National Park Service
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Natural Resource Stewardship and Science

Vegetation Classification and Map

Salinas Pueblo Missions National Monument

Natural Resource Technical Report NPS/SCPN/NRTR—2012/553

ON THE COVER
Abó Ruin looking west above Cañon Espinoso. Cibola National Forest, Mountainair Ranger District, is in the distance
Photography by: Amanda Kennedy

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Executive Summary

We developed vegetation classification and high-resolution vegetation maps for Salinas Pueblo Missions National Monument, New Mexico, for the U.S. Geological Survey-National Park Service National Vegetation Characterization Program. The three units of the monument house outstanding Puebloan and Spanish archaeological sites and are located in central New Mexico in the foothills of the Manzano Mountains and near Chupadera Mesa. This classic New Mexico landscape supports a diverse and productive pinyon-juniper woodlands, intermixed with grasslands, shrublands, riparian areas, and wetlands.

Following the National Vegetation Classification Standard (NVCS), we identified 52 plant associations from among 13 vegetation groups. These, in turn, were used to define a suite of vegetation map units. We developed the vegetation map using a combination of automