendula* Herbaceous Vegetation	1			
			Sparse Vegetation / Scree	1			
			Bouteloua eriopoda - *Bouteloua gracilis* Herbaceous Vegetation	Ri			
			Gutierrezia sarothrae / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation	Ri			
	D	Grama Grass/Rockland Grassland			73	451	1,114
			Bouteloua eriopoda - *Bouteloua curtipendula* Herbaceous Vegetation	1			
			Sparse Vegetation / Boulder Rockland	2			

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Bouteloua eriopoda - *Bouteloua gracilis* Herbaceous Vegetation	Ri			
			Gutierrezia sarothrae / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation	Ri			
17		Rocky Mountain Subalpine-Montane Riparian Forest and Woodland					
	A	Box Elder-Alder-Narrowleaf Cottonwood Montane Riparian Forest			13	33	82
			Acer negundo - *Alnus oblongifolia* Forest	1			
			Acer negundo - *Alnus incana* ssp. *tenuifolia* Forest	1			
			Populus angustifolia - *Acer negundo* / *Forestiera pubescens* Forest	1			
			Populus angustifolia / *Fallugia paradoxa* Forest	2			
			Alnus incana ssp. *tenuifolia* / Mesic Graminoids Shrubland	2			
			Acer negundo / *Salix irrorata* Forest	Ri			
			Acer negundo / *Prunus virginiana* Forest	Ri			
			Acer negundo / *Eleocharis palustris* Forest	Ri			
			Abies concolor - *Acer negundo* / *Alnus incana* ssp. *tenuifolia* Forest	Ci			
	B	White Fir-Box Elder-Thinleaf Alder Mixed Montane Riparian Forest			9	112	276
			Abies concolor - *Acer negundo* / *Alnus incana* ssp. *tenuifolia* Forest	1			
			Acer negundo - *Alnus incana* ssp. *tenuifolia* Forest	Ri			
			Pinus ponderosa / *Forestiera pubescens* Forest, *Acer negundo* Phase	Ci			
			Pinus ponderosa / *Forestiera pubescens* Forest, *Populus angustifolia* Phase	Ci			
	C	Ponderosa Pine-Broadleaf Mixed Montane Riparian Forest			20	58	142
			Pinus ponderosa / *Forestiera pubescens* Forest, *Acer negundo* Phase	1			
			Pinus ponderosa / *Forestiera pubescens* Forest, *Populus angustifolia* Phase	1			
			Pinus ponderosa / *Forestiera pubescens* Forest, Typic Phase	2			

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Populus angustifolia - Acer negundo / Forestiera pubescens Forest	Ri			
			Acer negundo - Alnus incana ssp. *tenuifolia* Forest	Ri			
			Abies concolor - Acer negundo / Alnus incana ssp. *tenuifolia* Forest	Ci			
	D	Ponderosa Pine Dry Wash Woodland			23	94	232
			Pinus ponderosa / Forestiera pubescens Forest, Typic Phase	1			
			Pinus ponderosa / Bouteloua gracilis Woodland	1			
			Pinus ponderosa - Quercus grisea Woodland	Ri			
			Populus angustifolia / Fallugia paradoxa Forest	Ri			
			Juniperus monosperma / Forestiera pubescens Woodland	Ci			
			Fallugia paradoxa / Colorado Desert Wash Shrubland	Ci			
	E	Oneseed Juniper Dry Wash Woodland			27	93	230
			Juniperus monosperma / Forestiera pubescens Woodland	1			
			Populus angustifolia - Acer negundo / Forestiera pubescens Forest	Ri			
			Fallugia paradoxa Colorado Desert Wash Shrubland	Ci			
18		Southwest Lowland Riparian Woodland & Shrubland					
	A	Sandbar Willow Riparian Shrubland			26	35	86
			Salix exigua / Mesic Graminoids Shrubland	1			
			Salix amygdaloides - Salix exigua Woodland	2			
			Populus deltoides ssp. *wislizeni / Salix irrorata Forest*	Ri			
			Tamarix chinensis - Salix exigua Semi-natural Shrubland	Ci			
	B	Tamarisk-Sandbar Willow Riparian Shrubland			5	7	17
			Tamarix chinensis - Salix exigua Semi-natural Shrubland	1			
			Tamarix chinensis / Sparse Undergrowth Semi-natural Shrubland	1			
			Tamarix chinensis / Forestiera pubescens Semi-natural Shrubland	Ri			
			Elaeagnus angustifolia / Bromus tectorum Semi-natural Woodland	Ri			

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Salix exigua / Mesic Graminoids Shrubland	Ci			
	C	Apache Plume-New Mexico Privet Dry Wash Riparian Shrubland			29	48	118
			Fallugia paradoxa / Colorado Plateau Desert Wash Shrubland	1			
			Forestiera pubescens / Ruderal Herbs Vegetation Shrubland	1			
			Sparse Vegetation / Recent Alluvial Deposits	Ri			
19		Southern Rocky Mountain Montane-Subalpine Emergent Wetland					
	A	Arctic Rush-Kentucky Bluegrass Montane Wetland/Wet Meadow			8	9	22
			Juncus arcticus Herbaceous Vegetation	1			
			Calamagrostis canadensis Herbaceous Vegetation	2			
			Open Water (Stock Tank)	Ri			
			Poa pratensis / *Taraxacum officinale* Semi-natural Herbaceous Vegetation, *Carex praegracilis* Phase	Ci			
20		North American Arid West Emergent Wetland					
	A	Lowland Emergent Wetland			10	7	17
			Eleocharis palustris - *Carex praegracilis* - *Berula erecta* Herbaceous Vegetation	1			
			Ruderal Flood Zone Herbaceous Vegetation	2			
			Sparse Vegetation / Recent Alluvial Deposits	Ri			
21		Rocky Mountain Cliff, Canyon and Massive Bedrock					
	A	Rockland/Cliff			68	110	271
			Sparse Vegetation / Boulder Rockland	1			
	B	Talus-Rubble Land			26	38	94
			Sparse Vegetation / Scree	1			
22		Urban or Built-up Land					
	A	Public Building/Residential			5	9	21
	B	Other Built-up Land			5	4	10
	C	Archeological Site			6	16	40

Table 9, *continued*. A hierarchical legend for the Bandelier National Monument Vegetation Map .

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
	D	Road			8	24	59
	E	Recreation Site			4	11	26
23		Water					
	A	Open Water			9	84	207
			Water - River	1			
			Sparse Vegetation / Recent Alluvial Deposits	Ri			
24		Southwest Ruderal Disturbance Vegetation					
	A	Post-fire Valley Ruderal Herbaceous Vegetation			21	50	123
			Ruderal Post-fire Herbaceous Vegetation	1			
			Bouteloua eriopoda - *Bouteloua gracilis* Herbaceous Vegetation, Ruderal Forbs Phase	2			
	B	Post-fire Montane Ruderal Herbaceous Vegetation (Cerro Grande)			34	97	241
			Ruderal Post-fire Herbaceous Vegetation	1			
			Elymus x *pseudorepens* - *Bromus carinatus* Semi-natural Herbaceous Vegetation	2			
			Festuca thurberi - *Danthonia parryi* / *Potentilla hippiana* Herbaceous Vegetation	2			
	C	Post-fire Montane Ruderal Herbaceous Vegetation (Dome Fire)			7	71	176
			Ruderal Post-fire Herbaceous Vegetation	1			
			Quercus gambelii / *Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland	2			
	D	Reservoir Flood Zone Ruderal Herbaceous Vegetation			12	87	214
			Ruderal Flood Zone Herbaceous Vegetation	1			
			Bouteloua curtipendula - *Bothriochloa barbinodis* Herbaceous Vegetation	2			
	E	Ruderal Herbaceous Vegetation			3	3	6
			Ruderal Disturbance Vegetation	1			

4 Accuracy Assessment

The thematic accuracy of the BAND vegetation map was assessed following the USGS-NPS guidelines (ESRI et al. 1994; pers. com. Chris Lea 2009). Under these guidelines, the goal is to achieve overall and individual map unit accuracies greater than 80% from both producers' and users' perspectives. We tested both Level 1 (NVCS Group) and Level 2 of the legend hierarchy, and also scaled up to broad physiognomic classes of forest, woodland, shrubland, grassland, and riparian. We report the results of the accuracy assessment here and make recommendations on the use of the map in the context of users' and producers' errors detected among the map units at various levels of the hierarchy.

Positional accuracy is usually omitted from USGS-NPS National Vegetation Mapping Program products because vegetation seldom splits along discrete edges that can be positively located in the field. The subjectivity involved in this effort, plus the high resolution and accuracy of the orthophoto imagery usually permits the assumption that all products derived from them are well within National Map Accuracy Standards for 1:12,000-scale maps (±30 ft). Given that resources were limited, and following the recommendations of Cogon (2007), we did not assess the positional accuracy.

4.1 Accuracy assessment methods

The USGS-NPS accuracy assessment (AA) methodology follows a point-based, minimum-mapping-unit design versus a polygon-based design. That is, to test the map, a set of points is distributed in a random systematic design, such that each point represents a non-overlapping area of, in this case, 0.50 ha (the required minimum mapping unit polygon area for the project). Each point is attributed according to the map unit of the polygon that it falls within. The points are then randomly selected for field sampling, but stratified by map unit and constrained by logistical considerations (primarily access and safety). For statistical robustness, the guidelines suggest a minimum of 30 sample points per map unit should be used for evaluating the accuracy of the map from both a producer and user perspective. These points would be used to construct a set of contingency tables and compute a suite of error statistics. In this case, at Level 2 1,440 sample plots would be required, well beyond the resources available for the accuracy assessment portion of the project. Instead, we targeted the 24 map units (MU) at Level 1. Five of these were limited in areal extent and remote (MU 1, 14, 18, 19, and 20 in Table 9) and so were not sampled. Expending resources on them was seen as compromising the evaluation of the remaining units of interest. Similarly, we did not sample the miscellaneous land cover types that were conspicuous in the imagery, such as water, cliff, urban development. (MU 21, 22, and 23). Lastly, because phases of plant associations are not considered standard targets for mapping and accuracy assessment under NPS guidelines, we grouped the mixed conifer forests units with aspen phases, MU 3 and MU 4, with their corresponding non-aspen mixed-conifer units, MU 5 and MU 6, respectively. However, we do address the error rates between these units in the text.

4.1.1 Field data collection

Overall, 14 Level 1 units were available for sampling, representing a sampling goal of 510 plots. This still posed a challenge, given our resources and a park that is mostly designated wilderness with little in the way of road access. We created the sampling pool by dividing the park into a set of 0.5 ha grid cells with a central sampling point in each. Points were excluded that were beyond 1,000 m from a known trail or a road that had open access. We then designed sampling tracks that a field person could reasonably cover in a single ten-hour day (including vehicle travel). Knowing that we were unlikely to meet the 510-plot target, we focused on the most common units in terms of meeting the 30-plot target, and

stepped down from there.

The AA sampling was conducted during the summers of 2007 and 2008. To support field sampling, paper maps were created at 1:12,000 scale with target sample points and the underlying imagery and topography. These were used by the field crew as guidance in developing optimal sampling strategies with respect to map unit targets and logistics, and for reconnoitering in the field. In the field, crews would navigate to the point location and determine if the point was representative of the surrounding vegetation as a whole. If not, crews were allowed to move the point to a representative area and provide a justification for the move. The key was to avoid sampling small patches or fragments of plant associations not typical of the target stand.

At the sample location, a validation plot was taken that included cover of the dominant species in each strata (trees, shrubs, subshrubs, grasses, and forbs), aspect (azimuth), slope (%), a brief description of the polygon landscape and composition relative to the sampling point, the GPS location (+/- 10 m precision), and four representative digital photos. A total of 211 validation plots were collected by NHNM and park staff in this way (fig. 28).

The plot data was entered from the paper field sheets into the Natural Heritage New Mexico (NHNM) Plot Database (MS Access-based) and quality control was maintained with automated error routines and manual read-backs of the data. The digital photos were also databased and archived. Plant voucher specimens of unknowns in the field were identified and those of high quality accessioned into the University of New Mexico Herbarium. These plots were also transferred to the NPS-developed Plot_v3_BE_BAND.mdb relational database (note: because our AA plots are quantitative, they were included in the main tPlots table of Plot_v3_BE_BAND.mdb and identified explicitly as AA plots).

4.1.2 Analysis methods

Initially, we classified each validation point, based on dominance and indicator species, into a plant association following the BAND vegetation classification and dichotomous key (table 4 and Appendix E). Validation points were then assigned to a map unit, according to the plant association composition of the unit as reflected in the map unit descriptions (table 6, Appendix G). In most cases, assignments were from either the primary or secondary components of the map units, and occasionally related inclusions (<5%). Contrasting inclusions were considered errors. During the AA sampling, we detected new plant associations that were not part of the original legend. These were labeled as "AA incidentals" and were counted as producer errors.

For each level of the map legend, we calculated both a users' and producers' accuracy (Congalton and Green 1999) for each map unit. Producers' accuracy reflects how well the map unit delineations represent the vegetation type on the ground, and not some other vegetation type (e.g., that juniper woodlands are mapped accurately based on the field validation point locations). This provides the map maker with a measure of how well the mapping product meets specifications. In contrast, the users' accuracy demonstrates how well the map performs when used in the field. For example, a juniper woodland encountered on the ground is mapped as such and not as some other map unit. This provides the user, regardless of training, a level of confidence that what one sees on the ground is actually the element as indicated by the map. In addition, we calculated the 90% confidence interval by map unit for each type of error.

To quantify overall accuracy, we calculated both an overall accuracy and an estimate of Kappa (Kappa Index) for each of the three map unit levels in the legend. The overall accuracy is simply the total number of agreements between the map and reference data. The estimate of Kappa is

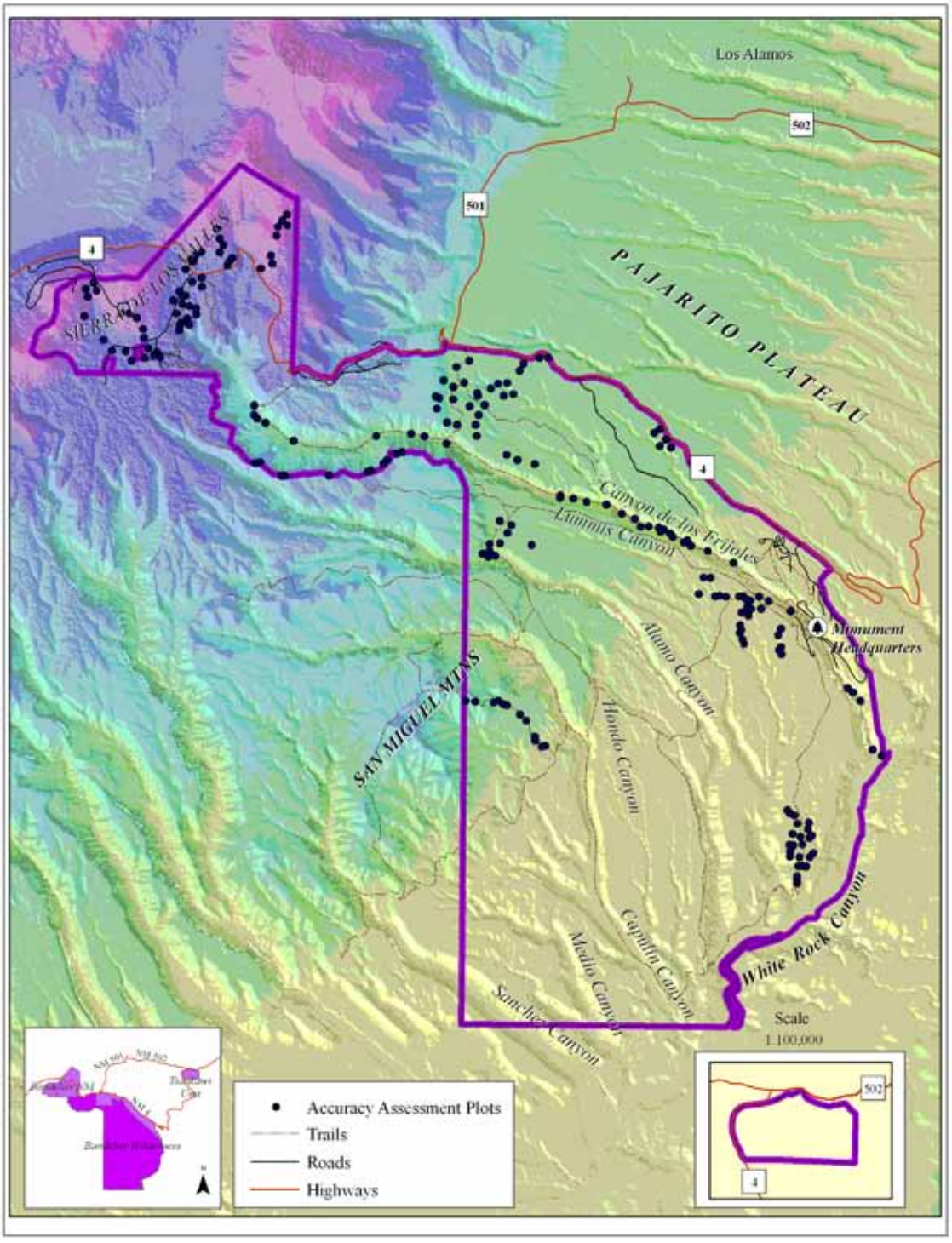


Figure 29. Distribution of 2007-08 Bandelier National Monument vegetation map accuracy assessment sampling points.

another measure of agreement or accuracy varying from 0 to 1 (often presented as a percentage), where higher values indicate better agreement. The Kappa statistic (KHAT) is used to measure the difference between the actual agreement between the reference data and the map and the chance agreement between the reference data and a random map. KHAT indicates the extent to which the percentage-correct values of an error matrix are due to "true" agreement versus "chance" agreement (Congalton and Green 1999).

The results are presented in a series of contingency tables for each level of the legend, showing the producers' and users' errors by map unit with associated 90%

confidence intervals, and the overall accuracy and the Kappa estimate for each level. These are also commonly referred to as "confusion" matrices.

4.2. Accuracy assessment results

At the broadest scale of the physiognomic classes of forest, woodland, shrubland, grassland, and riparian, overall accuracy was 93.8% (KHAT=91.8). Most of the errors occurred among shrublands and grasslands, but all accuracy values were above 80% (table 10). The error rates among shrublands suggests that accurately detecting trees among shrubs and shrubs among grasslands continues to be a challenge, particularly with respect to boundary conditions (i.e. > 10% trees to be classified as a woodland and forest and <25% shrubs to be considered a grassland). With respect to the two user errors in the Riparian category, the two plots were within 15 m of the boundary of the correct unit. This is indicative of the need for very careful delineation when dealing with long and narrow elements represented by riparian zones.

At Level 1, the NVCS Group level of the legend hierarchy and the primary target of the accuracy assessment, overall accuracy was 82.5% (KHAT=80.4). Once again, most of the errors occurred among shrublands and grasslands, but accuracy remained above 80% for all classes (table 11). Most of the errors occurred in differentiating the various higher-elevation mixed-conifer forest units and the low-elevation shrublands and grasslands. Among the forests, the most problematic class was Southern Rocky Mountain Douglas-fir-White Fir-Blue Spruce Mesic Forest (MU 21/22). While this group is relatively easily to identify in the field, based on floristic composition, we had mixed results in determining its spatial position relative to Southern Rocky Mountain White Fir-Douglas-fir Dry Forest (MU5). From a photo-interpretive perspective, the classes do not present much in the way of differences in canopy structure and composition. Our training data and previous work suggested that the mesic unit should occur along lower slopes and in ravines and coves, and using our terrain models, we delineated the unit accordingly. While this is still likely the

Table 10. **Accuracy assessment (AA) contingency table for physiognomic classes in Bandelier National Monument. Vegetation Map**. We provide the Producers and User's accuracies with 10% confidence intervals where n = number of sampling points per class used to calculate "% Correct" by class. Also presented is the overall accuracy based on the total n, and the associated Kappa (KHAT) index.

		Polygon mapped as						User's accuracy			
		Forest	Woodland	Shrubland	Grassland	Riparian	Other	n	% correct	90% CI (-)	90% CI (+)
Polygon validated as	Forest	83		2				85	97.6	94.4	100.9
	Woodland		42	1				44	89.2	89.2	101.8
	Shrubland	1	1	25	1			30	70.5	70.5	96.2
	Grassland			1	3			25	87.6	87.6	104.4
	Riparian	2			24	19		21	77.6	77.6	103.4
	Other				1		5	6	50.0	50.0	116.7
Producer's accuracy	n	86	43	29	29	19	5	**211**	Overall accuracy = 93.8%		
	% correct	96.5	97.7	86.2	82.8	100.00	100.00		Overall 90% CI (-) = 90.9		
	90% CI (-)	92.7	92.7	73.9	69.5	97.4	90.0		Overall 90% CI (+) = 96.8		
	90% CI (+)	100.3	102.6	98.5	96.0	102.6	110.00		Kappa index = 91.8%		

Table 11. Accuracy assessment (AA) contingency table for Level 1 map units of the Bandelier National Monument Vegetation Map. We provide the Producers and User's accuracies with 10% confidence intervals where n = number of sampling points per class used to calculate "% Correct" by class. Also presented is the overall accuracy based on the total n, and the associated Kappa (KHAT) index. Below the table is a key to various Level 1 classes.

		Polygon mapped as														User's accuracy			
	Map unit	2	3/5	4/6	7	8	9	10	11	12	13	15	16	17	24	# of AA samples	% correct	90% CI (-)	90% CI (+)
Polygon validated as	2	1	1	1												3	33.3	-28.1	94.8
	3/5	1	27	7		1										36	75.0	61.7	88.3
	4/6		5	6												11	54.5	25.3	83.8
	7		3		10					2						15	66.7	43.3	90.0
	8					20										20	100.0	97.5	102.5
	9						19				1					20	95.0	84.5	105.5
	10						1	4								5	80.0	40.6	119.4
	11								18				1			19	94.7	83.7	105.8
	12					1				18	1	2	1			23	78.3	61.9	94.6
	13										6					6	100.0	91.7	108.3
	14								1							1	0.0	-50.0	50.0
	15										1	15	1			17	88.2	72.4	104.0
	16											2	6			8	75.0	43.6	106.4
	17			2										19		21	90.5	77.6	103.4
	24											1			5	6	83.3	50.0	116.7
Producer's accuracy	# of AA samples	2	36	16	10	22	20	4	19	20	9	20	9	19	5	211	Overall Accuracy = 82.5%		
	% correct	50.0	75.0	37.5	100.0	90.9	95.0	100.0	94.7	90.0	66.7	75.0	66.7	100.0	100.0		Overall 90% CI(-) = 77.9		
	90% CI (-)	-33.2	61.7	14.5	95.0	78.6	84.5	87.5	83.7	76.5	35.3	56.6	35.3	97.4	90.0		Overall 90% CI(+) = 87.0		
	90% CI (+)	133.2	88.3	60.5	105.0	103.3	105.5	112.5	105.8	103.5	98.1	93.4	98.1	102.6	110.0		Kappa index = 80.8%		

Key to map unit codes

2 Rocky Mountain Subalpine and Montane Aspen Forest and Woodland
3 Southern Rocky Mountain White Fir-Douglas fir Dry Forest with Aspen
4 Southern Rocky Mountain Douglas fir-White fir-Blue Spruce Mesic Forest with Aspen
5 Southern Rocky Mountain White fir-Douglas fir Dry Forest
6 Southern Rocky Mountain Douglas fir-White fir-Blue Spruce Mesic Forest
7 Southern Rocky Mountain Ponderosa Pine Savanna
8 Southern Rocky Mountain Ponderosa Pine Forest and Woodland
9 Southern Rocky Mountain Pinyon-Oneseed Juniper Woodland
10 Madrean Pinyon-Juniper Woodland
11 Southern Rocky Mountain Juniper Woodland and Savanna
12 Southern Rocky Mountain Gambel Oak-Mixed [Mesic] Montane Shrubland
13 Southern Rocky Mountain Cercocarpus-Mixed [Dry] Foothill Shrubland
14 Great Plains Sand Shrubland
15 Southern Rocky Mountain Montant-Subalpine Grassland
16 Southwest Plains-Mesa Grassland
17 Rocky Mountain Subalpine-Montane Riparian Forest and Woodland
24 Southwest Ruderal Disturbance Vegetation

case, the outcome suggests that the mesic class was more restricted than we modeled and mapped. In contrast, the accuracy, both users' and producers', for Southern Rocky Mountain White Fir-Douglas-fir Dry Forest (MU5) was 75% with most of the error attributable to confusion with the mesic class. If all mixed-conifer classes are discounted, the remaining Level 1 accuracy rises to 89.1%.

With respect to aspen, pure aspen stands on BAND were relatively rare, and we were unable to obtain an adequate sample size for testing. Overall, detecting aspen in the imagery was a challenge from the onset. The aerial photography did not show a high contrast between broadleaf-deciduous trees and conifers except for a limited set of non-orthorectified flight lines from 2003 that had incomplete coverage. We did employ a Thematic Mapper index reflecting leaf-on in the growing season versus leaf-off in the dormant period, but the lower resolution coupled with the admixture conifers still limited the differentiation. Hence, our target of separating pure mixed-conifer from mixed conifer with aspen classes was not realized (20% overall accuracy). While most of the accuracy assessment points mapped to mixed-conifer with aspen classes had aspen as part of the canopy mix, it seldom exceeded the 25% relative cover on the ground as required for our definition of the class. Less commonly, classes mapped as pure mixed conifer cross classified with the mixed-conifer aspen classes. Overall, this suggests that either our rules are too strict for both the pure (greater that 75% relative cover) or the mixed stands of aspen (>25%), or that we have simply overestimated the abundance of aspen.

Given a sampling design focused on Level 1, the distribution of Level 2 sample points was more or less stochastic and reflected the relative abundance among units (table 12, pp 80-81). In addition, only 42 of the 63 units were sampled, and the majority were under-sampled. Yet, from this subsample we can get a sense of how Level 2, as well as some of the better represented map units, performed in general. Overall accuracy declined to 66.8% (KHAT=65.2) at this level, which includes AA incidental errors (69.1% without incidentals), and once again the error was concentrated among mixed-conifer forest units, and among grasslands and shrublands. If these mixed-conifer units are discounted, the remaining Level 2 accuracy rose to 72.4%, or if they are lumped into single functional group along with the remaining Level 2 classes, then the accuracy was 76.4%. Accuracy for ponderosa pine and pinyon-juniper woodland units, with a few exceptions, stayed above 80% for producer accuracy and 75% for user accuracy, as did the riparian classes. There was a modicum of cross-classification among the one-seed juniper units (within MU 11), although typically the errors were relatively minor and easily explained. For example, two of the producer errors associated with 11A were due to the plots being keyed to an incidental plant association detected only during the AA sampling: *Juniperus monosperma / Hesperostipa neomexicana* Woodland. If this association had been uncovered earlier it would have logically been placed in this map unit, but in the context of the AA, it remains an error.

A suite of polygon modifiers were applied during the mapping process (table 8), but these were not tested during the AA process. Hence, their use must be qualified because their accuracy is unknown.

4.3 Accuracy assessment discussion

While the sampling depth of this accuracy assessment is limited in several respects, it does suggest confidence in some patterns, particularly at the broad physiognomic level of forests, woodlands, etc., and at Level 1 representing the Group level of NVCS. The ponderosa and pinyon-juniper woodlands were relatively well mapped, but work is needed on differentiating the mixed-conifer zone and some shrublands and grasslands. For forests, this will likely require higher resolution aerial photogra-

phy (preferably six in or 15 cm) to detect differences among tree species in combination with enhanced GIS spatial analysis based on more precise terrain models and specifically designed site characteristics and vegetation sampling. Higher resolution imagery would also improve the accuracy of the mapping of shrubland and grassland units. At six-inch scale, structural differences among shrub and grass species can be detected and used in combination with spectral differences. Overall, for many natural resource planning and evaluations, Level 1 units will likely be sufficient and most appropriate.

The attempt to refine vegetation units at Level 2 did incur additional error that may or may not be acceptable, depending on the unit. At this level, many of the units are differentiated based on shrub versus grass cover as well as species differences that are not necessarily reflected at Level 1 . Many of these are likely to be important from a management perspective, and though errors exist, most are explainable to the degree that the units can be used at least provisionally with caution and an understanding that higher resolution mapping may be required at a later date (such as in the 11A example described above). At this time, given that many map units were not sampled or were under-sampled, we would recommend that all Level 2 units be maintained, pending either additional sampling or testing in field applications.

Table 12. Accuracy assessment contingency table for Level 2 map units of the Bandelier National Monument Vegetation Map.

Polygon mapped as

Polygon validated as: Map unit *	2B	3A/5A	3B/5B	5C	4A/6A	4B/6B	7A	7B	8A	8B	8C	8D	9A	9B	9D	10A	11A	11B	11D	11E	11F
2A			1.0		1.0																
2B	1.0																				
3A/5A		1.0	3.0																		
3B/5B		2.0	18.0		4.0	2.0				1.0											
5C	1.0		1.0	2.0	1.0																
6A			4.0		5.0																
6B			1.0			1.0															
7A		1.0					1.0														
7B								7.0													
8A			0.3						1.0	0.3											
8B				1.0						7.0	1.0										
8C			0.3							0.3	7.0										
8D			0.3							0.3		3.0									
9A													3.0	1.0							
9B														12.0							
9D															2.0						
10A														1.0		4.0					
11A																	4.0			0.3	0.3
11B																	1.5	3.0		0.8	0.3
11C																	1.5			0.5	
11D																			1.0	1.3	0.3
11E																				1.0	
11F																					0.0
12A										1.0											
12C																					
12D																					
13A																					
13B																					
13C																					
14A																				1.0	
15A																					
15B																					
15C																					
16A																					
16B																					
16D																					
17A																					
17B					2.0																
17C																					
17D																					
24B																					
24D																					
incidental							2.0							1.0			2.0				
Producer's accuracy: # of AA samples	2.0	4.0	29.0	3.0	13.0	3.0	3.0	7.0	1.0	10.0	8.0	3.0	3.0	15.0	2.0	4.0	9.0	3.0	1.0	5.0	1.0
% correct	50.0	25.0	62.1	66.7	38.5	33.3	33.3	100.0	100.0	70.0	87.5	100.0	100.0	80.0	100.0	100.0	44.4	100.0	100.0	20.0	0.0
90% CI (-)	-33.2	-23.1	45.5	5.2	12.4	-28.1	-28.1	92.9	50.0	41.2	62.0	83.3	83.3	59.7	75.0	87.5	11.6	83.3	50.0	-19.4	-50.1
90% CI (+)	133.2	73.1	78.6	128.1	64.5	94.8	94.8	107.1	150.0	98.8	113.0	116.7	116.7	100.3	125.0	112.5	77.2	116.7	150.0	59.5	50.1

Overall accuracy = 66.8% Overall 90% CI (-) = 61.3 Overall 90% CI (+) = 72.4 Kappa index = 65.2%

12A	12C	12D	13A	13B	13C	15A	15B	15C	16A	16B	16D	17A	17B	17C	17D	24B	24D	# of AA samples	% correct	90% CI (-)	90% CI (+)
																		2.0	0.0	-25.0	25.0
																		1.0	100.0	50.0	150.0
																		4.0	25.0	-23.1	73.1
																		27.0	66.7	49.9	83.4
																		5.0	40.0	-6.0	86.0
																		9.0	55.6	22.8	88.4
																		2.0	50.0	-33.2	133.2
		2.0																2.0	50.0	-33.2	133.2
																		9.0	77.8	49.4	106.1
																		1.7	60.0	-32.4	152.5
																		9.0	77.8	49.4	106.1
																		7.7	91.3	68.1	114.6
				1.0														3.7	81.3	35.1	128.6
																		5.0	60.0	14.0	106.0
																		12.0	100.0	95.8	104.2
																		2.0	100.0	75.0	125.0
																		5.0	80.0	40.6	119.4
																		4.7	85.7	48.4	123.1
											0.5							6.2	48.7	7.4	89.9
											0.5							2.5	0.0	-20.0	20.0
																		2.7	37.5	-30.0	105.0
																		1.0	100.0	50.0	150.0
																		0.0	0.0	NA	NA
5.0							2.0											8.0	62.5	28.1	96.9
	9.0				1.0						1.0							11.0	81.8	58.1	105.5
1.0	2.0	0.0																3.0	0.0	-16.7	16.7
			2.0		0.5													2.5	80.0	18.4	141.6
				0.0	0.5													0.5	0.0	-100.0	100.0
			1.0		2.0													3.0	66.7	5.2	128.1
																		1.0	0.0	-50.0	50.0
						3.0		1.0										4.0	75.0	26.9	123.1
				1.0			5.0		1.0									7.0	71.4	36.2	106.7
						1.0	1.0	4.0										6.0	66.7	26.7	106.7
							2.0		1.0									3.0	33.3	-28.1	94.8
										1.0								1.0	100.0	50.0	150.0
											3.0							3.0	100.0	83.3	116.7
												2.0		1.0				3.0	66.7	5.2	128.1
													14.0					16.0	87.5	70.8	104.2
														0.0				0.0	0.0	NA	NA
														1.0	1.0			2.0	50.0	-33.2	133.2
								1.0								4.0		5.0	80.0	40.6	119.4
																	1.0	1.0	100.0	50.0	150.0
	1.0									1.0								7.0	0.0	-7.1	7.1
6.0	12.0	2.0	3.0	2.0	4.0	4.0	10.0	6.0	2.0	2.0	5.0	2.0	14.0	2.0	1.0	4.0	1.0				
83.3	75.0	0.0	66.7	0.0	50.0	75.0	50.0	66.7	50.0	50.0	60.0	100.0	100.0	0.0	100.0	100.0	100.0				
50.0	50.3	-25.0	5.2	-25.0	-3.6	26.9	19.0	26.7	-33.2	-33.2	14.0	75.0	96.4	-25.0	50.0	87.5	50.0				
116.7	99.7	25.0	128.1	25.0	103.6	123.1	81.0	106.7	133.2	133.2	106.0	125.0	103.6	25.0	150.0	112.5	150.0				

User's accuracy

Total number of samples: 211

***** See next page for map unit codes key

Key to map unit codes in Table 12	
2A	Quaking Aspen/Thurber's Fescue Upper Montane Woodland
2B	Quaking Aspen/Fendler's Meadowrue Mesic-Wet Forest
3A	White Fir-Douglas fir-Aspen/Thurber's Fescue Forest Upper Montane Woodland
3B	White Fir-Douglas fir-Aspen/Common Juniper/Deer Sedge Dry-Mesic Forest
4A	White Fir-Douglas fir-Aspen/Fendler's Meadowrue Mesic-Wet Forest
4B	White Fir-Douglas fir-Aspen/Rocky Mountain Maple Canyon Forest
5A	White Fir-Douglas fir/Thurber's Fescue Forest Upper Montane Woodland Savanna
5B	White Fir-Douglas fir-Aspen/Thurber's Fescue Forest Upper Montane Woodland
5C	White Fir-Douglas fir-Gambel Oak Canyon Forest
6A	White Fir-Douglas fir/Fendler's Meadowrue Mesic-Wet Forest
6B	White Fir-Douglas fir/Rocky Mountain Maple Canyon Forest
7A	Ponderosa Pine/Thurber's Fescue Upper Montane Woodland
7B	Ponderosa Pine/Mountains Muhly-Blue Grama Mesa Woodland
8D	Ponderosa Pine Canyon Woodland
9D	(Pinyon) Oneseed Juniper/Grama Grass Mesa Woodland
10A	(Pinyon) Alligator Juniper/Wavyleaf Oak Woodland
11A	Oneseed Juniper/Blue Grama Mesa Woodland
11B	Oneseed Juniper/Black Grama-Blue Grama Mesa Woodland
11C	Oneseed Juniper/Black Grama Canyon Woodland
11D	Oneseed Juniper/Wavyleaf Oak-Grama Grass Canyon Woodland
11E	Oneseed Juniper/Rockland Canyon Woodland
11F	Oneseed Juniper/Wavyleaf Oak/Sparse Rockland Mesa Woodland
12A	Fendler Ceanothus-New Mexico Locust Montane Mesa Shrubland
12C	Gambel Oak/New Mexico Locust Canyon Shrubland
12D	Gambel Oak/New Mexico Locust-Mountain Muhly Mesa Shrubland
13A	Wavyleaf Oak/Sideoast Grama Mesa Shrubland
13B	Wavyleaf Oak/Ruderal Foothill Shrubland
13C	Wavyleaf Oak-Mountain Mahogany/Rockland Canyon Shrubland
14A	Sand Sagebrush/Talus Canyon Shrubland
15A	Thurber's Fescue-Parry's Danthonia Upper Montane Grassland
15B	Mountain Muhly-Little Bluestem Lower Montane Grassland
15C	Lower Montane Valley Bottom Grassland
16A	Western Wheatgrass-Ruderal Herbs Mesa Grassland
16B	Blue Grama-Black Grama Mesa Grassland
16D	Grama Grass/Rockland Grassland
17A	Box Elder-Alder-Narrowleaf Cottonwood Montane Riparian Forest
17B	White Fir-Box Elder-Thinleaf Alder Mixed Montane Riparian Forest
17C	Ponderosa Pine-Broadleaf Mixed Montane Riparian Forest
17D	Ponderosa Pine Dry Wash Woodland
24B	Post-fire Montane Ruderal Herbaceous Vegetation (Cerro Grande)
24D	Reservoir Flood Zone Ruderal Herbaceous Vegetation

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Appendix A: Rock units for Bandelier National Monument

Rock units for geology maps associated with Bandelier National Monument. Derived from Goff et al. (2002, 2005 & 2006).

Symbol	Name	Description
Qaf	Alluvial fans	Fan-shaped deposits of coarse to fine gravel and sand at the mouths of valleys, or older, coalesced fan deposits along the Pajarito fault zone
Qal	Alluvium	Deposits of gravel, sand and silt in canyon bottoms; locally includes stream terraces and canyon wall colluvium
Qbo	Lower Bandelier Tuff (Otowi Member)	White to pale pink, generally poorly welded rhyolitic ash-flow tuff containing abundant phenocrysts of sanidine and quartz, and sparse mafic phenocrysts
Qbt	Upper Bandelier Tuff (Tshirege Member)	White to orange to dark gray densely welded to non-welded rhyolitic, ash-flow tuff (ignimbrite)
Qco	Colluvium	Poorly sorted slope wash and talus deposits from local sources
Qct	Cerro Toledo Rhyolite	Volcanic domes; mainly gray lithoidal rhyolite
Qls	Landslides	Unsorted debris that has moved chaotically down steep slopes, or slumps or block slides partially to completely intact, that have moved down slope
Qog	Older Gravels	Dark gray to buff gravel, debris flow and minor fluvial deposits interbedded with the upper and lower Bandelier Tuff south and east of the caldera margin
Qrd1	Rabbit Mountain debris avalanche deposits	White to pale gray debris flows formed by multiple failures of the Rabbit Mountain dome
Qrm	Rhyolite of Rabbit Mountain (Cerro Toledo Rhyolite)	Large dome, thick flows and flow breccias of black, very aphyric obsidian to white, devitrified rhyolite
Qt	Terrace gravel	Slightly older alluvium that lies along the margins of present streams and basins; now undergoing erosion; maximum thickness as much as 15 m
QToa		Undefined
Qtr		Undefined
Qvec; Qvr	Tewa Group (Quaternary) Qvr, El Cajete pumice (El Cajete Member of Valles Rhyolite)	White to tan, moderately sorted, pyroclastic fall deposits of vesicular rhyolite
Tcb	Cerros del Rio Volcanic Field (Pliocene) Tcb Mafic lava flows	Undivided unit of flows, dikes and associated cinder deposits of basalt, hawaiite, and mugearite from Cerros del Rio volcanic field best exposed east of the Rio Grande (Dunker et al., 1991)
Tcba	Benmorite	Thick lava flow exposed in upper walls of lower Frijoles Canyon and adjacent White Rock Canyon
Tcbm	Mafic hydromagmatic deposits	Layered hydromagmatic (maar) deposits consisting of cinders, ash, and decomposed glass with pebble- to boulder-sized fragments of quartz, microcline, volcanic rocks, quartzite, intrusive igneous rocks and other lithologies from sedimentary rocks beneath the Pajarito Plateau
Tgs	Galisteo Formation	Orange to tan to brick red beds of well-indurated sandstone, siltstone, arkose, and conglomerate
Tka	Andesite (Paliza Canyon Formation)	Gray to pink to black flows, domes, and minor intrusives of porphyritic andesite
Tkbh	Bearhead Rhyolite	White to gray intrusions, domes, and flows of slightly porphyritic to aphyric devitrified rhyolite

Appendix A: Rock units for Bandelier Naitonal Monument *continued*

Symbol	Name	Description
Tkch	Volcaniclastic deposits (Cochiti Formation)	Black to gray to pale pink volcaniclastic unit consisting predominately of lahars, block and ash flows, and other debris flows formed contemporaneous with Paliza Canyon Formation volcanism
Tkct	Canovas Canyon Rhyolite tuff	White to pink pyroclastic fall and pyroclastic flow deposits of the Canovas Canyon Rhyolite
Tkhd	Hornblende dacite (Paliza Canyon Formation)	Domes, flows and intrusives of gray to pink porphyritic dacite
Tkoa	Olivine andesite (Paliza Canyon Formation)	Black to gray domes, flows, and minor red cinder deposits of slightly porphyritic andesite
Tkpa	Porphyritic andesite (Paliza Canyon Formation)	Gray to black domes and flows of coarsely porphyritic andesite
Tkpt	?	?
Tpa	Two-pyroxene andesite, undivided (Paliza Canyon Formation)	Domes, flows, flow breccia, spatter deposits, and scoria of andesite from multiple sources
Tpd	Dacite (Paliza Canyon Formation)	Tan to gray to black, flow banded to massive, slightly porphyritic to aphyric dacite lavas, dikes and plug
Tphd	Porphyritic hornblende dacite (Paliza Canyon Formation)	Eroded dome and flow complexes of gray to pale pink porphyritic dacite
Tpt	Puye Formation, ancestral Rio Grande facies (Totavi Lentil)	Pebble to cobble gravel rich in clasts of quartzite, intrusive igneous rocks and other Precambrian lithologies
Tsf	Santa Fe Group (Miocene)	White to tan to very pale green feldspathic sandstone
Tsfb	Basalt flows in Santa Fe Group (Miocene)	Flow and pillow-palagonite tuff of black alkali basalt
Tsfu	Santa Fe Group, undivided (middle to late Miocene)	White to tan to pale green, massive to well-bedded sandstone and siltstone
Ttcg	Dacite of Cerro Grande (Tschicoma Formation)	Extensive dome and flow complex of light to dark gray to pale pink, massive to sheeted porphyritic dacite containing phenocrysts of plagioclase, hypersthene, and (usually) conspicuous hornblende
Ttsd	Dacite of Sawyer Dome (Tschicoma Formation)	Dome and flow complex of gray to pale pink, generally massive, porphyritic dacite

Appendix B: Soil map units for Bandelier National Monument

Derived from Hibner (in press). Similar soils are grouped into the six soils groups mapped in Figure 7 on page 9. Soils series names preceded by an asterisk were designated by Hibner as "taxadjunct" soils on BAND, .i.e., the soil characteristics for the series in that map unit may lay outside the normal range of variation for the series.

Soil group		Unit #	Unit name	Landform	Elevation range m (ft) Min	Elevation range m (ft) Max	Soil series	Soil family	% of unit
A	Mesas, escarpments, and valley floors of White Rock Canyon (lowest elevation)	133	Vanto fine sandy loam, 1-3% slopes	Flood plain steps and valley floors	1600 (5300)	2000 (6400)	Vanto	Sandy, mixed, mesic Ustic Torriorthents	90
		138	Andanada very gravelly loam, 5-15% slopes	Mesas and undulating plateaus	1800 (5800)	2000 (6500)	Andanada	Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Ustic Torriorthents	90
		139	Ildefonso-Rock outcrop-Rubble land complex, 30-70% slopes	Escarpments and canyons	1700 (5600)	2000 (6500)	Ildefonso	Loamy-skeletal, mixed, superactive, mesic Ustic Haplocalcids	65
							Rock outcrop		
							Rubble land		
		143	Scogg very fine sandy loam, 0-2% slopes	Flood plains valley floors with perennial streams	1600 (5300)	1800 (5800)	Scogg	Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, calcareous, mesic Aeric Fluvaquents	85
B	Undulating plateaus and slopes (low elevation)	401	Rock outcrop-Abrojo-Palatka complex, 25-65% slopes	South-facing backslopes of mesas, undulating plateaus, and canyons	1800 (6000)	2100 (6900)	Rock outcrop		
							Abrojo	Ashy-skeletal, glassy, nonacid, mesic Vitritorrandic Ustorthents	30
							*Palatka	Ashy, glassy, nonacid, mesic, shallow Aridic Ustipsamments	20
		406	Rock outcrop-Zacaton-Palatka complex, 25-60% slopes	North-facing backslopes of mesas, undulating plateaus, and canyons	1800 (6000)	2100 (6900)	Rock outcrop		40
							Zacaton	Ashy-skeletal, glassy, mesic Vitrandic Haplustepts	30
							Palatka	Ashy, glassy, nonacid, mesic, shallow Aridic Ustipsamments	25
		407	Rock outcrop-Palatka complex, 20-50% slopes	Backslopes of mesas, undulating plateaus, and canyons	1800 (6000)	2100 (6900)	Rock outcrop		55

Appendix B, *continued*. Soil map units for Bandelier National Monument (from Hibner, in press) with similar soils grouped into the six soil groups mapped in Figure 7.

Soil group		Unit #	Unit name	Landform	Elevation range m (ft) Min (m)	Max (m)	Soil series	Soil family	% of unit
		410	Palatka-Canuela-Rock outcrop complex, low precipitation, 2-20% slopes	Interfluves on undulating plateaus	1900 (6100)	2000 (6400)	Palatka	Ashy, glassy, nonacid, mesic, shallow Vitritorrandic Ustorthents	30
							Palatka	Ashy, glassy, nonacid, mesic, shallow Aridic Ustipsamments	15
							Canuela	Loamy, mixed, superactive, mesic, shallow Aridic Haplustalfs	25
							Rock outcrop		20
		400	Palatka-Canuela-Rock outcrop complex, 2-20% slopes	Interfluves on undulating plateaus and mesas	2000 (6400)	2100 (6900)	Palatka	Ashy, glassy, nonacid, mesic, shallow Vitritorrandic Ustorthents	25
							Palatka	Ashy, glassy, nonacid, mesic, shallow Aridic Ustipsamments	15
							Canuela	Loamy, mixed, superactive, mesic, shallow Aridic Haplustalfs	30
		412	Canuela-Hackroy complex, 1-8% slopes	Interfluves on undulating plateaus	1900 (6100)	2000 (6400)	Canuela	Loamy, mixed, superactive, mesic, shallow Aridic Haplustalfs	50
							Hackroy	Clayey, mixed, superactive, mesic, shallow Aridic Haplustalfs	40
		409	Hackroy-Nyjack complex, 2-12% slopes	Interfluves on undulating plateaus	2000 (6400)	2100 (7000)	Hackroy	Clayey, mixed, superactive, mesic, shallow Aridic Haplustalfs	55
							Nyjack	Fine-loamy, mixed, superactive, mesic Aridic Haplustalfs	30
		413	Armenta very paragravelly ashy coarse sand, 3-20% slopes	Interfluves on undulating plateaus	1900 (6100)	2000 (6500)	Armenta	Ashy-pumiceous, glassy, mesic Vitritorrandic Haplustolls	90
		408	Adornado very paragravelly ashy coarse sandy loam, 8-15% slopes	Interfluves on undulating plateaus	2000 (6400)	2100 (6900)	Adornado	Ashy-pumiceous, glassy, mesic Vitrandic Haplustolls	90
C	Inter-plateau valleys (low elevation)	402	Navajita complex, 2-15% slopes	Valley sides	1760 (5800	2040 (6700)	Navajita	Fine-loamy, mixed, superactive, mesic Aridic Haplustalfs	90
		403	Piojillo paragravelly ashy loamy coarse sand, 3-15% slopes	Valley sides	1800 (6000)	2000 (6600)	Piojillo	Ashy, glassy, nonacid, mesic Aridic Ustipsamments	90
		404	Totavi ashy loamy coarse sand, 1-3% slopes	Low stream terraces and valley floors	1800 (6000)	2000 (6600)	Totavi	Ashy, glassy, mesic Vitritorrandic Haplustolls	85

Appendix B, *continued*. Soil map units for Bandelier National Monument (from Hibner, in press) with similar soils grouped into the six soil groups mapped in Figure 7.

Soil group		Unit #	Unit name	Landform	Elevation range m (ft) Min (m)	Max (m)	Soil series	Soil family	% of unit
		405	Espiritu-Pedregal complex, 1-50% slopes	High stream terraces	2000 (6500)	2000 (6500)	Espiritu	Loamy-skeletal, mixed, superactive, mesic Aridic Haplustalfs	50
							Pedregal	Fine-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Petrocalcic Paleustalfs	40
		414	Metate ashy loam, 0-3% slopes	Valley plain steps and valley floor	1800 (6000)	2100 (6900)	Metate	Ashy, glassy, mesic Vitrandic Haplustolls	90
D	Undulating plateaus, slopes, and valleys (mid elevation)	800	Rotado loam, 2-8% slopes	interfluves on undulating plateaus	2100 (6900)	2300 (7600)	Rotado	Fine, mixed, superactive, mesic Typic Paleustalfs	85
		801	Rock outcrop-Urioste complex, 30-45% slopes	South-facing canyon sides	2100 (6900)	2300 (7600)	Rock outcrop		50
							Urioste	Ashy, glassy, nonacid, mesic, shallow Typic Ustipsamments	35
		802	Tocal-Urioste-Rock outcrop complex, 3-20% slopes	Shoulders and backslopes of IInterfluves on undulating plateaus	2100 (6900)	2300 (7600)	Tocal	Clayey, mixed, superactive, mesic, shallow Typic Haplustalfs	45
							Urioste	Ashy, glassy, nonacid, mesic, shallow Vitrandic Ustorthents	35
							Rock outcrop		10
		805	Rock outcrop-Urioste complex, 10-25% slopes	Backslopes of Interfluves on undulating plateaus	2100 (6900)	2300 (7600)	Rock outcrop		65
							Urioste	Ashy, glassy, nonacid, mesic, shallow Vitrandic Ustorthents	25
		803	Adornado-Letrado complex, 5-20% slopes	Interfluves on undulating plateaus	2100 (6900)	2300 (7600)	Adornado	Ashy-pumiceous, glassy, mesic Vitrandic Haplustolls	55
							Letrado	Fine-loamy, mixed, superactive, mesic Typic Paleustalfs	35
		804	Adornado very paragravelly ashy coarse sandy loam, 2-8% slopes	Interfluves on undulating plateaus	2100 (6900)	2300 (7600)	Adornado	Pumiceous or ashy-pumiceous over loamy, glassy over mixed, superactive, mesic Vitrandic Argiustolls	90

Appendix B, *continued*. Soil map units for Bandelier National Monument (from Hibner, in press) with similar soils grouped into the six soil groups mapped in Figure 7.

Soil group		Unit #	Unit name	Landform	Elevation range m (ft) Min (m)	Max (m)	Soil series	Soil family	% of unit
		806	Cajete-Cymery complex, 25-60% slopes	North-facing canyon side and undulating plateaus	2100 (6900)	2400 (7900)	Cajete	Ashy-pumiceous, glassy, frigid Vitrandic Haplustolls	50
							Cymery	Ashy-skeletal, glassy, frigid Lithic Haplustepts	35
		807	Metate ashy loam, cool, 1-4% slopes	Valley plain steps and valley floor	2100 (6900)	2500 (8200)	Metate	Ashy, glassy, frigid Vitrandic Haplustolls	90
E	Undulating plateaus and slopes (high elevation)	813	Hoxoh gravelly ashy loam, 1-15% slopes	Interfluves on undulating plateaus	2300 (7500)	2500 (8200)	Hoxoh	Ashy-skeletal, glassy, frigid Lithic Haplustolls	90
		814	Jemez sandy loam, 2-8% slopes	Interfluves on undulating plateaus	2300 (7500)	2600 (8500)	Jemez	Fine-loamy, mixed, superactive, frigid Typic Haplustalfs	90
		810	Tschicoma loam, 2 -20% slopes	footslopes.of Interfluves on undulating plateaus and	2100 (6900)	2500 (8200)	Tschi-coma	Fine-loamy, mixed, superactive, frigid Pachic Argiustolls	85
		811	Cymery very gravelly ashy sandy loam, 15-35% slopes	Backslopes of Interfluves on undulating plateaus	2300 (7500)	2600 (8500)	Cymery	Ashy-skeletal, glassy, frigid Lithic Haplustepts	90
		816	Rock outcrop-Urioste-Estaban complex, 45-90% slopes	South-facing canyon sides	2200 (7200)	2600 (8500)	Rock outcrop		35
							Urioste	Ashy, glassy, nonacid, mesic, shallow Vitrandic Ustorthents	30
							Estaban	Fragmental, mixed, mesic Typic Haplustepts	25
		826	Estaban extremely gravelly loam, 45-90% slopes	Backslopes of undulating plateaus, and canyons	2400 (7900)	2700 (8900)	Estaban	Fragmental, mixed, frigid Typic Haplustepts	90
F	Mountains and montane valleys (highest elevation)	815	Wauquie-Laventana association, 25-70% slopes	High hills and mountains	2100 (6900)	2500 (8200)	Wauquie	Loamy-skeletal, mixed, superactive, mesic Aridic Haplustalfs	50
							Laven-tana	Loamy-skeletal, mixed, superactive, frigid Typic Haplustalfs	40
		820	Lucito loam, 1-8% slopes	Mountains	2700 (8900)	2900 (9500)	Lucito	Clayey-skeletal, mixed, superactive, frigid Pachic Argiustolls	90
		821	Mapache loam, 25-55% slopes	Mountains	2700 (8900)	3000 (9800)	Mapache	Loamy-skeletal, mixed, superactive, frigid Pachic Argiustolls	90

Appendix B, *continued*. Soil map units for Bandelier National Monument (from Hibner, in press) with similar soils grouped into the six soil groups mapped in Figure 7.

Soil group	Unit #	Unit name	Landform	Elevation range m (ft) Min (m)	Max (m)	Soil series	Soil family	% of unit
	822	Mapache gravelly loam, 10-25% slopes	Mountains	2600 (8500)	2900 (9500)	Mapache	Loamy-skeletal, mixed, superactive, frigid Pachic Haplustolls	90
	824	Mapache gravelly loam, 30-70% slopes	Mountains	2700 (8900)	3100 (10200)	Mapache	Loamy-skeletal, mixed, superactive, frigid Pachic Haplustolls	90
	825	Cosey complex, 5-20% slopes	Mountains	3000 (9800)	3100 (10200)	Cosey	Loamy-skeletal, mixed, superactive, frigid Alfic Argiustolls	55
						Cosey	Loamy-skeletal, mixed, superactive, frigid Pachic Argiustolls	35
	823	Tschicoma-Tranquilar complex, 0-5%slopes	Valley sides and valley floors	2600 (8500)	2800 (9200)	Tschi-coma	Fine-loamy, mixed, superactive, frigid Pachic Argiustolls	55
						Tranquilar	Very-fine, smectitic, frigid Vertic Argialbolls	35

Appendix C: Natural Heritage New Mexico Vegetation Survey Handbook

We used the methods and datasheets from the Natural Heritage New Mexico Vegetation Survey Handbook during the collection of all vegetation plot data during the Bandelier National Monument Vegetation mapping project. This appendix contains the handbook and associated datasheets. The handbook is the 2008 version; no significant changes were made to the protocol during the life of the project.

Vegetation Survey Handbook
Natural Heritage New Mexico, Department of Biology, University of New Mexico

Plot Establishment Guidelines and Techniques (May 2002)

Locating a plot

How plots are located varies with the survey/experimental design. For mapping/classification purposes where the intent is to place a plot in a stand of homogeneous vegetation, aerial photos and/or field reconnaissance generally determine where a plot is going to be established. Plots should be allocated to cover the range of variation in a study area (with the help of soils/geology and topographic maps i.e. gradsect sampling), but for logistical purposes this usually still entails landscape cluster sampling by a team usually in a small target watershed with a variety of habitats and vegetation types (but clusters should be widely separated). Where a map/photo is available, plot locations can be determined beforehand with prescribed UTM locations (often used in map validation) and navigated to with a GPS.

Plot size and design

NHNM standard plots (STP) are typically 400 sq. meters and either circular with an 11.3 m radius or square and 20 m on a side. These are the typical dimension for a forest or closed woodland. They can vary in dimension depending on the vegetation type. For riparian types, long and narrow (10 x 40 m) plots, fitted into the linear structure of a river bar or terrace is a common design. In large, for open savanna or grassland types, the plots may need to be larger (50 x 50 m or more) to capture tree numbers successfully and sub-sampled to determine shrub/herbaceous cover. This sub-sampling is done with a series of 40, 1 m quadrat frames or a set of 3 to 5, 10 x 10 m quadrats in which species covers are estimated and then averaged. For small patch communities, i.e. vegetation around a spring or a cryptogam community, the plot size may be as small as a 10 x 10 by itself or even a single quadrat frame in the latter case. Use a cloth tape or a self winding "Spencer" tape to measure the boundaries.

Plot Types

Relevé plots (RP) are established in the same way as standard plots, but the species list includes species from the surrounding stand (homogeneous area). Both standard and relevé plots include an in depth floristic analysis that not only allows for community classification, but also provides species richness and diversity.

Quick plots (QP) are generally used for vegetation mapping ground control or rapid assessment. They are the same size as standard plots but only the dominant and most common species are recorded in each strata along with their abundance and total cover for the strata to ensure proper identification of the type to the plant association level. Site info includes as a minimum the GPS location, one photo showing the general character of the site, along with a brief description of the site. Other attributes may be included depending on the project.

Observation points (OPT) contain mostly qualitative data on an occurrence, including: location and community type, which may or may not include photos. These points are generally used as supplemental points for vegetation mapping or to record the location of other element occurrences.

Monitoring plots are variable, but the general design is two parallel 30 m transects spaced 5 m apart within a 13.3 x 30

m macroplot (400 sq. meters). 1 m quadrat frames are placed at every third meter and cover estimated to the nearest 1% class and the median height measured to the nearest 1 cm. Since the exact spot is re-measured over time, the tapes must drawn tight, through shrubs not around¸ and as near the ground as possible. The quads should be aligned along one side of the tape with the inside of the corner of the frame at the position mark on the tape. Precision is key to good data in monitoring, particularly grasslands.

Along each line, 150 point intercepts are read for basal cover (intercept at ground level) at every 20 cm, starting from a different random location on the line for each monitoring session.

Quadrat framing and point intercept are the most precise methods and other ocular estimates of cover must be calibrated to them (plot cover estimated using scalars).

Monumenting a plot

Typically, the plot will be monumented in the center of a circular or square plot; or sometimes at the corners of square or rectangular plots, or if there are transects such as in a monitoring plot, at each end of a transect. Monuments are usually 3/8“ rebar driven 0.5 m or more into the ground to ensure stability. They can extend anywhere from 5 cm to 1 meter above the surface depending on the circumstances. Where aesthetics is not an issue and for ease of relocation, the rebar should be covered with ½ inch PVC pipe that can act as visible extensions of the rebar. The rebar should be tagged with permanent steel tags that are wired near the base with baling wire or similar gauge. Where possible, have the tag flush with the ground.

Photo points

The intensity of photo documentation varies with the purpose of the project. At a minimum, there should be a single photo taken from above the center monument stake in a direction that best encompasses the character of the plot. Additional photos can be taken at 90 degree angles from each other around the central monument, or in the case of transects, from either end looking back along the line. Record the azimuth/direction of the photo and the focal length of lens being used. Photos taken off monuments back at the plot or at elements of special interest are not normally considered for repeat photography. For analysis, it helps to have a photo taken from off of the plot looking back to get an overview of the composition and structure.

Instructions and Forms

General Plot Description

(General Plot Desc. Form 2 or Standard Form - Page 1)

PLOT ID: (seven character alphanumeric code). **[Required]**

This is the master NMNHP record identification number for all sampling at the site. All subsequent sampling or other independent data at the site will be tied to this number. It must be unique and is formatted as follows:

Record in order: the year (2 digits), the first and second initial of lead surveyor as designated under the Surveyors field (2 characters) or the assignment as designated for the project (2 characters), and the plot ascension number (3 digits).

Example (lead surveyor): The 33rd plot sampled in 1991 by Hank Gleason would be entered as 91HG033.

Example (project assignment): The 54th plot sampled in 2003 at Bandelier would be entered as 03BD054.

Monitoring data are assigned sub-record monitoring numbers under the PLOT ID, as are any quadrat sample numbers.

PLOT TYPE: [Required]

RP = Relevé or Reconnaissance plot. Full species list of both plot and stand are recorded and their abundance estimated, may also include Element Quality Ranking using the ranking form.

STP = Standard plot where all species within the plot are recorded and their abundance estimated, and enough site information to provisionally rank the quality of the occurrence.

QP = Quick plot where only the dominant and most common species recorded with their abundance to ensure proper identification of the type, and enough site information to provisionally rank the quality of the occurrence.

OPT = Observation point with mostly qualitative data on an occurrence, including: dominant species recorded with their abundance, location, community type and size; and at least one photos.

AP = Analytical plot. Full species list of both plot and stand with sub-sampling of abundance (usually quadrat based). May include Element Quality Ranking using the ranking form.

OVP = Observation video plot; community type or size is interpreted from either video or aerial photography.

OSP = Observation scope plot is used for surveys of plants growing on steep cliff faces that are otherwise inaccessible.

FSP = Floristic survey plot is used for general plant inventories when site information is not required and location encompasses an area greater than a standard size plot. Quantitative data is not recorded.

PROJECT: Project code— for example: LANL98. If no code is available, enter temporary project designation. **[Required]**

SUBPROJECT: Subproject code if applicable

MO DATE YEAR: Two digit month, day and year numbers. **[Required]**

EO/PA: Plant Association (community type) to which vegetation data refers to. Use six (seven) letter species acronyms. For example: PINPON/QUEGAM. Whoever makes the CT determination must date and initial the designation. Refer to the NMNHP vegetation classification for current types and acronyms. If the type does not appear to match any on the list, assign a temporary name and indicate your reasoning behind the assignment in the **PA COMMENT** field. If you are uncertain about what to call it, enter **UNCLASS**.

EO/PA Comment: Comments on plant association designation. Indicate whether it was assigned in the field or in the office; was vegetation key used or an analysis of the quantitative data etc. If you assigned a new acronym, indicate your reasons for the designation and any specific decision rules you have developed. If CT is questionable, make notes concerning the problem.

FIELD POINT ID: Alphanumeric code for GPS point assigned on field maps from GIS for plot location target (this is an approximate location based on imagery and should be evaluated for stand consistency prior to plot placement).

SURVEY SITE: Name assigned to the plot site at the time it is sampled, or the name of the site on a Survey Site form if it had been previously surveyed.

Naming guidelines:

1. Do not use element names in the site name
2. Use local place names when available or features on topographic maps.
3. Avoid names that are too generalized such as “Spring Site” or “Flat Top Mountain.” Good examples: “Lower Big Gyp Mountain East”, “Animas Canyon Main Spring”
4. Avoid using temporary GIS-based designations such as “Site 6b” or “polygon 41”

SURVEYORS: Last names and initial of first name of sampling personnel, l**ed by the person responsible for botanical determinations.**

LOCATION/ DIRECTIONS: Provide a brief description or place name that further defines where the survey site is located, so that a person reading the plot does not have to reference a map to know approximately where the site is, e.g., "the upper north slope of Freelove Canyon." Give the directions as necessary to ensure that the plot can be relocated with ease, as needed. Directions to remote areas can be given as arrow marked routes on a topo map, or by a sketch on the back of the form. Indicate if the route is marked on the back or on a topo map.

COUNTY and STATE: Abbreviations. (NMNHP code for the county assigned when entered into Biological Conservation Database – BCD).

MAP NAME: Map used to locate and mark plot, usually the USGS 7.5' topographic quadrangle map name. If duplicate maps are used, indicate by adding 1, 2, 3 etc. at end of map name.

MARGNUM: Margin number on the field map associated with the mapped plot position. Each plot position within the map is marked with a dot and associated margin number. The margin number for the plot is also placed along the margin of the topographic map. Associated with each margin number is a margin note indicating the PlotID, CT acronym and, in parentheses, the 10,10 (described below).

10,10: The 10,10 is an imaginary grid over the topo map, (10 cells across and 10 cells down) to facilitate locating the dot at a later time on the map. For example, (5,6) indicates 5 cells across from left to right and 6 cells down from top to bottom. This would be almost half way across the map, and more than half way down.

GPS Unit: Write name and number of GPS unit used, such as: Garmin 1, 2, 3, etc. or Trimble 221230 (UNM Number).

GPS File: List the name of the file, either default point assigned by unit or name designated by user.

UTM: Enter **Easting** and **Northing** UTM coordinates and **Zone**. Datum as either **NAD27** or **WGS84**. If something else was used, please indicate such in the comment field.

PREC (PRECISION): +/- meters from GPS unit:

MONUMENT: If plot is permanently marked, indicate with what (rebar, PVC, etc.), where it is located (such as center of plot), and height of marker (note whether ft or m). Indicate if it was used as a photo point.

PHOTO PT.: Check off if there are plot photos. Indicate if there is a permanent photo point established and describe its location, e.g., "over the plot monument" or elsewhere and how it is monumented for repeat photography. Indicate the height of the camera (**CAM Ht**) from the surface of the ground to the mid-point of the lens.

LOG #: Indicate name or number assigned to the photo log. Check box for either digital or film pictures (D☐/ F☐).

PHOTOGRAPHER: record the initials of the person taking the photographs

PP1 – PP8: Photo points: Indicate each photo taken of, or from the plot, with indication of direction (**AZM**), focal length (**FocLen**) and subject (**Notes**). e.g., "looking N across entire plot" or "looking to the western horizon towards the Tularosa Basin." Photos should have plot numbers, date and project name on a chalk board, flip pad or something similar, and a reference to show scale, but preferably not people (at least not in the center of the picture). High precision repeat photo points should be done on a tripod and the height indicated along with the focal length of shot.

OTHER SITE PHOTOS: indicate if other photos were taken of the PA and surrounding landscape.

ELEV: Elevation *in feet* unless otherwise noted.

SLOPE %: Enter the angle of the slope on which the plot occurs in percent slope.

ASPECT: Enter the *azimuth (0-360 degrees)* of the slope aspect on which the plot occurs.

SLOPE SHAPE: Enter one of the following codes to indicate the vertical shape of the slope on which the plot lies.

- S straight or even
- R rounded or convex
- D depression or concave
- P patterned (micro relief of hummocks and swales)
- U undulating pattern or low ridges or knolls and draws
- X – other, explain in landform comments section.

LANDFORM: (six number code). Enter the landform name (or describe it as best you can in the comments field below) and the code as classified in the NMNHP Landform Classification Handout.

LANDFORM/GEOLOGY/SOIL COMMENTS: Additional comments of landforms and rock types in the EO and surrounding landscape and comments on soils including soil texture by feel using standard SCS techniques and the soil triangle and/or evidence of dune formation and/or erosion.

SITE /VEG SUMMARY: Is a description (a "word picture") of the site and community sampled. Indicate stand dominants, the structure and physiognomy of the community along with a landscape position and site features narrative (including geomorphology, soils and geology). Indicate successional status if known (e.g. climax (old growth); young second growth). Reserve other condition comments for Condition section below. Use clear, complete sentences and avoid extraneous personal comments that do not belong in a scientific database (no jokes please or comments in bad taste; these plots are long-term records that will be read again and again in the future).

Adjacent Communities: Indicate surrounding plant associations and the spatial relationships (e.g. the occurrence is a matrix community with other smaller patch communities within it, or vice versa). Indicate the width and nature of ecotones to other communities.

Disease/exotics: Dwarf mistletoe damage (give a rating of average % extent spread of within and among trees); insect damage (SPRUCE BUDWORM); fungal rot and rusts.

Animal use evidence: Wildlife browse damage, sightings and sign (bird calls, tracks, scat and animal disturbances such as beaver dens, gopher holes etc., and remember the insects).

Condition (Disturbance, Fragmentation, Erosion): Describe disturbances both natural and otherwise, their extent, intensity and time frame: livestock grazing utilization and impacts; roads, number and distance from; logging and fuelwood cutting; buildings and obstructions; and fires, floods, landslides, significant recent erosion features, etc. Estimate frequency and degree of disturbance (light, moderate, heavy, etc.). Indicate degree of element fragmentation, i.e., reduced patch size and corridors, and other watershed -level impacts (dams, parking lots, settlements).

Distance: If relevant, note the distance in kilometers to the nearest human disturbance such as roads, dams, clearcut, housing mine dump, etc.).

On the Standard Data Form the summary description is condensed space wise, but should include the above information from Site/Veg Summary to Distance.

SURFACE ROCK TYPE: Enter the code for the dominant surface rock type:

Igneous

ANDE	andesite
BASA	basalt (including obsidian)
DIGA	diorite to gabbro
GRBG	granite and biotite granite
IFAL	igneous felsic(acid) alluvium
IGTU	igneous type unknown

IMAL igneous mafic(basic) alluvium
LATI latite
MIIG mixed igneous
PUMI pumice
QUMO quartz monzonite
RHYO rhyolite
SCOR scoria (porcelanite), clinker
TRSY trachyte and syenite
WETU welded tuff (tufa)

Metamorphic

ARGI argilliate
BISC biotite schist
CAAR calcareous argillite
GNBG gneiss and biotite gneiss
MEAL - metamorphic alluvium
METU type unknown
MIME - mixed metamorphic
MISC mica schist
PHYL phyllite
QUAR quartzite
SCHI schist
SILI siltite
SLAT slate

Sedimentary

CACO calcareous conglomerate
CASA calcareous sandstone
CASH calcareous shale
CASI calcareous siltstone
CLAY claystone
CONG conglomerate
DOLO dolomite
LIME limestone
MISE mixed sedimentary
MUDS mudstone
RESH red shale
SAND sandstone
SCAL sedimentary calcareous alluvium
SETU type unknown
SHAL shale
SILT siltstone
SNCA sedimentary non-calcareous alluvium

Miscellaneous

ASHT ash (of any origin)
CLAL clayey alluvium
DUNE sand dunes

GLTI	glacial till, mixed origin
GRAL	gravelly alluvium
GYPS	gypsum
LOES	loess
MIAL	mixed alluvium (full range of textures)
MIRT	mix of two or more rock types
NONE	no surface rocks
NORE	not recorded
SAAL	sandy alluvium
SIAL	silty alluvium

PLOTDIM(m): Plot size and shape entered in meters.

L/R: Plot Radius or Length enter plot radius (for circular plots) or length (for rectangular plots). Indicate units of measurement. Note: a 400 m squared plot has a radius of 11.3 m (37.1 ft); a 100 m squared plot has a radius of 5.6 m (18.5 ft)

PLOT W: Enter width if a rectangular plot shape is used. Enter 0 (numeric) if a circular plot shape is used. Indicate units of measurement

OCC SIZE: (hectares/acres). Occurrence or total stand size surrounding the plot. Indicate if the area was estimated on the ground or from a map. This information is very important for accurate mapping.

EO/PA MAPPED: indicate whether or not the EO boundaries were mapped on an aerial photo, topo map, or sketched on the back of the form. **List number(s) of aerial photos used.** Use sketch maps to help explain relationship among stands and plots in the area as necessary. A solid line indicates an actual boundary and a **dashed** line indicates a boundary of unknown extent.

MANAGEMENT/CONSERVATION/ OTHER COMMENTS: Comment on any stewardship (new or additional) needed to ensure continued existence of the community occurrence, and chances (and means) of bringing it about. Any other pertinent comments go here as well, e.g., "... clearing of competing vegetation has been tried in the past but without success". Comment on the conservation attributes of the occurrence, long-term viability and threats. Also, add miscellaneous comments from all sections. Again, no jokes please or comments in bad taste.

FORMS CHECKOFF: please indicate if other forms were used besides those given.

Forms: ☐ Floristics ☐ Trees ☐ Soils ☐ Quadrats ☐ Point/Line Intercept ☐ EO Assessment ☐ Site Evaluation

Floristic Inventory (Form 3)

PLOT ID: (seven character alphanumeric code). NMNHP standard record tracking number (see general description Form 2).

BOTANIST: Name of person responsible for assessing the botany.

DATE: Date of vegetation inventory. Two-digit month, day and year numbers.

GROUND SURFACE: Enter % cover fraction for each of the following types of cover as they occur over the surface of the plot (must add up to 100%).

- S exposed soil: particles < 1/16 in. (2 mm dia.)
- G – gravel: particles 1/16 to 3 in. dia. (2 mm to 7.5 cm dia.)
- R rock as composed of cobbles, stones and bed rock: particles > 3 in. (>7.5 cm dia.)

- L litter and duff. Litter includes dead and detached vegetation, freshly fallen leaves, needles, twigs < 2 in. (5 cm), bark, fruits, seeds; duff is decomposed litter (fermentation layer and humus layer)
- HCC – herbaceous canopy cover is the total combined canopy cover of forbs and graminoids, including attached litter and current years standing dead annuals, and does not include overlapping cover where canopies interlock
- WO – woody, downed debris: > 2 in. (5 cm dia.)
- M microphytic (cryptogams) crust cover; mosses, lichens and algae on soil surface (excludes cover found on logs, rocks and tree bases)
- WA – water, standing pools of water or streams if within the plot.

VEGETATION COMPOSITION AND ABUNDANCE CONVENTIONS: All species within the plot **and/or** in the stand, depending on plot type, are listed by Strata/lifeform categories (See the NMNHP species list for lifeform classification of individual species).

SPECIES NAME: Use the accepted acronyms from the current NMNHP species list or spell out the species scientific name. **Do not use common names.** If the species is not on the list, spell it out.

Tree species can occur in several height strata and should be listed separately under different acronyms representing different operating taxonomic units (OTU's). A number is attached to the end of the acronym to indicate which strata the OTU is from. For example: PINPON0 represents Pinus ponderosa seedlings of the forb layer, PINPON1 represents saplings < 1 in. dia. of the dwarf shrub layer, PINPON2 are saplings 1 in to 2 in. dia. of the shrub layer, and PINPON3 are mature trees of the tree layer.

If you do not know the name of a species, but know the genus or family, enter those acronyms or spell out the name. Otherwise indicate unknowns with the code UNIDT for unknown trees; UNIDS for unknown shrubs; UNIDDS for dwarf shrub, etc. for each different unknown species with in the different lifeforms. The species ID number will differentiate them.

SPECIES ID NUMBER: Each species that is listed has a line number on the form associated with it by strata/lifeform (T1, S3, G10, F20, etc.). Blank species number lines are available on the forb side of the form for additions: grasses, shrubs, and trees. **Circle the species number when a voucher has been taken for that species.**

Ht: Modal height of each species to the nearest meter for trees, nearest half meter for shrubs, and decimeter for grasses and forbs, but measured in meters. For example a 3dm high grass would be recorded on the data sheet as 0.3m.

P: Phenology. Use "*" for flowering or "@" for fruiting; "X" if it is a dead annual; and leave blank if vegetative.

VOUCHERS: When a voucher specimen is taken for species identification, the species ID number ***MUST BE CIRCLED*** on the plot sheet, and the plot number and species number put on the plant tag or collection sheet of the voucher.

Voucher Tag Format:

Plot ID	05YC001
Date	3/30/05
Species ID#	G5
Project	BAND-Val

If an unknown species from a previous data form is referred to on the current data sheet, **be sure the plot and species ID numbers** that the plant refers to are recorded on the current data sheet and the species ID number is **circled**. For example if you're at plot 05YC001 and you collect UNIDG5 (G5 should be circled on this plot form), then at plot 05YC004 you have the same unknown grass that is the 2nd grass on this data form; **circle G2** and write **05YC001-G5** after the species ID number. **If you know the genus or family, enter those acronyms or spell out the name** before the plot ID number.

Data sheet from 05YC004:

|G1_MUHMON_____ _____|_@|_20_|__.4||___ _____|__|____|____||

|G2_BROMUS - 05YC001-G5_____|__|___5|__.2||___ _____|__|____|____||

|G3_____|__|____|____||___ _____|__|____|____||

Circle G2

TREES: usually single bole with lateral branches, and with the potential to grow over 5 m tall (some may be less than 5 m such as various Juniperus spp.). See NMNHP species list for lifeform classification for verification.

SHRUBS: usually multi-stemmed woody species, spiny rosettes or succulents (cacti, yuccas and agave etc.) less than 5 m and greater than 0.5 m.

DWARF SHRUBS: usually multi-stemmed woody species, spiny rosettes and succulents (cacti, yuccas and agave etc.) less than 0.5 m. Small suffrutescent species that are only woody at or near the base or at the root-crown are usually considered forbs, e.g., *Eriogonum*. See the NMNHP species list for lifeform classification.

GRAMINOIDS: grasses and grass-like plants such as sedges and rushes, but not showy flowering monocots such as iris, lily or dayflower (Iridaceae, Liliaceae or Commelineceae).

FORBS: non-woody perennial and annual species that are not grass-like (includes monocots of the Iridaceae, Liliaceae, Commelineceae).

TOTAL COV. (BY STRATA): percent aerial cover for tree, shrub, dwarf shrub, graminoid and forb layers. This the total canopy cover of a strata as projected over the surface, regardless of species, and does not include overlapping cover where canopies interlock within a strata. ***Note: cover cannot exceed 100%**. For graminoides an additional category is added for **% green** which includes the current years growth (green or tawny), but disregards the standing dead litter (grey).

COV.: percent cover for each species within the plot is estimated by either directly using the precision guidelines below, or the Modified Domin-Krajina scale in Table 1 (both are at the bottom of Floristics-Form 3 and Standard Data Form).

Be sure to check box on data sheet to indicate which cover type is used.

Percent Cover Estimation Precision Guidelines:

+0	species outside the plot, but within the stand
+-	< .05% (trace <0.2 m^2/400 m^2)
0.1%	.05 - < 0.5% (>0.2 m^2 - <2.0 m^2 /400 m^2)
0.5%	.5 - < 1% (>2.0 m^2 - <4.0 m^2 /400 m^2)
1-10%	to the nearest 1% (each % equals 4 m^2/400 m^2)
10-30%	to the nearest 5%
30-100%	to nearest 10%

Table 1. Cover scale. Domin-Krajina cover-abundance scale.

Scalar	Cover range	Concept	Midpoint value	Data value	m^2 / 400m^2
+0	N/A	Outside quadrat	0.001	.001	
+	<0.05%	Solitary or very few	0.025	.025	<.2m^2
1	0.05- 0.124%	very scattered	0.0875	0.1	0.2m^2 - <.5m^2
2	0.125- 0.99%	scattered	0.56	0.5	.5 m^2 - <4 m^2
3	1.0 - 4.9%	common	3.0	3.0	4m^2 - <20m^2
4	5.0 - 9.9%	well-represented			
	7.5	7.5	20m^2 - <40m^2		
5	10.0- 24.9%		17.5	17.5	40m^2 - <100m^2
6	25.0- 32.9%	abundant			
	29.0	29.0	100m^2 - <132m^2		
7	33.0 - 49.9%		41.5	41.5	132m^2 - <200m^2
8	50.0 -74.9%	luxuriant			
	62.5	62.5	200m^2 - < 300m^2		
9	75.0 - 94.9%		85.0	85.0	300m^2 - <380m^2
10	95.0 -100.0%	full cover	97.5	97.5	380m^2 - 400m^2

STANDARD DATA FORM

The Standard Data Form is a combination of the General Plot Description (Form 2) and the Floristic Inventory (Form 3) on a single page, with the data fields in the same order as the previous forms. This form can be used for Standard Plots, Quick Plots, and Observation Points.

STANDARD DATA FORM – Page 2 is a continuation of the floristic inventory portion of the data form when more space is needed for additional species.

QUICK PLOT/OBSERVATION POINT FORM

This form is a condensed version of the Standard Data Form and has 3 observation points per page.

TREE INVENTORY FORM

In forested plots, the total number of trees is counted by species and size class. For each species and size class the count would be done using a dot/line matrix:

. .
. . One dot is used as each of the four corners and represents one tree.

☒ Lines are then used to connect the dots and cross from corner to corner.

Each line also represents one tree. A complete box =’s 10 trees.

For each species, the size class is divided into three categories. The upper box is a count of the live trees in the stand. The two lower boxes are divided into stumps (which are trees that have been cut) and snags (which are standing dead trees).

TRANSECT POINT INTERCEPT FORM

Element Occurrence Condition Evaluation

The ranking of a plant community element occurrence (EO) within a site focuses on three sets of factors: condition, landscape, and size. These are based on concepts originally developed by the Natural Heritage Network and The Nature Conservancy, and derived from protocols developed by the New Mexico Natural Heritage Program as part of its statewide wetland/riparian assessment project. All factors are weighted based on their importance for evaluating ecosystem function and biodiversity value. These weights vary depending on the type of ecosystem being considered, e.g., riparian communities are weighted strongly on hydrological regime, whereas upland communities may receive more emphasis on fire regime. For the pilot project, weighting specifications were developed for upland plant community occurrences. Where information is lacking for any given variable it is not considered in the ranking process. The overall intent is to create a set of consistent criteria for each element that can be used universally to compare occurrences not just at the local level, but the regional and national as well.

Condition Factors

There are nine condition factors that relate directly to the status of a given element occurrence (Table 1); these factors are usually based on direct field measurements of representative stands within a site. Exotic encroachments are considered to be very important indicators of ecosystem health in riparian systems (10 weight) and moderate indicators in uplands (5 weight). There are separate categories for exotics in the canopy versus the understory because of their differing effects on ecosystem structure and function. Structural diversity and cover reflect changes to the expected natural expression of a community as a function of utilization, e.g., logging and fuelwood removals, grazing, etc. Similarly, species richness is a measure of departure from the norm as a result of disturbance. The measurement of fuel loads speaks to the possibility that a given EO might be adversely affected or catastrophically removed due to human-induced fire hazards (fuel loads might be weighted higher in a non-fire-adapted riparian system than in a fire-adapted upland one). Erosion, although a natural process, can also be accelerated as function of disturbance, but the effect of disturbance will vary from community to community. Streambank conditions apply to wetland/riparian occurrence only. Contaminants range potentially from excess nitrogen from sewage outfalls to radioactive dumps. Lastly, parasites and infestations (insect, fungal or microbial) are perhaps some of the best measures of ecosystem health.

Landscape Context Factors

Beyond immediate impacts, an element occurrence is also subject to landscape-level processes that affect its condition and perhaps more importantly its long-term sustainability. Accordingly, there are seven landscape-level parameters considered in the ranking process that can be evaluated through a combination of field studies, historical inquiry and GIS-based map analysis. The first three center on the hydrologic regime and pertain primarily to wetland/riparian community assessment. Stream flow changes, lateral stream movement, and channel condition are best addressed through analysis of historical records, monitoring, and field assessment. Analogously, fire patch size and fire frequency can be addressed by a reconstruction of the past record through tree-ring fire-scar evidence and historical photography, as well as current stand structures as they might reflect fire history.

The last two parameters, landscape impact/fragmentation and landscape community diversity and function, can be evaluated to some degree through field studies. However, GIS-based map analysis can be a powerful evaluation tool because it can reveal the pattern and underlying structure of a site and the relationship of any given element to the landscape. This type of analysis requires detailed and accurate spatial information, e.g., good vegetation maps, road and impact coverages, high-resolution digital elevation models, etc.

Size Factor

Because of its importance in ecological assessment, size is considered independently of condition and landscape context. Greater size implies greater buffering against impacts and hence greater stability and long-term viability within the context of the natural dynamics of the ecosystem.

USGS-NPS Vegetation Mapping Program
Bandelier National Monument

NHNM VEGETATION SURVEY - Standard Data Form – 2008

PLOT ID_____**PLOT TYPE**_____**PROJECT**_____**Subproject** _____ **MO**___**DAY**___**YEAR**_____
EO/PA_____
EO/PA Comment_____
FIELD POINT ID_____**MONUMENT** ☐
_____**MU**_____
SURVEY SITE_____ **SURVEYORS**_____
COUNTY_____ **NM/**____ **MAP NAME**_____ - __ **MARGNUM**___ **10,10** __,__
DIRECTIONS_____
GPS Unit_____ **GPS File**_____ **PREC**____**m UTM:EASTING** __ __ __ __ __ __**NORTHING** __ __ __ __ __ __ __
Zone_____ **Datum: NAD83** ☐ **/ NAD27** ☐**; Other**_____**; Log#**_____D☐ / F☐ **Photographer**_____
PP1:Exp____**AZM**____**FocL**___ **Notes**_____ **PP3:Exp**___**AZM**____**FocL**___ **Notes**_____
PP2:Exp____**AZM**____**FocL**___ **Notes**_____ **PP4:Exp**___**AZM**____**FocL**___ **Notes**_____
Other Site Photos:_____
ELEV _____**ft., SLOPE** ___**%, ASPECT**____**, SLOPE SHAPE**_____/___**, Surface Rock Type**_____/_____
LANDFORM:_____/ __ __ __ __ __ __
Lndfrm/Geol/Soil Notes:_____
SUMMARY DESCRIPTION: □ **Site** □ **Veg** □ **Adjacent Com** □ **Disturb/Frag** □ **Animals** □ **Disease** □ **Management** □ **Condition**
_____
_____
_____
_____
_____
_____
_____
_____
PLOTDIM(M)L/R ____**W** ____ **EO Size**_____**Ha**__**/Ac**__ **Est**□ **Map** □ **Condition**____ **Landscape Context**_____ ☐ **EOMapped**:_____
Comments:_____
Ground Surface Cover (%) Soil_____ Grav_____ Rock_____ Litter_____ HCC_____ Wood_____ Micro_____ Water_____=100%
Botanist:_____ ***CIRCLE YOUR VOUCHER NUMBERS***
Phenology: * = Flowering; @ = fruiting; X = dead annual ☐ Cover Scale or ☐ Percent Cover

TREES Total Cov____%	P	Cov	Ht(m)	GRAMINOIDS Tot Cov____%; Green____%	P	Cov	Ht(m)
T1				G1			
T2				G2			
T3				G3			
T4				G4			
T5				G5			
SHRUBS >.5m Total Cov____ %	P	Cov	Ht(m)	G6			
S1				G7			
S2				G8			
S3				FORBS Total Cover____%	P	Cov	Ht(m)
S4				F1			
S5				F2			
S6				F3			
S7				F4			
S8				F5			
DWARF SHRUBS < .5m Tot.Cov____ %	P	Cov	Ht(m)	F6			
DS1				F7			
DS2				F8			
DS3				F9			
DS4				F10			
DS5				F11			
DS6				F12			
DS7				F13			

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Ht= species modal height (trees nearest m, shrubs nearest .5m, grasses & forbs nearest dm), recorded in meters

Cover: +0=outside plot,in stand	**2**=scattered, <1% (.5m^2 & <4m^2)	**5**=10-<25%(40m^2 & <100m^2)	**8**=50-<75%
Scale +=solitary/very few(<0.2m^2/400m^2)	**3**=1-<5% (>4m^2 & <20m^2)	**6**=25-<33%(100m^2 & <132m^2)	**9**=75-<95%
1=very scattered (0.2m^2 -<.5m/400m^2)	**4**=5-<10%(>20m^2 & <40m^2)	**7**=33-<50%	**10**=95-100%

Percent: +0=outside plot,in stand	**0.5%**= scattered, <1% (.5m^2 & <4m^2)	**30-100%** to nearest 10%
Scale +=solitary/very few(<0.2m^2/400m^2)	**1-10%** to the nearest 1% (each % equals 4m^2/400m^2)	
0.1%=very scattered (0.2m^2 -<.5m/400m^2)	**10-30%** to the nearest 5%	

☐ **Trees** ☐ **Soils** ☐ **Quadrats** ☐ **Point/Line Intercept** ☐ **EO Assessment Form** ☐ **Site Evaluation**

USGS-NPS Vegetation Mapping Program
Bandelier National Monument

NHNM VEGETATION SURVEY—GENERAL PLOT DESCRIPTION FORM 2 (2008)

PLOT ID_____**PLOT TYPE**_____**PROJECT**_____**Subproject** _____ **MO**___**DAY**___**YEAR**_____
EO/PA_____
EO/PA Comment_____
FIELD POINT ID_____**MU**_____
SURVEY SITE_____ **SURVEYORS**_____
LOCATION/DIRECTIONS_____
_____
COUNTY_____ **NM/**_____ **MAP NAME**_____ **-** __
MARGNUM___ **10,10** __,__
GPS Unit_____ **GPS File**_____ **UTM: EASTING** _ _ _ _ _ _ _ **NORTHING** _ _ _ _ _ _ _ _
PREC_____ **Zone**_____ **Datum: NAD83** ☐ **/ NAD27** ☐**;**
Other_____
☐ **Monument/:**_____
☐ **Photo Pt:**_____**/Cam Ht**_____ **Log#**____D☐ / F☐ **Photographer**_____
PP1:AZM___**FocL**___**Exp**___**Notes**_____**PP5:AZM**___**FocL**___**Exp**___**Notes**_____
PP2:AZM___**FocL**___**Exp**___**Notes**_____**PP6:AZM**___**FocL**___**Exp**___**Notes**_____
PP3:AZM___**FocL**___**Exp**___**Notes**_____**PP7:AZM**___**FocL**___**Exp**___**Notes**_____
PP4:AZM___**FocL**___**Exp**___**Notes**_____**PP8:AZM**___**FocL**___**Exp**___**Notes**_____
Other Site Photos/com:_____
_____
ELEV _____ **ft. SLOPE** _____**% ASPECT**_____ **SLOPE SHAPE**_____/_____
LANDFORM:_____/ __ __ __ __ __ __
Landform/Geology/Soil Comment_____
_____
SURFACE ROCK TYPE_____/_____
SITE / VEG SUMMARY:_____
_____
_____
_____
_____
_____
_____
_____
Adjacent Communities:_____
_____
_____
_____
Disease:_____
_____
Animal Use Evidence:_____
_____
Condition (Disturbance, Fragmentation, Erosion):_____
_____
_____
_____
_____
Distance in km to nearest human disturbance (roads, dam, clearcut, housing, mine, dump, etc.):_____**km**
Comments:_____
_____

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PLOTDIM (m) L/R ____W ____ Comments:_____
_____OCC Size ☐HA ☐AC, ☐ Ground Estimate ☐ Mapped Estimate Comments:_____
_____
☐ EO/PA Mapped:_____
Management/Conservation/Other Comments:_____
_____
Forms: ☐ Floristics ☐ Trees ☐ Soils ☐ Quadrats ☐ Point/Line Intercept ☐ EO Assessment ☐ Site Evaluation

TREE INVENTORY FORM – NHNM 2006

Plot ID:_____ Project_____ Subproject:_____ Surveyors:_____

Date:_____ - _____ - 200___

PLOTDIM (m) L/R ____W ____

Species Code	0-2" <4.5'	0-2" >4.5'	2-4"	4-6"	6-8"	8-10"	10-12"	12-14"	14-16"	16-18"	18-20"	>20"	DRC___ DBH___
													DRC___ DBH___
Stump →													DRC___ DBH___
→													DRC___ DBH___
													DRC___ DBH___
													DRC___ DBH___
													DRC___ DBH___
													DRC___ DBH___
													DRC___ DBH___
													DRC___ DBH___
													DRC___ DBH___
													DRC___ DBH___

Tree Species	DBH (in)	DCH (in)	Core Age	Tree Height (ft)	Comment		Tree Species	DBH (in)	DCH (in)	Core Age	Tree Height (ft)	Comment

DRC = diameter root crown; DBH = diameter breast height; DCH = diameter core height; measure trees > 20”

Appendix D: Bandelier National Monument Plant Species List

Appendix D lists the plant species recorded on vegetation plots at Bandelier National Monument between 2002 and 2008 as part of the vegetation mapping project. Plant voucher specimens were collected to confirm field identifications as necessary and are housed at the University of New Mexico Herbarium. Natural Heritage New Mexico botanist Yvonne Chauvin identified specimens to the lowest level possible given the material at hand and assigned names according to the PLANTS database (USDA-NRCS 2002) and the Integrated Taxonomic Information System (ITIS). Suitable quality specimens were accessioned with both UNM accession numbers and NPS record numbers tied to the Herbarium and NPS databases. Species are arranged alphabetically by family.

Plant species recorded at Bandelier National Monument during the vegetation mapping project.

Family	Scientific name	Common name
Aceraceae	*Acer glabrum*	Rocky Mountain maple
	Acer negundo	box elder
Agavaceae	*Yucca baccata*	banana yucca
	Yucca glauca	soapweed yucca
Anacardiaceae	*Rhus glabra*	smooth sumac
	Rhus trilobata	skunkbush sumac
	Toxicodendron rydbergii	western poison ivy
Apiaceae	*Berula erecta*	cutleaf waterparsnip
	Cicuta maculata	spotted water hemlock
	Conioselinum scopulorum	Rocky Mountain hemlockparsley
	Heracleum maximum	cow parsnip
	Osmorhiza depauperata	bluntseed sweetroot
	Pseudocymopterus montanus	alpine false springparsley
Apocynaceae	*Apocynum androsaemifolium*	spreading dogbane
	Apocynum cannabinum	Indianhemp
Araliaceae	*Aralia racemosa*	American spikenard
Asclepiadaceae	*Asclepias asperula* ssp. *asperula*	spider milkweed
	Asclepias tuberosa	butterfly milkweed
	Asclepias tuberosa ssp. *interior*	butterfly milkweed
Asteraceae	*Achillea millefolium*	common yarrow
	Achillea millefolium var. *occidentalis*	western yarrow
	Ageratina herbacea	fragrant snakeroot
	Agoseris aurantica	orange agoseris
	Antennaria marginata	whitemargin pussytoes
	Antennaria parvifolia	smallleaf pussytoes
	Artemisia bigelovii	Bigelow's sagebrush
	Artemisia campestris	field sagewort
	Artemisia carruthii	Carruth's sagewort
	Artemisia dracunculus	tarragon
	Artemisia filifolia	sand sagebrush
	Artemisia franserioides	ragweed sagebrush
	Artemisia frigida	fringed sagewort

Family	Scientific name	Common name
Asteraceae (*cont.*)	*Artemisia ludoviciana*	Louisiana sagewort
	Artemisia tridentata	big sagebrush
	Baccharis salicina	false willow
	Bahia dissecta	ragleaf bahia
	Berlandiera lyrata	lyreleaf greeneyes
	Bidens frondosa	devil's beggartick
	Brickellia brachyphylla	plumed brickellbush
	Brickellia californica	California brickellbush
	Brickellia eupatorioides var. *chlorolepis*	false boneset
	Brickellia grandiflora	tasselflower brickellbush
	Brickelliastrum fendleri	Fendler's brickellbush
	Chaetopappa ericoides	rose heath
	Cirsium palladium	pale thistle
	Cirsium parryi	Parry's thistle
	Cirsium undulatum	wavyleaf thistle
	Cirsium vulgare	bull thistle
	Conyza canadensis	Canadian horseweed
	Dieteria canescens	hoary aster
	Dieteria canescens var. *glabra*	hoary tansyaster
	Ericameria nauseosa	rubber rabbitbrush
	Ericameria parryi var. *attenuata*	Parry's rabbitbrush
	Erigeron divergens	spreading fleabane
	Erigeron eximius	sprucefir fleabane
	Erigeron flagellaris	trailing fleabane
	Erigeron formosissimus	beautiful fleabane
	Erigeron speciosus	aspen fleabane
	Erigeron subtrinervis	threenerve fleabane
	Euthamia occidentalis	western goldenrod
	Gaillardia pulchella	firewheel
	Gutierrezia sarothrae	broom snakeweed
	Helianthus annuus	common sunflower
	Helianthus petiolaris	prairie sunflower
	Helianthus spp	common sunflower
	Heliomeris multiflora	showy goldeneye
	Heterotheca villosa	hairy goldenaster
	Hieracium fendleri	yellow hawkweed
	Hymenopappus filifolius	fineleaf hymenopappus
	Hymenoxys richardsonii	pingue hymenoxys
	Isocoma pluriflora	southern jimmyweed
	Lactuca serriola	prickly lettuce
	Laennecia schiedeana	pineland marshtail

Family	Scientific name	Common name
Asteraceae (*cont.*)	*Liatris punctata*	dotted gayfeather
	Machaeranthera biglovii	Bigelow's tansyaster
	Machaeranthera tanacetifolia	tanseyleaf aster
	Oreochrysum parryi	Parry's goldenrod
	Packera fendleri	Fendler's ragwort
	Packera hartiana	Hart's ragwort
	Packera neomexicanus var. *mutabilis*	New Mexico groundsel
	Pericome caudata	mountain leaftail
	Pseudognaphalium macounii	Macoun's cudweed
	Pseudognaphalium stramineum	cottonbatting cudweed
	Rudbeckia hirta	black-eyed Susan
	Rudbeckia laciniata	cutleaf coneflower
	Senecio bigloviii	nodding ragwort
	Senecio eremophilus	desert groundsel
	Senecio spartioides	broom groundsel
	Senecio wootonii	Wooton's ragwort
	Solidago missouriensis	Missouri goldenrod
	Solidago mollis	velvety goldenrod
	Solidago nemoralis var. *decemflora*	goldenrod
	Solidago simplex ssp. *simplex* var. *simplex*	Mt. Albert goldenrod
	Solidago speciosa var. *pallida*	showy goldenrod
	Solidago wrightii var. *wrightii*	Wright's goldenrod
	Sonchus asper	spiny sowthistle
	Stephanomeria pauciflora	brownplume wirelettuce
	Symphyotrichum ascendens	western aster
	Symphyotrichum laeve var. *geyeri*	Geyer's aster
	Taraxacum officinale	common dandelion
	Tetraneuris argentea	perkysue
	Thelesperma filifolium	stiff greenthread
	Thelesperma filifolium var. *intermedium*	stiff greenthread
	Thelesperma megapotamicum	Hopi tea greenthread
	Thymophylla pentachaeta	fiveneedle pricklyleaf
	Townsendia eximia	tall townsendia
	Tragopogon dubius	yellow salsify
	Tragopogon pratensis	meadow salsify
	Xanthisma gracile	slender goldenweed
	Xanthisma spinulosum	lacy tansyaster
	Xanthium strumarium	rough cocklebur
Berberidaceae	*Berberis fendleri*	Colorado barberry
	Mahonia repens	Oregongrape
Betulaceae	*Alnus incana* ssp. *tenuifolia*	thinleaf alder

Family	Scientific name	Common name
Betulaceae (*cont.*)	*Alnus oblongifolia*	Arizona alder
	Betula occidentalis	water birch
Boraginaceae	*Cryptantha cinerea*	James' catseye
	Cryptantha minima	little cryptantha
	Hackelia besseyi	Bessey's stickseed
	Hackelia floribunda	manyflowered stickseed
	Lappula occidentalis	flatspine stickseed
	Lithospermum incisum	narrowleaf gromwell
	Lithospermum multiflorum	manyflowered gromwell
	Mertensia franciscana	Franciscan bluebells
	Mertensia lanceolata	prairie bluebells
Brassicaceae	*Arabis glabra*	tower rockcress
	Arabis lignifera	desert rockcress
	Boechera fendleri	Fendler's rockcress
	Descurainia incana ssp. *viscosa*	mountain tansymustard
	Descurainia obtusa ssp. *obtusa*	blunt tansymustard
	Descurainia pinnata ssp. *halictorum*	western tanseymustard
	Draba aurea	golden draba
	Erysimum capitatum	sanddune wallflower
	Lepidium ramosissimum var. *bourgeauanum*	Bourgeau's pepperweed
	Lepidium virginicum var. *medium*	medium pepperweed
	Pennellia longifolia	longleaf mock thelypody
	Rorippa nasturtium-aquaticum	watercress
	Schoenocrambe linearifolia	slimleaf plainsmustard
	Sisymbrium altissimum	tall tumblemustard
	Thelypodium wrightii	Wright's thelypody
Cactaceae	*Cylindropuntia imbricata*	tree cholla
	Echinocereus coccineus	scarlet hedgehog cactus
	Echinocereus dasyacanthus	rainbow cactus
	Echinocereus fendleri var. *fendleri*	Fendler's hedgehog cactus
	Echinocereus triglochidiatus	kingcup cactus
	Escobaria vivipara	spinystar
	Opuntia erinacea	grizzlybear pricklypear
	Opuntia phaeacantha	tulip pricklypear
	Opuntia polyacantha	plains pricklypear
Campanulaceae	*Campanula parryi*	Parry's bellflower
	Campanula rotundifolia	bluebell bellflower
	Lobelia cardinalis	cardinalflower
Cannabaceae	*Humulus lupulus* var. *neomexicanus*	common hop
Capparaceae	*Polanisia dodecandra* ssp. *trachysperma*	sandyseed clammyweed
Caprifoliaceae	*Lonicera involucrata*	twinberry honeysuckle

Family	Scientific name	Common name
Caprifoliaceae (*cont.*)	*Symphoricarpos oreophilus*	whortleleaf snowberry
Caryophyllaceae	*Arenaria fendleri*	Fendler's sandwort
	Arenaria fendleri var. *fendleri*	Fendler's sandwort
	Arenaria lanuginosa ssp. *saxosa*	spreading sandwort
	Cerastium arvense	mouseear chickweed
	Cerastium fontanum ssp. *vulgare*	big chickweed
	Silene menziesii ssp. *menziesii*	Menzies' campion
	Silene scouleri ssp. *pringlei*	Pringle's campion
Celastraceae	*Paxistima myrsinites*	myrtle boxleaf
Chenopodiaceae	*Atriplex canescens*	fourwing saltbush
	Chenopodium atrovirens	pinyon goosefoot
	Chenopodium berlandieri var. *berlandieri*	Berlandier's goosefoot
	Chenopodium fremontii	Fremont's goosefoot
	Chenopodium graveolens	fetid goosefoot
	Chenopodium leptophyllum	narrowleaf goosefoot
	Chenopodium pratericola	desert goosefoot
	Chenopodium rubrum	red goosefoot
	Kochia scoparia	common kochia
Cornaceae	*Cornus sericea*	redosier dogwood
Cupressaceae	*Juniperus communis*	common juniper
	Juniperus deppeana	alligator juniper
	Juniperus monosperma	oneseed juniper
	Juniperus scopulorum	Rocky Mountain juniper
Cyperaceae	*Carex bolanderi*	Bolanders's sedge
	Carex brevior	shortbeak sedge
	Carex geophila	White Mountain sedge
	Carex hystericina	porcupine sedge
	Carex inops ssp. *heliophila*	sun sedge
	Carex interior	inland sedge
	Carex microptera	smallwing sedge
	Carex obtusata	obtuse sedge
	Carex occidentalis	western sedge
	Carex pellita	woolly sedge
	Carex petasata	Liddon sedge
	Carex praegracilis	clustered field sedge
	Carex rossii	Ross' sedge
	Carex siccata	dryspike sedge
	Carex vulpinoidea	fox sedge
	Carex wootonii	Wooton's sedge
	Cyperus fendlerianus	Fendler's flatsedge
	Eleocharis palustris	common spikerush

Family	Scientific name	Common name
Cyperaceae (*cont.*)	*Schoenoplectus pungens* var. *longispicatus*	common threesquare
Dennstaedtiaceae	*Pteridium aquilinum*	western brackenfern
	Pteridium aquilinum var. *pubescens*	hairy brackenfern
	Cystopteris fragilis	brittle bladderfern
Dryopteridaceae	*Dryopteris filix-mas*	male fern
	Woodsia oregana	Oregon woodsia
Elaeagnaceae	*Elaeagnus angustifolia*	Russian olive
Ephedraceae	*Ephedra viridis*	mormon tea
Equisetaceae	*Equisetum arvense*	field horsetail
	Equisetum hyemale var. *affine*	scouringrush horsetail
	Equisetum laevigatum	smooth horsetail
Ericaceae	*Arctostaphylos uvD-ursi*	kinnikinnick
	Vaccinium myrtillus	whortleberry
Euphorbiaceae	*Chamaesyce fendleri*	Fendler's sandmat
	Croton texensis	Texas croton
	Euphorbia brachycera	horned spurge
	Tragia ramosa	branched noseburn
	Amorpha canescens	leadplant
	Dalea candida	slender white prairieclover
	Dalea candida var. *oligophylla*	white prairieclover
	Dalea purpurea	purple prairieclover
	Dalea purpurea var. *purpurea*	purple prairieclover
	Lathyrus lanszwertii	Nevada peavine
	Lathyrus lanszwertii var. *leucanthus*	Arizona peavine
	Lotus wrightii	Wright's deervetch
	Lupinus argenteus	silvery lupine
	Lupinus kingii	King's lupine
	Medicago lupulina	black medick
	Melilotus officinalis	yellow sweetclover
	Psoralidium tenuiflorum	slimflower scurfpea
	Robinia neomexicana	New Mexico locust
	Thermopsis montana var. *montana*	mountain goldenbanner
	Thermopsis rhombifolia var. *montana*	mountain thermopsis
	Trifolium repens	white clover
	Trifolium wormskioldii	cows clover
	Vicia americana	American vetch
Fagaceae	*Quercus* ×*pauciloba*	wavyleaf oak
	Quercus gambelii	Gambel's oak
	Quercus grisea	gray oak
	Quercus turbinella	shrub live oak
Fumariaceae	*Corydalis aurea*	golden smoke
Gentianaceae	*Frasera speciosa*	showy frasera

Family	Scientific name	Common name
Gentianaceae (*cont.*)	*Gentiana affinis*	pleated gentian
	Swertia radiata	showy frasera
Geraniaceae	*Geranium caespitosum*	pineywoods geranium
	Geranium richardsonii	Richardson's geranium
Grossulariaceae	*Ribes aureum*	golden currant
	Ribes cereum	wax currant
	Ribes inerme	whitestem gooseberry
	Ribes leptanthum	trumpet gooseberry
	Ribes montigenum	gooseberry currant
	Ribes wolfii	Wolf's currant
Hydrangeaceae	*Fendlera rupicola*	cliff fendlerbrush
	Jamesia americana	cliffbush
	Philadelphus microphyllus	littleleaf mockorange
	Hydrophyllum fendleri	Fendler's waterleaf
	Phacelia crenulata var. *corrugata*	notched scorpion-weed
Hydrophyllaceae	*Phacelia heterophylla*	varileaf phacelia
	Phacelia integrifolia var. *integrifolia*	gypsum phacelia
Iridaceae	*Iris missouriensis*	Rocky Mountain iris
Juncaceae	*Juncus arcticus* var. *balticus*	Baltic rush
	Juncus confusus	Colorado rush
	Juncus dudleyi	slender rush
	Juncus ensifolius var. *montanus*	Rocky Mountain rush
Lamiaceae	*Clinopodium vulgare*	wild basil
	Dracocephalum parviflorum	American dragonhead
	Hedeoma nana	dwarf false pennyroyal
	Mentha arvensis	wild mint
	Monarda fistulosa var. *menthifolia*	mintleaf beebalm
	Prunella vulgaris	common selfheal
Liliaceae	*Allium cernuum*	nodding onion
	Allium geyeri	Geyer's onion
	Maianthemum racemosum	feathery false lily of the vally
	Maianthemum racemosum ssp. *amplexicaule*	feathery false Solomon's seal
	Maianthemum stellatum	starry false Solomon's seal
	Zigadenus elegans	mountain deathcamas
Linaceae	*Linum neomexicanum*	New Mexico yellow flax
	Linum puberulum	plains flax
Loasaceae	*Mentzelia albicaulis*	whitestem blazingstar
	Mentzelia multiflora	manyflowered mentzelia
	Mentzelia multiflora var. *multiflora*	Adonis blazingstar
	Mentzelia springeri	Santa Fe blazingstar
Malvaceae	*Sidalacea candida*	white checkermallow

Family	Scientific name	Common name
Malvaceae (*cont.*)	*Sphaeralcea coccinea*	scarlet globemallow
	Sphaeralcea fendleri	Fendler's globemallow
Nyctaginaceae	*Mirabilis linearis*	narrowleaf four o'clock
	Mirabilis multiflora	Colorado four o'clock
	Mirabilis oxybaphoides	smooth spreading four o'clock
Oleaceae	*Forestiera pubescens*	New Mexico olive
	Forestiera pubescens var. *pubescens*	New Mexico olive
Onagraceae	*Epilobium brachycarpum*	willowherb
	Epilobium ciliatum	hairy willowherb
	Gaura mollis	velvetweed
	Oenothera elata ssp. *hirsutissima*	Hooker's eveningprimrose
Orchidaceae	*Corallorrhiza maculata*	summer coralroot
	Goodyera oblongifolia	western rattlesnake plantain
	Platanthera sparsiflora var. *sparsiflora*	sparse-flowered bog orchid
Oxalidaceae	*Oxalis violacea*	violet woodsorrel
Pinaceae	*Abies concolor*	white fir
	Picea engelmannii	Engelmann's spruce
	Picea pungens	blue spruce
	Pinus edulis	pinyon pine
	Pinus flexilis	limber pine
	Pinus ponderosa	ponderosa pine
	Pinus strobiformis	southwestern white pine
	Pseudotsuga menziesii	Douglas-fir
Plantaginaceae	*Plantago patagonica*	woolly plantain
Poaceae	*Achnatherum hymenoides*	Indian ricegrass
	Achnatherum lettermanii	Letterman's needlegrass
	Agropyron cristatum	crested wheatgrass
	Agrostis exarata	spike bentgrass
	Agrostis gigantean	redtop
	Agrostis scabra	rough bentgrass
	Agrostis stolonifera	creeping bentgrass
	Andropogon gerardii	big bluestem
	Aristida arizonica	Arizona threeawn
	Aristida longispica	slimspike threeawn
	Aristida purpurea	purple threeawn
	Aristida purpurea var. *fendleriana*	Fendler's threeawn
	Aristida purpurea var. *longiseta*	red threeawn
	Aristida purpurea var. *purpurea*	purple threeawn
	Blepharoneuron tricholepis	pine dropseed
	Bothriochloa barbinodis	cane bluestem
	Bothriochloa springfieldii	Springfield's beardgrass
	Bouteloua curtipendula	sideoats grama

Family	Scientific name	Common name
Poaceae (*cont.*)	*Bouteloua eriopoda*	black grama
	Bouteloua gracilis	blue grama
	Bouteloua hirsuta	hairy grama
	Bromus anomalus	nodding brome
	Bromus carinatus	California brome
	Bromus catharticus	rescuegrass
	Bromus ciliatus	fringed brome
	Bromus frondosus	weeping brome
	Bromus inermis	smooth brome
	Bromus japonicus	Japanese brome
	Bromus lanatipes	woolly brome
	Bromus porteri	Porter brome
	Bromus tectorum	cheatgrass
	Calamagrostis canadensis	Canada reedgrass
	Calamagrostis stricta ssp. *inexpansa*	northern reedgrass
	Dactylis glomerata	orchardgrass
	Danthonia parryi	Parry's Danthonia
	Danthonia spicata	Poverty oat grass
	Deschampsia cespitosa	tufted hairgrass
	Dichanthelium oligosanthes var. *scribnerianum*	Scribner's rosette grass
	Elymus canadensis	Canada wildrye
	Elymus elymoides	bottlebrush squirreltail
	Elymus glaucus	blue wildrye
	Elymus repens	quackgrass
	Elymus trachycaulus	slender wheatgrass
	Elymus trachycaulus ssp. *subsecundus*	bearded wheatgrass
	Elymus trachycaulus ssp. *trachycaulus*	slender wheatgrass
	Elymus x pseudorepens	false quackgrass
	Festuca arizonica	Arizona fescue
	Festuca arundinaceae	tall fescue
	Festuca idahoensis	Idaho fescue
	Festuca sororia	ravine fescue
	Festuca thurberi	Thurber's fescue
	Glyceria striata	fowl mannagrass
	Hesperostipa comata	needle-and-thread grass
	Hesperostipa comata ssp. *comata*	needle-and-thread grass
	Hordeum jubatum	foxtail barley
	Koeleria macrantha	prairie junegrass
	Leersia oryzoides	rice cutgrass
	Lolium perenne	perennial ryegrass
	Lycurus setosus	bristly wolfstail
	Melica porteri	Porter's melicgrass

Family	Scientific name	Common name
Poaceae (*cont.*)	*Muhlenbergia arsenei*	Navago muhly
	Muhlenbergia dubia	pine muhly
	Muhlenbergia mexicana	Mexican muhly
	Muhlenbergia montana	mountain muhly
	Muhlenbergia pauciflora	New Mexico muhly
	Muhlenbergia porteri	bush muhly
	Muhlenbergia ramulosa	green muhly
	Muhlenbergia richardsonis	Mat muhly
	Muhlenbergia torreyi	ring muhly
	Muhlenbergia wrightii	spike muhly
	Munroa squarrosa	false buffalograss
	Oryzopsis asperifolia	roughleaf ricegrass
	Oryzopsis micrantha	littleseed ricegrass
	Panicum bulbosum	bulb panicgrass
	Panicum hallii	Hall's panicgrass
	Panicum virgatum	switchgrass
	Pascopyrum smithii	western wheatgrass
	Phleum alpinum	alpine timothy
	Phleum pratense	timothy
	Piptatherum micranthum	littleseed ricegrass
	Pleuraphis jamesii	galleta
	Poa compressa	Canada bluegrass
	Poa fendleriana	muttongrass
	Poa occidentalis	New Mexico bluegrass
	Poa palustris	fowl bluegrass
	Poa pratensis	Kentucky bluegrass
	Polypogon monspeliensis	annual rabbitsfoot grass
	Polypogon viridis	beardless rabbitsfoot
	Psathyrostachys juncea	Russian wildrye
	Pseudoroegneria spicata ssp. *spicata*	bluebunch wheatgrass
	Schizachne purpurascens	false melic
	Schizachyrium scoparium	little bluestem
	Setaria leucopila	streambed bristlegrass
	Sorghastrum nutans	Indiangrass
	Sporobolus contractus	spike dropseed
	Sporobolus cryptandrus	sand dropseed
	Thinopyrum intermedium	intermediate wheatgrass
	Torreyochloa pallida	pale false mannagrass
	Trisetum spicatum	spike trisetum
	Vulpia octoflora	sixweeks fescue
Polemoniaceae	*Ipomopsis aggregata*	skyrocket gilia
	Ipomopsis aggregata ssp. *formosissima*	scarlet skyrocket

Family	Scientific name	Common name
Polemoniaceae (*cont.*)	*Ipomopsis longiflora*	flaxflowered gilia
Polygonaceae	*Eriogonum alatum*	winged buckwheat
	Eriogonum hieraciifolium	hawkweed buckwheat
	Eriogonum jamesii	James' buckwheat
	Eriogonum jamesii var. *jamesii*	James' buckwheat
	Eriogonum microthecum var. *simpsonii*	Simpson's buckwheat
	Eriogonum polycladon	sorrel buckwheat
	Eriogonum racemosum	redroot buckwheat
	Polygonum convolvulus	black bindweed
	Polygonum douglasii ssp. *johnstonii*	Johnston's knotweed
	Polygonum persicaria	Lady's thumb
	Rumex acetosella	common sheep sorrel
	Rumex crispus	curly dock
Portulacaceae	*Talinum parviflorum*	showy flameflower
Primulaceae	*Androsace septentrionalis*	pygmyflower rockjasmine
	Dodecatheon pulchellum	darkthroat shootingstar
Pteridaceae	*Cheilanthes fendleri*	Fendler's lipfern
Pyrolaceae	*Orthilia secunda*	sidebells wintergreen
Ranunculaceae	*Actaea rubra*	red baneberry
	Anemone cylindrica	candle anemone
	Aquilegia elegantula	western red columbine
	Clematis columbiana	rock clematis
	Clematis columbiana var.*columbiana*	rock clematis
	Clematis ligusticifolia	western white clematis
	Ranunculus cardiophyllus	heartleaf buttercup
	Ranunculus cymbalaria	alkali buttercup
	Thalictrum fendleri	Fendler's meadowrue
Rhamnaceae	*Ceanothus fendleri*	Fendler's ceanothus
	Rhamnus spp.	buckthorn
Rosaceae	*Agrimonia striata*	roadside agrimony
	Amelanchier pumila	dwarf serviceberry
	Argentina anserina	silverweed cinquefoil
	Cercocarpus montanus	mountain mahogany
	Cercocarpus montanus var. *paucidentatus*	Shaggy mountain mahogany
	Crataegus succulenta	fleshy hawthorn
	Dasiphora floribunda	shrubby cinquefoil
	Fallugia paradoxa	Apacheplume
	Fragaria vesca	woodland strawberry
	Fragaria virginiana	Virginia strawberry
	Fragaria virginiana ssp.*glauca*	Virginia strawberry
	Geum aleppicum	yellow avens

Family	Scientific name	Common name
Rosaceae (*cont.*)	*Geum triflorum*	old man whiskers
	Holodiscus dumosus	rockspirea
	Physocarpus monogynus	mountain ninebark
	Potentilla hippiana	woolly cinquefoil
	Potentilla norvegica	Norwegian cinquefoil
	Potentilla pulcherrima	beautiful cinquefoil
	Potentilla rivalis	brook cinquefoil
	Prunus serotina	black cherry
	Prunus virginiana	common chokecherry
	Prunus virginiana var. *melanocarpa*	black chokecherry
	Rosa woodsii	Woods' rose
	Rubus idaeus	red raspberry
	Rubus idaeus ssp. *strigosus*	grayleaf red raspberry
	Rubus parviflorus	thimbleberry
Rubiaceae	*Galium aparine*	stickywilly
	Galium boreale	northern bedstraw
Rutaceae	*Ptelea trifoliata*	common hoptree
Salicaceae	*Populus angustifolia*	narrowleaf cottonwood
	Populus deltoides ssp. *wislizeni*	Rio Grande cottonwood
	Populus tremuloides	quaking aspen
	Salix amygdaloides	peachleaf willow
	Salix exigua	coyote willow
	Salix irrorata	bluestem willow
Saxifragaceae	*Heuchera parvifolia*	littleleaf alumroot
	Saxifraga bronchialis	yellowdot saxifrage
Scrophulariaceae	*Castilleja integra*	wholeleaf Indian paintbrush
	Castilleja miniata	scarlet Indian paintbrush
	Cordylanthus wrightii	Wright's birdbeak
	Mimulus glabratus	roundleaf monkeyflower
	Orthocarpus luteus	yellow owlclover
	Orthocarpus purpureoalbus	purplewhite owlclover
	Pedicularis procera	giant lousewort
	Penstemon barbatus	beardlip penstemon
	Verbascum thapsus	common mullein
	Veronica americana	American speedwell
Solanaceae	*Datura wrightii*	sacred thornapple
	Solanum americanum	American black nightshade
Solanaceae (*cont*)	*Solanum elaeagnifolium*	silverleaf nightshade
Tamaricaceae	*Tamarix ramosissima*	saltcedar
Typhaceae	*Typha latifolia*	broadleaf cattail
Ulmaceae	*Celtis laevigata* var. *reticulata*	netleaf hackberry
	Ulmus pumila	Siberian elm

Family	Scientific name	Common name
Urticaceae	*Urtica dioica*	stinging nettle
	Urtica gracilenta	mountain nettle
Valerianaceae	*Valeriana acutiloba* var. *acutiloba*	sharpleaf valerian
	Valeriana edulis	edible valerian
Verbenaceae	*Glandularia bipinnatifida*	Dakota mock vervain
	Verbena bracteata	bigbract verbena
Violaceae	*Viola adunca*	hookedspur violet
	Viola canadensis	Canadian white violet
Vitaceae	*Parthenocissus vitacea*	thicket creeper
	Vitis arizonica	canyon grape

Appendix E: Plant Association Key

Appendix E presents dichotomous keys to the plant associations at Bandelier National Monument. The first key leads to four separate keys for the major classes (e.g., forests and woodlands, shrublands, etc.). The Forest and Woodlands key (Key 1) also has five forest subkeys. Find descriptions for each association in Appendix F.

At each step, the keys use either explicitly specified cover values for indicator species or specific adjectives that relate to species canopy cover as shown below in Table E-1.

Table E-1. Definitions for the canopy cover descriptions found in the plant association keys.

Canopy cover description	Definition
Absent	Individuals are not found in stand
Present	Individuals found in stand
Accidental	Individuals very infrequent, occasional, or limited to special microsites
Scarce/Scattered (uncommon)	Canopy coverage <1%
Common	Canopy coverage >1%
Poorly Represented	Canopy coverage <5%
Well Represented	Canopy coverage >5%, but less than 10%
Abundant	Canopy coverage >10%, but less than 25%
Very Abundant	Canopy coverage >25%, but less than 50%
Luxuriant	Canopy coverage >50%
Dominant	Cover is greater than any other species of the same life form
Codominant	Cover is as great as any other species of the same life form
Regeneration	Understory trees represented by established seedlings and/or saplings

Key to the major classes

A. Substrate of mostly rocks and boulders with total vegetation cover <10% or dominated by lithomorphic species: **KEY 4, Lithmorphic Vegetation, page E-9**

A. Total vegetation cover >10% and not dominated by lithomorphic species: **(B)**

B. Trees dominant, typically >25% canopy cover; or if <25%, clearly the dominant and/or the characteristic growth form: **KEY 1, Forests and Woodlands, page E-1**

B. Trees <10%, clearly not predominant: **(C)**

C. Shrubs >25%, or if <25%, clearly the dominant and/or the characteristic growth form: **KEY 2, Shrublands, page E-6**

C. Shrubs <25%, herbs clearly the dominant and/or characteristic growth form: **KEY 3, Herbaceous Vegetation, page E-7**

Key 1: Forests and Woodlands

1. *Picea engelmannii* or *Abies lasiocarpa* dominant: ***Picea engelmannii / Erigeron eximius* Forest**

1. *Picea engelmannii* or *Abies lasiocarpa* subdominant or absent: **(2)**

2. *Abies concolor*, *Pseudotsuga menziesii*, *Picea pungens*, *Pinus flexilis*, *Pinus strobiformis*, *Populus tremuloides* dominant, totaling >25% relative cover: **Forest Subkey I, Mixed Conifer and Aspen Forests (E-2)**

2. *Abies concolor*, *Pseudotsuga menziesii*, *Picea pungens*, *Pinus flexilis*, *Pinus strobiformis* subdominant or absent, totaling <25% relative cover: **(3)**

3. *Pinus ponderosa* dominant: **Forest and Woodlands Subkey II, Pinus ponderosa Forests** (E-3)

3. *Pinus ponderosa* subdominant or absent: **(4)**

4. Broadleaf riparian species dominant (*Populus* sp., *Acer negundo*): **Forest Subkey III, Broadleaf Riparian Forests (E-4)**

4. Tall conifers and riparian species poorly represented or absent: **Forest Subkey IV, Pinyon and Juniper Woodlands (E-5)**

Forest and Woodlands Subkey I: Mixed Conifer and Aspen Forests

1. Riparian trees codominant: ***Abies concolor - Acer negundo / Alnus incana* ssp. *tenuifolia* Forest**

1. Riparian trees subdominant or absent: **(2)**

2. *Quercus gambelii* well represented: **(3)**

2. *Quercus gambelii* poorly represented: (5)

3 *Populus tremuloides* codominant or dominant, >75% relative cover: ***Populus tremuloides* / Invasive Perennial Grasses Forest**

3 *Populus tremuloides* subdominant or absent, <75% relative cover: **(3a)**

3.a Forbs well represented to luxuriant, codominant or dominant over graminoids: ***Abies concolor - Pseudotsuga menziesii / Quercus gambelii / Thalictrum fendleri* Forest**

3.a Forbs poorly represented: **(4)**

4. *Abies concolor* dominant or codominant with *Pseudotsuga menziesii*: ***Abies concolor - Pseudotsuga menziesii / Quercus gambelii / Carex rossii* Forest**

4. *Pseudotsuga menziesii* dominant, *Abies concolor* subdominant or absent: ***Pseudotsuga menziesii - Quercus gambelii* Forest**

5. *Festuca thurberi* or *Danthonia parryi* well represented and dominant: **(6)**

5. *Festuca thurberi* or *Danthonia parryi* poorly represented or absent: **(7)**

6. *Populus tremuloides* codominant or dominant, >75% relative cover: ***Populus tremuloides / Festuca thurberi* Forest**

6. *Populus tremuloides* subdominant, <75% relative cover or absent: ***Abies concolor - Pseudotsuga menziesii / Festuca thurberi - Danthonia parryi* Woodland**

7. Seeded grass species (*Bromus inermis*, *Elymus* x *pseudorepens*, *Pascopyrum smithii*) common to abundant: ***Populus tremuloides* / Invasive Perennial Grasses Forest**

7. Seeded grass species uncommon or absent: **(8)**

8. Forbs well represented to luxuriant, codominant or dominant over graminoids: **(9)**
8. Forbs poorly represented: **(11)**

9. *Picea pungens* dominant or codominant: ***Picea pungens / Fragaria virginiana* Forest**
9. *Picea pungens* subdominant or absent: **(10)**

10. *Populus tremuloides* codominant or dominant, > 75% relative cover: ***Populus tremuloides / Thalictrum fendleri* Forest**
10. *Populus tremuloides* subdominant, <25% relative cover or absent: ***Abies concolor - Pseudotsuga menziesii / Thalictrum fendler*i Forest**

11. Shrubs and subshrubs well represented to abundant: **(12)**
11. Shrubs and subshrubs poorly represented: **(15)**

12. *Acer glabrum* common to well represented: **(13)**
12. *Acer glabrum* uncommon or absent: **(14)**

13. *Populus tremuloides* dominant, >75% relative cover: ***Populus tremuloides - Acer glabrum* Forest**
13. *Populus tremuloides* subdominant or absent, <75% relative cover: ***Abies concolor - Pseudotsuga menziesii / Acer glabrum* Forest**

14. *Juniperus communis* well represented: ***Abies concolor / Juniperus communis* Forest**
14. *Juniperus communis* poorly represented, mesic tall shrubs well represented (*Jamesia americana*, *Physocarpus monogynus*, *Holodiscus dumosus*): ***Abies concolor - Pseudotsuga menziesii / Jamesia americana - Holodiscus dumosus* Scree Woodland**

15. Graminoids common: ***Abies concolor - Pseudotsuga menziesii / Carex rossii* Forest**
15. Graminoids uncommon, understory sparse: **(16)**

16. *Abies concolor* dominant, *Pseudotsuga menziesii* subdominant: ***Abies concolor / Mahonia repens* Forest**
16. *Pseudotsuga menziesii* dominant, *Abies concolor* subdominant or absent: ***Pseudotsuga menziesii / Mahonia repens* Forest**

Forest and Woodlands Subkey II: Pinus Ponderosa Forests

1. Riparian tree species codominant, *Forestiera pubescens* common to abundant in the understory: ***Pinus ponderosa / Forestiera pubescens* Forest**
1. Riparian species poorly represented or absent: **(2)**

2. Shrubs well represented, dominant over herbs: **(3)**
2. Shrubs poorly represented: **(6)**

3. *Quercus* × *pauciloba* and/or *Cercocarpus montanus* well represented: ***Pinus ponderosa / Quercus* × *pauciloba* Woodland**

3. *Quercus* × *pauciloba* and/or *Cercocarpus montanus* poorly represented or absent: **(4)**

4. *Quercus gambelii* and/or *Robinia neomexicana* well represented: **(5)**

4. *Quercus gambelii* and/or *Robinia neomexicana* and other shrubs poorly represented: **(6)**

5. *Robinia neomexicana* well represented: ***Pinus ponderosa / Robinia neomexicana*** Woodland

5. *Robinia neomexicana* poorly represented: ***Pinus ponderosa - Quercus gambelii / Carex inops* ssp. *heliophila* Woodland**

6. *Festuca thurberi* or *Danthonia parryi* well represented: ***Pinus ponderosa / Festuca thurberi* Woodland**

6. *Festuca thurberi* or *Danthonia parryi* poorly represented: **(7)**

7. *Bouteloua gracilis* well represented to abundant, dominant: ***Pinus ponderosa / Bouteloua gracilis* Woodland**

7. *Bouteloua gracilis* poorly represented or absent: **(8)**

8. *Muhlenbergia montana* common, dominant or codominant: ***Pinus ponderosa / Muhlenbergia montana* Woodland**

8. *Muhlenbergia montana* uncommon or absent: **(9)**

9. *Schizachyrium scoparium* common, dominant: ***Pinus ponderosa / Schizachyrium scoparium* Woodland**

9. *Schizachyrium scoparium* uncommon or absent: ***Pinus ponderosa / Carex inops* ssp. *heliophila* Woodland**

Forest and Woodlands Subkey III: Broadleaf Riparian Forests

1. *Populus angustifolia* dominant: **(2)**

1. *Populus angustifolia* poorly represented or absent: **(3)**

2. *Acer negundo* and *Forestiera pubescens* dominant in the understory: ***Populus angustifolia - Acer negundo / Forestiera pubescens* Forest**

2. *Fallugia paradoxa* dominant shrub: ***Populus angustifolia / Fallugia paradoxa* Forest**

3. *Populus deltoides* dominant: ***Populus deltoides / Salix irrorata* Forest**

3. *Populus deltoides* absent: **(4)**

4. *Acer negundo* dominant: **(6)**

4. *Acer negundo* absent: **(9)**

5. *Alnus incana* ssp. *tenuifolia* well represented to abundant, codominant: ***Acer negundo - Alnus incana* ssp. *tenuifolia* Woodland**

5. *Alnus incana* ssp. *tenuifolia* absent: **(6)**

6. *Alnus oblongifolia* well represented to abundant, codominant: ***Acer negundo - Alnus oblongifolia* Forest**

6. *Alnus oblongifolia* absent: **(7)**

7. *Prunus virginiana* well represented to abundant, codominant: ***Acer negundo / Prunus virginiana* Forest**

7. *Prunus virginiana* poorly represented or absent: **(8)**

8. *Salix irrorata* well represented to abundant: ***Acer negundo / Salix irrorata* Forest**

8. *Salix irrorata* absent: ***Acer negundo / Eleocharis palustris* Forest**

9. *Alnus incana* ssp. *tenuifolia* abundant, dominant: ***Alnus incana* ssp. *tenuifolia* / *Agrostis gigantea Semi-natural* Shrubland**

9. *Alnus incana* ssp. *tenuifolia* poorly represented or absent: **(10)**

10. *Elaeagnus angustifolia* abundant, dominant: ***Elaeagnus angustifolia / Bromus tectorum Semi-natural* Woodland**

10. *Elaeagnus angustifolia* and other riparian tree species absent: **Forest Subkey IV, Pinyon and Juniper Woodlands (E-5)**

Forest and Woodlands Subkey IV: Pinyon and Juniper Woodlands

1. Substrate mostly rocks and boulders; total understory vegetative cover <10% or dominated by lithomorphic species: ***Juniperus monosperma* / Rockland Woodland**

1. Understory vegetative cover >10% and not dominated by lithomorphic species: **(2)**

2. Tall shrubs dominant over subshrubs or herbs: **(3)**

2. Tall shrubs poorly represented; herbs dominant: **(9)**

3. *Artemisia tridentata* well represented, dominant: ***Juniperus monosperma* / *Artemisia tridentata* Wood land**

3. *Artemisia tridentata* poorly represented or absent: **(4)**

4. *Forestiera pubescens* well represented: **Juniperus monosperma / Forestiera pubescens Woodland**

4. *Forestiera pubescens* poorly represented: **(5)**

5. *Rhus trilobata* common: ***Juniperus monosperma* / *Rhus trilobata* Woodland**

5. *Rhus trilobata* absent, scarce, or poorly represented: **(6)**

6. *Quercus* × *pauciloba* and/or *Cercocarpus montanus* well represented: **(7)**

6. *Quercus* × *pauciloba* absent, but *Cercocarpus montanus* common to well represented: ***Juniperus monosperma* / *Cercocarpus montanus* Woodland**

7. *Juniperus deppeana* well represented, dominant tree: ***Juniperus deppeana - Quercus* × *pauciloba* Woodland**

7. *Juniperus monosperma* well represented, dominant: **(8)**

8. Mature *Pinus edulis* greater than 25% of the total tree cover: ***Pinus edulis* / *Quercus* × *pauciloba* Woodland**
8. Mature *Pinus edulis* less than 25% of the total tree cover or absent: ***Juniperus monosperma* / *Quercus* × *pauciloba* Woodland [phases]**

9. *Hesperostipa neomexicana* well represented, dominant: ***Juniperus monosperma* / *Hesperostipa neomexicana* Woodland**
9. *Hesperostipa neomexicana* not dominant: **(10)**

10. *Bouteloua eriopoda* dominant: ***Juniperus monosperma* / *Bouteloua eriopoda* Woodland**
10. *Bouteloua eriopoda* not dominant: **(11)**

11. *Bouteloua gracilis* dominant: **(12)**
11. *Bouteloua gracilis* not dominant: (13)

12. Mature *Pinus edulis* greater than 25% of the total tree cover: ***Pinus edulis- (Juniperus monosperma)* / *Bouteloua gracilis* Woodland**
12. Mature *Pinus edulis* less than 25% of the total tree cover or absent: ***Juniperus monosperma* / *Bouteloua gracilis* Woodland**

13. *Bouteloua curtipendula* dominant: ***Juniperus monosperma* / *Bouteloua curtipendula* Woodland**
13. *Bouteloua curtipendula* not dominant: **(14)**

14. *Juniperus deppeana* greater than 25% of the total tree cover, usually dominant tree: ***Juniperus deppeana* / Sparse Woodland [Phases]**
14. *Juniperus deppeana* less than 25% of the total tree cover: ***Juniperus monosperma* / Sparse Woodland [Phases]**

Key 2: Shrublands

1. *Artemisia filifolia* abundant: ***Artemisia filifolia* / *Bouteloua eriopoda* Shrubland**
1. *Artemisia filifolia* poorly represented or absent: **(2)**

2. Mesic forest species such as *Jamesia americana* or *Physocarpus monogynus* dominate: ***Jamesia americana (Physocarpus monogynus, Holodiscus dumosa)* Rock Outcrop Shrubland**
2. Mesic forest species absent or poorly represented: **(3)**

3. *Ceanothus fendleri* well represented, dominant: ***Ceanothus fendleri* / *Muhlenbergia montana* Shrubland**
3. *Ceanothus fendleri* poorly represented or absent: **(4)**

4. *Fallugia paradoxa* well represented: **(5)**
4. *Fallugia paradoxa* poorly represented: **(6)**

5. Located on rocky or bouldery slopes, total herbaceous cover <5%: ***Fallugia paradoxa* / Rockland Shrubland**

5. Located in an arroyo or drainage, total herbaceous cover <5%: ***Fallugia paradoxa* / Dry WashShrubland**

6. *Quercus* × *pauciloba* and/or *Cercocarpus montanus* well represented: **(7)**
6. *Quercus* × *pauciloba* and/or *Cercocarpus montanus* poorly represented or absent: **(9)**

7. *Forestiera pubescens* well represented: ***Quercus* × *pauciloba* - *Forestiera pubescens* Shrubland**
7. *Forestiera pubescens* poorly represented or absent: **(8)**

8. Grasses well represented: ***Quercus* × *pauciloba* / *Bouteloua curtipendula* Shrubland**
8. Grasses poorly represented: ***Quercus* × *pauciloba* - *Cercocarpus montanus* Shrubland**

9. *Quercus gambelii* and/or *Robinia neomexicana* well represented, dominant or codominant: **(10)**
9. *Quercus gambelii* and/or *Robinia neomexicana* poorly represented or absent: **(12)**

10. *Muhlenbergia montana* common, dominant: ***Quercus gambelii* / *Robinia neomexicana* / *Muhlenbergia montana* Shrubland**
10. *Muhlenbergia montana* uncommon or absent: **(11)**

11. *Quercus gambelii* uncommon or absent: ***Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland**
11. *Quercus gambelii* common to luxuriant, *Robinia neomexicana* codominant: ***Quercus gambelii* / *Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland**

12. *Tamarix ramosissima* luxuriant, dominant: **(13)**
12. *Tamarix ramosissima* poorly represented or absent: **(14)**

13. *Forestiera pubescens* abundant: ***Tamarix chinensis* / *Forestiera pubescens* Semi-natural Shrubland**
13. *Salix exigua* abundant: ***Tamarix chinensis* - *Salix exigua* Semi-natural Shrubland**

14. *Salix amygdaloides* and *Salix exigua* abundant to luxuriant, codominant: ***Salix amygdaloides* - *Salix exigua* Shrubland**
14. Shrubs poorly represented or absent: **Key 3, Herbaceous Vegetation**

Key 3: Herbaceous Vegetation

1. *Calamagrostis canadensis* well represented, dominant: ***Calamagrostis canadensis* Herbaceous Vegetation**
1. *Calamagrostis canadensis* poorly represented or absent: **(2)**

2. *Festuca thurberi* or *Danthonia parryi* well represented to abundant: **(3)**
2. *Festuca thurberi* and *Danthonia parryi* uncommon or absent: **(5)**

3. *Festuca arizonica* well represented: ***Danthonia parryi* - *Festuca arizonica* Herbaceous Vegetation**
3. *Festuca arizonica* poorly represented or absent: **(4)**

4. *Festuca thurberi* dominant, *Danthonia parryi* uncommon or absent: ***Festuca thurberi / Potentilla hippiana* Herbaceous Vegetation**

4. *Festuca thurberi* or *Danthonia parryi* dominant: ***Festuca thurberi - Danthonia parryi / Potentilla hippiana* Herbaceous Vegetation**

5. *Poa pratensis* well represented: **(6)**

5. *Poa pratensis* poorly represented: **(7)**

6. *Pascopyrum smithii* well represented, dominant or codominant: ***Poa pratensis – (Pascopyrum smithii)* Herbaceous Semi-natural Herbaceous Vegetation**

6. *Pascopyrum smithii* poorly represented or absent: ***Poa pratensis / Taraxacum officinale* Semi-natural Herbaceous Vegetation**

7. *Muhlenbergia montana* well represented to abundant, dominant; seeded grasses poorly represented or absent: **(8)**

7. *Muhlenbergia montana* poorly represented or absent: **(9)**

8. *Schizachyrium scoparium* dominant over or codominant with *Blepharoneuron tricholepis*: ***Muhlenbergia montana - Schizachyrium scoparium* Herbaceous Vegetation**

8. *Blepharoneuron tricholepis* dominant over *Schizachyrium scoparium*: ***Muhlenbergia montana* Herbaceous Vegetation**

9. *Schizachyrium scoparium* common, dominant or codominant: **(10)**

9. *Schizachyrium scoparium* uncommon or absent: **(11)**

10. *Bouteloua gracilis* common, codominant: ***Schizachyrium scoparium - Bouteloua gracilis* Herbaceous Vegetation**

10. *Bouteloua gracilis* uncommon or absent: ***Schizachyrium scoparium - Koeleria macrantha* Herbaceous Vegetation**

11. *Bouteloua eriopoda* common, dominant or codominant: **(12)**

11. *Bouteloua eriopoda* uncommon or absent: **(13)**

12. *Bouteloua curtipendula* well represented: ***Bouteloua eriopoda - Bouteloua curtipendula* Herbaceous Vegetation**

12. *Bouteloua gracilis* common to well represented: ***Bouteloua eriopoda - Bouteloua gracilis* Herbaceous Vegetation**

13. *Bouteloua gracilis* common, dominant or codominant: **(14)**

13. *Bouteloua gracilis* poorly represented or absent: **(17)**

14. *Muhlenbergia torreyi* well represented, codominant: ***Bouteloua gracilis - Muhlenbergia torreyi* Herbaceous Vegetation**

14. *Muhlenbergia torreyi* poorly represented or absent: **(15)**

15. *Pleuraphis jamesii* common, codominant: ***Bouteloua gracilis - Pleuraphis jamesii* Herbaceous Vegetation**

15. *Pleuraphis jamesii* poorly represented or absent: **(16)**

16. *Pascopyrum smithii* common, codominant: ***Bouteloua gracilis - Pascopyrum smithii* / Ruderal Herbaceous Vegetation**

16. *Pascopyrum smithii* uncommon or absent: ***Bouteloua gracilis* / *Gutierrezia sarothrae* Herbaceous Vegetation**

17. Seeded grasses (*Elymus* x *pseudorepens*, *Bromus inermis*, *Festuca idahoensis*, or *Pascopyrum smithii*) well represented, abundant: **(18)**

17. Seeded grasses poorly represented: **(19)**

18. *Muhlenbergia montana* well represented: ***Muhlenbergia montana* - Seeded Grasses Herbaceous Vegetation**

18. *Elymus* x*pseudorepens* or other seeded species dominant: ***Elymus x pseudorepens - Bromus carinatus* Semi-natural Herbaceous Vegetation**

19. *Bothriochloa barbinodis*, *Setaria leucopila* well represented: ***Bothriochloa barbinodis - Setaria leucopila* Herbaceous Vegetation**

19. *Bothriochloa barbinodis*, *Setaria leucopila* poorly represented or absent: **(20)**

20. *Juncus arcticus* well represented to abundant, dominant: ***Juncus arcticus* Herbaceous Vegetation**

20. *Juncus arcticus* poorly represented or absent: **(21)**

21. *Eleocharis palustris* abundant, dominant: ***Eleocharis palustris – Carex praegracilis* / *Berula erecta* Herbaceous Vegetation**

21. *Eleocharis palustris* poorly represented or absent: **(22)**

22. Ruderal vegetation dominant: **(23)**

22. Ruderal vegetation poorly represented or absent; Lithomorphic vegetation dominant: **Key 4 , Lithomorphic Vegetation**

23. Plot located in a post-burn site: **Ruderal Post-fire Herbaceous Vegetation**

23. Plot not located in a post-burn site: **(24)**

24. Plot located in a previously flooded area: **Ruderal Flood Zone Herbaceous Vegetation**

24. Plot not located in a previously flooded area: **Ruderal Disturbed Ground Herbaceous Vegetation**

Key 4: Lithomorphic Vegetation

1. Substrate dominated by exposed bedrock or large boulders: **Sparse Vegetation / Boulder Rockland**

1. Substrate dominated by loose scree: **Sparse Vegetation / Scree**

Appendix F: Plant Association Descriptions for Bandelier National Monument

As part of the Bandelier National Monument (BAND) vegetation mapping project, 95 plant associations were identified, and these are described in this appendix in detail, following FGDC (1997 and 2008) protocols. 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 description are valuable for comparing each association as it appears in the park with the global range of variation for that association (Clark et al. 2009).

The Natural Heritage New Mexico at the University of New Mexico and NatureServe collaboratively prepared this report to provide local and global descriptions for each plant association found at BAND. These descriptions reflect NatureServe's accumulated data and analysis. Global descriptions of NVC associations are available on NatureServe's Explorer Web site (http://www.natureserve.org/explorer); local descriptions are not. Only local descriptions are available for provisional and park special vegetation types. In this appendix, the arrangement of the plant associations follows the original hierarchy structure of the 1997 NVC system (FGDC 1997; Grossman et al. 1998) to conform with prior NPS park mapping project products (in the main report the associations are arranged following the new hierarchy per FGDC (2008)). The descriptions often use specific adjectives that relate to species canopy cover as shown in Table F-1.

Table F-1. Definitions for the canopy cover descriptions found in the plant association keys.

Canopy cover description	Definition
Absent	
Individuals are not found in stand	
Present	Individuals found in stand.
Accidental	Individuals very infrequent, occasional, or limited to special microsites.
Scarce/Scattered (uncommon)	Canopy coverage < 1%.
Common	Canopy coverage > 1%.
Poorly Represented	Canopy coverage < 5%.
Well Represented	Canopy coverage >5%, but less than 10%.
Abundant	Canopy coverage >10%, but less than 25%.
Very Abundant	Canopy coverage > 25%, but less than 50%.
Luxuriant	Canopy coverage > 50%.
Dominant	Cover is greater than any other species of the same life form.
Codominant	Cover is as great as any other species of the same life form.
Regeneration	Understory trees represented by established seedlings and/or saplings.

Plant Associations

I. Forest

Conical-crowned temperate or subpolar needle-leaved evergreen forest

Abies concolor Forest Alliance

Abies concolor - (Pseudotsuga menziesii) / Quercus gambelii / Carex rossii Forest F-6
Abies concolor - (Pseudotsuga menziesii) / Quercus gambelii / Thalictrum fendleri Forest F-9
Abies concolor - (Pseudotsuga menziesii) / Thalictrum fendleri Forest F-12
Abies concolor - Acer negundo/ Alnus incana ssp. *tenuifolia* Forest F-15
Abies concolor - Pseudotsuga menziesii / Acer glabrum Forest F-17
Abies concolor - Pseudotsuga menziesii / Carex rossii Forest F-21
Abies concolor / Juniperus communis Forest F-24
Abies concolor / Mahonia repens Forest F-27

Picea engelmannii Forest Alliance

Picea engelmannii / Erigeron eximius Forest F-30

Picea pungens Forest Alliance

Picea pungens / Fragaria virginiana ssp.Forest F-33

Pseudotsuga menziesii Forest Alliance

Pseudotsuga menziesii / Mahonia repens Forest F-36
Pseudotsuga menziesii / Quercus gambelii Forest F-39

Montane or boreal cold-deciduous forest

Populus tremuloides Forest Alliance

Populus tremuloides / Acer glabrum Forest F-43
Populus tremuloides / Festuca thurberi Forest F-46
Populus tremuloides / Invasive Perennial Grasses Forest F-50
Populus tremuloides / Thalictrum fendleri Forest F-53

Temporarily flooded cold-deciduous forest

Acer negundo Temporarily Flooded Forest Alliance

Acer negundo - Alnus incana ssp. *tenuifolia* Forest F-56
Acer negundo - Alnus oblongifolia Forest F-59

Populus deltoides Temporarily Flooded Forest Alliance

Populus deltoides ssp. *wislizeni / Salix irrorata* Forest F-62

II. Woodland

Rounded-crowned temperate or subpolar needle-leaved evergreen woodland

Juniperus deppeana Woodland Alliance

Juniperus deppeana / Quercus X *pauciloba* Woodland F-65

Juniperus monosperma Woodland Alliance

Juniperus monosperma / Artemisia tridentata Woodland F-68

Juniperus monosperma / Bouteloua curtipendula Woodland F-71

Juniperus monosperma / Bouteloua eriopoda Woodland F-75

Juniperus monosperma / Bouteloua gracilis Woodland F-78

Juniperus monosperma / Forestiera pubescens Woodland F-82

Juniperus monosperma / Quercus X *pauciloba* Woodland F-85

Juniperus monosperma / Rockland Woodland F-88

Juniperus monosperma / Sparse Understory Woodland F-91

Pinus ponderosa Woodland Alliance

Pinus ponderosa / Bouteloua gracilis Woodland F-94

Pinus ponderosa / Carex inops ssp. *heliophila* Woodland F-97

Pinus ponderosa / Festuca thurberi Woodland F-101

Pinus ponderosa / Muhlenbergia montana Woodland F-104

Pinus ponderosa / Quercus X *pauciloba* Woodland F-107

Pinus ponderosa / Quercus gambelii / Carex inops ssp. *heliophila* Woodland F-110

Pinus ponderosa / Robinia neomexicana Woodland F-113

Pinus ponderosa / Schizachyrium scoparium Woodland F-116

Conical-crowned temperate or subpolar needle-leaved evergreen woodland

Abies concolor Woodland Alliance

Abies concolor - (Pseudotsuga menziesii) / Jamesia americana - Holodiscus dumosus Scree Woodland ... F-120

Abies concolor - Pseudotsuga menziesii / Festuca thurberi - Danthonia parryi Woodland F-123

Temporarily-flooded temperate or subpolar needle-leaved evergreen woodland

Pinus ponderosa Temporarily Flooded Woodland Alliance

Pinus ponderosa / Forestiera pubescens Forest F-126

Temporarily-flooded cold-deciduous woodland

Salix amygdaloides Temporarily Flooded Woodland Alliance

Salix amygdaloides / Salix exigua Woodland F-129

III. Shrubland

Sclerophyllous temperate broad-leaved evergreen shrubland

Ceanothus (*fendleri, velutinus*) Shrubland Alliance

Ceanothus fendleri / Muhlenbergia montana Shrubland F-132

Lowland microphyllous evergreen shrubland

Artemisia filifolia Shrubland Alliance

Artemisia filifolia / Bouteloua eriopoda Shrubland F-135

Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland

Fallugia paradoxa Shrubland Alliance

***F**allugia paradoxa - Brickellia* spp. - (*Holodiscus dumosus*) Scree Shrubland [Provisional] F-138

Temperate cold-deciduous shrubland

Jamesia americana Shrubland Alliance

Jamesia americana - (Physocarpus monogynus, Holodiscus dumosus) Rock Outcrop Shrubland F-141

Quercus X *pauciloba* Shrubland Alliance

Quercus X *pauciloba / Bouteloua curtipendula* Shrubland F-144

Quercus X pauciloba / Cercocarpus montanus Shrubland F-147

Quercus gambelii Shrubland Alliance

Quercus gambelii - Robinia neomexicana / Carex inops ssp. *heliophila* Shrubland F-150

Quercus gambelii - Robinia neomexicana / Muhlenbergia montana Shrubland F-153

Robinia neomexicana Shrubland Alliance

Robinia neomexicana / Carex inops ssp. *heliophila* Shrubland F-156

Intermittently flooded cold-deciduous shrubland

Fallugia paradoxa Intermittently Flooded Shrubland Alliance

Fallugia paradoxa Colorado Plateau Desert Wash Shrubland F-159

IV. Herbaceous Vegetation

Medium tall bunch temperate or subpolar grassland

Bouteloua curtipendula Herbaceous Alliance

Bouteloua curtipendula - Bothriochloa barbinodis Herbaceous Vegetation F-162

Festuca thurberi Herbaceous Alliance

Festuca thurberi - (Lathyrus lanszwertii var. leucanthus, Potentilla spp.) Herbaceous Vegetation F-165

Festuca thurberi - Danthonia parryi / Potentilla hippiana Herbaceous Vegetation F-168

Muhlenbergia montana Herbaceous Alliance

Muhlenbergia montana - Schizachyrium scoparium Herbaceous Vegetation F-171

Muhlenbergia montana Herbaceous Vegetation F-174

Poa pratensis Semi natural Herbaceous Alliance

Poa pratensis - (Pascopyrum smithii) Semi natural Herbaceous Vegetation F-177

Short sod temperate or subpolar grassland

Bouteloua eriopoda Herbaceous Alliance

Bouteloua eriopoda - Bouteloua curtipendula Herbaceous Vegetation F-180

Bouteloua eriopoda - Bouteloua gracilis Herbaceous Vegetation..... F-183

Seasonally flooded temperate or subpolar grassland

Eleocharis (*palustris, macrostachya*) Seasonally Flooded Herbaceous Alliance

Eleocharis palustris - Carex praegracilis - Berula erecta Herbaceous Vegetation F-186

Juncus balticus Seasonally Flooded Herbaceous Alliance

Juncus arcticus Herbaceous Vegetation..... F-189

Short temperate or subpolar lowland grassland with a sparse needle leaved or microphyllous dwarf shrub layer

Bouteloua gracilis Dwarf shrub Herbaceous Alliance

Gutierrezia sarothrae / *Bouteloua gracilis* Dwarf shrub Herbaceous Vegetation..... F-192

V. Hierarchy Placement Undetermined and Incidentals

Park Specials

Acer negundo / *Salix irrorata* Forest [Park Special].....F-195

Elymus x pseudorepens - Bromus carinatus Semi-natural Herbaceous Vegetation [Park Special].....F-197

Forestiera pubescens / Ruderal Herbs Shrubland [Park Special]..... F-199

Muhlenbergia montana - Seeded Grasses Herbaceous Vegetation [Park Special].....F-201

Pascopyrum smithii / Ruderal Herbaceous Vegetation [Park Special]..... F-203

Poa pratensis - Taraxacum officinale Semi-natural Herbaceous Vegetation [Park Special].....F-205

Populus angustifolia - Acer negundo / *Forestiera pubescens* Forest [Park Special].....F-207

Populus angustifolia / *Fallugia paradoxa* Forest [Park Special]..... F-209

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Tamarix chinensis / *Forestiera pubescens* Semi-natural Shrubland [Park Special]..... F-213

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I. Forest

Abies concolor - (*Pseudotsuga menziesii*) / *Quercus gambelii* / *Carex rossii* Forest

White Fir - (Douglas fir) / Gambel Oak / Ross' Sedge Forest

CODE	CEGL005351
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	ABIES CONCOLOR FOREST ALLIANCE (A.152) White 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 is widespread in New Mexico and Arizona and likely occurs throughout much of the southern Rocky Mountains and high plateaus of Utah. Stands occur from 2200 to 2900 m (7200-9500 feet) in elevation with aspects that range from the northwest through northeast at lower elevations to southerly on higher sites. Slopes are gentle on the shoulder slopes of drainages and canyons (8-18%) and steep on canyon sideslopes (5-75%). Geologic substrates include volcanic andesite, rhyolite, and rhyolitic tuffs. Ground surface is typically dominated by leaf litter with coarse woody debris often abundant. The vegetation is characterized by a moderate to dense mixed tree canopy (50-80% cover) that is dominated by *Abies concolor* and *Pseudotsuga menziesii*. *Pinus ponderosa* can also be a present to codominant, and *Pinus strobiformis* or *Pinus flexilis* are often present. The understory is characterized by *Quercus gambelii* shrubs and occasionally as mature trees with over 5% cover. Shrubs are often diverse and cover may exceed 25%, with *Jamesia americana* and *Rosa woodsii* often present with over 5% cover. In addition, on post fire sites, *Robinia neomexicana* can be present to codominant, but does not dominate. The herbaceous layer is characteristically poorly represented with total cover typically less than 5%. Graminoids are the most abundant, with *Carex rossii* usually dominant and *Poa fendleriana* as a common associate. Forbs are poorly represented, with *Thalictrum fendleri* the most frequent representative.

DISTRIBUTION

Bandelier National Monument

This association was observed and mapped on the drainage slopes of Burnt Mesa and Mesa del Rito and on the slopes Canon de los Frijoles and Capulin Canyon.

Globally

This forest association is widespread in New Mexico and Arizona and likely occurs throughout much of the southern Rocky Mountains and high plateaus of Utah.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association occurs from 2200 to 2700 m (7200-8900 feet) in elevation with aspects that range from the northwest through northeast at lower elevations to southerly on higher sites. Slopes are gentle on the shoulder slopes of the drainages and canyons (8-18%) and steep on the canyon sideslopes (50-75%). Geologic substrates include volcanic

andesite, rhyolite, and rhyolitic tuffs. Ground surface is typically dominated by leaf litter with coarse woody debris often abundant.

Globally

This association ranges in elevation from 2200 to 2900 m (7200-9500 feet) with aspects that range from the northwest through northeast at lower elevations to southerly on higher sites. Slopes are gentle on the shoulder slopes of drainages and canyons (8-18%) and steep on canyon sideslopes (50-75%). Geologic substrates include volcanic andesite, rhyolite, and rhyolitic tuffs. Ground surface is typically dominated by leaf litter with coarse woody debris often abundant.

VEGETATION DESCRIPTION

Bandelier National Monument

The canopy of this forest association is dominated by *Abies concolor* and *Pseudotsuga menziesii* with cover ranging from 50 80%. *Pinus ponderosa* can also be a well represented codominant, and *Pinus strobiformis* or *Pinus flexilis* are often present. The understory is characterized by *Quercus gambelii* shrubs and occasionally mature trees. Shrub cover can exceed 25%, with *Jamesia americana* and *Rosa woodsii* often well represented among the 15 shrubs and vines recorded for association. In addition, on post fire sites, *Robinia neomexicana* can be abundant. The herbaceous layer is characteristically poorly represented with total cover typically less than 5%. The graminoids are the most abundant with *Carex rossii* and with *Poa fendleriana* as a common associate. Forbs are poorly represented with *Thalictrum fendleri* the most frequent representative. Overall herbaceous species richness is comparatively low with only 17 graminoids and 19 forbs recorded.

Globally

Vegetation in this association is characterized by a moderate to dense mixed tree canopy (50 80% cover) that is dominated by *Abies concolor* and *Pseudotsuga menziesii*. *Pinus ponderosa* can also be a present to codominant, and *Pinus strobiformis* or *Pinus flexilis* are often present. The understory is characterized by *Quercus gambelii* shrubs and occasionally as mature trees with over 5% cover. Shrubs are often diverse and cover may exceed 25%, with *Jamesia americana* and *Rosa woodsii* often present with over 5% cover. In addition, on post fire sites, *Robinia neomexicana* can be present to codominant, but does not dominate. The herbaceous layer is characteristically poorly represented with total cover typically less than 5%. Graminoids are the most abundant, with *Carex rossii* usually dominant and *Poa fendleriana* as a common associate. Forbs are poorly represented, with *Thalictrum fendleri* the most frequent representative.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Abies concolor, Pinus ponderosa, Pseudotsuga menziesii*
Tree canopy	*Quercus gambelii*
Tall shrub/sapling	*Quercus gambelii*
Herb (field)	*Carex rossii*

Globally

Stratum	Species
Tree canopy	*Abies concolor, Pinus ponderosa, Pseudotsuga menziesii*
Tree canopy	*Quercus gambelii*
Herb (field)	*Carex rossii*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14 Feb 2008).

CLASSIFICATION COMMENTS

Bandelier National Monument

Data are not available.

Globally

This association was formerly considered part of the more broadly defined *Abies concolor* / *Quercus gambelii* Forest (CEGL000261), but was subsequently refined for New Mexico and now includes relatively dry stands as indicated by the presence of *Carex rossii*. Rangewide review of *Abies concolor* / *Quercus gambelii* Forest (CEGL000261) is needed to break out and reclassify these more xeric stands from relatively mesic types such as *Abies concolor* - (*Pseudotsuga menziesii*) / *Quercus gambelii* / *Thalictrum fendleri* Forest (CEGL005352).

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM plots 03BD103, 04BD010, 04BD022, 06JC181, 06JC537, 06JC546, and 06JC590 (3 standard and 3 rapid plots).

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz

REFERENCES

DeVelice et al. 1986, Moir and Ludwig 1979, Western Ecology Working Group n.d.

Abies concolor - (*Pseudotsuga menziesii*) / *Quercus gambelii* / *Thalictrum fendleri* Forest

White Fir - (Douglas fir) / Gambel Oak / Fendler's Meadowrue Forest

CODE	CEGL005352
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	ABIES CONCOLOR FOREST ALLIANCE (A.152) White Fir Forest Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland (CES306.825)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This forest association is only known to occur at Bandelier National Monument in north central New Mexico, at elevations from 2100 to 2800 m (6950-9250 feet) and likely occurs throughout parts of the southern Rocky Mountains and high plateaus and mountains in the Colorado Plateau. Sites are relatively mesic and are found on cool northeasterly to warm southwesterly aspects of moist canyon toeslopes shifting to mostly southerly lower backslopes at higher elevations. Slopes are generally moderately steep to very steep (25-80%) but can range as low as 10%. The ground surface is typically dominated by thick leaf litter and dense herbaceous cover, although some sites can have abundant rock. Substrates are derived from volcanic andesite, rhyolite, and rhyolitic tuffs. The vegetation is characterized by an open to closed (25-90% cover) tree canopy dominated by *Abies concolor* and *Pseudotsuga menziesii*, a tall shrub layer dominated by *Quercus gambelii* (>5% cover), and a diverse and productive herbaceous layer. *Quercus gambelii* may occur occasionally as mature trees in the canopy. Younger, post fire stands are sometimes represented by pole sized *Abies concolor*. Additional shrubs may be present to diverse, with *Jamesia americana* and *Rosa woodsii* being two common species. The productive herbaceous layer is a diverse mixture of mesic forbs and graminoids approaching 10 15% cover. *Thalictrum fendleri* is the most constant, with *Maianthemum stellatum*, *Artemisia franserioides*, *Galium aparine*, and *Oreochrysum parryi* as common associates. Graminoids include *Carex inops* ssp. *heliophila*, *Carex rossii*, and *Carex siccata*, along with *Koeleria macrantha*, *Bromus anomalus*, and *Bromus ciliatus*.

DISTRIBUTION

Bandelier National Monument

This association is known from the lower slopes of Cerro Grande and Scooter Peak, the lower slopes of upper Canon de los Frijoles, and in the headslopes of Capulin and Alamo canyons.

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico, and likely occurs throughout much of the southern Rocky Mountains and high plateaus of Utah.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association occurs from cool northeasterly to warm southwesterly aspects of moist canyon toeslopes shifting to mostly southerly lower backslopes at higher elevations. Elevations range from 2100 to 2800 m (6950-9250 feet). Slopes are generally moderately steep to very steep (25-80%) but can range as low as 10%. Stands occur on substrates derived from volcanic andesite, rhyolite, and rhyolitic tuffs. Typically, the ground surface is dominated by thick leaf litter and dense herbaceous cover, although some sites may have abundant rock.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

In this forest association, the overstory tree canopy can range from open to closed (25-90% cover) and is dominated by *Abies concolor* and *Pseudotsuga menziesii* along with seedlings and saplings in the understory. The younger, post fire stands are sometimes represented by pole sized *Abies concolor*. *Quercus gambelii* dominates the understory as tall shrubs or occasionally mature trees. In the shrub layer, *Jamesia americana* and *Rosa woodsii* may also be well represented to abundant among the 18 shrub species recorded for this association. A rich and productive herbaceous layer is also characteristic of the association, approaching 10-15% cover with 40 forb species and 22 grass species recorded. Among forbs, *Thalictrum fendleri* is common to well represented and the most constant, with *Maianthemum stellatum*, *Artemisia franserioides*, *Galium aparine*, and *Oreochrysum parryi* as common associates. Graminoids can also be well represented and include *Carex inops* ssp. *heliophila*, *Carex rossii*, and *Carex siccata*, along with *Koeleria macrantha*, *Bromus anomalus*, and *Bromus ciliatus*.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Abies concolor, Pseudotsuga menziesii*
Tree canopy	*Quercus gambelii*
Tall shrub/sapling	*Quercus gambelii*
Herb (field)	*Thalictrum fendleri*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15 Feb 2008).

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Jamesia americana* phase occurs when it is well represented in the understory. With respect to environment and floristics, this association lies between moister *Abies concolor* - (*Pseudotsuga menziesii*) / *Thalictrum fendleri* Forest (CEGL005353) and drier *Abies concolor* - (*Pseudotsuga menziesii*) / *Quercus gambelii* / *Carex rossii* Forest (CEGL005351).

Globally

This association was formerly considered part of the more broadly defined *Abies concolor* / *Quercus gambelii* Forest (CEGL000261), but was subsequently refined for New Mexico and now includes relatively dry stands as indicated by the presence of *Carex rossii*. Rangewide review of *Abies concolor* / *Quercus gambelii* Forest (CEGL000261) is needed

to break out and reclassify these more xeric stands from relatively dry types such as *Abies concolor* - (*Pseudotsuga menziesii*) / *Quercus gambelii* / *Carex rossii* Forest (CEGL005351).

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots 03BD027, 03BD044, 03BD073, 03BD082, 03BD131, 06JC503, 06JC533, 06JC539, 06JC551, 06JC589, and 06JC632 (5 standard and 6 rapid plots).

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz

REFERENCES

Western Ecology Working Group n.d.

Abies concolor - (*Pseudotsuga menziesii*) / *Thalictrum fendleri* Forest

White Fir - (Douglas fir) / Fendler's Meadowrue Forest

CODE	CEGL005353
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	ABIES CONCOLOR FOREST ALLIANCE (A.152) White Fir Forest Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland (CES306.825), Southern Rocky Mountain Dry Mesic Montane Mixed Conifer Forest and Woodland

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This mesic mixed montane conifer association is known from Valles Caldera National Preserve and Bandelier National Monument in north central New Mexico and likely occurs on mesic sites elsewhere in the southern Rocky Mountains. Sites are typically cool and moist and occur on northerly to northeasterly aspects at lower elevations shifting to southeasterly through southwesterly aspects at higher elevations. Elevations range from 1890-2990 m (6200-9800 feet). Slopes vary from very gentle rolling mesatops to steep mountain backslopes and canyon sideslopes (0-55%). Substrates are derived from volcanic andesite, rhyolite, and rhyolitic tuffs. Ground cover is typically characterized by deep leaf litter layers and herbaceous cover with little exposed soil, although some sites can be rocky or have significant accumulation of large woody debris. The vegetation is characterized by an open to closed tree canopy (25-90%) dominated by *Abies concolor* with seedlings and saplings in the understory. *Pseudotsuga menziesii* is typically a codominant in the canopy or subcanopy. Other conifers can be common to well represented, but are subdominants, and include *Pinus ponderosa*, *Pinus strobiformis*, *Pinus flexilis*, and occasionally *Picea pungens*. *Populus tremuloides* is often well represented as seedlings and saplings, or as a codominant in the canopy. Shrub and subshrub composition and cover are variable; shrubs are often absent but cover can range as high as 15%. The most frequent species are *Juniperus communis*, *Rosa woodsii*, *Rubus idaeus*, and *Rubus parviflorus*. However, the understory is characterized by a moderate to dense (25% to over 50% cover) herbaceous layer with high species richness dominated by a combination of mesic graminoids and forbs. The most abundant graminoids are *Bromus ciliatus*, *Koeleria macrantha*, *Poa fendleriana*, *Carex inops* ssp. *heliophila*, *Carex occidentalis*, and *Carex siccata*. Forbs can reach 30% cover and are characterized by *Thalictrum fendleri* and a mixture of other mesic forbs such as *Achillea millefolium*, *Fragaria vesca*, *Galium aparine*, *Lathyrus lanszwertii* var. *leucanthus*, *Maianthemum stellatum*, and *Viola canadensis*. *Erigeron eximius* is generally absent in this type. When present, *Carex siccata* does not form a dense sod that dominates the understory.

DISTRIBUTION

Bandelier National Monument

This association is known from mountain slopes of Cerro Grande, Rabbit Mountain, and Scooter Peak along the northern boundary of the park. It also extends down the slopes of the canyons (Canon de los Frijoles, Alamo Canyon, and Capulin Canyon), and on intervening mesa summits (Sawyer Mesa).

Globally

This association occurs at Valles Caldera National Preserve and Bandelier National Monument in north central New Mexico, and likely occurs throughout much of the southern Rocky Mountains and high plateaus of Utah.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association ranges in elevation from 1890-2900 m (6200-9600 feet). Sites are typically cool and moist and occur on northerly to northeasterly aspects at lower elevations shifting to southeasterly through southwesterly aspects at higher elevations. Slopes vary from very gentle rolling mesatops to steep mountain backslopes and canyon sideslopes (0-55%). Substrates are derived from volcanic andesite, rhyolite, and rhyolitic tuffs. Ground cover is typically characterized by deep leaf litter layers and herbaceous cover with little exposed soil, although some sites can be rocky or have significant accumulation of large woody debris.

Globally

This association ranges in elevation from 1890-2990 m (6200-9800 feet). Sites are typically cool and moist and occur on northerly to northeasterly aspects at lower elevations shifting to southeasterly through southwesterly aspects at higher elevations. Slopes vary from very gentle rolling mesatops to steep mountain backslopes and canyon sideslopes (0-55%). Substrates are derived from volcanic andesite, rhyolite, and rhyolitic tuffs. Ground cover is typically characterized by deep leaf litter layers and herbaceous cover with little exposed soil, although some sites can be rocky or have significant accumulation of large woody debris.

VEGETATION DESCRIPTION

Bandelier National Monument

This mesic mixed conifer association is characterized by an open to closed tree canopy (25-90%) dominated by *Abies concolor* with seedlings and saplings in the understory. *Pseudotsuga menziesii* is typically a codominant in the canopy or subcanopy. Other conifers can be common to well represented, but are subdominants, and include *Pinus ponderosa*, *Pinus strobiformis*, *Pinus flexilis*, and occasionally *Picea pungens*. *Populus tremuloides* is often well represented as seedlings and saplings, or as a codominant in the canopy. Shrub and subshrub composition and cover are variable; shrubs are often absent but cover can range as high as 15%. The most frequent species are *Juniperus communis*, *Rosa woodsii*, *Rubus idaeus*, and *Rubus parviflorus*. In contrast, the herbaceous layer is abundant to luxurious in cover and is dominated by a combination of mesic graminoids and forbs. The most abundant graminoids are *Bromus ciliatus*, *Koeleria macrantha*, *Poa fendleriana*, *Carex inops* ssp. *heliophila*, *Carex occidentalis*, and *Carex siccata*. Forbs can reach 30% cover and include *Thalictrum fendleri*, *Fragaria vesca*, *Lathyrus lanszwertii* var. *leucanthus*, *Maianthemum stellatum*, *Galium aparine*, *Achillea millefolium*, and *Viola canadensis*. Overall species richness is high, particularly in the herb layer where 76 forbs and 36 graminoids are known from this association.

Globally

The vegetation is characterized by an open to closed tree canopy (25-90%) dominated by *Abies concolor* with seedlings and saplings in the understory. *Pseudotsuga menziesii* is typically a codominant in the canopy or subcanopy. Other conifers can be common to well represented, but are subdominants, and include *Pinus ponderosa*, *Pinus strobiformis*, *Pinus flexilis*, and occasionally *Picea pungens*. *Populus tremuloides* is often well represented as seedlings and saplings, or as a codominant in the canopy. Shrub and subshrub composition and cover are variable; shrubs are often absent but cover can range as high as 15%. The most frequent species are *Juniperus communis*, *Rosa woodsii*, *Rubus idaeus*, and *Rubus parviflorus*. However, the understory is characterized by a moderate to dense (25% or over 50% cover) herbaceous layer with high species richness dominated by a combination of mesic graminoids and forbs. The most abundant graminoids are *Bromus ciliatus*, *Koeleria macrantha*, *Poa fendleriana*, *Carex inops* ssp. *heliophila*, *Carex occidentalis*, and *Carex siccata*. Forbs can reach 30% cover and are characterized by *Thalictrum fendleri* and a mixture of other mesic forbs such as *Achillea millefolium*, *Fragaria vesca*, *Galium aparine*, *Lathyrus lanszwertii* var. *leucanthus*, *Maianthemum stellatum*, and *Viola canadensis*. *Erigeron eximius* is generally absent in this type. When present, *Carex siccata* does not form a dense sod that dominates the understory.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Abies concolor, Pseudotsuga menziesii*

Herb (field)	*Thalictrum fendleri*

Globally

Stratum	Species
Tree canopy	*Abies concolor, Pseudotsuga menziesii*
Herb (field)	*Thalictrum fendleri*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15 Feb 2008).

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Populus tremuloides* phase has been identified where *Populus tremuloides* has greater than 25% canopy cover but not over 75% (see the *Populus tremuloides* Alliance where cover exceeds 75%). This association is similar to *Abies concolor - Pseudotsuga menziesii* / *Erigeron eximius* Forest (CEGL000247) and *Abies concolor* / *Carex siccata* Forest (CEGL000244), moist mesic mixed associations described elsewhere in the Jemez Mountains (DeVelice 1986, Muldavin et al. 2006) and elsewhere in the southwest U.S., but this *Abies concolor* / *Thalictrum fendleri* association is more broadly defined.

Globally

This mesic mixed montane conifer association is known from Valles Caldera National Preserve and Bandelier National Monument in northern New Mexico and likely occurs on mesic sites elsewhere in the southern Rocky Mountains. This broadly defined association is similar to the mesic *Abies concolor - Pseudotsuga menziesii* / *Erigeron eximius* Forest (CEGL000247) that is characterized by an understory dominated by *Erigeron eximius*, *Lathyrus* spp., or *Valeriana arizonica* and the generally wetter *Abies concolor* / *Carex siccata* Forest (CEGL000244) that is characterized by an understory of dense *Carex siccata* sod.

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM plots 03BD006, 03BD028, 03BD037, 03BD040, 03BD118, 03BD120, 03BD129, 04AB003, 04BD001, 04BD002, 04BD019, 04BD023, 04BD025, 04BD027, 04BD029, 06JC480, 06JC484, 06JC497, 06JC498, 06JC507, 06JC508, 06JC514, 06JC523, 06JC554, 07AK080, 07AK081, 07AK082, 07AK083.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz

REFERENCES

DeVelice et al. 1986, Muldavin et al. 2006, Western Ecology Working Group n.d.

Abies concolor - Acer negundo/ Alnus incana ssp. *tenuifolia* Forest

White Fir - Box elder / Thinleaf Alder Forest

CODE	CEGL005367
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	ABIES CONCOLOR FOREST ALLIANCE (A.152) White Fir Forest Alliance

ECOLOGICAL SYSTEM(S)

Rocky Mountain Subalpine Montane Riparian Woodland (CES306.833), Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland (CES306.825)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This white fir forest association is only known to occur at Bandelier National Monument in north central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This association occurs on toeslopes and alluvial bottom terraces in riparian zones between 1800 and 2200 m (6000-7250 feet) in elevation. Slopes are gentle (4-12%) and aspects are variable. The vegetation within this riparian forest is characterized by a closed (60-90% cover), complex canopy composed of a mix of conifer and broadleaf deciduous trees. Typically, *Abies concolor* dominates with *Pseudotsuga menziesii* and *Pinus ponderosa* as co-dominant or subdominant associates. The broadleaf *Acer negundo* dominates the subcanopy along with *Alnus incana* ssp. *tenuifolia*. *Betula occidentalis*, *Quercus gambelii*, and *Prunus serotina* are occasional associates. Shrubs are poorly represented, while the herbaceous layer can be rich and abundant in cover and characterized by a mix of mesic forest and riparian species. Among graminoids, *Oryzopsis asperifolia* is the most frequent and well represented. Forbs can be abundant and include facultative wetland species such as *Equisetum laevigatum* and *Hydrophyllum fendleri* along with mesic forest species such as *Thalictrum fendleri*, *Galium aparine*, *Viola canadensis*, and *Valeriana edulis*.

DISTRIBUTION

Bandelier National Monument

This association is known from along the toeslopes and bottom of Canon de los Frijoles.

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico, but likely occurs elsewhere in the southern Rocky Mountains.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association occurs on toeslopes and alluvial bottom terraces in riparian zones between 1800 and 2200 m (6000-7250 feet) in elevation. Slopes are gentle (4-12%) and aspects are variable.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This riparian forest is characterized by a closed (60-90% cover), complex canopy composed of a mix of conifer and broadleaf deciduous trees. Typically, *Abies concolor* dominates with *Pseudotsuga menziesii* and *Pinus ponderosa* as co-dominant or subdominant associates. The broadleaf *Acer negundo* dominates the subcanopy along with *Alnus incana* ssp. *tenuifolia*. *Betula occidentalis*, *Quercus gambelii*, and *Prunus serotina* are occasional associates. Shrubs are poorly represented, while the herbaceous layer can be rich and abundant in cover and characterized by a mix of mesic forest and riparian species. Among graminoids, *Oryzopsis asperifolia* is the most frequent and well represented. Forbs can be abundant and include facultative wetland species such as *Equisetum laevigatum* and *Hydrophyllum fendleri* along with mesic forest species such as *Thalictrum fendleri*, *Galium aparine*, *Viola canadensis*, and *Valeriana edulis*.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Abies concolor, Pseudotsuga menziesii*
Tree subcanopy	*Acer negundo*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Equisetum laevigatum, *Hydrophyllum fendleri*.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15 Feb 2008).

CLASSIFICATION COMMENTS

Bandelier National Monument

This is a newly described association known only from Bandelier National Monument.

Globally

Data are not available.

ELEMENT SOURCES

Bandelier National Monument Plots: NHNM plots: 03BD076, 06JC527, 06JC529, 06JC532.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Western Ecology Working Group n.d.

Abies concolor - Pseudotsuga menziesii / Acer glabrum Forest

White Fir - Douglas fir / Rocky Mountain Maple Forest

CODE	CEGL000240
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	ABIES CONCOLOR FOREST ALLIANCE (A.152) White Fir Forest Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland (CES306.825), Southern Rocky Mountain Dry Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This white fir forest association ranges from southern and central Utah and southern Colorado to northern New Mexico and central Arizona and is found between 2073 and 3140 m (6800-10,300 feet) elevation. This forest shows great variety with respect to topographic characteristics. In southern Colorado and northern New Mexico, it is one of the most widespread mixed conifer forests. Though it frequently occurs on moderate to steep north and northwest facing slopes, other slope aspects are represented. When found on southern aspects, this forest is at higher elevations or streamside settings. Predominantly found on lower slopes, it has also been located on mid and upper slopes. Sites can have high amounts of exposed rock (up to 50% or more cover), with abundant leaf litter and coarse woody debris. The overstory is highly complex and has high variability. *Abies concolor* dominates or codominates, if not in the overstory, then as regeneration. *Pseudotsuga menziesii* is a successional dominant and remains a codominant in late successional stands, becoming minor in very old stands. *Picea pungens* and *Pinus flexilis* may be important, as well as *Pinus strobiformis* at lower latitudes. *Abies lasiocarpa* and *Picea engelmannii* may occur in frost pockets as regeneration or occasional mature trees, but they are minor and almost always are under severe competition from dense regeneration and canopy dominance of *Abies concolor* and *Pseudotsuga menziesii*. The open to dense tall shrub layer dominates the undergrowth with *Acer glabrum* and often *Amelanchier alnifolia*. If present, *Quercus gambelii* has low cover (<5%). Common low growing shrubs are *Holodiscus dumosus*, and *Jamesia americana*, which occur on cobbly substrates, along with *Mahonia repens* (= *Berberis repens*), *Paxistima myrsinites*, *Physocarpus monogynus*, and *Symphoricarpos oreophilus*; however, some stands have an open shrub of layer of *Acer glabrum* and little else in the understory. The herb layer species are typically low in cover value.

DISTRIBUTION

Bandelier National Monument

This association is known from the slopes of Rabbit Mountain, Cerro Grande, and Scooter Peak, in the headslopes of Canon de los Frijoles and Capulin Canyon, and along the upper slopes of Obsidian Ridge.

Globally

This montane forest is common in the southern portion of the southern Rocky Mountains and ranges from central and southern Utah and southern Colorado to northern New Mexico and central Arizona.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association is known to occur between 2500 and 2910 m (8250-9550 feet) in elevation, on moderate to steep slopes with cool, moist mostly northeasterly aspects (occasionally northwesterly). Slopes range from moderate on the shoulder or in the headslopes of drainages and canyons to steep on upper to mid sideslopes of ridges, mountains, and canyons. Stands occur on substrates derived from Bandelier tuff, rhyolite or andesite rocks. Sites can be rocky, with abundant leaf litter and coarse woody debris well represented.

Globally

This montane forest shows great variety with respect to topographic characteristics where it occurs in the southern portion of the southern Rocky Mountains and high plateaus and mountains of the Colorado Plateau, extending north into the Wasatch Range. In southern Colorado and northern New Mexico, it is one of the most widespread mixed conifer forests. It ranges between 2400 and 3140 m (7900-10,300 feet) in elevation in upland canyon and mountain slopes, down to 2100 m (6800 feet) along stream terraces and valley bottoms. In Wasatch Range in Utah stands were sampled in canyons between 1850 and 2040 m (6065-6690 feet) elevation. Though it frequently occurs on cool northeast to northwest facing slopes, other slope aspects are represented. When found on southern aspects, this forest occurs at higher elevations or in streamside settings (Fitzhugh et al. 1987). Predominantly found on lower slopes, it has also been located on mid and upper slopes of mountain, ridges and canyons (DeVelice et al. 1986). Where it lies at lower elevations, sites will be locally wet and cool. Therefore, it is located along canyonsides and cool drainages, and its presence is most striking in cool drainages where the adjacent communities may be much drier. At upper elevations, this forest occurs along the tops of ridges and knolls (Alexander et al. 1984a). This association occurs on shallow, even skeletal soils as it is frequently found on steep slopes. Sites can have high amounts of exposed rock (up to 50% or more cover), with abundant leaf litter and coarse woody debris (Alexander et al. 1984a, Youngblood and Mauk 1985). Soils are moderately well drained sandy loams and clay loams derived from alluvial deposits or sideslope colluvial derived from a variety of parent materials, including Bandelier tuff, rhyolite, sandstone or andesite rocks. Common soil types are Borolls, Boralfs, and Ochrepts.

VEGETATION DESCRIPTION

Bandelier National Monument

In this forest association, tree canopies are typically moderately open to closed (40-70% cover) and dominated by *Abies concolor* and *Pseudotsuga menziesii*. *Acer glabrum* is diagnostic and common to well represented in the subcanopy and as a tall shrub. Other mesic shrubs such as *Jamesia americana* and *Physocarpus monogynus* are occasionally present and can be well represented. In the herbaceous layer, grass cover can range up to 20%, with *Bromus ciliatus*, *Carex siccata*, and *Carex inops* ssp. *heliophila* common to well represented and the most frequently found. Forbs can be well represented and typically include mesic species such as *Thalictrum fendleri*, *Fragaria vesca*, and *Viola canadensis*. Overall species richness is moderate, with 16 grass and 31 forb species recorded from this association.

Globally

The moderately open to closed overstory is highly complex and has high variability. *Abies concolor* dominates or codominates, if not in the overstory, then as regeneration. *Pseudotsuga menziesii* is a successional dominant and remains a codominant in late successional stands, becoming minor in very old stands. *Picea pungens*, *Pinus longaeva*, *Pinus flexilis*, and *Juniperus scopulorum* may be important, as well as *Pinus strobiformis* at lower latitudes. *Abies lasiocarpa* and *Picea engelmannii* may occur in frost pockets as regeneration or occasional mature trees, but they are minor and almost always are under severe competition from dense regeneration and canopy dominance of *Abies concolor* and *Pseudotsuga menziesii* (Moir and Ludwig 1979). *Pinus ponderosa* is an accidental or minor species, since neither regeneration nor mature trees are important in late successional stands (Moir and Ludwig 1979). Seral stands are often codominated by *Populus tremuloides* (Stuever and Hayden 1997b). The tall shrub layer dominates the undergrowth typically dominated or codominated by *Acer glabrum* or less frequently *Amelanchier alnifolia*. *Quercus gambelii*, if present, has relatively low cover (<5%). Other short and dwarf shrubs may be present with low cover, such as *Holodiscus dumosus* and *Jamesia americana*, which occur on cobbly substrates, along with Acer grandidentatum, *Juniperus communis*, *Mahonia repens* (= *Berberis repens*), *Paxistima myrsinites*, *Physocarpus monogynus*, *Rosa woodsii*, *Shepherdia canadensis*, and *Symphoricarpos oreophilus*; however, some stands have an open shrub of layer of *Acer glabrum* and little else. Herb layer species are typically low in cover. Common species are *Artemisia franserioides*, *Bromus*

anomalus, *Bromus ciliatus*, *Carex* spp., *Erigeron* spp., *Lathyrus* spp., *Maianthemum racemosum*, *Penstemon* spp., *Pyrola chlorantha*, *Solidago velutina*, *Stellaria longifolia*, *Thalictrum fendleri*, and *Viola canadensis*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Abies concolor, Pseudotsuga menziesii*
Tree canopy	*Acer glabrum*
Shrub/sapling (tall & short)	*Acer glabrum*

Globally

Stratum	Species
Tree canopy	*Abies concolor, Pseudotsuga menziesii*
Shrub/sapling (tall & short)	*Acer glabrum*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Erigeron arenarioides, *Penstemon platyphyllus*.

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (1 Feb 1996).

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Populus tremuloides* phase occurs in stands where *Populus tremuloides* comprises 25-75% of the total tree canopy (relative cover).

Globally

On steep rocky slopes *Jamesia americana* and *Holodiscus dumosus* become more abundant and this type transitions to scree associations such as *Abies concolor* - (*Pseudotsuga menziesii*) / *Jamesia americana* - *Holodiscus dumosus* Scree Woodland (CEGL000890). According to Alexander et al. (1987), this type represents a transition from the *Abies concolor* / *Quercus gambelii* type to types representative of spruce fir forests. This type appears to be related to the *Pseudotsuga menziesii* / *Paxistima myrsinites* habitat type of central and northern Colorado of Hoffman and Alexander (1980). The foothill ravine forest community of Rocky Mountain National Park, Colorado (Peet 1981), is weakly related to this association, as is the *Abies grandis* / *Acer glabrum* habitat type of central Idaho (Steele et al. 1981). The *Abies concolor* / *Acer glabrum* / *Berberis nervosa* Plant Association (Atzet and McCrimmon 1990) found in southern Oregon Cascades is not part of this association.

CLASSIFICATION CONFIDENCE: 1- Strong

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM plots 03BD005, 03BD022, 03BD025, 03BD113, 04BD004, 04BD016, 04BD026, 06AB186, 06JC549, and 06JC625.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: L. D. Engelking, mod. K. A. Schulz

REFERENCES

Alexander et al. 1984a, Alexander et al. 1987, Atzet and McCrimmon 1990, Atzet and Wheeler 1984, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Crane 1982, DeVelice 1983, DeVelice and Ludwig 1983a, DeVelice et al. 1986, Dieterich 1980, Driscoll et al. 1984, Fitzhugh et al. 1987, Hoffman and Alexander 1980, Larson and Moir 1987, Moir and Ludwig 1979, Muldavin et al. 1996, Muldavin et al. 2006, Peet 1981, Steele et al. 1981, Stuever and Hayden 1997b, Western Ecology Working Group n.d., Youngblood and Mauk 1985.

Abies concolor - Pseudotsuga menziesii / Carex rossii Forest

White Fir - Douglas fir / Ross' Sedge Forest

CODE	CEGL000431
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	ABIES CONCOLOR FOREST ALLIANCE (A.152) White 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 minor forest association has been described from the southern Rocky Mountains in northern Colorado and New Mexico and possibly Arizona. Stands are found on gentle to typically steep (5-65%), north to northwest facing slopes with shallow, coarse textured, well drained colluvium at elevations of 1670-2930 m. Stands are recognized by the moderately dense tree canopy dominated by *Pseudotsuga menziesii*, although *Pinus ponderosa* and *Juniperus scopulorum* may be present with nearly equal cover. The short shrub layer is sparse and represented by widely scattered *Juniperus communis* and *Physocarpus monogynus*. *Carex rossii* is the only significant graminoid (4-15% cover), although *Carex inops*, *Carex occidentalis*, *Koeleria macrantha*, *Leucopoa kingii* (= *Festuca kingii*), and *Poa fendleriana* may be present. Common forbs include *Achillea millefolium* var. *occidentalis* (= *Achillea lanulosa*), *Campanula rotundifolia*, *Cystopteris fragilis*, *Fragaria virginiana*, *Heuchera bracteata*, *Pulsatilla patens* ssp. *multifida* (= *Pulsatilla ludoviciana*), *Saxifraga rhomboidea*, and *Thalictrum fendleri*. Overstory shade is needed for successful regeneration of *Pseudotsuga*. These forests were originally subject to a high natural fire frequency. Recently, fire suppression activities have resulted in unnaturally high sapling densities, as well as increased fuel loads. Sapling densities have resulted in a decreasing reproductive success of the shade intolerant *Pinus ponderosa* relative to *Pseudotsuga menziesii*.

DISTRIBUTION

Bandelier National Monument

This association is known from slopes of Cerro Grande, Scooter Peak, and Rabbit Mountain, and on slopes of Frijoles, Water, Alamo, and Capulin canyons.

Globally

This montane forest association has been described from the southern Rocky Mountains of northern Colorado, northern New Mexico and possibly northern Arizona. More survey is needed to locate stands in southern Colorado.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association occurs between 2130 and 2900 m (6980-9530 feet) in elevation, typically on cooler northeasterly aspects but tending to southerly at higher elevations. Slopes range from gentle on shoulder and toeslopes to steep on sideslopes of mountains and canyons (5-65%). Sites occur on substrates derived from volcanic andesite, rhyolite, and rhyolitic tuffs. Ground cover is dominated by leaf litter with some exposed soil and rock.

Globally

This minor forest association has been described from the mountains of northern Colorado and northern New Mexico and ranges from 1670 to 2930 m (5700-9640 feet) in elevation. Stands are found on gentle shoulder and toeslopes to steep sideslopes of mountains and canyons (5-65%) often on cooler northeast to northwest facing slopes and on southerly slopes at higher elevations. Ground cover is dominated by leaf litter with some exposed soil and rock. Substrates are shallow, well drained, coarse textured, often skeletal colluvial soils derived from gneiss, granite, schist, volcanic andesite, rhyolite, and rhyolitic tuffs (Hess 1981, Hess and Alexander 1986).

VEGETATION DESCRIPTION

Bandelier National Monument

In this forest association, tree canopies are dominated by *Pseudotsuga menziesii* and range from open (25%) to closed (70%). *Pinus ponderosa* is a common codominant along with *Abies concolor*, forming a typical mixed conifer canopy. This is a mid to late seral forest association, but remnant early seral *Populus tremuloides* can be present. Shrub canopies tend to be sparse (<5% cover) and made up of scattered individuals (*Juniperus communis* is the most frequent). While the herbaceous species richness is relatively high (24 grass and 40 forb species), overall cover generally is low (<5%). The undergrowth is typified by scattered *Carex rossii*, *Carex inops*, and *Carex occidentalis*, along with *Koeleria macrantha* and *Poa fendleriana* as common graminoid associates. Forbs are also scattered and most often represented by mesic species such as *Thalictrum fendleri* and *Fragaria virginiana*.

Globally

This minor forest association is characterized by a moderately dense tree canopy dominated by *Pseudotsuga menziesii*, although *Pinus ponderosa*, *Abies concolor*, and *Juniperus scopulorum* may be present with nearly equal cover. Remnant early seral *Populus tremuloides* tree can be present in the canopy. The short shrub layer is sparse and represented by widely scattered *Juniperus communis* and *Physocarpus monogynus*. The *Carex rossii* dominated herbaceous layer characterizes the understory with 4-15% cover (Hess 1981, Hess and Alexander 1986). Other graminoids present include *Carex inops*, *Carex occidentalis*, *Leucopoa kingii* (= *Festuca kingii*), *Koeleria macrantha*, and *Poa fendleriana*. Forbs are sparse, but may be diverse, and include *Achillea millefolium* var. *occidentalis* (= *Achillea lanulosa*), *Campanula rotundifolia*, *Cystopteris fragilis*, *Fragaria virginiana*, *Heuchera bracteata*, *Pulsatilla patens* ssp. *multifida* (= *Pulsatilla ludoviciana*), *Saxifraga rhomboidea*, and *Thalictrum fendleri*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Abies concolor, Pinus ponderosa, Pseudotsuga menziesii*
Herb (field)	*Carex inops, Carex occidentalis, Carex rossii*

Globally

Stratum	Species
Tree canopy	*Abies concolor, Pinus ponderosa, Pseudotsuga menziesii*
Herb (field)	*Carex rossii*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G2? (10 Dec 1999). This minor association has been described from the mountains of Col-

orado and may also occur in New Mexico and Arizona. Less than 20 occurrences are estimated to occur across this association's range. Stands may be restricted to steep north to northwest facing slopes. More survey work is needed to determine the full extent of this plant association, thus the rank is G2?.

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Populus tremuloides* phase has been identified where *Populus tremuloides* represents between 25 and 75% of the canopy cover.

Globally

This forest association is based on quantitative data from several classification studies, primarily along Colorado's Front Range that described *Pseudotsuga menziesii* dominated conifer forests (Hess 1981, Peet 1981, Wasser and Hess 1982, Hess and Alexander 1986). The concept of this association was broadened to include *Abies concolor - Pseudotsuga menziesii* mixed canopy stands with an abundant herbaceous layer dominated by *Carex rossii* that occur in northern New Mexico (Muldavin et al. 2006) and moved to the *Abies concolor* Forest Alliance (A.152). The similar *Pseudotsuga menziesii* / *Physocarpus monogynus* Forest (CEGL000449) has higher shrub coverage (14-35%) by *Physocarpus monogynus*. Also, *Pinus ponderosa* / *Carex rossii* Forest (CEGL000183) may occur in adjacent stands, but that association is dominated by *Pinus ponderosa* and does not occur on north to northwest exposures. Over time and with continued effective fire suppression, these *Pinus ponderosa* stands may convert to *Pseudotsuga menziesii* dominated stands.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM plots 04BD021. 03BD152, 03BD111, 03BD046, 04BD003, 03BD023, 03ER021, 04CJ001, 06JC544, 06JC174, 06JC475, 06JC481, 06BF002, 06JC515, 06BF004, and 04AB001.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: R.J. Rondeau, mod. K.A. Schulz

REFERENCES

Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Hess 1981, Hess and Alexander 1986, Johnston 1987, Muldavin et al. 2006, NMNHP unpubl. data, Peet 1975, Peet 1981, Wasser and Hess 1982, Western Ecology Working Group n.d.

Abies concolor / Juniperus communis Forest

White Fir / Common Juniper Forest

CODE	CEGL000249
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	ABIES CONCOLOR FOREST ALLIANCE (A.152) White 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 montane forest association occurs on a wide variety of aspects, slopes and landforms and is found in southern Utah on the Markegunt, Sevier and Paunsaugunt plateaus, in the Escalante and Tushar mountains and in the southern Rocky Mountains in northern New Mexico. Sites range between 2400 and 2850 m (7900-9360 feet) in elevation. Soils are often gravelly, rapidly drained loams (sandy to silty clay loams) and silts. Litter accumulations tend to be high but may be non uniform and patchy. The vegetation is characterized by an open to closed tree canopy (10-70% cover) that is dominated or codominated by *Abies concolor* with a sparse to moderately dense understory dominated by clumps of the short shrub *Juniperus communis*. *Pseudotsuga menziesii* is frequently a codominant with other trees such as *Picea pungens*, *Pinus flexilis*, *Pinus strobiformis* (southern latitudes), *Populus tremuloides*, and *Juniperus scopulorum*. *Abies lasiocarpa* and *Pinus ponderosa* are accidental in the tree canopy and have relatively low cover. Other shrubs include scattered *Symphoricarpos oreophilus*, *Shepherdia canadensis*, *Rosa woodsii*, *Ribes cereum*, *Paxistima myrsinites*, *Mahonia repens* (= *Berberis repens*), or *Ceanothus martinii*. *Acer glabrum* is typically absent. The herbaceous layer is generally depauperate but can range as high as 10% cover in some stands. *Carex rossii*, *Carex inops* ssp. *heliophila*, *Bromus anomalus*, and *Poa fendleriana* are the most consistent species.

DISTRIBUTION

Bandelier National Monument

This association is known from the slopes of Rabbit Mountain and Scooter Peak, the headslopes of Frijoles Canyon, and along Sawyer Mesa.

Globally

This conifer forest is found in Utah on the Markegunt, Sevier and Paunsaugunt plateaus and the Escalante and Tushar mountains and in the southern Rocky Mountains in northern New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This forest association can be found at elevations between 2660 and 2850 m (8730-9360 feet) on a wide variety of aspects, slopes and landforms. These include gently rolling mesatops to moderate mountain sideslopes to steep canyon headslopes. Stands occur on substrates derived from volcanic andesite, rhyolite, and rhyolitic tuffs. Ground cover is dominated by needle litter with little to no exposed soil or rock. Downed wood can be common, particularly in areas hit by insect damage.

Globally

This montane forest association occurs on a wide variety of aspects, slopes and landforms such as low to high slopes of ridges, hills, mesas, plateaus, valleys, ravines, canyons, saddles and rolling mesatops. Sites range between 2410 and 2850 m (7900-9360 feet) in elevation. Soils are often gravelly, rapidly drained loams (sandy to silty clay loams) and silts. Litter accumulations tend to be high but may be non uniform and patchy. Parent materials include limestone, basaltic and andesitic volcanics, rhyolite, rhyolitic tuffs, and the Pink and White members of the Claron Formation (soft limestone).

VEGETATION DESCRIPTION

Bandelier National Monument

Tree canopies vary from open to closed (20-70% in cover) and are dominated by *Abies concolor* and *Pseudotsuga menziesii* with regeneration of both species common to well represented. *Populus tremuloides* can be abundant and codominant in some stands. *Pinus ponderosa* and *Pinus strobiformis* are occasional canopy or subcanopy associates. The understory of this association is characteristically shrubby (5-65% cover), with *Juniperus communis* dominant and well represented to abundant. The herbaceous layer tends to be poorly represented but can range as high as 10% cover in some stands. *Carex rossii*, *Carex inops* ssp. *heliophila*, and *Poa fendleriana* are the most consistent graminoid representatives. Among forbs, mesic species such as *Fragaria vesca* and *Thalictrum fendleri* are the most frequent and abundant. Overall species richness is moderate with 19 graminoid and 36 forb species recorded for the association.

Globally

This mixed montane forest has an open to closed tree canopy (10-70% cover). *Abies concolor* is the indicated late seral tree and usually dominates mature stands. *Pseudotsuga menziesii*, *Picea pungens*, *Pinus flexilis*, *Pinus strobiformis* (southern latitudes), and *Populus tremuloides* are seral associates. *Abies lasiocarpa* and *Pinus ponderosa* are accidental in the tree canopy and have relatively low cover. Some stands may have scattered saplings of *Abies concolor*, *Pseudotsuga menziesii*, *Pinus flexilis*, *Populus tremuloides*, or *Juniperus scopulorum*. The undergrowth is characterized by a clumpy, typically open to moderately dense, short shrub layer of *Juniperus communis* (5-65% cover). Other shrubs, such as *Symphoricarpos oreophilus*, *Shepherdia canadensis*, *Rosa woodsii*, *Ribes cereum*, *Paxistima myrsinites*, *Mahonia repens* (= *Berberis repens*), or *Ceanothus martinii*, may be present with low cover. *Acer glabrum* is typically absent. The herbaceous layer is generally depauperate but can range as high as 10% cover in some stands. *Carex rossii*, *Carex inops* ssp. *heliophila*, *Bromus anomalus*, *Elymus elymoides*, and *Poa fendleriana* are the most consistent graminoids. Among forbs, mesic species such as *Fragaria vesca*, *Pyrola chlorantha*, and *Thalictrum fendleri* are the most frequent and abundant.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Abies concolor, Pseudotsuga menziesii*
Shrub/sapling (tall & short)	*Juniperus communis*

Globally

Stratum	Species
Tree canopy	*Abies concolor, Pseudotsuga menziesii*
Shrub/sapling (tall & short)	*Juniperus communis*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G4? (23 Feb 1994).

CLASSIFICATION COMMENTS

Bandelier National Monument

Two phases were identified from this association. A *Populus tremuloides* phase occurs when *Populus tremuloides* comprises 25 to 75% of the relative canopy cover as a codominant or subdominant. A *Pinus strobiformis* phase occurs where *Pinus strobiformis* (or *Pinus flexilis*) is abundant in the tree canopy (>25% cover).

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM plots 03BD007, 03BD024, 03BD117, 04AB002, 04BD014, 04BD017, 04BD018, 04BD028, 04BD031, 06BF001, 06JC473, 06JC474, 06JC477 and 06JC482.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: L.D. Engelking, mod. K.A. Schulz and G. Kittel

REFERENCES

Bourgeron and Engelking 1994, Driscoll et al. 1984, Fischer and Bradley 1987, Muldavin et al. 2006, Roberts et al. 1992, Western Ecology Working Group n.d., Youngblood and Mauk 1985.

Abies concolor / *Mahonia repens* Forest

White Fir / Creeping Oregon grape Forest

CODE	CEGL000251
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	ABIES CONCOLOR FOREST ALLIANCE (A.152) White Fir Forest Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland (CES306.825), Southern Rocky Mountain Dry Mesic Montane Mixed Conifer Forest and Woodland (CES306.823)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This white fir forest occurs in mountains and higher plateaus in the Colorado Plateau and southern Rocky Mountains and ranges from central Utah and southern Colorado south into New Mexico and Arizona, and possibly extends into eastern Nevada. Stands are found on a variety of generally cool and dry sites with gentle to steep slopes (3 50%). Landforms include valleys and plateaus, low and midslopes of hills, mesas, ravines, and canyonsides, and exposed ridge and mountain summits at elevations ranging from 2230 to 2930 m (7300-9600 feet). Aspect is variable, but stands often occur on cooler northerly aspects, especially at mid to lower elevations. Substrates are rapidly drained coarse to fine textured loam soils derived from limestone, sandstone, shale, and rhyolitic volcanics. The vegetation is characterized by a moderate to closed tree canopy (25-72% cover) that is generally dominated or codominated by *Abies concolor* or is at least present in the tree canopy and dominates understory regeneration. *Pseudotsuga menziesii* is often present to codominant in the canopy. Other trees may be present in the canopy or subcanopy with low to moderate cover, such as *Pinus ponderosa*, *Pinus flexilis*, *Populus tremuloides*, and *Picea engelmannii* (accidental). The understory is characterized by the sparse to occasionally moderately dense, low diversity understory with 1-10% cover of the diagnostic dwarf shrub *Mahonia repens*. If the shrub layer is moderately dense, then it is dominated by *Mahonia repens*. Other shrubs may be present and include a few scattered *Symphoricarpos oreophilus*, *Arctostaphylos patula*, *Holodiscus dumosus*, *Paxistima myrsinites*, *Rosa woodsii*, or *Juniperus communis*. The herbaceous layer is typically sparse, with low diversity, and frequently includes the graminoids *Carex rossii*, *Carex geophila*, *Carex inops* ssp. *heliophila*, *Poa fendleriana*, and the forbs *Goodyera oblongifolia*, *Lathyrus lanszwertii* var. *leucanthus* (= *Lathyrus* arizonicus), *Mertensia arizonica*, *Thalictrum fendleri*, and *Viola canadensis*. *Pseudotsuga menziesii* and *Abies concolor* seedlings are typically present.

DISTRIBUTION

Bandelier National Monument

This association was sampled from the slopes of Cerro Grande.

Globally

This white fir forest association occurs in mountains and higher plateaus in the Colorado Plateau and southern Rocky Mountains and ranges from central Utah and southern Colorado south into New Mexico and Arizona, and possibly extends into eastern Nevada.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association occurs at elevations ranging from 2575 to 2875 m (8450 9400 feet) on steep slopes (35 50%) with westerly aspects (near more exposed ridges and summits, cooler northeasterly aspects may prevail). Substrates are derived from rhyolitic volcanics (Bandelier tuff).

Globally

This white fir forest occurs in mountains and higher plateaus in the Colorado Plateau and southern Rocky Mountains and ranges from central Utah and southern Colorado south into New Mexico and Arizona, and possibly extends into eastern Nevada. Stands are found on a variety of generally cool and dry sites with gentle to steep slopes (3-50%). Landforms include valleys and plateaus, low and midslopes of hills, mesas, ravines, and canyonsides, and exposed ridge and mountain summits at elevations ranging from 2230 to 2930 m (7300-9600 feet) (Moir and Ludwig 1979, Graybosch and Buchanan 1983, Mauk and Henderson 1984, Youngblood and Mauk 1985, Johnston 1987, Roberts et al. 1992, Muldavin et al. 1996, Stuever and Hayden 1997b). Aspect is variable, but stands often occur on cooler northerly aspects, especially at lower elevations. Soils are rapidly drained, sandy loams to silty clay loams derived from limestone, sandstones, shales, and rhyolitic volcanics (Bandelier tuff). The ground surface has low to moderate exposure of bare soil, low to high cover of litter, low to moderate cover of small rocks, sparse to low cover of large rocks, and sparse to moderate cover of downed wood. Litter depths range from 0-2.1 cm.

VEGETATION DESCRIPTION

Bandelier National Monument

This forest association is characterized by a closed tree canopy of *Abies concolor* and *Pseudotsuga menziesii*. Regeneration is uncommon, and other tree species are rare. The understory is sparse with a combined cover that seldom exceeds 5%, and species diversity is low (only six shrubs or vines, six graminoids, and five forb species were recorded for the association). Scattered individuals of *Mahonia repens* and deer sedges such as *Carex inops* ssp. *heliophila* and *Carex rossii* are characteristic but do not need to be present, i.e., it is the sparse, low diversity understory that is the diagnostic.

Globally

This forest is characterized by a moderate to closed tree canopy (25-72% cover) that is generally dominated or codominated by *Abies concolor* or is at least present in the tree canopy and dominates understory regeneration. *Pseudotsuga menziesii* is often present to codominant in the canopy. Other trees may be present in the canopy or subcanopy with low to moderate cover, such as *Pinus ponderosa*, *Pinus flexilis*, *Populus tremuloides*, and *Picea engelmannii* (accidental). The understory is characterized by the sparse to occasionally moderately dense, low diversity understory with 1-10% cover of the diagnostic dwarf shrub *Mahonia repens*. If the shrub layer is moderately dense, then it is dominated by *Mahonia repens*. Other shrubs present in stands may include a few scattered *Symphoricarpos oreophilus*, *Amelanchier alnifolia*, *Arctostaphylos patula*, *Holodiscus dumosus*, *Paxistima myrsinites*, *Rosa woodsii*, or *Juniperus communis* (Moir and Ludwig 1979, Alexander et al. 1984a, Mauk and Henderson 1984, Youngblood and Mauk 1985, DeVelice et al. 1986, Muldavin et al. 1996, Stuever and Hayden 1997b). The herbaceous layer is typically sparse, with low diversity, but is occasionally moderately dense. It is frequently composed of a mixture of graminoids, including *Carex rossii*, *Carex geophila*, *Carex inops* ssp. *heliophila*, *Poa fendleriana*, *Bromus anomalus*, and *Elymus elymoides*, and the forbs *Geranium viscosissimum*, *Goodyera oblongifolia*, *Lathyrus lanszwertii* var. *leucanthus* (= *Lathyrus arizonicus*), *Mertensia arizonica*, *Senecio wootonii*, *Thalictrum fendleri*, and *Viola canadensis*. *Pseudotsuga menziesii* and *Abies concolor* seedlings are typically present.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Abies concolor, Pseudotsuga menziesii*

Globally

Stratum	Species
Tree canopy	*Abies concolor, Pseudotsuga menziesii*
Shrub/sapling (tall & short)	*Mahonia repens*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Bandelier National Monument

Data are not available.

Globally

This association includes some white fir / sparse understory habitat types that have *Mahonia repens* present (Alexander et al. 1984a, DeVelice et al. 1986). *Pseudotsuga menziesii* / *Mahonia repens* Forest (CEGL000442) is similar except it lacks *Abies concolor* and can occur outside the range of *Abies concolor* extending north into Idaho and Oregon (Pfister 1977, Steele et al. 1981, 1983, Cole 1982).

CLASSIFICATION CONFIDENCE: 1- Strong

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM plots 04BD008, 06AB185, 06JC215, and 06JC483.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz

REFERENCES

Alexander et al. 1984a, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, DeVelice et al. 1986, Driscoll et al. 1984, Fitzhugh et al. 1987, Graybosch and Buchanan 1983, Heinze et al. 1962, Johnston 1984, Johnston 1987, Larson and Moir 1987, Mauk and Henderson 1984, Moir and Ludwig 1979, Muldavin et al. 1996, Muldavin et al. 2006, Pfister 1972, Roberts et al. 1992, Steele et al. 1981, Steele et al. 1983, Stuever and Hayden 1997b, Western Ecology Working Group n.d., Youngblood and Mauk 1985

Picea engelmannii / *Erigeron eximius* Forest

Engelmann Spruce / Spruce fir Fleabane Forest

CODE	CEGL000364
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	PICEA ENGELMANNII FOREST ALLIANCE (A.164), Engelmann Spruce Forest Alliance

ECOLOGICAL SYSTEM(S)

Rocky Mountain Subalpine Dry Mesic Spruce Fir Forest and Woodland (CES306.828), Rocky Mountain Subalpine Mesic Wet Spruce Fir Forest and Woodland (CES306.830)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This subalpine forest occurs throughout the mountains of central Arizona to southwestern and central New Mexico into the Jemez Mountains of northern New Mexico and into southern Colorado. It occurs on cool, relatively mesic to moist sites with gentle to steep slopes on all aspects (especially northerly) and also on lower slopes of canyon drainages. Elevations range from 2655 to 3000 m (8850 [>8100 in canyons]-10000 feet). Soils are derived from latite or dactite volcanics. Typically, the ground surface is dominated by thick litter and dense herbaceous cover. This subalpine forest is characterized by a closed canopy of *Picea engelmannii* with *Pseudotsuga menziesii* as a codominant along with scattered *Pinus flexilis*. Occasional *Populus tremuloides* may be present, but total canopy cover is less than 10%. *Abies concolor* and *Pinus strobiformis* are sometimes abundant as reproduction, but never in the larger size classes. Sapling *Picea engelmannii* are well represented in the understory along with seedlings of *Populus tremuloides*. Shrubs are scarce or absent. The herb layer can be relatively well developed and is dominated by *Erigeron eximius* along with a mix of other forbs and grasses.

DISTRIBUTION

Bandelier National Monument

This minor association occurs in the Sierra de los Valles (Rabbit Mountain).

Globally

This subalpine forest occurs throughout the mountains of central Arizona to southwestern and central New Mexico into the Jemez Mountains of northern New Mexico and into southern Colorado.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This high elevation association is know from 2990 m (9800 feet) on a moderately steep (35%), northeast facing upper backslope. Soils are derived from latite or dactite volcanics. Typically, the ground surface is dominated by thick litter and dense herbaceous cover.

Globally

This subalpine forest occurs on cool, relatively mesic to moist sites with gentle to steep slopes on all aspects (especially northerly) and also on lower slopes of canyon drainages. Elevations range from 2655 to 3000 m (8850 [>8100 in canyons]-10000 feet). Soils are derived from latite or dactite volcanics. Typically, the ground surface is dominated by

thick litter and dense herbaceous cover.

VEGETATION DESCRIPTION

Bandelier National Monument

This subalpine forest association is characterized by a closed canopy of *Picea engelmannii* with *Pseudotsuga menziesii* as a codominant along with scattered *Pinus flexilis*. Occasional *Populus tremuloides* are present but total canopy cover is less than 10%. Sapling *Picea engelmannii* are well represented in the understory along with seedlings of *Populus tremuloides*. Shrubs are scarce or absent, but the herb layer can be relatively well developed and is dominated by *Erigeron eximius* along with a mix of other forbs and grasses such as *Bromus ciliatus*, *Thalictrum fendleri*, *Viola canadensis*, *Orthilia secunda*, and *Goodyera oblongifolia*.

Globally

Vegetation is characterized by a closed canopy of *Picea engelmannii* with *Pseudotsuga menziesii* as a codominant along with scattered *Pinus flexilis*. Occasional *Populus tremuloides* may be present, but total canopy cover is less than 10%. *Abies concolor* and *Pinus strobiformis* are sometimes abundant as reproduction, but never in the larger size classes. Sapling *Picea engelmannii* are well represented in the understory along with seedlings of *Populus tremuloides*. Shrubs are scarce or absent. The herb layer can be relatively well developed and is dominated by *Erigeron eximius* along with a mix of other forbs and graminoids such as *Carex siccata*, *Bromus ciliatus*, *Geranium richardsonii*, *Maianthemum stellatum*, *Goodyera oblongifolia*, *Orthilia secunda*, *Thalictrum fendleri*, *Valeriana* spp., and *Viola canadensis*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Picea engelmannii*
Herb (field)	*Erigeron eximius, Thalictrum fendleri*
Herb (field)	*Bromus ciliatus*

Globally

Stratum	Species
Tree canopy	*Picea engelmannii*
Herb (field)	*Erigeron eximius, Thalictrum fendleri*
Herb (field)	*Bromus ciliatus*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Populus tremuloides* phase was identified where canopy cover is greater than 10%.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plot: 03BD107.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King and K.A. Schulz after A. Kennedy and E. Muldavin

REFERENCES

Bourgeron and Engelking 1994, Driscoll et al. 1984, Fitzhugh et al. 1987, Larson and Moir 1987, Muldavin et al. 1996, Stuever and Hayden 1997b, Western Ecology Working Group n.d.

Picea pungens / *Fragaria virginiana* ssp.Forest

Blue Spruce / Virginia Strawberry Forest

CODE	CEGL000391
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	PICEA PUNGENS FOREST ALLIANCE (A.165) Blue Spruce Forest Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland (CES306.825)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This mid to upper elevation tall mixed conifer forest occurs in the mountains of Arizona and New Mexico on sites with moderate to high solar exposure that increases with elevation. Sites tend to be moist mesic canyon bottoms or toeslopes shifting to backslopes at higher elevations (but slopes are generally low (<10%)). Elevations range between 2487 and 2740 m (8159-9000 feet). Soils are primarily loamy Mollisols. Typically, the ground surface is dominated by thick litter and dense herbaceous cover. The overstory tree canopy of this tall mixed conifer association can range from open to closed (25-80% cover) and is dominated by *Picea pungens*. *Abies concolor*, *Pinus ponderosa*, and *Pseudotsuga menziesii* may be common to well represented as seedlings, saplings, or mature individuals. Shrubs are generally scarce but may include a variety of different species. A rich and productive herbaceous layer is characteristic with total cover ranging from 10 to 60%. Numerous forb and grass species may be present.

DISTRIBUTION

Bandelier National Monument

This minor association occurs in Canon de los Frijoles and in the Sierra de los Valles (Scooter Peak and Rabbit Mountain).

Globally

This mid to upper elevation tall mixed conifer forest occurs in the mountains of Arizona and New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid to upper elevation association occurs between 2640 and 2740 m (8670-9000 feet) on sites with moderate to high solar exposure that increases with elevation (i.e., somewhat warmer aspects with higher elevations). Sites tend to be moist mesic canyon bottoms or toeslopes shifting to backslopes at higher elevations (but slopes are generally low (<10%)). Soils are derived from latite or dactite and are mapped primarily as loamy Mollisols (Hibner 2009). Typically, the ground surface is dominated by thick litter and dense herbaceous cover.

Globally

This mid to upper elevation tall mixed conifer forest association occurs in the mountains of Arizona and New Mexico on sites with moderate to high solar exposure that increases with elevation. Sites tend to be moist mesic canyon bottoms or toeslopes shifting to backslopes at higher elevations (but slopes are generally low (<10%)). Elevations range between 2487 and 2740 m (8159-9000 feet). Soils are primarily loamy Mollisols (Hibner 2009). Typically, the

ground surface is dominated by thick litter and dense herbaceous cover.

VEGETATION DESCRIPTION

Bandelier National Monument

In this tall mixed conifer forest association, the overstory tree canopy can range from open to closed (25-80% cover) and is dominated by *Picea pungens* with *Abies concolor*, *Pinus ponderosa*, and *Pseudotsuga menziesii* common to well represented as seedlings, saplings, or mature individuals. Shrubs are generally scarce, but *Juniperus communis* can be well represented on occasion. A rich and productive herbaceous layer is characteristic with total cover ranging from 10 to 60% distributed among 39 forb and 16 grass species reported. Among forbs, *Fragaria virginiana* ssp. *glauca* (or *Fragaria vesca*) and *Erigeron eximius* are at least well represented and diagnostic. Other common mesic forbs include *Geranium richardsonii*, *Geranium caespitosum*, *Lathyrus lanszwertii* var. *leucanthus*, *Viola canadensis*, *Iris missouriensis*, and *Thalictrum fendleri*. Graminoids can also be well represented and include *Carex* sp. (*Carex inops* ssp. *heliophila*, *Carex rossii*, and *Carex siccata*), along with *Koeleria macrantha*, *Bromus anomalus*, and *Bromus ciliatus*.

Globally

The overstory tree canopy of this tall mixed conifer association can range from open to closed (25-80% cover) and is dominated by *Picea pungens*. *Abies concolor*, *Pinus ponderosa*, and *Pseudotsuga menziesii* may be common to well represented as seedlings, saplings, or mature individuals. Shrubs are generally scarce but may include a variety of different species. A rich and productive herbaceous layer is characteristic with total cover ranging from 10 to 60%. Numerous forb and grass species may be present. Among forbs, *Fragaria virginiana* ssp. *glauca* (or *Fragaria vesca*) and *Erigeron eximius* are at least well represented and diagnostic. Other common mesic forbs may include *Geranium caespitosum*, *Geranium richardsonii*, *Iris missouriensis*, *Lathyrus lanszwertii* var. *leucanthus*, *Thalictrum fendleri*, and *Viola canadensis*. Graminoids can also be well represented and include *Carex* sp. (*Carex inops* ssp. *heliophila*, *Carex rossii*, and *Carex siccata*), along with *Koeleria macrantha*, *Bromus anomalus*, and *Bromus ciliatus*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Picea pungens*
Herb (field)	*Erigeron eximius, Fragaria vesca, Fragaria virginiana* ssp. *glauca*
Herb (field)	*Carex siccata*

Globally

Stratum	Species
Tree canopy	*Picea pungens*
Herb (field)	*Erigeron eximius, Fragaria vesca, Fragaria virginiana* ssp. *glauca*
Herb (field)	*Carex siccata*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G4 (23 Feb 1994).

CLASSIFICATION COMMENTS

Bandelier National Monument

In one plot, *Erigeron eximius* is clearly dominant and the plot could have been classified as the closely related and perhaps synonymous *Picea pungens* / *Erigeron eximius* Forest (CEGL000390).

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD004, 03BD041, 06JC509.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Alexander et al. 1984a, Bourgeron and Engelking 1994, Driscoll et al. 1984, Hibner 2009, Szaro 1989, Western Ecology Working Group n.d.

Pseudotsuga menziesii / *Mahonia repens* Forest

Douglas fir / Creeping Oregon grape Forest

CODE	CEGL000442
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), 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 dry, often nutrient poor sites in the southern and central Rocky Mountains and high plateaus of the Colorado Plateau from northern Arizona and New Mexico north through Colorado and Utah into central Idaho, Wyoming and *Montana*, and extends to the eastern Cascades in Oregon. Stands occur on lower mountain slopes and upper canyon slopes. Elevations range from 1740 to 2930 m (5700-9600 feet) in northern New Mexico, Arizona and Colorado, and 1375 to 2595 m (4500-8500 feet) in Utah, Wyoming and southern Idaho. Soils are variable in texture and parent material but are usually deep and often rocky. The vegetation is representative of closed canopy stands of *Pseudotsuga menziesii* where most species other than *Mahonia repens* have been shaded out. In some stands, a few individual *Pinus ponderosa*, *Pinus contorta*, *Pinus flexilis*, *Pinus strobiformis*, *Populus tremuloides*, or *Juniperus scopulorum* may persist in the canopy or subcanopy. The understory may be sparse, with 10% or less total cover, but sometimes will have up to 30% total herbaceous and shrub cover. *Mahonia repens* is the dominant species with at least 1% cover, but other species are usually present with at least trace cover, including *Juniperus communis*, *Symphoricarpos oreophilus*, *Paxistima myrsinites*, and *Prunus virginiana*. The herbaceous layer is generally sparse but may include small amounts of graminoids such as *Poa fendleriana*, *Festuca arizonica*, *Carex geyeri*, *Carex rossii*, and scattered forbs such as *Arnica cordifolia*, *Galium boreale*, and *Thalictrum fendleri*. The mature, older canopy trees in some stands are fire scarred, indicating that ground fire activity may be important in stands of this type. Some stands appear to be ponderosa pine woodlands that have filled in within the last 150 years with a closed canopy of Douglas fir.

DISTRIBUTION

Bandelier National Monument

This association is known from the slopes of Cerro Grande and Rabbit Mountain.

Globally

This association occurs in dry mountain and canyon sites in northern Arizona and New Mexico, north through central Utah into Oregon and southern Idaho, and east into Wyoming and Colorado.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association occurs at 2890 to 2950 m (9480-9675 feet) in elevation, on moderate to steep mountain sideslopes (20-60%) with a variety of aspects. Sites occur on substrates derived from rhyolite and andesite volcanic rocks.

Globally

This forest occurs on dry, often nutrient poor sites in northern Arizona and New Mexico north through Colorado and Utah into Idaho, Wyoming and Montana, and extends to the eastern Cascades in Oregon (Cole 1982, Atzet and Wheeler 1984, Mauk and Henderson 1984, Stuever and Hayden 1997b). Stands occur on lower mountain slopes and upper canyon slopes. Elevations range from 2135 to 2595 m (7000-8500 feet) in northern Arizona and New Mexico, 1740 to 2930 m (5700-9600 feet) in Colorado, and 1375 to 2595 m (4500-8500 feet) in Utah, Wyoming and southern Idaho. Soils are variable in texture and parent material but are usually deep and often rocky. Litter and downed wood cover nearly all the unvegetated surface.

VEGETATION DESCRIPTION

Bandelier National Monument

This forest association is characterized by closed tree canopies dominated by *Pseudotsuga menziesii*. *Pinus ponderosa* is often well represented in the canopy, and *Pinus strobiformis* and *Populus tremuloides* can also be present. *Abies concolor* is absent or accidental. *Pseudotsuga menziesii* saplings can be common, but regeneration of other tree species is usually scarce or absent. The shady conditions result in a sparse understory of mostly leaf litter with scattered shrubs, graminoids, and herbaceous species.

Globally

This association represents closed canopy stands of *Pseudotsuga menziesii* where most species other than *Mahonia repens* have been shaded out. In some stands, a few individual *Pinus ponderosa*, *Pinus contorta*, *Pinus flexilis*, *Pinus strobiformis*, *Populus tremuloides*, or *Juniperus scopulorum* may persist in the canopy or subcanopy. The understory may be sparse, with 10% or less total cover, but sometimes will have up to 30% total herbaceous and shrub cover. *Mahonia repens* is the dominant species with at least 1% cover, but other species are usually present with at least trace cover, including *Juniperus communis*, *Symphoricarpos oreophilus*, *Paxistima myrsinites*, and *Prunus virginiana*. The herbaceous layer is generally sparse but may include small amounts of *Poa fendleriana*, *Festuca arizonica*, *Carex geyeri*, *Carex rossii*, *Arnica cordifolia*, *Maianthemum racemosum* (= *Smilacina racemosa*), *Galium boreale*, *Bromus ciliatus*, *Clematis columbiana*, and *Thalictrum fendleri*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*

Globally

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*
Herb (field)	*Mahonia repens*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Bandelier National Monument

Data are not available.

Globally

This association describes a dry, mature to old growth, closed canopy *Pseudotsuga menziesii* forest of the *interior* western U.S.; earlier seral stages have a more open, mixed canopy and more diversity and cover by shrubs and herbaceous species. *Mahonia repens* is a common understory species in all seral stages of these dry Douglas fir forests, but usually is mixed with varying amounts of species that are also indicators in other associations. It is not necessarily clear what degree of dominance by *Mahonia repens* versus other diagnostic species (such as *Carex geyeri*, *Paxistima myrsinites*, *Symphoricarpos oreophilus*, or *Juniperus communis*) constitutes a stand of this association. This association is similar to *Pseudotsuga menziesii* / *Arnica cordifolia* Habitat Type of Pfister et al. (1977) in Montana.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM plots 04BD007, 06JC210, and 06JC510.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES

Alexander et al. 1984b, Atzet and Wheeler 1984, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Cole 1977b, Cole 1982, Driscoll et al. 1984, Hoffman and Alexander 1976, Johnston 1984, Johnston 1987, Jones and Ogle 2000, Kagan et al. 2004, Larson and Moir 1987, MTNHP 2002b, Mauk and Henderson 1984, Pfister et al. 1977, Roberts 1980, Roberts et al. 1992, Steele et al. 1981, Steele et al. 1983, Stuever and Hayden 1997b, 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), Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland

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

DISTRIBUTION

Bandelier National Monument

This association is known from American Spring, Escobas, Burnt, and Frijoles mesas, and the slopes of Frijoles, Alamo, and Capulin canyons.

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

Bandelier National Monument

This association occurs between 2060 and 2680 m (6750-8800 feet) in elevation, across a range of slopes and aspects. Stands occur on gentle, rolling mesatops, shoulder slopes of the canyons to steep canyon sideslopes. Substrates are derived from volcanic Bandelier tuff. Sites tend to be rocky or gravelly with significant litter accumulation.

Globally

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

VEGETATION DESCRIPTION

Bandelier National Monument

This forest association is dominated by open canopies of *Pseudotsuga menziesii* (10-55%) with *Pinus ponderosa* a common codominant. *Abies concolor* and *Pinus strobiformis* are occasional associates but not dominant. If present, *Abies concolor* always has low cover (<5%). *Pseudotsuga menziesii* and *Pinus ponderosa* saplings can be common in the understory. *Quercus gambelii* is diagnostic and well represented to abundant in the subcanopy and/or shrub layer. *Robinia neomexicana* and *Quercus* X *pauciloba* can also be well represented in the shrub layer but not dominant. The herbaceous layer is typically poorly represented. Among the 23 graminoid species recorded, the most prevalent are *Carex rossii*, *Koeleria macrantha*, and *Muhlenbergia montana* (one post burn site with an tree open canopy had abundant *Poa fendleriana*). Although 21 forb species have been recorded from this association, they are inconsistent in occurrence and scattered.

Globally

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

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa, Pseudotsuga menziesii*
Tree canopy	*Quercus gambelii*
Shrub/sapling (tall & short)	*Quercus gambelii*

Globally

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

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Bandelier National Monument

Three phases were identified from this association. A *Poa fendleriana* phase occurs when it is abundant (>25% cover). A *Quercus* X *pauciloba* phase or a *Robinia neomexicana* phase occurs where these shrubs are well represented (>5% cover).

Globally

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

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM plots 03BD105, 03BD125, 03BD110, 03BD132, 06JC149, 03YC008, 06JC550, 06JC552, 06AB170, 06JC609, 06JC156, 06JC157, 06JC173, 06BF005, 06BF006, 06JC606, and 06AB158.

Local Description Authors: A. Kennedyt and E. Muldavin

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

Populus tremuloides / *Acer glabrum* Forest

Quaking Aspen / Rocky Mountain Maple Forest

CODE	CEGL000563
PHYSIOGNOMIC SUBCLASS	Deciduous forest (I.B.)
PHYSIOGNOMIC GROUP	Cold deciduous forest (I.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural cold deciduous forest (I.B.2.N.)
FORMATION	Montane or boreal cold deciduous forest (I.B.2.N.b.)
ALLIANCE	POPULUS TREMULOIDES FOREST ALLIANCE (A.274) Quaking Aspen Forest Alliance

ECOLOGICAL SYSTEM(S)

Rocky Mountain Aspen Forest and Woodland (CES306.813)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This uncommon *Populus tremuloides* forest association is found in a mountainous region east of the Continental Divide in central Colorado. Stands also occur in north-central New Mexico where the association is seral to conifer forests with *Acer glabrum*-dominated understories. This association commonly occurs on north- to northeast-facing, moist-wet slopes and alluvial terraces from 2420 to 2930 m (7930 -9600 feet) elevation, but it is also reported from easterly to southerly slopes. Slopes are moderately steep (generally 5-13%) and undulating. Soils are saturated or poorly drained and range from silty clay loams to sandy loams, often with high organic matter content in the top 10 cm (4 inches) of the soil profile. Species richness is moderately high for aspen associations. This association is characterized by a nearly closed canopy of the broaF-leaved deciduous tree *Populus tremuloides*. *Populus balsamifera* or *Populus angustifolia* may be present in some stands. The understory is very lush. Shrubs are primarily broaF-leaved deciduous species, with *Acer glabrum* being characteristic and dominant, occasionally reaching tree stature. Other important tall shrubs include *Sambucus racemosa*, *Prunus virginiana*, and *Amelanchier alnifolia*. Short shrubs present include *Rosa woodsii*, *Ribes montigenum*, and *Mahonia repens*. Conifer species may be present in the understory but with low cover. The herbaceous layer is dominated by perennial forbs such as *Actaea rubra*, *Artemisia franserioides*, *Chamerion angustifolium* (= *Epilobium angustifolium*), *Erigeron eximius*, *Maianthemum stellatum*, *Osmorhiza depauperata*, *Oreochrysum parryi* (= *Solidago parryi*, and *Thalictrum fendleri*. Common grasses are *Calamagrostis canadensis* and Elymus spp. Diagnostic of this forest association is the tree canopy dominated by *Populus tremuloides* with an *Acer glabrum*-dominated tall-shrub layer.

DISTRIBUTION

Bandelier National Monument

This minor association is known from the slopes Water and Alamo Canyons just outside the monument.

Globally

This type is only recorded from the Rocky Mountains in Colorado and northern New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association occurs between 7,930 and 8,520 feet (2,420-2,600 meters) in elevation on steep, northeast-facing canyon sideslopes. Stands occur on substrates derived from Bandelier Tuff.

Globally

This type is found in a mountainous region just to the east of the Continental Divide. This region includes the high-

est ranges in the Rocky Mountain system; many peaks are in excess of 4267 m (14,000 feet) elevation. Extensive Pleistocene glaciation occurred in these ranges. The climate is characterized by cool summers and cold winters. An average of 40% of the annual precipitation falls from June through August, with the remainder occurring as winter and early spring snows. Due to a rainshadow effect from the massive San Juan Mountains to the west, annual precipitation (approximately 20 inches) is less than what occurs farther south in northern New Mexico. Maximum snowfall accumulations are about 26 feet.This association commonly occurs on north- to northeast-facing, moist-wet slopes and alluvial terraces from 2420 to 2930 m (7930-9600 feet) elevation, but it is also reported from easterly to southerly slopes. Slopes are moderately steep (generally 5-13%) and undulating. Soils are saturated and range from silty clay loams to sandy loams, often with high organic matter content in the top 10 cm (4 inches) of the soil profile.

VEGETATION DESCRIPTION

Bandelier National Monument

Tree canopies of this association are closed and are monotypically dominated by *Populus tremuloides* and a subcanopy or tall shrub layer characterized by *Acer glabrum*, well represented as either saplings or mature individuals. Sapling quaking aspen can be well represented in the subcanopy as well. Shrubs are well represented to abundant in these stands and most commonly include the mesic forest species *Jamesia americana* and *Physocarpus monogynus*. In the herbaceous layer, graminoids are typically scarce to poorly represented, while forb species vary from common to well represented. *Artemisia franserioides* most frequently represents the forbs of this mesic, canyon association.

Globally

The broaF-leaved deciduous tree *Populus tremuloides* dominates the canopy of this forest association with over 90% cover. *Populus balsamifera* or *Populus angustifolia* may be present in some stands. The understory is very lush, with both shrub and herbaceous layers having over 100% cover. Shrubs are primarily broaF-leaved deciduous species, with *Acer glabrum* being the characteristic and dominant (averaging 56% cover). Occasionally *Acer glabrum* may reach tree stature, some individuals being over 8 m in height. Other important tall shrubs include *Sambucus racemosa*, *Prunus virginiana*, and *Amelanchier alnifolia*. Short shrubs present include *Jamesia americana*, *Physocarpus monogynus Rosa woodsii*, *Ribes montigenum*, and *Mahonia repens*. Conifer species may be present in the understory but with low cover. The herbaceous layer is dominated by perennial forbs such as *Actaea rubra*, *Artemisia franserioides*, *Chamerion angustifolium* (= *Epilobium angustifolium*), *Oreochrysum parryi*, *Osmorhiza depauperata*, *Maianthemum stellatum* (= *Smilacina stellata*), and *Thalictrum fendleri*. Common grasses are *Calamagrostis canadensis* and *Elymus* spp. Species richness is moderately high for aspen associations, with 49 species of vascular plants occurring in the sampled stands.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Populus tremuloides, Acer glabrum*

Globally

Stratum	Species
Tree canopy	*Populus tremuloides*
Shrub/sapling (tall & short)	*Acer glabrum*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G1G2 (7-Nov-1997).

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Poa pratensis* phase was identified for this association where it exceeds 10% cover. Balice et al. (1997) have reported a *Populus tremuloides* / *Pteridium aquilinum* Cover Type for the Los Alamos region that has a similar grassy understory, but it lacks *Festuca thurberi*. Muldavin and Tonne (2003) and Muldavin et al. (2006) described this association for the adjacent Valles Caldera National Preserve.

Globally

Powell (1988a) describes this as a riparian forest, but it may not be restricted to streams. This association and *Pseudotsuga menziesii* / *Acer glabrum* Forest (CEGL000418) are closely related as many of these aspen stands may be seral to *Pseudotsuga menziesii* / *Acer glabrum* Forest (CEGL000418).

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots 06JC171 and 06JC543..

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: M.S. Reid, mod. S.L. Neid and K.A. Schulz

REFERENCES

Bourgeron and Engelking 1994, Carsey et al. 2003a, Carsey et al. 2003b, CONHP unpubl. data 2003, Driscoll et al. 1984, Kittel et al. 1999b, Powell 1988a, Reid et al. 1994, Western Ecology Working Group n.d.

Populus tremuloides / *Festuca thurberi* Forest

Quaking Aspen / Thurber's Fescue Forest

CODE	CEGL000585
PHYSIOGNOMIC SUBCLASS	Deciduous forest (I.B.)
PHYSIOGNOMIC GROUP	Cold deciduous forest (I.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural cold deciduous forest (I.B.2.N.)
FORMATION	Montane or boreal cold deciduous forest (I.B.2.N.b.)
ALLIANCE	POPULUS TREMULOIDES FOREST ALLIANCE (A.274) Quaking Aspen Forest Alliance

ECOLOGICAL SYSTEM(S)

Rocky Mountain Aspen Forest and Woodland (CES306.813)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This high elevation forest association is present in southern and western Colorado and occurs on both sides of the Continental Divide in the Colorado Rocky Mountains. It is also known to occur within the Valles Caldera National Preserve and Bandelier National Monument in north central New Mexico, as well as on the Aquarius and Fish Lake plateaus in Utah. In Colorado, this association is found on gentle to moderately steep slopes (ranging from 6 30%) with variable slope aspects on soils which are moderately deep, loamy alluvium and colluviums derived from a wide variety of parent material. In New Mexico, it occurs on cold, mid to upper slopes and ridges on northerly aspects and on lower slopes to ridges on southerly aspects. In Utah, this association occurs on relatively gentle slopes on soils derived from either volcanic or granitic parent material. Elevations range from 2400 to 3110 m (8600-10,200 feet). The ground surface is characterized by scattered bunch grasses and sedges intermixed with litter and some exposed soil. The vegetation within this type is characterized by an open canopy forest overstory dominated by *Populus tremuloides* with the herbaceous understory dominated by *Festuca thurberi*.

In north central Colorado, this association is recognized by the overstory dominance and reproductive success of *Populus tremuloides* and the dominance of the undergrowth by *Festuca thurberi* (10-65% cover). Shrubs, weakly represented, include *Amelanchier alnifolia*, *Artemisia tridentata*, *Rosa woodsii*, and *Symphoricarpos oreophilus*. Other important graminoids are *Elymus trachycaulus* (= *Agropyron trachycaulum*), *Bromus anomalus*, *Carex geyeri*, *Poa nemoralis* ssp. *interior* (= *Poa interior*), and *Achnatherum nelsonii* ssp. *dorei* (= *Stipa columbiana*). Important forbs often include *Achillea millefolium*, *Carex siccata* (= *Carex foenea*), *Campanula rotundifolia*, *Chamerion angustifolium*, *Erigeron speciosus*, *Lathyrus lanszwertii* var. *leucanthus* (= *Lathyrus leucanthus*), *Fragaria virginiana*, *Potentilla gracilis*, *Pseudocymopterus montanus*, and *Vicia americana*. In south central Colorado, overstories consist entirely of *Populus tremuloides*, with various species present in the understory (most frequently encountered conifer is *Picea engelmannii*). The most constant herbaceous plant species include *Festuca thurberi*, *Carex siccata*, *Achillea millefolium*, *Campanula rotundifolia*, *Chamerion angustifolium*, *Fragaria virginiana*, *Potentilla gracilis*, and *Pseudocymopterus montanus*.

In north central New Mexico, the understory is characteristically grassy (approaches 70% cover) and, other than scattered young *Populus tremuloides*, shrubs are absent. Other grasses and sedges may be abundant, including *Bromus ciliatus*, *Koeleria macrantha*, *Carex siccata*, and the introduced perennial grass *Poa pratensis*. Forbs are well represented by a mix of forest and montane grassland species (e.g., forest species include *Galium aparine*, *Viola canadensis*, *Geranium richardsonii*, *Thalictrum fendleri*, and *Fragaria virginiana* ssp. *glauca*; meadow species include *Taraxacum officinale*, *Lathyrus lanszwertii* var. *leucanthus*, *Achillea millefolium*, *Campanula rotundifolia*, *Androsace septentrionalis*, and *Iris missouriensis*). The fern *Pteridium aquilinum* var. pubescens is also often well represented. This aspen association may represent an invasion of a montane meadow grassland by trees.

In Utah, shrubs, particularly *Symphoricarpos oreophilus*, are sometimes present but never abundant. The grasses most commonly associated with *Festuca thurberi* in the undergrowth are *Achnatherum occidentale* (= *Stipa occidentalis*) and *Elymus trachycaulus*. Occasionally, *Bromus carinatus* or *Poa pratensis* may be abundant. Forbs are seldom abundant and few have high constancy. The most common forbs are *Achillea millefolium* and *Taraxacum officinale*.

DISTRIBUTION

Bandelier National Monument

This association is known from slopes of Cerro Grande, and it likely occurs in other portions of the Sierra de los Valles.

Globally

This high elevation forest association is present in southern and western Colorado and occurs on both sides of the Continental Divide in the Colorado Rocky Mountains. It is also known to occur within the Valles Caldera National Preserve and Bandelier National Monument in north central New Mexico, as well as on the Aquarius and Fish Lake plateaus in Utah.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This high elevation association is known from 2880 m (9460 feet) on a moderately steep (27%), east facing, mountain backslope. Soils are mapped as deep and loamy Mollisols derived from latite or dactite slope colluvium. The ground surface is characterized by scattered bunch grasses and sedges intermixed with litter and some exposed soil.

Globally

In Colorado, this association is found on gentle to moderately steep slopes (ranging from 6 to 30%) with variable slope aspects on soils which are moderately deep, loamy alluvium and colluviums derived from a wide variety of parent material. In New Mexico, it occurs on cold, mid to upper slopes and ridges on northerly aspects and on lower slopes to ridges on southerly aspects. In Utah, this association occurs on relatively gentle slopes on soils derived from either volcanic or granitic parent material. Elevations range from 2400 to 3110 m (8600-10,200 feet). The ground surface is characterized by scattered bunch grasses and sedges intermixed with litter and some exposed soil.

VEGETATION DESCRIPTION

Bandelier National Monument

This is a tall subalpine deciduous forest with an open canopy (20% cover) that is dominated by *Populus tremuloides*. *Pseudotsuga menziesii* can be present with scattered individuals, but it is clearly subordinate. The understory is characteristically grassy; other than scattered young *Populus tremuloides*, shrubs are absent. Graminoid cover approaches 70% and is dominated by *Festuca thurberi*. The introduced perennial grass *Poa pratensis* is also abundant. Forbs are well represented by a mix of forest and montane grassland species (e.g., forest species include *Galium aparine*, *Viola canadensis*, *Geranium richardsonii*, *Thalictrum fendleri*, and *Fragaria virginiana* ssp. *glauca*; meadow species include *Taraxacum officinale*, *Lathyrus lanszwertii* var. *leucanthus*, *Achillea millefolium*, *Campanula rotundifolia*, *Androsace septentrionalis*, and *Iris missouriensis*). The fern *Pteridium aquilinum* var. *pubescens* is also well represented.

Globally

The vegetation is characterized by an open canopy forest overstory dominated by *Populus tremuloides* with the herbaceous understory dominated by *Festuca thurberi*. In north central Colorado, this association is recognized by the overstory dominance and reproductive success of *Populus tremuloides* and the dominance of the undergrowth by *Festuca thurberi* (10-65% cover). Shrubs, weakly represented, include *Amelanchier alnifolia*, *Artemisia tridentata*, *Rosa woodsii*, and *Symphoricarpos oreophilus*. Other important graminoids are *Elymus trachycaulus* (= *Agropyron trachycaulum*), *Bromus anomalus*, *Carex geyeri*, *Poa nemoralis* ssp. *interior* (= *Poa interior*), and *Achnatherum nelsonii* ssp. *dorei* (= *Stipa columbiana*). Important forbs often include *Achillea millefolium*, *Carex siccata* (= *Carex foenea*), *Campanula rotundifolia*, *Chamerion angustifolium*, *Erigeron speciosus*, *Lathyrus lanszwertii* var. *leucanthus* (= *Lathyrus leucanthus*), *Fragaria virginiana*, *Potentilla gracilis*, *Pseudocymopterus montanus*, and *Vicia americana*. In south central Colorado, overstories consist entirely of *Populus tremuloides*, with various species present in the understory (most frequently encountered conifer is *Picea engelmannii*). The most constant herbaceous plant species include *Fes-*

tuca thurberi, *Carex siccata*, *Achillea millefolium*, *Campanula rotundifolia*, *Chamerion angustifolium*, *Fragaria virginiana*, *Potentilla gracilis*, and *Pseudocymopterus montanus*.

In north central New Mexico, the understory is characteristically grassy (approaches 70% cover) and, other than scattered young *Populus tremuloides*, shrubs are absent. Other grasses and sedges may be abundant, including *Bromus ciliatus*, *Koeleria macrantha*, *Carex siccata*, and the introduced perennial grass *Poa pratensis*. Forbs are well represented by a mix of forest and montane grassland species (e.g., forest species include *Galium aparine*, *Viola canadensis*, *Geranium richardsonii*, *Thalictrum fendleri*, and *Fragaria virginiana* ssp. *glauca*; meadow species include *Taraxacum officinale*, *Lathyrus lanszwertii* var. *leucanthus*, *Achillea millefolium*, *Campanula rotundifolia*, *Androsace septentrionalis*, and *Iris missouriensis*). The fern *Pteridium aquilinum* var. pubescens is also often well represented. This aspen association may represent an invasion of a montane meadow grassland by trees.

In Utah, shrubs, particularly *Symphoricarpos oreophilus*, are sometimes present but never abundant. The grasses most commonly associated with *Festuca thurberi* in the undergrowth are *Achnatherum occidentale* (= *Stipa occidentalis*) and *Elymus trachycaulus*. Occasionally, *Bromus carinatus* or *Poa pratensis* may be abundant. Forbs are seldom abundant and few have high constancy. The most common forbs are *Achillea millefolium* and *Taraxacum officinale*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Populus tremuloides*
Herb (field)	*Festuca thurberi, Poa pratensis*

Globally

Stratum	Species
Tree canopy	*Populus tremuloides*
Herb (field)	*Festuca thurberi*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (23 Feb 1994).

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Poa pratensis* phase was identified for this association where it exceeds 10% cover. Balice et al. (1997) have reported a *Populus tremuloides* / *Pteridium aquilinum* Cover Type for the Los Alamos region that has a similar grassy understory, but it lacks *Festuca thurberi*. Muldavin and Tonne (2003) and Muldavin et al. (2006) described this association for the adjacent Valles Caldera National Preserve.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plot: 03BD033.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King

REFERENCES

Balice et al. 1997, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Costello 1954, Cox 1968, Driscoll et al. 1984, Hess and Alexander 1986, Johnston 1987, Johnston and Hendzel 1985, Komarkova et al. 1988a, Langenheim 1962, Mueggler 1988, Mueggler and Campbell 1986, Muldavin and Tonne 2003, Muldavin et al. 2006, Paulsen 1969, Powell 1988a, Western Ecology Working Group n.d.

Populus tremuloides / Invasive Perennial Grasses Forest

Quaking Aspen / Invasive Perennial Grasses Forest

CODE	CEGL003748
PHYSIOGNOMIC SUBCLASS	Deciduous forest (I.B.)
PHYSIOGNOMIC GROUP	Cold deciduous forest (I.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural cold deciduous forest (I.B.2.N.)
FORMATION	Montane or boreal cold deciduous forest (I.B.2.N.b.)
ALLIANCE	POPULUS TREMULOIDES FOREST ALLIANCE (A.274) Quaking Aspen Forest Alliance

ECOLOGICAL SYSTEM(S):

Rocky Mountain Aspen Forest and Woodland (CES306.813)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is a widespread grazing induced type found across much of the western U.S. within the range of aspen, including the southern and central Rocky Mountains west into the Colorado Plateau and Great Basin into eastern California and throughout much of Idaho and *Montana*. Stands typically occur within the elevational range of 1830-2830 m (6000-9280 feet) on flat to moderate (1-27%) benches, alluvial terraces and lower slopes, swales, near springs and especially along stream channels and valley bottoms where livestock congregate. Stands typically have current or past heavy grazing. Aspects and substrates are variable. Soils are often relatively mesic and well developed (Mollisols) but include sandy, silty, or clay loams derived from recent alluvium, shales, granite or volcanics. The vegetation is characterized by a moderately dense (40-60% cover) tree canopy 5-15 m tall composed of *Populus tremuloides* but may include sparse and scattered conifers, such as *Pinus contorta*, *Picea engelmannii*, and *Abies lasiocarpa*. There is no distinct shrub stratum; however, scattered shrubs, such as *Dasiphora fruticosa* ssp. *floribunda*, *Juniperus communis* var. *montana*, *Mahonia repens*, *Ribes inerme*, *Rosa woodsii*, and *Symphoricarpos rotundifolius*, may be present. The diagnostic feature of the understory is the lush herbaceous layer that is strongly dominated by introduced perennial graminoids, usually *Poa pratensis* (20-30% cover or more), or other introduced forage species, such as *Agrostis stolonifera*, *Alopecurus* spp., *Bromus inermis*, *Dactylis glomerata*, and *Phleum pratense*. Other graminoid species may include *Bromus carinatus*, *Bromus ciliatus*, *Bromus porteri*, *Carex* spp., *Elymus trachycaulus*, and *Juncus balticus*. Forb cover is generally low but often diverse. Forb species with high frequency include *Achillea millefolium*, *Artemisia ludoviciana*, *Astragalus miser*, *Fragaria* spp., *Galium boreale*, *Geranium viscosissimum*, *Ligusticum porteri*, Lupinus sp., Potentilla spp., *Thalictrum fendleri*, *Thermopsis divaricarpa*, and *Trifolium longipes*. Introduced species, such *Taraxacum officinale* and *Trifolium* spp., are common in this frequently grazing disturbed type.

DISTRIBUTION

Bandelier National Monument

This minor association is known from the slopes of Los Alamos Canyon, Mesa del Rito, and Capulin Canyon.

Globally

This association is a widespread grazing induced type found across much of the western U.S. within the range of aspen, including the southern and central Rocky Mountains west into the Colorado Plateau and Great Basin into eastern California and throughout southern and eastern Idaho and much of Montana and western Wyoming.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs between 2560 and 2580 m (8400-8470 feet) and is associated with post fire treatment areas on rolling mesatops to steep canyon sideslopes with moderate solar exposure.

Globally

This association is a widespread grazing induced type found across much of the western U.S. within the range of aspen, including the southern and central Rocky Mountains west into the Colorado Plateau and Great Basin into eastern California and throughout much of Idaho and Montana. Stands typically occur within the elevational range of 1830-2830 m (6000-9280 feet) on typically flat to moderate (1-54%) benches, alluvial terraces and lower slopes, moist hillsides, swales, near springs and especially along stream channels and valley bottoms where livestock congregate. In semi arid areas, stands are found on seep saturated hillslopes. Stands typically have current or past heavy livestock grazing. Aspects and substrates are variable. Soils are often relatively mesic and well developed (Mollisols) but include sandy, silty, or clay loams derived from recent alluvium, shales, granite or volcanics. Surface rock does not play a large role in the surface cover; however, litter and duff may comprise significant ground cover.

VEGETATION DESCRIPTION

Bandelier National Monument

This deciduous forest is characterized by open to dense stands of seedling and sapling *Populus tremuloides*. Mature trees are few or absent. Regeneration of *Quercus gambelii* can also be common, but other tree species are represented by standing, burned snags, or are absent. The herbaceous layer is diverse (18 graminoids and 21 forbs) and is dominated by grasses that were part of a post fire seed mix (*Bromus inermis*, Elymus X *pseudorepens*, *Festuca idahoensis*, or *Pascopyrum smithii*). While forb diversity is high, there are few constant species. The most abundant is *Verbascum thapsus*.

Globally

This deciduous forest association is characterized by a moderately dense (40-60% cover) tree canopy 5-15 m tall composed of *Populus tremuloides* but may include sparse and scattered conifers, such as *Pinus contorta*, *Picea engelmannii*, and *Abies lasiocarpa*. There is no distinct shrub stratum; however, scattered shrubs, such as *Artemisia cana*, *Dasiphora fruticosa* ssp. *floribunda*, *Juniperus communis* var. *montana*, *Mahonia repens*, *Ribes inerme*, *Rosa woodsii*, and *Symphoricarpos rotundifolius*, may be present. The diagnostic feature of the understory is the lush herbaceous layer that is strongly dominated by introduced perennial graminoids, usually *Poa pratensis* (20-30% cover or more), or other introduced forage species, such as *Agrostis stolonifera*, *Alopecurus* spp., *Bromus inermis*, *Dactylis glomerata*, and *Phleum pratense*. Other graminoid species may include *Bromus carinatus*, *Bromus ciliatus*, *Bromus porteri*, *Carex* spp., *Deschampsia caespitosa*, *Elymus trachycaulus*, and *Juncus balticus*. Forb cover is generally low but often diverse. Forb species with high frequency include *Achillea millefolium*, *Artemisia ludoviciana*, *Astragalus miser*, *Fragaria* spp., *Galium boreale*, *Geranium viscosissimum*, *Ligusticum filicinum*, *Ligusticum porteri*, Lupinus sp., *Maianthemum stellatum*, Potentilla spp., *Senecio integerrimus*, *Thalictrum fendleri*, *Thermopsis divaricarpa*, and *Trifolium longipes*. Introduced species, such *Taraxacum officinale* and *Trifolium* spp., are common in this frequently grazing disturbed type (Mueggler 1988, Powell 1988a, Padgett et al. 1989, Hansen et al. 1995).

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Populus tremuloides*
Herb (field)	*Bromus inermis, Elymus x pseudorepens, Festuca idahoensis, Pascopyrum smithii*

Globally

Stratum	Species
Tree canopy	*Populus tremuloides*
Herb (field)	*Agrostis stolonifera, Bromus inermis, Dactylis glomerata, Phleum pratense, Poa pratensis*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (26 May 2004).

CLASSIFICATION COMMENTS

Bandelier National Monument

Data are not available.

Globally

The concept of this semi natural aspen forest association includes aspen stands with understories dominated by introduced herbaceous species, especially forage species that have escaped from cultivation, such as *Agrostis stolonifera*, *Alopecurus* spp., *Bromus inermis*, *Dactylis glomerata*, *Phleum pratense*, *Medicago sativa*, *Melilotus officinalis*, and *Trifolium* spp.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03AB048, 03BD029, 06JC628.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz

REFERENCES

Girard et al. 1997, Hall and Hansen 1997, Hansen et al. 1995, Manning and Padgett 1995, Mueggler 1988, Mueggler and Campbell 1982, Mueggler and Campbell 1986, Padgett et al. 1989, Powell 1988a, Western Ecology Working Group n.d., Wexelman et al. 1999

Populus tremuloides / *Thalictrum fendleri* Forest

Quaking Aspen / Fendler's Meadowrue Forest

CODE	CEGL000619
PHYSIOGNOMIC SUBCLASS	Deciduous forest (I.B.)
PHYSIOGNOMIC GROUP	Cold deciduous forest (I.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural cold deciduous forest (I.B.2.N.)
FORMATION	Montane or boreal cold deciduous forest (I.B.2.N.b.)
ALLIANCE	POPULUS TREMULOIDES FOREST ALLIANCE (A.274) Quaking Aspen Forest Alliance

ECOLOGICAL SYSTEM(S)

Rocky Mountain Aspen Forest and Woodland (CES306.813)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This infrequent forest association is known from Idaho, western Wyoming, Utah, Colorado, and north central New Mexico. It occurs on sheltered sites, swales, benches and lower slopes, or on sideslopes of canyons. Soils are variable and include silty loam, silty clay loam, gravelly and loamy Mollisols, or less developed gravelly Inceptisols derived from latite, dactite, or rhyolitic tuff. Soil depth ranges from moderately deep to deep, and moisture varies from well drained to moist. Slopes are moderate to steep (17-45%), straight to concave, and occur on all aspects. The ground surface is characterized by scattered bunches of grasses and sedges intermixed with litter and some exposed soil and rock. Elevation ranges from 1737 to 3414 m (5700-11,200 feet). The vegetation is essentially two layered: a tree stratum usually of only *Populus tremuloides* and a low herb stratum. In this tall subalpine deciduous forest, tree canopies are closed (>65% cover) and dominated by *Populus tremuloides*. An occasional conifer, usually *Abies lasiocarpa* but sometimes *Pseudotsuga menziesii* or *Pinus contorta*, may be present. While seedlings and saplings of *Abies concolor* and/or *Pseudotsuga menziesii* may be common to well represented, mature trees are scattered. *Populus tremuloides* regeneration may also be present in the understory of these stands. Shrub occurrence in the understory is variable; shrub species may include *Mahonia repens* (= *Berberis repens*), *Physocarpus monogynus*, *Robinia neomexicana*, *Rosa woodsii*, and *Symphoricarpos oreophilus*. A diverse and moderately high herbaceous cover is characteristic. The herbaceous layer is usually abundant and rich in forbs. On mesic sites, forb species commonly include *Erigeron eximius*, *Fragaria vesca*, *Fragaria virginiana*, *Geranium richardsonii*, *Geranium viscosissimum*, *Maianthemum stellatum*, *Osmorhiza berteroi* (= *Osmorhiza chilensis*), and *Thalictrum fendleri*. Other forbs frequently present in substantial amounts include *Achillea millefolium*, *Fragaria vesca*, *Lathyrus lanszwertii* var. *leucanthus* (= *Lathyrus leucanthus*), *Ligusticum porteri*, *Lupinus argenteus*, and *Vicia americana*. Graminoids, including *Bromus anomalus*, *Bromus carinatus*, *Carex siccata*, and *Elymus glaucus*, may be common. This association is characterized by the lack of conifers and the lack of a distinct shrub layer, the absence of substantial amounts of *Carex geyeri* or *Calamagrostis rubescens*, and the prominence of *Thalictrum fendleri*, *Geranium viscosissimum*, or *Osmorhiza berteroi*.

DISTRIBUTION

Bandelier National Monument

This association is known from the slopes of Cerro Grande, Scooter Peak, and Canon de los Frijoles.

Globally

This in an infrequent forest association known from Idaho, western Wyoming, Utah, north central New Mexico, and Colorado, and possibly California.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This high elevation association occurs between 2280 and 2740 m (7480-8990 feet) on slopes of moderate solar exposure (predominantly northerly aspects). Stands are found on sideslopes of canyons and mountains of moderate to steep slope (20-45%). Soils are mapped as gravelly and loamy Mollisols, or less developed gravelly Inceptisols derived from latite, dactite, or rhyolitic tuff (Hibner 2009). The ground surface is characterized by scattered bunches of grasses and sedges intermixed with litter and some exposed soil and rock.

Globally

This forested association occurs on sheltered sites, swales, benches and lower slopes, or on sideslopes of canyons. Soils are variable and include silty loam, silty clay loam, gravelly and loamy Mollisols, or less developed gravelly Inceptisols derived from latite, dactite, or rhyolitic tuff. Soil depth ranges from moderately deep to deep, and moisture varies from well drained to moist. Slopes are moderate to steep (17-45%), straight to concave, and occur on all aspects. The ground surface is characterized by scattered bunches of grasses and sedges intermixed with litter and some exposed soil and rock. Elevation ranges from 1737 to 3414 m (5700-11,200 feet).

VEGETATION DESCRIPTION

Bandelier National Monument

In this tall subalpine deciduous forest, tree canopies are closed (>65% cover) and dominated by *Populus tremuloides*. While seedlings and saplings of *Abies concolor* and/or *Pseudotsuga menziesii* are common to well represented, mature trees are scattered. Regeneration of quaking aspen is also common in the understory of these stands. Shrub species are well represented and most frequently include *Robinia neomexicana*, *Rosa woodsii*, and *Physocarpus monogynus*. A diverse and moderately high herbaceous cover is characteristic (9 graminoid and 19 forb species were recorded). Graminoids are well represented, reaching up to 10% total cover, and include mesic species such as *Carex siccata* and *Bromus anomalus*. Forb species are also well represented and most commonly include mesic forest species such as *Thalictrum fendleri*, *Geranium richardsonii*, *Erigeron eximius*, *Maianthemum stellatum*, *Fragaria vesca*, and *Fragaria virginiana*.

Globally

The vegetation is essentially two layered: a tree stratum usually of only *Populus tremuloides* and a low herb stratum. In this tall subalpine deciduous forest, tree canopies are closed (>65% cover) and dominated by *Populus tremuloides*. An occasional conifer, usually *Abies lasiocarpa* but sometimes *Pseudotsuga menziesii* or *Pinus contorta*, may be present. While seedlings and saplings of *Abies concolor* and/or *Pseudotsuga menziesii* may be common to well represented, mature trees are scattered. *Populus tremuloides* regeneration may also be present in the understory of these stands. Shrub occurrence in the understory is variable; shrub species may include *Mahonia repens* (= *Berberis repens*), *Physocarpus monogynus*, *Robinia neomexicana*, *Rosa woodsii*, and *Symphoricarpos oreophilus*. A diverse and moderately high herbaceous cover is characteristic. The herbaceous layer is usually abundant and rich in forbs. On mesic sites, forb species commonly include *Erigeron eximius*, *Fragaria vesca*, *Fragaria virginiana*, *Geranium richardsonii*, *Geranium viscosissimum*, *Maianthemum stellatum*, *Osmorhiza berteroi* (= *Osmorhiza chilensis*), and *Thalictrum fendleri*. Other forbs frequently present in substantial amounts include *Achillea millefolium*, *Fragaria vesca*, *Lathyrus lanszwertii* var. *leucanthus* (= *Lathyrus leucanthus*), *Ligusticum porteri*, *Lupinus argenteus*, and *Vicia americana*. Graminoids, including *Bromus anomalus*, *Bromus carinatus*, *Carex siccata* and *Elymus glaucus*, may be common. This association is characterized by the lack of conifers and the lack of a distinct shrub layer, the absence of substantial amounts of *Carex geyeri* or *Calamagrostis rubescens*, and the prominence of *Thalictrum fendleri*, *Geranium viscosissimum*, or *Osmorhiza berteroi*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Populus tremuloides*
Herb (field)	*Thalictrum fendleri*

Globally

Stratum	Species
Tree canopy	*Populus tremuloides*
Herb (field)	*Geranium viscosissimum, Thalictrum fendleri*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Senecio serra var. admirabilis

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Bandelier National Monument

Balice et al. (1997) have reported a *Populus tremuloides* / *Erigeron eximius* Cover Type for the Los Alamos region that is likely synonymous with this association. Muldavin and Tonne (2003) and Muldavin et al. (2006) described this association for the adjacent Valles Caldera National Preserve.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 04BD024, 06JC504, 06JC536.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: G. Kittel, mod. K.S. King

REFERENCES

Balice et al. 1997, Bourgeron and Engelking 1994, Boyce 1977, Bunin 1975a, Bunin 1975c, CONHP unpubl. data 2003, Crouch 1983, Driscoll et al. 1984, Hess 1981, Hess and Alexander 1986, Hibner 2009, Hoffman and Alexander 1980, Hoffman and Alexander 1983, Johnston 1987, Johnston and Hendzel 1985, Jones and Ogle 2000, Keammerer and Stoecker 1980, Komarkova et al. 1988a, Langenheim 1962, Mueggler 1988, Muldavin and Tonne 2003, Muldavin et al. 2003, Muldavin et al. 2006, Powell 1988a, Western Ecology Working Group n.d.

Acer negundo - Alnus incana ssp. *tenuifolia* Forest

Box elder - Thinleaf Alder Forest

CODE	CEGL005940
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	ACER NEGUNDO TEMPORARILY FLOODED FOREST ALLIANCE (A.278) Box elder 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 association is found in the mountainous regions of northern New Mexico in the Rio Grande and Pecos River watersheds. It occurs in lower montane regions, typically in the riparian zone of canyon floors. Elevations range between 1970 and 2160 m (6470-7100 feet). Stands occur on alluvial terraces and bars adjacent to perennial stream channels with gradients up to 5%. Soils include moist Entisols (Typic Fluvaquents and Oxyaquic Udifluvents) that are shallow and have a sandy to loamy layer over a gravelly cobbly layer, or loamy Mollisols derived from dacite and rhyolitic alluvium. The ground surface is characterized by shrubs rooted among rhizomatous grasses, exposed gravels and soil intermixed litter patches. The community is at least partially flooded every other year or completely inundated, on average, every four years. Flood debris is often evident near the banks as driftlines or larger debris piles. This riparian forest is characterized by a closed canopy (80-95%) dominated by *Acer negundo*. *Alnus incana* ssp. *tenuifolia* may be present in the subcanopy; other tree species are uncommon or absent. Shrubs may vary from poorly represented to abundant, with *Alnus incana* ssp. *tenuifolia* the most abundant. Occasionally *Salix irrorata* and a variety of other shrubs may be present. The herbaceous layer is also very diverse but variable, with over 70 grasses and forbs reported for the type.

DISTRIBUTION

Bandelier National Monument

This association is known from the bottoms of Canon de los Frijoles and Capulin Canyon.

Globally

This association is found in the mountainous regions of northern New Mexico in the Rio Grande and Pecos River watersheds (Sandoval and San Miguel counties).

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association occurs at elevations between 1970 and 2020 m (6470-6630 feet) in the riparian zone of canyon floors. Stands occur on alluvial terraces and bars adjacent to perennial stream channels with gradients up to 5%. Soils are mapped as loamy Mollisols derived from dacite and rhyolitic alluvium (Hibner 2009). The ground surface is characterized by shrubs rooted among rhizomatous grasses, exposed gravels and soil intermixed litter patches.

Globally

This association is found in the mountainous regions of northern New Mexico in the Rio Grande and Pecos River

watersheds. It occurs in lower montane regions, typically in the riparian zone of canyon floors. Elevations range between 1970 and 2160 m (6470-7100 feet). Stands occur on alluvial terraces and bars adjacent to perennial stream channels with gradients up to 5%. Soils include moist Entisols (Typic Fluvaquents and Oxyaquic Udifluvents) that are shallow and have a sandy to loamy layer over a gravelly cobbly layer, or loamy Mollisols derived from dacite and rhyolitic alluvium. The ground surface is characterized by shrubs rooted among rhizomatous grasses, exposed gravels and soil intermixed litter patches. The community is at least partially flooded every other year or completely inundated, on average, every four years. Flood debris is often evident near the banks as driftlines or larger debris piles.

VEGETATION DESCRIPTION

Bandelier National Monument

This riparian forest is characterized by closed canopies (80-95%) dominated by either *Acer negundo* with *Alnus incana* ssp. *tenuifolia* in the subcanopy; other tree species are uncommon or absent. Shrubs range may vary from poorly represented to abundant, with shrubby *Alnus incana* and occasionally *Salix irrorata* the most abundant. The herbaceous layer is species rich and can be luxuriant in cover ranges from well represented to luxuriant and represented by facultative and obligate wetland species such as *Mentha arvensis*, *Equisetum laevigatum*, *Agrimonia striata*, and *Sidalcea candida* among forbs, and *Carex interior*, *Carex bolanderi*, *Agrostis gigantea*, and *Torreyochloa pallida* among graminoids.

Globally

This riparian forest is characterized a closed canopy (80 95%) dominated by *Acer negundo*. *Alnus incana* ssp. *tenuifolia* may be present in the subcanopy; other tree species are uncommon or absent. Shrubs may vary from poorly represented to abundant, with *Alnus incana* ssp. *tenuifolia* the most abundant. Occasionally *Salix irrorata* and a variety of other shrubs may be present. The herbaceous layer is also very diverse but variable, with over 70 grasses and forbs reported for the type. The herbaceous layer may be species rich with cover ranging from well represented to luxuriant and represented by facultative and obligate wetland species such as *Mentha arvensis*, *Equisetum laevigatum*, *Agrimonia striata*, and *Sidalcea candida* among forbs, and *Carex interior*, *Carex bolanderi*, *Agrostis gigantea*, and *Torreyochloa pallida* among graminoids.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Acer negundo, Alnus incana* ssp. *tenuifolia*
Herb (field)	*Mentha arvensis*
Herb (field)	*Carex interior, Torreyochloa pallida*
Herb (field)	*Equisetum laevigatum*

Globally

Stratum	Species
Tree canopy	*Acer negundo, Alnus incana* ssp. *tenuifolia*
Herb (field)	*Mentha arvensis*
Herb (field)	*Carex interior, Torreyochloa pallida*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Agrostis gigantea, *Poa pratensis*

Globally

Agrostis gigantea, *Poa pratensis*

CONSERVATION STATUS RANK

Global Rank & Reasons: G3? (19 Jul 2004).

CLASSIFICATION COMMENTS

Bandelier National Monument

Data are not available.

Globally

At lower elevations, *Alnus incana* ssp. *tenuifolia* tends to decrease in dominance and drop out of the stand, while at upper elevations *Acer negundo* will decrease in dominance, being replaced by *Picea pungens*, or in some cases *Populus angustifolia*. This type is similar to *Acer negundo* / *Cornus sericea* described by Padgett et al. (1989) and *Acer negundo* / *Cornus sericea* Forest (CEGL000625) reported for Colorado, Utah, and Idaho.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03YC009, 03YC020.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: E. Muldavin et al., mod. K.S. Kingg

REFERENCES

Hibner 2009, Muldavin et al. 2000a, Padgett et al. 1989, Western Ecology Working Group n.d.

Acer negundo - Alnus oblongifolia Forest

Box elder Arizona Alder Forest

CODE	CEGL005383
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	ACER NEGUNDO TEMPORARILY FLOODED FOREST ALLIANCE (A.278) Box elder 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 association is only known to occur at Bandelier National Monument in north central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This riparian association occurs at elevations between 1810 and 1820 m (5940-5980 feet) along canyon bottoms with low solar exposure. Stands occur on alluvial terraces and bars adjacent to perennial stream channels with gradients less than 5%. Soils are mapped as loamy Mollisols derived from latite, dacite, and rhyolitic alluvium. The ground surface is characterized by shrubs rooted among rhizomatous grasses, exposed gravels and soil intermixed litter patches. This riparian forest association is characterized by a moderately open to closed tree canopy (45-60%) dominated by broadleaf deciduous *Acer negundo* and *Alnus oblongifolia* (facultative wetland species). In the shrub layer, *Betula occidentalis*, also a facultative wetland species, can be well represented. *Pinus ponderosa* may occur at the edges of a stand. The shrub *Forestiera pubescens* and the vine *Parthenocissus vitacea* may be common, but it is the rich and luxuriant herbaceous layer that is characteristic (reaching as much as 50% cover). The graminoids are dominated by *Poa pratensis* along with *Bromus inermis*, *Carex* spp., and *Dactylis glomerata* as common associates. The facultative wetland species *Lactuca serriola* and *Cicuta maculata* are the most frequent among the forbs.

DISTRIBUTION

Bandelier National Monument

This association is known from the bottom of Capulin Canyon.

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This riparian association occurs at elevations between 1810 and 1820 m (5940-5980 feet) along canyon bottoms with low solar exposure. Stands occur on alluvial terraces and bars adjacent to perennial stream channels with gradients less than 5%. Soils are mapped as loamy Mollisols derived from latite, dacite, and rhyolitic alluvium (Hibner 2009). The ground surface is characterized by shrubs rooted among rhizomatous grasses, exposed gravels and soil intermixed litter patches.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This riparian forest association is characterized by a moderately open to closed tree canopy (45-60%) dominated by broadleaf deciduous *Acer negundo* and *Alnus oblongifolia* (facultative wetland species). In the shrub layer, *Betula occidentalis*, also a facultative wetland species, can be well represented. *Pinus ponderosa* may occur at the edges of a stand. The shrub *Forestiera pubescens* and the vine *Parthenocissus vitacea* may be common, but it is the rich and luxuriant herbaceous layer that is characteristic (reaching as much as 50% cover). The graminoids are dominated by *Poa pratensis* along with *Bromus inermis*, *Carex* spp., and *Dactylis glomerata* as common associates. The facultative wetland species *Lactuca serriola* and *Cicuta maculata* are the most frequent among the forbs.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Acer negundo, Alnus oblongifolia*
Herb (field)	*Cicuta maculata, Lactuca serriola*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Bromus inermis, *Dactylis glomerata*, *Lactuca serriola*, *Poa pratensis*

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (25 Feb 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Betula occidentalis* phase occurs where that species exceeds 10% cover.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD092, 03BD172.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Hibner 2009, Western Ecology Working Group n.d.

Populus deltoides ssp. *wislizeni* / *Salix irrorata* Forest

Rio Grande Cottonwood / Bluestem Willow Forest

CODE	CEGL005993
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 DELTOIDES TEMPORARILY FLOODED FOREST ALLIANCE (A.290) Eastern Cottonwood Temporarily Flooded Forest Alliance

ECOLOGICAL SYSTEM(S)

Western Great Plains Riparian (CES303.956)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This lower montane riparian association is known from small tributaries of the Rio Grande in northern New Mexico. Also, within Bandelier National Monument, this association occurs along a canyon bottom with low solar exposure. It occurs on narrow valley bottom alluvial sediments with low to moderate gradients. Flooding is estimated to occur on a 10 year return interval or less. Elevations range from 1525 to 1900 m (5000-6250 feet). Stands occur on alluvial terraces and bars adjacent to perennial stream channels with gradients less than 10%. The substrates are alluvial deposits derived from basalt and andesite volcanics. The ground surface is characterized by shrubs rooted among rhizomatous grasses, exposed gravels and soil intermixed litter patches. Stands are dominated by *Populus deltoides* ssp. *wislizeni* with moderately open canopies along with scattered *Acer negundo*, *Juniperus monosperma*, and *Juniperus scopulorum*. The undergrowth is characterized by thickets of *Salix irrorata* and a diverse complement of grasses and forbs. 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

Bandelier National Monument

This association is found at the mouth of Ancho Canyon.

Globally

This association is known only from northern New Mexico but may occur farther west into Arizona. It is not expected to occur in Colorado.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This riparian association occurs at 1685 m (5530 feet) elevation along a canyon bottom with low solar exposure. Stands occur on alluvial terraces and bars adjacent to perennial stream channels with gradients less than 10%. The substrates are alluvial deposits derived from basalt and andesite volcanics. The ground surface is characterized by shrubs rooted among rhizomatous grasses, exposed gravels and soil intermixed litter patches.

Globally

This lower montane riparian association is known from small tributaries of the Rio Grande in northern New Mexico. Also, within Bandelier National Monument, this association occurs along a canyon bottom with low solar exposure. It occurs on narrow valley bottom alluvial sediments with low to moderate gradients. Flooding is estimated to occur

on a 10 year return interval or less. Elevations range from 1525 to 1900 m (5000-6250 feet). Stands occur on alluvial terraces and bars adjacent to perennial stream channels with gradients less than 10%. The substrates are alluvial deposits derived from basalt and andesite volcanics. The ground surface is characterized by shrubs rooted among rhizomatous grasses, exposed gravels and soil intermixed litter patches.

VEGETATION DESCRIPTION

Bandelier National Monument

This riparian forest association is characterized by a moderately closed tree canopy dominated by *Populus deltoides* ssp. *wislizeni*, with *Acer negundo* and *Juniperus monosperma* well represented in the subcanopy. Shrubs are luxuriant and dominated by *Salix irrorata*. *Vitis arizonica*, a vine is common. The herbaceous layer is dominated by facultative and obligate wetland species and includes *Lolium arundinaceum* (= *Festuca arundinacea*), *Schoenoplectus pungens* var. *longispicatus*, *Eleocharis palustris*, and *Polypogon viridis* among graminoids and *Berula erecta* and *Rorippa nasturtium aquaticum* among forbs.

Globally

Stands are dominated by *Populus deltoides* ssp. *wislizeni* with moderately open canopies along with scattered *Acer negundo*, *Juniperus monosperma*, and *Juniperus scopulorum*. The undergrowth is characterized by thickets of *Salix irrorata* and a diverse complement of grasses and forbs. As a keystone species, the reproduction of *Populus deltoides* after flooding (and sufficient subsequent base flows) is critical to the sustainability of this community.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Populus deltoides*
Tall shrub/sapling	*Salix irrorata*

Globally

Stratum	Species
Tree canopy	*Populus deltoides*
Tall shrub/sapling	*Salix irrorata*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Lolium arundinaceum, *Parthenocissus vitacea*, *Tamarix ramosissima*

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G2G3 (28 Sep 2004). This association, like other montane riparian communities of the Southwest, has likely been impacted by livestock use and hydrological alterations (principally diversions for irrigation that lower baseline in stream flows). This has led to declines and replacement by upland associations or early successional riparian communities dominated by forbs and grasses. With these suspected declines, and with only limited quantitative data, this association is ranked between G2 and G3.

CLASSIFICATION COMMENTS

Bandelier National Monument

Data are not available.

Globally

This association is tentative, known only from two plots in northern New Mexico taken a decade apart. It is an unusual association, consisting of a lower elevation, valley floor cottonwood with a lower montane willow species.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plot: 03BR005.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: E. Muldavin, mod. K.S. King

REFERENCES

Muldavin et al. 2000a, NMNHP unpubl. data, Western Ecology Working Group n.d.

II. Woodland

Juniperus deppeana / *Quercus* X *pauciloba* Woodland

Alligator Juniper /Wavyleaf Oak Woodland

CODE	CEGL005370
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar needle leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded crowned temperate or subpolar needle leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	JUNIPERUS DEPPEANA WOODLAND ALLIANCE (A.534) Alligator Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S)

Madrean Lower Montane Pine Oak Forest and Woodland (CES305.796), Madrean Pinyon Juniper Woodland (CES305.797), Madrean Upper Montane Conifer Oak Forest and Woodland (CES305.798)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is known to occur in Bandelier National Monument in north central New Mexico, as well as in the Guadalupe Mountains in southern New Mexico and likely extends across the border into Texas; however, no information is currently available from these locations. The current description is based on data received from Bandelier National Monument and will be updated when additional inventory data are available. This mid elevation association occurs between 2050 and 2440 m (6700-8000 feet) elevation on southeasterly to southwesterly aspects of moderate to high solar exposure. Sites are steep (45-60%), rocky backslopes and shoulders of mesas. Stands occur on rocky colluvial soils derived from rhyolitic tuff, andesite, or basalt. This is a low statured coniferous woodland where tree canopies are open (10-20% cover) and dominated by *Juniperus deppeana* with other conifers such as *Juniperus monosperma* and *Pinus edulis* occasionally present as seedlings, saplings, or mature trees. A well represented to abundant shrub layer is characteristic and dominated by *Quercus* X *pauciloba* with *Cercocarpus montanus* often as a codominant. Succulents such as *Opuntia imbricata* var. *imbricata* (= *Opuntia imbricata*), *Opuntia phaeacantha*, and *Opuntia erinacea* are prevalent, and the rosetophyllous *Yucca baccata* is usually present. Graminoids vary from scarce to abundant, and most commonly include *Bouteloua gracilis*, *Elymus elymoides*, and *Poa fendleriana*. Forbs are common to well represented in stands, and overall species richness diversity is moderate. The most common and abundant forbs are *Artemisia ludoviciana* and *Schoenocrambe linearifolia*.

DISTRIBUTION

Bandelier National Monument

This minor association is known only from Capulin Canyon, Boundary Peak, and the Turkey Springs area.

Globally

This association is known to occur in Bandelier National Monument in north central New Mexico, as well as the Guadalupe Mountains in southern New Mexico and likely extends across the border into Texas; however, no information is currently available from these locations.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs between 2050 and 2440 m (6700-8000 feet) on southeasterly to southwest-

erly aspects of moderate to high solar exposure. Sites are steep (45-60%), rocky backslopes and shoulders of mesas. Stands occur on rocky colluvial soils derived from rhyolitic tuff, andesite, or basalt.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This is low statured coniferous woodland where tree canopies are open (10-20% cover) and dominated by *Juniperus deppeana* with other conifers such as *Juniperus monosperma* and *Pinus edulis* occasionally present as seedlings, saplings, or mature trees. A well represented to abundant shrub layer is characteristic and dominated by *Quercus* X *pauciloba* with *Cercocarpus montanus* often as a codominant. Succulents such as *Opuntia imbricata* var. *imbricata* (= *Opuntia imbricata*), *Opuntia phaeacantha*, and *Opuntia erinacea* are prevalent, and the rosetophyllous *Yucca baccata* is usually present. Graminoids vary from scarce to abundant, and most commonly include *Bouteloua gracilis*, *Poa fendleriana*, and *Elymus elymoides*. Forbs are common to well represented in stands, and overall species richness diversity is moderate (26 species were recorded for the association). The most common and abundant forbs are *Schoenocrambe linearifolia* and *Artemisia ludoviciana*.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Juniperus deppeana*
Shrub/sapling (tall & short)	*Quercus x pauciloba*
Shrub/sapling (tall & short)	*Cercocarpus montanus*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Pinus edulis

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23 Jan 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

Mature *Pinus edulis* was present in many stands prior to a die off during the drought of 2002-03, but it is now represented only by seedlings and samplings. These plots are indicated in the database as a *Pinus edulis* (PINEDUX) Dead Phase. This association has also been provisionally described from Guadalupe Mountains National Park.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD144, 03BD155, 03BD164, 06JC584.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King

REFERENCES

Western Ecology Working Group n.d.

Juniperus monosperma / Artemisia tridentata Woodland

One seed Juniper / Basin Big Sagebrush Woodland

CODE	CEGL000706
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar needle leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded crowned temperate or subpolar needle leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	JUNIPERUS MONOSPERMA WOODLAND ALLIANCE (A.504) One seed Juniper 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 community is known to occur in northern New Mexico within Bandelier National Monument and the upper Rio Puerco watershed. It has been found along breakslopes or on mesatops and on northeasterly to easterly aspects of low solar exposure. Stands occur on rubble of steep canyon slopes with rocky soils derived from basalt or andesite colluvium. Within Bandelier National Monument, this community has been found at elevations ranging from 1695 to 1825 m (5460-5740 feet), and it occurs at 2012 m (6600 feet) within the upper Rio Puerco watershed. Within Bandelier National Monument, this association is a short statured coniferous and open canopied (10-20% cover) woodland dominated by *Juniperus monosperma*. Occasionally, mature individuals of *Pinus edulis* or *Pinus ponderosa* can be present, although they are typically poorly represented. The understory is characteristically shrubby with *Artemisia tridentata* well represented and *Ephedra viridis* codominant. *Fallugia paradoxa*, *Gutierrezia sarothrae*, *Opuntia phaeacantha*, or *Yucca baccata* are common associates. Graminoids are common to well represented with *Bouteloua curtipendula* and *Poa fendleriana* the most frequent species. Forbs, while common, are variable in composition and include *Eriogonum jamesii* and *Heterotheca villosa*. Within the upper Rio Puerco watershed, this community forms a unique floristic group with *Juniperus monosperma* and *Artemisia tridentata* codominant. Additional characteristic species include *Pleuraphis jamesii* (= *Hilaria jamesii*) and *Sporobolus cryptandrus*.

DISTRIBUTION

Bandelier National Monument

This minor association is known from Canon de los Frijoles and Ancho Canyon.

Globally

This woodland community is known to occur in northern New Mexico within Bandelier National Monument and the upper Rio Puerco watershed.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This is a lower elevation community that lies between 1695 and 1825 m (5460-5740 feet) elevation on northeasterly to easterly aspects of low solar exposure. Stands occur on rubble of steep canyon slopes with rocky soils derived from basalt or andesite colluvium.

Globally

This woodland community has been found along breakslopes or on mesatops and on northeasterly to easterly aspects of low solar exposure. Stands occur on rubble of steep canyon slopes with rocky soils derived from basalt or andesite colluvium. This community has been found at elevations ranging from 1695 to 1825 m (5460-5740 feet) within Bandelier National Monument and at 2012 m (6600 feet) within the upper Rio Puerco watershed.

VEGETATION DESCRIPTION

Bandelier National Monument

This short statured coniferous and open canopied (10-20% cover) woodland is dominated by *Juniperus monosperma*. Occasionally, mature individuals of *Pinus edulis* or *Pinus ponderosa* can be present, although they are typically poorly represented. The understories are characteristically shrubby with *Artemisia tridentata* well represented and *Ephedra viridis* as a potential codominant. *Gutierrezia sarothrae*, *Opuntia phaeacantha*, *Fallugia paradoxa*, or *Yucca baccata* are common associates. Graminoids are common to well represented with *Bouteloua curtipendula* and *Poa fendleriana* the most frequent species. Forbs, while common, are variable in composition and include *Eriogonum jamesii* and *Heterotheca villosa*.

Globally

Within Bandelier National Monument, this association is a short statured coniferous and open canopied (10 20% cover) woodland dominated by *Juniperus monosperma*. Occasionally, mature individuals of *Pinus edulis* or *Pinus ponderosa* can be present, although they are typically poorly represented. The understory is characteristically shrubby with *Artemisia tridentata* well represented and *Ephedra viridis* codominant. *Fallugia paradoxa*, *Gutierrezia sarothrae*, *Opuntia phaeacantha*, or *Yucca baccata* are common associates. Graminoids are common to well represented with *Bouteloua curtipendula* and *Poa fendleriana* the most frequent species. Forbs, while common, are variable in composition and include *Eriogonum jamesii* and *Heterotheca villosa*. Within the upper Rio Puerco watershed, this community forms a unique floristic group with *Juniperus monosperma* and *Artemisia tridentata* codominant. Additional characteristic species include *Pleuraphis jamesii* (= *Hilaria jamesii*) and *Sporobolus cryptandrus*. The community can be somewhat degraded with *Gutierrezia sarothrae* occurring within 30% of sample plots (Francis 1986).

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma*
Shrub/sapling (tall & short)	*Artemisia tridentata*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma*
Shrub/sapling (tall & short)	*Artemisia tridentata*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots 03BR006 and 06JC202.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King

REFERENCES

Bourgeron and Engelking 1994, Dick Peddie 1986, Driscoll et al. 1984, Francis 1986, Moir and Carleton 1987, Western Ecology Working Group n.d.

Juniperus monosperma / *Bouteloua curtipendula* Woodland

One seed Juniper / Sideoats Grama Woodland

CODE	CEGL000708
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar needle leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded crowned temperate or subpolar needle leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	JUNIPERUS MONOSPERMA WOODLAND ALLIANCE (A.504) One seed Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S)

Colorado Plateau Pinyon Juniper Woodland (CES304.767), Inter Mountain Basins Juniper Savanna (CES304.782), Southern Rocky Mountain Juniper Woodland and Savanna (CES306.834), Southern Rocky Mountain Pinyon Juniper Woodland (CES306.835), Southwestern Great Plains Canyon (CES303.664)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association is known to occur in Arizona, Colorado, New Mexico, Oklahoma, and Texas. It occurs on sites with moderate solar exposure, on all aspects of lower hillslopes or on alluvial terraces in or adjacent to canyon bottom floodplains. This association can also occur on steep, colluvial slopes of escarpments, dipslopes of moderate slope, and occasionally on lower toeslopes and valley bottoms. Soils are shallow, gravelly to rocky and are derived from basalt, andesite, or tuff colluvium, or mixed mineralogy alluvium. Slope sites tend to be rocky and gravelly, while terraces are less so, but with significant exposed soil and litter accumulation. Boulders and bedrock may occupy 50% of the site. Soils may also be loamy Inceptisols and Mollisols derived from sedimentary limestone and calcitic sandstone. Elevation ranges from 1500 to 2300 m (5000-7500 feet).

Within the Bandelier National Monument in north central New Mexico, this low statured woodland is characterized by mature *Juniperus monosperma* trees forming sparse to open canopies (10-35%) with scattered *Pinus edulis* seedlings or saplings in the subcanopy. Shrubs are poorly represented but may include succulents such as Opuntia spp. Scattered graminoids are found in the inter tree spaces with *Bouteloua curtipendula* the most abundant and dominant, with an assortment of other plains grassland species present but not dominant. Within the adjacent Los Alamos region, this is the dominant community type in the juniper savanna. Numerous shrub species may be present with frequencies ranging from 30 to 40%. However, overall shrub coverages are low. The understory vegetation tends to be graminoid; however, the overall grass coverage may be as little as 5%. One or more of *Bouteloua curtipendula*, *Bouteloua eriopoda*, *Lycurus phleoides*, or *Pleuraphis jamesii* (= *Hilaria jamesii*) represents up to 50% of the overall grass coverage. *Bouteloua gracilis* or *Bouteloua hirsuta* may also be abundant.

At White Sands Missile Range, this juniper woodland occurs on steep rocky slopes. *Juniperus monosperma* is the dominant tree in the very open to moderately open tree canopy. *Pinus edulis* may be present, but it is only an occasional or minor associate. *Bouteloua curtipendula* is the dominant grass species. *Bouteloua gracilis*, *Bouteloua hirsuta*, and *Aristida purpurea* can be abundant but not dominant; *Hesperostipa neomexicana* (= *Stipa neomexicana*) can occur under the tree canopies. The shrub layer is very diverse but is generally under 5% cover. Forb diversity is likewise very high, but forb cover is very low and not consistent in composition from stand to stand. Within Lake Meredith National Recreation Area in Texas, this community is dominated by *Juniperus monosperma* with an understory of smaller shrubs, grasses and forbs. The amount of juniper in the community has generally increased over the past several decades. More mesic slopes facing east or north grow larger juniper and tend to have more species diversity. The most common grass is *Bouteloua curtipendula*, which is well distributed throughout the community.

DISTRIBUTION

Bandelier National Monument

This association is known only from the mouths of Lummis and Capulin canyons.

Globally

This woodland association is known to occur in Arizona, Colorado, New Mexico, Oklahoma, and Texas.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This lower elevation association occurs between 1665 and 1750 m (5460-5740 feet) elevation on sites with moderate solar exposure. Stands occur either on southwesterly aspects of lower hillslopes or on alluvial terraces in or adjacent to canyon bottom floodplains. Accordingly, soils are shallow, gravelly to rocky and derived from basalt, andesite, or Bandelier tuff colluvium, or mixed mineralogy alluvium. Slope sites tend to be rocky and gravelly, while terraces are less so, but with significant exposed soil and litter accumulation.

Globally

Within the Bandelier National Monument in north central New Mexico, this association occurs at lower elevations between 1665 and 1750 m (5460-5740 feet) on sites with moderate solar exposure. Stands occur either on southwesterly aspects of lower hillslopes or on alluvial terraces in or adjacent to canyon bottom floodplains. Accordingly, soils are shallow, gravelly to rocky and derived from basalt, andesite, or tuff colluvium, or mixed mineralogy alluvium. Slope sites tend to be rocky and gravelly, while terraces are less so, but with significant exposed soil and litter accumulation. Within the adjacent Los Alamos region, this community occupies all aspects at lower elevations and continues on south facing aspects to 1768 m (5800 feet). To the south, this community extends to 1966 m (6450 feet) above sea level. Soils are stony and mostly derived from basalts. Boulders and bedrock may occupy 50% of the site (Balice et al. 1997). At White Sands Missile Range, this association typically occurs on steep, colluvial slopes of escarpments, dipslopes of moderate slope, and occasionally on lower toeslopes and valley bottoms. Soils are loamy Inceptisols and Mollisols derived from sedimentary limestone and calcitic sandstone. They tend to be gravelly, are often stony or rocky, and may be interrupted by outcrops (Muldavin et al. 2000b, 2000c). Elevation range is 1500 to 2300 m (5000 7500 feet).Within Lake Meredith National Recreation Area in Texas, this community occurs on moderate to steeply sloping shallow soils with moderate amounts of small rocks or gravel throughout the profile. These areas tend to be droughty and do not store great amounts of moisture in the soil.

VEGETATION DESCRIPTION

Bandelier National Monument

This low statured woodland is characterized by mature *Juniperus monosperma* trees forming sparse to open canopies (10-35%) with scattered *Pinus edulis* seedlings or saplings in the subcanopy. Shrubs are poorly represented but may include succulents such as *Opuntia polyacantha*, *Opuntia phaeacantha*, or *Opuntia imbricata* var. *imbricata* (= *Cylindropuntia imbricata*). Scattered graminoids are found in the inter tree spaces with *Bouteloua curtipendula* the most abundant and dominant. *Bouteloua gracilis* is usually present, but low in cover, along with an assortment of other plains grassland species such as *Pleuraphis jamesii* or *Bouteloua hirsuta*. Among forbs, *Artemisia ludoviciana*, *Erigeron divergens*, *Ipomopsis longiflora*, and *Penstemon barbatus* are the most frequent species, but cover is generally low. Overall, herbaceous species richness is moderate with 17 forb and 11 graminoid species recorded from this association.

Globally

Within the Bandelier National Monument in north central New Mexico, this low statured woodland is characterized by mature *Juniperus monosperma* trees forming sparse to open canopies (10-35%) with scattered *Pinus edulis* seedlings or saplings in the subcanopy. Shrubs are poorly represented but may include succulents such as *Opuntia polyacantha*, *Opuntia phaeacantha*, or *Opuntia imbricata* var. *imbricata* (= *Cylindropuntia imbricata*). Scattered graminoids are found in the inter tree spaces with *Bouteloua curtipendula* the most abundant and dominant. *Bouteloua gracilis* is usually present, but low in cover, along with an assortment of other plains grassland species such as *Pleuraphis jamesii* or *Bouteloua hirsuta*. Among forbs, *Artemisia ludoviciana*, *Erigeron divergens*, *Ipomopsis longiflora*, and *Penstemon barbatus* are the most frequent species, but cover is generally low. Overall, herbaceous species rich-

ness is moderate with 17 forb and 11 graminoid species recorded from this association.

Within the adjacent Los Alamos region, this is the dominant community type in the juniper savanna. Shrubs are present with frequencies ranging from 30 to 40%. However, overall shrub coverages are low. Typical shrub species include *Artemisia tridentata*, *Fallugia paradoxa*, *Fendlera rupicola*, *Forestiera pubescens* (= *Forestiera neomexicana*), and *Quercus* X *pauciloba* (= *Quercus undulata*). The understory vegetation tends to be graminoid; however, the overall grass coverage may be as little as 5%. One or more of *Bouteloua curtipendula*, *Bouteloua eriopoda*, *Lycurus phleoides*, or *Pleuraphis jamesii* (= *Hilaria jamesii*) represents up to 50% of the overall grass coverage. *Bouteloua gracilis* or *Bouteloua hirsuta* may also be abundant (Balice et al. 1997).

At White Sands Missile Range, this juniper woodland is often found on steep rocky slopes. *Juniperus monosperma* is the dominant tree in the very open to moderately open tree canopy. *Pinus edulis* may be present, but it is only an occasional or minor associate. *Bouteloua curtipendula* is the dominant among the 29 grass species reported for the type, and is well represented to luxuriant in the grassy inter tree spaces. *Bouteloua gracilis*, *Bouteloua hirsuta*, and *Aristida purpurea* can be abundant but not dominant; *Hesperostipa neomexicana* (= *Stipa neomexicana*) can occur under the tree canopies. The shrub layer is very diverse (40+ species reported), but is generally under 5% cover. Common shrub species include *Yucca baccata*, *Rhus trilobata*, *Opuntia phaeacantha*, *Nolina microcarpa*, and *Cercocarpus montanus*. Forb diversity is likewise very high (69 species reported), but forb cover is very low and not consistent in composition from stand to stand. *Melampodium leucanthum*, *Lesquerella fendleri*, and *Viguiera dentata* are the most constant forbs and are the highest in cover (Muldavin et al. 2000b, 2000c).

Within Lake Meredith National Recreation Area in Texas, this community is dominated by *Juniperus monosperma* with an understory of smaller shrubs, grasses and forbs. The amount of juniper in the community has generally increased over the past several decades. More mesic slopes facing east or north grow larger juniper and tend to have more species diversity. *Rhus trilobata* is the most prominent shrub along with some occurrence of *Dalea formosa* and Mimosa borealis. The most common grass is *Bouteloua curtipendula*, which is well distributed throughout the community. Other common grasses include *Bouteloua eriopoda*, *Bouteloua hirsuta*, and *Aristida purpurea*. On more mesic slopes, *Schizachyrium scoparium* is often present in significant amounts. The most common forbs are *Tetraneuris scaposa*, *Krameria lanceolata*, *Melampodium leucanthum*, and *Chaetopappa ericoides*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma*
Herb (field)	*Bouteloua curtipendula*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma*
Herb (field)	*Bouteloua curtipendula*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Bandelier National Monument

A rockland phase occurs when trees are scattered and rock and gravel compose 60% of the ground cover.

Mature *Pinus edulis* was present in some stands prior to a die off during the drought of 2003, but it is now represented only by seedlings and samplings. Accordingly, these stands could be classified as *Pinus edulis* / *Bouteloua curtipendula* Woodland (CEGL000777). These plots are indicated in the database as *Pinus edulis* (PINEDUX) Dead Phase.

Both of these associations have been reported extensively elsewhere in New Mexico.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots 03AB002, 03AB009, 03BD086, and 03BD177.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King

REFERENCES

Anderson et al. 1985, Baker 1984a, Balice et al. 1997, Barnes 1987, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Diamond 1993, Dick Peddie 1986, Driscoll et al. 1984, Harlan 1957, Hoagland 2000, Johnston 1984, Johnston 1987, Larson and Moir 1987, Muldavin and Mehlhop 1992, Muldavin et al. 2000b, Muldavin et al. 2000c, Rogers 1949, Rogers 1953, Rogers 1954, Stuever and Hayden 1997a, Terwilliger et al. 1979a, Western Ecology Working Group n.d.

Juniperus monosperma / *Bouteloua eriopoda* Woodland

One seed Juniper / Black Grama Woodland

CODE	CEGL000709
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar needle leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded crowned temperate or subpolar needle leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	JUNIPERUS MONOSPERMA WOODLAND ALLIANCE (A.504) One seed Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S)

Colorado Plateau Pinyon Juniper Woodland (CES304.767), Inter Mountain Basins Juniper Savanna (CES304.782), Madrean Juniper Savanna (CES301.730), Southern Rocky Mountain Juniper Woodland and Savanna (CES306.834), Southern Rocky Mountain Pinyon Juniper Woodland (CES306.835), Southwestern Great Plains Canyon (CES303.664)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is known to occur in north central and southwestern New Mexico. At present, it has only been described in New Mexico, but unconfirmed reports also place it in the Trans Pecos region of Texas and in southeastern Arizona. Within Bandelier National Monument in north central New Mexico, this lower elevation association occurs between 1660 and 1860 m (5440-6100 feet) elevation on a variety of aspects, but generally with low to moderate solar exposure. Stands are found on moderate to very steep canyon slopes and escarpments (26-65%). Soils are typically shallow, rocky and derived from basalt or rhyolitic tuff colluvium. On occasion, the association occurs on deep pumice soils. The ground surface is rocky and/or gravelly with scattered grass bunches and litter. Within White Sands Missile Range, this association is found at lower elevations ranging from 1460 m (4800 feet) on north facing slopes to 2100 m (6900 feet) on warm, southerly aspects. It commonly occurs on moderate to steep slopes of lower mountain escarpments and gentle dipslopes of fault block mountains. It can also extend down onto the upper piedmont slopes of the lower valleys and occasionally into basins. Soils are commonly derived from limestone, or occasionally a mix of sedimentary or granitic parent materials.

Within Bandelier National Monument, this short statured woodland savanna type is dominated by *Juniperus monosperma* with canopies that range from 10 to 40% cover. *Juniperus* regeneration is common, but *Pinus edulis* seedlings and saplings are accidental or absent. While shrubs can be well represented by succulents *Opuntia polyacantha* or *Opuntia polyacantha*, this is a characteristically grassy association dominated by *Bouteloua eriopoda* that is well represented to abundant. *Bouteloua curtipendula* and *Bouteloua gracilis* are common associates. Forbs are variable and scattered, with herbaceous Artemisia spp. the most common. Within White Sands Missile Range, *Juniperus monosperma* is the dominant species of this savannalike woodland. *Bouteloua eriopoda* is well represented to abundant. *Bouteloua curtipendula* and *Bouteloua gracilis* are often present, occasionally as codominants. Species diversity overall is moderately high; however, shrub and forb cover tend to be low. Shrubs are generally widely scattered and, with the exception of *Gutierrezia sarothrae* and *Gutierrezia microcephala*, seldom exceed 1% cover.

DISTRIBUTION

Bandelier National Monument

This minor association is known from Ancho and Capulin canyons and Canon de los Frijoles.

Globally

This association is known to occur in north central and southwestern New Mexico. At present, it has only been described in New Mexico, but unconfirmed reports also place it in the Trans Pecos region of Texas and in southeastern Arizona (Muldavin et al. 2000b, 2000c).

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This lower elevation association occurs between 1660 and 1860 m (5440-6100 feet) elevation on a variety of aspects, but generally with low to moderate solar exposure. Stands are found on moderate to very steep canyon slopes and escarpments (26-65%). Soils are typically shallow, rocky and derived from basalt or rhyolitic tuff colluvium. On occasion, the association occurs on deep pumice soils. The ground surface is rocky and/or gravelly with scattered grass bunches and litter.

Globally

Within Bandelier National Monument, this lower elevation association occurs between 1660 and 1860 m (5440-6100 feet) elevation on a variety of aspects, but generally with low to moderate solar exposure. Stands are found on moderate to very steep canyon slopes and escarpments (26-65%). Soils are typically shallow, rocky and derived from basalt or rhyolitic tuff colluvium. On occasion, the association occurs on deep pumice soils. The ground surface is rocky and/or gravelly with scattered grass bunches and litter. Within White Sands Missile Range, this association is found at lower elevations ranging from 1460 m (4800 feet) on north facing slopes to 2100 m (6900 feet) on warm, southerly aspects. It commonly occurs on moderate to steep slopes of lower mountain escarpments and gentle dipslopes of fault block mountains. It can also extend down onto the upper piedmont slopes of the lower valleys and occasionally into basins. Soils are commonly derived from limestone, or occasionally a mix of sedimentary or granitic parent materials (Muldavin et al. 2000b, 2000c).

VEGETATION DESCRIPTION

Bandelier National Monument

This short statured woodland savanna type is dominated by *Juniperus monosperma* with canopies that range from 10 to 40% cover. *Juniperus* regeneration is common, but *Pinus edulis* seedlings and saplings are accidental or absent. While shrubs can be well represented by succulents *Opuntia polyacantha* or *Opuntia polyacantha*, this is a characteristically grassy association dominated by *Bouteloua eriopoda* that is well represented to abundant. *Bouteloua curtipendula* and *Bouteloua gracilis* are common associates among 15 graminoids reported for the type. Forbs are variable and scattered; among the 15 species reported for the type herbaceous, *Artemisias* are the most common (*Artemisia dracunculus* and *Artemisia ludoviciana*), along with occasional grassland associated species (*Bahia dissecta*, *Heterotheca villosa*, *Ipomopsis longiflora*, *Eriogonum jamesii*, and *Mirabilis oxybaphoides*).

Globally

Within Bandelier National Monument, this short statured woodland savanna type is dominated by *Juniperus monosperma* with canopies that range from 10 to 40% cover. *Juniperus* regeneration is common, but *Pinus edulis* seedlings and saplings are accidental or absent. While shrubs can be well represented by succulents *Opuntia polyacantha* or *Opuntia polyacantha*, this is a characteristically grassy association dominated by *Bouteloua eriopoda* that is well represented to abundant. *Bouteloua curtipendula* and *Bouteloua gracilis* are common associates among 15 graminoids reported for the type. Forbs are variable and scattered; among the 15 species reported for the type herbaceous, *Artemisia* spp. are the most common (*Artemisia dracunculus* and *Artemisia ludoviciana*) along with occasional grassland associated species (*Bahia dissecta*, *Heterotheca villosa*, *Ipomopsis longiflora*, *Eriogonum jamesii*, and *Mirabilis oxybaphoides*). Within White Sands Missile Range, *Juniperus monosperma* is the dominant species of this savannalike woodland. *Bouteloua eriopoda* is well represented to abundant. *Bouteloua curtipendula* and *Bouteloua gracilis* are often present, occasionally as codominants. Species diversity overall is moderately high (65 species); however, shrub and forb cover tend to be low. Shrubs are generally widely scattered and, with the exception of *Gutierrezia sarothrae* and *Gutierrezia microcephala*, seldom exceed 1% cover. Common shrubs include *Gutierrezia sarothrae*, *Opuntia imbricata*, *Opuntia phaeacantha*, and *Yucca elata*. Forbs include *Chamaesyce fendleri*, *Lesquerella fendleri*, *Machaeranthera pinnatifida* ssp. *pinnatifida* var. *pinnatifida*, and *Melampodium leucanthum* (Muldavin et al. 2000b, 2000c).

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma*
Herb (field)	*Bouteloua eriopoda*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma*
Herb (field)	*Bouteloua eriopoda*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23 Feb 1994).

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Bouteloua gracilis* phase occurs where that species is well represented. This is an established type that has been well documented elsewhere in New Mexico.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots 03AB006, 03ER023, 03ER025, 03YC017, 06AB195, 06BF014, and 06JC197.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King

REFERENCES

Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Muldavin and Mehlhop 1992, Muldavin et al. 2000b, Muldavin et al. 2000c, Western Ecology Working Group n.d.

Juniperus monosperma / Bouteloua gracilis Woodland

One seed Juniper / Blue Grama Woodland

CODE	CEGL000709
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar needle leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded crowned temperate or subpolar needle leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	JUNIPERUS MONOSPERMA WOODLAND ALLIANCE (A.504) One seed Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S)

Colorado Plateau Pinyon Juniper Woodland (CES304.767), Inter Mountain Basins Juniper Savanna (CES304.782), Southern Rocky Mountain Pinyon Juniper Woodland (CES306.835), Southern Rocky Mountain Juniper Woodland and Savanna (CES306.834), Southwestern Great Plains Canyon (CES303.664)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This Southern Rocky Mountains woodland occur on foothills in south central Colorado and northern New Mexico and extends out into the southwestern Great Plains where it is largely restricted to areas near hills and escarpments. It also extends westward into the southeastern portion of the Colorado Plateau and southward into south central New Mexico where it is a major association on desert mountains and mesas. Elevation ranges from 1372-2286 m (4500-7500 feet). Sites include gently rolling slopes on a variety of aspects with a tendency of increasing southerly slopes with increasing elevation. Further south it is generally cool (northwest to west), even at higher elevations. Substrates are variable but are frequently finer textured Mollisols and Aridisols derived from limestone and sandstone, often with piedmont alluvial and slope colluvial deposits. The ground surface is characterized by scattered grass patches and litter amid an equal amount of exposed soil and gravel. Vegetation is characterized by an open to very open tree canopy (10-40% cover) of mature *Juniperus monosperma* forming a generally open woodland or savanna with the grassy inter tree spaces dominated by *Bouteloua gracilis*. Occasionally mature individuals, seedlings or saplings of *Pinus edulis* can be present. The dwarf shrub *Gutierrezia sarothrae* is usually present and scattered throughout sites. Other shrubs are poorly represented or absent; succulents such as *Opuntia imbricata* (= *Cylindropuntia imbricata*) and *Opuntia phaeacantha* are the most frequent. The herbaceous layer is characteristically grassy and dominated by abundant *Bouteloua gracilis* with ruderal *Muhlenbergia torreyi* and *Aristida purpurea* often well represented along with *Pleuraphis jamesii*, *Sporobolus cryptandrus*, and *Sporobolus airoides* as common subordinate associates. *Bouteloua curtipendula* may be present but is clearly not dominant. Forbs may be diverse but variable, and cover is generally low and may include *Artemisia dracunculus*, *Astragalus* spp., *Erigeron divergens*, *Heterotheca villosa*, *Ipomopsis longiflora*, *Ipomopsis multiflora*, *Penstemon* spp., T*ownsendia* spp., and *Thelesperma megapotamicum*.

DISTRIBUTION

Bandelier National Monument

This is a very common association known from in the Tsankawi unit; Frijoles Mesa; the slopes of Canon de los Frijoles; the mesas between Canon de los Frijoles, Alamo Canyon, and Hondo Canyon; the Turkey Springs area, and slopes of Cerro Picacho.

Globally

This Southern Rocky Mountains woodland occur in foothills in south central Colorado and northern New Mexico and extends out into the southwestern Great Plains where it is largely restricted to areas near breaks and escarpments. It also extends southward into central New Mexico and westward into the southeastern Colorado Plateau.

Specific locations include the San Isabel National Forest in south central Colorado, Comanche National Grassland in southeastern Colorado, the Upper Rio Puerco watershed in northwestern New Mexico, Bandelier National Monument, Salinas Pueblo Missions National Monument in central New Mexico, and White Sands Missile Range in south central New Mexico where it is also a major association of the Oscura and San Andres mountains and of the Chupadera Mesa Red Rio area.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This lower-elevation association ranges from around 6,000 to 7,000 feet (1,845-2,120 m) on a variety of aspects. Solar exposure is generally moderate, but increases with higher elevation (i.e, aspects tend to be more northerly at lower elevation more southerly on higher sites). The majority of sites occur on the summits and shoulders of undulating plateaus with gentle to moderate slopes (2-25%). Soils as mapped by Hibner (2009) are composed of eolian material, alluvium, or colluvium derived from rhyolitic tuff or pumice and quite variable. Occasionally, stands are found on sideslopes of plateaus with rockier soils derived from rhyolitic colluvium. Lastly, some stands are found on deep colluvial and alluvial soils along the toeslopes and bottoms of valleys. The ground surface is characterized by exposed soils or gavels interspersed with patches of bunch grasses and litter.

Globally

This widespread open woodland / savanna association occurs on valleys, plains, piedmont alluvial fans , mesas and foothills between 1372-2286 m (4500-7500 feet) in elevation. It typically is found on gently rolling slopes on a variety of aspects with a tendency of increasing southerly aspects with increasing elevation. Further south it is generally cool (northwest to west), even at higher elevations. Soils are composed of a variety of substrates including eolian material, alluvium, or colluvium derived from rhyolitic tuff or pumice, sandstones and limestones. The ground surface is characterized by scattered grass patches and litter amid an equal amount of exposed soil and gravel.

VEGETATION DESCRIPTION

Bandelier National Monument

This short-statured woodlanF-savanna type is dominated by *Juniperus monosperma* with canopies that range from 10% to 60% cover. *Juniperus* regeneration is common along with scattered *Pinus edulis* seedlings and saplings. Shrubs are generally poorly represented with the exception of the dwarf shrub *Gutierrezia sarothrae*. Instead, the understory is characteristically grassy and dominated by well represented to abundant *Bouteloua gracilis*, along with a variety of other graminoid associates growing in the inter-tree spaces (24 graminoid species have been recorded for the association). Forbs are common but variable with an overall high diversity (47 forb species recorded); herbaceous *Artemisias* are the most common (*Artemisia campestris*, *Artemisia carruthii*, *Artemisia dracunculus*, and *Artemisia ludoviciana*) along with occasional grassland-associated species (*Bahia dissecta*, *Heterotheca villosa*, *Hymenopappus filifolius*, *Hymenoxys richardsonii*, *Ipomopsis longiflora*, *Eriogonum jamesii*, *Mirabilis multiflora*, and *Mirabilis oxybaphoides*).

Globally

Vegetation within this open woodland consists of an overstory (10-40% tree cover) dominated by *Juniperus monosperma*. *Pinus edulis* may also be present in microsites. The grassy inter-tree spaces are dominated by *Bouteloua gracilis*. *Bouteloua curtipendula* is occasionally well represented, but it is not normally a codominant. Diversity can be high (>150 species). The subshrub *Gutierrezia sarothrae* is usually present and scattered throughout many sites (Muldavin et al. 2000b). Shrub species are poorly represented or absent; succulents such as *Opuntia imbricata* (= *Cylindropuntia imbricata*) and *Opuntia phaeacantha* are the most frequent. The herbaceous layer is characteristically grassy and dominated by abundant *Bouteloua gracilis* with ruderal *Muhlenbergia torreyi* and *Aristida purpurea* often well represented along with *Piptatherum micranthum*, *Pleuraphis jamesii*, *Sporobolus cryptandrus*, and *Sporobolus airoides* as common subordinate associates. Forbs are diverse but variable and may incude species such as *Artemisia dracunculus*, *Artemisia ludoviciana*, *Astragalus brandegeei*, *Cordylanthus wrightii*, *Erigeron divergens*, *Eriogonum jamesii*, *Heterotheca villosa*, *Hymenopappus filifolius*, *Ipomopsis longiflora*, *Ipomopsis multiflora*, *Menodora scabra*, *Mirabilis multiflora*, *Penstemon virgatus*, *Schoenocrambe linearifolia*, *Townsendia annua*, and *Thelesperma megapotamicum* are the most frequent species, but cover is generally low.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma*
Herb (field)	*Bouteloua gracilis*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma*
Herb (field)	*Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Mature *Pinus edulis* were present in stands but died during the drought of 2002-03 from bark beetle infestation. *Gutierrezia sarothrae* is an associated species, especially on disturbed sites.

Globally

Data are not available.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Bandelier National Monument

Mature *Pinus edulis* was present in many stands prior to a die-off during the drought of 2002-03, but it is now represented only by seedlings and samplings. These plots are indicated in the database as a *Pinus edulis* (PINEDUX) Dead Phase. Accordingly, these stands may have belonged to the *Pinus edulis* - (*Juniperus monosperma*) / *Bouteloua gracilis* Woodland (CEGL002151) before the die-off. Both associations are established types that have been well documented elsewhere in New Mexico. This type was previously described for Bandelier National Monument by Barnes 1983.

Globally

In northern New Mexico, mature *Pinus edulis* was present in many stands prior to a die-off during the drought of 2002-03, but it is now represented only by seedlings and samplings. Some of these stands may have belonged to the *Pinus edulis* - (*Juniperus monosperma*) / *Bouteloua gracilis* Woodland (CEGL002151) before the pinyon die-off. Both associations are established types that have been well documented elsewhere in New Mexico.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: The description is based on 5 field plots (03BD043, 03BD074, 03BD093, 03BD167, 03BD175) and 3 observation points (05BD001, 05BD027, 05BD037)

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King, mod. K.A. Schulz

REFERENCES

Barnes 1983, Baxter 1977, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Dick Peddie 1986, Dick Ped-

die 1987, Dick Peddie et al. 1984, Donart et al. 1978a, Driscoll et al. 1984, Dwyer and Pieper 1967, Fischer and Bradley 1987, Francis 1986, Hendricks 1934, Hibner 2009, Johnsen 1962, Johnston 1987, Larson and Moir 1986, Larson and Moir 1987, Moir and Carleton 1987, Muldavin and Mehlhop 1992, Muldavin et al. 2000b, Nelson and Redders 1982, Pieper et al. 1971, Rippel et al. 1998, Shaw et al. 1989, Stuever and Hayden 1997a, Terwilliger et al. 1979a, USFS 1983c, USFS 1985f, USFS 1985g, Western Ecology Working Group n.d., Wright et al. 1973, Wright et al. 1979.

Juniperus monosperma / Forestiera pubescens Woodland

One seed Juniper / Stretchberry Woodland

CODE	CEGL005371
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar needle leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded crowned temperate or subpolar needle leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	JUNIPERUS MONOSPERMA WOODLAND ALLIANCE (A.504) One seed Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Juniper Woodland and Savanna (CES306.834), Southern Rocky Mountain Pinyon Juniper Woodland (CES306.835)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This lower elevation semi riparian association occurs between 1655 and 1880 m (5430-6170 feet) along canyon drainage bottoms adjacent to intermittent and perennial stream channels of moderate gradients (8-22%) or around springs or seeps. Solar exposures are low to moderate, and aspects are predominantly southeasterly (with occasional northerly exposure). Sites vary from boulder strewn canyon bottoms, to gravelly and sandy washes with colluvial or alluvial substrates derived from basalt, andesite, and rhyolitic tuff. This short statured coniferous woodland has a very open (10% cover) to closed canopy (85% cover) that is dominated by *Juniperus monosperma*. Occasional riparian trees are present but never dominant (e.g., *Celtis laevigata* var. *reticulata*, *Populus angustifolia*, or introduced tree *Elaeagnus angustifolia*). This association is characteristically shrubby and dominated by *Forestiera pubescens*, which can be well represented to abundant. Among the 18 other shrubs reported for the type, *Fallugia paradoxa* and *Rhus trilobata* are the most frequent and abundant. The herbaceous layer is highly variable in cover (3-80%) and species composition. Among the 66 species reported for the association are obligate wetland species (*Eleocharis palustris*, *Polypogon viridis*, *Carex praegracilis*, or *Mimulus glabratus*) and typical upland associates (*Bouteloua gracilis*, *Poa fendleriana*, or *Sporobolus cryptandrus*).

DISTRIBUTION

Bandelier National Monument

This minor association occurs along the Rio Grande in White Rock Canyon and in Alamo, Hondo, and Capulin canyons.

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This lower elevation semi riparian association occurs between 1655 and 1880 m (5430-6170 feet) along canyon drainage bottoms adjacent to intermittent and perennial stream channels of moderate gradients (8-22%) or around springs or seeps. Solar exposures are low to moderate, and aspects are predominantly southeasterly (with occasional northerly exposure). Sites vary from boulder strewn canyon bottoms, to gravelly and sandy washes with colluvial or alluvial

substrates derived from basalt, andesite, and rhyolitic tuff.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This short statured coniferous woodland has very open (10% cover) to closed canopied stands (85% cover) that are dominated by *Juniperus monosperma*. Occasional riparian trees are present but never dominant (e.g., *Celtis laevigata* var. *reticulata*, *Populus angustifolia*, or introduced tree *Elaeagnus angustifolia*). This association is characteristically shrubby and dominated by *Forestiera pubescens*, which can be well represented to abundant. Among the 18 other shrubs reported for the type, *Fallugia paradoxa* and *Rhus trilobata* are the most frequent and abundant. The herbaceous layer is highly variable in cover (3-80%) and species composition. Among the 66 species reported for the association are obligate wetland species (*Eleocharis palustris*, *Polypogon viridis*, *Carex praegracilis*, or *Mimulus glabratus*) and typical upland associates (*Bouteloua gracilis*, *Poa fendleriana*, or *Sporobolus cryptandrus*).

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma*
Shrub/sapling (tall & short)	*Forestiera pubescens*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23 Jan 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

This association has not previously been described in New Mexico.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03AB015, 03BR002, 03BR007, 03BR008, 03ER001, 03ER029,

06JC123, 03YC029.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Western Ecology Working Group n.d.

Juniperus monosperma / *Quercus* X *pauciloba* Woodland

One-seed Juniper / Wavyleaf Oak Woodland

CODE	CEGL000721
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar needle leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded crowned temperate or subpolar needle leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	JUNIPERUS MONOSPERMA WOODLAND ALLIANCE (A.504) One seed Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Juniper Woodland and Savanna (CES306.834), Southern Rocky Mountain Pinyon Juniper Woodland (CES306.835)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland is known to occur in the Rocky Mountains in central and northern New Mexico, on gentle to steep (10-65%) rocky slopes, and less commonly on flat mesa tops and valley bottoms. It intergrades to scarp woodland with increasing steepness and rocky outcrop terrain. Elevations range from 1830 to 2265 m (6000-6600 feet). In central New Mexico, stands occur on soils derived from limestones of the Permian San Andres Formation. The ground surface is characterized by exposed soil and gravel with widely scattered grass patches and litter. This woodland/savanna is characterized by an open canopy of mature *Juniperus monosperma* trees with scattered saplings or seedlings. In the shrub layer, *Quercus* X *pauciloba* is well-represented in the intercanopy spaces. Additional shrub species may be present, including *Atriplex canescens*, *Cercocarpus montanus* var. *paucidentatus*, *Dalea formosa*, *Ephedra viridis*, *Fallugia paradoxa*, *Lycium pallidum*, *Nolina microcarpa*, *Opuntia* spp., *Quercus turbinella*, and *Yucca* spp. In the herbaceous layer, graminoids can be well-represented with dominant species including *Bouteloua gracilis* along with *Bouteloua eriopoda* and *Schizachyrium scoparium*. Additional graminoids may include *Bouteloua curtipendula*, *Elymus elymoides*, *Eragrostis intermedia*, *Muhlenbergia* spp., and *Achnatherum* and *Hesperostipa* spp. (= *Stipa* spp.). Forbs are scarce.

DISTRIBUTION

Bandelier National Monument

This is a major, widely-distributed association known from the Tsankawi Unit; Frijoles Mesa; Canon de los Frijoles; the uplands between Canon de los Frijoles, Alamo Canyon, and Capulin Canyon; Sanchez Canyon; and in the Turkey Springs area.

Globally

This woodland association is known to occur in the Rocky Mountains in central and northern New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This lower-elevation association lies between 6,150 and 6,900 feet (2,210 and 2,265 m) on sites with moderate to high solar exposure that increases with elevation (i.e, aspects tend to be more northerly at lower elevation more southerly on higher sites). It is generally found on moderately steep to steep (10-65%) rocky escarpment sideslopes and shoulders of plateaus, but occasionally extending onto valley floors, or conversely, on rocky exposures of the undulating plateau tops (<5% slopes). Soils were mapped primarily as loamy and rocky Alfisols; occasionally as loamy Mollisols

derived from pumice slope alluvium; or less-developed and rocky Inceptisols derived from rhyolitic tuff, or simply as Rock Outcrop (Hibner 2009). Accordingly, the ground surface can be gravelly, cobbly, or rocky, interspersed with bunch grasses and liter.

Globally

This woodland is known to occur in the Rocky Mountains in central and northern New Mexico on gentle to steep (10-65%) rocky escarpment sideslopes and shoulders of plateaus, but occasionally extending onto valley floors, or conversely, on rocky exposures of the undulating plateau tops (<5% slopes). . It intergrades to scarp woodland with increasing steepness and rocky outcrop terrain. Elevations range from 1830 to 2265 m (6000-6900 feet). In central New Mexico, stands occur on soils derived from limestones of the Permian San Andres Formation. In northern New Mexico soils are loamy and rocky Alfisols; occasionally loamy Mollisols derived from pumice slope alluvium; or less-developed and rocky Inceptisols derived from rhyolitic tuff, or simply as Rock Outcrop (Hibner 2009). The ground surface is characterized by exposed soil and gravel cobble, or rocks with widely scattered grass patches and litter.

VEGETATION DESCRIPTION

Bandelier National Monument

This short-statured coniferous woodland varies from very open (10% canopy) to partially closeF-canopied stands (50%). *Juniperus monosperma* dominates and is diagnostic; other mature trees are accidental or absent. *Juniperus monosperma* regeneration is common along with scattered *Pinus edulis* seedlings and saplings. The shrub layer is characteristically shrubby and dominated by semi-deciduous *Quercus* ×*pauciloba* with the deciduous *Cercocarpus montanus* often as a codominant. Low-lying succulents such as *Opuntia polyacantha*, *O. phaeacantha*, or *O. erinacea* can be prevalent. While the herbaceous layer is generally low in cover (<5%), it can be diverse with 31 graminoid species and 37 forb species reported. Occasionally graminoids such as *Bouteloua gracilis*, *Bouteloua hirsuta*, *Bouteloua curtipendula*, *Muhlenbergia montana* can be common to well represented while forbs are scattered with *Artemisia ludoviciana*, *Bahia dissecta*, and *Heterotheca villosa* the most frequent associates.

Globally

This woodland/savanna is characterized by an open canopy of mature *Juniperus monosperma* trees with scattered saplings or seedlings. In the shrub layer, *Quercus* X *pauciloba* is well-represented in the intercanopy spaces. Additional shrub species may be present, including *Atriplex canescens*, *Cercocarpus montanus* var. *paucidentatus*, *Dalea formosa*, *Ephedra viridis*, *Fallugia paradoxa*, *Lycium pallidum*, *Nolina microcarpa*, *Opuntia* spp., *Quercus turbinella*, and *Yucca* spp. Low-lying succulents such as *Opuntia polyacantha*, *O. phaeacantha*, or *O. erinacea* can be prevalent In the herbaceous layer, graminoids can be well-represented with dominant species including *Bouteloua gracilis* along with *Bouteloua eriopoda* and *Schizachyrium scoparium*. Additional graminoids may include *Bouteloua curtipendula*, *Elymus elymoides*, *Eragrostis intermedia*, *Muhlenbergia* spp., and *Achnatherum* and *Hesperostipa* spp. (= *Stipa* spp.). Forbs are scarce with *Artemisia ludoviciana*, *Bahia dissecta*, and *Heterotheca villosa* frequently present.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma*
Shrub/sapling (tall & short)	*Quercus X pauciloba, Cercocarpus montanus*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma*
Shrub/sapling (tall & short)	*Quercus X pauciloba*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Pinus edulis, *Bouteloua gracilis*, *Bouteloua gracilis*, *Bouteloua hirsuta*, *Bouteloua curtipendula*, *Muhlenbergia montana*.

Globally

Data are not available.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Bandelier National Monument

Plots where various grasses (*Bouteloua gracilis*, *Bouteloua hirsuta*, *Bouteloua curtipendula*, *Muhlenbergia montana*, or *Poa fendleriana*) are well-represented are indicated in the database as transitional to their respective grass -dominated *Juniperus monosperma* (e.g., *Juniperus monosperma* / *Bouteloua gracilis*, etc.).

Mature *Pinus edulis* was present in many stands prior to a die-off during the drought of 2002-03, but it is now represented only by seedlings and samplings. These plots are indicated in the database as a *Pinus edulis* (PINEDUX) Dead Phase. Accordingly, these stands may have belonged to the *Pinus edulis* / *Quercus pauciloba* Association [CEGL000794] before the die-off. While neither has been previously explicitly described for BAND and adjacent areas, both associations are established types that have been well documented elsewhere in New Mexico.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots 03BD108, 03ER026, 03BD089, 03BD053, 03BD119, 03YC028, 03ER049, 06AB157, 05BD003, 05BD035, 06AB146, 06AB148, 06AB149, 06AB153, 06AB155, 06AB267, 06AB268, 06AB271, 06AB278, 06AB279, 06AB280, 06AB281, 06AB282, 06JC120, 06JC121, 06JC124, 06JC126, 06JC130, 06JC133, 06JC137, 06JC491, 06JC492, 06JC494, 06JC525, 06BF030..

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King

REFERENCES

Bourgeron and Engelking 1994, Driscoll et al. 1984, Dwyer and Pieper 1967, Fischer and Bradley 1987, Hibner 2009, Larson and Moir 1986, Moir and Carleton 1987, Pettit et al. 1980, Stuever and Hayden 1997a, USFS 1981a, Western Ecology Working Group n.d., Wright et al. 1979.

Juniperus monosperma / Rockland Woodland

One seed Juniper / Rockland Woodland

CODE	CEGL005369
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar needle leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded crowned temperate or subpolar needle leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	JUNIPERUS MONOSPERMA WOODLAND ALLIANCE (A.504) One seed Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Pinyon Juniper Woodland (CES306.835), Southern Rocky Mountain Juniper Woodland and Savanna (CES306.834)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This lower elevation woodland association has only been described from Bandelier National Monument in north central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This association occurs between 1820 and 1970 m (5960-6470 feet) elevation on northeasterly through southeasterly to southwesterly aspects with moderate solar exposure. Sites vary from moderately steep (22%) shoulders of plateaus to steep (50%) canyon escarpment sideslopes. Stands typically occur on shallow, often rocky soils or rock outcrops derived from soft rhyolitic tuff parent material or sandstone. Hence, ground surfaces are mainly dominated by rock, cobbles, and gravel with scattered litter and bunch grasses. This short statured coniferous woodland varies from very open (20% canopy cover) to partially closed canopied stands (50%) dominated by *Juniperus monosperma*. Other mature trees species are accidental or absent, but scattered *Pinus edulis* seedlings and saplings can occur. Understories are typically sparsely vegetated. While shrubs can be common, they seldom exceed 5% cover and usually include deciduous *Cercocarpus montanus* and *Quercus* X *pauciloba*, rosetophyllous *Yucca baccata*, and the succulents *Opuntia polyacantha*, *Opuntia phaeacantha*, and *Opuntia imbricata* var. *imbricata* (= *Cylindropuntia imbricata*). The herbaceous layer is poorly represented and characterized by scattered grasses and forbs among the rocks and boulders. Among the 20 herbs reported for the association, *Bouteloua curtipendula*, *Bouteloua gracilis*, and *Bahia dissecta* are the most frequent.

DISTRIBUTION

Bandelier National Monument

This minor association is known from the slopes of Canon de los Frijoles and Lummis, Alamo, Hondo, and Capulin canyons.

Globally

This lower elevation woodland has only been described from Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This lower elevation association occurs between 1820 and 1970 m (5960-6470 feet) on northeasterly through southeasterly to southwesterly aspects with moderate solar exposure. Sites vary from moderately steep (22%) shoulders of plateaus to steep (50%) canyon escarpment sideslopes. Stands typically occur on shallow, often rocky soils or rock

outcrops derived from soft rhyolitic tuff parent material or sandstone. Hence, ground surfaces are mainly dominated by rock, cobbles, and gravel with scattered litter and bunch grasses.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This short statured coniferous woodland varies from very open (20% canopy) to partially closed canopied stands (50%) dominated by *Juniperus monosperma*. Other mature trees species are accidental or absent, but scattered *Pinus edulis* seedlings and saplings can occur. Understories are typically sparsely vegetated. While shrubs can be common, they seldom exceed 5% cover and usually include deciduous *Cercocarpus montanus* and *Quercus* X *pauciloba*, rose-tophyllous *Yucca baccata*, and the succulents *Opuntia polyacantha*, *Opuntia phaeacantha*, and *Opuntia imbricata* var. *imbricata* (= *Cylindropuntia imbricata*). The herbaceous layer is poorly represented and characterized by scattered grasses and forbs among the rocks and boulders. Among the 20 herbs reported for the association, *Bouteloua curti-pendula*, *Bouteloua gracilis*, and *Bahia dissecta* are the most frequent.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Pinus edulis.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23 Jan 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

Mature *Pinus edulis* was present in many stands prior to a die off during the drought of 2002 03, but it is now represented only by seedlings and samplings. These plots are indicated in the database as a *Pinus edulis* (PINEDUX) Dead Phase. Accordingly, these stands may have belonged to *Pinus edulis* / Rockland Woodland (CEGL000794) before the die off. Both associations are provisional types that have been documented elsewhere in New Mexico.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD075, 03BD123, 03ER027, 03YC023.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Western Ecology Working Group n.d.

Juniperus monosperma / Sparse Understory Woodland

One seed Juniper / Sparse Understory Woodland

CODE	CEGL005368
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar needle leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded crowned temperate or subpolar needle leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	JUNIPERUS MONOSPERMA WOODLAND ALLIANCE (A.504) One seed Juniper Woodland Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Pinyon Juniper Woodland (CES306.835), Southern Rocky Mountain Juniper Woodland and Savanna (CES306.834)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This lower elevation woodland association has only been described from Bandelier National Monument in north central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This association occurs between 1700 and 2025 m (5590-6650 feet) elevation on northeasterly through southeasterly to southwesterly aspects, although solar exposure tends to go from low to high with increasing elevation. The majority of sites occur on summits and undulating plateaus with gentle to moderate slopes (4-20%). Soils are composed of eolian material, alluvium, or colluvium derived from rhyolitic tuff or pumice. Occasionally, stands can be found on sideslopes of plateaus with rockier soils derived from rhyolitic colluvium. Lastly, some stands are found on deep colluvial and alluvial soils along the toeslopes and bottoms of valleys. The ground surface is characterized by exposed soils or gravels and scattered litter. This short statured woodland is dominated by *Juniperus monosperma* with open canopies that range from 10 to 40% cover. *Juniperus* regeneration is common along with scattered *Pinus edulis* seedlings and saplings. Shrubs are generally poorly represented with the dwarf shrub *Gutierrezia sarothrae* the most abundant. Herbaceous cover is also limited with scattered grasses and forbs. *Bouteloua gracilis* is the most frequent among 16 graminoids and 32 forbs reported. Forbs can be common but are mostly represented by annuals and biennials such as *Ipomopsis aggregata*, *Ipomopsis longiflora*, *Erysimum capitatum*, *Chenopodium* sp., and *Mentzelia* sp. plus perennial herbaceous *Artemisia* spp. (*Artemisia campestris*, *Artemisia carruthii*, *Artemisia dracunculus*, and *Artemisia ludoviciana*).

DISTRIBUTION

Bandelier National Monument

This major association is known from the Tsankawi Unit, Canon de los Frijoles, the uplands between Canon de los Frijoles, Alamo Canyon, and Capulin Canyon.

Globally

This lower elevation woodland has only been described from Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This lower elevation association occurs between 1700 and 2025 m (5590-6650 feet) on northeasterly through southeasterly to southwesterly aspects, although solar exposure tends to go from low to high with increasing elevation.

The majority of sites occur on summits and undulating plateaus with gentle to moderate slopes (4-20%). Soils are composed of eolian material, alluvium, or colluvium derived from rhyolitic tuff or pumice. Occasionally, stands can be found on sideslopes of plateaus with rockier soils derived from rhyolitic colluvium. Lastly, some stands are found on deep colluvial and alluvial soils along the toeslopes and bottoms of valleys. The ground surface is characterized by exposed soils or gravels and scattered litter.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This short statured woodland is dominated by *Juniperus monosperma* with open canopies that range from 10 to 40% cover. *Juniperus* regeneration is common along with scattered *Pinus edulis* seedlings and saplings. Shrubs are generally poorly represented with the dwarf shrub *Gutierrezia sarothrae* the most abundant. Herbaceous cover is also limited with scattered grasses and forbs. *Bouteloua gracilis* is the most frequent among 16 graminoids and 32 forbs reported. Forbs can be common but are mostly represented by annuals and biennials such as *Ipomopsis aggregata*, *Ipomopsis longiflora*, *Erysimum capitatum*, *Chenopodium* sp., and *Mentzelia* sp., plus perennial herbaceous *Artemisia* spp. (*Artemisia campestris*, *Artemisia carruthii*, *Artemisia dracunculus*, and *Artemisia ludoviciana*).

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Pinus edulis

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23 Jan 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

Mature *Pinus edulis* was present in many stands prior to a die off during the drought of 2002 03, but it is now represented only by seedlings and samplings. These plots are indicated in the database as a *Pinus edulis* (PINEDUX) Dead Phase. This association has been moderately well documented elsewhere in New Mexico (16 plots).

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03AB043, 03AB044, 03BD055, 03BD059, 03BD060, 03BD095, 03BD130, 03BD140, 03BD176, 03ER022, 03YC019, 05BD030, 06AB143, 06AB275, 06JC161.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Western Ecology Working Group n.d.

Pinus ponderosa / *Bouteloua gracilis* Woodland

Ponderosa Pine / Blue Grama Woodland

CODE	CEGL005368
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 PONDEROSA WOODLAND ALLIANCE (A.530) Ponderosa Pine Woodland Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Ponderosa Pine Woodland (CES306.648), Southern Rocky Mountain Ponderosa Pine Savanna (CES306.649)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This widespread woodland occurs at foothill and lower montane elevations from the southern Rocky Mountains, extending east onto southern Great Plains escarpments, south to the mountains of western Texas, and west to the Colorado Plateau and Mogollon Rim of New Mexico, Arizona and Utah. Sites occur on dry, gentle to steep slopes of all aspects, but are more common on southern and western aspects, especially at higher elevations. Substrates are quite variable and include shallow sandy loam soils derived from granitic parent materials, coarse cinder soils, and clayey soil with or without high coarse fragment content. The ground surface is typically characterized by scattered grass patches and litter amid exposed soil. The vegetation is characterized by an open to moderately dense evergreen, needle leaved tree canopy 10-30 m tall that is typically dominated by *Pinus ponderosa*. Some stands may be co-dominated by *Pinus ponderosa* and *Pinus edulis*. Species of *Juniperus* may be important subdominants. The typically moderately dense herbaceous layer has greater cover than the shrub layer and is dominated by graminoids. The warm season, sod forming shortgrass *Bouteloua gracilis* dominates the herbaceous layer. Forb cover is typically sparse.

DISTRIBUTION

Bandelier National Monument

This minor association is known from Escobas and Frijoles mesas.

Globally

This ponderosa pine woodland occurs in the southern Rocky Mountains, extending east on southern Great Plains escarpments as far as Oklahoma, south to the mountains of western Texas, west to the Colorado Plateau and Mogollon Rim of New Mexico, Arizona, and southern Utah.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs between 2015 and 2190 m (6610-7200 feet) on sites of high solar exposure (i.e., aspects tend to be southerly). Stands occur on gently rolling mesatops of low slope (<15%). Soils are primarily mapped as either poorly developed Entisols derived from rhyolitic tuff slope alluvium, or occasionally as fine textured Alfisols derived from mixed eolian and slope alluvium (Hibner 2009). The ground surface is typically characterized by scattered grass patches and litter amid exposed soil.

Globally

This widespread woodland occurs at foothill and lower montane elevations from the southern Rocky Mountains, extending east onto southern Great Plains escarpments, south to the mountains of western Texas, and west to the Colorado Plateau and Mogollon Rim of New Mexico, Arizona and Utah. Elevation ranges from 1740-2610 m (5700-8550 feet). Sites occur on dry, gentle to steep slopes of all aspects, but are more common on southern and western aspects, especially at higher elevations. Substrates are quite variable and include shallow sandy loam soils derived from granitic parent materials, coarse cinder soils, and clayey soil with or without high coarse fragment content.

VEGETATION DESCRIPTION

Bandelier National Monument

This woodland savanna association is characterized by an open canopy of *Pinus ponderosa* with an occasional *Juniperus monosperma* or *Pinus edulis*. Shrubs species are poorly represented or absent except for an occasional *Quercus* X *pauciloba*. The herbaceous layer is characteristically grassy and dominated by abundant *Bouteloua gracilis*. *Muhlenbergia montana* can occur but is clearly subordinate.

Globally

This plant association is characterized by an open to moderately dense evergreen, needle leaved tree canopy 10 30 m tall that is typically dominated by *Pinus ponderosa*. Some stands may be codominated by *Pinus ponderosa* and *Pinus edulis*. *Juniperus monosperma*, *Juniperus osteosperma*, *Juniperus deppeana*, or *Juniperus scopulorum* may be important subdominants. The typically moderately dense herbaceous layer has greater cover than the shrub layer and is dominated by graminoids. The warm season, sod forming shortgrass *Bouteloua gracilis* dominates the herbaceous layer. Common graminoid associates include Aristida spp., *Bouteloua hirsuta*, *Carex geophila*, *Elymus elymoides*, *Hesperostipa comata*, *Koeleria macrantha*, *Muhlenbergia montana*, *Poa fendleriana*, or *Schizachyrium scoparium*. *Quercus gambelii* may be present in the sparse shrub layer (<10% cover) with low cover (<5%). Other shrubs may include scattered *Artemisia tridentata*, *Ceanothus fendleri*, *Cercocarpus montanus*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa*, *Fallugia paradoxa*, *Purshia tridentata*, *Quercus grisea*, *Rhus trilobata*, and *Tetradymia canescens*. Forb cover is typically sparse and may include species such as *Antennaria* spp., *Artemisia ludoviciana*, *Erigeron* spp., *Eriogonum racemosum*, *Chaetopappa ericoides*, *Packera neomexicana*, and *Penstemon* spp.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herb (field)	*Bouteloua gracilis*

Globally

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herb (field)	*Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (1 Feb 1996).

CLASSIFICATION COMMENTS

Bandelier National Monument

Data are not available.

Globally

This ponderosa pine woodland is a broadly defined plant association. Stuever and Hayden (1997b) report 6 phases: the *Bouteloua gracilis*, *Schizachyrium scoparium*, *Andropogon hallii*, *Artemisia tridentata*, *Quercus grisea*, and *Quercus gambelii* phases. Hanks et al. (1983) described 4 phases of the *Pinus ponderosa* / *Bouteloua gracilis* Habitat Type from northern Arizona. More classification review is needed to further define the relationships between these phases and other similar plant associations. Alexander et al. (1987), DeVelice et al. (1986), and Muldavin et al. (1996) also described phases of this Habitat Type that need further review and cross walking to the USNVC. Youngblood and Mauk (1985) included stands of this association in their broadly defined *Pinus ponderosa* / *Muhlenbergia montana* Habitat Type.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 06AB147, 06AB162.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz, mod. K.S. King

REFERENCES

Alexander et al. 1987, Bourgeron and Engelking 1994, Bradley et al. 1992, Bruner 1931, CONHP unpubl. data 2003, DeVelice et al. 1986, Diamond 1993, Driscoll et al. 1984, Fitzhugh et al. 1987, Francis 1986, Hanks et al. 1983, Hansen et al. 2004c, Hibner 2009, Hoagland 2000, Johnston 1987, Larson and Moir 1987, Madany and West 1980b, Muldavin et al. 1996, Savage and Swetnam 1990, Stuever and Hayden 1997b, Western Ecology Working Group n.d., Wright and Bailey 1980, Youngblood and Mauk 1985

Pinus ponderosa / *Carex inops* ssp. *heliophila* Woodland

Ponderosa Pine / Sun Sedge Woodland

CODE	CEGL000849
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 PONDEROSA WOODLAND ALLIANCE (A.530) Ponderosa Pine Woodland Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Ponderosa Pine Woodland (CES306.648), Northwestern Great Plains Black Hills Ponderosa Pine Woodland and Savanna (CES303.650)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This ponderosa pine / sedge woodland is found in the Black Hills region, along the Rocky Mountain Front Range from *Montana* to Colorado, and in Bandelier National Monument in north central New Mexico. Along the Rocky Mountains, this association occurs from the foothills to 2900 m (9500 feet) in elevation, although its elevation decreases farther north. Stands occur in relatively mesic savanna habitats, on gentle to moderate south and west facing slopes. In north central New Mexico, this association occurs at mid elevation (1920-2560 m [6300-8400 feet]) on sites with moderate to high solar exposure that increases with elevation. Aspects tend to be more northerly at lower elevation, more southerly on higher sites. Slopes range from gentle to moderate (8 20%), and occasionally very steep (>50%). Substrates are variable and may include the following soil types: poorly developed and rocky Inceptisols from rhyolitic colluviums; finer textured Alfisols from rhyolitic slope alluvium; gravely Mollisols from rhyolite tuff; or pumice slope alluvium. Some sites are predominantly rock outcrop. The ground surface is characterized by scattered bunch grasses and sedges intermixed with litter, and some sites are very rocky. Diagnostic characteristics of this association are the canopy of *Pinus ponderosa* over a graminoid layer dominated by *Carex inops* ssp. *heliophila*. Occasional canopy associates include *Juniperus scopulorum*, *Pseudotsuga menziesii*, or *Quercus macrocarpa* in the subcanopy, depending on which portion of the geographic range the stand is found. Shrubs are uncommon. The herbaceous layer is dominated by *Carex inops* ssp. *heliophila*, with inclusions of *Danthonia spicata*, *Schizachyrium scoparium*, *Pseudoroegneria spicata*, and *Bouteloua gracilis*, generally in areas with more open canopies. Within Bandelier National Monument in north central New Mexico, canopy cover ranges from open woodland to closed canopied forests (25% to >60% cover). Density of mature *Pinus ponderosa* is moderate and reproduction is rare or absent. Other conifers such as *Abies concolor*, *Pseudotsuga menziesii*, and *Pinus flexilis* are rare or absent in the overstory. Shrubs are a minor component of the stands. The herbaceous layer is rich in species but variable in cover. The most diagnostic and abundant graminoid is *Carex inops* ssp. *heliophila*, with other abundant species including deer sedges (*Carex occidentalis*, *Carex rossii*, and *Carex geophila*). While forbs are diverse, composition is variable from stand to stand and usually less than 5% total cover.

DISTRIBUTION

Bandelier National Monument

This common association is known from the slopes of Cerro Grande south to Escobas Mesa and the slopes of Capulin Canyon.

Globally

This ponderosa pine / sedge woodland is found in the Black Hills region, along the Rocky Mountain Front Range

from *Montana* to Colorado, and in Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs from 1920 to 2560 m (6300-8400 feet) on sites with moderate to high solar exposure that increases with elevation (i.e., aspects tend to be more northerly at lower elevation, more southerly on higher sites). Stands occur on slopes ranging from gentle to moderate (8-20%), and occasionally very steep (>50%). Soils are variable and mapped as either poorly developed and rocky Inceptisols from rhyolitic colluvium; finer textured Alfisols from rhyolitic slope alluvium, and gravely Mollisols from rhyolite tuff, or pumice slope alluvium, or also as rock outcrop (Hibner 2009). The ground surface is characterized by scattered bunch grasses and sedges intermixed with litter, and some sites are very rocky.

Globally

This community is often found on gentle and moderate south to west facing slopes in the western Dakotas and eastern parts of Wyoming and Montana (Hoffman and Alexander 1987, Hansen and Hoffman 1988). Along the Rocky Mountains from Montana to Colorado, this association occurs from the foothills to 2900 m (9500 feet) in elevation, although its elevation decreases farther north. Stands occur in relatively mesic savanna habitats, on gentle to moderate south and west facing slopes. In north central New Mexico, this association occurs at mid elevation (1920-2560 m [6300 8400 feet]) on sites with moderate to high solar exposure that increases with elevation. Aspects tend to be more northerly at lower elevation, more southerly on higher sites. Slopes range from gentle to moderate (8-20%) and occasionally very steep (>50%). Substrates are variable and may include the following soil types: poorly developed and rocky Inceptisols from rhyolitic colluviums; finer textured Alfisols from rhyolitic slope alluvium; gravely Mollisols from rhyolite tuff; or pumice slope alluvium. Some sites are predominantly rock outcrop (Hibner 2009). The ground surface is characterized by scattered bunch grasses and sedges intermixed with litter, and some sites are very rocky.

VEGETATION DESCRIPTION

Bandelier National Monument

This is a tall conifer woodland that ranges from open woodland where tree canopies are as low as 25% cover to closed canopied forests with over 60% cover. Stands are dominated by *Pinus ponderosa*, which reaches heights greater that 30 m (100 feet) with boles up to 65 cm (25 inches) dbh. Density of mature *Pinus ponderosa* is moderate (88/ha [218/acre]), and reproduction is rare or absent. Other conifers such as *Abies concolor*, *Pseudotsuga menziesii*, and *Pinus flexilis* are rare or absent in the overstory. Shrubs are a minor component of the stands (rarely exceeding 3% total cover), and, in particular, *Quercus gambelii* is usually poorly represented or absent. The herbaceous layer is rich in species (25 graminoids and 563 forbs) but variable in cover (5 40%). The graminoids are the most abundant with *Carex inops* ssp. *heliophila* and other deer sedges (*Carex occidentalis*, *Carex rossii*, and *Carex geophila*) diagnostic and often abundant. *Elymus elymoides*, *Koeleria macrantha*, *Poa fendleriana*, and *Muhlenbergia montana* are frequent and often well represented associates. While forbs are diverse, composition is variable from stand to stand and usually less than 5% total cover. The most frequent and abundant species are *Heterotheca villosa*, *Artemisia ludoviciana*, *Achillea millefolium*, *Erigeron subtrinervis*, *Erigeron speciosus*, *Allium cernuum*, *Antennaria parvifolia*, *Psoralidium tenuiflorum*, and *Penstemon barbatus*.

Globally

Diagnostic characteristics of this association are the canopy of *Pinus ponderosa* over a graminoid layer dominated by *Carex inops* ssp. *heliophila*. *Juniperus scopulorum*, *Quercus macrocarpa*, or *Pseudotsuga menziesii* are occasionally found in the subcanopy, depending on which portion of the geographic range the stand is found. Shrubs are infrequent. The herbaceous layer is dominated by *Carex inops* ssp. *heliophila*, with inclusions of *Danthonia spicata*, *Schizachyrium scoparium*, *Pseudoroegneria spicata*, and *Bouteloua gracilis*, generally in areas with more open canopies. Other common herbaceous species that occur with low cover include *Artemisia ludoviciana*, *Piptatherum micranthum* (= *Oryzopsis micrantha*), *Nassella viridula*, and *Poa pratensis* (H. Marriott pers. comm. 1999), as well as *Andropogon gerardii*, *Muhlenbergia montana*, *Sporobolus heterolepis*, *Arctostaphylos uva ursi*, and *Heuchera richardsonii* (CONHP 2000).

Within Bandelier National Monument in north central New Mexico, canopy cover ranges from open woodland to closed canopied forests (25% to >60% cover). Density of mature *Pinus ponderosa* is moderate and reproduction is rare or absent. Other conifers such as *Abies concolor*, *Pseudotsuga menziesii*, and *Pinus flexilis* are rare or absent in the overstory. Shrubs are a minor component (rarely exceeding 3% total cover), and, in particular, *Quercus gambelii* is usually poorly represented or absent. The herbaceous layer is rich in species but variable in cover (5-40%). The graminoids are the most abundant with *Carex inops* ssp. *heliophila* and other deer sedges (*Carex occidentalis*, *Carex rossii*, and *Carex geophila*) diagnostic and often abundant. *Elymus elymoides*, *Koeleria macrantha*, *Muhlenbergia montana*, and *Poa fendleriana* are frequent and often well represented associates. While forbs are diverse, composition is variable from stand to stand and usually less than 5% total cover. The most frequent and abundant forb species include *Achillea millefolium*, *Allium cernuum*, *Antennaria parvifolia*, *Artemisia ludoviciana*, *Erigeron speciosus*, *Erigeron subtrinervis*, *Heterotheca villosa*, *Penstemon barbatus*, and *Psoralidium tenuiflorum*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herb (field)	*Carex inops* ssp. *heliophila*

Globally

Stratum	Species
Tree (canopy & subcanopy)	*Pinus ponderosa*
Herb (field)	*Carex inops* ssp. *heliophila*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G4 (26 May 2000).

CLASSIFICATION COMMENTS

Bandelier National Monument

This association is similar to *Pinus ponderosa* / *Quercus gambelii* / *Carex inops* ssp. *heliophila* Woodland (CEGL005372), but it lacks a significant shrub component. Muldavin and Tonne (2003) and Muldavin et al. (2006) described this association for the adjacent Valles Caldera National Preserve.

Globally

The stands used by Hoffman and Alexander (1987) and Hansen and Hoffman (1988) to document the *Pinus ponderosa* / *Carex inops* ssp. *heliophila* Woodland habitat type had very high basal area and densities for a woodland, possibly due to their sampling procedure. The dense structure may have affected the floristic makeup of the stands. This type is expected to have an open canopy where natural fire disturbances occur.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: The description is based on 2003 and 2006 field data: (NHNM Plots: 03BD001, 03BD010, 03BD013, 03BD080, 03BD126, 03BD143, 03BD146, 03BD148, 03BD150, 03BD166, 03BD168, 03BD174, 03BD181, 03YC001, 03YC015, 06AB184, 06BF003, 06JC185).

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: A.G. McAdams, mod. S.L. Neid and K.S. King

REFERENCES

Ahlenslager 1988, Baker 1984a, Bourgeron and Engelking 1994, CONHP unpubl. data 2000, CONHP unpubl. data 2003, Driscoll et al. 1984, Hall 1967, Hall 1973, Hansen 1985, Hansen and Hoffman 1988, Hibner 2009, Hoffman and Alexander 1976, Hoffman and Alexander 1987, Johnston 1987, Kooiman and Linhart 1986, Livingston 1947, Livingston 1949, MTNHP 2002b, Marriott and Faber Langendoen 2000, Marriott pers. comm., McAdams et al. unpubl. data 1998, Muldavin and Tonne 2003, Muldavin et al. 2006, Western Ecology Working Group n.d.

Pinus ponderosa / *Festuca thurberi* Woodland

Ponderosa Pine / Thurber's Fescue Woodland

CODE	CEGL005373
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 PONDEROSA WOODLAND ALLIANCE (A.530) Ponderosa Pine Woodland Alliance

ECOLOGICAL SYSTEM(S): Southern Rocky Mountain Ponderosa Pine Woodland (CES306.648)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This high elevation association occurs on sites with high solar exposure (i.e., southeasterly to westerly aspects). Stands occur on mid to upper slopes and ridges of moderate slope (10-40%). Soils are well developed loamy Mollisols derived from volcanic lactite and dacite. The ground surface is characterized by scattered bunch grasses and litter with little exposed soil or rock. Elevation ranges from 2545 to 2940 m (8350-9650 feet). The dominant overstory species within this high montane woodland savanna is *Pinus ponderosa*. Canopy cover ranges from 30-60%. Density of mature *Pinus ponderosa* is high, but reproduction is scarce. Other conifers such as *Abies concolor*, *Picea engelmannii*, *Pinus flexilis*, and *Pseudotsuga menziesii* occasionally occur in the canopy. Shrubs including *Rosa woodsii* or *Juniperus communis* may be present, but seldom reach 10% cover. A well developed herbaceous layer dominated by grasses is diagnostic, with cover ranging from 15 to 45% distributed among 35 forb and 20 grass species. *Festuca thurberi* dominates the herbaceous layer, but *Danthonia parryi* is often a codominant, and *Koeleria macrantha*, *Poa fendleriana*, and *Poa pratensis* are common associates. Forbs are diverse and variable, generally representing less than 10% total cover.

DISTRIBUTION

Bandelier National Monument

This association is known from the slopes of Cerro Grande and to the northwest of Sawyer Spring.

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This high elevation association occurs at 2545 to 2940 m (8350-9650 feet) on sites with high solar exposure (i.e., southeasterly to westerly aspects). Stands occur on mid to upper slopes and ridges of moderate slope (10-40%). Soils are mapped as well developed loamy Mollisols derived from volcanic lactite and dacite. The ground surface is characterized by scattered bunch grasses and litter with little exposed soil or rock.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This high montane woodland savanna is dominated *Pinus ponderosa* with canopies that range from 30 60% cover. *Pinus ponderosa* can reach 25 m (80 feet) in height with boles that are 80 cm (30 inches) dbh. Density of mature *Pinus ponderosa* is high (119/ha [295/acre]), but reproduction is scarce. Other conifers such as *Abies concolor*, *Pseudotsuga menziesii*, *Pinus flexilis*, and *Picea engelmannii* occasionally occur in the canopy. In this herbaceous dominated association, the shrub layer seldom reaches 10% cover, but may include *Rosa woodsii* or *Juniperus communis*. A well developed herbaceous layer dominated by grasses is diagnostic, with cover ranging from 15 to 45% distributed among 35 forb and 20 grass species. *Festuca thurberi* dominates with an average cover of 10% and up to 30%. *Danthonia parryi* is often a codominant, with *Poa fendleriana*, *Koeleria macrantha*, and *Poa pratensis* as common associates. While forbs are diverse, they are variable from stand to stand and generally less than 10% total cover. The most frequent and abundant are montane meadow species such as *Iris missouriensis* and *Potentilla hippiana* along with common forest species such as *Pseudocymopterus montanus*, *Senecio eremophilus*, and *Vicia americana*.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herb (field)	*Danthonia parryi, Festuca thurberi*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23 Jan 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

A quaking aspen phase occurs within this association when relative cover for that species exceeds 25%.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: The description is based on 2003, 2004 and 2006 field data: (Plots: 03AB041, 03BD036, 03BD048, 04BD005, 04BD012, 04BD013, 06AB199, 06JC207, 06JC211).

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Western Ecology Working Group n.d.

Pinus ponderosa / Muhlenbergia montana Woodland

Ponderosa Pine / Mountain Muhly Woodland

CODE	CEGL000862
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 PONDEROSA WOODLAND ALLIANCE (A.530) Ponderosa Pine Woodland Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Ponderosa Pine Woodland (CES306.648)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This widespread woodland occurs at foothill and lower montane elevations in the southern Rocky Mountains, extending south to the mountains of western Texas, and west to the Mogollon Rim and Colorado Plateau. Elevation ranges from 2150 to 2870 m (7050-9400 feet). Stands occur on bottomlands, elevated plains, cinder cones, piedmont slopes, mesas, foothills, and mountains. Sites include gentle to steep slopes on all aspects, but are more common on southern and western aspects, especially at higher elevations. Substrates are variable but are typically shallow, rocky, coarse textured soils derived from granitic or cinder parent materials. There is considerable cover of bare soil and exposed bedrock. The vegetation is characterized by an open to moderately dense evergreen, needle leaved tree canopy to 10 30 m tall that is dominated or codominated by *Pinus ponderosa*. Associated tree species vary geographically. *Pinus edulis*, *Pinus discolor*, and *Juniperus* spp. may be important in the tree canopy. *Pseudotsuga menziesii*, *Pinus flexilis*, and *Populus tremuloides* may also be present but are considered accidental. The typically moderately dense herbaceous layer has greater cover than the shrub layer and is dominated by graminoids. *Muhlenbergia montana*, a warm season, medium tall perennial, typically dominates the herbaceous layer and is diagnostic of this association. Common graminoid associates include *Aristida* spp., *Blepharoneuron tricholepis*, *Bouteloua gracilis*, *Carex geophila*, *Carex rossii*, *Elymus elymoides*, *Koeleria macrantha*, *Poa fendleriana*, and *Schizachyrium scoparium*. *Festuca arizonica*, *Muhlenbergia virescens*, *Muhlenbergia dubia*, *Muhlenbergia emersleyi*, and *Hesperostipa* spp. are typically absent. *Quercus gambelii* may be present with low cover (to 5%) in the sparse shrub layer (<10% cover). Other scattered shrubs may include *Artemisia tridentata*, *Ceanothus fendleri*, *Cercocarpus montanus*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa*, *Juniperus communis*, *Purshia tridentata*, *Rhus trilobata*, *Ribes cereum*, or *Yucca baccata*. Forb cover is typically sparse and highly variable.

DISTRIBUTION

Bandelier National Monument

This common association is known from the slopes of Cerro Grande, Escobas Mesa, Canon de los Frijoles, Mesa del Rito, and Sanchez Canyon.

Globally

This widespread woodland occurs at foothill and lower montane elevations in the southern Rocky Mountains, extending south to the mountains of western Texas, and west to the Mogollon Rim and Colorado Plateau of New Mexico, Arizona and Utah.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs between 1890 and 2500 m (6190-8210 feet) on sites with low to high solar exposure that increases with elevation (i.e., aspects tend to be more northerly at lower elevation, more southerly on higher sites). Stands occur on gentle to moderate slopes (5-20%), and occasionally on canyon slopes as steep as 50%. Soils were primarily mapped as well developed Mollisols derived from pumice or rhyolitic tuff slope alluvium, or occasionally as fine textured Alfisols or Inceptisols derived from mixed eolian and slope alluvium (Hibner 2009). The ground surface is typically characterized by scattered bunch grasses amid litter, pumice gravel, or exposed soil.

Globally

This widespread woodland occurs at foothill and lower montane elevations in the southern Rocky Mountains, extending south to the mountains of western Texas, and west to the Mogollon Rim and Colorado Plateau. Elevation ranges from 2150-2870 m (7050-9400 feet). Stands occur on bottomlands, elevated plains, cinder cones, piedmont slopes, mesas, foothills, and mountains. Sites include gentle to steep slopes on all aspects, but are more common on southern and western aspects, especially at higher elevations. Substrates are variable, but are typically shallow, rocky, coarse textured soils derived from granitic or cinder parent materials. There is considerable cover of bare soil and exposed bedrock.

VEGETATION DESCRIPTION

Bandelier National Monument

This woodland savanna is dominated *Pinus ponderosa* with canopies that range from 10-60% cover. *Pinus ponderosa* seedling and sapling reproduction is typically present. Shrubs are poorly represented, and stands are distinctively grassy (occasionally *Quercus gambelii*, *Robinia neomexicana*, and *Ceanothus fendleri* are well represented). In more closed stands, herbaceous cover can be low (<5%), but as the canopy opens, grass cover can reach 50%. *Muhlenbergia montana* is the dominant and diagnostic grass with *Koeleria macrantha*, *Poa fendleriana*, *Schizachyrium scoparium*, *Elymus elymoides*, and *Blepharoneuron tricholepis* frequent and often well represented associates. *Bouteloua gracilis*, while often present, is clearly subordinate. Forbs can be common to well represented, yet variable from stand to stand. The most frequent and abundant are *Artemisia carruthii*, *Artemisia ludoviciana*, *Erigeron subtrinervis*, *Heterotheca villosa*, *Bahia dissecta*, and *Lithospermum multiflorum*. Overall species richness is high, with 35 forb species and 24 grass species recorded for this association.

Globally

This association is characterized by an open to moderately dense evergreen, needle leaved tree canopy to 10-30 m tall that is dominated or codominated by *Pinus ponderosa*. Associated tree species vary geographically. *Pinus edulis*, *Pinus discolor*, *Juniperus monosperma*, *Juniperus osteosperma*, *Juniperus deppeana*, and *Juniperus scopulorum* may be important in the tree canopy. *Pseudotsuga menziesii*, *Pinus flexilis*, and *Populus tremuloides* may also be present, but are considered accidental. The typically moderately dense herbaceous layer has greater cover than the shrub layer, and is dominated by graminoids. *Muhlenbergia montana*, a warm season, medium tall perennial, typically dominates the herbaceous layer and is diagnostic of this association. Common graminoid associates include Aristida spp., *Blepharoneuron tricholepis*, *Bouteloua gracilis*, *Carex geophila*, *Carex rossii*, *Elymus elymoides*, *Koeleria macrantha*, *Poa fendleriana*, and *Schizachyrium scoparium*. *Festuca arizonica*, *Muhlenbergia virescens*, *Muhlenbergia dubia*, *Muhlenbergia emersleyi*, and *Hesperostipa* spp. are typically absent. *Quercus gambelii* may be present with low cover (to 5%) in the sparse shrub layer (<10% cover). Other scattered shrubs may include *Artemisia tridentata*, *Brickellia californica*, *Ceanothus fendleri*, *Cercocarpus montanus*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa*, *Fallugia paradoxa*, *Mahonia* spp., *Purshia tridentata*, *Quercus grisea*, *Rhus trilobata*, *Tetradymia canescens*, or *Yucca baccata*. Forb cover is typically sparse and may include species such as *Antennaria* spp., *Artemisia ludoviciana*, *Erigeron* spp., *Eriogonum racemosum*, *Chaetopappa ericoides*, *Lotus wrightii*, *Oxytropis lambertii*, *Packera neomexicana*, and *Penstemon* spp.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*

Herb (field)	*Muhlenbergia montana*

Globally

Stratum	Species
Tree canopy	*Pinus ponderosa, Pinus edulis*
Herb (field)	*Muhlenbergia montana*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G4G5 (1 Feb 1996).

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Schizachyrium scoparium* phase can be recognized when that species has greater than 5% cover, but *Muhlenbergia montana* is the dominant graminoid. Balice et al. (1997) have reported a *Pinus ponderosa* / *Muhlenbergia montana* Cover Type for the Los Alamos region.

Globally

This ponderosa pine woodland is a broadly defined plant association. Stuever and Hayden (1997b) suggested the xeric upland and mesic bottomland stands be put into different phases. Fitzhugh et al. (1987) suggested it be divided into regional phases.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: The description is based on 2003, 2005, and 2006 field data: (NHNM Plots: 03BD009, 03BD019, 03BD020, 03BD084, 03BD137, 05BD002, 06AB165, 06AB172, 06AB265, 06BF018, 06BF020, 06JC136, 06JC140, 06JC154, 06JC158, 06JC186, 06JC487, 06JC521, 06JC528, 06JC545, 06JC564, 06JC565, 06JC594, 06JC600, 06JC603, 06JC617, 06JC619).

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz

REFERENCES

Alexander et al. 1987, Baker 1984a, Balice et al. 1997, Bourgeron and Engelking 1994, Bradley et al. 1992, CONHP unpubl. data 2003, DeVelice 1983, DeVelice and Ludwig 1983a, DeVelice et al. 1986, Diamond 1993, Driscoll et al. 1984, Fischer and Bradley 1987, Fitzhugh et al. 1987, Hanks et al. 1983, Hansen et al. 2004c, Hess 1981, Hess and Alexander 1986, Hibner 2009, Johnston 1987, Larson and Moir 1987, Madany and West 1980b, Muldavin et al. 1996, Peet 1975, Peet 1981, Savage and Swetnam 1990, Stuever and Hayden 1997a, Stuever and Hayden 1997b, Terwilliger et al. 1979a, Wasser and Hess 1982, Western Ecology Working Group n.d., Youngblood and Mauk 1985

Pinus ponderosa / *Quercus* X *pauciloba* Woodland

Ponderosa Pine / Wavyleaf Oak Woodland

CODE	CEGL000874
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 PONDEROSA WOODLAND ALLIANCE (A.530) Ponderosa Pine Woodland Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Ponderosa Pine Woodland (CES306.648)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This ponderosa pine woodland occurs at mid elevations in the southern Rocky Mountains of southern Colorado and northern New Mexico on sites with moderate to high solar exposure on all aspects. Sites vary from gentle on rolling mesatops and shoulders (5-20% slope) to steep canyon slopes and rock outcrops (up 60% slope). Elevation ranges between 1995 and 2500 m (6550-8200 feet). Soils range from sandy to loamy, including well developed Mollisols derived from pumice slope alluvium or rhyolitic colluvium, or occasionally as fine textured Alfisols, or rock outcrop. Sites are often rocky or boulder strewn with accumulations of litter in between. This tall conifer association ranges from open woodland where tree canopies are as low as 10% cover to closed canopied forest with over 60% cover. *Pinus ponderosa* dominates the tree canopy. Stand understories are distinctively shrubby, dominated by the hybrid scrub oak *Quercus* X *pauciloba*. The herbaceous layer is generally less than 5% cover but diverse. Dominant graminoid species may include *Bouteloua gracilis*, *Muhlenbergia montana*, *Poa fendleriana*, and *Schizachyrium scoparium*. While forbs are diverse, composition is variable from stand to stand and total forb cover is usually less than 5%.

DISTRIBUTION

Bandelier National Monument

This common association is known from Escobas, Burnt, Frijoles, and Capulin mesas, Mesa del Rito, and associated canyons.

Globally

This association occurs at mid elevations in the southern Rocky Mountains of southern Colorado and northern New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs between 1995 and 2480 m (6550-8130 feet) on sites with moderate to high solar exposure that increases with elevation (i.e., aspects tend to be more northerly at lower elevation, more southerly on higher sites). Sites vary from gentle on rolling mesatops and shoulders (5-20% slope) to steep canyon slopes and rock outcrops (up 60% slope). Soils are primarily mapped as well developed Mollisols derived from pumice slope alluvium or rhyolitic colluvium, or occasionally as fine textured Alfisols, or rock outcrop (Hibner 2009). Sites are often rocky or boulder strewn with accumulations of litter in between.

Globally

This association occurs at mid elevation in the southern Rocky Mountains of southern Colorado and northern New Mexico on sites with moderate to high solar exposure on all aspects. Sites vary from gentle on rolling mesatops and shoulders (5-20% slope) to steep canyon slopes and rock outcrops (up 60% slope). Elevation ranges between 1995 and 2500 m (6550-8200 feet). Soils range from sandy to loamy, including well developed Mollisols derived from pumice slope alluvium or rhyolitic colluvium, or occasionally as fine textured Alfisols, or rock outcrop (Hibner 2009). Sites are often rocky or boulder strewn with accumulations of litter in between.

VEGETATION DESCRIPTION

Bandelier National Monument

This is a tall conifer association that ranges from open woodland where tree canopies are as low as 10% cover to closed canopied forest with over 60% cover. *Pinus ponderosa* dominates the canopy, and other conifers are uncommon (there can be rare individuals of *Pinus edulis*, *Juniperus scopulorum*, *Juniperus monosperma*, and *Juniperus deppeana* in the subcanopy). *Pinus ponderosa* densities are moderate (158 mature individuals/ha [64/acre]), and reproduction is ongoing (133 saplings/ha [54/acre]). Stand understories are distinctively shrubby with shrub cover that can reach 35%. Shrubs are dominated by the hybrid scrub oak, *Quercus* X *pauciloba* that typically is under 1.5 m (4 feet) tall. Other common shrub associates include *Robinia neomexicana* and *Cercocarpus montanus*. *Quercus gambelii* is poorly represented or absent. The herbaceous layer is generally less than 5% cover but diverse with 39 forbs and 20 grasses recorded for the association. Graminoids predominate with *Muhlenbergia montana*, *Poa fendleriana*, and *Schizachyrium scoparium* often well represented along with *Carex inops* ssp. *heliophila* and other deer sedges (*Carex occidentalis*, *Carex rossii*, and *Carex geophila*). While forbs are diverse, composition is variable from stand to stand and usually less than 5% total cover. The most frequent and abundant species are *Heterotheca villosa*, *Artemisia ludoviciana*, *Bahia dissecta*, and *Brickellia brachyphylla*.

Globally

This is a tall conifer association ranges from open woodland where tree canopies are as low as 10% cover to closed canopied forest with over 60% cover. *Pinus ponderosa* dominates the canopy. Other conifers may be uncommon to codominant, including *Pinus edulis*, *Juniperus scopulorum*, *Juniperus monosperma*, and *Juniperus deppeana*. Stand understories are distinctively shrubby, dominated by the hybrid scrub oak *Quercus* X *pauciloba*. Other common shrub associates may include *Cercocarpus montanus* and *Robinia neomexicana*. *Quercus gambelii* is poorly represented or absent. The herbaceous layer generally has less than 5% cover but is diverse. Dominant graminoid species may include *Bouteloua gracilis*, *Muhlenbergia montana*, *Poa fendleriana*, and *Schizachyrium scoparium*. *Andropogon gerardii*, *Carex inops* ssp. *heliophila*, and other deer sedges (*Carex geophila*, *Carex occidentalis*, and *Carex rossii*) may also be present but not dominant. While forbs are diverse, composition is variable from stand to stand and total forb cover is usually less than 5%. The most frequent and abundant forb species may include *Artemisia ludoviciana*, *Bahia dissecta*, *Brickellia brachyphylla*, and *Heterotheca villosa*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Tall shrub/sapling	*Quercus x pauciloba*
Herb (field)	*Festuca thurberi, Muhlenbergia montana, Schizachyrium scoparium*

Globally

Stratum	Species
Tree canopy	*Pinus ponderosa*
Tall shrub/sapling	*Quercus x pauciloba*
Herb (field)	*Festuca thurberi, Muhlenbergia montana, Schizachyrium scoparium*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (15 Oct 1996).

CLASSIFICATION COMMENTS

Bandelier National Monument

Three phases were identified from this association. *Muhlenbergia montana* or *Schizachyrium scoparium* phases occur where they are well represented. Balice et al. (1997) have reported a *Pinus ponderosa* / *Quercus undulata* [x *pauciloba*] Cover Type for the Los Alamos region.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD056, 03BD057, 03BD079, 03BD083, 03BD109, 03BD112, 03BD135, 03BD136, 03BD163, 06AB156, 06JC138, 06JC145, 06JC146, 06JC153, 06JC155, 06JC184, 06JC488, 06JC493, 06JC530, 06JC598.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Alexander et al. 1984a, Balice et al. 1997, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, DeVelice et al. 1986, Driscoll et al. 1984, Hibner 2009, Rogers 1953, Western Ecology Working Group n.d.

Pinus ponderosa / *Quercus gambelii* / *Carex inops* ssp. *heliophila* Woodland

Ponderosa Pine / Gambel Oak / Sun Sedge Woodland

CODE	CEGL005372
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 PONDEROSA WOODLAND ALLIANCE (A.530) Ponderosa Pine Woodland Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Ponderosa Pine Woodland (CES306.648)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This coniferous woodland is known from Bandelier National Monument in north central New Mexico and likely occurs on mesic sites elsewhere in the southern Rocky Mountains. Sites vary from mesatops and shoulders with low to moderate slopes (6-25%) to steep canyon slopes (50-65%); aspects vary from northwest through northeast at lower elevations to southerly on higher sites. Soils vary and are mapped as poorly developed and rocky Entisols or Inceptisols derived from rhyolitic colluvium; fine textured Alfisols and loamy Mollisols from rhyolite, dacite, or pumice slope alluvium; or simply as rock outcrop. The ground surface is characterized by scattered bunch grasses and sedges intermixed with litter, and some sites are very rocky. Elevation ranges from 1980 to 2652 m (6500-8700 feet). Conifer canopy cover ranges from open (25%) to closed (>60%). The overstory is dominated by *Pinus ponderosa* with seedlings and saplings present in the understory. *Pseudotsuga menziesii* can also be present in the canopy or as seedlings and saplings, but it is clearly subordinate, and other conifers are rare. The understory of this association is characteristically shrubby with *Quercus gambelii* well represented to abundant as shrubs or mature trees. *Robinia neomexicana* and *Rosa woodsii* can also be abundant. The herbaceous layer is rich in species but variable in cover. Diagnostic and often abundant graminoids include *Carex inops* ssp. *heliophila* and other deer sedges (*Carex occidentalis*, *Carex rossii*, and *Carex wootonii*). Additional graminoids may include *Elymus elymoides*, *Koeleria macrantha*, *Muhlenbergia montana*, and *Poa fendleriana*. Forb composition, while diverse, is variable and usually less than 5% total cover. The most frequent and abundant forb species include *Achillea millefolium*, *Antennaria parvifolia*, *Artemisia carruthii*, *Artemisia ludoviciana*, *Erigeron subtrinervis*, *Heterotheca villosa*, *Lithospermum multiflorum*, and *Penstemon barbatus*.

DISTRIBUTION

Bandelier National Monument

This common association is known from the slopes of Cerro Grande south to Burnt and Escobas mesas, Canon de los Frijoles, Obsidian Ridge, Mesa del Rito, and Lummis, Capulin, and Sanchez canyons.

Globally

This coniferous woodland is known from Bandelier National Monument, Valles Caldera National Preserve, and the Los Alamos region in north central New Mexico and likely occurs on mesic sites elsewhere in the southern Rocky Mountains.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs from 1980 to 2550 m (6500-8375 feet) on sites with moderate solar exposure

that increases somewhat with elevation (i.e., aspects that range from the northwest through northeast at lower elevations to southerly on higher sites). Sites vary from mesatops and shoulders on low of moderate slopes (6-25%) to steep on canyon slopes (50-65%). Soils are variable and are mapped as either poorly developed and rocky Entisols or Inceptisols from rhyolitic colluvium; fine textured Alfisols and loamy Mollisols from rhyolite, dacite, or pumice slope alluvium, or simply as rock outcrop (Hibner 2009). The ground surface is characterized by scattered bunch grasses and sedges intermixed with litter, and some sites are very rocky.

Globally

In New Mexico, this mid elevation association occurs on sites varying from mesatops and shoulders with low to moderate slopes (6-25%) to steep canyon slopes (50-65%); aspects vary from northwest through northeast at lower elevations to southerly on higher sites Soils vary and are mapped as poorly developed and rocky Entisols or Inceptisols derived from rhyolitic colluvium; fine textured Alfisols and loamy Mollisols from rhyolite, dacite, or pumice slope alluvium; or simply as rock outcrop (Hibner 2009). The ground surface is characterized by scattered bunch grasses and sedges intermixed with litter, and some sites are very rocky. Elevation ranges from 1980 to 2652 m (6500 8700 feet).

VEGETATION DESCRIPTION

Bandelier National Monument

This is a tall conifer woodland that ranges from open where tree canopies are low as 25% cover to closed canopied forests with over 60% cover. The overstory is dominated by *Pinus ponderosa* with seedlings and saplings present in the understory. *Pseudotsuga menziesii* can also be present in the canopy or as seedlings and saplings, but it is clearly subordinate, and other conifers are rare. The understory of this association is characteristically shrubby with *Quercus gambelii* well represented to abundant as shrubs or mature trees. *Robinia neomexicana* and *Rosa woodsii* can also be abundant. The herbaceous layer is rich in species (31 graminoids and 36 forbs) but variable in cover from 5 to 40%. The graminoids are the most abundant with *Carex inops* ssp. *heliophila* and other deer sedges (*Carex occidentalis*, *Carex rossii*, and *Carex wootonii*) diagnostic and often abundant along with *Poa fendleriana*, *Muhlenbergia montana*, *Koeleria macrantha*, and *Elymus elymoides*. Forb composition, while diverse, is variable from stand to stand and usually less than 5% total cover. The most frequent and abundant species are *Heterotheca villosa*, *Artemisia ludoviciana*, *Achillea millefolium*, *Lithospermum multiflorum*, *Erigeron subtrinervis*, *Artemisia carruthii*, *Antennaria parvifolia*, and *Penstemon barbatus*.

Globally

Conifer canopy cover ranges from open (25%) to closed (>60%). The overstory is dominated by *Pinus ponderosa* with seedlings and saplings present in the understory. *Pseudotsuga menziesii* can also be present in the canopy or as seedlings and saplings, but it is clearly subordinate, and other conifers are rare. The understory of this association is characteristically shrubby with *Quercus gambelii* well represented to abundant as shrubs or mature trees. *Robinia neomexicana* and *Rosa woodsii* can also be abundant. The herbaceous layer is rich in species but variable in cover. Diagnostic and often abundant graminoids include *Carex inops* ssp. *heliophila* and other deer sedges (*Carex occidentalis*, *Carex rossii*, and *Carex wootonii*). Additional graminoids may include *Elymus elymoides*, *Koeleria macrantha*, *Muhlenbergia montana*, and *Poa fendleriana*. Forb composition, while diverse, is variable and usually less than 5% total cover. The most frequent and abundant forb species include *Achillea millefolium*, *Antennaria parvifolia*, *Artemisia carruthii*, *Artemisia ludoviciana*, *Erigeron subtrinervis*, *Heterotheca villosa*, *Lithospermum multiflorum*, and *Penstemon barbatus*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Tree subcanopy	*Quercus gambelii*
Tall shrub/sapling	*Quercus gambelii*
Herb (field)	*Carex inops* ssp. *heliophila*

Globally

Stratum	Species
Tree canopy	*Pinus ponderosa*
Tree subcanopy	*Quercus gambelii*
Tall shrub/sapling	*Quercus gambelii*
Herb (field)	*Carex inops* ssp. *heliophila*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23 Jan 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

Three phases are identified for this association: a *Muhlenbergia montana* phase or *Poa pratensis* phase occur where they are well represented; a seeded grass phase occurs where species such as *Bromus inermis* or *Pascopyrum smithii* are well represented to abundant. Except for the shrub component, this association is similar to *Pinus ponderosa* / *Carex inops* ssp. *heliophila* Woodland (CEGL000849).

Balice et al. (1997) have reported a *Pinus ponderosa* / *Quercus gambelii* Cover Type for the Los Alamos region, and Muldavin and Tonne (2003) and Muldavin et al. (2006) described this *Pinus ponderosa* / *Quercus gambelii* association for the adjacent Valles Caldera National Preserve that are likely synonymous with this association.

Globally

Balice et al. (1997) have reported a *Pinus ponderosa* / *Quercus gambelii* Cover Type for the Los Alamos Region. Also, Muldavin and Tonne (2003) and Muldavin et al. (2006) described the *Pinus ponderosa* / *Quercus gambelii* association for the adjacent Valles Caldera National Preserve that is likely synonymous with this association. This woodland was once part of the broadly defined *Pinus ponderosa* / *Quercus gambelii* Woodland (CEGL000870), but it represents relatively mesic stands of that association.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD011, 03BD016, 03BD017, 03BD106, 03BD149, 03BD154, 03YC007, 04CJ005, 06AB159, 06AB167, 06AB169, 06AB284, 06BF011, 06JC139, 06JC141, 06JC142, 06JC159, 06JC182, 06JC183, 06JC193, 06JC489, 06JC531, 06JC566, 06JC567, 06JC570, 06JC574, 06JC602, 06JC610, 06JC611.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King

REFERENCES

Balice et al. 1997, Hibner 2009, Muldavin and Tonne 2003, Muldavin et al. 2006, Western Ecology Working Group n.d.

Pinus ponderosa / *Robinia neomexicana* Woodland

Ponderosa Pine / New Mexico Locust Woodland

CODE	CEGL005374
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 PONDEROSA WOODLAND ALLIANCE (A.530) Ponderosa Pine Woodland Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Ponderosa Pine Woodland (CES306.648)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This mid elevation association occurs on sites with moderate to high solar exposure that increases with elevation. Sites vary from gentle on rolling mesatops (5-20% slope) to moderate slopes on the shoulders and upper slopes of canyons (up to 30% slope). Soils are primarily mapped as well developed, finer textured Alfisols or Mollisols derived from rhyolitic colluvium and slope alluvium, and occasionally as rocky Inceptisols or rock outcrop. The ground surface is characterized by scattered bunch grasses and sedges intermixed with litter and bare soil. Most stands occur on sites that have been burned by wildfire within the last 30 years. Elevation ranges from 2050 to 2630 m (6700-8625 feet).

This is a tall coniferous woodland that ranges from open woodland to closed canopied forest with canopy coverage ranging from 20 to >60%. *Pinus ponderosa* is dominant in the overstory, and seedlings and saplings may be present in the understory. Other conifers such as *Pseudotsuga menziesii*, *Pinus flexilis*, and *Juniperus monosperma* are rare or incidental. A well developed shrub layer is diagnostic, with *Robinia neomexicana* dominant and well represented with cover as high as 40%. *Quercus gambelii* may be present but cover is less than 5%. Other common shrubs that may be present include *Ceanothus fendleri* and *Rosa woodsii*. The herbaceous layer is also well developed and diverse. Dominant graminoids include *Elymus elymoides*, *Koeleria macrantha*, *Muhlenbergia montana*, and *Poa fendleriana*. Numerous *Carex* species may also be present. Sites that were artificially seeded after fire may be dominated (up to 90% cover) by introduced species such as *Bromus inermis*, *Elymus trachycaulus* ssp. *trachycaulus*, *Festuca idahoensis*, and *Pascopyrum smithii*. While forbs are diverse, composition is variable and usually less than 5% total cover.

DISTRIBUTION

Bandelier National Monument

This common association is known from the Pajarito Plateau along Mesa del Rito, Escobas Mesa, Canon de los Frijoles, Lummis Canyon Mesa, and the slopes of the San Miguel Mountains.

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs from 2050 to 2630 m (6700-8625 feet) on sites with moderate to high solar

exposure that increases with elevation (i.e., aspects tend to be more northerly at lower elevation, more southerly on higher sites). Sites vary from gentle on rolling mesatops (5-20% slope) to moderate slopes on the shoulders and upper slopes of canyons (up to 30% slope). Soils are primarily mapped as well developed, finer textured Alfisols or Mollisols derived from rhyolitic colluvium and slope alluvium, and occasionally as rocky Inceptisols or rock outcrop (Hibner 2009). The ground surface is characterized by scattered bunch grasses and sedges intermixed with litter and bare soil. Most stands occur on sites that have been burned by wildfire within the last 30 years.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This is a tall conifer woodland that ranges from open woodland where tree canopies are as low as 20% cover to closed canopied forests with over 60% cover. *Pinus ponderosa* is dominant and reproducing in the understory of most stands. Other conifers such as *Pseudotsuga menziesii*, *Pinus flexilis*, and *Juniperus monosperma* are rare or incidental. A well developed shrub layer is diagnostic, with *Robinia neomexicana* dominant and well represented with cover as high as 40%. *Quercus gambelii* may be present but cover is less than 5%. Other common shrubs that may be present include *Ceanothus fendleri* and *Rosa woodsii*. The herbaceous layer is also well developed and diverse (39 forb species and 27 graminoid species). Graminoids dominate with *Elymus elymoides*; *Koeleria macrantha*, *Poa fendleriana*, and *Muhlenbergia montana* are frequent and often well represented along with *Carex inops* ssp. *heliophila* and other deer sedges (*Carex occidentalis*, *Carex rossii*, and *Carex geophila*). In addition, many sites that were artificially seeded after fire may have covers that reach 90% and are dominated by introduced species such as *Pascopyrum smithii*, *Festuca idahoensis*, *Elymus trachycaulus* ssp. *trachycaulus*, and *Bromus inermis*. While forbs are diverse, composition is variable from stand to stand and usually less than 5% total cover. The most frequent and abundant species are *Heterotheca villosa*, *Artemisia carruthii*, *Artemisia ludoviciana*, *Achillea millefolium*, *Erigeron subtrinervis*, *Erigeron speciosus*, *Erigeron flagellaris*, *Heliomeris multiflora*, *Lithospermum multiflorum*, *Thalictrum fendleri*, *Thermopsis montana*, *Thermopsis montana* var. *montana*, and *Antennaria parvifolia*.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Shrub/sapling (tall & short)	*Robinia neomexicana*
Herb (field)	*Muhlenbergia montana*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Bromus inermis, *Elymus trachycaulus* ssp. *trachycaulus*, *Festuca idahoensis*, *Pascopyrum smithii*.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23 Jan 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

A seeded grass phase occurs in this association when grass species such as *Bromus inermis*, *Festuca idahoensis*, or *Pascopyrum smithii* are well represented to luxuriant. Balice et al. (1997) have reported a *Pinus ponderosa* / *Quercus gambelii* Cover Type for the Los Alamos region that likely includes this association.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD008, 03BD015, 03BD077, 03BD100, 03BD101, 03ER011, 04EM002, 06AB171, 06AB180, 06AB183, 06BF021, 06BF028, 06JC189, 06JC191, 06JC495, 06JC535, 06JC573, 06JC591, 06JC592, 06JC593, 06JC601, 06JC612, 06JC613, 06JC614, 06JC615, 06JC616, 06JC618, 06JC620, 06JC622.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Balice et al. 1997, Hibner 2009, Western Ecology Working Group n.d.

Pinus ponderosa / Schizachyrium scoparium Woodland

Ponderosa Pine / Little Bluestem Woodland

CODE	CEGL000201
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 PONDEROSA WOODLAND ALLIANCE (A.530) Ponderosa Pine Woodland Alliance

ECOLOGICAL SYSTEM(S)

Northwestern Great Plains Black Hills Ponderosa Pine Woodland and Savanna (CES303.650), Southern Rocky Mountain Ponderosa Pine Woodland (CES306.648)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This ponderosa pine / little bluestem association is a dry woodland found in the Great Plains of the United States. It is also known to occur within Bandelier National Monument in north central New Mexico. In the Great Plains, it usually occurs on south and west facing slopes of hills, rocky breaks, and watercourses. Within Bandelier National Monument, this association occurs at mid elevation, ranging from 1780 and 2430 m (5840-7970 feet), on sites with low to high solar exposure that increases with elevation. Stands occur on gentle slopes of mesatops and shoulders (5 10%) and occasionally on steep (40%) upper canyon slopes. Soils are primarily mapped as well developed Mollisols derived from pumice slope alluvium, or occasionally as fine textured Alfisols derived from mixed eolian, and rarely, Aridisols derived from colluvial basalts. The ground surface is typically characterized by scattered bunch grasses amid pumice gravel and litter. In the Great Plains, the overstory is dominated by *Pinus ponderosa*. *Juniperus scopulorum* may often be present, but typically only as scattered individuals. The shrub layer is composed of species such as *Juniperus scopulorum*, *Rhus trilobata*, and *Symphoricarpos* spp. *Schizachyrium scoparium* is the most abundant graminoid, often accompanied by *Andropogon gerardii*, *Bouteloua curtipendula*, *Bouteloua gracilis*, *Carex inops* ssp. *heliophila*, *Carex siccata* (= *Carex foenea*), *Hesperostipa comata* (= *Stipa comata*), *Pascopyrum smithii*, and *Poa pratensis*. Common forbs include *Achillea millefolium*, *Phlox hoodii*, and *Allium* spp. Within Bandelier National Monument, this open woodland / savanna is dominated by *Pinus ponderosa* with canopies that range from 10-30% cover. *Pinus ponderosa* seedling and sapling reproduction is typically present. *Juniperus monosperma* and *Pinus edulis* saplings are also occasionally present in the subcanopy. Shrubs are poorly represented (occasionally *Robinia neomexicana* is well represented). Stands are distinctively grassy (cover can reach 30%). Dominant graminoids include prairie species *Schizachyrium scoparium* along with *Muhlenbergia montana* and *Elymus elymoides*. *Bouteloua gracilis*, while often present, is clearly subdominant. Numerous forb species may be common to well represented and are variable from stand to stand.

DISTRIBUTION

Bandelier National Monument

This is a common association found at on Frijoles Mesa, Mesa del Rito, Lummis Mesa, and near the San Miguel Ruins.

Globally

This ponderosa pine / little bluestem dry woodland is found in the Great Plains of the United States. It is also known to occur within Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs between 1780 and 2430 m (5840-7970 feet) on sites with low to high solar exposure that increases with elevation (i.e., aspects tend to be more northerly at lower elevation, more southerly on higher sites). Stands occur on gentle slopes of mesatops and shoulders (5-10%) and occasionally on steep (40%) upper canyon slopes. Soils are primarily mapped as well developed Mollisols derived from pumice slope alluvium, or occasionally as fine textured Alfisols derived from mixed eolian, and rarely, Aridisols derived from colluvial basalts (Hibner 2009). The ground surface is typically characterized by scattered bunch grasses amid pumice gravel and litter.

Globally

This community is usually found on south facing slopes and in rocky breaks. The soils are derived from limestone and sandstone (Johnston 1987, McAdams et al. 1998). Slopes are usually moderately inclined. In the Great Plains, it usually occurs on south and west facing slopes of hills, rocky breaks, and watercourses. Within Bandelier National Monument, this association occurs at mid elevation, ranging from 1780 and 2430 m (5840-7970 feet), on sites with low to high solar exposure that increases with elevation. Stands occur on gentle slopes of mesatops and shoulders (5-10%) and occasionally on steep (40%) upper canyon slopes. Soils are primarily mapped as well developed Mollisols derived from pumice slope alluvium, or occasionally as fine textured Alfisols derived from mixed eolian, and rarely, Aridisols derived from colluvial basalts (Hibner 2009). The ground surface is typically characterized by scattered bunch grasses amid pumice gravel and litter.

VEGETATION DESCRIPTION

Bandelier National Monument

This open woodland / savanna is dominated by *Pinus ponderosa* with canopies that range from 10-30% cover. *Pinus ponderosa* seedling and sapling reproduction is typically present. The low statured *Juniperus monosperma* and *Pinus edulis* saplings are also occasionally present in the subcanopy. The shrubs are poorly represented, and stands are distinctively grassy (occasionally *Robinia neomexicana* is well represented). Grass cover can reach 30% and is dominated by the prairie species *Schizachyrium scoparium* along with *Muhlenbergia montana* and *Elymus elymoides*. *Bouteloua gracilis*, while often present, is clearly subordinate. Forbs can be common to well represented, yet variable from stand to stand. The most frequent and abundant are *Heterotheca villosa*, *Bahia dissecta*, *Lithospermum multiflorum*, and *Liatris punctata*. Overall species richness is high with 47 forb and 18 graminoid species known from the association.

Globally

This community is dominated by *Pinus ponderosa* in the overstory and dry prairie graminoids in the understory. *Juniperus scopulorum* may be present as a tall shrub or small tree, but typically only as scattered individuals. Other shrubs that are typically found are *Rhus aromatica*, *Symphoricarpos* spp., and *Yucca glauca*. *Schizachyrium scoparium* is the most abundant graminoid, often accompanied by *Pascopyrum smithii*, *Bouteloua curtipendula*, *Bouteloua gracilis*, *Hesperostipa comata* (= *Stipa comata*), *Poa pratensis*, *Andropogon gerardii*, and *Carex siccata* (= *Carex foenea*). Common forbs include *Achillea millefolium*, *Phlox hoodii*, and *Allium* spp. In the Great Plains, the overstory is dominated by *Pinus ponderosa*. *Juniperus scopulorum* may often be present, but typically only as scattered individuals. The shrub layer is composed of species such as *Juniperus scopulorum*, *Rhus trilobata*, and *Symphoricarpos* spp. *Schizachyrium scoparium* is the most abundant graminoid, often accompanied by *Andropogon gerardii*, *Bouteloua curtipendula*, *Bouteloua gracilis*, *Carex inops* ssp. *heliophila*, *Carex siccata*, *Hesperostipa* spp., *Pascopyrum smithii*, and *Poa pratensis*. Within Bandelier National Monument, this open woodland / savanna is dominated by *Pinus ponderosa* with canopies that range from 10-30% cover. *Pinus ponderosa* seedling and sapling reproduction is typically present. *Juniperus monosperma* and *Pinus edulis* saplings are also occasionally present in the subcanopy. Shrubs are poorly represented (occasionally *Robinia neomexicana* is well represented). Stands are distinctively grassy (cover can reach 30%). Dominant graminoids include *Elymus elymoides*, *Muhlenbergia montana*, and *Schizachyrium scoparium*. *Bouteloua gracilis* is often present but not dominant. Numerous forb species may be common to well represented and are variable from stand to stand. The most frequent and abundant forbs include *Bahia dissecta*, *Heterotheca villosa*, *Liatris punctata*, and *Lithospermum multiflorum*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herb (field)	*Schizachyrium scoparium*

Globally

Stratum	Species
Tree canopy	*Juniperus scopulorum, Pinus ponderosa*
Herb (field)	*Schizachyrium scoparium*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G4 (22 Jun 1998). There are probably more than 100 occurrences of this community rangewide. It is reported from Nebraska (where it is ranked S3S4, and is common in much of the Wildcat Hills and Pine Ridge), South Dakota (S?), Wyoming (S2?), and Montana (S2?); it may also occur in Oklahoma, Colorado, and New Mexico. One occurrence is currently documented from Nebraska. Historical acreage and trends are unknown, but its persistence is dependent on a combination of drought and fires.

CLASSIFICATION COMMENTS

Bandelier National Monument

Balice et al. (1997) have reported a *Pinus ponderosa* / *Bouteloua gracilis* Cover Type for the Los Alamos region that likely includes this association.

Globally

Steinauer and Rolfsmeier (2000) suggest that, in Nebraska, stands dominated by *Schizachyrium scoparium* are more savanna like. The savanna structure (10-25% tree canopy) cover was formerly treated as a separate type (CEGL002019), but is now treated as a savanna phase of this woodland type, which typically has 25-60% canopy cover. Nebraska's woodland stands may best fit with *Pinus ponderosa* / *Carex inops* ssp. *heliophila* Woodland (CEGL000849).

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03AB010, 03BD081, 03BD085, 03BD102, 03BD133, 03BD165, 03YC021, 06BF029, 06JC568.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: J. Drake, mod. K.S. King

REFERENCES

Balice et al. 1997, Bruner 1931, CONHP unpubl. data 2003, Diamond 1993, Driscoll et al. 1984, Hibner 2009, Hoagland 2000, Hoffman and Alexander 1987, Johnston 1987, Jones 1992b, MTNHP 2002b, Marriott and Faber Langendoen 2000, McAdams et al. unpubl. data 1998, Midwestern Ecology Working Group n.d., Pfister et al. 1977, Steinauer and Rolfsmeier 2000, Terwilliger et al. 1979a, Thilenius 1970, Thilenius 1971, Thilenius 1972, Wasser and Hess 1982

Abies concolor - (*Pseudotsuga menziesii*) / *Jamesia americana* - *Holodiscus dumosus* Scree Woodland

White Fir - (Douglas fir) / Five petal Cliffbush - Glandular Oceanspray Scree Woodland

CODE	CEGL000890
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar needle leaved evergreen woodland (II.A.4.N.)
FORMATION	Conical crowned temperate or subpolar needle leaved evergreen woodland (II.A.4.N.b.)
ALLIANCE	ABIES CONCOLOR WOODLAND ALLIANCE (A.553) White Fir Woodland Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland (CES306.825), Southern Rocky Mountain Dry Mesic Montane Mixed Conifer Forest and Woodland, Rocky Mountain Cliff, Canyon and Massive Bedrock (CES306.815)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This white fir woodland association occurs in the southern Rocky Mountains in southern Colorado, New Mexico and Arizona at elevations between 2370 and 2900 m (7780-9250 feet). Stands are found on moderately steep to very steep (45-85%) colluvial slopes that may occur on any aspect, but they are often found on cool northerly aspects. Soils are shallow, poorly developed and rocky loams or clay loams, often with surfaces covered with talus and scree. Soils can be saturated (seeps) and range from somewhat poorly drained to rapidly drained. Cover of litter and duff, wood and moss is often moderate to high, but not as high as rock and gravel. The vegetation is characterized by a very open (10%) tree canopy on steep scree fields to a moderately closed canopy on sheltered canyon slopes (up to 75% cover). The overstory is dominated by *Abies concolor* with *Pseudotsuga menziesii* as the common codominant or subdominant. Other conifers, such as several species of Pinus and *Juniperus scopulorum*, may be present in the canopy. *Populus tremuloides* can be well represented in the canopy. The understory is a mixture of mesic tall shrubs that are well represented to abundant and typically dominated by *Jamesia americana* and/or *Holodiscus dumosus*. *Physocarpus monogynus* can also codominate some stands. Other frequent shrubs may include Ribes spp., *Robinia neomexicana*, *Rubus idaeus*, and *Symphoricarpos* spp. The herbaceous layer is typically low in cover and diversity. *Saxifraga bronchialis* ssp. *austromontana* is a common forb. Where shrub cover is lower, graminoids such as *Carex rossii*, *Carex inops* ssp. *heliophila*, and *Koeleria macrantha* may be more prevalent.

DISTRIBUTION

Bandelier National Monument

This association is known from the slopes of Scooter Peak and the canyon slopes of Canon de Valle, Canon de los Frijoles, and Alamo Canyon.

Globally

This association occurs in the southern Rocky Mountains in southern Colorado, New Mexico and Arizona.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association can be found at elevations between 2370 and 2900 m (7780-9250 feet) on steep slopes (45-80%) with cool northwesterly to northeasterly aspects. Stands occur on substrates derived from volcanic andesite, rhyolite, and

rhyolitic tuffs. Sites tend to be rocky with low herbaceous ground cover and abundant leaf litter.

Globally

This white fir woodland occurs in the southern Rocky Mountains in southern Colorado, New Mexico and Arizona at elevations between 2370 and 2900 m (7780-9250 feet). Stands are found on moderately steep to very steep (45-85%) colluvial slopes that may occur on any aspect, but they are often found on cool northerly aspects. Soils are shallow, poorly developed and rocky loams or clay loams, often with the surface covered with talus and scree. Soils can be saturated (seeps) and range from somewhat poorly drained to rapidly drained. Cover of litter and duff, wood and moss is often moderate to high, but not as high as rock and gravel. Substrates are derived from volcanic andesite, rhyolite, and rhyolitic tuffs.

VEGETATION DESCRIPTION

Bandelier National Monument

This is a woodland association where tree canopies can vary from very open (10%) on steep scree fields to closed on sheltered canyon slopes (up to 75% cover). The overstory is dominated by *Abies concolor* with *Pseudotsuga menziesii* as the common codominant or subdominant. While other conifers are rare in the canopy, *Populus tremuloides* can be well represented. This association is characterized by an understory mix of mesic tall shrubs that are well represented to abundant which is typically dominated by *Jamesia americana*, but *Holodiscus dumosus* and *Physocarpus monogynus* can also codominate. Other frequent shrubs include *Robinia neomexicana* and *Rubus idaeus*. In these shrub dominated stands, herbaceous cover is typically low in cover and diversity low (11 forbs and 7 grasses were recorded from this association). In stands where shrub cover is lower, graminoids such as *Koeleria macrantha*, *Carex rossii*, and *Carex inops* ssp. *heliophila* can be prevalent.

Globally

This woodland is characterized by a very open (10%) tree canopy on steep scree fields to a moderately closed canopy on sheltered canyon slopes (up to 75% cover). The overstory is dominated by *Abies concolor* with *Pseudotsuga menziesii* as the common codominant or subdominant. While other conifers, such as *Pinus aristata*, *Pinus flexilis*, *Pinus ponderosa*, *Pinus strobiformis*, and *Juniperus scopulorum*, are uncommon in the canopy, *Populus tremuloides* can be well represented. The understory is a mixture of mesic tall shrubs that are well represented to abundant and typically dominated by *Jamesia americana* and/or *Holodiscus dumosus*. *Physocarpus monogynus* can also codominate some stands Other frequent shrubs may include *Ribes cereum*, *Ribes inerme*, *Ribes leptanthum*, *Robinia neomexicana*, *Rubus idaeus*, and *Symphoricarpos* spp. The herbaceous layer is typically low in cover and diversity. *Saxifraga bronchialis* ssp. *austromontana* is a common forb. Where shrub cover is lower, graminoids such as *Carex rossii*, *Carex inops* ssp. *heliophila*, and *Koeleria macrantha* may be more prevalent.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Abies concolor, Pseudotsuga menziesii*
Shrub/sapling (tall & short)	*Jamesia americana*

Globally

Stratum	Species
Tree canopy	*Abies concolor, Pseudotsuga menziesii*
Shrub/sapling (tall & short)	*Jamesia americana*
Tall shrub/sapling	*Holodiscus dumosus, Physocarpus monogynus*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Pinus aristata.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23 Feb 1994).

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Populus tremuloides* phase occurs where quaking aspen comprises greater than 25% of the total tree canopy.

Globally

This white fir scree association includes former *Abies concolor* / *Holodiscus dumosus* Scree Woodland (CEGL000889). *Holodiscus dumosus* and *Jamesia americana* are often both present to codominant and share some reference types (Fitzhugh et al. 1987, Stuever and Hayden 1997b).

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM plots 03BD062, 04BD009, 04CJ002, 06JC478, 06JC479, 06JC541, 06JC605, and 06JC623.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz

REFERENCES

Alexander et al. 1984a, Bourgeron and Engelking 1994, DeVelice et al. 1986, Driscoll et al. 1984, Fitzhugh et al. 1987, Johnston 1987, Larson and Moir 1987, Moir and Ludwig 1979, Muldavin et al. 1996, Stuever and Hayden 1997b, Western Ecology Working Group n.d.

Abies concolor - Pseudotsuga menziesii / Festuca thurberi - Danthonia parryi Woodland

White Fir - Douglas fir / Thurber Fescue - Parry's Oatgrass Woodland

CODE	CEGL005350
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar needle leaved evergreen woodland (II.A.4.N.)
FORMATION	Conical crowned temperate or subpolar needle leaved evergreen woodland (II.A.4.N.b.)
ALLIANCE	ABIES CONCOLOR WOODLAND ALLIANCE (A.553) White Fir Woodland Alliance

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

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This forest association is only known from Bandelier National Monument in New Mexico and likely occurs elsewhere in the southern Rocky Mountains. Stands are found on gently rolling mesatops to upper slopes of mountains on gentle to steep slopes with a variety of aspects at elevations between 2630 and 2945 m (8630-9660 feet). Substrates are derived from rhyolite, andesite and Bandelier tuff. The ground cover is dominated by leaf litter, but coarse woody debris can be as high 10% in cover. The vegetation is characterized by a moderately open to closed tree canopy (35-75%) dominated by *Abies concolor* along with *Pseudotsuga menziesii* as a codominant. *Pinus ponderosa* is a frequent associate, but other conifer species are rare or incidental. *Populus tremuloides* can also be abundant as saplings or mature individuals in the canopy. Shrub cover is generally low, often with scattered *Juniperus communis*. The herbaceous layer characterizes the understory with total cover that ranges from 10 to 70% and typically diverse species. Graminoids dominate, with either *Danthonia parryi* and/or *Festuca thurberi* diagnostic. Forb species can also be well represented and most frequently include montane meadow species such as *Iris missouriensis*, *Lathyrus lanszwertii* var. *leucanthus*, *Erigeron formosissimus*, and *Achillea millefolium*. The introduced perennial grass *Poa pratensis* is common in some stands.

DISTRIBUTION

Bandelier National Monument

This association is known from the slopes of Cerro Grande, Scooter Peak, and Rabbit Mountain, and on Sawyer Mesa.

Globally

This association is only known from Bandelier National Monument in New Mexico and likely occurs elsewhere in the southern Rocky Mountains.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association occurs at elevations between 2630 and 2945 m (8630-9660 feet) on gently rolling mesatops extending to upper slopes of mountains. Accordingly, slopes vary from gentle to steep and represent a variety of aspects. Substrates are derived from rhyolite, andesite and Bandelier tuff. The ground cover is dominated by leaf litter, but coarse woody debris can be as high 10% in cover.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This association is characterized by a moderately open to closed tree canopy (35-75%) dominated by *Abies concolor* along with *Pseudotsuga menziesii* as a codominant. *Pinus ponderosa* is a frequent associate, but other conifer species are rare or incidental. *Populus tremuloides* can also be abundant as saplings or mature individuals. While shrubs can be well represented, generally they are scattered, with *Juniperus communis* the most frequent. In contrast, the herbaceous layer can be luxuriant with total cover that ranges from 10 to 70% and rich in species (23 grass species and 42 forb species have been recorded for the association). Graminoids dominate with either *Danthonia parryi* and/or *Festuca thurberi* diagnostic. Forb species can also be well represented and most frequently include montane meadow species such as *Iris missouriensis*, *Lathyrus lanszwertii* var. *leucanthus*, *Erigeron formosissimus*, and *Achillea millefolium*.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Abies concolor, Pseudotsuga menziesii*
Tree canopy	*Populus tremuloides*
Herb (field)	*Danthonia parryi, Festuca thurberi*

Globally

Stratum	Species
Tree canopy	*Abies concolor, Pseudotsuga menziesii*
Tree canopy	*Populus tremuloides*
Herb (field)	*Danthonia parryi, Festuca thurberi*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Poa pratensis.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (8 Feb 2008).

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Populus tremuloides* phase occurs where *Populus tremuloides* comprises between 25 and 75% of the total tree canopy.

Globally

This association is related to *Abies concolor* / *Festuca arizonica* Woodland (CEGL000887), but the understory is dominated by a different species of *Festuca*.

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM plots 03BD003, 03BD034, 03BD035, 03BD039, 04BD030, 04BD006, 03BD030, 04BD015, 06JC214, 03YC003, 06JC205, 06JC558, 06JC216, 06JC469, 06JC471, 06JC476, 06JC499, 06JC501, 06JC502, 06JC512, 03YC004.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz

REFERENCES

DeVelice et al. 1986, Stuever and Hayden 1997a, Western Ecology Working Group n.d.

Pinus ponderosa / Forestiera pubescens Forest

Ponderosa Pine / Stretchberry Forest

CODE	CEGL005384
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	Temporarily flooded temperate or subpolar needle leaved evergreen woodland (II.A.4.N.d.)
ALLIANCE	PINUS PONDEROSA TEMPORARILY FLOODED WOODLAND ALLIANCE (A.565) Ponderosa Pine Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S)

Rocky Mountain Lower Montane Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This riparian association occurs at elevations between 1660 and 2035 m (5450-6675 feet) along canyon bottoms with low to moderate solar exposure. Stands occur on alluvial terraces and bars adjacent to perennial stream channels with gradients between 5 and 10% (in a few cases, stands are found along moist ephemeral or intermittent channels). Soils are mapped as loamy Mollisols derived from latite, dacite, and rhyolitic alluvium, or simply as rock outcrop. The ground surface is characterized by shrubs rooted in exposed gravels and soil intermixed with grass and litter patches. This mixed broadleaf and conifer riparian forest is dominated by *Pinus ponderosa* with broadleaf deciduous riparian trees such as *Acer negundo* or *Populus angustifolia* as codominants that form open to closed canopies (10 80% canopy cover). *Juniperus monosperma* or *Juniperus scopulorum* along with *Alnus incana* ssp. *tenuifolia* or *Betula occidentalis* can be found in the subcanopy or as understory shrubs. The shrub layer is characterized by abundant *Forestiera pubescens* with a mix of other mesic shrubs and vines such as *Brickellia californica*, *Ptelea trifoliata*, *Rhus trilobata*, *Ribes leptanthum*, *Robinia neomexicana*, *Rosa woodsii*, *Rubus parviflorus*, *Toxicodendron rydbergii*, and *Vitis arizonica*. The herbaceous layer is a rich assortment of mesic trending species (26 graminoids and 35 forbs) but variable in composition and cover (5-30% total cover). Common species include facultative and obligate wetland species such as *Agrostis exarata*, *Agrostis stolonifera*, *Carex hystericina*, and *Juncus dudleyi* among graminoids, and *Aralia racemosa*, *Berula erecta*, *Brickellia brachyphylla*, *Equisetum arvense*, *Lobelia cardinalis*, *Prunella vulgaris*, and *Rudbeckia laciniata* among forbs.

DISTRIBUTION

Bandelier National Monument

This common association is known from Hondo Canyon, Alamo Canyon, and Canon de los Frijoles.

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This riparian association occurs at elevations between 1660 and 2035 m (5450-6675 feet) along canyon bottoms with low to moderate solar exposure. Stands occur on alluvial terraces and bars adjacent to perennial stream channels with gradients between 5 and 10% (in a few cases, stands are found along moist ephemeral or intermittent channels).

Soils are mapped as loamy Mollisols derived from latite, dacite, and rhyolitic alluvium, or simply as rock outcrop (Hibner 2009). The ground surface is characterized by shrubs rooted in exposed gravels and soil intermixed with grass and litter patches.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This mixed broadleaf and conifer riparian forest association is dominated by *Pinus ponderosa* with broadleaf deciduous riparian trees such as *Populus angustifolia* or *Acer negundo* as codominants that form open to closed canopies (10 80% canopy cover). *Juniperus monosperma* or *Juniperus scopulorum* along with *Alnus incana* ssp. *tenuifolia* or *Betula occidentalis* can be found in the subcanopy or as understory shrubs. The shrub layer is characterized by abundant *Forestiera pubescens* with a mix of other mesic shrubs and vines such as *Rosa woodsii*, *Vitis arizonica*, *Ptelea trifoliata*, *Ribes leptanthum*, *Robinia neomexicana*, *Brickellia californica*, *Rubus parviflorus*, *Toxicodendron rydbergii*, and *Rhus trilobata*. The herbaceous layer is a rich assortment of mesic trending species (26 graminoids and 35 forbs) but variable in composition and cover (5-30% total cover). Common species include facultative and obligate wetland species such as *Juncus dudleyi*, *Carex hystericina*, *Agrostis stolonifera*, and *Agrostis exarata* among graminoids, and *Berula erecta*, *Lobelia cardinalis*, *Aralia racemosa*, *Prunella vulgaris*, *Rudbeckia laciniata*, *Equisetum arvense*, and *Brickellia brachyphylla* among forbs.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Pinus ponderosa*
Tree canopy	*Acer negundo, Populus angustifolia*
Tall shrub/sapling	*Forestiera pubescens*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (25 Feb 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

Two phases were identified where either *Acer negundo* or *Populus angustifolia* canopy cover is greater than 10%. Upon further review, the *Populus angustifolia* phase may prove to be synonymous with *Populus angustifolia Pinus ponderosa* Woodland (CEGL000935).

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD052, 03BD091, 03BR009, 03ER047, 03MP882, 03MP883, 03YC026, 03YC031, 06JC203, 06JC204, 06JC520, 06JC524.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Hibner 2009, Western Ecology Working Group n.d.

Salix amygdaloides / *Salix exigua* Woodland

Peachleaf Willow / Coyote Willow Woodland

CODE	CEGL000948
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural cold deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold deciduous woodland (II.B.2.N.b.)
ALLIANCE	SALIX AMYGDALOIDES TEMPORARILY FLOODED WOODLAND ALLIANCE (A.645) Peachleaf Willow Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S)

Columbia Basin Foothill Riparian Woodland and Shrubland (CES304.768)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This association occurs in riparian habitats on the Columbia Plateau in the *interior* northwest, in the Uinta Basin in northeastern Utah, and within Bandelier National Monument in north central New Mexico. Elevation ranges from 100-1600 m. Stands are located in overflow channels of large rivers, and on narrow floodplains of small creeks. Substrates include a wide range of soil textures with the exception of clay. Soils are classified predominantly as Entisols (Fluvents) or Mollisols (Borolls). The water table is within 1 m of the soil surface during the growing season, and the vegetation is tolerant of prolonged flooding. The ground surface is characterized by shrubs rooted in exposed gravels and sands. This riparian woodland has a moderately open overstory canopy dominated by the small tree *Salix amygdaloides* with *Salix exigua* dominating the tall shrub layer near the shore. Other tree species may include scattered *Populus fremontii*, *Acer negundo*, *Populus angustifolia*, *Populus deltoides*, and the introduced *Elaeagnus angustifolia*. Associated shrubs in the moderately dense short shrub layer include *Rhus trilobata* and *Apocynum cannabinum*. The invasive exotic *Tamarix ramosissima* may present in the tall shrub layer in disturbed stands. The herbaceous layer is often dominated by graminoids such as *Hordeum jubatum*, *Phalaris arundinacea*, *Pascopyrum smithii*, *Eleocharis palustris*, and *Distichlis spicata*, along with forbs such as *Maianthemum stellatum*, *Ambrosia tomentosa*, and *Iva axillaris*. Introduced herbaceous species are present to dominant in many stands and may include *Bromus inermis*, *Cirsium arvense*, *Lepidium latifolium*, *Melilotus officinalis* (= *Melilotus albus*), and *Poa pratensis*.

DISTRIBUTION

Bandelier National Monument

This minor association is found at the mouth of Alamo Canyon.

Globally

This association occurs in riparian habitats on the Columbia Plateau in the interior northwest, in the Uinta Basin in northeastern Utah, and within Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This riparian association is known from 1640 m (5370 feet) in elevation along a canyon bottom with low solar exposure. *Populus deltoides* is present as scattered reproducing saplings. Stands occur on alluvial terraces and bars adjacent to river channels with gradients less than 5%. Soil is mapped as a sandy Entisol derived from mixed mineral alluvium (granite, gneiss, schist, and granitic sandstone and mudstone (Hibner 2009). The ground surface is characterized by shrubs rooted in exposed gravels and sands.

Globally

This association occurs in riparian habitats on the Columbia Plateau in the interior northwest and in the Uinta Basin in northeastern Utah. Elevation ranges from 100-1600 m. It is also known to occur at 1640 m (5370 feet) in elevation along a canyon bottom with low solar exposure within Bandelier National Monument in north central New Mexico. Stands are located in overflow channels of large rivers, and on narrow floodplains of small creeks. Substrates include a wide range of soil textures with the exception of clay. Soils are classified predominantly as Entisols (Fluvents) or Mollisols (Borolls). The water table is within 1 m of the soil surface during the growing season (Hansen et al. 1995), and the vegetation is tolerant of prolonged flooding. The ground surface is characterized by shrubs rooted in exposed gravels and sands. Adjacent riparian vegetation may include *Acer negundo*, *Fraxinus pennsylvanica*, and *Populus deltoides* woodlands and *Schoenoplectus pungens* and *Typha latifolia* herbaceous communities.

VEGETATION DESCRIPTION

Bandelier National Monument

This riparian association is characterized by a short statured tree canopy dominated by *Salix amygdaloides*, with *Salix exigua* intermixed in the lower shrub canopy. Total willow cover can exceed 90%. The herbaceous layer is characterized by abundant *Bromus tectorum* along with scattered bunches of other introduced grasses such as *Dactylis glomerata* and *Lolium arundinaceum* (= *Festuca arundinacea*). Total forb cover is less than 10% and is dominated by exotic *Verbascum thapsus*.

Globally

This riparian woodland has a moderately open overstory canopy dominated by the small tree *Salix amygdaloides* with *Salix exigua* dominating the tall shrub layer near the shore. Other tree species may include scattered *Populus fremontii*, *Acer negundo*, *Populus angustifolia*, *Populus deltoides*, and the introduced *Elaeagnus angustifolia*. Associated shrubs in the moderately dense short shrub layer may include *Apocynum cannabinum* and *Rhus trilobata*. The invasive exotic *Tamarix ramosissima* may be present in the tall shrub layer in disturbed stands. The herbaceous layer is often dominated by graminoids such as *Distichlis spicata*, *Eleocharis palustris*, *Hordeum jubatum*, *Phalaris arundinacea*, and *Pascopyrum smithii*, along with forbs such as *Ambrosia tomentosa*, *Iva axillaris*, and *Maianthemum stellatum*. Introduced herbaceous species are present to dominant in many stands and may include *Bromus inermis*, *Cirsium arvense*, *Lepidium latifolium*, *Melilotus officinalis* (= *Melilotus albus*), and *Poa pratensis*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Salix amygdaloides*
Tall shrub/sapling	*Salix exigua*

Globally

Stratum	Species
Tree canopy	*Salix amygdaloides*
Tall shrub/sapling	*Salix exigua*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Bromus tectorum, *Dactylis glomerata*, *Lolium arundinaceum*, *Verbascum thapsus*.

Globally

Lepidium latifolium, *Tamarix ramosissima*.

CONSERVATION STATUS RANK

Global Rank & Reasons: G1Q (1 Feb 1996).

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Bromus tectorum* phase was identified where that species exceeds 25% cover.

Globally

Stands from the Green River in Utah may be different from the stands described from small creeks on the Hanford Site along the Columbia River in Washington.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plot: 03BR011.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz, mod. K.S. King

REFERENCES

Bourgeron and Engelking 1994, Driscoll et al. 1984, Evans 1989a, Hansen et al. 1995, Hibner 2009, Hinschberger 1978, IDCDC 2005, Kagan et al. 2000, Von Loh 2000, WNHP unpubl. data, Western Ecology Working Group n.d.

III. Shrubland

Ceanothus fendleri / *Muhlenbergia montana* Shrubland

Fendler's Buckbrush / Mountain Muhly Shrubland

CODE	CEGL005376
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Temperate broad leaved evergreen shrubland (III.A.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate broad leaved evergreen shrubland (III.A.2.N.)
FORMATION	Sclerophyllous temperate broad leaved evergreen shrubland (III.A.2.N.c.)
ALLIANCE	CEANOTHUS (FENDLERI, VELUTINUS) SHRUBLAND ALLIANCE (A.787) (Fendler's Buckbrush, Tobacco brush) Shrubland Alliance

ECOLOGICAL SYSTEM(S)

Rocky Mountain Lower Montane Foothill Shrubland (CES306.822)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This mid elevation association occurs on sites with low to moderate solar exposure (mostly northerly aspects). Typically these stands are found on gently rolling mesatops (5-15% slope), though occasionally they can be found on moderately steep mesa sideslopes (30% slope). Soils are primarily well developed loamy Mollisols derived from pumice or rhyolitic tuff aslope alluvium or colluvium parent materials, or on occasion, fine textured Alfisols developed from eolian deposits over rhyolitic tuff parent materials. The ground surface is characterized by scattered patches of exposed soil and herbaceous litter amid an abundant herbaceous layer. Elevation ranges between 2200 and 2330 m (7210-7630 feet). A well represented shrub canopy dominated by *Ceanothus fendleri* is characteristic of these mesatop shrublands. *Quercus gambelii* and *Robinia neomexicana* are frequent associates, but are usually poorly represented and are clearly not dominant. Scattered *Pinus ponderosa* saplings and mature trees can occur, but cover is less than 10%. The herbaceous layer can be luxuriant, reaching higher than 80% total cover, with *Muhlenbergia montana* diagnostic and predominant. Codominants often include *Muhlenbergia wrightii*, *Pascopyrum smithii*, or *Schizachyrium scoparium*. Forb cover is highly variable from stand to stand, but *Artemisia carruthii* is most commonly found.

DISTRIBUTION

Bandelier National Monument

This minor association is known from Escobas Mesa, Burnt Mesa, and Mesa del Rito.

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs between 2200 and 2330 m (7210-7630 feet) on sites with low to moderate solar exposure (mostly northerly aspects). Typically these stands are found on gently rolling mesatops (5-15% slope), though occasionally they can be found on moderately steep mesa sideslopes (30% slope). Soils are mapped primarily as well developed loamy Mollisols derived from pumice or rhyolitic tuff aslope alluvium or colluvium parent materials, or on occasion, fine textured Alfisols developed from eolian deposits over rhyolitic tuff parent materials (Hibner

2009). The ground surface is characterized by scattered patches of exposed soil and herbaceous litter amid an abundant herbaceous layer.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

A well represented shrub canopy dominated by *Ceanothus fendleri* is characteristic of these mesatop shrublands. *Quercus gambelii* and *Robinia neomexicana* are frequent associates, but usually poorly represented and clearly not dominant. Among trees, scattered *Pinus ponderosa* saplings and mature trees can occur, but cover is less than 10%. The herbaceous layer can be luxuriant, reaching higher than 80% total cover, typically with graminoids such as the diagnostic *Muhlenbergia montana* predominant. Often *Schizachyrium scoparium*, *Pascopyrum smithii*, or *Muhlenbergia wrightii* can be codominant. Forb cover is highly variable from stand to stand, but *Artemisia carruthii* is most commonly found.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tall shrub/sapling	*Ceanothus fendleri*
Herb (field)	*Muhlenbergia montana*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (17 Feb 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

Data are not available.

Globally

Data are not available.

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD026, 03YC006, 06BF027, 06JC147, 06JC595.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Hibner 2009, Western Ecology Working Group n.d.

Artemisia filifolia / *Bouteloua eriopoda* Shrubland

Sand Sagebrush / Black Grama Shrubland

CODE	CEGL001077
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	ARTEMISIA FILIFOLIA SHRUBLAND ALLIANCE (A.816) Sand Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S)

Colorado Plateau Blackbrush Mormon tea Shrubland (CES304.763), Southern Colorado Plateau Sand Shrubland (CES304.793)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This sand sagebrush shrubland occurs in Bandelier National Monument in north central New Mexico, in the northern Jornada del Muerto and Tulerosa basins in south central New Mexico, and within Petrified Forest National Park in the southern Colorado Plateau. It occurs at elevations ranging from 1416-1748 m (4646-5735 feet). Stands frequently occur on flat to rolling sandsheets or sandy plains, mesatops, lower hillslopes and dunes. Within Bandelier National Monument, this association occurs at 1660 m (5430 feet) in elevation on a sloping east facing bench above the mouth of Canon de los Frijoles. Slopes range from 0-27%. Soils are often sandy, but range from fine sandy loams to silty clay loams with an abrupt clay or caliche layer within 100 cm of the surface, to rocky Aridisols derived from basalt colluvium. The ground surface is characterized by shrubs rooted in exposed sandy soil with scattered grass bunches and litter patches. The vegetation is characterized by an open to moderately dense (10-30 % cover) short shrub layer (<1.5 m tall) dominated by *Artemisia filifolia*, with an open to moderately dense (5-60% cover) grassy understory dominated by *Bouteloua eriopoda* or sometimes codominated with *Bouteloua gracilis* or *Sporobolus cryptandrus*. Other common species include *Aristida* spp., *Gutierrezia sarothrae*, *Opuntia* spp., and *Sporobolus flexuosus*. In the southern portion of its range, Chihuahuan Desert species are usually present, such as *Yucca elata* and *Dasyochloa pulchella*.

DISTRIBUTION

Bandelier National Monument

This minor association is known from the mouth of Canon de los Frijoles.

Globally

This association is described from north central and south central New Mexico and northeastern Arizona.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association occurs at 1660 m (5430 feet) in elevation on a sloping east facing bench above the mouth of Canon de los Frijoles. Soils are mapped as rocky Aridisols derived from basalt colluvium. The ground surface is characterized by shrubs rooted in exposed sandy soil with scattered grass bunches and litter patches.

Globally

This sand sagebrush shrubland occurs in the northern Jornada and Tulerosa basins in south central New Mexico and

at Petrified Forest National Park in the southern Colorado Plateau at 1416-1748 m (4646-5735 feet) elevation. It also occurs within Bandelier National Monument at 1660 m (5430 feet) in elevation on a sloping east facing bench above the mouth of Canon de los Frijoles. Stands frequently occur on flat to rolling sandsheets or sandy plains, mesatops, lower hillslopes and dunes. Northern Chihuahuan Desert stands are often found near the periphery of sandsheets or on deflated plains where sand deposits are thinner and soils more developed (Muldavin et al. 2000b). Slopes range from 2-11% in New Mexico and 0-27% in Arizona. Soils are often sandy, but range from fine sandy loams to silty clay loams with an abrupt clay or caliche layer within 100 cm of the surface (Muldavin et al. 2000b). Within Bandelier National Monument, soils are mapped as rocky Aridisols derived from basalt colluvium. The ground surface is characterized by shrubs rooted in exposed sandy soil with scattered grass bunches and litter patches.

VEGETATION DESCRIPTION

Bandelier National Monument

Artemisia filifolia dominates this shrubland and is abundant along with *Opuntia phaeacantha*. Graminoids dominate the herbaceous layer and are characterized by *Bouteloua eriopoda* and *Sporobolus cryptandrus*.

Globally

The vegetation is characterized by an open to moderately dense short shrub layer (<1.5 m tall) dominated by *Artemisia filifolia*, with an open to moderately dense grassy understory dominated by *Bouteloua eriopoda* or sometimes codominated with *Bouteloua gracilis*. In Bandelier National Monument, graminoids dominate the herbaceous layer and are characterized by *Bouteloua eriopoda* and *Sporobolus cryptandrus*. Other common species may include *Aristida* spp., *Gutierrezia sarothrae*, and *Sporobolus flexuosus*. In the southern portion of its range, Chihuahuan Desert species are usually present, such as *Yucca elata* and *Dasyochloa pulchella*. *Opuntia phaeacantha* is also characteristic of northern Chihuahuan Desert and Bandelier National Monument stands. In northeastern Arizona, other characteristic species include *Achnatherum hymenoides*, *Chamaesyce fendleri*, *Cryptantha crassisepala*, *Ephedra torreyana*, *Eriogonum leptocladon*, *Ipomopsis longiflora*, *Machaeranthera canescens*, *Phacelia crenulata*, *Plantago patagonica*, *Senecio spartioides*, *Stephanomeria exigua*, and *Yucca angustissima*. The introduced annual grass *Bromus tectorum* is common in some stands.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Short shrub/sapling	*Artemisia filifolia*
Herb (field)	*Bouteloua eriopoda, Sporobolus cryptandrus*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia filifolia*
Herb (field)	*Bouteloua eriopoda, Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Bromus tectorum.

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (17 Jul 2000).

CLASSIFICATION COMMENTS

Bandelier National Monument

There is limited documentation for this association in the park, but it is described extensively from elsewhere in New Mexico.

Globally

Stands from the Tulerosa and Jornada basins have a strong Madrean floristic element that may justify classifying them as distinct from the Colorado Plateau stands. More classification work is needed to clarify this. Many stands have an open shrub layer and significant graminoid layer that may be better classified as a shrub steppe or shrub herbaceous vegetation association.

CLASSIFICATION CONFIDENCE: 2 - Moderate.

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plot: 06JC196.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz, mod. K.S. King

REFERENCES

Bourgeron and Engelking 1994, Dick Peddie 1993, Driscoll et al. 1984, Muldavin and Mehlhop 1992, Muldavin et al. 2000b, Sims et al. 1976, Western Ecology Working Group n.d.

Fallugia paradoxa - Brickellia spp. - (*Holodiscus dumosus*) Scree Shrubland [Provisional]

Apache Plume - Brickellbush species - (Glandular Oceanspray) Scree Shrubland

CODE	CEGL003496
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Broad leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland (III.A.5.N.a.)
ALLIANCE	FALLUGIA PARADOXA SHRUBLAND ALLIANCE (A.2575) Apache Plume Shrubland Alliance

ECOLOGICAL SYSTEM(S)

Rocky Mountain Lower Montane Foothill Shrubland (CES306.822)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This scree shrubland is known only from Sunset Crater National Monument in north central Arizona and Bandelier National Monument in north central New Mexico. It occurs on steep (25-37%) to very steep (70-120%) canyon slopes at elevations ranging between 1670 and 2750 m (5420-9022 feet). Substrates include unstable boulders, talus, and cinder scree. The ground surface is characterized by shrubs rooted among boulders, rocks, and cobbles with scattered bunch grasses intermixed. This is a very open canyon shrubland where shrub cover ranges between 10 and 45% and is dominated by *Fallugia paradoxa*. In Arizona, *Brickellia grandiflora* and *Holodiscus dumosus* are also abundant. Shrub associates at sites in New Mexico include *Opuntia imbricata* and *Opuntia phaeacantha*, though they are scarce. Trees such as *Pinus edulis* or *Juniperus monosperma* can be present but poorly represented. The herbaceous layer is sparse (total cover is less than 12%) and variable in composition. Graminoids and forbs may include upland species such as *Artemisia dracunculus*, *Bouteloua curtipendula*, *Cirsium undulatum*, and *Schizachyrium scoparium*.

DISTRIBUTION

Bandelier National Monument

This uncommon association is known Ancho Canyon and Canon de los Frijoles.

Globally

This scree shrubland is known only from Sunset Crater National Monument in north central Arizona and Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This low elevation association occurs between 1670 and 1680 m (5420-5520 feet) on canyon slopes of low solar exposure. Slopes are very steep (70-120%), boulder strewn or taluslike, and unstable. The ground surface is characterized by shrubs rooted among boulders, rocks, and cobbles with scattered bunch grasses intermixed.

Globally

At Sunset Crater National Monument, this association occurs between 2380 and 2750 m (7808-9022 feet) on steep slopes (25-37%) with substrates including basaltic boulders and cinder scree. Within Bandelier National Monument, this low elevation association occurs between 1670 and 1680 m (5420-5520 feet) on canyon slopes of low solar exposure. Slopes are very steep (70-120%), boulder strewn or taluslike, and unstable. The ground surface is characterized by shrubs rooted among boulders, rocks, and cobbles with scattered bunch grasses intermixed.

VEGETATION DESCRIPTION

Bandelier National Monument

This is a very open canyon shrubland where shrub cover ranges between 10 and 25% and is dominated by *Fallugia paradoxa* with *Opuntia imbricata* and *Opuntia phaeacantha* as frequent associates on these rocky slopes, though they are scarce. Trees such as *Pinus edulis* or *Juniperus monosperma* can be present but poorly represented. The herbaceous layer is sparse (total cover is less than 10%) and variable in composition. Graminoids and forbs are represented by upland species such as *Bouteloua curtipendula*, *Schizachyrium scoparium*, *Cirsium undulatum*, and *Artemisia dracunculus*.

Globally

This association is a very open canyon shrubland where shrub cover ranges between 10 and 45% and is dominated by *Fallugia paradoxa*. At Sunset Crater National Monument, total vegetation cover within this scree shrubland ranges from 30-50%, with a sparse (0-12% cover) tree layer and a dominant shrub layer (17-45%). The herbaceous layer ranges from 3-15% cover. *Fallugia paradoxa* is the dominant shrub, with *Brickellia grandiflora* and *Holodiscus dumosus* also abundant. Within Bandelier National Monument, this is a very open canyon shrubland where shrub cover ranges between 10 and 25% and is dominated by *Fallugia paradoxa* with *Opuntia imbricata* and *Opuntia phaeacantha* as frequent associates on these rocky slopes, though they are scarce. Trees such as *Pinus edulis* or *Juniperus monosperma* can be present but poorly represented. The herbaceous layer is sparse (total cover is less than 10%) and variable in composition. Graminoids and forbs are represented by upland species such as *Artemisia dracunculus*, *Bouteloua curtipendula*, *Cirsium undulatum*, and *Schizachyrium scoparium*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tall shrub/sapling	*Fallugia paradoxa*

Globally

Stratum	Species
Tall shrub/sapling	*Fallugia paradoxa*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14 Apr 2003).

CLASSIFICATION COMMENTS

Bandelier National Monument

Data are not available.

Globally

This type is likely to be more widespread than currently documented. Scree shrublands in the western U.S. are poorly studied and classified.

CLASSIFICATION CONFIDENCE: 3 - Weak.

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03AB003, 06AB193.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King

REFERENCES

Hansen et al. 2004c, Western Ecology Working Group n.d.

Jamesia americana - (*Physocarpus monogynus*, *Holodiscus dumosus*) Rock Outcrop Shrubland

Five petal Cliffbush - (Mountain Ninebark, Glandular Oceanspray) Rock Outcrop Shrubland

CODE	CEGL002783
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	JAMESIA AMERICANA SHRUBLAND ALLIANCE (A.2566) Five petal Cliffbush Shrubland Alliance

ECOLOGICAL SYSTEM(S)

Rocky Mountain Cliff, Canyon and Massive Bedrock (CES306.815), Rocky Mountain Gambel Oak Mixed Montane Shrubland (CES306.818)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This foothill and montane rock outcrop shrubland is found in the southern Rocky Mountains from central Colorado to northern New Mexico. Many of these sites are small, but some of the best examples grow from very large cliff faces on the upper shoulders of large hills. Sites are moderately steep to very steep with cooler northerly aspects at lower elevations and warmer southerly aspects at higher elevations, which range from 1890 and 2715 m (6210 8900 feet). Substrates are dominated by various rock types , such as bedrock outcrop, boulders, and talus. Vegetation is characterized by open to dense stands of mesic forest shrubs that are variously dominated by *Jamesia americana*, *Physocarpus monogynus*, *Holodiscus dumosus*, and *Philadelphus microphyllus*. Scattered trees may be present, including *Abies concolor* and *Pseudotsuga menziesii* saplings and mature trees, but cover is less than 5%. Many other shrubs may be present, such as *Rubus deliciosus* and *Ribes cereum*. However, *Quercus gambelii* and *Acer glabrum* are poorly represented or absent. The herbaceous layer is variable and may be sparse to moderately dense. Common species include *Bouteloua gracilis*, *Muhlenbergia montana*, and *Poa fendleriana* often well represented along with seeded *Bromus inermis* and *Festuca idahoensis*. Forbs can also be well represented and typically include *Artemisia dracunculus* or *Artemisia ludoviciana*.

DISTRIBUTION

Bandelier National Monument

This association is known from Canon de los Frijoles, Capulin Canyon, and Boundary Peak.

Globally

This association is reported from central Colorado, known only from the Front Range, as well as in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs between 1890 and 2430 m (6210-7970 feet) on slopes with low solar exposure (mostly northerly aspects). Slopes are very steep (70-120%), boulder strewn or taluslike, and unstable. Soils are mapped as either rocky Inceptisols with little development, or as simply rock outcrop. The ground surface is characterized by many shrubs rooted among boulders, rocks, and cobbles with scattered bunch grasses intermixed.

Globally

This foothill and montane rock outcrop shrubland is found in the southern Rocky Mountains from central Colorado to northern New Mexico. Sites are moderately steep to very steep with cooler northerly aspects at lower elevations and warmer southerly aspects at higher elevations, which range from 1890 and 2715 m (6210-8900 feet). Substrates are dominated by various rock types, such as bedrock outcrop, boulders, and talus. Within Florissant Fossil Beds National Monument in central Colorado in the vicinity of the Pike San Isabel National Forest, this shrubland occupies nearly every rock outcrop, regardless of size. Many of these sites are small, but the best examples grow from very large cliff faces on the upper shoulders of large hills. The slopes are steep (30-60%) and a few appear vertical. The aspect is predominantly southerly, but a few western exposures occur (150-270 degrees). Elevation here ranges from 2530-2715 m (8300-8950 feet). The exposures are large Pikes Peak granite boulders that have sometimes weathered and cracked. The shrubs grow within the cracks on the rocks and around the base of the rocks where accumulations of small gravel and soil occur. Within Bandelier National Monument in north central New Mexico, this mid elevation association occurs between 1890 and 2430 m (6210-7970 feet) on slopes with low solar exposure (mostly northerly aspects). Slopes are very steep (70-120%), boulder strewn or taluslike, and unstable. Soils are mapped as either rocky Inceptisols with little development, or as simply rock outcrop. The ground surface is characterized by many shrubs rooted among boulders, rocks, and cobbles with scattered bunch grasses intermixed.

VEGETATION DESCRIPTION

Bandelier National Monument

This mesic shrubland association is characterized by open to dense stands of mesic forest shrubs that are variously dominated by *Jamesia americana*, *Physocarpus monogynus*, *Holodiscus dumosus*, and *Philadelphus microphyllus* among 17 shrub species reported. With respect to trees, scattered *Abies concolor* and *Pseudotsuga menziesii* saplings and mature trees can occur, but cover is less than 5%. *Quercus gambelii* and *Acer glabrum* are poorly represented or absent. Grass cover can be high with *Poa fendleriana* often well represent along with seeded *Bromus inermis* and *Festuca idahoensis*. Forbs can also be well represented and typically include abundant *Artemisia dracunculus* or *Artemisia ludoviciana*.

Globally

Vegetation is characterized by open to dense stands of mesic forest shrubs that are variously dominated by *Jamesia americana*, *Physocarpus monogynus*, *Holodiscus dumosus*, and *Philadelphus microphyllus*. Scattered trees may be present, including *Abies concolor* and *Pseudotsuga menziesii* saplings and mature trees, but cover is less than 5%. Many other shrubs may be present, such as *Rubus deliciosus* and *Ribes cereum*. However, *Quercus gambelii* and *Acer glabrum* are poorly represented or absent. The herbaceous layer is variable and ranges from sparse to moderately dense.

Within Florissant Fossil Beds National Monument in central Colorado in the vicinity of the Pike San Isabel National Forest, this shrubland is relatively sparse because of the large boulders that are strewn on the landscape or appear as outcropping bedrock. Often, the lichens covering these rocks provide large amounts of foliar cover, at times from 30 -60%. Typically, the dominant shrubs are from 1-2 m in height and provide foliar cover from approximately 10-25% across the rock outcrops. *Jamesia americana*, *Rubus deliciosus*, and *Ribes cereum* shrubs are always present, and lesser amounts of *Prunus virginiana*, *Cercocarpus montanus*, and *Dasiphora fruticosa* ssp. *floribunda* are sometimes observed. Common graminoids associated with these dry exposures include *Muhlenbergia montana* and *Bouteloua gracilis*, which provide foliar cover from 5 10% on most outcrops. Because the rock outcrops shed water and direct runoff to small drainages and protected sites, it is not unusual to have some more mesic graminoid species present, including *Deschampsia caespitosa*, *Bromus inermis*, and *Poa pratensis*. A few moist, protected sites support ferns, e.g., *Woodsia* spp. and *Dryopteris filix-mas*. Forbs rarely contribute more than 1-2% foliar cover on the rock outcrop formations and a variety are present. Non vegetative cover within rock outcrops is typically that of boulders, small rock, and bare soil, which approach 55-95% ground cover values. *Jamesia americana* shrubs often grow at the base of some boulders and drape around the sides much like a curtain, resulting in only a minor foliar cover value for the shrub.

Within Bandelier National Monument in north central New Mexico, vegetation is characterized by open to dense stands of mesic forest shrubs that are variously dominated by *Jamesia americana*, *Physocarpus monogynus*, *Holodiscus dumosus*, and *Philadelphus microphyllus*. Scattered *Abies concolor* and *Pseudotsuga menziesii* saplings and mature trees can occur, but cover is less than 5%. *Quercus gambelii* and *Acer glabrum* are poorly represented or absent. Grass

cover can be high with *Poa fendleriana* often well represented along with *Festuca idahoensis* and seeded introduced species *Bromus inermis*. Forbs can also be well represented and typically include abundant *Artemisia dracunculus* or *Artemisia ludoviciana*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tall shrub/sapling	*Holodiscus dumosus, Jamesia americana, Philadelphus microphyllus, Physocarpus monogynus*
Herb (field)	*Poa fendleriana*

Globally

Stratum	Species
Tall shrub/sapling	*Holodiscus dumosus, Jamesia americana, Physocarpus monogynus*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Bromus inermis.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (27 Aug 2002).

CLASSIFICATION COMMENTS

Bandelier National Monument

A seeded grass phase occurs in post burn areas where grasses such as *Bromus inermis*, Elymus X *pseudorepens*, *Festuca idahoensis*, *Festuca ovina*, or *Pascopyrum smithii* have been seeded for erosion control following fire.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak.

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 06JC522, 06JC578, 06JC588, 06JC604.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz and K.S. King

REFERENCES

Western Ecology Working Group n.d.

Quercus X *pauciloba* / *Bouteloua curtipendula* Shrubland

Wavyleaf Oak / Sideoats Grama Shrubland

CODE	CEGL005378
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 X PAUCILOBA SHRUBLAND ALLIANCE (A.921) Wavyleaf Oak Shrubland Alliance

ECOLOGICAL SYSTEM(S)

Rocky Mountain Lower Montane Foothill Shrubland (CES306.822)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This mid elevation association occurs on sites with moderate to high solar exposure that increases with elevation. Stands are found on gentle shoulder slopes, toeslopes, or rolling mesatops (5-20% slopes), and occasionally on steep mountain backslopes (20-50%). The ground surface is characterized by bunch grasses and forbs amid a mix of gravel, rock, boulders, or exposed bedrock. Elevation ranges between 2040 and 2485 m (6690-8150 feet). These montane shrublands are dominated by the hybrid scrub oak *Quercus* X *pauciloba* and *Cercocarpus montanus*, which can form thickets with 50% or more canopy cover. *Cercocarpus montanus* and other shrubs such as *Ceanothus fendleri* and *Robinia neomexicana* may be present but at less than 5% cover. Scattered regeneration of conifers such as *Juniperus deppeana*, *Juniperus monosperma*, or *Pinus ponderosa* can occur, but cover is less than 10%. In the herbaceous layer, *Bouteloua curtipendula* is the diagnostic dominant species. Numerous additional graminoids and forbs may be common to abundant.

DISTRIBUTION

Bandelier National Monument

This common association is known from Escobas Mesa, Lummis Mesa, Burnt Mesas, the slopes of Canon de los Frijoles, Upper Sanchez Canyon, Turkey Springs, and the slopes of the San Miguel Mountains.

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs between 2040 and 2485 m (6690-8150 feet) on sites with moderate to high solar exposure that increases with elevation (i.e., aspects tend to be more northerly at lower elevation and more southerly on higher sites). Stands are found on gentle shoulder slopes, toeslopes, or rolling mesatops (5-20% slopes), and occasionally on steep mountain backslopes (20-50%). The ground surface is characterized by bunch grasses and forbs amid a mix of gravel, rock, boulders, or exposed bedrock.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

These montane shrublands are dominated by the hybrid scrub oak *Quercus* X *pauciloba* and *Cercocarpus montanus*, which can form thickets with 50% or more canopy cover. *Cercocarpus montanus* and other shrubs such as *Ceanothus fendleri* and *Robinia neomexicana* may be present but at less than 5% cover. Scattered regeneration of conifers such as *Juniperus deppeana*, *Juniperus monosperma*, or *Pinus ponderosa* can occur, but cover is less than 10%. The herbs are characteristically abundant and dominated by graminoids with *Bouteloua curtipendula* as the diagnostic dominant along with *Bouteloua gracilis*, *Andropogon gerardii*, *Elymus elymoides*, *Muhlenbergia montana*, *Poa fendleriana*, and *Schizachyrium scoparium* as common to abundant associates. Among the 22 forb species reported, *Artemisia ludoviciana*, *Bahia dissecta*, and *Heterotheca villosa* are the most common.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tall shrub/sapling	*Quercus x pauciloba*
Herb (field)	*Bouteloua curtipendula*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (17 Feb 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

Four phases were identified from this association: *Andropogon gerardii*, *Muhlenbergia montana*, or *Schizachyrium scoparium* phases where these species are well represented (i.e., >5% cover), and a seeded grass phase in post burn areas where grasses such as *Bromus inermis*, *Elymus* X *pseudorepens*, *Festuca idahoensis*, or *Festuca ovina* have been seeded for erosion control.

Globally

Data are not available.

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD151, 03BD162, 05BD008, 06AB177, 06JC148, 06JC177, 06JC178, 06JC561, 06JC562, 06JC581, 06JC582, 06JC583.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Western Ecology Working Group n.d.

Quercus X *pauciloba* / *Cercocarpus montanus* Shrubland

Wavyleaf Oak / Alderleaf Mountain mahogany Shrubland

CODE	CEGL001118
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 X PAUCILOBA SHRUBLAND ALLIANCE (A.921) Wavyleaf Oak Shrubland Alliance

ECOLOGICAL SYSTEM(S)

Madrean Lower Montane Pine Oak Forest and Woodland (CES305.796), Rocky Mountain Lower Montane Foothill Shrubland (CES306.822)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This shrubland association occurs in the mountains of north central and south central New Mexico. It occurs predominantly on steep and rocky canyon sideslopes (40-70% slope), but occasionally on rockier sites of rolling plateau mesas. Elevation ranges between 2050 and 2280 m (6740-7500 feet). Soils are poorly developed and rocky Entisols derived from rhyolitic tuff parent materials, or simply rock outcrop. The ground surface is characterized by scattered bunch grasses and litter amid rocks and boulders. The vegetation within these montane shrublands is dominated by the hybrid scrub oak *Quercus* X *pauciloba* and *Cercocarpus montanus*, which can form thickets with 50% or more canopy cover. *Fallugia paradoxa* and *Robinia neomexicana* are also common shrub associates. Among trees, scattered *Juniperus monosperma* and *Pinus ponderosa* saplings and mature trees may occur, but cover is less than 10%. The herbaceous layer is variable in composition and seldom exceeds 10% total cover.

DISTRIBUTION

Bandelier National Monument

This association is known from Escobas Mesa and Lummis Mesa, the slopes of Canon de los Frijoles, and in the Turkey Springs area.

Globally

This shrubland association occurs in the mountains of north central and south central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs between 2050 and 2190 m (6740-7200 feet) on sites with moderate solar exposure. Stands are mostly found on steep and rocky canyon sideslopes (40-70% slope), but occasionally on rockier sites of rolling plateau mesas. Soils are mapped as poorly developed and rocky Entisols derived from rhyolitic tuff parent materials, or simply as rock outcrop (Hibner 2009). The ground surface is characterized by scattered bunch grasses and litter amid rocks and boulders.

Globally

Within Bandelier National Monument in north central New Mexico, this mid elevation association occurs between 2050 and 2190 m (6740-7200 feet) on sites with moderate solar exposure. Stands are mostly found on steep and rocky canyon sideslopes (40-70% slope), but occasionally on rockier sites of rolling plateau mesas. Soils are mapped as

poorly developed and rocky Entisols derived from rhyolitic tuff parent materials, or simply as rock outcrop (Hibner 2009). The ground surface is characterized by scattered bunch grasses and litter amid rocks and boulders. Within White Sands Missile Range in south central New Mexico, this association occurs on steep, warm scarp slopes at elevations ranging from 2130 to 2280 m (7000-7500 feet).

VEGETATION DESCRIPTION

Bandelier National Monument

These montane shrublands are dominated by the hybrid scrub oak *Quercus* X *pauciloba* and *Cercocarpus montanus*, which can form thickets with 50% or more canopy cover. *Fallugia paradoxa* and *Robinia neomexicana* are also common shrub associates. Among trees, scattered *Juniperus monosperma* and *Pinus ponderosa* saplings and mature trees can occur, but cover is less than 10%. The herbaceous layer is variable in composition and seldom exceeds 10% total cover. Scattered grasses are predominant and may include *Muhlenbergia montana*, *Bouteloua curtipendula*, *Bouteloua gracilis*, and *Schizachyrium scoparium*. The most prevalent forbs are *Artemisia ludoviciana*, *Heterotheca villosa*, and *Eriogonum jamesii*.

Globally

Within Bandelier National Monument in north central New Mexico, these montane shrublands are dominated by the hybrid scrub oak *Quercus* X *pauciloba* and *Cercocarpus montanus*, which can form thickets with 50% or more canopy cover. *Fallugia paradoxa* and *Robinia neomexicana* are also common shrub associates. Among trees, scattered *Juniperus monosperma* and *Pinus ponderosa* saplings and mature trees can occur, but cover is less than 10%. The herbaceous layer is variable in composition and seldom exceeds 10% total cover. Scattered grasses are predominant and may include *Bouteloua curtipendula*, *Bouteloua gracilis*, *Muhlenbergia montana*, and *Schizachyrium scoparium*. The most prevalent forbs are *Artemisia ludoviciana*, *Eriogonum jamesii*, and *Heterotheca villosa*. Within White Sands Missile Range in south central New Mexico, this association is a minor and provisional type, is very chaparral like, and is codominated by *Cercocarpus montanus* and *Quercus* X *pauciloba*. Other shrub associates usually present include *Garrya flavescens*, *Mahonia haematocarpa*, *Nolina microcarpa*, and *Rhus trilobata*. Grasses and forbs are usually poorly represented.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tall shrub/sapling	*Quercus x pauciloba*
Tall shrub/sapling	*Cercocarpus montanus*

Globally

Stratum	Species
Tall shrub/sapling	*Quercus x pauciloba*
Tall shrub/sapling	*Cercocarpus montanus*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (1 Feb 1996).

CLASSIFICATION COMMENTS

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03AB042, 03YC024, 06AB283, 06BF026, 06JC144, 06JC485, 06JC486.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King

REFERENCES

Bourgeron and Engelking 1994, Driscoll et al. 1984, Hibner 2009, Muldavin and Mehlhop 1992, Muldavin et al. 2000b, Western Ecology Working Group n.d.

Quercus gambelii - Robinia neomexicana / Carex inops ssp. *heliophila* Shrubland

Gambel Oak - New Mexico Locust / Sun Sedge Shrubland

CODE	CEGL005379
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 is only known to occur at Bandelier National Monument in north central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This association occurs on sites with moderate to high solar exposure that increases with elevation. Stands occur on steep canyon and mountain slopes (30-65% slope) to gently rolling mesatops (<10%). Soils are mapped primarily as rocky but well developed Mollisols or as poorly developed and rocky Inceptisols derived from latite, dacite, or rhyolitic tuff alluvium and colluvium parent materials. The ground surface is characterized by scattered bunch grasses and sedges intermixed with litter, exposed soil, rock, and gravel; some sites are very rocky. This montane shrubland occurs across a wide elevational gradient between 1980 and 2900 m (6500-9550 feet). It typically occurs in burned areas that once supported pine and mixed conifer forests. Shrub cover can exceed 80% and is dominated by deciduous broadleaf *Quercus gambelii* and *Robinia neomexicana* (occasionally *Quercus gambelii* can be present as mature trees). Common to abundant shrub associates may include *Ceanothus fendleri*, *Physocarpus monogynus*, *Rosa woodsii*, *Rubus idaeus*, and *Symphoricarpos oreophilus*. Tree seedlings and saplings (including *Abies concolor*, *Pinus ponderosa*, and *Pseudotsuga menziesii*) may be present. The herbaceous layer is rich in species, but variable in cover (5-70%). Graminoids are most abundant with *Carex inops* ssp. *heliophila* and other deer sedges (*Carex geophila*, *Carex occidentalis*, and *Carex rossii*) diagnostic and often abundant. Common associates include *Koeleria macrantha* and *Poa fendleriana*. On sites that have been seeded following fire, *Agropyron cristatum*, *Bromus catharticus*, *Bromus inermis*, *Elymus trachycaulus*, and *Pascopyrum smithii*, among others, can be common to abundant. While forbs are diverse, composition is variable from stand to stand, and cover is usually less than 5%.

DISTRIBUTION

Bandelier National Monument

This widespread association is known from the slopes of the Sierra de los Valles and the San Miguel Mountains; the upper reaches of Frijoles, Alamo, Lummis, Capulin, and Sanchez canyons; and the intervening mesas (Mesa del Rito, Escobas, and Burnt).

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association occurs across a wide elevational gradient between 1980 and 2900 m (6500-9550 feet) on sites with

moderate to high solar exposure that increases with elevation (i.e., sites tend to be more northerly aspects or in protected canyon bottoms at lower elevation, and more southerly and exposed slopes on higher sites). Stands occur on steep canyon and mountain slopes (30 to 65% slope) to gently rolling mesatops (<10%). Soils are mapped primarily as rocky, but well developed Mollisols or as poorly developed and rocky Inceptisols derived from latite, dacite, or rhyolitic tuff alluvium and colluvium parent materials (Hibner 2009). The ground surface is characterized by scattered bunch grasses and sedges intermixed with litter, exposed soil, rock, and gravel; some sites are very rocky.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This montane shrubland typically occurs in burned areas that once supported pine and mixed conifer forests. Shrub cover can exceed 80% and is dominated by deciduous broadleaf *Quercus gambelii* and *Robinia neomexicana* (occasionally *Quercus gambelii* can be present as mature trees). *Rosa woodsii*, *Physocarpus monogynus*, *Rubus idaeus*, *Symphoricarpos oreophilus*, and *Ceanothus fendleri* can be common to abundant shrub associates. *Pinus ponderosa*, *Pseudotsuga menziesii*, and *Abies concolor* seedling and sapling reproduction can be present. The herbaceous layer is rich in species (46 graminoid and 73 forb species), but variable in cover (5 to 70%). The graminoids are the most abundant with *Carex inops* ssp. *heliophila* and other deer sedges (*Carex occidentalis*, *Carex rossii*, and *Carex geophila*) diagnostic and often abundant with *Poa fendleriana* and *Koeleria macrantha* as common associates. On sites that have been seeded following fire, *Bromus inermis*, *Elymus trachycaulus*, *Pascopyrum smithii*, *Agropyron cristatum*, and *Bromus catharticus*, among others, can be common to abundant. While forbs are diverse, composition is variable from stand to stand, and cover is usually less than 5%. The most frequent and abundant species are *Heterotheca villosa*, *Artemisia ludoviciana*, *Achillea millefolium*, *Erigeron subtrinervis*, *Erigeron speciosus*, *Allium cernuum*, *Antennaria parvifolia*, *Psoralidium tenuiflorum*, *Penstemon barbatus*, and *Thalictrum fendleri*.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Quercus gambelii*
Tall shrub/sapling	*Quercus gambelii, Robinia neomexicana*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Agropyron cristatum, *Bromus catharticus*, *Bromus inermis*.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (17 Feb 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

Three phases were identified from this association: a *Poa pratensis* phase occurs where its total cover is greater than

10%; a seeded grass phase occurs in post burn areas where grasses such as *Bromus inermis*, *Elymus* X *pseudorepens*, *Festuca idahoensis*, or *Festuca ovina* have been seeded for erosion control; and a *Pteridium aquilinum* phase occurs where it is luxuriant, reaching as high as 60% total cover.

Globally

This association may represent a splitting of more broadly defined *Quercus gambelii* / *Robinia neomexicana* Shrubland (CEGL001115). However, initial review indicates that it has a sparse herbaceous understory. *Quercus gambelii Robinia neomexicana* / *Muhlenbergia montana* Shrubland (CEGL005380) is similar, but typically occurs on less xeric sites, and the herbaceous layer is dominated by mountain muhly rather than dry sedges. This association is also similar to *Quercus gambelii* / *Robinia neomexicana* / *Symphoricarpos rotundifolius* Shrubland (CEGL001116), but lacks a short shrub layer dominated by species of *Symphoricarpos*.

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03AB045, 03AB047, 03AB049, 03AB050, 03BD012, 03BD014, 03BD018, 03BD061, 03BD063, 03BD069, 03BD116, 03BD121, 03BD122, 03BD124, 03BD127, 03BD128, 03BD142, 03BD145, 03BD158, 03ER010, 03ER012, 03ER014, 03ER016, 03ER017, 03ER018, 03ER019, 03ER020, 04BD011, 04CJ003, 04CJ004, 06AB181, 06AB182, 06AB286, 06BF007, 06JC143, 06JC150, 06JC162, 06JC165, 06JC172, 06JC175, 06JC180, 06JC187, 06JC208, 06JC213, 06JC534, 06JC538, 06JC542, 06JC547, 06JC553, 06JC560, 06JC563, 06JC571, 06JC572, 06JC575, 06JC576, 06JC577, 06JC579, 06JC580, 06JC586, 06JC587, 06JC596, 06JC607, 06JC608, 06JC624, 06JC627, 06JC634.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Hibner 2009, Western Ecology Working Group n.d.

Quercus gambelii - Robinia neomexicana / *Muhlenbergia montana* Shrubland

Gambel Oak - New Mexico Locust / Mountain Muhly Shrubland

CODE	CEGL005380
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 is only known to occur at Bandelier National Monument in north central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This mid elevation association occurs on sites with low to high solar exposure that increases with elevation. Stands occur on gentle to moderate slopes (5-20%) including rolling mesatops and mountain shoulder slopes, and occasionally on steep canyon slopes (>40%). Soils are primarily well developed Mollisols derived from pumice, or occasionally fine textured Alfisols derived from eolian deposits over rhyolitic tuff residuum. The ground surface is typically characterized by scattered bunch grasses amid litter, pumice gravel, or exposed soil. Elevation ranges between 2050 and 2585 m (6720-8480 feet). This montane shrubland typically occurs in burned areas that once supported pine and mixed conifer forests. Shrub cover can exceed 80% and is dominated by deciduous broadleaf *Quercus gambelii* and *Robinia neomexicana* (occasionally *Quercus gambelii* can be present as mature trees). Common to abundant shrub associates may include *Ceanothus fendleri*, *Cercocarpus montanus*, *Quercus* X *pauciloba*, *Rosa woodsii*, and *Symphoricarpos oreophilus*. Tree seedlings and saplings (*Abies concolor*, *Pinus ponderosa*, and *Pseudotsuga menziesii*) may be present. The herbaceous layer is moderately rich in species but variable in cover (5-50%). A grassy understory is diagnostic and is characterized by well represented to abundant *Muhlenbergia montana* with *Blepharoneuron tricholepis* and *Schizachyrium scoparium* as occasional codominants. *Andropogon gerardii*, *Bouteloua gracilis*, *Elymus elymoides*, or *Poa fendleriana* are also common associates. On sites that have been seeded following fire, *Bromus inermis*, *Festuca idahoensis*, and *Pascopyrum smithii*, among others, can be common to abundant. While forbs are diverse, composition is variable from stand to stand, and cover is usually less than 5%.

DISTRIBUTION

Bandelier National Monument

This common association is known from the slopes of the Sierra de los Valles and the San Miguel Mountains, the upper reaches of Lummis and Capulin canyons, and the plateau tops of Mesa del Rito and Escobas Mesa.

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs between 2050 and 2585 m (6720-8480 feet) on sites with low to high solar exposure that increases with elevation (i.e., aspects tend to be more northerly at lower elevation and more southerly on

higher sites). Stands occur on gentle to moderate slopes (5-20%) including rolling mesatops and mountain shoulder slopes, and occasionally on steep canyon slopes (>40%). Soils are primarily mapped as well developed Mollisols derived from pumice, or occasionally as fine textured Alfisols derived from eolian deposits over rhyolitic tuff residuum (Hibner 2009). The ground surface is typically characterized by scattered bunch grasses amid litter, pumice gravel, or exposed soil.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This montane shrubland typically occurs in burned areas that once supported pine and mixed conifer forests. Shrub cover can exceed 80% and is dominated by deciduous broadleaf *Quercus gambelii* and *Robinia neomexicana* (occasionally *Quercus gambelii* can be present as mature trees). *Rosa woodsii*, *Symphoricarpos oreophilus*, *Quercus* X *pauciloba*, *Cercocarpus montanus*, and *Ceanothus fendleri* can be common to abundant shrub associates. *Pinus ponderosa*, *Pseudotsuga menziesii*, and *Abies concolor* seedling and sapling reproduction can be present. The herbaceous layer is moderately rich in species (36 graminoid and 50 forb species) but variable in cover (5 to 50%). A grassy understory is diagnostic and is characterized by well represented to abundant *Muhlenbergia montana* with *Blepharoneuron tricholepis* and *Schizachyrium scoparium* as occasional codominants. *Bouteloua gracilis*, *Andropogon gerardii*, *Poa fendleriana*, or *Elymus elymoides* are also common associates. On sites that have been seeded following fire, *Bromus inermis*, *Pascopyrum smithii*, and *Festuca idahoensis*, among others, can be common to abundant. While forbs are diverse, composition is variable from stand to stand, and cover is usually less than 5%. The most frequent and abundant species are *Heterotheca villosa*, *Artemisia ludoviciana*, *Artemisia carruthii*, and *Verbascum thapsus*.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Quercus gambelii*
Tall shrub/sapling	*Quercus gambelii, Robinia neomexicana*
Herb (field)	*Muhlenbergia montana*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Bromus inermis.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (18 Feb 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Blepharoneuron tricholepis* phase occurs where cover of that species exceeds 25% cover. This association may represent a parsing of *Quercus gambelii* / *Robinia neomexicana* (CEGL001115).

Globally

This association may represent a splitting of more broadly defined *Quercus gambelii* / *Robinia neomexicana* Shrubland (CEGL001115). However, initial review indicates that it has a sparse herbaceous understory. *Quercus gambelii Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland (CEGL005379) is similar, but typically occurs on drier sites, and the herbaceous layer is dominated by dry sedges rather than mountain muhly. This association is also similar to *Quercus gambelii* / *Robinia neomexicana* / *Symphoricarpos rotundifolius* Shrubland (CEGL001116), but lacks a short shrub layer dominated by *Symphoricarpos* spp.

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM plots: 03ER013, 06AB160, 06AB163, 06AB173, 06AB175, 06AB285, 06BF023, 06JC151, 06JC152, 06JC170, 06JC559, 06JC569, 06JC626, 06JC630.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Hibner 2009, Western Ecology Working Group n.d.

Robinia neomexicana / *Carex inops* ssp. *heliophila* Shrubland

New Mexico Locust / Sun Sedge Shrubland

CODE	CEGL005375
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	ROBINIA NEOMEXICANA SHRUBLAND ALLIANCE (A.924) New Mexico Locust Shrubland Alliance

ECOLOGICAL SYSTEM(S)

Rocky Mountain Gambel Oak Mixed Montane Shrubland (CES306.818)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This mid elevation association occurs on sites with moderate to high solar exposure that increases with elevation. Stands occur on gentle to moderate slopes (5-20%) including rolling mesatops and mountain shoulder slopes, and occasionally on steep canyon or mountain slopes (>40%). Soils are primarily well developed Mollisols derived from pumice, or occasionally fine textured Alfisols derived from eolian deposits over rhyolitic tuff residuum. The ground surface is typically characterized by scattered bunch grasses amid litter, pumice gravel, or exposed soil. Elevation ranges between 2020 and 2550 m (6640-8370 feet). This montane shrubland typically occurs in burned areas that once supported pine and mixed conifer forests. Shrub cover can exceed 80% and is dominated by deciduous broadleaf *Robinia neomexicana*. *Quercus gambelii* is absent or accidental, and other shrubs such as *Ceanothus fendleri* and *Rosa woodsii* are uncommon. Tree seedlings and saplings (*Abies concolor*, *Pinus ponderosa*, and *Pseudotsuga menziesii*) can be present. The herbaceous layer richness is moderate, but variable in cover (5-80%). Diagnostic and often abundant graminoids include *Carex inops* ssp. *heliophila* and other deer sedges (*Carex geophila*, *Carex occidentalis*, and *Carex rossii*). Common associates include *Koeleria macrantha* and *Poa fendleriana*. On sites that have been seeded following fire, common to abundant species may include *Agropyron cristatum*, *Bromus inermis*, *Elymus trachycaulus*, and *Pascopyrum smithii*, among others. While forbs are diverse, composition is variable from stand to stand, and cover is usually less than 10%.

DISTRIBUTION

Bandelier National Monument

This common association is known from the slopes of the Sierra de los Valles, the upper reaches of Canyon de los Frijoles (and likely in other canyons), and the intervening mesas (Lummis, Mesa del Rito, Escobas and Burnt mesas).

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico, but it likely occurs elsewhere within the range of *Robinia neomexicana*.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs between 2020 and 2550 m (6640-8370 feet) on sites with moderate to high solar exposure that increases with elevation (i.e., aspects tend to be more northerly at lower elevation and more south-

erly on higher sites). Stands occur on gentle to moderate slopes (5-20%) including rolling mesatops and mountain shoulder slopes, and occasionally on steep canyon or mountain slopes (>40%). Soils are primarily mapped as well developed Mollisols derived from pumice, or occasionally as fine textured Alfisols derived from eolian deposits over rhyolitic tuff residuum (Hibner 2009). The ground surface is typically characterized by scattered bunch grasses amid litter, pumice gravel, or exposed soil.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This montane shrubland typically occurs in burned areas that once supported pine and mixed conifer forests. Shrub cover can exceed 80% and is dominated by deciduous broadleaf *Robinia neomexicana*. *Quercus gambelii* is absent or accidental, and other shrubs such as *Rosa woodsii* and *Ceanothus fendleri* are uncommon. *Pinus ponderosa*, *Pseudotsuga menziesii*, and *Abies concolor* seedling and sapling reproduction can be present. The herbaceous layer richness is moderate (22 graminoid and 33 forb species reported), but variable in cover (5 to 80%). The graminoids are the most abundant with *Carex inops* ssp. *heliophila* and other deer sedges (*Carex occidentalis*, *Carex rossii*, and *Carex geophila*) diagnostic and often abundant, with *Poa fendleriana* and *Koeleria macrantha* as common associates. On sites that have been seeded following fire, *Bromus inermis*, *Elymus trachycaulus*, *Pascopyrum smithii*, and *Agropyron cristatum*, among others, can be common to abundant. While forbs are diverse, composition is variable from stand to stand, and cover is usually less than 10%. The most frequent and abundant species are *Heterotheca villosa*, *Achillea millefolium*, *Artemisia carruthii*, *Artemisia ludoviciana*, *Liatris punctata*, *Antennaria parvifolia*, and *Mentzelia springeri*.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tall shrub/sapling	*Robinia neomexicana*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Agropyron cristatum, *Bromus inermis*.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (17 Feb 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

Two phases are recognized: a seeded grass phase occurs in post burn areas where grasses such as *Bromus inermis*, Elymus X *pseudorepens*, *Festuca idahoensis*, *Festuca ovina*, or *Pascopyrum smithii* have been seeded for erosion control; and a ruderal phase occurs on disturbed sites that have not been seeded and are dominated by weedy forbs such as *Amaranthus* spp. and *Artemisia dracunculus*.

Globally

Robinia neomexicana / *Thalictrum fendleri* Shrubland (CEGL001125) is similar to this association, but it is likely relatively mesic with the herbaceous layer dominated by forbs such as *Thalictrum fendleri* rather than dry sedges such as *Carex inops* ssp. *heliophila*. More survey is needed to fully clarify classification concept.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD104, 03BD141, 03YC013, 03YC014, 06AB198, 06AB201, 06JC190, 06JC555, 06JC556, 03BD021, 05BD007, 06AB179, 06BF025, 06JC134, 06JC179, 06JC557.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Hibner 2009, Western Ecology Working Group n.d.

Fallugia paradoxa Colorado Plateau Desert Wash Shrubland

Apache Plume Colorado Plateau Desert Wash Shrubland

CODE	CEGL002357
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural cold deciduous shrubland (III.B.2.N.)
FORMATION	Intermittently flooded cold deciduous shrubland (III.B.2.N.c.)
ALLIANCE	FALLUGIA PARADOXA INTERMITTENTLY FLOODED SHRUBLAND ALLIANCE (A.934) Apache Plume Intermittently Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S)

North American Warm Desert Riparian Woodland and Shrubland (CES302.753), Inter Mountain Basins Wash (CES304.781)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association occurs within Capitol Reef National Park in southeastern Utah and within Bandelier National Monument in north central New Mexico. It may occur elsewhere in the central and southern Colorado Plateau and Great Basin. This is a low elevation shrubland occurring in canyon bottoms with low solar exposure (i.e., protected canyon drainages), or in interrupted patches on banks and point bars in larger intermittent drainages, wash bottoms, and on alluvial terraces and bars adjacent to or within drainage channels. Slopes are low to moderate (3-20%). Elevation ranges between 1524 and 1829 m (5000-6000 feet). Aspect is not important in determining the distribution of this association. Drainages are subject to ephemeral flood events following large summer thunderstorms that may scour the channels. Soils include rapidly drained sands and loamy sands derived from mixed alluvium of stream terraces, or are part of rock outcrop or rubble lands map units. The unvegetated surface is variable depending on site location. In Utah, the ground surface is typical of alluvial terraces and point bars, and is composed of sand, gravel, rocks and very little litter or live vegetation. In New Mexico, the ground surface is characterized by shrubs rooted in exposed gravels, cobble and soil intermixed with grass and litter patches. Within Capitol Reef National Park, total vegetation cover ranges from 22 to 95%. The shrub canopy is characterized by *Fallugia paradoxa* with 6 to 50% cover. Associated shrubs include *Amelanchier utahensis*, *Purshia stansburiana*, *Mahonia fremontii*, *Rhus trilobata*, *Fraxinus anomala*, *Atriplex canescens*, *Chrysothamnus viscidiflorus*, *Shepherdia rotundifolia*, *Ephedra viridis*, *Ericameria nauseosa*, *Gutierrezia microcephala*, and *Gutierrezia sarothrae*. The herbaceous layer is low in species diversity and provides sparse to low cover; a combination of severe occasional flooding and otherwise dry conditions makes it difficult for herbaceous species to become established. Commonly associated graminoids include *Achnatherum hymenoides*, the exotic annual *Bromus tectorum*, and *Pleuraphis jamesii*. Forbs are typically rare in this community; however, *Stanleya pinnata* frequently occurs. Scattered *Juniperus osteosperma* and *Pinus edulis* may be present but do not form a tree layer. Within Bandelier National Monument, *Fallugia paradoxa* dominates with *Ericameria nauseosa* a frequent and well represented associate. *Forestiera pubescens* is uncommon or absent. The herbaceous layer is variable. In general, annuals predominate and include the exotic *Bromus tectorum* and native *Vulpia octoflora* among grasses, and *Ipomopsis longiflora* and *Lappula occidentalis* among forbs. Trees are generally absent; however, scattered individual *Juniperus monosperma* or *Pinus edulis* may occur.

DISTRIBUTION

Bandelier National Monument

This association is known from lower Lummis, Hondo, and Capulin canyons.

Globally

This association occurs within Capitol Reef National Park in southeastern Utah and within Bandelier National Monument in north central New Mexico. It may occur elsewhere in the central and southern Colorado Plateau and Great Basin.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This low elevation association occurs between 1685 and 1800 m (5525-5915 feet) in canyon bottoms with low solar exposure (i.e., protected canyon drainages). Stands occur on alluvial terraces and bars adjacent to or within drainage channels with low gradients (3-7% slope). Drainages are subject to ephemeral flood events following large summer thunderstorms that may scour the channels. Sites may also occur within the high water zone of Cochiti Reservoir. Soils are mapped as either sandy Mollisols derived from mixed alluvium of stream terraces, or as part of rock outcrop or rubble lands map units. The ground surface is characterized by shrubs rooted in exposed gravels, cobble and soil intermixed with grass and litter patches.

Globally

Within Capitol Reef National Park in southeastern Utah, this Apache plume desert wash community occurs in intermittent drainages and wash bottoms. Sites are gentle (1-8 degrees), occur between 1524 and 1829 m (5000-6000 feet) elevation, and are oriented to all aspects. The unvegetated surface has low to moderate cover of litter, live vegetation basal area, and exposure of sand and bare soil. Large rock, small rock and gravel cover is low to moderate. Parent materials are shale of the Moenkopi Formation and sandstones of the Wingate, Navajo and Morrison formations. Soils are rapidly drained and texturally are sand and loamy sand.

Within Bandelier National Monument in north central New Mexico, this low elevation association occurs between 1685 and 1800 m (5525-5915 feet) in canyon bottoms with low solar exposure (i.e., protected canyon drainages). Stands occur on alluvial terraces and bars adjacent to or within drainage channels with low gradients (3-7% slope). Drainages are subject to ephemeral flood events following large summer thunderstorms that may scour the channels. Sites may also occur within the high water zone of Cochiti Reservoir. Soils are mapped as either sandy Mollisols derived from mixed alluvium of stream terraces, or as part of rock outcrop or rubble lands map units. The ground surface is characterized by shrubs rooted in exposed gravels, cobble and soil intermixed with grass and litter patches.

VEGETATION DESCRIPTION

Bandelier National Monument

Fallugia paradoxa dominates these canyon shrublands with *Ericameria nauseosa* a frequent and well represented associate. *Forestiera pubescens* is uncommon or absent. The herbaceous layer is variable, but generally, annuals predominate and include the exotic *Bromus tectorum* and native *Vulpia octoflora* among grasses, and *Lappula occidentalis* and *Ipomopsis longiflora* among forbs. Trees are generally absent, however scattered individual *Pinus edulis* or *Juniperus monosperma* may occur.

Globally

Within Capitol Reef National Park in southeastern Utah, total vegetation cover ranges from 22 to 95% and in excess of 100% in terms of abundance determined from biomass estimates in this sparsely to densely vegetated community. This tall shrub community is characterized by *Fallugia paradoxa* shrubs that range in cover from 6 to 50% and from 6 to 100% in terms of abundance determined from biomass estimates. Canopy trees, typically 2-5 m tall, are sometimes present, providing sparse to low cover and include *Juniperus osteosperma* and *Pinus edulis*. The associated shrub layer has moderate to high species composition and provides moderate to dense cover. Commonly associated tall shrubs include *Amelanchier utahensis*, *Purshia stansburiana*, *Mahonia fremontii*, *Rhus trilobata*, and *Fraxinus anomala*. Short and dwarf shrubs that are typically present include *Atriplex canescens*, *Chrysothamnus viscidiflorus*, *Shepherdia rotundifolia*, *Ephedra viridis*, *Ericameria nauseosa*, *Gutierrezia microcephala*, and *Gutierrezia sarothrae*. The herbaceous layer is low in species diversity and provides sparse to low cover. Commonly associated graminoids include *Achnatherum hymenoides*, the exotic annual *Bromus tectorum*, and *Pleuraphis jamesii*. Forbs are typically rare in this community; however, *Stanleya pinnata* frequently occurs.

Within Bandelier National Monument in north central New Mexico, *Fallugia paradoxa* dominates these canyon shrublands with *Ericameria nauseosa* a frequent and well represented associate. *Forestiera pubescens* is uncommon or absent. The herbaceous layer is variable, but generally annuals predominate and include the exotic *Bromus tectorum* and native *Vulpia octoflora* among grasses, and *Ipomopsis longiflora* and *Lappula occidentalis* among forbs. Trees are generally absent, however scattered individual *Juniperus monosperma* or *Pinus edulis* may occur.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tall shrub/sapling	*Ericameria nauseosa*
Tall shrub/sapling	*Fallugia paradoxa*

Globally

Stratum	Species
Tall shrub/sapling	*Ericameria nauseosa, Fallugia paradoxa*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Bromus tectorum.

Globally

Bromus tectorum.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (22 Mar 2005).

CLASSIFICATION COMMENTS

Bandelier National Monument

Two phases were identified from this association: a *Bromus tectorum* phase occurs where it is luxuriant, i.e., greater than 25% cover and reaching as high as 60%; and an *Ericameria nauseosa* phase occurs where it is well represented, or in sparse stands, where it represents 25% of the total shrub cover.

Globally

This association has only been described from Capitol Reef National Park. Until further inventory is completed, there is no global information.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03AB008, 03AB019, 03BD147, 03BD173.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: J. Coles, mod. K.S. King

REFERENCES

Western Ecology Working Group n.d.

IV. Herbaceous

Bouteloua curtipendula - Bothriochloa barbinodis Herbaceous Vegetation

Sideoats Grama Cane Beardgrass Herbaceous Vegetation

CODE	CEGL001590
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	BOUTELOUA CURTIPENDULA HERBACEOUS ALLIANCE (A.1244) Sideoats Grama Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Apacherian Chihuahuan Semi Desert Grassland and Steppe (CES302.735)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This minor association is known from Bandelier National Monument in north central New Mexico and from White Sands Missile Range in south central New Mexico. It has been recorded at 1660 m (5450 feet) elevation on a southerly aspect of a steep (40%), lower canyon slope within the high water flood zone above a river terrace along the Rio Grande. It is also known to occur in the Oscura and San Andres mountains at elevations between 1850 and 1890 m (6075-6200 feet) on moderately steep slopes. Substrates include colluvial deposits derived from basalt and andesite volcanic flows. Ground cover is characterized by scattered bunch grasses in a matrix of boulders and rocks. Within Bandelier National Monument, this ruderal grassland is dominated by *Bothriochloa barbinodis* with scattered *Bouteloua curtipendula*; *Elymus elymoides* and *Setaria leucopila* are also well represented. Shrubs are scattered and poorly represented. On White Sands Missile Range, *Bouteloua curtipendula* and *Bothriochloa barbinodis* codominate and can be luxuriant in cover. Shrubs are insignificant, but a wide variety of forbs is known for this association.

DISTRIBUTION

Bandelier National Monument

This association is known from the mouth of Lummis Canyon within White Water Canyon.

Globally

This minor association is known from Bandelier National Monument in north central New Mexico and from White Sands Missile Range in south central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This minor association occurs at 1660 m (5450 feet) elevation on a southerly aspect of a steep (40%), lower canyon slope. The site is located above a river terrace along the Rio Grande within the high water flood zone of Cochiti Reservoir. The substrate is a colluvial deposit derived from basalt and andesite volcanic flows. Ground cover is characterized by scattered bunch grasses in a matrix of boulders and rocks.

Globally

Within Bandelier National Monument in north central New Mexico, this minor association occurs at 1660 m (5450 feet) elevation on a southerly aspect of a steep (40%), lower canyon slope. The site is located above a river terrace

along the Rio Grande within the high water flood zone of Cochiti Reservoir. The substrate is a colluvial deposit derived from basalt and andesite volcanic flows. Ground cover is characterized by scattered bunch grasses in a matrix of boulders and rocks. On White Sands Missile Range in south central New Mexico, this minor plant association is known from the Oscura and San Andres mountains. It occurs on moderately steep slopes on sandstone substrates at elevations between 1850 and 1890 m (6075-6200 feet).

VEGETATION DESCRIPTION

Bandelier National Monument

This ruderal grassland is dominated by *Bothriochloa barbinodis* with scattered *Bouteloua curtipendula*; *Elymus elymoides* and *Setaria leucopila* are also well represented. *Lepidium virginicum* var. *medium* and *Glandularia bipinnatifida* are well represented among a diverse set, but ruderal compliment of forbs (i.e., 17 species). Shrubs are scattered and poorly represented; *Brickellia californica* is the most abundant species at 2% cover.

Globally

Within Bandelier National Monument, this ruderal grassland is dominated by *Bothriochloa barbinodis* with scattered *Bouteloua curtipendula*; *Elymus elymoides*, and *Setaria leucopila* are also well represented. *Lepidium virginicum* var. *medium* and *Glandularia bipinnatifida* are well represented among a diverse, but ruderal complement of forbs (i.e., 17 species). Shrubs are scattered and poorly represented; *Brickellia californica* is the most abundant species at 2% cover. On White Sands Missile Range, *Bouteloua curtipendula* and *Bothriochloa barbinodis* codominate and can be luxuriant in cover. Shrubs are insignificant, but a wide variety of forbs is known for this association.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Bothriochloa barbinodis*

Globally

Stratum	Species
Herb (field)	*Bothriochloa barbinodis*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (23 Feb 1994).

CLASSIFICATION COMMENTS

Bandelier National Monument

This is disturbance type with limited documentation within the park and elsewhere in New Mexico.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plot: 03BR012.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King

REFERENCES

Bourgeron and Engelking 1994, Driscoll et al. 1984, Johnson 1961c, Muldavin et al. 2000b, Western Ecology Working Group n.d.

Festuca thurberi - (*Lathyrus lanszwertii* var. *leucanthus*, *Potentilla* spp.) Herbaceous Vegetation

Thurber's Fescue (Nevada Peavine, Cinquefoil species) Herbaceous Vegetation

CODE	CEGL001630
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	FESTUCA THURBERI HERBACEOUS ALLIANCE (A.1256) Thurber's Fescue Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Montane Subalpine Grassland (CES306.824)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This montane association is a major and extensively distributed grassland in the Colorado Rocky Mountains along the western slope of the Front Range and the eastern slope of the Park Range in the Arapaho National Forest. It also occurs in north central New Mexico at elevations between 2760 and 2950 m (9050-9680 feet). It is found on sites with moderate to high solar exposure (mostly southerly aspects) from the toe to upper slopes of mountains (5-25% slope). Soils are well developed and relatively deep Mollisols with loamy textures in a cobbly matrix. They are derived from latite and dacite slope alluvium or colluvium parent materials. The ground surface is typically characterized by bunch grasses with inter grass spaces covered with leaf litter or some exposed soil. The vegetation is characterized by abundant to luxuriant growth of *Festuca thurberi* with *Carex inops* ssp. *heliophila*, *Elymus elymoides*, and *Poa pratensis* as common associates. *Danthonia parryi* is poorly represented or absent. Forbs are moderately diverse but variable from stand to stand with cover that is usually less than 10%. Trees are rare or incidental but can include such conifer species as *Abies concolor*, *Pinus ponderosa*, or *Pseudotsuga menziesii*. Typically, shrubs are absent as well, though occasionally such species as *Juniperus communis*, *Ribes inerme*, or *Rosa woodsii* can be common to well represented.

DISTRIBUTION

Bandelier National Monument

This common association is known from the mountain slopes of Cerro Grande, Scooter Peak, and Rabbit Mountain.

Globally

This montane association occurs in the Colorado Rocky Mountains and in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This high elevation association occurs between 2760 and 2950 m (9050-9680 feet) on sites with moderate to high solar exposure (mostly southerly aspects). Stands are found from the toe to upper slopes of mountains (5 to 25% slope). Soils are mapped as well developed and relatively deep Mollisols with loamy textures in a cobbly matrix. They are derived from latite and dacite slope alluvium or colluvium parent materials (Hibner 2009). The ground surface is typically characterized by bunch grasses with inter grass spaces covered with leaf litter or some exposed soil.

Globally

This high elevation association occurs between 2760 and 2950 m (9050-9680 feet) on sites with moderate to high solar exposure (mostly southerly aspects). Stands are found from the toe to upper slopes of mountains (5-25%

slope). Soils are mapped as well developed and relatively deep Mollisols with loamy textures in a cobbly matrix. They are derived from latite and dacite slope alluvium or colluvium parent materials (Hibner 2009). The ground surface is typically characterized by bunch grasses with inter grass spaces covered with leaf litter or some exposed soil.

VEGETATION DESCRIPTION

Bandelier National Monument

This montane grassland association is characterized by abundant to luxuriant growth of *Festuca thurberi* with *Carex inops* ssp. *heliophila*, *Elymus elymoides*, and *Poa pratensis* as common associates among 12 graminoid species recorded for the association. *Danthonia parryi* is poorly represented or absent. Forbs are moderately diverse (26 species have been recorded for the association) but variable from stand to stand with cover that is usually less than 10%. *Potentilla hippiana* is the typical dominant along with other open meadow species such as *Achillea millefolium* and *Taraxacum officinale* as common associates; occasionally *Iris missouriensis*, *Campanula rotundifolia*, *Erigeron formosissimus*, *Senecio eremophilus*, and *Symphyotrichum ascendens* are prevalent. Trees are rare or incidental but can include such conifer species as *Abies concolor*, *Pseudotsuga menziesii*, or *Pinus ponderosa*. Typically, shrubs are absent as well, though occasionally such species as *Juniperus communis*, *Ribes inerme*, or *Rosa woodsii* can be common to well represented.

Globally

This montane grassland association is characterized by abundant to luxuriant growth of *Festuca thurberi* with *Carex inops* ssp. *heliophila*, *Elymus elymoides*, and *Poa pratensis* as common associates among 12 graminoid species reported for the association. *Danthonia parryi* is poorly represented or absent. Forbs are moderately diverse (26 species have been reported) but variable from stand to stand with cover that is usually less than 10%. *Potentilla hippiana* is the typical dominant along with other open meadow species such as *Achillea millefolium* and *Taraxacum officinale* as common associates; occasionally *Campanula rotundifolia*, *Erigeron formosissimus*, *Iris missouriensis*, *Senecio eremophilus*, and *Symphyotrichum ascendens* are prevalent. Trees are rare or incidental but can include such conifer species as *Abies concolor*, *Pinus ponderosa*, or *Pseudotsuga menziesii*. Typically, shrubs are absent as well, though occasionally such species as *Juniperus communis*, *Ribes inerme*, or *Rosa woodsii* can be common to well represented.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Festuca thurberi, Poa pratensis*

Globally

Stratum	Species
Herb (field)	*Festuca thurberi*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Poa pratensis, *Taraxacum officinale*.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (23 Feb 1994).

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Poa pratensis* phase occurs where it exceeds 10% cover (cover can reach high enough to dominate the graminoids).

Except for lacking codominance of *Danthonia parryi*, this association is similar to *Festuca thurberi - Danthonia parryi* / *Potentilla hippiana* Herbaceous Vegetation (CEGL005377). Balice et al. (1997) and McKown et al. (2003) have reported a similar montane grassland dominated by *Danthonia parryi* and *Festuca thurberi* for the Los Alamos region. Muldavin and Tonne (2003) and Muldavin et al. (2006) described a *Festuca thurberi - Poa pratensis* Plant Association for the adjacent Valles Caldera National Preserve that is synonymous with this association.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD038, 03BD049, 03YC002, 06JC500.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King

REFERENCES

Balice et al. 1997, Bourgeron and Engelking 1994, Boyce 1977, CONHP unpubl. data 2003, Cox 1968, Driscoll et al. 1984, Giese 1975, Hess 1981, Hess and Wasser 1982, Hibner 2009, Johnson 1939, Johnson 1970a, Keammerer and Stoecker 1980, Klemmedson 1953, Klish 1977, Komarkova 1986, Langenheim 1956, McKown et al. 2003, Miller 1964, Morgan 1969, Muldavin and Tonne 2003, Muldavin et al. 2006, Paulsen 1960, Paulsen 1970a, Paulsen 1970b, Ramaley 1942, Rydberg 1915, Soil Conservation Service 1978, Turner and Dortignac 1954, Western Ecology Working Group n.d.

Festuca thurberi - Danthonia parryi / Potentilla hippiana Herbaceous Vegetation

Thurber's Fescue - Parry's Oatgrass / Woolly Cinquefoil Herbaceous Vegetation

CODE	CEGL005377
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	FESTUCA THURBERI HERBACEOUS ALLIANCE (A.1256) Thurber's Fescue Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Montane Subalpine Grassland (CES306.824)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This montane grassland occurs in north central New Mexico between 2710 and 2950 m (8900-9680 feet) elevation on sites with moderate to high solar exposure that increases with elevation. Stands are found on gentle footslopes or shoulder slopes (5-10% slope) to moderately steep upper backslopes (up to 40%). Soils are primarily mapped as well developed and relatively deep Mollisols with textures that are loamy to clayey in a gravelly to cobbly matrix. They are derived from latite and dacite slope alluvium or colluvium parent materials. The ground surface is typically characterized by bunch grasses with inter grass spaces covered with leaf litter or some exposed soil. The vegetation is characterized by abundant to luxuriant growth of *Festuca thurberi* with *Danthonia parryi* as a codominant. *Carex inops* ssp. *heliophila*, *Elymus elymoides*, and *Poa pratensis* are common associates. Forbs are moderately diverse but variable from stand to stand with cover that is usually less than 10%. Trees are rare or incidental but can include such conifer species as *Abies concolor*, *Pinus ponderosa*, or *Pseudotsuga menziesii*. Typically, shrubs are absent as well, though occasionally such species as *Juniperus communis*, *Ribes leptanthum*, or *Rosa woodsii* can be common to well represented.

DISTRIBUTION

Bandelier National Monument

This common association is known from the mountain slopes of Cerro Grande, Scooter Peak, and Rabbit Mountain along the northern and western boundary of the park.

Globally

This montane grassland association occurs in north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This high elevation association occurs between 2710 and 2950 m (8900-9680 feet) on sites with moderate to high solar exposure that increases with elevation (i.e., aspects tend to be more northerly at lower elevation and more southerly on higher sites). Stands are found on gentle footslopes or shoulder slopes (5-10% slope) to moderately steep upper backslopes (up to 40%). Soils are primarily mapped as well developed and relatively deep Mollisols with textures that are loamy to clayey in a gravelly to cobbly matrix. They are derived from latite and dacite slope alluvium or colluvium parent materials (Hibner 2009). The ground surface is typically characterized by bunch grasses with inter grass spaces covered with leaf litter or some exposed soil.

Globally

This high elevation association occurs between 2710 and 2950 m (8900-9680 feet) on sites with moderate to high solar exposure that increases with elevation (i.e., aspects tend to be more northerly at lower elevation and more southerly on higher sites). Stands are found on gentle footslopes or shoulder slopes (5-10% slope) to moderately steep upper backslopes (up to 40%). Soils are primarily mapped as well developed and relatively deep Mollisols with textures that are loamy to clayey in a gravelly to cobbly matrix. They are derived from latite and dacite slope alluvium or colluvium parent materials (Hibner 2009). The ground surface is typically characterized by bunch grasses with inter grass spaces covered with leaf litter or some exposed soil.

VEGETATION DESCRIPTION

Bandelier National Monument

This montane grassland association is characterized by abundant to luxuriant growth of *Festuca thurberi* with *Danthonia parryi* as a codominant. *Carex inops* ssp. *heliophila*, *Elymus elymoides*, and *Poa pratensis* are common associates among 29 graminoid species recorded for the association. Forbs are moderately diverse (25 species have been recorded for the association) but variable from stand to stand with cover that is usually less than 10%. *Potentilla hippiana* is the typical dominant along with other open meadow species such as *Achillea millefolium* and *Iris missouriensis* as common associates; occasionally *Campanula rotundifolia*, *Erigeron formosissimus*, and *Arenaria fendleri* are prevalent. Trees are rare or incidental but can include such conifer species as *Abies concolor*, *Pseudotsuga menziesii*, or *Pinus ponderosa*. Typically, shrubs are absent as well, though occasionally such species as *Juniperus communis*, *Ribes leptanthum*, or *Rosa woodsii* can be common to well represented.

Globally

This montane grassland is characterized by abundant to luxuriant growth of *Festuca thurberi* with *Danthonia parryi* as a codominant. *Carex inops* ssp. *heliophila*, *Elymus elymoides*, and *Poa pratensis* are common associates among 29 graminoid species reported for the association. Forbs are moderately diverse but variable from stand to stand with cover that is usually less than 10%. *Potentilla hippiana* is the typical dominant along with other open meadow species such as *Achillea millefolium* and *Iris missouriensis* as common associates; occasionally *Arenaria fendleri*, *Campanula rotundifolia*, and *Erigeron formosissimus* are prevalent. Trees are rare or incidental but can include such conifer species as *Abies concolor*, *Pinus ponderosa*, or *Pseudotsuga menziesii*. Typically, shrubs are absent as well, though occasionally such species as *Juniperus communis*, *Ribes leptanthum*, or *Rosa woodsii* can be common to well represented.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Danthonia parryi, Festuca thurberi*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (17 Feb 2009)

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Poa pratensis* phase occurs where it exceeds 10% cover (and it may dominate over *Festuca thurberi* and *Danthonia parryi* on these occasions). Except for the codominance of *Danthonia parryi*, this association is similar to *Festuca thurberi* - (*Lathyrus lanszwertii* var. *leucanthus*, Potentilla spp.) Herbaceous Vegetation (CEGL001630). Balice et al. (1997) and McKown et al. (2003) have reported a similar montane grassland dominated by *Danthonia parryi* and *Festuca thurberi* for the Los Alamos region. Muldavin and Tonne (2003) and Muldavin et al. (2006) described a *Festuca thurberi - Danthonia parryi* Plant Association for the adjacent Valles Caldera National Preserve that is synonymous with this association.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD032, 03BD047, 06JC209, 06JC217, 06JC505, 06JC511.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Balice et al. 1997, Hibner 2009, McKown et al. 2003, Muldavin and Tonne 2003, Muldavin et al. 2006, Western Ecology Working Group n.d.

Muhlenbergia montana - Schizachyrium scoparium Herbaceous Vegetation

Mountain Muhly - Little Bluestem Herbaceous Vegetation

CODE	CEGL005381
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	MUHLENBERGIA MONTANA HERBACEOUS ALLIANCE (A.1260) Mountain Muhly Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Montane Subalpine Grassland (CES306.824)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This mid elevation association occurs on sites with moderate solar exposure (mostly northerly aspects). Stands generally occur on gently rolling mesatops (4-10%) and occasionally on moderately steep mesa toeslopes (25%). Soils are primarily mapped as well developed Mollisols derived from rhyolitic tuff or pumice slope alluvium, or occasionally as fine textured Alfisols derived from eolian deposits over rhyolitic tuff residuum. The ground surface is typically characterized by bunch grasses with inter grass spaces covered with leaf litter or some exposed soil. Elevation ranges between 2200 and 2360 m (7220-7740 feet). This montane grassland association is characterized by abundant to luxuriant growth of *Muhlenbergia montana* with *Schizachyrium scoparium* as a codominant. *Bouteloua gracilis* and *Andropogon gerardii* are also common associates. Total grass cover can approach 50%. Forbs are typically well represented in these grasslands and most frequently include *Artemisia carruthii* and *Heterotheca villosa*. Among trees, scattered *Pinus ponderosa* saplings and mature trees can occur, but cover is less than 10%. Shrubs are also poorly represented, but *Quercus gambelii* and *Robinia neomexicana* may be common.

DISTRIBUTION

Bandelier National Monument

This common association is known from Burnt and Escobas mesas and Mesa del Rito.

Globally

This association is only known to occur at Bandelier National Monument in north central New Mexico, but likely occurs elsewhere in the southern Rocky Mountains.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid elevation association occurs between 2200 and 2360 m (7220-7740 feet) on sites with moderate solar exposure (mostly northerly aspects). Stands generally occur on gently rolling mesatops (4-10%) and occasionally on moderately steep mesa noseslopes (25%). Soils are primarily mapped as well developed Mollisols derived from rhyolitic tuff or pumice slope alluvium, or occasionally as fine textured Alfisols derived from eolian deposits over rhyolitic tuff residuum (Hibner 2009). The ground surface is typically characterized by bunch grasses with inter grass spaces covered with leaf litter or some exposed soil.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This montane grassland association is characterized by abundant to luxuriant growth of *Muhlenbergia montana* with *Schizachyrium scoparium* as a codominant. *Bouteloua gracilis* and *Andropogon gerardii* are also common associates. Total grass cover can approach 50%. Forbs are typically well represented in these grasslands and most frequently include *Artemisia carruthii* and *Heterotheca villosa*. Among trees, scattered *Pinus ponderosa* saplings and mature trees can occur, but cover is less than 10%. Shrubs are also poorly represented, but *Quercus gambelii* and *Robinia neomexicana* may be common.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Muhlenbergia montana, Schizachyrium scoparium*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (18 Feb 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

McKown et al. (2003) have reported a similar submontane grassland dominated by *Muhlenbergia montana*, *Blepharoneuron tricholepis*, and *Schizachyrium scoparium* for the Los Alamos region.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 06AB164, 06AB166, 06AB168, 06JC160, 06JC176, 06JC597.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Hibner 2009, McKown et al. 2003, Western Ecology Working Group n.d.

Muhlenbergia montana Herbaceous Vegetation

Mountain Muhly Herbaceous Vegetation

CODE	CEGL001646
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	MUHLENBERGIA MONTANA HERBACEOUS ALLIANCE (A.1260) Mountain Muhly Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Montane Subalpine Grassland (CES306.824)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This plant association has been described from meadows in the mountains, plateaus and foothills of Colorado, Arizona, Utah, and in north central New Mexico. Sites are typically xeric forest openings or parks in the ponderosa pine zone with southern aspects on moderately steep slopes and ridgetops. Occasionally the stands occupy rolling parklands or volcanic cinder fields. The xeric nature of sites appears to be an important environmental factor. Substrates are shallow to moderately deep, rocky, sand to sandy loam textured soils. Bare soil, exposed gravels, and small rocks account for as much as 50% of the ground surface area. The vegetation is characterized by a moderately dense herbaceous layer that is typically dominated by the warm season, perennial bunchgrass *Muhlenbergia montana*, but may be codominated by *Blepharoneuron tricholepis* or *Trisetum spicatum* (= *Trisetum montanum*) (in New Mexico). Other associated graminoids include *Bouteloua curtipendula*, *Bouteloua gracilis*, *Danthonia parryi*, *Festuca brachyphylla*, *Hesperostipa comata*, *Koeleria macrantha*, *Muhlenbergia filiculmis*, *Pascopyrum smithii*, *Poa secunda*, and *Schizachyrium scoparium*. In New Mexico, deer sedges (*Carex inops* ssp. *heliophila*, *Carex occidentalis*, and *Carex rossii*) and *Schizachyrium scoparium* are common associates. The typically sparse forb layer often consists of *Allium geyeri*, *Antennaria rosea*, *Arenaria fendleri*, *Eriogonum umbellatum*, *Heterotheca villosa*, and *Phlox diffusa*. Except for the abundant dwarf shrub *Artemisia frigida*, scattered *Ericameria nauseosa* shrub, or occasional *Pinus ponderosa* trees, woody species are very sparse or absent. In New Mexico, shrubs are poorly represented, but *Quercus gambelii* and *Robinia neomexicana* may be present. The exotic grasses *Poa pratensis* and *Bromus tectorum* are common in some of these stands. Diagnostic of this grassland association is the dominance of *Muhlenbergia montana* in the herbaceous layer and low cover of *Festuca arizonica*. It can be distinguished from *Muhlenbergia montana - Hesperostipa comata* Herbaceous Vegetation (CEGL001647) by the very low cover or lack of *Hesperostipa comata*.

DISTRIBUTION

Bandelier National Monument

This association is known from the slopes of upper Alamo and Capulin canyons.

Globally

This plant association has been described from meadows in the mountains, plateaus and foothills of Colorado, Arizona, Utah, and north central New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid to upper elevation association occurs between 2540 and 2570 m (8350-8400 feet) on sites with moderate to

high solar exposure (mostly southerly aspects). Stands occur commonly on moderate slopes (5-15%) but occasionally on steep canyonsides (up to 50%). Soils are mapped as well developed and relatively deep Mollisols with loamy textures. They are derived from latite and dacite slope alluvium parent materials (Hibner 2009). The ground surface is typically characterized by bunch grasses with inter grass spaces covered with leaf litter or some exposed soil.

Globally

This plant association has been described from meadows in the mountains, plateaus and foothills of Colorado, Arizona, Utah, and north central New Mexico. Elevation ranges from 2300-2800 m (7540-9200 feet). Sites are typically xeric forest openings or parks in the ponderosa pine zone with southern aspects on moderately steep slopes and ridgetops. In New Mexico, stands occur commonly on moderate slopes (5-15%) but occasionally on steep canyonsides (up to 50%). Occasionally the stands occupy rolling parklands or volcanic cinder fields. The xeric nature of these sites appears to be an important environmental factor. Substrates are shallow to moderately deep, rocky, sand to sandy loam textured soils sometimes with a distinct clay horizon. Parent materials are primarily colluvium derived from granite and gneiss or cinder, but may include clay loam soils, or latite and dacite slope alluvium parent materials (Hibner 2009). Bare soil, exposed gravels, and small rocks may account for as much as 50% of the ground surface area. In north central New Mexico, the ground surface is typically characterized by bunch grasses with inter grass spaces covered with leaf litter or some exposed soil.

VEGETATION DESCRIPTION

Bandelier National Monument

This montane grassland association is characterized by abundant to luxuriant growth of *Muhlenbergia montana* with *Blepharoneuron tricholepis* as a codominant. Deer sedges (*Carex inops* ssp. *heliophila*, *Carex rossii*, and *Carex occidentalis*) and *Schizachyrium scoparium* are common associates. Forbs are variable from stand to stand with cover that is usually less than 10%. *Artemisia ludoviciana* and *Heterotheca villosa* are most frequent. Among trees, scattered *Pinus ponderosa* saplings and mature trees can occur, but cover is less than 10%. Shrubs are also poorly represented, but *Quercus gambelii* and *Robinia neomexicana* may be present.

Globally

Vegetation is characterized by a moderately dense to dense herbaceous layer that is typically dominated by the warm season, perennial bunchgrass *Muhlenbergia montana*, but may be codominated by *Blepharoneuron tricholepis* or *Trisetum spicatum* (= *Trisetum montanum*) (in New Mexico). Other associated graminoids include *Bouteloua curtipendula*, *Bouteloua gracilis*, *Carex duriuscula* (= *Carex eleocharis*), *Danthonia parryi*, *Elymus albicans* (= *Elymus lanceolatus* ssp. *albicans*), *Elymus lanceolatus* ssp. *lanceolatus* (= *Elytrigia dasystachya*), *Festuca brachyphylla*, *Festuca arizonica* (low cover), *Hesperostipa comata* (low cover), *Koeleria macrantha*, *Muhlenbergia filiculmis*, *Pascopyrum smithii*, *Poa secunda*, and *Schizachyrium scoparium*. In New Mexico, deer sedges (*Carex inops* ssp. *heliophila*, *Carex occidentalis*, and *Carex rossii*) and *Schizachyrium scoparium* are common associates. The typically sparse forb layer often consists of *Allium geyeri*, *Antennaria rosea*, *Arenaria fendleri*, *Eriogonum umbellatum*, *Harbouria trachypleura*, *Heterotheca villosa*, *Mertensia lanceolata*, *Opuntia polyacantha*, *Penstemon secundiflorus*, and *Phlox diffusa*. Except for the abundant dwarf shrub *Artemisia frigida*, scattered *Ericameria nauseosa* shrubs, or occasional *Pinus ponderosa* trees, woody species are very sparse or absent. In New Mexico, shrubs are poorly represented, but *Quercus gambelii* and *Robinia neomexicana* may be present. The exotic grasses *Poa pratensis* and *Bromus tectorum* are common in some of these stands. Diagnostic of this grassland association is the dominance of *Muhlenbergia montana* in the herbaceous layer and low cover of *Festuca arizonica*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Blepharoneuron tricholepis, Muhlenbergia montana*

Globally

Stratum	Species
Herb (field)	*Blepharoneuron tricholepis, Muhlenbergia montana, Trisetum spicatum*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Bromus tectorum, *Harbouria trachypleura*, *Poa pratensis*.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G4 (23 Feb 1994).

CLASSIFICATION COMMENTS

Bandelier National Monument

McKown et al. (2003) have reported a similar submontane grassland dominated by *Muhlenbergia montana*, *Blepharoneuron tricholepis*, and *Schizachyrium scoparium* for the Los Alamos region. Muldavin and Tonne (2003) and Muldavin et al. (2006) describe a *Blepharoneuron tricholepis - Muhlenbergia montana* Plant Association for the adjacent Valles Caldera National Preserve that is synonymous with this association.

Globally

Diagnostic of this grassland association is the dominance of *Muhlenbergia montana* in the herbaceous layer and low cover of *Festuca arizonica*. This association can be distinguished from *Muhlenbergia montana - Hesperostipa comata* Herbaceous Vegetation (CEGL001647) by the low cover (<10% absolute cover and <25% relative cover) or lack of *Hesperostipa comata*.

Muldavin and Tonne (2003) and Muldavin et al. (2006) describe a *Blepharoneuron tricholepis - Muhlenbergia montana* association for Valles Caldera National Preserve that is synonymous with this association.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 06JC188, 06JC540, 06JC631, 06JC633.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz, mod. G. Kittel and K.S. King

REFERENCES

Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Clary 1978, Driscoll et al. 1984, Fischer and Bradley 1987, Hansen et al. 2004c, Hibner 2009, Johnston 1987, Loveless 1963, Loveless 1967, McIntosh 1923, McKown et al. 2003, Merkle 1962, Muldavin and Tonne 2003, Muldavin et al. 2003, Muldavin et al. 2006, Ramaley 1915, Ramaley 1916a, Ramaley 1916b, Reid 1974, Shanks 1977, Shepherd 1975, Terwilliger et al. 1979b, USFS 1983b, Western Ecology Working Group n.d.

Poa pratensis - (*Pascopyrum smithii*) Semi natural Herbaceous Vegetation

Kentucky Bluegrass (Western Wheatgrass) Semi natural Herbaceous Vegetation

CODE	CEGL005265
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Medium tall bunch temperate or subpolar grassland (V.A.5.N.d.)
ALLIANCE	POA PRATENSIS SEMI NATURAL HERBACEOUS ALLIANCE (A.3562) Kentucky Bluegrass Semi natural Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Montane Subalpine Grassland (CES306.824)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This Kentucky bluegrass type is widespread throughout the Great Plains, the midwestern United States and plains of Canada, throughout montane elevations in the Colorado Plateau and southern Rocky Mountains. Stands can occur in a wide variety of upland human disturbed and native habitats. Stands are typically found on fine textured, poorly drained, often alluvial or well developed soils that are topographically situated to receive supplemental moisture, such as flat areas, swales, creek bottoms, riparian areas, moist toeslopes of upland draws and drainages. The vegetation is dominated by medium tall (0.5-1 m) graminoids. The dominant grass is *Poa pratensis*, considered to be both a native and naturalized species from Eurasia. Other native species may occur as well, but they are generally less than 10% cover. Native species may include mixed grass prairie grasses, such as *Pascopyrum smithii* and *Hesperostipa comata* (= *Stipa comata*), as well as others. Where native species are conspicuous enough to identify the native plant association that could occupy the site, the stand should be typed as such. This type includes only naturalized examples of *Poa pratensis* stands. Maintained lawns are treated as cultural types.

DISTRIBUTION

Bandelier National Monument

This association is known from the slopes of Cerro Grande.

Globally

This Kentucky bluegrass type is potentially widespread throughout the Great Plains and into the midwestern United States and Canada. Stands are also found on upland sites in the northwestern Great Plains and occur elsewhere in the western U.S. where *Poa pratensis* has invaded native western rangeland.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This mid to high elevation association occurs between 2210 and 2950 m (7200-9680 feet) on sites with relatively high solar exposure. Stands are found on mountain sideslopes and rolling mesatops. Soils are mapped as well developed, deep, and fine textured Mollisols derived from latite, dacite, rhyolite tuff, or pumice slope alluvium. The ground surface is typically characterized by mats of rhizomatous grasses intermixed with leaf litter, scattered bunch grasses, or exposed soil.

Globally

This Kentucky bluegrass type is potentially widespread throughout the Great Plains and into the midwestern United

States and Canada, at montane elevations in the Colorado Plateau and southern Rocky Mountains, and elsewhere in the western U.S. where the introduced perennial *Poa pratensis* has invaded native western rangeland. Stands can occur in a wide variety of upland human disturbed and native habitats. Stands in western North Dakota are found on deep, well developed, fine textured soils that are topographically situated to receive supplemental moisture in the form of runoff from adjacent slopes. Such conditions exist in the toeslopes of upland draws and drainages, and in shallow depressions on north and east facing, nearly level slopes. Stands in the semi arid western U.S. are typically found at montane elevations (1800-3250 m) on lowland and relatively mesic upland sites, such as canyon floors and swales on high terraces with permanently saturated soils. Substrates are also typically finer textured, poorly drained alluvial soils. The unvegetated surface has a moderate to high cover of litter.

VEGETATION DESCRIPTION

Bandelier National Monument

This semi natural montane meadow association is characterized by the luxuriant cover codominated by exotic *Poa pratensis* and the native *Pascopyrum smithii* with an admixture of graminoids and forbs that may include *Carex occidentalis*, *Bouteloua gracilis*, *Schizachyrium scoparium*, *Muhlenbergia montana* among the graminoids and *Artemisia carruthii*, *Artemisia dracunculus*, *Heterotheca villosa*, and *Antennaria parvifolia* among forbs. Among trees, scattered *Pinus ponderosa* saplings and mature trees can occur, but cover is less than 10%. Shrubs are generally poorly represented, but *Quercus gambelii*, *Ceanothus fendleri*, or *Robinia neomexicana* may occur on occasion.

Globally

The vegetation is dominated by medium tall (0.5-1 m) graminoids. The dominant grass is *Poa pratensis*, considered to be both a native and naturalized species from Eurasia (Great Plains Flora Association 1986, Gleason and Cronquist 1991). Other native species may occur as well, but they are generally less than 10% cover. Native species may include mixedgrass prairie grasses, such as *Pascopyrum smithii* and *Hesperostipa comata* (= *Stipa comata*), as well as other mesic forbs, such as *Achillea millefolium* and exotic *Taraxacum officinale*.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Pascopyrum smithii, Poa pratensis*

Globally

Stratum	Species
Herb (field)	*Poa pratensis*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Poa pratensis.

Globally

Poa pratensis, *Taraxacum officinale*.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (17 Jun 1999). This is primarily a naturalized type from Europe and Asia, widely planted for lawns and pasture, and it has escaped into a variety of habitats (Great Plains Flora Association 1986, Gleason and Cronquist 1991). Although native populations do exist and may be integral parts of some prairie and other native habitats, most stands that are thoroughly dominated by *Poa pratensis* are a result of human modifications to the habitat.

CLASSIFICATION COMMENTS

Bandelier National Monument

Data are not available.

Globally

The debate over whether *Poa pratensis* is either native or introduced appears to be resolved in favor of it being both (Great Plains Flora Association 1986, Gleason and Cronquist 1991). The Great Plains Flora Association (1986) cites Boivin and Love (1960) as the source of this decision. Gleason and Cronquist (1991) state that in most parts of their Manual's range (Northeast and Midwest United States and adjacent Canada), the species is introduced, but that it is probably native along their northern boundary and in Canada.

This type could be narrowly restricted to mixed grass prairie stands where *Poa pratensis* dominates to the exclusion of most other species, or it could be expanded to include almost any naturalized stand dominated by *Poa pratensis*. Where native species are conspicuous enough to identify the native plant association that could occupy the site, the stand should be typed as such. This type includes only naturalized examples of *Poa pratensis* stands. Maintained lawns are treated as cultural types.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03AB040, 06AB202, 03BD078, 03BD139, 06AB176.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: D. Faber Langendoen, mod. K.A. Schulz

REFERENCES

Butler et al. 2002, Gleason and Cronquist 1991, Great Plains Flora Association 1986, MTNHP 2002b, Midwestern Ecology Working Group n.d., NDNHI n.d., Trammell 1994, USFS 1937, Von Loh et al. 2000

Bouteloua eriopoda - Bouteloua curtipendula Herbaceous Vegetation

Black Grama Sideoats Grama Herbaceous Vegetation

CODE	CEGL001747
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 ERIOPODA HERBACEOUS ALLIANCE (A.1284) Black Grama Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Apacherian Chihuahuan Semi Desert Grassland and Steppe (CES302.735)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This semi desert grassland occurs on bajadas and midslopes of small desert mountain ranges and mesas, from north central to south central New Mexico to southeastern Arizona and likely extends into northern Mexico. Elevations range from 1340 to 1975 m (4400-6475 feet). Slopes can be gentle to very steep and with variable aspects. Parent materials are sandstone and limestone colluvium, basalt colluvium or rock outcrop. Soils are sandy loam in texture, often with much gravel and rock on the soil surface (over 50% cover together). Soils may be shallow or of moderate depth with indurated carbonate layers. Ground cover is characterized by scattered bunch grasses in a matrix of boulders and rocks. This association is characterized by sparse to moderate cover of perennial bunch grasses, of which *Bouteloua eriopoda* and *Bouteloua curtipendula* are the most abundant and characteristic species. Several other perennial grasses may be present, including *Aristida* spp., *Dasyochloa pulchella* (= *Erioneuron pulchellum*), *Bouteloua gracilis*, *Pleuraphis mutica* (= *Hilaria mutica*), and *Muhlenbergia porteri*. The forb component is variable and diverse with total forb cover less than 10% and often less than 5%. Forb species typical of these desert grasslands may include *Allionia incarnata*, *Bahia absinthifolia*, *Baileya multiradiata*, *Croton texensis*, *Gaillardia pulchella*, *Melampodium leucanthum*, *Penstemon fendleri*, and *Zinnia* spp. Most stands have scattered shrubs present, typically having less than 10% cover. Most species are microphyllous evergreens or succulents, the former including *Ephedra trifurca*, *Ephedra nevadensis*, *Gutierrezia sarothrae*, and *Gutierrezia microcephala*; the later including *Yucca elata*, *Yucca baccata*, and *Opuntia* spp. Other shrubs may include *Acacia constricta*, *Aloysia wrightii*, *Parthenium incanum*, and *Prosopis glandulosa*. The diagnostic characteristics of this sparse to moderately dense grassland are the codominance of *Bouteloua eriopoda* and *Bouteloua curtipendula* often with scattered *Ephedra* spp. or other desert shrubs.

DISTRIBUTION

Bandelier National Monument

This minor association is known from the slopes of White Rock Canyon and Canon de los Frijoles.

Globally

This semi desert grassland occurs on bajadas and midslopes of small desert mountain ranges and mesas, from north central to south central New Mexico, southeastern Arizona, and likely extends into northern Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This low elevation association ranges from 1660 to 1975 m (5480-6475 feet) on sites with high solar exposure (predominantly warmer southerly aspects). Stands are found on steep and rocky canyon slopes. Soils are mapped as

rocky Aridisols derived from basalt colluvium or rock outcrop. Ground cover is characterized by scattered bunch grasses in a matrix of boulders and rocks.

Globally

This semi desert grassland occurs on bajadas and midslopes of small desert mountain ranges and mesas, from north central to south central New Mexico to southeastern Arizona and likely extends into northern Mexico. Elevations range from 1340 to 1975 m (4400-6475 feet). Slopes can be gentle to very steep and with variable aspects. Parent materials are sandstone and limestone colluvium, basalt colluvium or rock outcrop. Soils are sandy loam in texture, often with much gravel and rock on the soil surface (over 50% cover together). Soils may be shallow or of moderate depth with indurated carbonate layers. Ground cover is characterized by scattered bunch grasses in a matrix of boulders and rocks. This association is found in a semidesert region. The climate is characterized by a wide diurnal range of temperatures, relatively low humidities, and annual precipitation ranging from 22 to 35 cm. Over 50% of the annual precipitation falls from July to October as rain resulting from convectional thunderstorms. Summers are hot, while winters can occasionally be cold.

VEGETATION DESCRIPTION

Bandelier National Monument

This sparse semi arid grassland association is dominated by *Bouteloua eriopoda* and *Bouteloua curtipendula* with total grass cover ranging from 10-25%. Other bunch grasses such as *Sporobolus cryptandrus*, *Aristida purpurea*, and *Schizachyrium scoparium* may be present but cover is low. Forb diversity and overall cover are low; the most common forb is *Chaetopappa ericoides*. Shrubs, with the exception of *Gutierrezia sarothrae*, are not dominant and seldom exceed 5% cover. *Opuntia imbricata* (= *CylindrOpuntia imbricata*) and *Yucca baccata* are typical shrub associates. Trees are absent or occur as a few scattered individuals of *Juniperus monosperma*.

Globally

This grassland association is characterized by sparse to moderate cover of mid height perennial bunch grasses, of which *Bouteloua eriopoda* and *Bouteloua curtipendula* are the most abundant and characteristic species. Cover of these two species ranges from 1-10%, and from less than 1% to over 20%, respectively. Several other perennial grasses can occur, including several *Aristida* spp., *Dasyochloa pulchella* (= *Erioneuron pulchellum*), and *Bouteloua gracilis*. The forb component is variable and diverse, but total forb cover is less than 10% and often less than 5%. Species typical of desert grasslands include *Allionia incarnata*, *Bahia absinthifolia*, *Baileya multiradiata*, *Gaillardia pulchella*, *Melampodium leucanthum*, and *Penstemon fendleri*. Most stands have a scattered shrub layer, typically having less than 10% cover. Most species are microphyllous evergreens or succulents, the former including *Ephedra trifurca*, *Ephedra nevadensis*, *Gutierrezia sarothrae*, and *Gutierrezia microcephala*; the later including *Yucca elata*, *Yucca baccata*, and *Opuntia* species.

Within Bandelier National Monument, this sparse semi arid grassland is dominated by *Bouteloua eriopoda* and *Bouteloua curtipendula* with total grass cover ranging from 10-25%. Other bunch grasses such as *Aristida purpurea*, *Schizachyrium scoparium* and *Sporobolus cryptandrus* may be present, but cover is low. Forb diversity and overall cover are low; the most common forb is *Chaetopappa ericoides*. Shrubs, with the exception of *Gutierrezia sarothrae*, are not dominant and seldom exceed 5% cover. *Opuntia imbricata* (= *Cylindropuntia imbricata*) and *Yucca baccata* are typical shrub associates. Trees are absent or occur as a few scattered individuals of *Juniperus monosperma*.

At White Sands Missile Range, this association is characterized by an abundant to luxuriant cover of *Bouteloua eriopoda* with *Bouteloua curtipendula* as a codominant. Other grass species present include *Aristida purpurea*, *Bouteloua gracilis*, and *Bouteloua hirsuta*. Shrubs are scattered and diverse, with common species including *Dalea formosa*, *Gutierrezia sarothrae*, *Opuntia phaeacantha*, *Parthenium incanum*, and *Yucca baccata*. The forb layer is moderate in diversity but highly variable (Muldavin et al. 2000b).

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Bouteloua curtipendula, Bouteloua eriopoda*

Globally

Stratum	Species
Herb (field)	*Bouteloua curtipendula, Bouteloua eriopoda*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G2 (10 Nov 1997). This once extensive desert grassland of the Chihuahuan Desert and Southern Great Plains Ecoregions has experienced significant declines throughout its range, resulting in conversions to desert shrublands. These grasslands have been heavily impacted and compositionally altered by grazing over the last two centuries. Remaining examples that are not grazed and not invaded by desert shrubs are rare.

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Gutierrezia sarothrae* phase is assigned where its cover exceeds 5%. This is a minor association in Bandelier National Monument, but it is well documented elsewhere in New Mexico and the Southwest.

Globally

This vegetation may also occur in Texas and needs to be compared with *Bouteloua curtipendula - Bouteloua* (*eriopoda*, *gracilis*) Herbaceous Vegetation (CEGL002250). This association needs to be compared with the several *Bouteloua eriopoda* shrub herbaceous associations dominated by *Ephedra trifurca*, *Prosopis glandulosa*, *Parthenium incanum*, or *Yucca elata*. This association is generally found on piedmont slopes with gravelly substrates often with sandy loam textured soils. The similar association *Bouteloua eriopoda - Bouteloua gracilis* Herbaceous Vegetation (CEGL001748) is often found on tablelands where finer textured loam and silt loam soils are present. Does the increased soil moisture holding properties of the finer textured soils favor this similar community?

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03AB005, 06AB194.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: M.S. Reid, mod. K.A. Schulz and K.S. King

REFERENCES

Anderson et al. 1985, Bourgeron and Engelking 1994, Driscoll et al. 1984, Johnson 1961c, Muldavin and Mehlhop 1992, Muldavin et al. 1998c, Muldavin et al. 2000b, NMNHP unpubl. data, Reid et al. 1994, Stein and Ludwig 1979, UNESCO 1973, Western Ecology Working Group n.d.

Bouteloua eriopoda - Bouteloua gracilis Herbaceous Vegetation

Black Grama - Blue Grama Herbaceous Vegetation

CODE	CEGL001748
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 ERIOPODA HERBACEOUS ALLIANCE (A.1284) Black Grama Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Apacherian Chihuahuan Semi Desert Grassland and Steppe (CES302.735), Western Great Plains Shortgrass Prairie (CES303.672)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This grassland association occurs on tablelands in a transition zone between the Southern Great Plains, within Bandelier National Monument in north central New Mexico, and in the Chihuahuan Desert in southern New Mexico. It likely extends into adjacent Texas and northern Mexico. Stands have also been described from colluvial slopes in northwestern New Mexico and from valley bottoms, slopes and benches in isolated desert mountains in southwestern New Mexico. In north central New Mexico, this association is known from low to mid elevation mountain slopes and foothills, but can form more extensive stands on the upper alluvial fan piedmonts. Elevations range from 1430-1950 m. Sites are often flat to gently sloping, but range to moderately steep with variable aspects. Soils are often gravelly or sandy loam derived from gravely and sandy alluvium parent materials. On mesatops the soils are finer textured sandy and silty loam. This desert grassland also occurs on piedmonts (bajadas) in Lower Creek watershed, San Bernardino and Animas valleys, and on cindercones of the San Bernardino Malpai. It is found in small occurrences at low to mid elevations (1500-1600 m [4900-5300 feet]). The largest occurrences are found near Red Hill in the Animas Valley and along the Mexican border in the Deer Creek watershed.

This association is characterized by sparse to moderate cover of perennial bunch grasses, of which *Bouteloua eriopoda* (1-20% cover) and *Bouteloua gracilis* (1-12% cover) are the most abundant and characteristic species. Other perennial grasses that may be present include several *Aristida* spp., *Bouteloua curtipendula*, *Bouteloua hirsuta*, *Eragrostis intermedia*, *Pleuraphis jamesii* (= *Hilaria jamesii*), and *Pleuraphis mutica* (= *Hilaria mutica*). The forb component is variable and may be diverse, but total forb cover is less than 10% and often less than 5%. Forb species typical of these desert grasslands may include species of *Croton*, *Eriogonum*, *Sida*, *Solanum*, *Sphaeralcea*, *Talinum*, or *Zinnia*. Some stands have scattered shrubs present, typically with less than 5% cover. Species include *Ephedra trifurca*, *Gutierrezia sarothrae*, *Opuntia imbricata*, *Prosopis glandulosa*, and *Yucca elata*. The diagnostic characteristics of this sparse to moderately dense grassland are the codominance of *Bouteloua eriopoda* and *Bouteloua gracilis* often with scattered shrubs.

DISTRIBUTION

Bandelier National Monument

This association is known from White Rock, Lummis, and Capulin canyons.

Globally

This grassland association occurs on tablelands in a transition zone between the Southern Great Plains, within Bandelier National Monument in north central New Mexico, and in the Chihuahuan Desert in southern New Mexico. It likely extends into adjacent Texas and northern Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This low elevation association ranges from 1670 to 1725 m (5480-5660 feet) on sites with moderate to high solar exposure (predominantly warmer southerly aspects). Slopes range from gentle to moderate on the toe and footslopes of the canyons (10-30%). Soils are mapped as rocky Aridisols derived from basalt colluvium or as Entisols derived from pumice (Hibner 2009). Ground cover is characterized by scattered bunch grasses in a matrix of rock, gravels, exposed soil, and litter.

Globally

This association occurs on low to mid elevation mountain slopes and foothills, but can form more extensive stands on the upper alluvial fan piedmonts. Elevation ranges from 1490 to 1830 m (4900-6000 feet). Slopes range from very gentle to moderate on the toe and footslopes of the canyons (10-30%). Aspects are often cool, but sites may have moderate to high solar exposure (predominantly warmer southerly aspects). Soils include moderately deep, coarse to fine textured skeletal loams, with indurated carbonate layers (Muldavin et al. 2000b), rocky Aridisols derived from basalt colluviums or Entisols derived from pumice (Hibner 2009). Ground cover is characterized by scattered bunch grasses in a matrix of rock, gravels, exposed soil, and litter.

This desert grassland also occurs on piedmonts (bajadas) in Lower Creek watershed, San Bernardino and Animas valleys, and on cindercones of the San Bernardino Malpai. It is found in small occurrences at low to mid elevations (1500 1600 m [4900 5300 feet]). The largest occurrences are found near Red Hill in the Animas Valley and along the Mexican border in the Deer Creek watershed.

VEGETATION DESCRIPTION

Bandelier National Monument

In this semi arid grassland, graminoid cover ranges from 5 to 35% and is dominated by *Bouteloua eriopoda* and *Bouteloua gracilis*. Forbs can be common to abundant and include such shortgrass prairie species as *Glandularia bipinnatifida* and *Machaeranthera pinnatifida* var. *pinnatifida* (= *Xanthisma spinulosum*). Overall herbaceous species richness is moderate, with 11 graminoid and 16 forb species recorded for this association. Shrubs can be well represented, but not dominant, and with the subshrub *Gutierrezia sarothrae* and the succulent *Opuntia phaeacantha* the most constant and abundant. Trees are absent or represented by scattered individuals of *Juniperus monosperma*.

Globally

Within Bandelier National Monument, graminoid cover ranges from 5 to 35% and is dominated by *Bouteloua eriopoda* and *Bouteloua gracilis*. Forbs can be common to abundant and include such shortgrass prairie species as *Glandularia bipinnatifida* and *Machaeranthera pinnatifida* var. *pinnatifida* (= *Xanthisma spinulosum*). Overall herbaceous species richness is moderate, with 11 graminoid and 16 forb species recorded for this association. Shrubs can be well represented, but not dominant, and with the subshrub *Gutierrezia sarothrae* and the succulent *Opuntia phaeacantha* the most constant and abundant. Trees are absent or represented by scattered individuals of *Juniperus monosperma*. Within White Sands Missile Range, this association is highly diverse, but is generally characterized by an abundant to luxuriant cover of *Bouteloua eriopoda* with *Bouteloua gracilis* codominant or subdominant. *Aristida purpurea*, *Bouteloua curtipendula*, and *Bothriochloa barbinodis* are usually well represented. Shrubs are common but mostly represented by dwarf shrubs such as *Gutierrezia sarothrae*, *Parthenium incanum*, *Dalea formosa*, and *Opuntia phaeacantha*. Forb diversity can be high but variable from stand to stand (Muldavin et al. 2000b).

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Bouteloua eriopoda, Bouteloua gracilis*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G2 (10 Nov 1997). This once extensive desert grassland of the Chihuahuan Desert and Southern Great Plains Ecoregions has experienced significant declines throughout its range, resulting in conversions to desert shrublands. These grasslands have been heavily impacted and compositionally altered by grazing over the last two centuries. Remaining examples that are not grazed and not invaded by desert shrubs are rare.

CLASSIFICATION COMMENTS

Bandelier National Monument

This association is well documented elsewhere in New Mexico, particularly to the south.

Globally

This association may also occur outside the Great Plains in Texas. It needs to be compared with *Bouteloua curtipendula Bouteloua* (*eriopoda*, *gracilis*) Herbaceous Vegetation (CEGL002250).

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03AB007, 03AB011, 03BD096, 03BD134.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz, mod. K.S. King

REFERENCES

Arbetan et al. 2002, Bourgeron and Engelking 1994, Bourgeron et al. 1993b, Bourgeron et al. 1995, DeOliviera 1961, Diamond 1993, Dick Peddie 1986, Donart et al. 1978a, Driscoll et al. 1984, Francis 1986, Gardner 1951, Hibner 2009, Muldavin and Mehlhop 1992, Muldavin et al. 1998a, Muldavin et al. 1998c, Muldavin et al. 1998d, Muldavin et al. 1999, Muldavin et al. 2000b, Muldavin et al. 2000c, Muldavin et al. 2003, Western Ecology Working Group n.d., Whitfield and Anderson 1938

Eleocharis palustris - Carex praegracilis - Berula erecta Herbaceous Vegetation

Common Spikerush - Clustered Field Sedge Cutleaf Water parsnip Herbaceous Vegetation

CODE	CEGL002634
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k.)
ALLIANCE	ELEOCHARIS (PALUSTRIS, MACROSTACHYA) SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1422) (Common Spikerush, Page Spikerush) Seasonally Flooded Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

North American Warm Desert Cienega (CES302.747), North American Warm Desert Interdunal Swale Wetland (CES302.039), North American Arid West Emergent Marsh (CES300.729)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This association is restricted to southeastern Arizona, north central and southwestern New Mexico, and northern Sonora, Mexico. It is found along perennial streams in valleys and mountain foothills, from 1060-1700 m elevation. The habitats supporting cienega marshes are associated with perennial springs and headwater streams, with permanent, scarcely fluctuating sources of water. The valleys where they occur are typically wide and gently sloping, where flood velocities are readily dissipated. The soils consist of layers of organic peats and fine textured silts, and can build to depths of several meters. These spongelike soils store water and provide a base flow during drought periods. As described here, this association is composed of the emergent, herbaceous vegetation found in the areas of shallower water between pools rather than the deeper zones of these cienegas. Vegetation is composed of a highly diverse mixture of perennial and annual forb and graminoid species. Structurally these herbaceous species form a dense mat of growth, typically around 0.5 m in height. Perennial, semi aquatic sedges and rushes are typically dominant. Some of the more constant and abundant species include *Eleocharis palustris*, *Juncus balticus*, *Schoenoplectus americanus* (= *Scirpus americanus*), *Carex praegracilis*, *Carex pellita* (= *Carex lanuginosa*), and *Cyperus* spp. Some of the more common grasses include *Panicum bulbosum*, *Polypogon monspeliensis*, *Muhlenbergia asperifolia*, and *Elymus trachycaulus* ssp. *trachycaulus*. Forbs can be locally common and include such species as *Berula erecta*, *Bidens aurea*, *Bidens ferulifolia*, *Bidens laevis*, *Hydrocotyle* spp., *Ranunculus macranthus*, *Oenothera speciosa*, and *Mimulus guttatus*. There are occasionally woody species occurring within the herbaceous matrix, primarily from nearby sites supporting riparian woodlands.

DISTRIBUTION

Bandelier National Monument

This minor association is known from the mouth of Ancho Canyon.

Globally

This association is restricted to southeastern Arizona, north central and southwestern New Mexico, and northern Sonora, Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association occurs at 1650 m (5400 feet) elevation in canyon bottoms of low solar exposure. Stands occur on alluvial terraces and bars adjacent to perennial stream channels with gradients less than 5%. Ground cover is domi-

nated by volcanic boulders and exposed soil. The ground surface is typically characterized by mats of rhizomatous graminoids and litter with some exposed soil or gravel.

Globally

The association is found along perennial streams in valleys and mountain foothills, from 1060-1700 m elevation. The climate of the region is continental with hot summers and mild winters. Annual precipitation has a bi-modal distribution with summer convective storms and winter frontal storms contributing almost equal proportions, primarily as rainfall.

The habitats supporting cienega marshes are associated with perennial springs and headwater streams, with permanent, scarcely fluctuating sources of water. The valleys where they occur are typically wide and gently sloping, where flood velocities are readily dissipated. The hydrologic regimes are characterized as low energy, with low probability of scouring from floods and rarely subjected to harsh winter conditions. There are gradients of water availability within these marshes, from areas of deep to shallow perennial water bordered by drier margins with intermittently saturated soils. The soils consist of layers of organic peats and fine textured silts, and can build to depths of several meters. These sponge like soils store water and provide a base flow during drought periods. As described here, this association is composed of the emergent, herbaceous vegetation found in the areas of shallower water between pools rather than the deeper zones of these cienegas.

VEGETATION DESCRIPTION

Bandelier National Monument

This herbaceous wetland is characterized by a luxuriant cover of graminoids dominated by *Eleocharis palustris* with a mixture of other obligate and facultative wetland species such as *Juncus saximontanus* (= *Juncus ensifolius* var. *montanus*), *Juncus dudleyi*, *Leersia oryzoides*, *Schoenoplectus* spp., *Lolium arundinaceum* (= *Festuca arundinacea*), and *Polypogon viridis*. Among forbs, the obligate wetland species *Berula erecta* is abundant and diagnostic, along with a suite of other wetland indicators such as *Epilobium ciliatum*, *Mimulus glabratus*, *Veronica americana*, *Ranunculus cymbalaria*, and *Monarda fistulosa* var. *menthifolia*. While trees are generally rare or absent, scattered seedlings of *Acer negundo* and *Elaeagnus angustifolia* can occur. Shrubs are also scattered and may include *Artemisia filifolia* moving in from the surrounding uplands along with wetland species such as *Salix exigua* and *Tamarix ramosissima*.

Globally

This association is composed of a highly diverse mixture of perennial and annual forb and graminoid species. Structurally these herbaceous species form a dense mat of growth, typically around 0.5 m in height. Perennial, semi aquatic sedges and rushes are typically dominant. Some of the more constant and abundant species include *Eleocharis palustris*, *Juncus balticus*, *Schoenoplectus americanus* (= *Scirpus americanus*), *Carex praegracilis*, *Carex pellita* (= *Carex lanuginosa*), and *Cyperus* spp. Some of the more common grasses include *Panicum bulbosum*, *Polypogon monspeliensis*, *Muhlenbergia asperifolia*, and *Elymus trachycaulus* ssp. *trachycaulus*. Forbs can be locally common and include such species as *Berula erecta*, *Bidens aurea*, *Bidens ferulifolia*, *Bidens laevis*, *Hydrocotyle* spp., *Ranunculus macranthus*, *Oenothera speciosa*, and *Mimulus guttatus*. There are occasionally woody species occurring within the herbaceous matrix, primarily from nearby sites supporting riparian woodlands. The broad leaved deciduous trees *Populus fremontii*, *Salix gooddingii*, and/or *Salix lasiolepis* may occasionally be present.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Berula erecta*
Herb (field)	*Eleocharis palustris*

Globally

Stratum	Species
Herb (field)	*Berula erecta, Ranunculus macranthus*
Herb (field)	*Carex praegracilis, Eleocharis palustris, Juncus balticus, Schoenoplectus americanus, Typha domingensis*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Elaeagnus angustifolia, *Lolium arundinaceum*, *Polypogon viridis*, *Tamarix ramosissima*.

Globally

Lilaeopsis schaffneriana var. *recurva*, *Polypogon monspeliensis*, *Spiranthes delitescens*.

CONSERVATION STATUS RANK

Global Rank & Reasons: G2 (23 Feb 1994). This association is currently known from fewer than 20 high quality occurrences. It is restricted in geographic range of distribution, as well as being dependent upon permanent, perennial streamflow. It may formerly have been more widespread in the region, but has been severely reduced in abundance because of water diversions, erosion, and agricultural development. All occurrences are highly vulnerable as a result of these continuing threats.

CLASSIFICATION COMMENTS

Bandelier National Monument

Data are not available.

Globally

Floristic composition is very diverse and highly variable within sites, in relation to wet and dry zones, and between sites due to local hydrology and history.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plot: 03BR003.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: M.S. Reid

REFERENCES

Cross 1991, Davis 1992, Driscoll et al. 1984, Gori 1992, Hendrickson and Minckley 1984, Reid et al. 1994, Stromberg 1993b, Western Ecology Working Group n.d.

Juncus arcticus Herbaceous Vegetation

Baltic Rush Herbaceous Vegetation

CODE	CEGL001838
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k.)
ALLIANCE	JUNCUS BALTICUS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1374) Baltic Rush Seasonally Flooded Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Inter Mountain Basins Interdunal Swale Wetland (CES304.059), Boreal Wet Meadow (CES103.873), North American Arid West Emergent Marsh (CES300.729), Northern Columbia Plateau Basalt Pothole Pond (CES304.058), Western Great Plains Open Freshwater Depression Wetland (CES303.675), Rocky Mountain Alpine Montane Wet Meadow (CES306.812), Temperate Pacific Subalpine Montane Wet Meadow (CES200.998), Rocky Mountain Lower Montane Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This Baltic rush community is found widely throughout the western United States and into western Canada. This herbaceous wet meadow occurs as small to extensive, open to typically dense patches on flat stream benches, along overflow channels, and near springs. Habitats are often alkaline meadows and may have long term grazing disturbance. Soils are variable and range from poorly to well drained, sandy clay loam to fine sand textured and are usually mottled or gleyed. Stands are characterized by dense swards of *Juncus arcticus*(=*J. balticus*). In montane zones and the Great Basin, minor cover of *Carex* species, including *Carex aquatilis*, *Carex praegracilis*, *Carex nebrascensis*, or *Carex utriculata*, is often present; other common species include *Deschampsia caespitosa*, *Distichlis spicata*, *Glyceria striata*, *Hordeum jubatum*, *Muhlenbergia asperifolia*, *Pascopyrum smithii*, *Phleum alpinum*, and *Sporobolus airoides*. The introduced perennial sod grasses *Poa pratensis* or *Agrostis stolonifera* codominate some stands. Forb cover is generally low and includes wetland species such as *Caltha leptosepala*, *Rumex aquaticus*, and *Dodecatheon pulchellum*. *Iris missouriensis* can be common in heavily grazed stands. Shrubs are not common. This association is often considered to be a grazing induced community since it increases with disturbance, though it can be a stable late seral community.

DISTRIBUTION

Bandelier National Monument

This association is known from Sierra de los Valles (Rabbit Mountain, Scooter Peak, and Cerro Grande).

Globally

This Baltic rush wet meadow community is found widely throughout the western United States, ranging from South Dakota and Nebraska west to Washington, south to California, and east to New Mexico. It also occurs in western Canada.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This high elevation association occurs between 2470 and 2730 m (8100-8950 feet) in valley bottoms of low slope and moderate solar exposure. Soils are mapped as well developed and relatively deep Mollisols with loamy textures derived rhyolitic slope alluvium. The ground surface is typically characterized by mats of rhizomatous graminoids and

litter with little exposed soil or rock.

Globally

This broadly defined and widespread herbaceous wetland community is found throughout western North America. Elevation ranges from 138 to 3500 m (454-11,475 feet). Far northern stands in the Boreal Plains are at about 800 m (2625 feet). Stands usually occur as small, dense patches on flat to gently sloping sites near seeps and streams. Stream channels are highly variable in size and type, ranging from narrow to moderately wide, and from deeply entrenched to very sinuous (Kittel et al. 1999b). In the boreal regions, this community occurs more commonly on gradual sandy shorelines. Soils are also variable and range from sandy well drained to poorly drained silty clay loam or silty clay alluvium to organic muck; however, soils tend to be finer textured, alkaline and may be saline (Brotherson and Barnes 1984, Padgett et al. 1989, Kittel et al. 1999b). Sites with sandy soils are usually saturated for part of the growing season or have high water tables. Cobbles and gravel are common on many sites, and gleyed and mottled horizons are often present because of flooding or high water tables (Kittel et al. 1999b).

VEGETATION DESCRIPTION

Bandelier National Monument

This wet mountain meadow is characterized by the dominance of facultative or obligate wetland graminoids that include well represented to abundant *Juncus arcticus* (=*J. balticus*)) along with *Carex microptera*, *Carex pellita*, or *Deschampsia caespitosa*. *Poa pratensis* is well represented to abundant and codominant. Forbs are also represented by wet meadow species such as *Ranunculus cardiophyllus* and *Mentha arvensis*.

Globally

This broadly defined association is characterized by a low (<50 cm), open to typically dense graminoid layer dominated by the rhizomatous perennial *Juncus balticus* (=*J. arcticus*). In montane zones and the Great Basin, minor cover of *Carex* species, including *Carex aquatilis*, *Carex praegracilis*, *Carex microptera*, *Carex nebrascensis*, or *Carex utriculata*, is often present. Other common graminoids include *Deschampsia caespitosa*, *Distichlis spicata*, *Glyceria striata*, *Hordeum brachyantherum*, *Hordeum jubatum*, *Muhlenbergia andina*, *Muhlenbergia asperifolia*, *Pascopyrum smithii*, *Poa nemoralis* ssp. *interior*, *Phleum alpinum*, and *Sporobolus airoides*. Forb cover is generally low but may include *Achillea millefolium*, *Artemisia ludoviciana*, *Caltha leptosepala*, *Cirsium scariosum* (= *Cirsium tioganum*), *Dodecatheon pulchellum*, *Glaux maritima*, *Iris missouriensis*, *Maianthemum stellatum*, *Rumex aquaticus*, *Polygonum bistortoides*, *Potentilla plattensis*, and *Solidago canadensis*. Many other forb species may be present, given the wide elevational amplitude and broad geographic spread of this type. Shrubs and dwarf shrubs are not common; however, *Artemisia frigida* cover may be significant in some stands, and occasional *Artemisia cana*, *Artemisia tridentata* ssp. tridentata, *Dasiphora fruticosa* ssp. *floribunda*, *Ericameria nauseosa*, *Populus* spp., *Rosa woodsii*, *Salix* spp., or *Sarcobatus vermiculatus* shrubs may occur. Some stands may be codominated by the introduced perennial sod grasses *Poa pratensis*, *Bromus inermis*, or *Agrostis stolonifera*. Other introduced species, such as *Cirsium arvense*, *Cirsium vulgare*, *Erodium cicutarium*, *Iva axillaris*, *Lactuca serriola*, *Phleum pratense*, *Taraxacum officinale*, *Thinopyrum intermedium*, *Trifolium* spp., *Tragopogon dubius*, *Xanthium strumarium*, and others, may occur in disturbed stands.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Carex microptera, Carex pellita, Juncus arcticus, Poa pratensis*

Globally

Stratum	Species
Herb (field)	*Juncus arcticus*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Poa pratensis.

Globally

Agrostis stolonifera, *Bromus inermis*, *Cirsium arvense*, *Cirsium vulgare*, *Erodium cicutarium*, *Iva axillaris*, *Lactuca serriola*, *Phleum pratense*, *Poa pratensis*, *Taraxacum officinale*, *Thinopyrum intermedium*, *Tragopogon dubius*, *Xanthium strumarium*.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Carex pellita* phase occurs where cover exceeds 25%. Muldavin et al. (2003, 2006) described this association for the adjacent Valles Caldera National Preserve.

Globally

This association is often considered to be a grazing induced community since it increases with grazing disturbance. Based on the extensive geographic and environmental range (from alpine meadows to sagebrush dominated landscapes), it verges on astonishing that any number of *Juncus balticus* associations have not been recognized.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD042, 03YC103, 06JC168.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: J. Drake, mod. D. Faber Langendoen, K.A. Schulz, L. Allen, G. Kittel

REFERENCES

ANHIC 2005, Baker 1984a, Bourgeron and Engelking 1994, Brotherson and Barnes 1984, Bunin 1985, Butler et al. 2002, CONHP unpubl. data 2003, Carsey et al. 2003a, Carsey et al. 2003b, Christy 2004, Cogan et al. 2004, Cowardin et al. 1979, Crowe and Clausnitzer 1997, Crowe et al. 2004, Donnelly et al. 2006, Driscoll et al. 1984, Evans 1989b, Evenden 1990, Faber Langendoen 2001, Flowers 1962, Hall and Hansen 1997, Hansen et al. 1995, Henderson and McAllister 1983, Hess 1981, IDCDC 2005, Jankovsky Jones et al. 1999, Jankovsky Jones et al. 2001, Johnston 1987, Jones 1992b, Jones and Walford 1995, Kagan et al. 2000, Kartesz 1994a, Kierstead and Pogson 1976, Kittel and Lederer 1993, Kittel et al. 1997a, Kittel et al. 1999a, Kittel et al. 1999b, Klein et al. 2007, Komarkova 1986, Kovalchik 1987, Kunze 1994, MTNHP 2002b, Manning 1988, Manning and Padgett 1991, Manning and Padgett 1992, Muldavin et al. 2000a, Muldavin et al. 2003, Muldavin et al. 2006, Murray 2000, Mutel 1973, Mutz and Graham 1982, Olson and Gerhart 1982, Padgett 1981, Padgett 1982, Padgett et al. 1989, Rector 1979, Richard et al. 1996, Shupe et al. 1986, Stewart 1940, Taylor 1980, Taylor and Teare 1979a, Thompson and Hansen 2002, Titus and Christy 1996a, Tuhy and Jensen 1982, Volland 1976, WNHP unpubl. data, Wasser and Hess 1982, Western Ecology Working Group n.d., Youngblood et al. 1985a

Gutierrezia sarothrae / Bouteloua gracilis Dwarf shrub Herbaceous Vegetation

Broom Snakeweed / Blue Grama Dwarf shrub Herbaceous Vegetation

CODE	CEGL005382
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland with a sparse dwarf shrub layer (V.A.8.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi natural temperate or subpolar grassland with a sparse dwarf shrub layer (V.A.8.N.)
FORMATION	Short temperate or subpolar lowland grassland with a sparse needle leaved or microphyllous dwarf shrub layer (V.A.8.N.a.)
ALLIANCE	BOUTELOUA GRACILIS DWARF SHRUB HERBACEOUS ALLIANCE (A.1571) Blue Grama Dwarf shrub Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Western Great Plains Foothill and Piedmont Grassland (CES303.817)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This grassland association is known to occur in the mountains of northern New Mexico. It most commonly occurs on gently rolling mesatops, terraces, and occasionally along canyon footslopes (4-10% slopes) on sites with moderate solar exposure. Elevation ranges from 1670 to 2230 m (5470-7310 feet). Soils are primarily fine textured Alfisols derived from eolian or slope alluvium deposits over rhyolitic tuff residuum, or occasionally well developed Mollisols derived from pumice slope alluvium. The ground surface is characterized by bunchgrass patches in a matrix of exposed soil and litter with little or no gravel or rock. The vegetation within this association is characterized by abundant to luxuriant grass cover dominated by *Bouteloua gracilis* (30-60%). Other common grasses may include *Elymus elymoides*, *Pleuraphis jamesii*, and *Sporobolus cryptandrus*. While forbs are typically poorly represented, the ruderal subshrub *Gutierrezia sarothrae* can be dominant and reach up to 30% cover. Ruderal succulents such as *Opuntia phaeacantha* or *Opuntia polyacantha* may also be common. Trees are absent or represented by scattered individuals of *Juniperus monosperma* or *Pinus edulis*, mostly as seedlings or saplings.

DISTRIBUTION

Bandelier National Monument

This common association is known from the Tsankawi Unit, Burnt Mesa, White Rock Canyon, Lummis, Alamo, and Capulin canyons.

Globally

This grassland association is known to occur in the mountains of northern New Mexico.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This low to mid elevation association ranges from 1670 to 2230 m (5470-7310 feet) on sites with moderate solar exposure. Stands most commonly occur on gently rolling mesatops, terraces, and occasionally along canyon footslopes (slopes range from 4-10%). Soils are primarily mapped as fine textured Alfisols derived from eolian or slope alluvium deposits over rhyolitic tuff residuum or occasionally as well developed Mollisols derived from pumice slope alluvium (Hibner 2009). The ground surface is characterized by bunchgrass patches in a matrix of exposed soil and litter with little or no gravel or rock.

Globally

This association most commonly occurs on gently rolling mesatops, terraces, and occasionally along canyon foot-

slopes (4-10% slopes) on sites with moderate solar exposure. Elevation ranges from 1670 to 2230 m (5470-7310 feet). Soils are primarily fine textured Alfisols derived from eolian or slope alluvium deposits over rhyolitic tuff residuum, or occasionally well developed Mollisols derived from pumice slope alluvium (Hibner 2009). The ground surface is characterized by bunchgrass patches in a matrix of exposed soil and litter with little or no gravel or rock.

VEGETATION DESCRIPTION

Bandelier National Monument

Vegetation is characterized by abundant to luxuriant grass cover dominated by *Bouteloua gracilis* (30-60%). Other common grasses are *Pleuraphis jamesii*, *Elymus elymoides*, and *Sporobolus cryptandrus*. While forbs are typically poorly represented, the ruderal subshrub *Gutierrezia sarothrae* can be dominant and reach up to 30% cover. Ruderal succulents such as *Opuntia polyacantha* or *Opuntia phaeacantha* are also common. Trees are absent or represented by scattered individuals of *Juniperus monosperma* or *Pinus edulis*, mostly as seedlings or saplings.

Globally

Vegetation is characterized by abundant to luxuriant grass cover dominated by *Bouteloua gracilis* (30-60%). Other common grasses are *Pleuraphis jamesii*, *Elymus elymoides*, and *Sporobolus cryptandrus*. While forbs are typically poorly represented, the ruderal subshrub *Gutierrezia sarothrae* can be dominant and reach up to 30% cover. Ruderal succulents such as *Opuntia polyacantha* or *Opuntia phaeacantha* are also common. Trees are absent or represented by scattered individuals of *Juniperus monosperma* or *Pinus edulis*, mostly as seedlings or saplings.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Bouteloua gracilis*

Globally

Stratum	Species
Herb (field)	*Gutierrezia sarothrae*
Herb (field)	*Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (18 Feb 2009).

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Carex pellita* phase occurs where cover exceeds 25%. Muldavin et al. (2003, 2006) described this association for the adjacent Valles Caldera National Preserve.

Globally

This association is often considered to be a grazing induced community since it increases with grazing disturbance. Based on the extensive geographic and environmental range (from alpine meadows to sagebrush dominated landscapes), it verges on astonishing that any number of *Juncus balticus* associations have not been recognized.

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM plots: 03ER031, 06AB154, 06AB178, 06BF015, 03AB001, 03AB012, 06JC128.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Kennedy and E. Muldavin

REFERENCES

Francis 1986, Hibner 2009, Western Ecology Working Group n.d.

V. Hierarchy Placement Undetermined and Incidentals

Park Specials

Acer negundo / *Salix irrorata* Forest [Park Special]

Box-elder / Bluestem Willow Forest [Park Special]

CODE	Park Special
PHYSIOGNOMIC CLASS	Not applicable
PHYSIOGNOMIC SUBCLASS	Not applicable
PHYSIOGNOMIC GROUP	Not applicable
PHYSIOGNOMIC SUBGROUP	Not applicable
FORMATION	Not applicable
ALLIANCE	Not applicable

ECOLOGICAL SYSTEM(S)

Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

Data are not available.

DISTRIBUTION

Bandelier National Monument

This association occurs in the bottoms of Ancho Canyon and Canon de los Frijoles.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This riparian association is found at elevations between 1695 and 1700 m (5560-5580 feet) along canyon bottoms with low solar exposure. Stands occur on alluvial terraces and bars adjacent to perennial stream channels with gradients less than 10%. The substrates are alluvial deposits derived from basalt and andesite volcanics. The ground surface is characterized by shrubs rooted among rhizomatous grasses, exposed gravels and soil-intermixed litter patches.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This riparian forest association is characterized by *Acer negundo* forming open to moderately closed tree canopies with a shrubby understory dominated by *Salix irrorata* (20-70% total cover). *Forestiera pubescens* and *Rhus trilobata* are also common to well-represented. The herbaceous layer is well-represented by a rich mix of riparian and upland mesic graminoids and forbs (27 species), and may include *Carex brevior*, *Dichanthelium oligosanthes* var. *scribnerianum*, *Poa compressa*, *Polygonum persicaria*, and *Rorippa nasturtium-aquaticum*.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Acer negundo*
Tall shrub/sapling	*Salix irrorata*
Herb (field)	*Carex brevior, Dichanthelium oligosanthes* var. *scribnerianum*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Associated species: *Forestiera pubescens*, *Rhus trilobata*, *Fallugia paradoxa*. The exotics *Bromus tectorum* and *Melilotus officinalis* can be common in the herbaceous layer.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS

Bandelier National Monument

Data are not available.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BR004, 06JC201.).

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: Data are not available

REFERENCES

Western Ecology Working Group n.d.

Elymus x *pseudorepens* - *Bromus carinatus* Semi-natural Herbaceous Vegetation [Park Special]

False Quackgrass - California Brome Semi-natural Herbaceous Vegetation [Park Special]

CODE	Park Special
PHYSIOGNOMIC CLASS	Not applicable
PHYSIOGNOMIC SUBCLASS	Not applicable
PHYSIOGNOMIC GROUP	Not applicable
PHYSIOGNOMIC SUBGROUP	Not applicable
FORMATION	Not applicable
ALLIANCE	Not applicable

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

Data are not available.

DISTRIBUTION

Bandelier National Monument

This is a special park association is known from post-fire sites in Capulin Canyon, and the Cerro Grande area.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This miF- to upper-elevation association occurs between 2475 and 2730 m (8120-8950 feet) on sites with moderate solar exposure. Most sites were burned during the Cerro Grande (2000) or Dome (1996) fires. Stands are found on gently rolling mesatops of low slopes (<10%) and moderate mountain sideslopes (up to 30%).

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This semi-natural montane grassland association is characterized by abundant to luxuriant growth of species that were part of post-fire rehabilitation seed mixes: *Elymus* X *pseudorepens*, *Elymus trachycaulus*, *Bromus carinatus*, *Bromus catharticus*, and *Bromus inermis*. Overall graminoid richness is moderate (25 species) and includes non-seeded graminoids such as deer sedges (*Carex inops* ssp. *heliophila* and *Carex pellita*) and the exotic *Poa pratensis*. Forbs species richness is also moderate (22 species) and characterized by meadow and forest edge species such as *Oreochrysum parryi*, *Geranium richardsonii*, *Achillea millefolium*, and *Taraxacum officinale*. There are occasional shrub patches of *Quercus gambelii* and *Robinia neomexicana*, but overall shrub cover is generally less than 5%. Trees are absent or only represented by scattered seedlings and young poles of *Populus tremuloides* or *Pinus ponderosa*.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Elymus X pseudorepens, Elymus trachycaulus, Bromus carinatus*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Exotic species: *Bromus inermis*, *Poa pratensis*.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS

Bandelier National Monument

This is a special semi-natural association for the park that is prevalent because of extensive artificial seeding after the La Mesa, Dome, and Cerro Grande fires.

This association is likely synonymous with *Bromus carinatus - Agropyron trachycaulum* Grassland reported by McKown et al. (2003) form post-Cerro Grande rehabilitation sites in the Los Alamos region. While *Bromus carinatus* is usually present in our stands, it is never the dominant.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03AB051, 03BD070, 03BD072, 06JC163, 06JC169, 06JC629.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: Data are not available

REFERENCES

McKown et al. 2003, Western Ecology Working Group n.d.

Forestiera pubescens / Ruderal Herbs Shrubland [Park Special]

Stretchberry / Weedy Herbs Shrubland [Park Special]

CODE	Park Special
PHYSIOGNOMIC CLASS	Not applicable
PHYSIOGNOMIC SUBCLASS	Not applicable
PHYSIOGNOMIC GROUP	Not applicable
PHYSIOGNOMIC SUBGROUP	Not applicable
FORMATION	Not applicable
ALLIANCE	Not applicable

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

Data are not available.

DISTRIBUTION

Bandelier National Monument

This special park association is known only from the bottom of lower Hondo Canyon but likely occurs in other canyons of the park.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This low-elevation association occurs at 1810 m (5940 feet) on a shaded flat alluvial terrace adjacent to the drainage bottom and bounded by canyon walls. The ground surface is characterized by abundant grass and herbaceous litter.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This lower-montane canyon shrubland is dominated by a luxuriant (70% cover) growth of the hybrid scrub oak *Quercus* X *pauciloba* and *Forestiera pubescens* and other scattered shrubs common to canyon environments of the park (*Ribes cereum*, *Rhus trilobata*, *Parthenocissus vitacea*, and *Ptelea trifoliata*). The herbaceous understory is dominated by the annual exotic *Bromus tectorum* among scattered annual forbs.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tall shrub/sapling	*Quercus X pauciloba, Forestiera pubescens*
Herb (field)	*Bromus tectorum*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Associated Species: *Ribes cereum*, *Rhus trilobata*, *Parthenocissus vitacea*, *Ptelea trifoliata*. The Eurasian invasive annual grass *Bromus tectorum* dominates the herbaceous layer.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS

Bandelier National Monument

This is a special semi-natural association for the park that may result from periodic reservoir inundation.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM plots: 03ER028, 06AB196, 06AB192, 03ER024.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: Data are not available

REFERENCES

Western Ecology Working Group n.d.

Muhlenbergia montana - Seeded Grasses Herbaceous Vegetation [Park Special]

Mountain Muhly - Seeded Grasses Herbaceous Vegetation [Park Special]

CODE	Park Special
PHYSIOGNOMIC CLASS	Not applicable
PHYSIOGNOMIC SUBCLASS	Not applicable
PHYSIOGNOMIC GROUP	Not applicable
PHYSIOGNOMIC SUBGROUP	Not applicable
FORMATION	Not applicable
ALLIANCE	Not applicable

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

Data are not available.

DISTRIBUTION

Bandelier National Monument

This special park association is known from post-fire areas of Lummis and Escobas mesas and Mesa del Rito.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This miF-elevation association occurs between 2140 and 2490 m (7030-8170 feet) on gently rolling mesatops. It is limited to post-fire sites that were artificially reseeded. Soils are mapped as well-developed Mollisols derived from rhyolitic tuff or pumice slope alluvium. The ground surface is typically characterized by bunch grasses with inter-grass spaces covered with leaf litter or some exposed soil.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This semi-natural montane grassland association is characterized by abundant to luxuriant growth of *Muhlenbergia montana* with an assortment of grasses that were part of post-fire rehabilitation seed mixes. *Pascopyrum smithii*, *Bromus inermis*, and *Festuca idahoensis* are the most common and abundant. Total grass cover can approach 50%. Forbs are common to well-represented in these grasslands and most frequently include *Artemisia carruthii*, *Erigeron flagellaris*, *Antennaria parvifolia*, *Verbascum thapsus*, *Artemisia ludoviciana*, *Bahia dissecta*, *Bidens frondosa*, *Lupinus argenteus*, and *Heterotheca villosa*. Among trees, scattered *Pinus ponderosa* saplings and mature trees can occur, but cover is less than 10%. Shrubs are generally poorly represented, but *Quercus gambelii* and *Robinia neomexicana* may be common.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Muhlenbergia montana, Pascopyrum smithii*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Bromus inermis and *Festuca idahoensis* are present as part of a post-fire seed mix.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS

Bandelier National Monument

This is a special semi-natural association for the park that is prevalent because of extensive artificial seeding after the La Mesa, Dome, and Cerro Grande fires.

McKown et al. (2003) have reported a similar *Bromus carinatus - Agropyron trachycaulum* Grassland from post-Cerro Grande rehabilitation sites in the Los Alamos region.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots 06AB161, 06BF024, 06JC621.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: Data are not available

REFERENCES

McKown et al. 2003, Western Ecology Working Group n.d.

Pascopyrum smithii / Ruderal Herbaceous Vegetation [Park Special]

Western Wheatgrass / Weedy Herbaceous Vegetation [Park Special]

CODE	Park Special
PHYSIOGNOMIC CLASS	Not Applicable
PHYSIOGNOMIC SUBCLASS	Not Applicable
PHYSIOGNOMIC GROUP	Not Applicable
PHYSIOGNOMIC SUBGROUP	Not Applicable
FORMATION	Not Applicable
ALLIANCE	Not Applicable

ECOLOGICAL SYSTEM(S):

Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

Data are not available.

DISTRIBUTION

Bandelier National Monument

This association is known from Escobas and Burnt Mesas.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association occurs between 7,180-7,570 ft (2,190-2,300 m) in elevation on gently rolling mesa tops. Sites show evidence of having been burned in the last 50 years. Substrates are colluvium derived from Bandelier tuff. The ground cover is characterized by scattered bunch grasses in a matrix of exposed soil and litter.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This grassland dominated by *Pascopyrum smithii* that was mostly likely artificially established on post-fire forest and woodland sites. There are variety of other graminoids, but they generally low in cover and inconsistent in occurrence (*Bouteloua gracilis* is the most common). Forbs species richness is high (26 species), and ruderal species are particularly common such as *Artemisia carruthii, Artemisia dracunculus, Lupinus argenteus, Cirsium undulatum,* and *Erigeron divergens*. Tree and shrub species are rare or absent.

Globally

Data are not available.

MOST ABUNDANT SPECIES
Bandelier National Monument

Stratum	Species
Herb (field)	*Pascopyrum smithii, Bouteloua gracilis*
Herb (field)	*Artemisia carruthii, Artemisia dracunculus*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES
Bandelier National Monument

Association species: *Lupinus argenteus*, *Cirsium undulatum*, and *Erigeron divergenss*

Globally

Data are not available.

CONSERVATION STATUS RANK
Global Rank & Reasons: Not Applicable

CLASSIFICATION COMMENTS
Bandelier National Monument

This association has been described only at Bandelier National Monument and is closely related to *Elymus* x *pseudorepens-Bromus carinatus* Herbaceous Vegetation, another seeded grasses vegetation type described for the park.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - WEAK

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: NM databse code:NPS_NM045 .

Bandelier National Monument Plots: NHNM Plots: 03AB104, 03BD139, 03BD078, and 06AB176.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: Data are not available

REFERENCES:

Poa pratensis - Taraxacum officinale Semi-natural Herbaceous Vegetation [Park Special]

Kentucky Bluegrass - Common Dandelion Semi-natural Herbaceous Vegetation [Park Special]

CODE	Park Special
PHYSIOGNOMIC CLASS	Not applicable
PHYSIOGNOMIC SUBCLASS	Not applicable
PHYSIOGNOMIC GROUP	Not applicable
PHYSIOGNOMIC SUBGROUP	Not applicable
FORMATION	Not applicable
ALLIANCE	Not applicable

ECOLOGICAL SYSTEM(S)

Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

Data are not available.

DISTRIBUTION

Bandelier National Monument

This is association is known from the slopes of Cerro Grande and Rabbit Mountain and the slopes of Canon de los Frijoles.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This miF- to high-elevation association occurs between 2490 and 2730 m (8100-8960 feet) on sites of high solar exposure (mostly southerly slopes). Stands are found in valley to footslope positions in the landscape. Soils are mapped as well-developed, deep, and fine-textured Mollisols derived from latite and dacite alluvium. The ground surface is typically characterized by mats of rhizomatous grasses intermixed with leaf litter or some exposed soil.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This semi-natural montane meadow association is characterized by the luxuriant cover of the exotic *Poa pratensis* with a diverse compliment of other graminoids that include deer sedges (*Carex inops* ssp. *heliophila* and *Carex occidentalis*) and remnant montane grassland species (*Danthonia parryi*, *Festuca arizonica*, and *Blepharoneuron tricholepis*). On wetter sites *Carex siccata*, or even facultative wetland species such as *Carex microptera* and *Carex praegracilis*, may be present. Forbs can also be abundant, reaching as much as 50% in cover, and are typically represented by meadow species such as *Erigeron formosissimus*, *Iris missouriensis*, *Achillea millefolium*, *Potentilla hippiana*, *Potentilla pulcherrima*, *Symphyotrichum ascendens*, and *Taraxacum officinale*. Among trees, scattered *Pinus ponderosa* or *Picea pungens* saplings and mature trees can occur, but cover is less than 10%. Shrubs are generally absent.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Poa pratensis*
Herb (field)	*Achillea millefolium, Taraxacum officinale*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Bromus inermis and *Festuca idahoensis* are present as part of a post-fire seed mix.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS

Bandelier National Monument

Associated species: *Erigeron formosissimus*, *Iris missouriensis*, *Potentilla hippiana*, *Potentilla pulcherrima*, *Symphyotrichum ascendens*, *Carex inops* ssp. *heliophila*, *Carex occidentalis*. When conifer species such as *Pinus ponderosa* or *Picea pungens* are present, they are likely either invasive or occur on rocky microsites within the grassland.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD002, 06JC206, 06JC506.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: Data are not available

REFERENCES

Muldavin and Tonne 2003, Muldavin et al. 2006, Western Ecology Working Group n.d.

Populus angustifolia - Acer negundo / Forestiera pubescens Forest [Park Special]

Narrowleaf Cottonwood - Box-elder / Stretchberry Forest [Park Special]

CODE	Park Special
PHYSIOGNOMIC CLASS	Not applicable
PHYSIOGNOMIC SUBCLASS	Not applicable
PHYSIOGNOMIC GROUP	Not applicable
PHYSIOGNOMIC SUBGROUP	Not applicable
FORMATION	Not applicable
ALLIANCE	Not applicable

ECOLOGICAL SYSTEM(S)

Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

Data are not available.

DISTRIBUTION

Bandelier National Monument

This association is known from the riparian zones of Ancho Canyon and Canon de Los Frijoles.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This riparian association occurs at elevations between 1700 and 1870 m (5580-6130 feet) along canyon bottoms with low solar exposure. Stands occur on alluvial terraces and bars adjacent to perennial stream channels with gradients between 2 and 10%. Soils are mapped as loamy Mollisols derived from latite, dacite, and rhyolitic alluvium (Hibner 2009). The ground surface is characterized by shrubs rooted in exposed gravels and soil intermixed with grass and litter patches.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This mixed broadleaf riparian forest association is dominated by the broadleaf deciduous riparian trees *Populus angustifolia* or *Acer negundo* that form closed canopies. The shrub layer is characterized by abundant *Forestiera pubescens* with a mix of other mesic shrubs and vines such as *Rosa woodsii* or *Ribes* spp. The herbaceous layer is an assortment of mesic-trending species and variable in composition and cover (5-30% total cover). Common species include facultative and obligate wetland species such as *Carex pellita*, *Carex praegracilis*, *Agrostis stolonifera*, and *Equisetum arvense*.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Populus angustifolia, Acer negundo*
Tall shrub/sapling	*Forestiera pubescens*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

Associated Species: *Carex pellita*, *Carex praegracilis*, *Agrostis stolonifera*, *Equisetum arvense*.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS

Bandelier National Monument

This association is closely related to *Populus angustifolia - Acer negundo* / *Poa pratensis* Woodland (CEGL005961) and *Populus angustifolia - Acer negundo* Woodland (CEGL005992) reported in the USNVC.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD051, 03BR017, 06JC518.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: Data are not available

REFERENCES

Hibner 2009, Western Ecology Working Group n.d.

Populus angustifolia / *Fallugia paradoxa* Forest [Park Special]

Narrowleaf Cottonwood / Apache Plume Forest [Park Special]

CODE	Park Special
PHYSIOGNOMIC CLASS	Not applicable
PHYSIOGNOMIC SUBCLASS	Not applicable
PHYSIOGNOMIC GROUP	Not applicable
PHYSIOGNOMIC SUBGROUP	Not applicable
FORMATION	Not applicable
ALLIANCE	Not applicable

ECOLOGICAL SYSTEM(S)

Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

Data are not available.

DISTRIBUTION

Bandelier National Monument

This park special association is known from the riparian zone of Capulin Canyon.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This riparian association occurs at elevations between 1725 and 1730 m (5660-5690 feet) in canyon bottoms with low solar exposure. Stands occur on alluvial terraces and bars adjacent to intermittent and ephemeral stream channels with gradients up to 5%. Soils are mapped as loamy Mollisols derived from latite, dacite, and rhyolitic alluvium (Hibner 2009). The ground surface is characterized by shrubs rooted in exposed gravels and soil intermixed with grass and litter patches. Locally, stands were burned in the Dome Fire of 2000.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This broadleaf riparian association is dominated by resprouting *Populus angustifolia*. Occasionally scattered, mature *Pinus ponderosa* are present. Shrubs are well-represented to abundant and are dominated by *Fallugia paradoxa*. *Forestiera pubescens* is a common to well-represented frequent associate. The herbaceous layer of these stands is well-represented by a mix of forbs and grasses. The exotic *Bromus tectorum* is well-represented and typically dominates the graminoids. Forbs are also well-represented and commonly include annuals or biennials such as *Machaeranthera canescens*, *Chenopodium pratericola*, and *Descurainia* spp.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tree canopy	*Populus angustifolia*
Tall shrub/sapling	*Fallugia paradoxa*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

The exotic annual grass *Bromus tectorum* often dominates the herbaceous layer.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS

Bandelier National Monument

This is a park special association.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD114, 03YC016.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: Data are not available

REFERENCES

Hibner 2009, Western Ecology Working Group n.d.

Schizachyrium scoparium - Koeleria macrantha Herbaceous Vegetation [Park Special]

Little Bluestem - Prairie Junegrass Herbaceous Vegetation [Park Special]

CODE	Park Special
PHYSIOGNOMIC CLASS	Not applicable
PHYSIOGNOMIC SUBCLASS	Not applicable
PHYSIOGNOMIC GROUP	Not applicable
PHYSIOGNOMIC SUBGROUP	Not applicable
FORMATION	Not applicable
ALLIANCE	Not applicable

ECOLOGICAL SYSTEM(S)

Western Great Plains Foothill and Piedmont Grassland (CES303.817)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

Data are not available.

DISTRIBUTION

Bandelier National Monument

This minor association is known from upper Lummis Mesa.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This association occurs at mid elevations between 2010 and 2180 m (6600-7160 feet) on sites of high solar exposure. Stands occur on shoulders and tops of rolling mesas with slopes below 15% and sites that have been burned in recent history. Soils are primarily mapped as loamy and well-developed Mollisols derived from pumice slope alluvium (Hibner 2009). The ground surface is characterized by bunchgrass patches in a matrix of exposed soil and litter with little or no gravel or rock.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

These post-fire grasslands are dominated by *Schizachyrium scoparium* with *Koeleria macrantha* as a common associate. Total graminoid cover can reach 20%. Forbs are common with *Mentzelia springeri*, *Heterotheca villosa*, *Liatris punctata*, *Psoralidium tenuiflorum*, and *Bahia* spp. the most abundant. Trees are absent and shrubs are poorly represented; *Rhus trilobata*, *Brickellia eupatorioides* var. *chlorolepis*, *Ceanothus fendleri*, or *Gutierrezia sarothrae* may be present, but overall cover is less than 2% cover.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Herb (field)	*Schizachyrium scoparium, Koeleria macrantha*

Globally
Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument
Associated Species: *Mentzelia springeri*, *Heterotheca villosa*, *Liatris punctata*, *Psoralidium tenuiflorum*.

Globally
Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS

Bandelier National Monument
This may be an association unique to Bandelier National Monument.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plots: 03BD054, 03BD11.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: Data are not available

REFERENCES

Hibner 2009, Western Ecology Working Group n.d.

Tamarix chinensis / *Forestiera pubescens* Semi-natural Shrubland [Park Special]

Salt-cedar / Stretchberry Shrubland [Park Special]

CODE	Park Special
PHYSIOGNOMIC CLASS	Not applicable
PHYSIOGNOMIC SUBCLASS	Not applicable
PHYSIOGNOMIC GROUP	Not applicable
PHYSIOGNOMIC SUBGROUP	Not applicable
FORMATION	Not applicable
ALLIANCE	Not applicable

ECOLOGICAL SYSTEM(S)

Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

Data are not available.

DISTRIBUTION

Bandelier National Monument

This minor association is found in White Rock Canyon along the Rio Grande (near the mouth of Water Canyon and elsewhere).

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Bandelier National Monument

This riparian association is known from 1650 m (5420 feet) in elevation along a canyon bottom with moderate solar exposure. Stands occur on alluvial terraces and bars adjacent to river channels with gradients less than 10%. Soil is mapped as a sandy Entisol derived from mixed mineral alluvium (granite, gneiss, schist, and granitic sandstone and mudstone (Hibner 2009). The ground surface is characterized by shrubs rooted in exposed gravels and sands.

Globally

Data are not available.

VEGETATION DESCRIPTION

Bandelier National Monument

This riparian association is characterized by a tall-shrub canopy dominated by *Tamarix ramosissima*, with *Forestiera pubescens* intermixed in the lower shrub canopy along with *Rosa woodsii*. *Populus deltoides* is present as scattered reproducing saplings. The herbaceous layer is characterized by abundant *Bromus tectorum* with other scattered grasses and forbs.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Bandelier National Monument

Stratum	Species
Tall shrub/sapling	*Tamarix ramosissima, Forestiera pubescens*
Herb (field)	*Bromus tectorum*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Bandelier National Monument

The exotic annual grass *Bromus tectorum* is prevalent and may reflect that the site is within the high-water zone of Cochiti Reservoir.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: Not applicable.

CLASSIFICATION COMMENTS

Bandelier National Monument

A *Bromus tectorum* phase was identified where that species exceeds 25% cover.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Bandelier National Monument Inventory Notes: Data are not available.

Bandelier National Monument Plots: NHNM Plot: 03BR001.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: Data are not available

REFERENCES

Hibner 2009, Western Ecology Working Group n.d.

Incidental Associations

Incidental associations are either: 1) minor in distribution and usually known only from one plot or observation point, or 2) they were identified during the accuracy assessment (AA) phase of the project (post-classification and description development). They are listed below by major types with database codes (either from NatureServe (CEGL numbers) if established USNVC types or from NHNM (NPS_NHNM numbers) if not yet part of the USNVC pending the acquisition of additional data on their distribution, composition, and environment.

Woodlands

- *Juniperus deppeana* / *Bouteloua gracilis* Woodland, Dead *Pinus edulis* Phase [AA only] (CEGL000693)
- *Juniperus deppeana* / Ruderal Herbs Vegetation Woodland, Dead *Pinus edulis* Phase [minor] (NPS_NM008)
- *Juniperus deppeana* / Sparse Woodland, Dead *Pinus edulis* Phase [minor] (NPS_NM009)
- *Juniperus monosperma* / *Hesperostipa neomexicana* Woodland [AA only] (CEGL000722)
- *Juniperus monosperma* / *Rhus trilobata* Woodland [minor] (NPS_NM010)
- *Pinus edulis* - (*Juniperus monosperma, Juniperus deppeana*) / *Bouteloua gracilis* Woodland [AA only] (CEGL002151)
- *Pinus ponderosa* / *Poa pratensis* Semi-natural Forest [AA only] (NPS_NM016)
- *Pinus ponderosa* / *Quercus grisea* Woodland [minor] (CEGL000871)

Shrublands

- *Cercocarpus montanus* / *Bouteloua curtipendula* Shrubland [AA only] (CEGL001086)
- *Fallugia paradoxa* / Ruderal Herbs Shrubland [minor] (NPS_NM006)
- *Rhus trilobata* Rocky Mountain Shrub Herbaceous Vegetation [minor] (CEGL002910)

Grasslands

- *Rosa woodsii* / *Muhlenbergia montana* Shrub Herbaceous Vegetation [minor] (NPSNM011

Riparian/Wetlands

- *Acer negundo* / *Eleocharis palustris* Forest [minor] (NPS_NM001)
- *Acer negundo* / *Prunus virginiana* Forest [minor] (CEGL000628)
- *Alnus incana* / Mesic Graminoids Shrubland [minor] (CEGL001148)
- *Calamagrostis canadensis* Western Herbaceous Vegetation [minor] (CEGL001559)
- *Elaeagnus angustifolia* / *Bromus tectorum* Semi-natural Woodland [minor] (NPS_NM005)
- *Salix exigua* / Mesic Graminoids Shrubland (CEGL001203)
- *Tamarix chinensis* - *Salix exigua* Semi-natural Shrubland [minor] (NPS_NM031)
- *Tamarix chinensis* / Sparse Undergrowth Semi-natural Shrubland [minor] (NPS_NM032)l

Miscelleaneous

- Ruderal Disturbance Herbaceous Vegetation [minor] (NPS_NM027)
- Ruderal Flood Zone Herbaceous Vegetation [minor] (NPS_NM026)
- Ruderal Post-fire Herbaceous Vegetation [minor] (NPS_NM025)
- Sparse Vegetation / Boulder Rockland [minor] (NPS_NM013)
- Sparse Vegetation / Recent Alluvial Deposits [minor] (NPS_NM049)
- Sparse Vegetation / Scree [minor] (NPS_NM014)

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Appendix G: Level 2 Map Unit Summaries

Appendix G contains the map unit summaries for the vegetation map of Bandelier National Monument based on Table 9 of the main report. For each Level 2 map unit, we provide a description with the following:

- The name of the level 1 map unit (the top-most line) that each level 2 map unit falls under
- A list of primary and secondary plant association components plus related and contrasting inclusions, if applicable (see main report for definitions)
- Elevation range derived from the GIS
- A summary of the distribution, environment, and floristic composition of the unit
- A representative ground photograph
- A distribution map of the unit where polygons are filled in with black against a backdrop of shaded relief and elevation
- An image map showing the delineation of a representative polygon(s) in the 2004 color aerial photography
- The total hectares and acres of the unit and number of polygons as derived from the GIS

1 Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest & Woodland

A Engelmann Spruce / Sprucefir Fleabane Mesic-Wet Forest

Area	12 ha, 30 ac
Polygons	7
Primary component associations	*Picea engelmannii / Erigeron eximius* Forest
Secondary component associations	*Abies concolor / Mahonia repens* Forest *Pseudotsuga menziesii / Mahonia repens* Forest *Pseudotsuga menziesii - Quercus gambelii* Forest
Contrasting inclusions	*Abies concolor - Pseudotsuga menziesii / Thalictrum fendleri* Forest *Abies concolor - Pseudotsuga menziesii / Acer glabrum* Forest
Elevation	9,600 to 10,100 ft (2,900 to 3,100 m)
Summary	This unit is found along the north-facing upper slopes and ridgelines of the caldera rim along the Sierra de los Valles. Stands occur on cold, mid to upper slopes on northerly aspects. The understory is dominated by herbs and can be diverse and luxuriant in cover; shrubs and subshrubs are typically poorly represented. Grassy understories may occur adjacent to upper montane grasslands.



Figure G-1. Ground photo of map unit 1A.

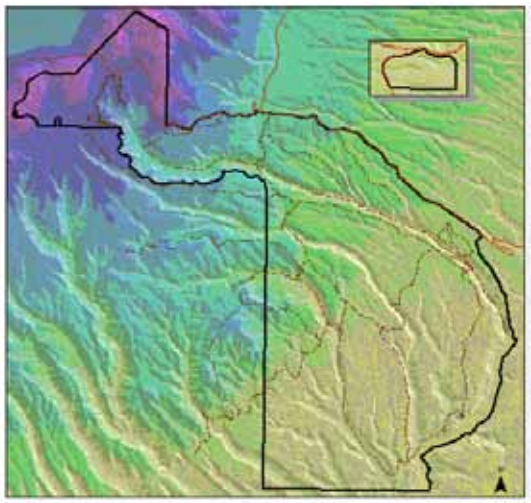


Figure G-2. Distribution of the polygons (in black) of map unit 1A.

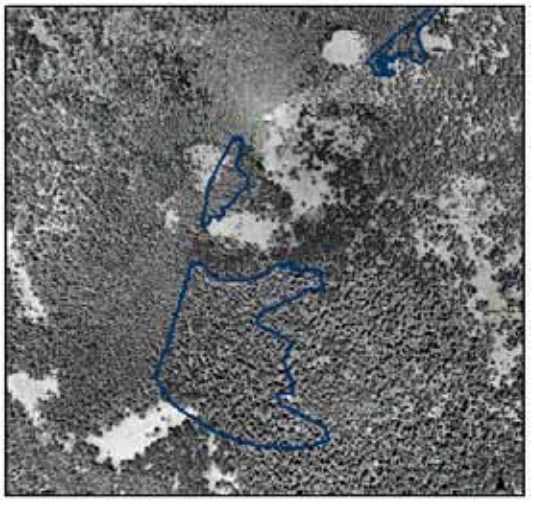


Figure G-3. Aerial photo of a representative polygon of map unit 1A.

2 Rocky Mountain Subalpine & Montane Aspen Forest & Woodland

A Quaking Aspen / Thurber's Fescue Upper Montane Woodland

Area	35 ha, 87 ac
Polygons	20
Primary component associations	*Populus tremuloides / Festuca thurberi* Forest
Secondary component associations	*Populus tremuloides* / Invasive Perennial Grasses Forest
Contrasting inclusions	*Abies concolor - Pseudotsuga menziesii / Festuca thurberi - Danthonia parryi* Woodland, *Populus tremuloides* Phase
Elevation	8,300 to 9,900 ft (2,500 to 3,000 m)
Summary	These forests and woodlands are found along the north-facing, upper slopes and ridgelines of the caldera rim along the Sierra de los Valles. These sites tend to be more exposed and may occur on former montane grassland sites. Aspen dominates these montane woodlands with cover that exceeds 75% of the total tree cover. Tall montane bunch grasses such as Thurber fescue or Parry's Oatgrass dominate in the understory. Some sites have a high cover of exotic grasses that were seeded following forest fire. Shrubs are typically poorly represented or absent.



Figure G-4. Ground photo of map unit 2A.

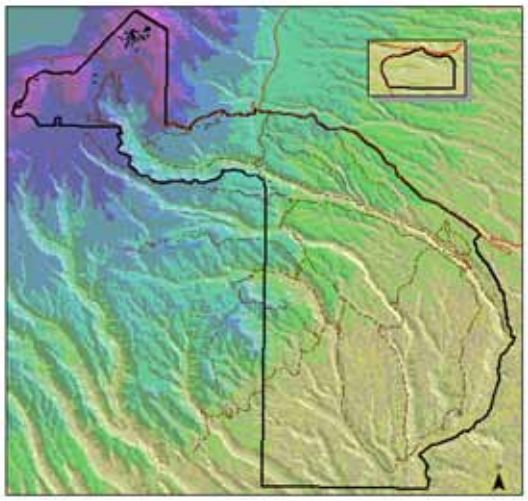


Figure G-5. Distribution of the polygons (in black) of map unit 2A.

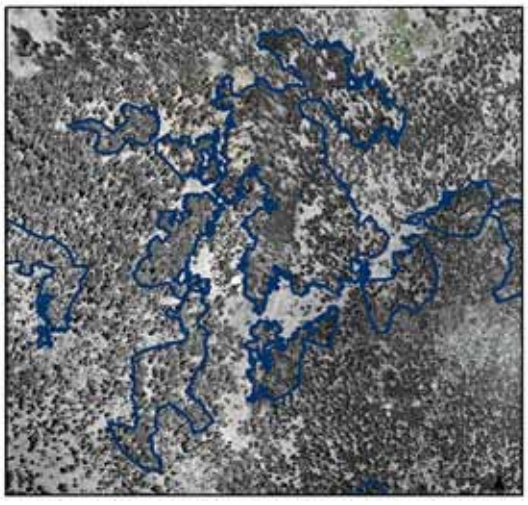


Figure G-6. Aerial photo of a representative polygon of map unit 2A.

2 Rocky Mountain Subalpine & Montane Aspen Forest & Woodland

B Quaking Aspen / Fendler's Meadowrue Mesic-Wet Forest

Area	42 ha, 103 ac
Polygons	29
Primary component associations	*Populus tremuloides* / *Thalictrum fendleri* Forest
Secondary component associations	*Populus tremuloides* / *Acer glabrum* Forest
Related inclusions	*Populus tremuloides* / Invasive Perennial Grasses Forest
Elevation	7,400 to 10,000 ft (2,200 to 3,000 m)
Summary	These forests and woodlands are found on mid to lower slopes on northerly aspects, and occasionally in lower slope canyon bottoms and coves in the Sierra de los Valles and Cañon de los Frijoles. Aspen dominates these montane forests with cover that exceeds 75% of the total tree cover. The understory is dominated by herbs and can be diverse and luxuriant in cover. Common species include Fendler's meadowrue, Virginia strawberry, stickywilly, and sprucefir fleabane. With the exception Rocky Mountain maple, shrubs and subshrubs are typically poorly represented or absent.



Figure G-7. Ground photo of map unit 2B.

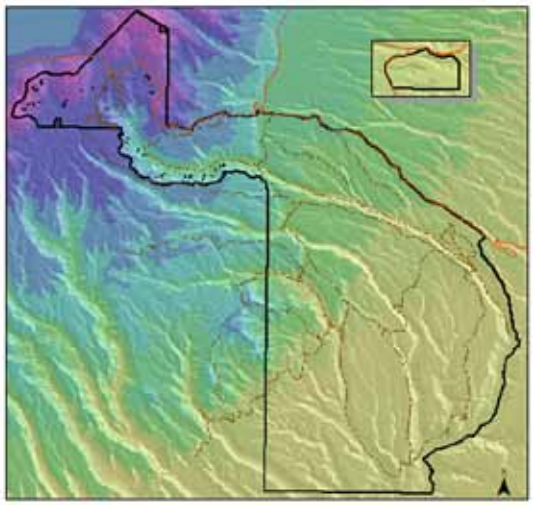


Figure G-8. Distribution of the polygons (in black) of map unit 2B.



Figure G-9. Aerial photo of a representative polygon of map unit 2B.

3 Southern Rocky Mountain White Fir-Douglas-fir Dry Forest with Aspen

A White Fir-Douglas-fir-Aspen / Thurber's Fescue Upper Montane Woodland with Aspen

Area	67 ha, 166 ac
Polygons	21
Primary component associations	*Abies concolor - Pseudotsuga menziesii / Festuca thurberi - Danthonia parryi* Woodland, *Populus tremuloides* Phase
Contrasting inclusions	*Populus tremuloides / Festuca thurberi* Forest
Elevation	9,000 to 9,800 ft (2,400 to 3,000 m)
Summary	These forests and woodlands are found along mostly southerly upper slopes of the caldera rim along the Sierra de los Valles. The overstory is a mixture of conifers (Douglas-fir, white fir, blue spruce, southwestern white pine, limber pine, and ponderosa pine) along with quaking aspen, which comprised between 25% and 75% of the total tree cover. Tall montane bunch grasses such as Thurber fescue or Parry's Oatgrass are dominant in the understory. Forbs are diverse with montane grassland species often common to abundant (e.g., Rocky Mountain iris, woolly cinquefoil, common yarrow, and Arizona peavine).



Figure G-10. Ground photo of map unit 3A.

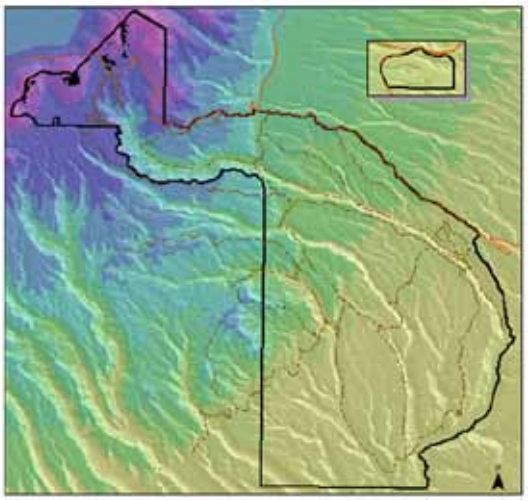


Figure G-11. Distribution of the polygons (in black) of map unit 3A.

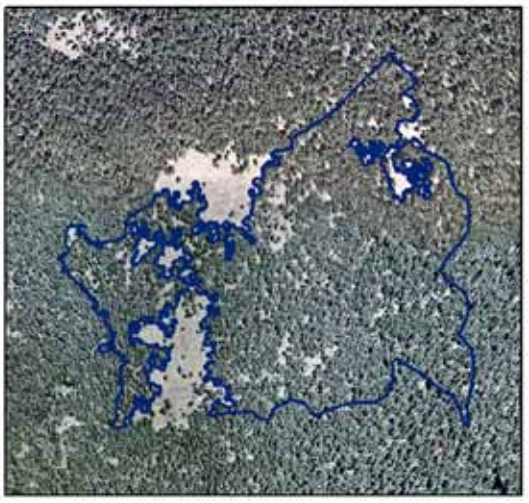


Figure G-12. Aerial photo of a representative polygon of map unit 3A.

3 Southern Rocky Mountain White Fir-Douglas-fir Dry Forest with Aspen

B White Fir-Douglas-fir-Aspen / Common Juniper / Deer Sedge Dry-Mesic Forest

Area	235 ha, 580 ac
Polygons	63
Primary component associations	*Abies concolor / Juniperus communis Forest, Populus tremuloides* Phase *Abies concolor - Pseudotsuga menziesii / Carex rossii* Forest, *Populus tremuloides* Phase
Related inclusions	*Pseudotsuga menziesii / Mahonia repens* Forest, *Populus tremuloides* Phase
Contrasting inclusions	*Abies concolor - Pseudotsuga menziesii/ Festuca thurberi - Danthonia parryi* Woodland, *Populus tremuloides* Phase
Elevation	7,800 to 9,800 ft (2,200 to 3,000 m)
Summary	These forests are found on more southerly, mid to lower slopes of the Sierra de los Valles, and extending into upper Cañon de los Frijoles. The overstory is a mixture of conifers (Douglas-fir, white fir, blue spruce, southwestern white pine, limber pine, and ponderosa pine) along with quaking aspen, which comprises between 25% and 75% of the total tree cover. Understories are typically dominated by common juniper with scattered forbs and graminoids.

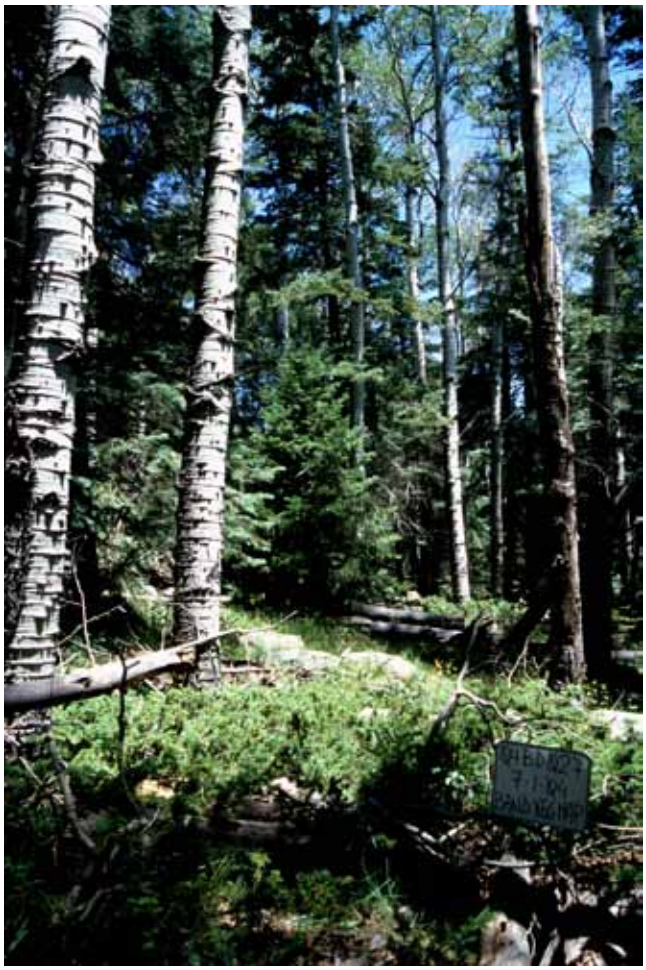


Figure G-13. Ground photo of map unit 3B.

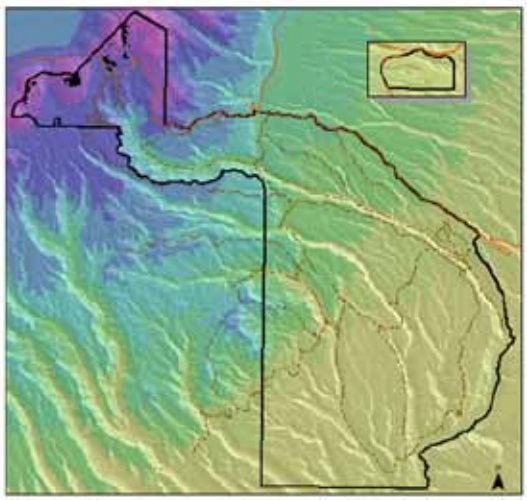


Figure G-14. Distribution of the polygons (in black) of map unit 3B.

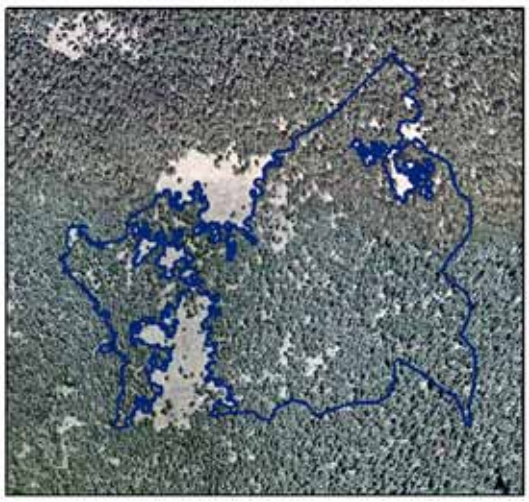


Figure G-15. Aerial photo of a representative polygon of map unit 3B.

4 Southern Rocky Mountain Douglas-fir-White Fir-Blue Spruce Mesic Forest with Aspen

A White Fir-Douglas-fir-Aspen / Fendler's Meadowrue Mesic-Wet Forest

Area	192 ha, 475 ac
Polygons	75
Primary component associations	*Abies concolor - Pseudotsuga menziesii / Thalictrum fendleri* Forest, *Populus tremuloides* Phase
Contrasting inclusions	*Abies concolor - Pseudotsuga menziesii / Acer glabrum* Forest, *Populus tremuloides* Phase
Elevation	7,300 to 10,000 ft (2,200 to 3,000 m)
Summary	These forests are found on more northerly, mid to lower slopes of the Sierra de los Valles, extending into upper Cañon de los Frijoles. The overstory is a mixture of conifers (Douglas-fir, white fir, blue spruce, southwestern white pine, limber pine, and ponderosa pine) along with quaking aspen, which comprises between 25% and 75% of the total tree cover. The understory is dominated by herbs and can be diverse and luxuriant in cover. Common species include Fendler's meadowrue, Virginia strawberry, stickywilly, and sprucefir fleabane. There are scattered shrubs and subshrubs with common juniper and gooseberry the most common.



Figure G-16. Ground photo of map unit 4A.

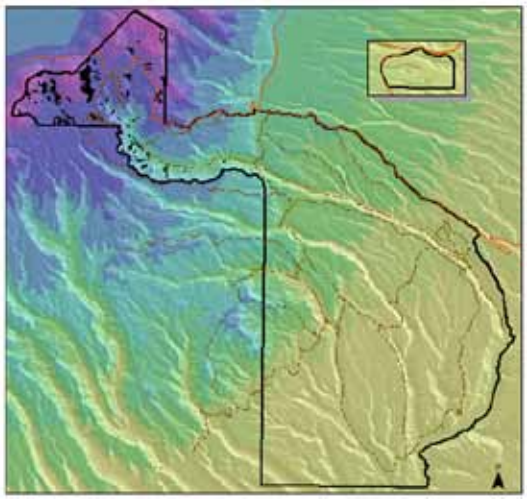


Figure G-17. Distribution of the polygons (in black) of map unit 4A.



Figure G-18. Aerial photo of a representative polygon of map unit 4A.

4 Southern Rocky Mountain Douglas-fir-White Fir-Blue Spruce Mesic Forest with Aspen

B White Fir-Douglas-fir-Aspen / Rocky Mountain Maple Canyon Forest

Area	24 ha, 58 ac
Polygons	13
Primary component associations	*Abies concolor - Pseudotsuga menziesii / Acer glabrum* Forest, *Populus tremuloides* Phase
Secondary component associations	*Abies concolor - Pseudotsuga menziesii / Jamesia americana - Holodiscus dumosus* Scree Woodland, *Populus tremuloides* Phase
Contrasting inclusions	*Abies concolor - Pseudotsuga menziesii / Thalictrum fendleri* Forest, *Populus tremuloides* Phase
Elevation	7,200 to 9,600 ft (2,200 to 3,000 m)
Summary	These forests are associated with cool, often steep lower canyon slopes and ravines in Cañon de los Frijoles. The overstory is a mixture of conifers (Douglas-fir, white fir, blue spruce, southwestern white pine, limber pine, and ponderosa pine) along with quaking aspen, which comprises between 25% and 75% of the total tree cover. The understory is dominated by Rocky Mountain maple along with an assortment of other shrubs such as thimbleberry, mountain ninebark, and cliffbush. The herbaceous layer can also be diverse and luxuriant in cover. Common species include Fendler's meadowrue, Virginia strawberry, stickywilly, and Canadian white violet.



Figure G-19. Ground photo of map unit 4B.

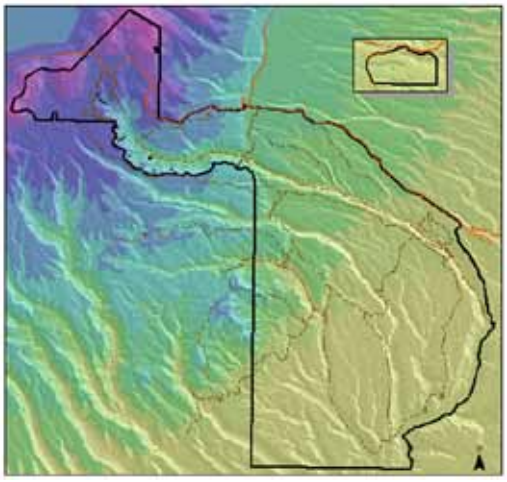


Figure G-20. Distribution of the polygons (in black) of map unit 4B.



Figure G-21. Aerial photo of a representative polygon of map unit 4B.

5 Southern Rocky Mountain White Fir-Douglas-fir Dry Forest

A White Fir-Douglas-fir / Thurber's Fescue Upper Montane Woodland Savanna

Area	58 ha, 144 ac
Polygons	27
Primary component associations	*Abies concolor - Pseudotsuga menziesii/ Festuca thurberi - Danthonia parryi* Woodland
Contrasting inclusions	*Pinus ponderosa / Festuca thurberi* Woodland
Elevation	9,000 to 10,200 ft (2,800 to 3,100 m)
Summary	These woodlands are found mostly on southerly upper slopes along the caldera rim of the Sierra de los Valles. The overstory is a mixture of conifers, including Douglas-fir, white fir, blue spruce, southwestern white pine, limber pine, and ponderosa pine. The understory is characterized by the dominance of tall montane bunch grasses, such as Thurber fescue or Parry's Oatgrass. Forbs are diverse with montane grassland species often common to abundant (e.g., Rocky Mountain iris, woolly cinquefoil, common yarrow, and Arizona peavine).



Figure G-22. Ground photo of map unit 5A.

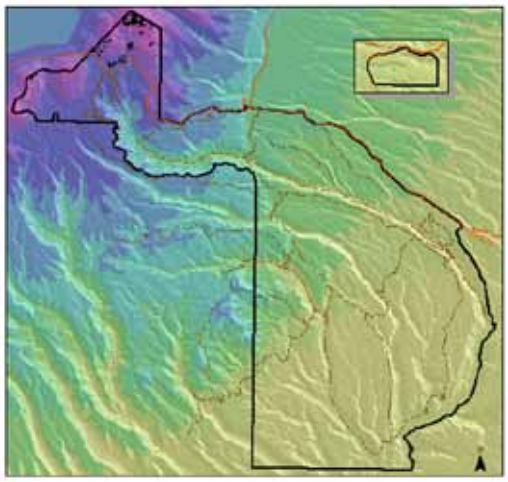


Figure G-23. Distribution of the polygons (in black) of map unit 5A.

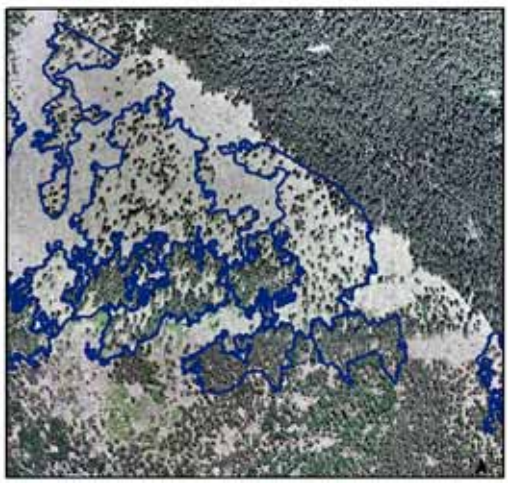


Figure G-24. Aerial photo of a representative polygon of map unit 5A.

5 Southern Rocky Mountain White Fir-Douglas-fir Dry Forest

B White Fir-Douglas-fir / Common Juniper-Gambel Oak / Deer Sedge Dry-Mesic Forest

Area	735 ha, 1,817 ac
Polygons	205
Primary component associations	*Abies concolor / Juniperus communis* Forest *Abies concolor - Pseudotsuga menziesii / Quercus gambelii / Carex rossii* Forest *Abies concolor - Pseudotsuga menziesii / Carex rossii* Forest
Secondary component associations	*Abies concolor / Mahonia repens* Forest *Pseudotsuga menziesii / Mahonia repens* Forest *Pseudotsuga menziesii - Quercus gambelii* Forest
Contrasting inclusions	*Abies concolor* - (*Pseudotsuga menziesii)* / *Jamesia americana - Holodiscus dumosus* Scree Woodland *Abies concolor* - (*Pseudotsuga menziesii)* / *Thalictrum fendleri* Forest
Elevation	6,500 to 9,800 ft (2,000 to 3,000 m)
Summary	These forests are found on more southerly, mid to lower slopes of the Sierra de los Valles and extending into upper Cañon de los Frijoles and lower elevation side canyons where they are more common on northerly slopes. The overstory is a mixture of conifers, including Douglas-fir, white fir, blue spruce, southwestern white pine, limber pine, and ponderosa pine. Understories are typically sparse with scattered shrubs and herbs that include common juniper, Gambel's oak, prairie junegrass, and various deer sedges.



Figure G-25. Ground photo of map unit 5B.

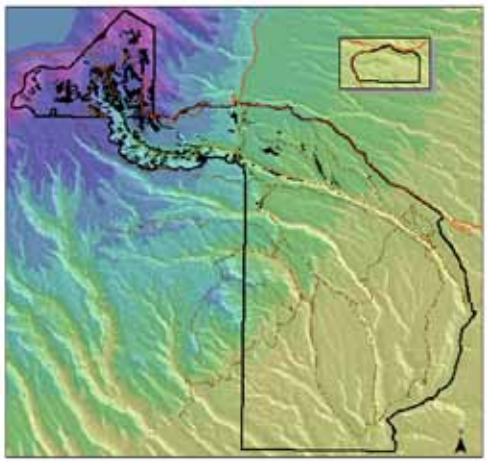


Figure G-26. Distribution of the polygons (in black) of map unit 5B.



Figure G-27. Aerial photo of a representative polygon of map unit 5B.

5 Southern Rocky Mountain White Fir-Douglas-fir Dry Forest

C White Fir-Douglas-fir-Gambel Oak Canyon Forest

Area	212 ha, 523 ac
Polygons	72
Primary component associations	*Pseudotsuga menziesii* - *Quercus gambelii* Forest
Secondary component associations	Sparse Vegetation / Boulder Rockland *Pseudotsuga menziesii* / *Mahonia repens* Forest *Abies concolor* - (*Pseudotsuga menziesii*) / *Jamesia americana* - *Holodiscus dumosus* Scree Woodland
Related inclusions	Sparse Vegetation / Scree *Abies concolor* - (*Pseudotsuga menziesii)* / *Quercus gambelii* / *Carex rossii* Forest
Contrasting inclusions	*Pinus ponderosa* - *Quercus gambelii* / *Carex inops* ssp. *heliophila* Woodland *Quercus gambelii* / *Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland
Elevation	6,500 to 8,800 ft (2,000 to 2,700 m)
Summary	These forests occur on southerly, mid to lower slopes of upper Cañon de los Frijoles and lower elevation side canyons. Sites are often steep and rocky. The overstory is a mixture of conifers, including Douglas-fir, white fir, blue spruce, southwestern white pine, limber pine, and ponderosa pine. Understories are typically shrubby and dominated by Gambel's oak and a variety of other shrubs. The herbaceous layer is variable, but grasses can be common and can include mountain muhly, prairie junegrass, and various deer sedges.



Figure G-28. Ground photo of map unit 5C.

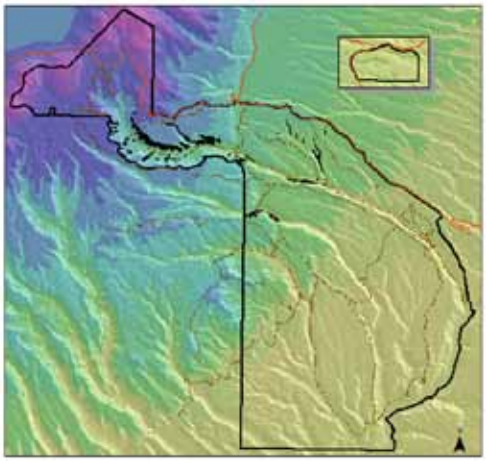


Figure G-29. Distribution of the polygons (in black) of map unit 5C.



Figure G-30. Aerial photo of a representative polygon of map unit 5C.

6 Southern Rocky Mountain Douglas-fir-White Fir-Blue Spruce Mesic Forest

A White Fir-Douglas-fir / Fendler's Meadowrue Mesic-Wet Forest

Area	370 ha, 913 ac
Polygons	131
Primary component associations	*Abies concolor* - (*Pseudotsuga menziesii)* / *Thalictrum fendleri* Forest
Secondary component associations	*Abies concolor* - (*Pseudotsuga menziesii)* / *Quercus gambelii* / *Thalictrum fendleri* Forest *Picea pungens* / *Fragaria virginiana* Forest
Contrasting inclusions	*Abies concolor* - *Pseudotsuga menziesii* / *Acer glabrum* Forest *Abies concolor* / *Juniperus communis* Forest *Abies concolor* - (*Pseudotsuga menziesii)* / *Quercus gambelii* / *Carex rossii* Forest
Elevation	7,000 to 9,800 ft (2,000 to 3,000 m)
Summary	These forests are found on more northerly, mid to lower slopes of the Sierra de los Valles and extending into upper Cañon de los Frijoles. The overstory is a mixture of conifers (Douglas-fir, white fir, blue spruce, southwestern white pine, limber pine, and ponderosa pine). The understory is dominated by herbs and can be diverse and luxuriant in cover. Common species include Fendler's meadowrue, Virginia strawberry, stickywilly, and spruce-fir fleabane. There are scattered shrubs and subshrubs with common juniper and gooseberry the most common.



Figure G-31. Ground photo of map unit 6A.

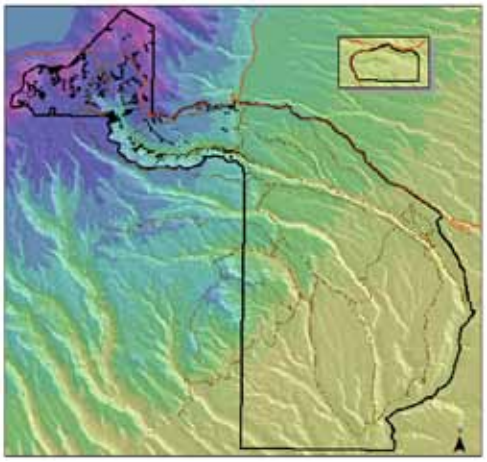


Figure G-32. Distribution of the polygons (in black) of map unit 6A.



Figure G-33. Aerial photo of a representative polygon of map unit 6A.

6 Southern Rocky Mountain Douglas-fir-White Fir-Blue Spruce Mesic Forest

B White Fir-Douglas-fir / Rocky Mountain Maple Canyon Forest

Area	69 ha, 171 ac
Polygons	29
Primary component associations	*Abies concolor - Pseudotsuga menziesii / Acer glabrum* Forest
Secondary component associations	*Abies concolor* - (*Pseudotsuga menziesii)* / *Jamesia americana - Holodiscus dumosus* Scree Woodland
Contrasting inclusions	*Abies concolor* - (*Pseudotsuga menziesii)* / *Thalictrum fendleri* Forest *Abies concolor* - (*Pseudotsuga menziesii)* / *Quercus gambelii* / *Thalictrum fendleri* Forest
Elevation	7,300 to 9,800 ft (2,200 to 3,000 m)
Summary	These forests are associated with cool, often steep lower canyon slopes and ravines in Cañon de los Frijoles. The overstory is a mixture of conifers (Douglas-fir, white fir, blue spruce, southwestern white pine, limber pine, and ponderosa pine). The understory is dominated by Rocky Mountain maple along with an assortment of other shrubs such as thimbleberry, mountain ninebark, and cliffbush. The herbaceous layer can also be diverse and luxuriant in cover. Common species include Fendler's meadowrue, Virginia strawberry, stickywilly, and Canadian white violet.

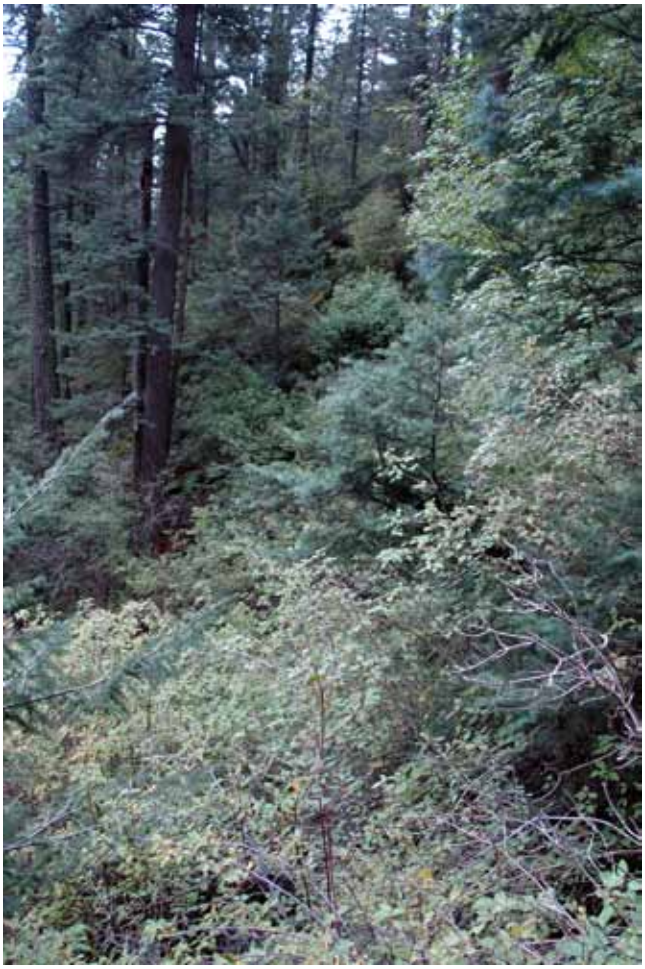


Figure G-34. Ground photo of map unit 6B.

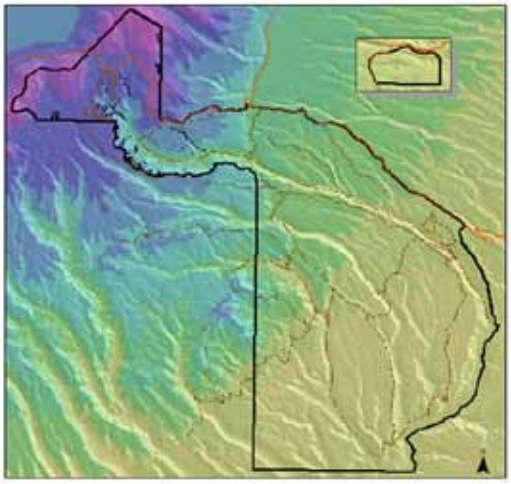


Figure G-35. Distribution of the polygons (in black) of map unit 6B.



Figure G-36. Aerial photo of a representative polygon of map unit 6B.

7 Southern Rocky Mountain Ponderosa Pine Savanna

A Ponderosa Pine/Thurber's Fescue Upper Montane Woodland

Area	74 ha, 184 ac
Polygons	22
Primary component associations	*Pinus ponderosa* / *Festuca thurberi* Woodland
Related inclusions	Pinus ponderosa / Poa pratensis Semi-natural Forest
Contrasting inclusions	*Abies concolor* - *Pseudotsuga menziesii* / *Festuca thurberi* - *Danthonia parryi* Woodland *Pinus ponderosa* / *Carex inops* ssp. *heliophila* Woodland
Elevation	9,000 to 10,000 ft (2,800 to 3,000 m)
Summary	These woodlands are found mostly on southerly, upper slopes along the caldera rim of the Sierra de los Valles. The overstory is dominated by ponderosa pine. The understory is characterized by the dominance of tall montane bunch grasses such as Thurber fescue or Parry's Oatgrass. Forbs are diverse with montane grassland species often common to abundant (e.g., Rocky Mountain iris, woolly cinquefoil, common yarrow, and Arizona peavine).



Figure G-37. Ground photo of map unit 7A.

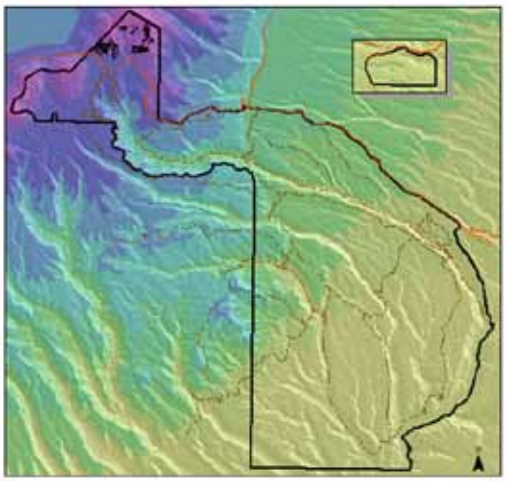


Figure G-38. Distribution of the polygons (in black) of map unit 7A.

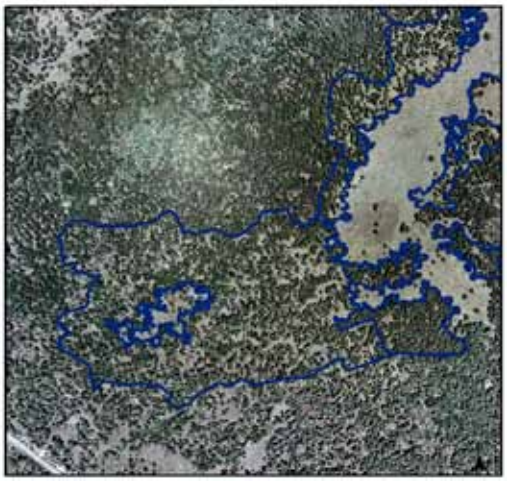


Figure G-39. Aerial photo of a representative polygon of map unit 7A.

7 Southern Rocky Mountain Ponderosa Pine Savanna

B Ponderosa Pine / Mountain Muhly-Blue Grama Mesa Woodland

Area	689 ha, 1,704 ac
Polygons	197
Primary component associations	*Pinus ponderosa* / *Muhlenbergia montana* Woodland *Pinus ponderosa* / *Bouteloua gracilis* Woodland
Secondary component associations	*Pinus ponderosa* / *Schizachyrium scoparium* Woodland *Pinus ponderosa* / *Robinia neomexicana* Woodland, Seeded Grasses Phase
Contrasting inclusions	*Pinus ponderosa* / *Carex inops* ssp. *heliophila* Woodland *Pinus ponderosa* / *Quercus* x *pauciloba* Woodland *Pinus ponderosa* - *Quercus gambelii* / *Carex inops* ssp. *heliophila* Woodland
Elevation	6,200 to 8,200 ft (1,900 to 2,500 m)
Summary	These woodlands are found on mesa tops of low slopes, often in association with soils derived from pumice. Stands are typically open-canopied and dominated by ponderosa pine. The understories are grassy and dominated by mountain muhly, little bluestem, western wheatgrass, and blue grama with scattered forbs. Shrubs are absent or scattered.



Figure G-40. Ground photo of map unit 7B.

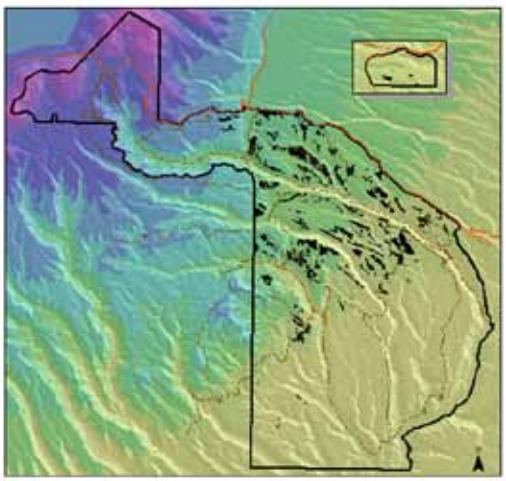


Figure G-41. Distribution of the polygons (in black) of map unit 7B.



Figure G-42. Aerial photo of a representative polygon of map unit 7B.

8 Southern Rocky Mountain Ponderosa Pine Forest and Woodland

A Ponderosa Pine / Wavyleaf Oak Mesa Woodland

Area	345 ha, 852 ac
Polygons	87
Primary component associations	*Pinus ponderosa* / *Quercus* x *pauciloba* Woodland
Contrasting inclusions	*Pinus ponderosa* - *Quercus gambelii* / *Carex inops* ssp. *heliophila* Woodland, Rockland Phase *Pinus ponderosa* / *Bouteloua gracilis* Woodland
Elevation	6,500 to 8,100 ft (2,000 to 2,500 m)
Summary	These woodlands are found along mesa tops of gentle slopes (<5%), typically in association with rocky, non-pumice soils. Stands are typically open-canopies and dominated by ponderosa pine. The understories are shrubby and dominated by wavyleaf oak. Grasses such as mountain muhly and little bluestem can be common.



Figure G-43. Ground photo of map unit 8A.

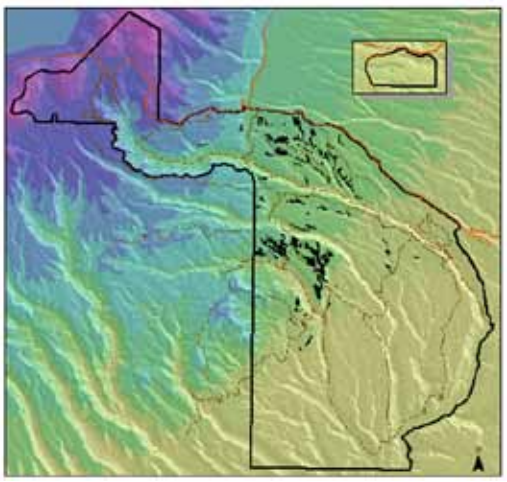


Figure G-44. Distribution of the polygons (in black) of map unit 8A.



Figure G-45. Aerial photo of a representative polygon of map unit 8A.

8 Southern Rocky Mountain Ponderosa Pine Forest and Woodland

B Ponderosa Pine-Gambel Oak / Deer Sedge Woodland

Area	680 ha, 1,681 ac
Polygons	220
Primary component associations	*Pinus ponderosa - Quercus gambelii / Carex inops* ssp. *heliophila* Woodland *Pinus ponderosa / Carex inops* ssp. *heliophila* Woodland
Secondary component associations	*Pinus ponderosa / Muhlenbergia montana* Woodland, *Poa fendleriana* Phase
Related inclusions	*Pinus ponderosa / Robinia neomexicana* Woodland
Contrasting inclusions	Sparse Vegetation / Boulder Rockland
Elevation	6,200 to 8,700 ft (1,900 to 2,600 m)
Summary	These forests and woodlands are found on mesa tops at high elevations and extend onto north-facing canyon slopes at lower elevations. Stands are typically moderately closed and dominated by ponderosa pine. The understories are typically sparse but shrubs such as Gambel's oak and New Mexico locust can be well represented. Graminoids are scattered and may include muttongrass, prairie junegrass, mountain muhly, fringed brome, and various deer sedges.



Figure G-46. Ground photo of map unit 8B.

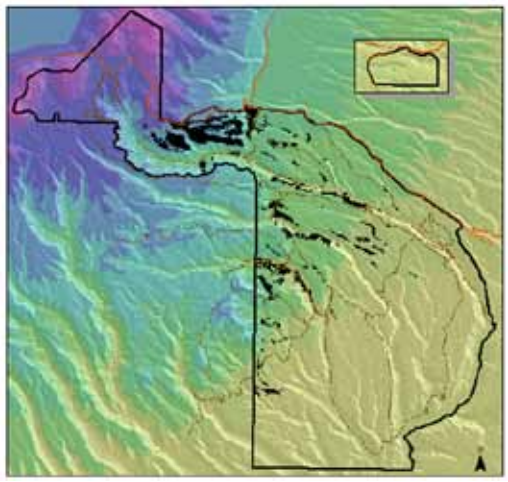


Figure G-47. Distribution of the polygons (in black) of map unit 8B.

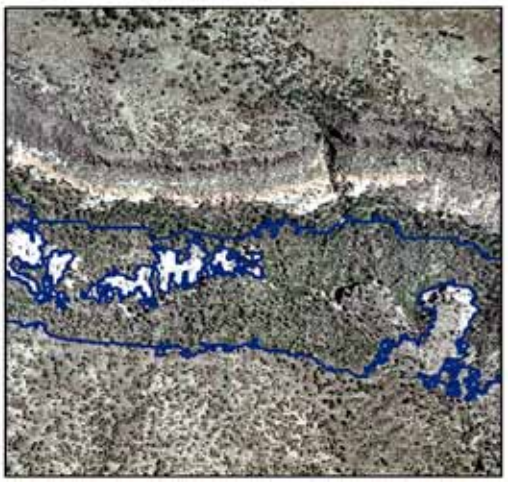


Figure G-48. Aerial photo of a representative polygon of map unit 8B.

8 Southern Rocky Mountain Ponderosa Pine Forest and Woodland

C Ponderosa Pine Ravine Woodland

Area	223 ha, 551 ac
Polygons	57
Primary component associations	*Pinus ponderosa* / *Quercus* x *pauciloba* Woodland *Pinus ponderosa* / *Forestiera pubescens* Forest, Typic Phase
Secondary component associations	*Pinus ponderosa* / *Bouteloua gracilis* Woodland *Pinus ponderosa* / *Muhlenbergia montana* Woodland, *Poa fendleriana* Phase *Pinus ponderosa* - *Quercus gambelii* / *Carex inops* ssp. *heliophila* Woodland
Related inclusions	Sparse Vegetation / Boulder Rockland
Elevation	5,800 to 7,300 ft (1,800 to 2,200 m)
Summary	These woodlands are found in lower-elevation, rocky, narrow canyons that dissect the mesas. Stands are typically moderately open and dominated by ponderosa pine. This unit is a complex of associations found on both north and south-facing slopes and canyon bottoms. Understories are most commonly dominated by shrubs such as wavyleaf oak, Gambel's oak, and occasionally New Mexico olive. But graminoids can also be well represented and may include muttongrass, prairie junegrass, mountain muhly, and little bluestem.



Figure G-49. Ground photo of map unit 8C.

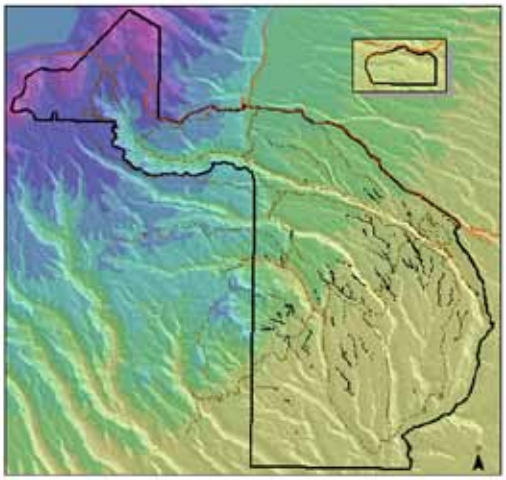


Figure G-50. Distribution of the polygons (in black) of map unit 8C.



Figure G-51. Aerial photo of a representative polygon of map unit 8C.

8 Southern Rocky Mountain Ponderosa Pine Forest and Woodland

D Ponderosa Pine Canyon Woodland

Area	131 ha, 323 ac
Polygons	52
Primary component associations	*Pinus ponderosa* / *Quercus* x *pauciloba* Woodland
Secondary component associations	*Pinus ponderosa* / *Carex inops* ssp. *heliophila* Woodland, Rockland Phase Sparse Vegetation / Boulder Rockland
Related inclusions	*Pinus ponderosa* / *Schizachyrium scoparium* Woodland
Contrasting inclusions	*Pinus ponderosa* / *Muhlenbergia montana* Woodland, *Poa fendleriana* Phase
Elevation	5,600 to 8,500 ft (1,700 to 2,600 m)
Summary	These forests and woodlands are found on steep, rocky, southerly slopes of canyons. Stands are open and dominated by ponderosa pine with undertstories of wavyleaf oak. Graminoids are common, but seldom abundant, and may include muttongrass, prairie junegrass, mountain muhly, and little bluestem.



Figure G-52. Ground photo of map unit 8D.

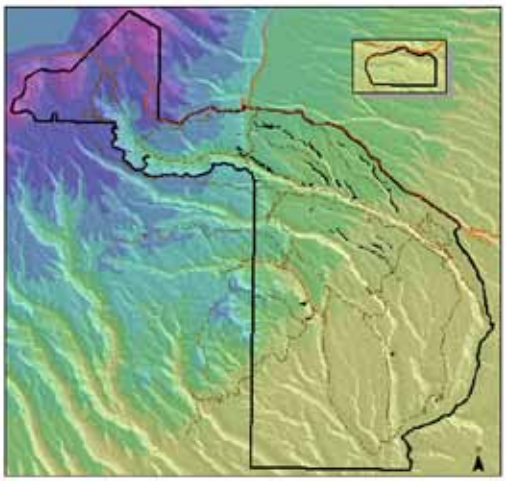


Figure G-53. Distribution of the polygons (in black) of map unit 8D.



Figure G-54. Aerial photo of a representative polygon of map unit 8D.

9 Southern Rocky Mountain Pinyon-Oneseed Juniper Woodland

A (Pinyon) Oneseed Juniper / Grama Grass Mesa Woodland

Area	1,491 ha, 3,685 ac
Polygons	344
Primary component associations	*Juniperus monosperma* / *Bouteloua gracilis* Woodland, Dead *Pinus edulis* Phase
Secondary component associations	*Juniperus monosperma* / Sparse Understory Woodland, Dead *Pinus edulis* Loamy Phase *Pinus edulis* - (*Juniperus monosperma Juniperus deppeana*) / *Bouteloua gracilis* Woodland
Related inclusions	*Pinus ponderosa* / *Schizachyrium scoparium* Woodland
Contrasting inclusions	*Juniperus monosperma* / *Rhus trilobata* Woodland *Juniperus monosperma* / *Quercus* x *pauciloba* Woodland, Dead *Pinus edulis* Phase
Elevation	6,000 to 7,200 ft (1,800 to 2,200 m)
Summary	These woodlands are found on mesa tops of low slopes, often (but not always) in association with soils derived from pumice. Stands are typically open-canopied and were co-dominated by pinyon pine and oneseed juniper before the pinyon die-off in 2003-4. While pinyon reproduction is common, stands are now dominated by oneseed juniper. The understories vary from very sparse with exposed soil in inter-tree spaces to grassy and dominated by blue grama along with black grama, hairy grama, bottlebrush squirreltail, and muttongrass as common associates. Succulents and subshrubs such as pricklypear and broom snakeweed can be abundant.





Figure G-55. Ground photos of map unit 9A.

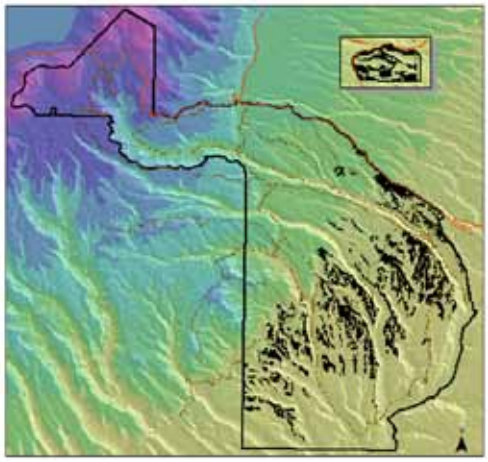


Figure G-56. Distribution of the polygons (in black) of map unit 9A.



Figure G-57. Aerial photo of a representative polygon of map unit 9A.

9 Southern Rocky Mountain Pinyon-Oneseed Juniper Woodland

B (Pinyon) Oneseed Juniper / Wavyleaf Oak Mesa Woodland

Area	821 ha, 2,028 ac
Polygons	231
Primary component associations	*Juniperus monosperma* / *Quercus* x *pauciloba* Woodland, Dead *Pinus edulis* Phase
Secondary component associations	*Juniperus monosperma* / Sparse Woodland, Dead *Pinus edulis* Stony Phase
Contrasting inclusions	*Juniperus monosperma* / *Bouteloua gracilis* Woodland, Dead *Pinus edulis* Phase
Elevation	6,000 to 7,200 ft (1,800 to 2,200 m)
Summary	These woodlandsare found along mesa tops of gentle slopes (<5%), often on stony soils. Stands are typically open-canopied and were co-dominated by pinyon pine and oneseed juniper before the pinyon die-off in 2003-4. While pinyon reproduction is common, stands are now dominated by oneseed juniper. Understories vary from very sparse with exposed cobble and bedrock to shrubby and dominated by wavyleaf oak along with mountain mahogany. Grasses can be well-represented with blue grama, bottlebrush squirreltail, little bluestem, and muttongrass the most common associates. Succulents and subshrubs such as pricklypear, yucca, and broom snakeweed can be abundant.



Figure G-58. Ground photo of map unit 9B.

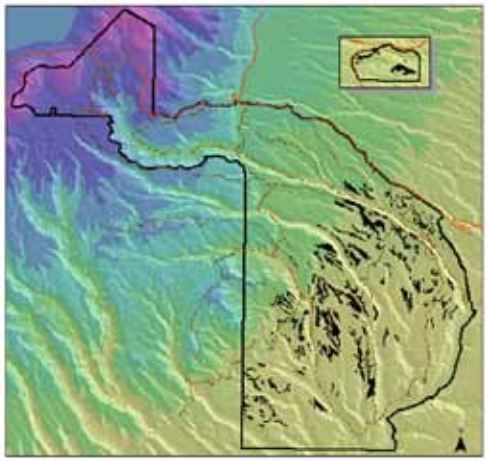


Figure G-59. Distribution of the polygons (in black) of map unit 9B.



Figure G-60. Aerial photo of a representative polygon of map unit 9B.

9 Southern Rocky Mountain Pinyon-Oneseed Juniper Woodland

C (Pinyon) Oneseed Juniper / Wavyleaf Oak-Grama Grass Canyon Woodland

Area	184 ha, 456 ac
Polygons	65
Primary component associations	*Juniperus monosperma* / *Quercus* x *pauciloba* Woodland, Dead *Pinus edulis* Phase
Secondary component associations	*Juniperus monosperma* / *Bouteloua gracilis* Woodland, Dead *Pinus edulis* Phase
Contrasting inclusions	*Juniperus monosperma* / *Bouteloua curtipendula* Woodland *Juniperus monosperma* / Rockland Woodland, Dead *Pinus edulis* Phase Sparse Vegetation / Boulder Rockland
Elevation	5,900 to 7,400 ft (1,800 to 2,200 m)
Summary	These woodlands are found on north-facing steep canyon slopes. Stands are typically open-canopied and were co-dominated by pinyon pine and oneseed juniper before the pinyon die-off in 2003-4. While pinyon reproduction is common, stands are now dominated by oneseed juniper. Understories vary from being shrubby and dominated by wavyleaf oak along with mountain mahogany, to grassy with blue grama, sideoats grama, and muttongrass as the most common associates. Succulents and subshrubs such as pricklypear, yucca, and broom snakeweed can be abundant.





Figure G-61. Ground photos of map unit 9C.

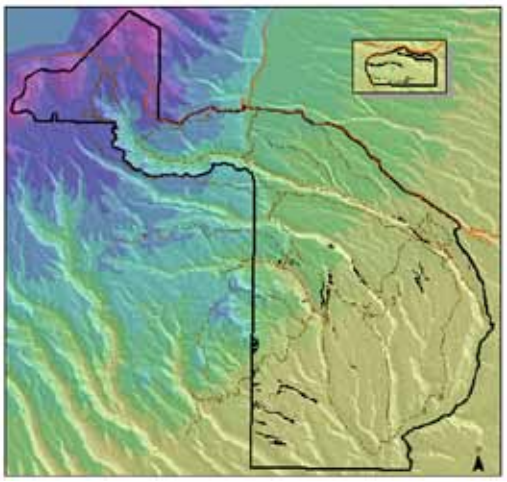


Figure G-62. Distribution of the polygons (in black) of map unit 9C.



Figure G-63. Aerial photo of a representative polygon of map unit 9C.

9 Southern Rocky Mountain Pinyon-Oneseed Juniper Woodland

D (Pinyon) Oneseed Juniper / Rockland Canyon Woodland

Area	190 ha, 469 ac
Polygons	69
Primary component associations	*Juniperus monosperma* / Rockland Woodland, Dead *Pinus edulis* Phase
Secondary component associations	*Juniperus monosperma* / *Quercus* x *pauciloba* Woodland, Dead *Pinus edulis* Phase Sparse Vegetation / Boulder Rockland
Contrasting inclusions	*Juniperus monosperma* / *Bouteloua curtipendula* Woodland
Elevation	5,800 to 7,500 ft (1,800 to 2,300 m)
Summary	These woodlands are found on south-facing, steep canyon slopes. Stands are typically open-canopied and were co-dominated by pinyon pine and oneseed juniper before the pinyon die-off in 2003-4. While pinyon reproduction is common, stands are now dominated by oneseed juniper. Stands occur on rock outcrops and rubble slopes and with scattered shrubs and herbs.





Figure G-64. Ground photos of map unit 9D.

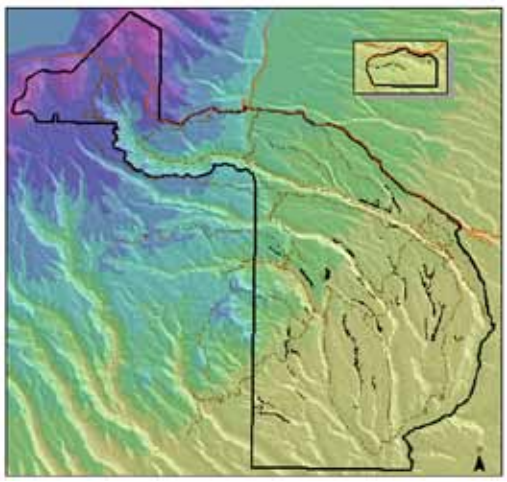


Figure G-65. Distribution of the polygons (in black) of map unit 9D.



Figure G-66. Aerial photo of a representative polygon of map unit 9D.

9 Southern Rocky Mountain Pinyon-Oneseed Juniper Woodland

E (Pinyon) Oneseed Juniper Ravine Woodland

Area	41 ha, 101 ac
Polygons	26
Primary component associations	*Juniperus monosperma* / *Quercus* x *pauciloba* Woodland, Dead *Pinus edulis* Phase *Juniperus monosperma* / *Bouteloua curtipendula* Woodland, Dead *Pinus edulis* Phase *Juniperus monosperma* / Rockland Woodland, Dead *Pinus edulis* Phase
Secondary component associations	*Juniperus monosperma* / *Forestiera pubescens* Woodland, Dead *Pinus edulis* Phase Sparse Vegetation / Boulder Rockland
Contrasting inclusions	*Juniperus monosperma* / *Bouteloua gracilis* Woodland, Dead *Pinus edulis* Phase
Elevation	5,700 to 7,300 ft (1,700 to 2,200)
Summary	These woodlands are found in lower-elevation, rocky, narrow canyons that dissect the mesas. Stands are typically open-canopied and were co-dominated by pinyon pine and oneseed juniper before the pinyon die-off in 2003-4. While pinyon reproduction is common, stands are now dominated by oneseed juniper. This unit is a complex of associations found on both north- and south-facing slopes and canyon bottoms, Understories vary from shrubby and dominated by by wavyleaf oak along with mountain mahogany, to grassy with blue grama and sideoats grama.





Figure G-67. Ground photos of map unit 9E.

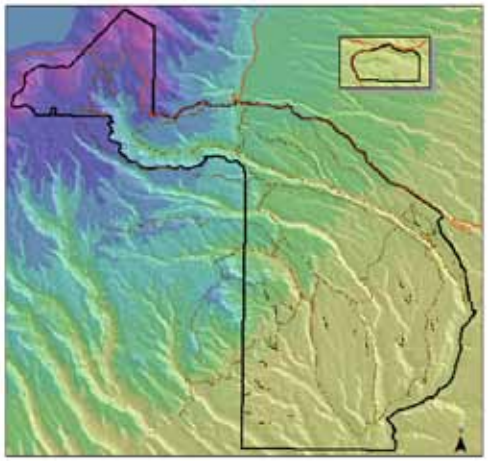


Figure G-68. Distribution of the polygons (in black) of map unit 9E.



Figure G-69. Aerial photo of a representative polygon of map unit 9E.

9 Southern Rocky Mountain Pinyon-Oneseed Juniper Woodland

F (Pinyon) Oneseed Juniper / Treatment Woodland

Area	29 ha, 72 ac
Polygons	3
Primary component associations	*Juniperus monosperma* / *Bouteloua gracilis* Woodland, Treatment Phase
Secondary component associations	*Juniperus monosperma* / Sparse Understory Woodland, Treatment Phase
Elevation	6,400 to 6,700 ft (1,900 to 2,000 m)
Summary	These woodlandsare found along mesa tops of gentle slopes (<5%), that have been mechanically thinned of trees to varying degree. The ground cover tends to be sparse or dominated by ruderal, weedy species.



Figure G-70. Ground photo of map unit 9F.

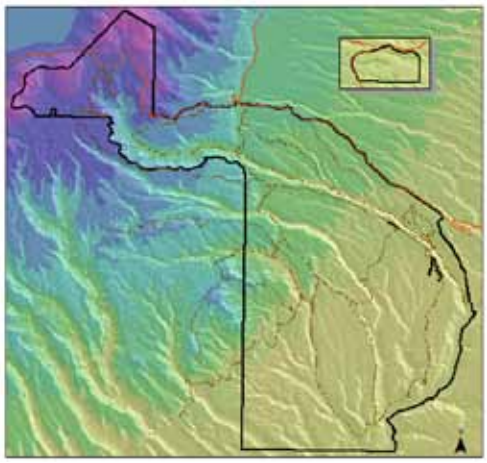


Figure G-71. Distribution of the polygons (in black) of map unit 9F.



Figure G-72. Aerial photo of a representative polygon of map unit 9F.

10 Madrean Pinyon-Juniper Woodland

A (Pinyon) Alligator Juniper / Wavyleaf Oak Woodland

Area	301 ha, 744 ac
Polygons	64
Primary component associations	*Juniperus deppeana* / *Quercus* x *pauciloba* Woodland, Dead *Pinus edulis* Phase
Secondary component associations	*Juniperus deppeana* / Sparse Woodland, Dead *Pinus edulis* Phase
Related inclusions	*Juniperus deppeana* / *Bouteloua gracilis* Woodland, Dead *Pinus edulis* Phase *Juniperus deppeana* / Ruderal Herbs Vegetation Woodland, Dead *Pinus edulis* Phase
Contrasting inclusions	*Juniperus monosperma* / Rockland Woodland, Dead *Pinus edulis* Phase
Elevation	6,200 to 8000 ft (1,900 to 2,400 m)
Summary	These woodlands are found on the southerly aspects of mountain slopes (San Miguel Mountains) extending into neighboring steep canyon slopes. Stands are typically open-canopied and were co-dominated by pinyon pine and alligator juniper before the pinyon die-off in 2003-4. While pinyon reproduction is common, stands are now dominated by alligator juniper. Understories are shrubby and dominated by wavyleaf oak along with mountain mahogany. Grasses are common to well represented with blue grama, mountain muhly, and muttongrass the most common associates.





Figure G-73. Ground photos of map unit 10A.

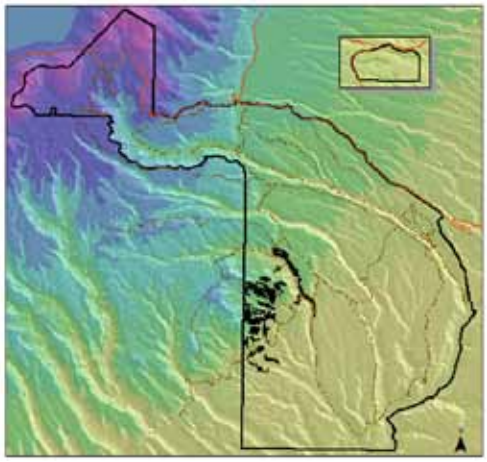


Figure G-74. Distribution of the polygons (in black) of map unit 10A.



Figure G-75. Aerial photo of a representative polygon of map unit 10A.

11 Southern Rocky Mountain Juniper Woodland & Savanna

A Oneseed Juniper / Blue Grama Mesa Woodland

Area	606 ha, 1,498 ac
Polygons	121
Primary component associations	*Juniperus monosperma* / *Bouteloua gracilis* Woodland
Secondary component associations	*Juniperus monosperma* / Sparse Woodland, Loamy Phase
Contrasting inclusions	*Juniperus monosperma* / *Hesperostipa neomexicana* Woodland *Juniperus monosperma* / *Bouteloua curtipendula* Woodland *Juniperus monosperma* / *Quercus* x *pauciloba* Woodland
Elevation	5,500 to 6,500 ft (1,700 to 2,000 m)
Summary	These woodlands are found along mesa tops of gentle slopes (<5%). Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper. Pinyon pine was likely less than 25% of the total tree cover before the die-off in 2003-4. The understories vary from very sparse with exposed soil in inter-tree spaces to grassy and dominated by blue grama. Succulents and subshrubs such as pricklypear and broom snakeweed can be abundant.



Figure G-76. Ground photo of map unit 11A.

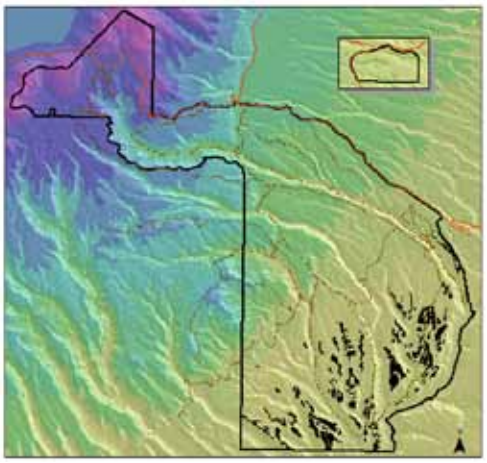


Figure G-77. Distribution of the polygons (in black) of map unit 11A.

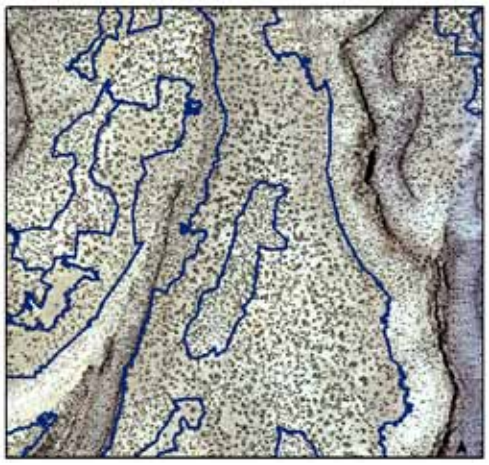


Figure G-78. Aerial photo of a representative polygon of map unit 11A.

11 Southern Rocky Mountain Juniper Woodland & Savanna

B Oneseed Juniper/Black Grama–Blue Grama Mesa Woodland

Area	278 ha, 688 ac
Polygons	68
Primary component associations	*Juniperus monosperma* / *Bouteloua eriopoda* Woodland *Juniperus monosperma* / *Bouteloua gracilis* Woodland
Related inclusions	*Juniperus monosperma* / *Quercus* x *pauciloba* Woodland *Juniperus monosperma* / Sparse Understory Woodland, Stony Phase
Elevation	5,400 to 6,500 ft (1,700 to 2,000 m)
Summary	These woodlands are found along mesa tops of gentle slopes (<5%). Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper. Pinyon pine was likely less than 25% of the total tree cover before the die-off in 2003-4. In this woodland savanna, groundcover is grassy and dominated by blue grama and/or black grama. Succulents and subshrubs such as pricklypear and broom snakeweed can be abundant.



Figure G-79. Ground photo of map unit 11B.

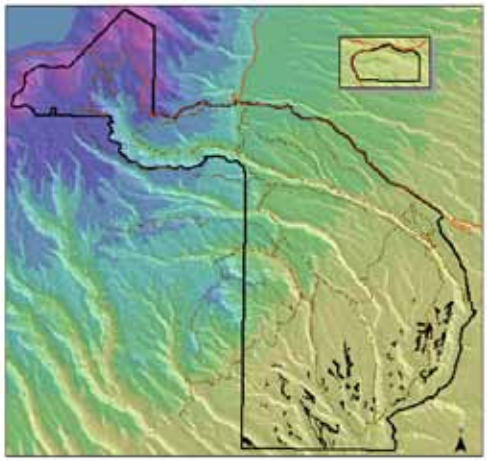


Figure G-80. Distribution of the polygons (in black) of map unit 11B.

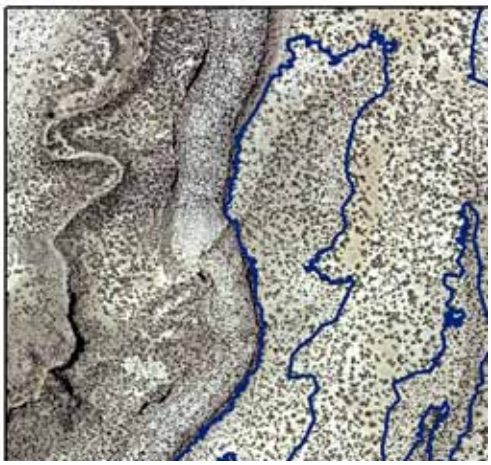


Figure G-81. Aerial photo of a representative polygon of map unit 11B.

11 Southern Rocky Mountain Juniper Woodland & Savanna

C Oneseed Juniper/Black Grama Canyon Woodland

Area	634 ha, 1,567 ac
Polygons	120
Primary component associations	*Juniperus monosperma* / *Bouteloua eriopoda* Woodland
Secondary component associations	*Juniperus monosperma* / *Bouteloua curtipendula* Woodland *Juniperus monosperma* / Sparse Understory Woodland, Stony Phase
Related inclusions	*Juniperus monosperma* / Rockland Woodland *Juniperus monosperma* / *Artemisia tridentata* Woodland
Contrasting inclusions	*Juniperus monosperma* / *Quercus* x *pauciloba* Woodland Sparse Vegetation / Boulder Rockland
Elevation	5,400 to 6,800 ft (1,600 to 2,000 m)
Summary	These woodlands are found on steep, south-facing lower slopes of canyons. Stands are typically very open-canopied (>10% cover) and dominated oneseed juniper. Pinyon pine was likely less than 25% of the total tree cover before the die-off in 2003-4. Groundcover can range from grassy savannas dominated by black grama to cobble slopes with little vegetative cover. Succulents and subshrubs such as pricklypear and broom snakeweed can be abundant.





Figure G-82. Ground photos of map unit 11C.

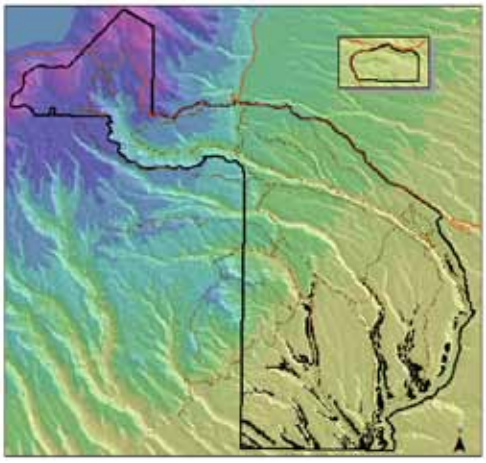


Figure G-83. Distribution of the polygons (in black) of map unit 11C.

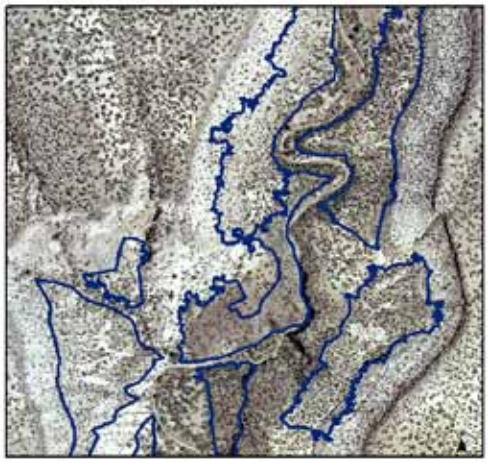


Figure G-84. Aerial photo of a representative polygon of map unit 11C.

11 Southern Rocky Mountain Juniper Woodland & Savanna

D Oneseed Juniper/Wavyleaf Oak-Grama Grass Canyon Woodland

Area	54 ha, 134 ac
Polygons	13
Primary component associations	*Juniperus monosperma* / *Quercus* x *pauciloba* Woodland *Juniperus monosperma* / *Bouteloua gracilis* Woodland
Secondary component associations	*Juniperus monosperma* / *Bouteloua curtipendula* Woodland *Juniperus monosperma* / *Rhus trilobata* Woodland
Contrasting inclusions	*Juniperus monosperma* / Rockland Woodland Sparse Vegetation / Boulder Rockland
Elevation	5,800 to 6,600 ft (1,800 to 2,000 m)
Summary	These woodlands are found on steep, north-facing, lower slopes of canyons. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper. Pinyon pine was likely less than 25% of the total tree cover before the die-off in 2003-4. Understories can be shrubby and dominated by wavyleaf oak along with mountain mahogany and other montane scrub species. They also tend to have a grassy component, with blue grama, sideoats grama, and muttongrass well represented to abundant.



Figure G-85. Ground photo of map unit 11D.

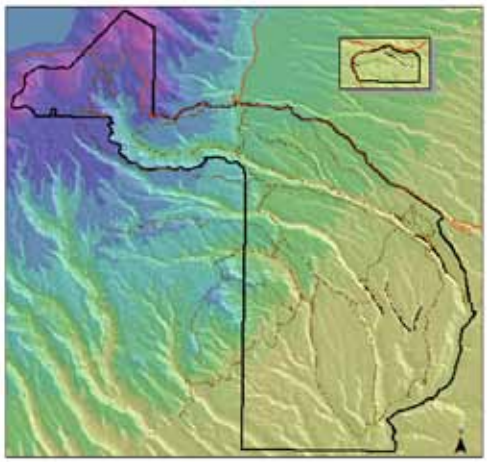


Figure G-86. Distribution of the polygons (in black) of map unit 11D.



Figure G-87. Aerial photo of a representative polygon of map unit 11D.

11 Southern Rocky Mountain Juniper Woodland & Savanna

E Oneseed Juniper/Rockland Canyon Woodland

Area	366 ha, 905 ac
Polygons	109
Primary component associations	*Juniperus monosperma* / Rockland Woodland
Secondary component associations	*Juniperus monosperma* / *Quercus* x *pauciloba* Woodland Sparse Vegetation / Boulder Rockland
Contrasting inclusions	*Juniperus monosperma* / *Bouteloua curtipendula* Woodland
Elevation	5,400 to 7,000 ft (1,600 to 2,100 m)
Summary	These woodlands are found on steep, upper slopes of canyon walls. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper. Pinyon pine was likely less than 25% of the total tree cover before the die-off in 2003-4. Stands occur on rock outcrops and rubble slopes and with scattered shrubs and herbs.



Figure G-88. Ground photo of map unit 11E.

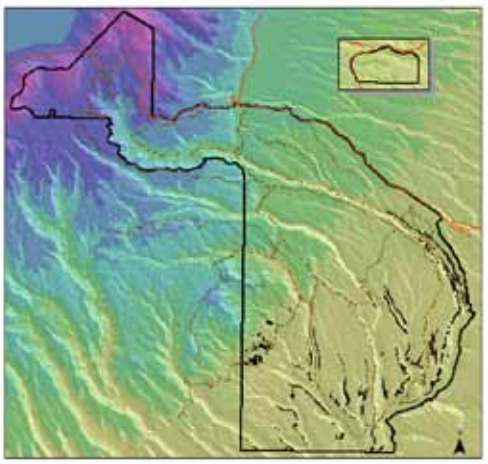


Figure G-89. Distribution of the polygons (in black) of map unit 11E.

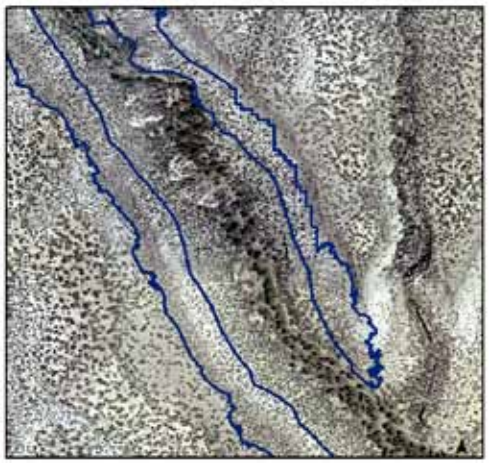


Figure G-90. Aerial photo of a representative polygon of map unit 11E.

11 Southern Rocky Mountain Juniper Woodland & Savanna

F Oneseed Juniper / Wavyleaf Oak / Sparse Rockland Mesa Woodland

Area	373 ha, 921 ac
Polygons	143
Primary component associations	*Juniperus monosperma* / *Quercus* x *pauciloba* Woodland
Secondary component associations	*Juniperus monosperma* / Sparse Understory Woodland, Stony Phase
Contrasting inclusions	*Juniperus monosperma* / *Bouteloua gracilis* Woodland
Elevation	5,500 to 7,000 ft (1,700 to 2,100 m)
Summary	These woodlands are found on mesa tops with gentle to moderate slope associated with erosional remnants of upper member of the Bandelier Tuff. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper. Pinyon pine was likely less than 25% of the total tree cover before the die-off in 2003-4. Sites are gravelly and rocky with scattered wavyleaf oaks among the trees and a sparse ground cover of forbs and grasses.





Figure G-91. Ground photos of map unit 11F.

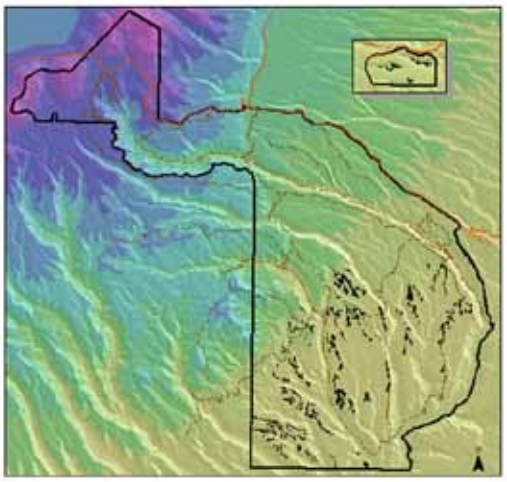


Figure G-92. Distribution of the polygons (in black) of map unit 11F.



Figure G-93. Aerial photo of a representative polygon of map unit 11F.

11 Southern Rocky Mountain Juniper Woodland & Savanna

G Oneseed Juniper / Sparse Canyon Woodland

Area	199 ha, 491 ac
Polygons	55
Primary component associations	*Juniperus monosperma* / Sparse Understory Woodland, Pumice Phase
Contrasting inclusions	*Juniperus monosperma* / *Bouteloua eripopoda* Woodland
Elevation	5,400 to 6,400 ft (1,600 to 2,000 m)
Summary	These woodlands are found on north-facing, pumaceous toe slopes of canyons and hills. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper. Pinyon pine was likely less than 25% of the total tree cover before the die-off in 2003-4. Ground cover is sparse with only scattered grasses and forbs.



Figure G-94. Ground photo of map unit 11G.

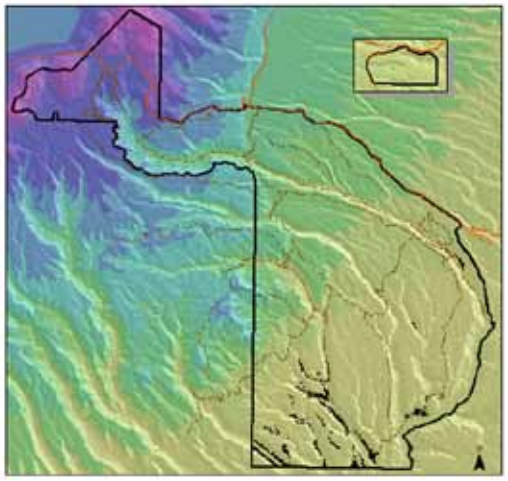


Figure G-95. Distribution of the polygons (in black) of map unit 11G.



Figure G-96. Aerial photo of a representative polygon of map unit 11G.

11 Southern Rocky Mountain Juniper Woodland & Savanna

H Oneseed Juniper / Grama Grass Valley Bottom Woodland

Area	33 ha, 82 ac
Polygons	13
Primary component associations	*Juniperus monosperma* / *Bouteloua curtipendula* Woodland
Secondary component associations	*Juniperus monosperma* / *Bouteloua gracilis* Woodland
Contrasting inclusions	*Juniperus monosperma* / *Forestiera pubescens* Woodland
Elevation	5,500 to 6,000 ft (1,700 to 1,800 m)
Summary	These woodlands are found on valley bottom cobbly alluvial terraces. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper. Pinyon pine was likely less than 25% of the total tree cover before the die-off in 2003-4. Ground cover is characterized by scattered grasses and forbs with blue grama, hairy grama, and side oats grama the most common.



Figure G-97. Ground photo of map unit 11H.

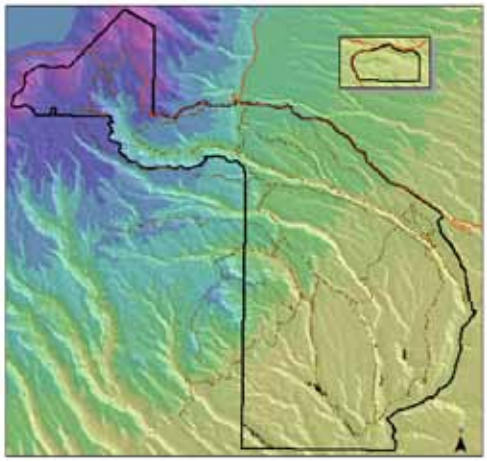


Figure G-98. Distribution of the polygons (in black) of map unit 11H.



Figure G-99. Aerial photo of a representative polygon of map unit 11H.

12 Southern Rocky Mountain Gambel Oak-Mixed [Mesic] Montane Shrubland

A Fendler Ceanothus-New Mexico Locust Montane Mesa Shrubland

Area	367 ha, 906 ac
Polygons	111
Primary component associations	*Ceanothus fendleri* / *Muhlenbergia montana* Shrubland *Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland
Contrasting inclusions	*Fallugia paradoxa* / Ruderal Herbs Shrubland *Quercus gambelii* / *Robinia neomexicana* / *Muhlenbergia montana* Shrubland *Quercus gambelii* / *Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland, Seeded Grasses Phase
Elevation	6,800 to 8,800 ft (2,000 to 2,600 m)
Summary	These shrublands are found on mesatops of gentle to moderate slope, and often (but not always) in association with soils derived from pumice. While these sites tend to be grassy, shrub cover typically exceeds 25% and is dominated by Fendler Ceanothus and New Mexico locust. The grass are dominated by mountain muhly, little bluestem, western wheatgrass, and blue grama. This unit is likely a post-fire, successional type related to the 1977 La Mesa fire, and ruderal forbs and seeded ruderal grasses can be prevalent. Young ponderosa pines can also be common but their cover does not exceed 10%.





Figure G-100. Ground photos of map unit 12A.

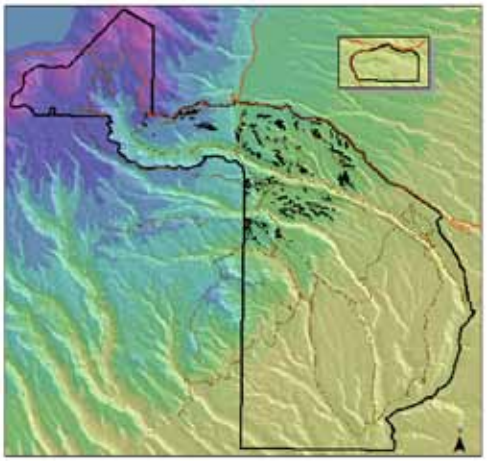


Figure G-101. Distribution of the polygons (in black) of map unit 12A.



Figure G-102. Aerial photo of a representative polygon of map unit 12A.

12 Southern Rocky Mountain Gambel Oak-Mixed [Mesic] Montane Shrubland

B Apache Plume-New Mexico Locust Mesa Shrubland

Area	42 ha, 104 ac
Polygons	22
Primary component associations	*Fallugia paradoxa* / Ruderal Herbs Shrubland *Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland, Ruderal Herbs Phase
Secondary component associations	Ruderal Post-fire Herbaceous Vegetation
Elevation	6,500 to 7,200 ft (2,000 to 2,200 m)
Summary	These shrublands are found on the mesatops of gentle to moderate slope, and in association with soils derived from pumice. These sites are dominated by either Apache plume or New Mexico locust. Grasses are well represented and are dominated by mountain muhly, little bluestem, western wheatgrass, and blue grama. The exotic cheat grass can also be abundant. This unit is likely a post-fire, successional type related to the burning of ponderosa pine woodlands in the 1977 La Mesa fire, and ruderal forbs can still be abundant. Young ponderosa pines can also be common but their cover does not exceed 10%.





Figure G-103. Ground photos of map unit 12B.

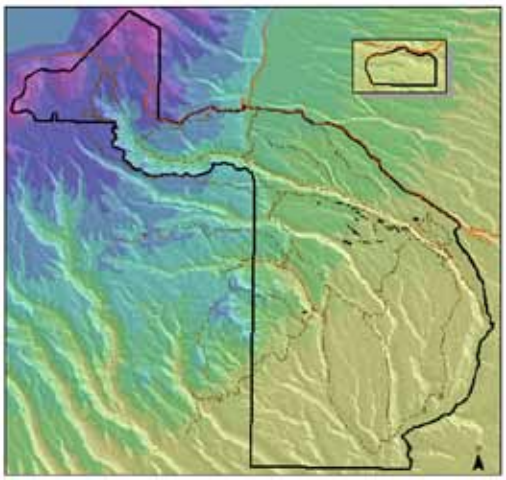


Figure G-104. Distribution of the polygons (in black) of map unit 12B.



Figure G-105. Aerial photo of a representative polygon of map unit 12B.

12 Southern Rocky Mountain Gambel Oak-Mixed [Mesic] Montane Shrubland

C Gambel Oak/New Mexico Locust Canyon Shrubland

Area	352 ha, 870 ac
Polygons	174
Primary component associations	*Quercus gambelii* / *Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland
Secondary component associations	*Jamesia americana* (*Physocarpus monogynus*, *Holodiscus dumosa*) Rock Outcrop Shrubland Sparse Vegetation / Boulder Rockland
Contrasting inclusions	*Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland *Ceanothus fendleri* / *Muhlenbergia montana* Shrubland
Elevation	6,300 to 9,900 ft (1,900 to 3,000 m)
Summary	These shrublands are found on north-facing steep and rocky canyon slopes. Stands are dominated by Gambel's oak and/or New Mexico locust. Graminoids range from sparse to well-represented with mountain muhly, muttongrass, and various deer sedges the most common. This unit is likely a post-fire, successional type related to the 1977 La Mesa and other fires.





Figure G-106. Ground photos of map unit 12C.

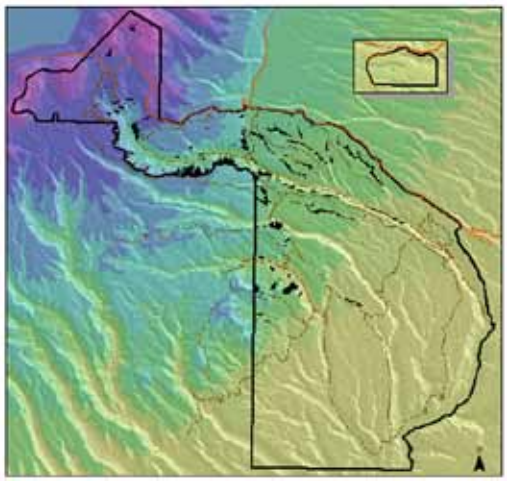


Figure G-107. Distribution of the polygons (in black) of map unit 12C.



Figure G-108. Aerial photo of a representative polygon of map unit 12C.

12 Southern Rocky Mountain Gambel Oak-Mixed [Mesic] Montane Shrubland

D Gambel Oak / New Mexico Locust-Mountain Muhly Mesa Shrubland

Area	102 ha, 253 ac
Polygons	49
Primary component associations	*Quercus gambelii - Robinia neomexicana / Muhlenbergia montana* Shrubland
Secondary component associations	*Quercus gambelii / Robinia neomexicana / Carex inops* ssp. *heliophila* Shrubland, Seeded Grasses Phase
Contrasting inclusions	*Ceanothus fendleri / Muhlenbergia montana* Shrubland *Robinia neomexicana / Carex inops* ssp. *heliophila* Shrubland
Elevation	7,000 to 8,800 ft (2,100 to 2,700 m)
Summary	These shrublands occur on mesa tops of gentle slope, and usually in association with soils derived from Bandelier Tuff. These shrublands are dominated by Gambel's oak and/or New Mexico locust. Grasses are scattered, to well represented, and dominated by mountain muhly, prairie junegrass, and muttongrass. This unit is likely a post-fire, successional type related to the 1977 La Mesa Fire, and seeded ruderal grasses can be prevalent.



Figure G-109. Ground photo of map unit 12D.

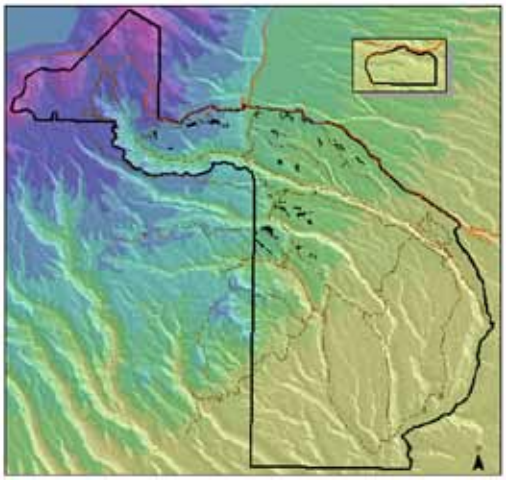


Figure G-110. Distribution of the polygons (in black) of map unit 12D.



Figure G-111. Aerial photo of a representative polygon of map unit 12D.

13 Southern Rocky Mountain Cercocarpus-Mixed [Dry] Foothill Shrubland

A Wavyleaf Oak / Sideoats Grama Mesa Shrubland

Area	254 ha, 629 ac
Polygons	101
Primary component associations	*Quercus* x *pauciloba* / *Bouteloua curtipendula* Shrubland
Contrasting inclusions	*Quercus* x *pauciloba* / *Cercocarpus montanus* Shrubland *Quercus gambelii* / *Robinia neomexicana* / *Muhlenbergia montana* Shrubland *Fallugia paradoxa* / Ruderal Herbs Shrubland *Gutierrezia sarothrae* / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation
Elevation	6,100 to 7,700 ft (1,900 to 2,300 m)
Summary	These shrublands occurs on mesa tops of gentle slope, and usually in association with soils derived from Bandelier Tuff. These shrublands are dominated by Gambel's oak and/or New Mexico locust. Grasses are scattered, to well represented, and dominated by mountain muhly, prairie junegrass, and muttongrass. This unit is likely a post-fire, successional type related to the 1977 La Mesa Fire, and seeded ruderal grasses can be prevalent.





Figure G-112. Ground photos of map unit 13A.

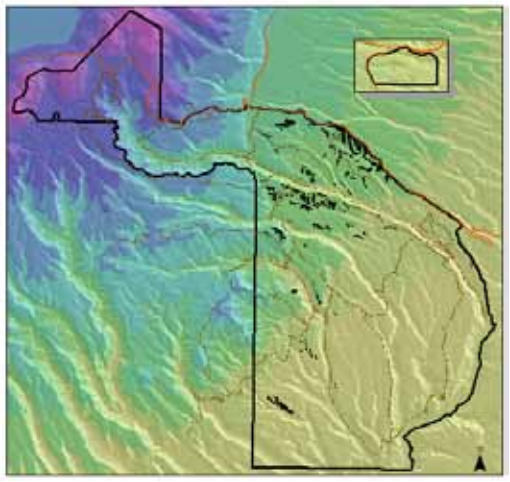


Figure G-113. Distribution of the polygons (in black) of map unit 13A.



Figure G-114. Aerial photo of a representative polygon of map unit 13A.

13 Southern Rocky Mountain Cercocarpus-Mixed [Dry] Foothill Shrubland

B Wavyleaf Oak / Ruderal Foothill Shrubland

Area	117 ha, 289 ac
Polygons	36
Primary component associations	*Quercus* x *pauciloba* / *Bouteloua curtipendula* Shrubland
Secondary component associations	Ruderal Post-fire Herbaceous Vegetation
Elevation	6,400 to 7,800 ft (1,900 to 2,400 m)
Summary	These shrublands are found on the southerly aspects of mountain slopes (San Miguel Mountains) extending into neighboring steep canyon slopes. These shrublands are dominated by wavyleaf oak with a grassy understory dominated by sideoats grama and blue grama. This unit is a post-fire, successional type related to the burning of pinyon-alligator juniper woodlands in the 1996 Dome Fire.



Figure G-115. Ground photo of map unit 13B.

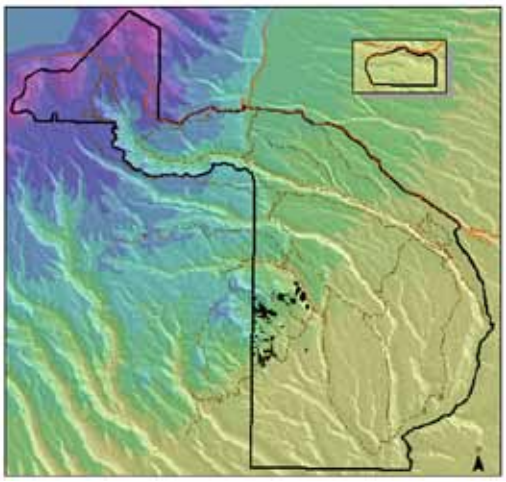


Figure G-116. Distribution of the polygons (in black) of map unit 13B.



Figure G-117. Aerial photo of a representative polygon of map unit 13B.

13 Southern Rocky Mountain Cercocarpus-Mixed [Dry] Foothill Shrubland

C Wavyleaf Oak-Mountain Mahogany/Rockland Canyon Shrubland

Area	341 ha, 843 ac
Polygons	115
Primary component associations	*Quercus* x *pauciloba* - *Cercocarpus montanus* Shrubland
Secondary component associations	*Rhus trilobata* Rocky Mountain Shrub Herbaceous Vegetation Sparse Vegetation / Boulder Rockland
Contrasting inclusions	*Quercus gambelii* / *Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland *Gutierrezia sarothrae* / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation *Fallugia paradoxa* - *Brickellia* spp. - (*Holodiscus dumosus*) Scree Shrubland
Elevation	5,800 to 8,000 ft (1,700 to 2,500 m)
Summary	These shrublands are found on south-facing, steep, and rocky canyon slopes. Stands are characterized by scattered wavyleaf and/or mountain mahogany among boulders and rock outcrops. Grasses can be well represented with mountain muhly, little bluestem, and blue grama the most common. This unit may be a post-fire, successional type related to the 1977 La Mesa and other fires.





Figure G-118. Ground photos of map unit 13C.

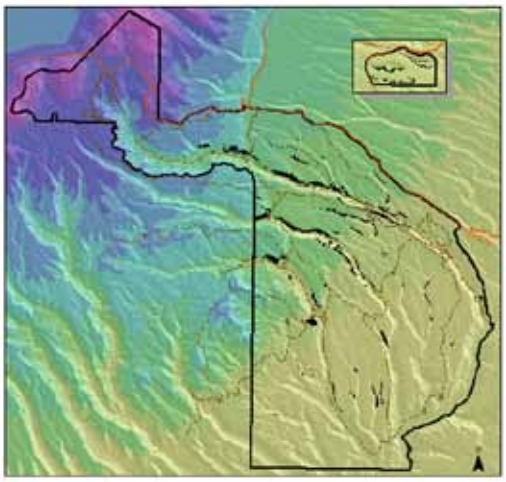


Figure G-119. Distribution of the polygons (in black) of map unit 13C.



Figure G-120. Aerial photo of a representative polygon of map unit 13C.

14 Great Plains Sand Shrubland

A Sand Sagebrush / Talus Canyon Shrubland

Area	66 ha, 163 ac
Polygons	11
Primary component associations	*Artemisia filifolia* / *Bouteloua eriopoda* Shrubland Sparse Vegetation / Scree
Secondary component associations	*Fallugia paradoxa* - *Brickellia* spp. - (*Holodiscus dumosus*) Scree Shrubland
Related inclusions	*Juniperus monosperma* / *Artemisia tridentata* Woodland
Contrasting inclusions	*Bouteloua eriopoda* - *Bouteloua curtipendula* Herbaceous Vegetation
Elevation	5,400 to 6,200 ft (1,600 to 1,900 m)
Summary	These semi-arid shrublands are found on south-facing, steep, and often unstable and rocky canyon slopes (White Rock Canyon). They are dominated by either sand sagebrush with a grassy ground cover of black grama or Apache plume stands on rocky, talus slopes.





Figure G-121. Ground photos of map unit 14A.

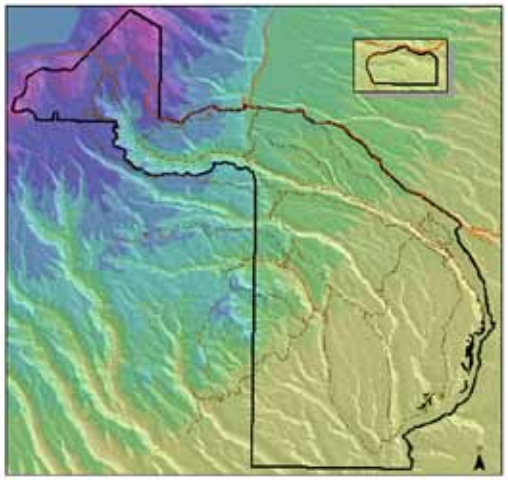


Figure G-122. Distribution of the polygons (in black) of map unit 14A.



Figure G-123. Aerial photo of a representative polygon of map unit 14A.

15 Southern Rocky Mountain Montane-Subalpine Grassland

A Thurber's Fescue-Parry's Danthonia Upper Montane Grassland

Area	61 ha, 150 ac
Polygons	40
Primary component associations	*Festuca thurberi - Danthonia parryi / Potentilla hippiana* Herbaceous Vegetation *Festuca thurberi / Potentilla hippiana* Herbaceous Vegetation
Contrasting inclusions	*Poa pratensis / Taraxacum officinale* Semi-natural Herbaceous Vegetation
Elevation	9,000 to 10,200 ft (2,700 to 3,100 m)
Summary	These upper montane grasslands are found on south-facing upper slopes and ridgelines of the caldera rim of the Sierra de los Valles. They are characterized by the dominance of tall montane bunch grasses such as Thurber fescue or Parry's oatgrass with Arizona fescue and Kentucky bluegrass sometimes abundant. Forbs are diverse and represented by montane meadow species such as woolly cinquefoil, bluebell bellflower, beautiful fleabane, common yarrow, Rocky Mountain iris, and Arizona peavine. Trees can be present but their cover does not exceed 10%.





Figure G-124. Ground photos of map unit 15A.

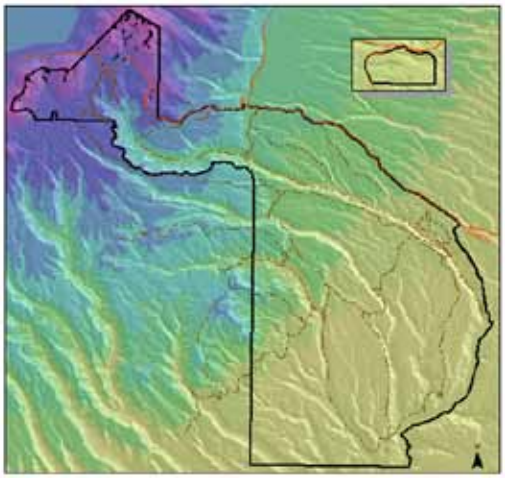


Figure G-125. Distribution of the polygons (in black) of map unit 15A.



Figure G-126. Aerial photo of a representative polygon of map unit 15A.

15 Southern Rocky Mountain Montane-Subalpine Grassland

B Mountain Muhly-Little Bluestem Lower Montane Grassland

Area	290 ha, 716 ac
Polygons	81
Primary component associations	*Muhlenbergia montana - Schizachyrium scoparium* Herbaceous Vegetation *Muhlenbergia montana* - Seeded Grasses Herbaceous Vegetation
Secondary component associations	*Schizachyrium scoparium - Koeleria macrantha* Herbaceous Vegetation *Elymus* x *pseudorepens - Bromus carinatus* Semi-natural Herbaceous Vegetation *Rosa woodsii / Muhlenbergia montana* Shrub Herbaceous Vegetation
Contrasting inclusions	*Fallugia paradoxa* / Ruderal Herbs Shrubland *Pascopyrum smithii* / Ruderal Herbaceous Vegetation *Gutierrezia sarothrae / Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation
Elevation	6,300 to 9,500 ft (1,900 to 2,900 m)
Summary	These lower montane grasslands are found at mid elevations on mesa tops, often associated with soils derived from pumice. They are dominated by bunch grasses such as mountain muhly, little bluestem, pine dropseed, and blue grama. This is likely a post-fire, successional type related to the burning of ponderosa pine woodlands in the 1977 La Mesa fire, and ruderal forbs and seeded ruderal grasses can be prevalent (nodding brome, smooth brome, western wheatgrass). Young ponderosa pines can also be common.



Figure G-127. Ground photo of map unit 15B.

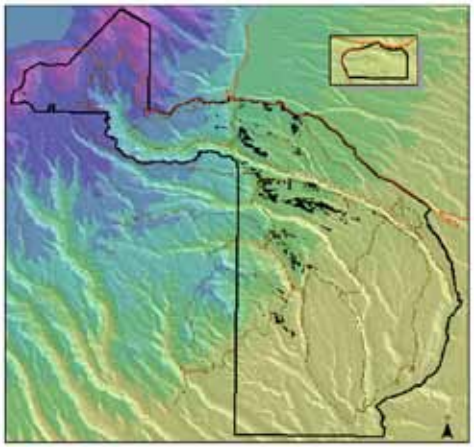


Figure G-128. Distribution of the polygons (in black) of map unit 15B.



Figure G-129. Aerial photo of a representative polygon of map unit 15B.

15 Southern Rocky Mountain Montane-Subalpine Grassland

C Lower Montane Valley Bottom Grassland

Area	45 ha, 112 ac
Polygons	32
Primary component associations	*Poa pratensis* / *Taraxacum officinale* Semi-natural Herbaceous Vegetation
Secondary component associations	*Poa pratensis* - (*Pascopyrum smithii*) Semi-natural Herbaceous Vegetation
Related inclusions	*Muhlenbergia montana* Herbaceous Vegetation
Elevation	7,700 to 9,400 ft (2,400 to 2,900 m)
Summary	These upper montane grassland/wet meadows are associated with valley bottoms and lower slopes in the Sierra de los Valles. They are characterized by the dominance of Kentucky bluegrass and a suite of sedges, such as clustered field sedge, smallwing sedge, Liddon sedge, and dryspike sedge. Forbs are diverse and represented by mesic meadow species, such as common dandelion, common selfheal, common sheep sorrel, woolly cinquefoil, bluebell bellflower, beautiful fleabane, and common yarrow.



Figure G-130. Ground photo of map unit 15C.

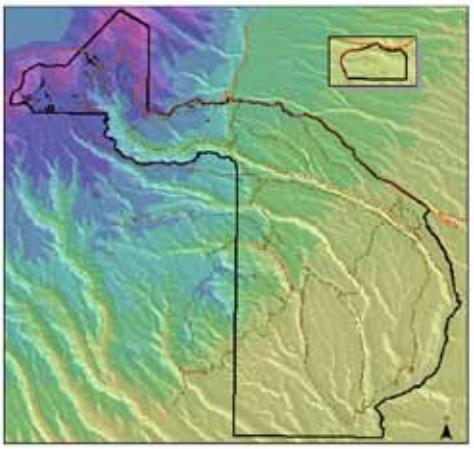


Figure G-131. Distribution of the polygons (in black) of map unit 15C.



Figure G-132. Aerial photo of a representative polygon of map unit 15C.

16 Southwest Plains-Mesa Grassland

A Western Wheatgrass-Ruderal Herbs Mesa Grassland

Area	283 ha, 699 ac
Polygons	70
Primary component associations	*Pascopyrum smithii* / Ruderal Herbaceous Vegetation Ruderal Post-fire Herbaceous Vegetation
Related inclusions	*Elymus* x *pseudorepens* - *Bromus carinatus* Semi-natural Herbaceous Vegetation
Contrasting inclusions	*Gutierrezia sarothrae* / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation *Fallugia paradoxa* / Ruderal Herbs Shrubland
Elevation	6,200 to 7,600 ft (1,800 to 2,300 m)
Summary	These mid-elevation grasslands are found on mesa tops, often associated with soils derived from pumice. They are dominated by western wheatgrass with blue grama as a common associate. This is likely a post-fire, successional type related to the burning of ponderosa pine woodlands in the 1977 La Mesa fire, and ruderal forbs and seeded ruderal grasses can be prevalent (nodding brome, smooth brome, western wheatgrass). Young ponderosa pines can also be common but their cover does not exceed 10%.





Figure G-133. Ground photos of map unit 16A.

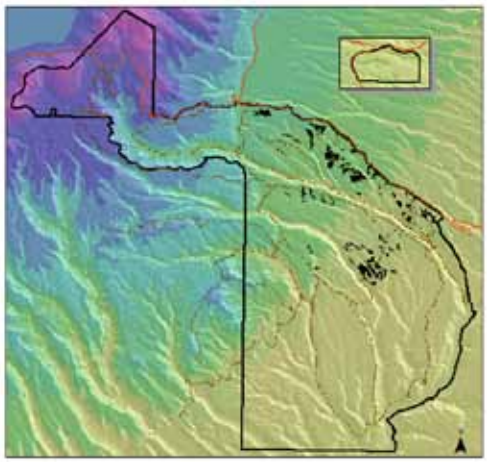


Figure G-134. Distribution of the polygons (in black) of map unit 16A.



Figure G-135. Aerial photo of a representative polygon of map unit 16A.

16 Southwest Plains-Mesa Grassland

B Blue Grama-Black Grama Mesa Grassland

Area	73 ha, 181 ac
Polygons	56
Primary component associations	*Gutierrezia sarothrae* / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation
Secondary component associations	*Bouteloua eriopoda* - *Bouteloua gracilis* Herbaceous Vegetation
Contrasting inclusions	*Pascopyrum smithii* / Ruderal Herbaceous Vegetation
Elevation	5,400 to 6,600 ft (1,600 to 2,000 m)
Summary	These mid to low elevation grasslands are found on mesa tops, usually on loamy soils. They are dominated by blue grama and/or black grama with ring muhly, purple three-awn, sand dropseed, and galleta as common associates. Succulents and subshrubs such as tulip pricklypear, plains pricklypear, tree cholla, and broom snakeweed can be abundant. Scattered oneseed junipers may be present, but tree cover does not exceed 10%.



Figure G-136. Ground photo of map unit 16B.

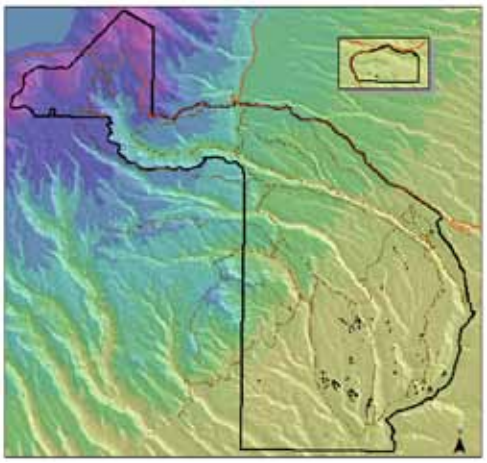


Figure G-137. Distribution of the polygons (in black) of map unit 16B.



Figure G-138. Aerial photo of a representative polygon of map unit 16B.

16 Southwest Plains-Mesa Grassland

C Grama Grass/Talus Grassland

Area	49 ha, 122 ac
Polygons	27
Primary component associations	*Bouteloua eriopoda - Bouteloua curtipendula* Herbaceous Vegetation Sparse Vegetation / Scree
Related inclusions	*Bouteloua eriopoda - Bouteloua gracilis* Herbaceous Vegetation *Gutierrezia sarothrae / Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation
Elevation	5,500 to 6,700 ft (1,700 to 2,000 m)
Summary	These lower elevation grasslands are found on steep, lower slopes of canyon escarpments. Sites are rocky and often unstable. They are dominated by black grama with sideoats grama, purple threeawn, and sand dropseed as common associates. Tall shrubs are scattered and may include fourwing saltbush, and big sagebrush. Succulents and subshrubs such as tulip pricklypear, plains pricklypear, tree cholla, and broom snakeweed can be abundant. Scattered oneseed junipers may be present, but tree cover does not exceed 10%.



Figure G-139. Ground photo of map unit 16C.

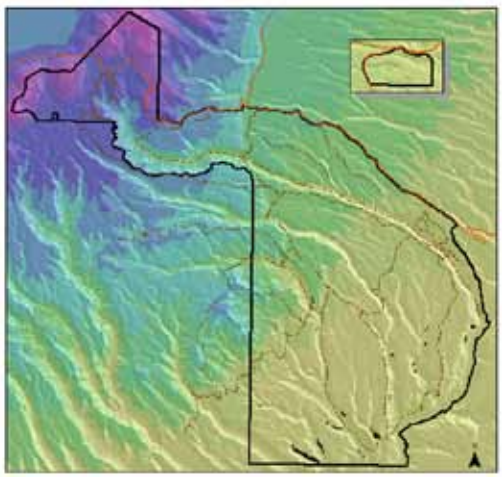


Figure G-140. Distribution of the polygons (in black) of map unit 16C.



Figure G-141. Aerial photo of a representative polygon of map unit 16C.

16 Southwest Plains-Mesa Grassland

D Grama Grass/Rockland Grassland

Area	451 ha, 1,114 ac
Polygons	73
Primary component associations	*Bouteloua eriopoda - Bouteloua curtipendula* Herbaceous Vegetation
Secondary component associations	Sparse Vegetation / Boulder Rockland
Related inclusions	*Bouteloua eriopoda - Bouteloua gracilis* Herbaceous Vegetation *Gutierrezia sarothrae / Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation
Elevation	5,400 to 7,000 ft (1,600 to 2,200 m)
Summary	These lower elevation grasslands are found on steep, lower slopes of canyon escarpments. Sites are rocky and often unstable. They are dominated by black grama with sideoats grama, purple threeawn, and sand dropseed as common associates. Tall shrubs are scattered and may include fourwing saltbush, and big sagebrush. Succulents and subshrubs such as tulip pricklypear, plains pricklypear, tree cholla, and broom snakeweed can be abundant. Scattered oneseed junipers may be present, but tree cover does not exceed 10%.



Figure G-142. Ground photo of map unit 16D.

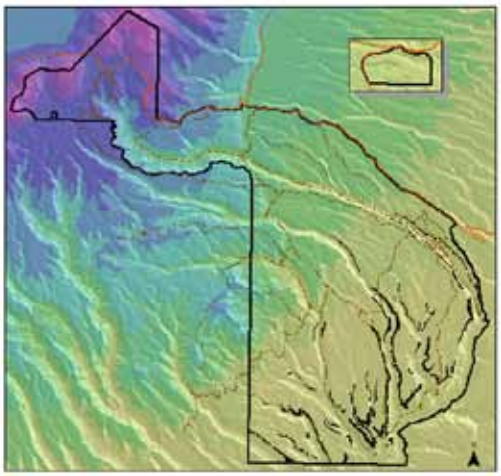


Figure G-143. Distribution of the polygons (in black) of map unit 16D.

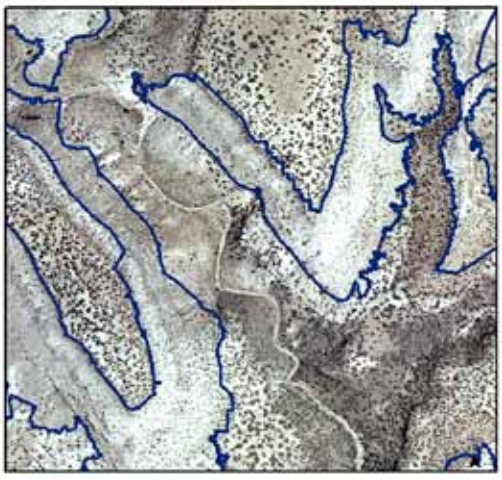


Figure G-144. Aerial photo of a representative polygon of map unit 16D.

17 Rocky Mountain Subalpine-Montane Riparian Forest and Woodland

A Box Elder-Alder-Narrowleaf Cottonwood Montane Riparian Forest

Area	33 ha, 82 ac
Polygons	13
Primary component associations	*Acer negundo - Alnus oblongifolia* Forest *Acer negundo - Alnus incana* ssp. *tenuifolia* Forest *Populus angustifolia - Acer negundo / Forestiera pubescens* Forest
Secondary component associations	*Populus angustifolia / Fallugia paradoxa* Forest *Alnus incana* / Mesic Graminoids Shrubland
Related inclusions	*Acer negundo / Salix irrorata* Forest *Acer negundo / Prunus virginiana* Forest *Acer negundo / Eleocharis palustris* Forest
Contrasting inclusions	*Abies concolor - Acer negundo / Alnus incana* ssp. *tenuifolia* Forest
Elevation	5,500 to 7,700 ft (1,700 to 2,400 m)
Summary	These riparian forests occur at mid to lower elevations along perennial stream reaches or ephemeral reaches with near-surface ground water. They are dominated by broad-leaf deciduous trees such as box elder, narrowleaf cottonwood, or Arizona alder. Small trees and tall shrubs include Goodding's willow, thinleaf alder, and water birch at upper elevations; common chokecherry, bluestem willow, New Mexico olive, and coyote willow at lower elevations. The herbaceous layer is rich and diverse and may include facultative and obligate wetland species such as smooth horsetail, common spikerush, Franciscan bluebells, spotted water hemlock, stinging nettle, and hairy willowherb.





Figure G-145. Ground photos of map unit 17A.

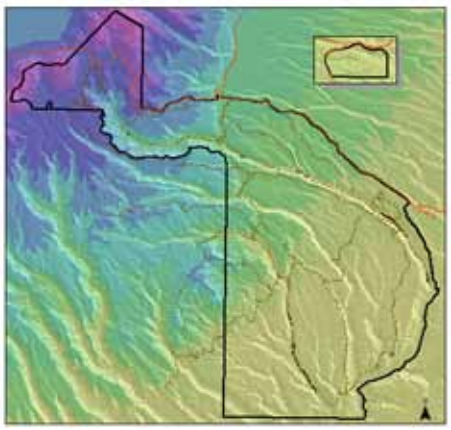


Figure G-146. Distribution of the polygons (in black) of map unit 17A.

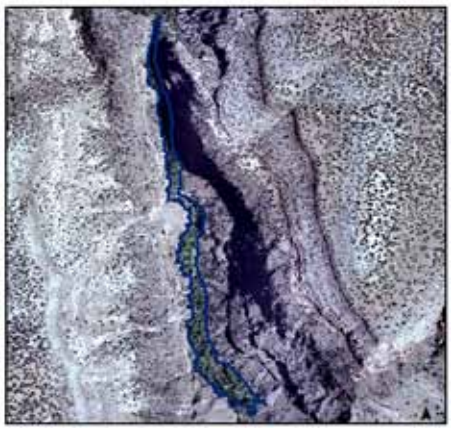


Figure G-147. Aerial photo of a representative polygon of map unit 17A.

17 Rocky Mountain Subalpine-Montane Riparian Forest and Woodland

B White Fir-Box Elder-Thinleaf Alder Mixed Montane Riparian Forest

Area	112 ha, 276 ac
Polygons	9
Primary component associations	*Abies concolor* - *Acer negundo* / *Alnus incana* ssp. *tenuifolia* Forest
Related inclusions	*Acer negundo* - *Alnus incana* ssp. *tenuifolia* Forest
Contrasting inclusions	*Pinus ponderosa* / *Forestiera pubescens* Forest, *Acer negundo* Phase *Pinus ponderosa* / *Forestiera pubescens* Forest, *Populus angustifolia* Phase
Elevation	6,200 to 8,400 ft (1,900 to 2,600 m)
Summary	These riparian forests occur at mid to upper elevations along perennial stream reaches. They are characterized by a mix of conifer and broadleaf deciduous trees such as white fir, Douglas-fir, bluespruce, box elder, narrowleaf cottonwood, or Arizona alder. Small trees and tall shrubs include thinleaf alder, water birch, and Gambel's oak. The herbaceous layer is rich and diverse and may include facultative and obligate wetland species such as smooth horsetail, spreading dogbane, and Fendler's waterleaf.



Figure G-148. Ground photo of map unit 17B.

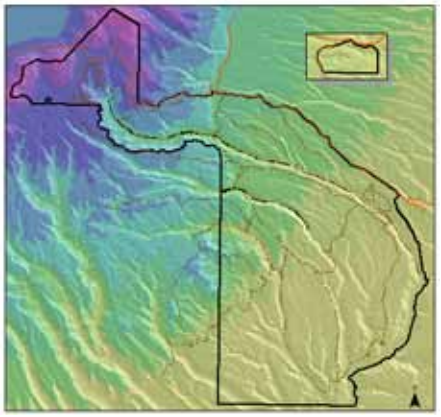


Figure G-149. Distribution of the polygons (in black) of map unit 17B.



Figure G-150. Aerial photo of a representative polygon of map unit 17B.

17 Rocky Mountain Subalpine-Montane Riparian Forest and Woodland

C Ponderosa Pine-Broadleaf Mixed Montane Riparian Forest

Area	58 ha, 142 ac
Polygons	20
Primary component associations	*Pinus ponderosa / Forestiera pubescens* Forest, *Acer negundo* Phase *Pinus ponderosa / Forestiera pubescens* Forest, *Populus angustifolia* Phase
Secondary component associations	*Pinus ponderosa / Forestiera pubescens* Forest, Typic Phase
Related inclusions	*Populus angustifolia - Acer negundo / Forestiera pubescens* Forest *Acer negundo - Alnus incana* ssp. *tenuifolia* Forest
Contrasting inclusions	*Abies concolor - Acer negundo / Alnus incana* ssp. *tenuifolia* Forest
Elevation	5,800 to ,000 ft (1,800 to 2,100 m)
Summary	These riparian forests occur at mid to lower elevations along perennial stream reaches or where there is near-surface ground water. They are characterized by a mix of ponderosa pine and the broadleaf deciduous trees box elder or narrowleaf cottonwood. Small trees and tall shrubs include thinleaf alder, water birch, Gambel's oak, common chokecherry, and New Mexico olive. The herbaceous layer is rich and diverse and may include facultative and obligate wetland species such as smooth horsetail, common spikerush, spotted water hemlock, stinging nettle, and hairy willowherb. Ponderosa pine often occupies the outer portion of the zone and there can be bands of broadleaf trees along the stream edge.



Figure G-151. Ground photo of map unit 17C.

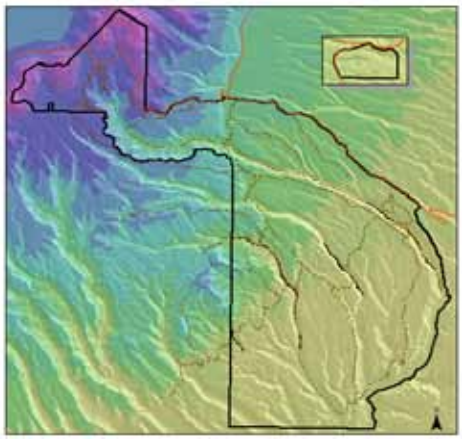


Figure G-152. Distribution of the polygons (in black) of map unit 17C.



Figure G-153. Aerial photo of a representative polygon of map unit 17C.

17 Rocky Mountain Subalpine-Montane Riparian Forest and Woodland

D Ponderosa Pine Dry Wash Woodland

Area	94 ha, 232 ac
Polygons	23
Primary component associations	*Pinus ponderosa / Forestiera pubescens* Forest, Typic Phase *Pinus ponderosa / Bouteloua gracilis* Woodland
Related inclusions	*Pinus ponderosa - Quercus grisea* Woodland *Populus angustifolia / Fallugia paradoxa* Forest
Contrasting inclusions	*Juniperus monosperma / Forestiera pubescens* Woodland *Fallugia paradoxa* Colorado Plateau Desert Wash Shrubland
Elevation	5,400 to 6,500 ft (1,600 to 2,000 m)
Summary	These riparian woodlands occur at lower elevations along intermittent or ephemeral stream reaches and can extend up into mid- elevation ravines. They are dominated by ponderosa pine with abundant New Mexico olive in the understory. The herbaceous layer is primarily made up of upland species such as plumed brickellbush, Carruth's sagewort, and butterfly milkweed.



Figure G-154. Ground photo of map unit 17D.

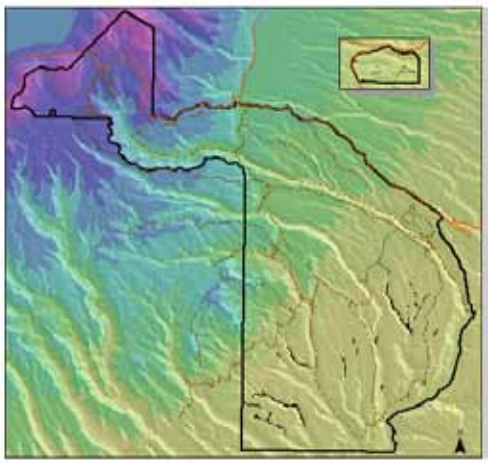


Figure G-155. Distribution of the polygons (in black) of map unit 17D.



Figure G-156. Aerial photo of a representative polygon of map unit 17D.

17 Rocky Mountain Subalpine-Montane Riparian Forest and Woodland

E Oneseed Juniper Dry Wash Woodland

Area	93 ha, 230 ac
Polygons	27
Primary component associations	*Juniperus monosperma* / *Forestiera pubescens* Woodland
Related inclusions	*Populus angustifolia* - *Acer negundo* / *Forestiera pubescens* Forest
Contrasting inclusions	*Fallugia paradoxa* / Colorado Plateau Desert Wash Shrubland
Elevation	5,500 to 6,500 ft (1,700 to 2,000 m)
Summary	These dry-wash riparian woodlands occur at lower elevations along intermittent or ephemeral stream reaches and can extend up into mid-elevation ravines. They are dominated by oneseed juniper with scattered New Mexico olive.



Figure G-157. Ground photo of map unit 17E.

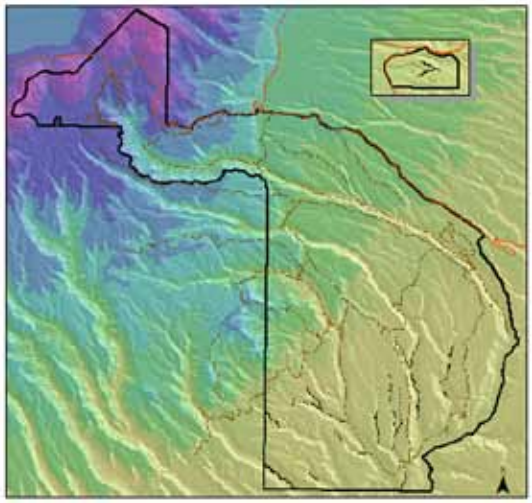


Figure G-158. Distribution of the polygons (in black) of map unit 17E.



Figure G-159. Aerial photo of a representative polygon of map unit 17E.

18 Southwest Lowland Riparian Woodland & Shrubland

A Sandbar Willow Riparian Shrubland

Area	35 ha, 86 ac
Polygons	26
Primary component associations	*Salix exigua* / Mesic Graminoids Shrubland
Secondary component associations	*Salix amygdaloides* - *Salix exigua* Shrubland
Related inclusions	*Populus deltoides* ssp. *wislizeni* / *Salix irrorata* Forest
Contrasting inclusions	*Tamarix chinensis* - *Salix exigua* Semi-natural Shrubland
Elevation	5,400 to 5,500 ft (1,600 to 1,700 m)
Summary	These riparian willow shrublands occur along the river bars of the Rio Grande in White Rock Canyon. They are dominated by coyote willow with understories that range from sparse to abundant with facultative wetland species such as clustered field sedge, Indian-hemp, and smooth horsetail.





Figure G-160. Ground photos of map unit 18A.

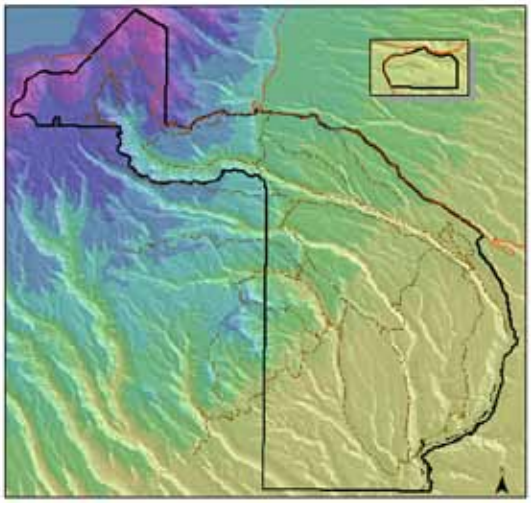


Figure G-161. Distribution of the polygons (in black) of map unit 18A.



Figure G-162. Aerial photo of a representative polygon of map unit 18A.

18 Southwest Lowland Riparian Woodland & Shrubland

B Tamarisk-Sandbar Willow Riparian Shrubland

Area	7 ha, 17 ac
Polygons	5
Primary component associations	*Tamarix chinensis* - *Salix exigua* Semi-natural Shrubland *Tamarix chinensis* / Sparse Undergrowth Semi-natural Shrubland
Related inclusions	*Tamarix chinensis* / *Forestiera pubescens* Semi-natural Shrubland Elaeagnus angustifolia / *Bromus tectorum* Semi-natural Woodland
Contrasting inclusions	*Salix exigua* / Mesic Graminoids Shrubland
Elevation	5,400 to 5,500 ft (1,600 to 1,700 m)
Summary	These riparian shrublands occur along the river bars of the Rio Grande in White Rock Canyon. They are dominated by tamarisk (salt cedar) with coyote willow or exotic Russian olive often as co-dominants. Understories are variable. They can be very sparse in cover or well-developed and may include a mix facultative wetland species such as clustered field sedge, Indianhemp, western goldenrod, and smooth horsetail.





Figure G-163. Ground photos of map unit 18B.

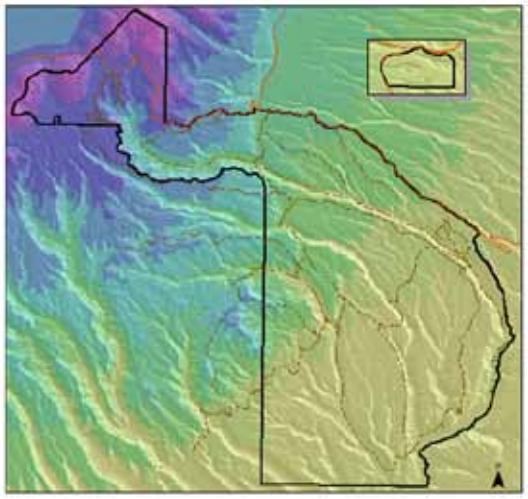


Figure G-164. Distribution of the polygons (in black) of map unit 18B.



Figure G-165. Aerial photo of a representative polygon of map unit 18B.

18 Southwest Lowland Riparian Woodland & Shrubland

C Apache Plume-New Mexico Privet Dry Wash Riparian Shrubland

Area	48 ha, 118 ac
Polygons	29
Primary component associations	*Fallugia paradoxa* / Colorado Plateau Desert Wash Shrubland *Forestiera pubescens* / Ruderal Herbs Vegetation Shrubland
Related inclusions	Sparse Vegetation / Recent Alluvial Deposits
Elevation	5,400 to 6,300 ft (1,600 to 1,900 m)
Summary	These dry-wash riparian shrublands occur at lower elevations along intermittent or ephemeral stream reaches and can extend up into mid-elevation ravines. They are dominated by Apache plume, along with rubber rabbitbrush, big sage, and an admixture of scattered forbs and grasses. The exotic cheatgrass can be abundant.



Figure G-166. Ground photo of map unit 18C.

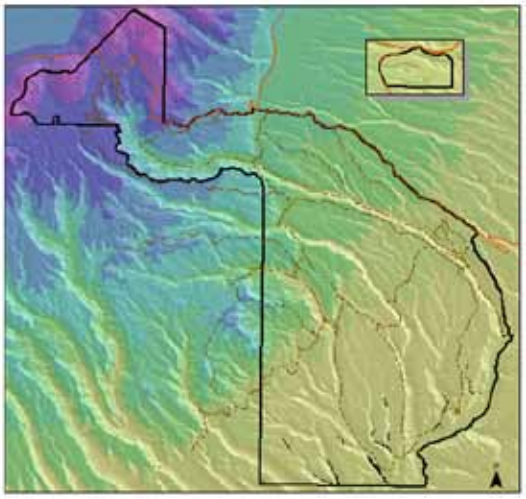


Figure G-167. Distribution of the polygons (in black) of map unit 18C.



Figure G-168. Aerial photo of a representative polygon of map unit 18C.

19 Southern Rocky Mountain Montane-Subalpine Emergent Wetland

A Arctic Rush-Kentucky Bluegrass Montane Wetland/Wet Meadow

Area	9 ha, 22 ac
Polygons	8
Primary component associations	*Juncus balticus* Herbaceous Vegetation
Secondary component associations	*Calamagrostis canadensis* Western Herbaceous Vegetation
Related inclusions	Open Water (Stock Tank)
Contrasting inclusions	*Poa pratensis* / *Taraxacum officinale* Semi-natural Herbaceous Vegetation, *Carex praegracilis* Phase
Elevation	7,600 to 9,700 ft (2,300 to 3,000 m)
Summary	These upper montane wetlands occur in valley bottom swales of the Sierra de los Valles or in association with old stock tank catchments. They are characterized by a mixture of wet meadow species (e.g., Kentucky bluegrass, yellow avens, and Rocky Mountain iris), and facultative and obligate wetland graminoids and forbs, such as Baltic rush, Canada reedgrass, woolly sedge, smallwing sedge, heartleaf buttercup, horsetails, stinging nettle, and wild mint.





Figure G-169. Ground photos of map unit 19A.

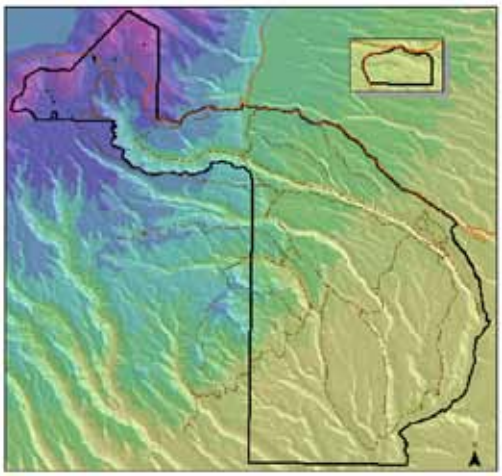


Figure G-170. Distribution of the polygons (in black) of map unit 19A.



Figure G-171. Aerial photo of a representative polygon of map unit 19A.

20 North American Arid West Emergent Wetland

A Lowland Emergent Wetland

Area	7 ha, 17 ac
Polygons	10
Primary component associations	*Eleocharis palustris* - *Carex praegracilis* - *Berula erecta* Herbaceous Vegetation
Secondary component associations	Ruderal Flood Zone Herbaceous Vegetation
Related inclusions	Sparse Vegetation / Recent Alluvial Deposits
Elevation	5,300 to 5,400 ft (1,600 to 1,700 m)
Summary	These low elevation emergent wetlands are associated with river bars of the Rio Grande and immediate side drainages in White Rock Canyon. They are dominated by an admixture of facultative or obligate wetland species, such as common spikerush, slender rush, fox sedge, alkali buttercup, American speedwell, and hairy willowherb.





Figure G-172. Ground photos of map unit 20A.

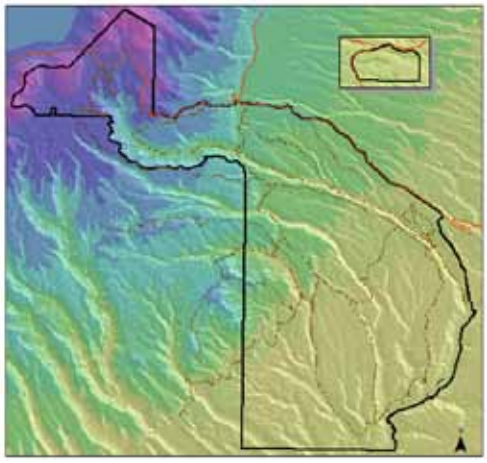


Figure G-173. Distribution of the polygons (in black) of map unit 20A.

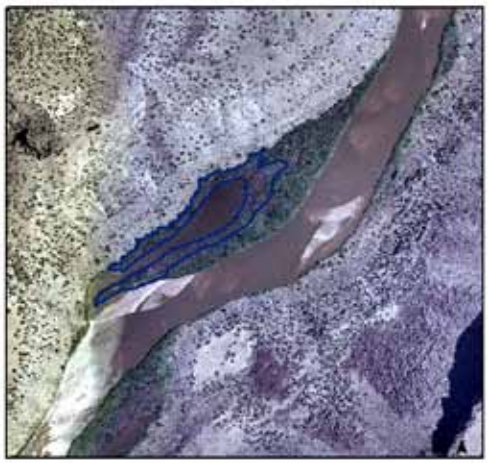


Figure G-174. Aerial photo of a representative polygon of map unit 20A.

21 Rocky Mountain Cliff, Canyon and Massive Bedrock

A Rockland/Cliff

Area	110 ha, 271 ac
Polygons	68
Primary component associations	Sparse Vegetation / Boulder Rockland
Elevation	5,400 to 8,600 ft (1,600 to 2,600 m)
Summary	Steep, sparsely to non-vegetated cliffs and rock outcrops.



Figure G-175. Ground photo of map unit 21A.

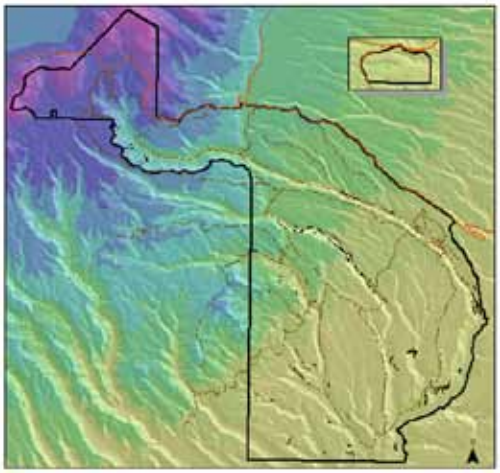


Figure G-176. Distribution of the polygons (in black) of map unit 21A.

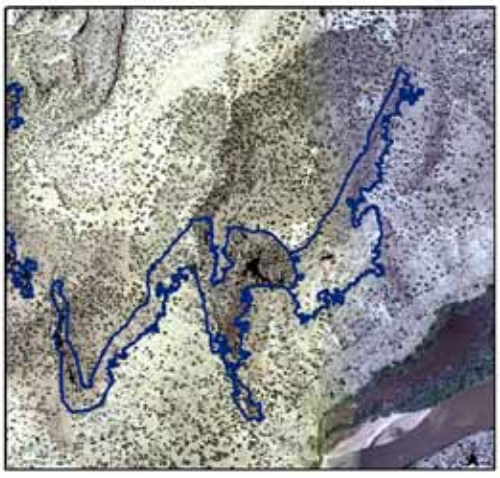


Figure G-177. Aerial photo of a representative polygon of map unit 21A.

21 Rocky Mountain Cliff, Canyon and Massive Bedrock

B Talus-Rubble Land

Area	38 ha, 94 ac
Polygons	26
Primary component associations	Sparse Vegetation / Scree
Elevation	5,400 to 8,600 ft (1,600 to 2,600 m)
Summary	Sparsely vegetated loose rock slopes that occur at higher elevations on the slopes of the Sierra de los Valles and at lower elevations of the major canyons.



Figure G-178. Ground photo of map unit 21B.

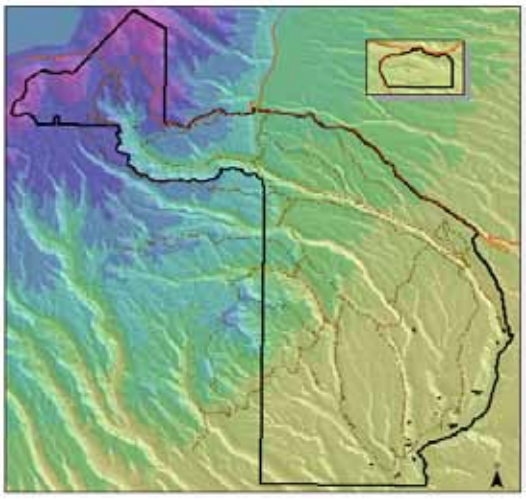


Figure G-179. Distribution of the polygons (in black) of map unit 21B.



Figure G-180. Aerial photo of a representative polygon of map unit 21B.

22 Urban or Built-up Land

A-E Public Building/Residential; Other Built-up Land; Archaeological Site; Road; Recreation Site

Area	64 ha, 158 ac
Polygons	28
Primary component associations	Public Building/Residential Other Built-up Land Archaeological Site Road Recreation Site
Elevation	6,000 to 9,500 ft (1,800 to 2,900 m)
Summary	Built-up land includes vegetation in and surrounding archeological sites, recreation and residential areas as well pavement and public buildings.

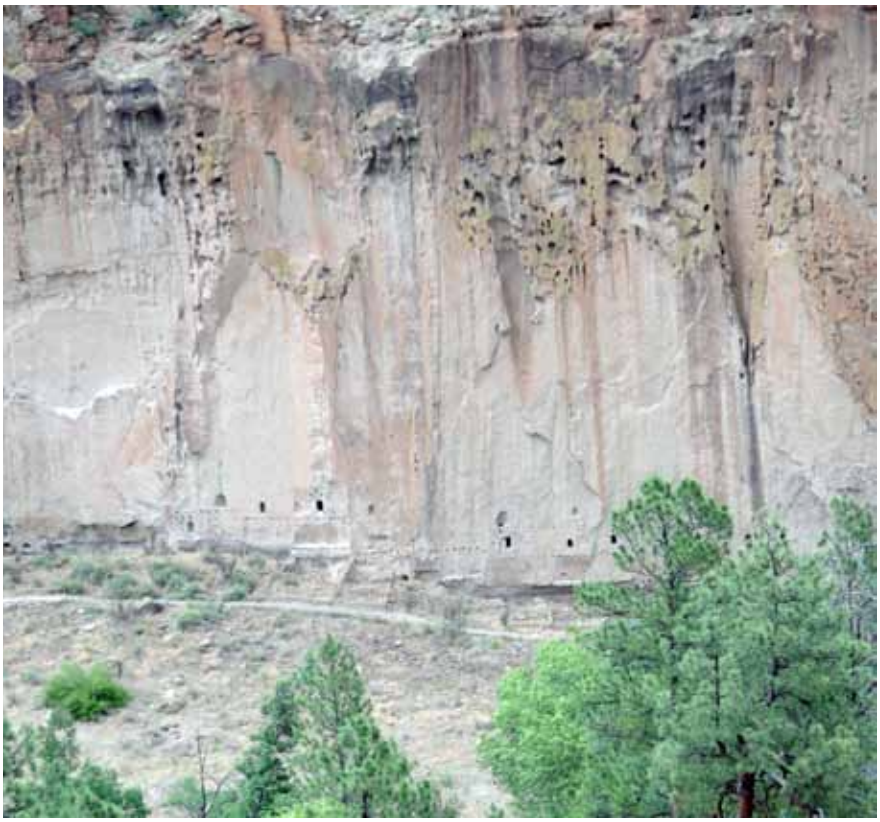


Figure G-181. Ground photo of map units 22A-E.

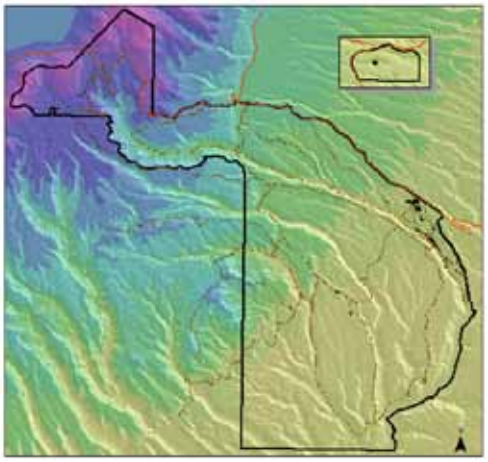


Figure G-182. Distribution of the polygons (in black) of map units 22A-E.



Figure G-183. Aerial photo of a representative polygon of map unit 22A-E.

23 Water

A Open Water

Area	84 ha, 207 ac
Polygons	9
Primary component associations	Water-River
Related inclusions	Sparse Vegetation / Recent Alluvial Deposits
Elevation	5,300 to 5,400 ft (1,600 to 1,700 m)
Summary	Waters of the Rio Grande.



Figure G-184. Ground photo of map unit 23A.

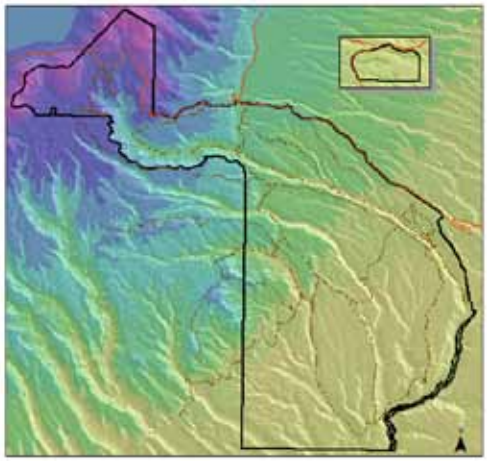


Figure G-185. Distribution of the polygons (in black) of map unit 23A.



Figure G-186. Aerial photo of a representative polygon of map unit 23A.

24 Southwest Ruderal Disturbance Vegetation

A Post-fire Valley Ruderal Herbaceous Vegetation

Area	50 ha, 123 ac
Polygons	21
Primary component associations	Ruderal Post-fire Herbaceous Vegetation
Secondary component associations	*Bouteloua eriopoda* - *Bouteloua gracilis* Herbaceous Vegetation, Ruderal Forbs Phase
Elevation	5,500 to 9,500 ft (1,700 to 2,900 m)
Summary	Post-fire ruderal vegetation associated with the recent burning of valley bottom woodlands and riparian areas in lower Capulin Canyon.



Figure G-187. Ground photo of map unit 24A.

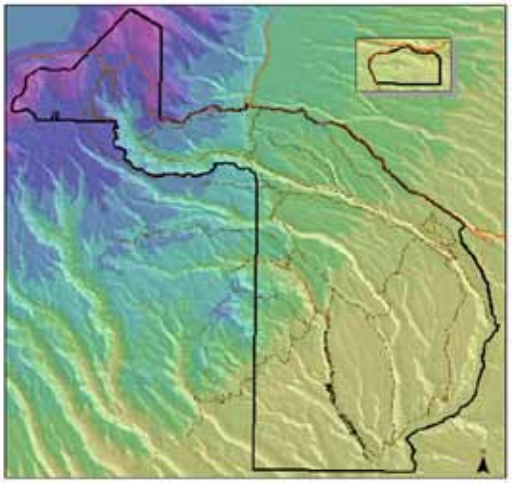


Figure G-188. Distribution of the polygons (in black) of map unit 24A.



Figure G-189. Aerial photo of a representative polygon of map unit 24A.

24 Southwest Ruderal Disturbance Vegetation

B Post-fire Montane Ruderal Herbaceous Vegetation (Cerro Grande)

Area	97 ha, 241 ac
Polygons	34
Primary component associations	Ruderal Post-fire Herbaceous Vegetation
Secondary component associations	*Elymus* x *pseudorepens* - *Bromus carinatus* Semi-natural Herbaceous Vegetation *Festuca thurberi* - *Danthonia parryi* / *Potentilla hippiana* Herbaceous Vegetation
Elevation	7,800 to 9,700 ft (2,400 to 3,000 m)
Summary	Post-fire vegetation of the 2000 Cerro Grande fire. Typically, the herbaceous layer can be luxuriant with an assortment of native montane bunch grasses such as Thurber fescue or Parry's oatgrass plus exotic species introduced through seeding such as slender wheatgrass, false quackgrass, and California brome.





Figure G-190. Ground photos of map unit 24B.

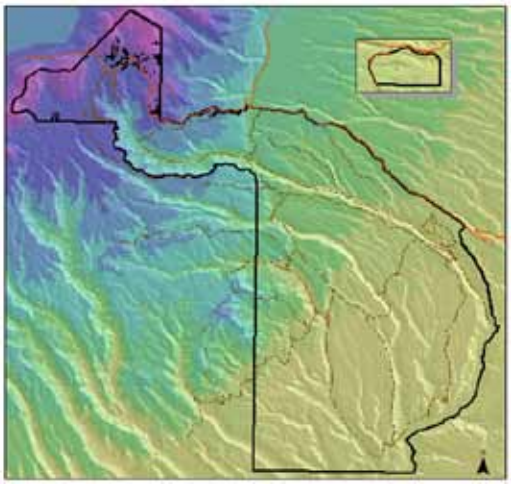


Figure G-191. Distribution of the polygons (in black) of map unit 24B.



Figure G-192. Aerial photo of a representative polygon of map unit 24B.

24 Southwest Ruderal Disturbance Vegetation

C Post-fire Montane Ruderal Herbaceous Vegetation (Dome Fire)

Area	71 ha, 176 ac
Polygons	7
Primary component associations	Ruderal Post-fire Herbaceous Vegetation
Secondary component associations	*Quercus gambelii* / *Robinia neomexicana* / *Carex inops* ssp. *heliophila* Shrubland
Elevation	6,500 to 8,200 ft (2,000 to 2,500 m)
Summary	Post-fire, ruderal vegetation associated with the 1996 Dome Fire in the San Miguel Mountains. Variable admixture of forbs and grasses that are mostly early successional disturbance- related species (e.g., common mullein, prairie sunflower, prickly lettuce, sanddune wallflower, etc.). Cheatgrass may be prevalent.



Figure G-193. Ground photo of map unit 24C.

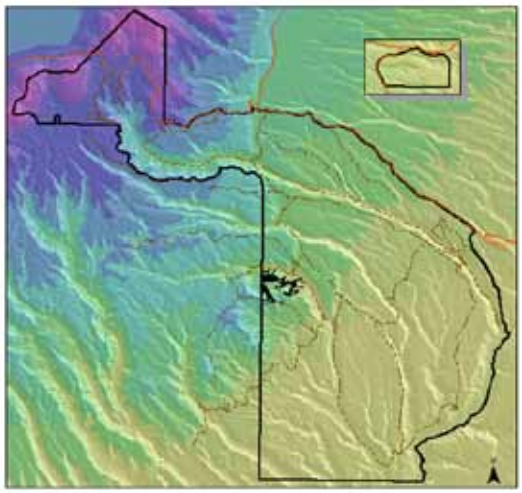


Figure G-194. Distribution of the polygons (in black) of map unit 24C.

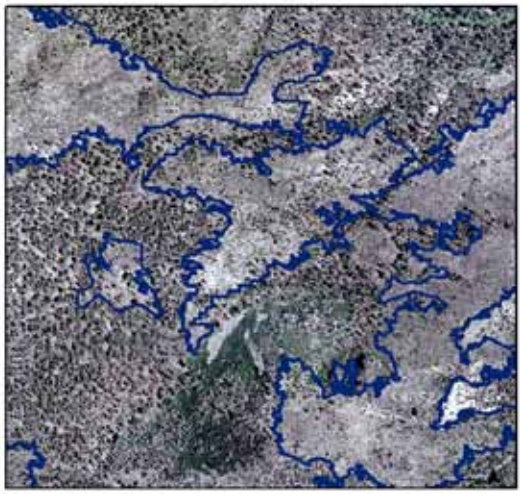


Figure G-195. Aerial photo of a representative polygon of map unit 24C.

24 Southwest Ruderal Disturbance Vegetation

D Reservoir Flood Zone Ruderal Herbaceous Vegetation

Area	87 ha, 214 ac
Polygons	12
Primary component associations	Ruderal Flood Zone Herbaceous Vegetation *Forestiera pubescens* / Ruderal Herbs Shrubland
Secondary component associations	*Bouteloua curtipendula* - *Bothriochloa barbinodis* Herbaceous Vegetation
Elevation	5,300 to 5,600 ft (1,600 to 1,700 m)
Summary	Ruderal disturbance vegetation associated with the high-water mark of Cochiti Reservoir in White Rock Canyon. Common species include cheatgrass, kochia, silverleaf nightshade, and common mullein, often amid the skeletons of flood-killed junipers.





Figure G-196. Ground photos of map unit 24D.

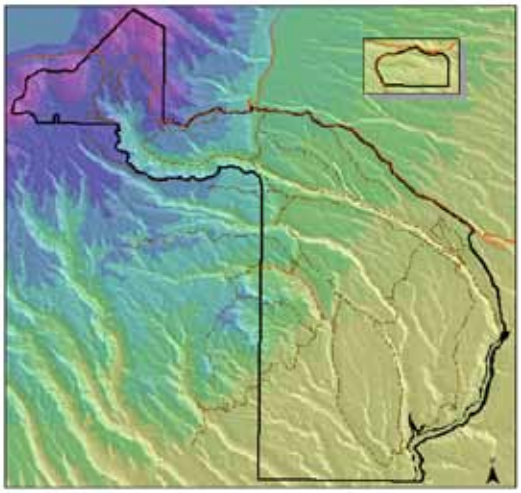


Figure G-197. Distribution of the polygons (in black) of map unit 24D.



Figure G-198. Aerial photo of a representative polygon of map unit 24D.

24 Southwest Ruderal Disturbance Vegetation

E Ruderal Herbaceous Vegetation

Area	3 ha, 6 ac
Polygons	3
Primary component associations	Ruderal Disturbance Herbaceous Vegetation
Elevation	6,200 to 6,600 ft (1,900 to 2,000 m)
Summary	Miscellaneous areas or disturbed ground.

NO GROUND PHOTOS AVAILABLE

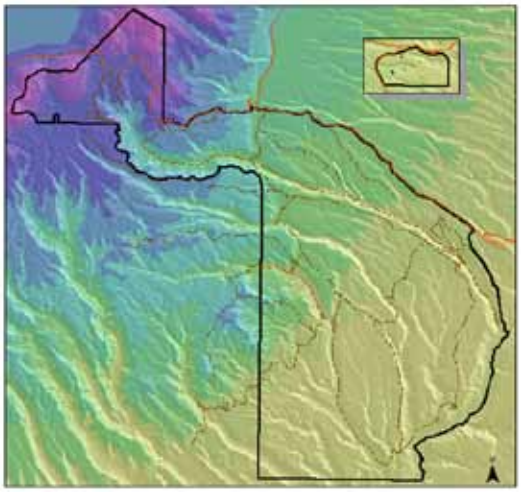


Figure G-199. Distribution of the polygons (in black) of map unit 24E.



Figure G-200. Aerial photo of a representative polygon of map unit 24E.

Appendix H: NVC Association lookup table, organized by macrogroup, for Bandelier National Monument

Plant associations are grouped into separate tables by NVCS macrogroup. The corresponding groups are also noted. The (G*) designation refers to a proposed NVCS group. Each plant association is designated as either a primary component (1), secondary component (2), Related Inclusion (Ri), or Contrasting Inclusion (Ci). See page 48 in the report for an explanation of map unit components.

Table H-1

Madrean Warm Lowland Evergreen Woodland (MG010)
- Madrean Pinyon - Juniper Woodland Group (G200)

NVCS Association	Map Unit Map Unit Name 10A (Pinyon) Alligator Juniper/Wavyleaf Oak Woodland
Juniperus deppeana / *Bouteloua gracilis* Woodland	1
Juniperus deppeana - *Quercus x pauciloba* Woodland	Ri
Juniperus deppeana / Sparse Woodland	Ri
Juniperus deppeana / Ruderal Herbs Vegetation Woodland	2

Table H-2

Madrean Montane Forest & Woodland (MG011)
- Madrean Lower Montane Pine-Oak Forest & Woodland Group (G203)

NVCS Association	Map Unit Map Unit Name 17D Ponderosa Pine Dry Wash Woodland
Pinus ponderosa / *Quercus grisea* Woodland	Ri

Table H-3

Rocky Mountain Subalpine & High Montane Forest (MG020)

- Rocky Mountain Subalpine & Montane Aspen Forest & Woodland Group (G222)
- Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest & Woodland (G218)

	Map Unit Name	Engelmann Spruce/Sprucefir Fleabane Mesic-Wet Forest	Quaking Aspen/Fendler's Meadowrue Mesic-Wet Forest	Quaking Aspen/Thurber's Fescue Upper Montane Woodland	White Fir-Douglas-fir-Aspen/Thurber's Fescue Upper Montane Woodland
NVCS Association	**Map Unit**	1A	2B	2A	3A
Picea engelmannii / Erigeron eximius Forest		1			
Populus tremuloides / Acer glabrum Forest			2		
Populus tremuloides / Festuca thurberi Forest				1	Ci
Populus tremuloides / Invasive Perennial Grasses Forest			Ri	2	
Populus tremuloides / Thalictrum fendleri Forest			1		

Table H-4

Southern Rocky Mountain Lower Montane Forest (MG022)

- Southern Rocky Mountain Douglas-fir-White Fir-Blue Spruce Mesic Forest (G225)
- Southern Rocky Mountain Ponderosa Pine Forest & Woodland (G228)
- Southern Rocky Mountain Ponderosa Pine Savanna (G229)
- Southern Rocky Mountain White Fir-Douglas-fir Dry Forest (G226)

NVCS Association	Map Unit	1A	8D	17D	8C	7B	7A	8A	8B	2A	5B	6A	6B	5A	3B	4A	4B	3A	5C
	Map Unit Name	Engelmann Spruce/Sprucefir Fleabane Mesic-Wet Forest	Ponderosa Pine Canyon Woodland	Ponderosa Pine Dry Wash Woodland	Ponderosa Pine Ravine Woodland	Ponderosa Pine/Mountain Muhly-Blue Grama Mesa Woodland	Ponderosa Pine/Thurber's Fescue Upper Montane Woodland	Ponderosa Pine/Wavyleaf Oak Mesa Woodland	Ponderosa Pine-Gambel Oak/Deer Sedge Woodland	Quaking Aspen/Thurber's Fescue Upper Montane Woodland	White Fir-Douglas-fir/Common Juniper-Gambel Oak/Deer Sedge Dry-Mesic Forest	White Fir-Douglas-fir/Fendler's Meadowrue Mesic-Wet Forest	White Fir-Douglas-fir/Rocky Mountain Maple Canyon Forest	White Fir-Douglas-fir/Thurber's Fescue Upper Montane Woodland Savanna	White Fir-Douglas-fir-Aspen/Common Juniper/Deer Sedge Dry-Mesic Forest	White Fir-Douglas-fir-Aspen/Fendler's Meadowrue Mesic-Wet Forest	White Fir-Douglas-fir-Aspen/Rocky Mountain Maple Canyon Forest	White Fir-Douglas-fir-Aspen/Thurber's Fescue Upper Montane Woodland	White Fir-Douglas-fir-Gambel Oak Canyon Forest
Abies concolor - (Pseudotsuga menziesii) / Jamesia americana - Holodiscus dumosus Scree Woodland											Ci		2				2		2
Abies concolor - (Pseudotsuga menziesii) / Quercus gambelii / Carex rossii Forest											1	Ci							Ri
Abies concolor - (Pseudotsuga menziesii) / Quercus gambelii / Thalictrum fendleri Forest												2	Ci						
Abies concolor - (Pseudotsuga menziesii) / Thalictrum fendleri Forest		Ci									Ci	1	Ci			1	Ci		
Abies concolor - Pseudotsuga menziesii / Acer glabrum Forest		Ci										Ci	1			Ci	1		
Abies concolor - Pseudotsuga menziesii / Carex rossii Forest											1				1				
Abies concolor - Pseudotsuga menziesii / Festuca thurberi - Danthonia parryi Woodland							Ci			Ci				1	Ci			1	
Abies concolor / Juniperus communis Forest											1	Ci			1				

Table H-4 *continued*

NVCS Association	Map Unit	1A	8D	17D	8C	7B	7A	8A	8B	2A	5B	6A	6B	5A	3B	4A	4B	3A	5C
Abies concolor / Mahonia repens Forest											2								
Picea pungens / Fragaria virginiana Forest												2							
Pinus ponderosa / Bouteloua gracilis Woodland				1	2	1		Ci											
Pinus ponderosa / Carex inops ssp. *heliophila* Woodland			2			Ci	Ci		1										
Pinus ponderosa / Festuca thurberi Woodland							1							Ci					
Pinus ponderosa / Muhlenbergia montana Woodland			Ci		2	1			2										
Pinus ponderosa / Poa pratensis Semi-natural Forest							Ri												
Pinus ponderosa / Quercus gambelii / Carex inops ssp. *heliophila* Woodland					2	Ci		Ci	1										Ci
Pinus ponderosa / Quercus x *pauci-loba* Woodland			1		1	Ci		1											
Pinus ponderosa / Robinia neomexi-cana Woodland						2			Ri										
Pinus ponderosa / Schizachyrium scoparium Woodland			Ri			2													
Pseudotsuga menziesii / Mahonia repens Forest											2				Ri				
Pseudotsuga menziesii / Quercus gambelii Forest											2								1

Table H-5

Rocky Mountain Pinyon-Juniper Woodland (MG027)

- Southern Rocky Mountain Juniper Woodland & Savanna (G252)
- Southern Rocky Mountain Pinyon-Juniper Woodland (G253)

NVCS Association	Map Unit	10A	9E	9A	9D	9F	9B	9C	11C	11B	11A	11H	11E	11G	11F	11D	14A
	Map Unit Name	(Pinyon) Alligator Juniper/Wavyleaf Oak Woodland	(Pinyon) Oneseed Juniper Ravine Woodland	(Pinyon) Oneseed Juniper/Grama Grass Mesa Woodland	(Pinyon) Oneseed Juniper/Rockland Canyon Woodland	(Pinyon) Oneseed Juniper/Treatment Woodland	(Pinyon) Oneseed Juniper/Wavyleaf Oak Mesa Woodland	(Pinyon) Oneseed Juniper/Wavyleaf Oak-Grama Grass Canyon Woodland	Oneseed Juniper/Black Grama Canyon Woodland	Oneseed Juniper/Black Grama–Blue Grama Mesa Woodland	Oneseed Juniper/Blue Grama Mesa Woodland	Oneseed Juniper/Grama Grass Valley Bottom Woodland	Oneseed Juniper/Rockland Canyon Woodland	Oneseed Juniper/Sparse Canyon Woodland	Oneseed Juniper/Wavyleaf Oak/Sparse Rockland Mesa Woodland	Oneseed Juniper/Wavyleaf Oak-Grama Grass Canyon Woodland	Sand Sagebrush/Talus Canyon Shrubland
Juniperus monosperma / Artemisia tridentata Woodland									Ri								Ri
Juniperus monosperma / Bouteloua curtipendula Woodland			1		Ci			Ci	2		Ci	1	Ci			2	
Juniperus monosperma / Bouteloua eriopoda Woodland									1	1				Ci			
Juniperus monosperma / Bouteloua gracilis Woodland			Ci	1		1	Ci	2		1	1	2			Ci	1	
Juniperus monosperma / Hesperostipa neomexicana Woodland											Ci						
Juniperus monosperma / Quercus x pauciloba Woodland			1	Ci	2		1	1	Ci	Ri	Ci		2		1	1	
Juniperus monosperma / Rhus trilobata Woodland				Ci												2	
Juniperus monosperma / Rockland Woodland		Ci	1		1			Ci	Ri				1			Ci	
Juniperus monosperma / Sparse Understory Woodland				2		2	2		2	Ri	2			1	2		
Pinus edulis – (Juniperus monosperma, Juniperus deppeana) / Bouteloua gracilis Woodland				2													

Table H-6

Rocky Mountain and Great Basin Flooded & Swamp Forest (MG034)
- Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (G*)
- Rocky Mountain Subalpine-Montane Riparian Shrubland (G*)

NVCS Association	Map Unit	Box Elder-Alder-Narrowleaf Cottonwood Montane Riparian Forest	Oneseed Juniper Dry Wash Woodland	onderosa Pine Dry Wash Woodland	Ponderosa Pine Ravine Woodland	Ponderosa Pine-Broadleaf Mixed Montane Riparian Forest	White Fir-Box Elder-Thinleaf Alder Mixed Montane Riparian Forest
	Map Unit Name						
NVCS Association	**Map Unit**	17A	17E	17D	8C	17C	17B
Abies concolor - Acer negundo / Alnus incana ssp. *tenuifolia* Forest		Ci				Ci	1
Acer negundo - Alnus incana ssp. *tenuifolia* Forest		1				Ri	Ri
Acer negundo - Alnus oblongifolia Forest		1					
Acer negundo / Eleocharis palustris Forest		Ri					
Acer negundo / Prunus virginiana Forest		Ri					
Acer negundo / Salix irrorata Forest		Ri					
Alnus incana / Mesic Graminoids Shrubland		2					
Pinus ponderosa / Forestiera pubescens Woodland				1	1	1, 2	Ci
Populus angustifolia - Acer negundo / Forestiera pubescens Forest		1	Ri			Ri	
Populus angustifolia / Fallugia paradoxa Forest		2		Ri			

Table H-7

Warm Desert Riparian, Flooded & Swamp Forest (MG036)
- Southwest Lowland Riparian Woodland & Shrubland (G*)

NVCS Association	Map Unit	(Pinyon) Oneseed Juniper Ravine Woodland	Apache Plume-New Mexico Privet Dry Wash Riparian Shrubland	Oneseed Juniper Dry Wash Woodland	Oneseed Juniper/Grama Grass Valley Bottom Woodland	Ponderosa Pine Dry Wash Woodland	Sandbar Willow Riparian Shr	Tamarisk-Sandbar Willow Riparian Shrubland
	Map Unit Name							
NVCS Association	**Map Unit**	9E	18C	17E	11H	17D	18A	18B
Elaeagnus angustifolia / Bromus tectorum Semi-natural Woodland								Ri
Fallugia paradoxa Colorado Plateau Wash Shrubland			1	Ci		Ci		
Forestiera pubescens / Ruderal Herbs Shrubland			1					
Juniperus monosperma / Forestiera pubescens Woodland		2		1	Ci	Ci		
Populus deltoides ssp. wislizeni / Salix irrorata Forest							Ri	
Salix amygdaloides / Salix exigua Woodland							2	
Salix exigua / Mesic Graminoids Shrubland							1	Ci
Tamarix chinensis - Salix exigua Semi-natural Shrubland							Ci	1
Tamarix chinensis / Forestiera pubescens Semi-natural Shrubland								Ri
Tamarix chinensis / Sparse Undergrowth Semi-natural Shrubland								1

Table H-8

Southern Rocky Mountain Montane Shrubland & Grassland (MG049)

- Southern Rocky Mountain Montane-Subalpine Grassland (G268)
- Southern Rocky Mountain Cercocarpus-Mixed [Dry] Foothill Shrubland (G276)
- Southern Rocky Mountain Gambel Oak-Mixed [Mesic] Montane Shrubland (G277)

NVCS Associates	Map Unit	Map Unit Name: Apache Plume-New Mexico Locust Mesa Shrubland	Arctic Rush-Kentucky Bluegrass Montane Wetland/Wet Meadow	Fendler Ceanothus-New Mexico Locust Montane Mesa Shrubland	Gambel Oak/New Mexico Locust Canyon Shrubland	Gambel Oak/New Mexico Locust-Mountain Muhly Mesa Shrubland	Lower Montane Valley Bottom Grasslan	Mountain Muhly-Little Bluestem Lower Montane Grassland	Post-fire Montane Ruderal Herbaceous Vegetation (Cerro Grande)	Post-fire Montane Ruderal Herbaceous Vegetation (Dome Fire)	Sand Sagebrush/Talus Canyon Shrubland	Thurber's Fescue-Parry's Danthonia Upper Montane Grassland	Wayleaf Oak/Ruderal Foothill Shrubland	Wayleaf Oak/Sideoats Grama Mesa Shrubland	Wayleaf Oak-Mountain Mahogany/ Rockland Canyon Shrubland	Western Wheatgrass-Ruderal Herbs Mesa Grassland	White Fir-Douglas-fir-Gambel Oak Canyon Forest
		12B	19A	12A	12C	12D	15C	15B	24B	24C	14A	15A	13B	13A	13C	16A	5C
Ceanothus fendleri / Muhlenbergia montana Shrubland				1	Ci	Ci											
Cercocarpus montanus / Bouteloua curtipendula Shrubland														Ri			
Fallugia paradoxa - Brickellia spp. - (Holodiscus dumosus) Scree Shrubland											2				Ci		
Fallugia paradoxa / Ruderal Herbs Shrubland		1		Ci				Ci						Ci		Ci	
Festuca thurberi - (Lathyrus lanszwertii var. *leucanthus, Potentilla* spp.) Herbaceous Vegetation												1					
Festuca thurberi - Danthonia parryi / Potentilla hippiana Herbaceous Vegetation									2			1					
Jamesia americana - (Physocarpus monogynus, Holodiscus dumosus) Rock Outcrop Shrubland					2												
Muhlenbergia montana - Schizachyrium scoparium Herbaceous Vegetation								1									

Table H-8 *continued*

NVCS Associates	Map Unit	12B	19A	12A	12C	12D	15C	15B	24B	24C	14A	15A	13B	13A	13C	16A	5C
Muhlenbergia montana - Seeded Grasses Herbaceous Vegetation								1									
Muhlenbergia montana Herbaceous Vegetation							Ri										
Poa pratensis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation							2										
Poa pratensis - Taraxacum officinale Semi-natural Herbaceous Vegetation			Ci				1					Ci					
Quercus gambelii - Robinia neomexicana / Carex inops ssp. *heliophila* Shrubland				Ci	1	2				2					Ci		Ci
Quercus gambelii - Robinia neomexicana / Muhlenbergia montana Shrubland				Ci										Ci			
Quercus X pauciloba / Bouteloua curtipendula Shrubland													1	1			
Quercus x *pauciloba / Cercocarpus montanus* Shrubland														Ci	1		
Rhus trilobata Rocky Mountain Shrub Herbaceous Vegetation															2		
Robinia neomexicana / Carex inops ssp. *heliophila* Shrubland		1		1	Ci	Ci											
Rosa woodsii / Muhlenbergia montana Shrub Herbaceous Vegetation								2									

Table H-9

Great Plains Shortgrass Prairie & Shrubland (MG053)
- Southwest Plains-Mesa Grassland (G*)
- Southwest Ruderal Disturbance Herbaceous Vegetation (G*)

NVCS Association	Map Unit	12B	16B	16D	16C	20A	15B	24B	24C	24A	24D	24E	14A	13B	13A	13C	16A
	Map Unit Name	Apache Plume-New Mexico Locust Mesa Shrubland	Blue Grama-Black Grama Mesa Grassland	Grama Grass/Rockland Grassland	Grama Grass/Talus Grassland	Lowland Emergent Wetland	Mountain Muhly-Little Bluestem Lower Montane Grassland	Post-fire Montane Ruderal Herbaceous Vegetation (Cerro Grande)	Post-fire Montane Ruderal Herbaceous Vegetation (Dome Fire)	Post-fire Valley Ruderal Herbaceous Vegetation	Reservoir Flood Zone Ruderal Herbaceous Vegetation	Ruderal Herbaceous Vegetation	Sand Sagebrush/Talus Canyon Shrubland	Wavyleaf Oak/Ruderal Foothill Shrubland	Wavyleaf Oak/Sideoats Grama Mesa Shrubland	Wavyleaf Oak-Mountain Mahogany/Rockland Canyon Shrubland	Western Wheatgrass-Ruderal Herbs Mesa Grassland
Bouteloua curtipendula - Bothriochloa barbinodis Herbaceous Vegetation											2						
Bouteloua eriopoda - Bouteloua curtipendula Herbaceous Vegetation				1	1								Ci				
Bouteloua eriopoda - Bouteloua gracilis Herbaceous Vegetation			2	Ri	Ri					2							
Elymus x pseudorepens - Bromus carinatus Semi-natural Herbaceous Vegetation							2	2									Ri
Gutierrezia sarothrae / Bouteloua gracilis Dwarf-shrub Herbaceous Vegetation			1	Ri	Ri		Ci								Ci	Ci	Ci
Pascopyrum smithii / Ruderal Herbaceous Vegetation			Ci				Ci										1
Ruderal Disturbance Herbaceous Vegetation												1					
Ruderal Flood Zone Herbaceous Vegetation						2					1						
Ruderal Post-fire Herbaceous Vegetation		2						1	1	1				2			1
Schizachyrium scoparium - Koeleria macrantha Herbaceous Vegetation							2										

Table H-10

Great Plains Sand Grassland & Shrubland (MG052)
- Great Plains Sand Shrubland (G069)

	Map Unit name	Sand Sagebrush/Talus Canyon Shrubland
NVCS Association	**Map Unit**	14A
Artemisia filifolia / Bouteloua eriopoda Shrubland		1

Table H-11

Western North America Freshwater Marsh (MG073)
- Southern Rocky Mountain Montane-Subalpine Emergent Wetland (G*)

	Map Unit Name	Arctic Rush-Kentucky Bluegrass Montane Wetland/Wet Meadow
NVCS Association	**Map Unit**	19A
Calamagrostis canadensis Western Herbaceous Vegetation		2
Juncus balticus Herbaceous Vegetation		1

Table H-12

Warm Desert Freshwater Shrubland, Meadow & Marsh (MG076)
- North American Arid West Emergent Wetland (G*)

	Map Unit Name	Lowland Emergent Wetland
NVCS Association	**Map Unit**	20A
Eleocharis palustris - Carex praegracilis - Berula erecta Herbaceous Vegetation		1

Table H-13

Rocky Mountain Cliff, Scree, & Other Rock Vegetation (MG113)
- Rocky Mountain Cliff, Canyon & Massive Bedrock (G*)

NVCS Association	Map Unit	9E	9D	9C	18C	12C	16D	16C	20A	11C	11E	11D	23A	8D	8C	8B	21A	14A	21B	13C	5C
	Map Unit Name	(Pinyon) Oneseed Juniper Ravine Woodland	(Pinyon) Oneseed Juniper/Rockland Canyon Woodland	(Pinyon) Oneseed Juniper/Wavyleaf Oak-Grama Grass Canyon Woodland	Apache Plume-New Mexico Privet Dry Wash Riparian Shrubland	Gambel Oak/New Mexico Locust Canyon Shrubland	Grama Grass/Rockland Grassland	Grama Grass/Rockland Grassland	Lowland Emergent Wetland	Oneseed Juniper/Black Grama Canyon Woodland	Oneseed Juniper/Black Grama Canyon Woodland	Oneseed Juniper/Wavyleaf Oak-Grama Grass Canyon Woodland	Open Water	Ponderosa Pine Canyon Woodland	Ponderosa Pine Ravine Woodland	Ponderosa Pine-Gambel Oak/Deer Sedge Woodland	Rockland/Cliff	Sand Sagebrush/Talus Canyon Shrubland	Talus-Rubble Land	Wavyleaf Oak-Mountain Mahogany/Rockland Canyon Shrubland	White Fir-Douglas-fir-Gambel Oak Canyon Forest
Sparse Vegetation / Recent Alluvial Deposits		2	2	Ci		2	2			Ci	2	Ci		2	Ri	Ci	1			2	2
Sparse Vegetation / Boulder Rockland					Ri				Ri				Ri								
Sparse Vegetation / Scree								1										1	1		

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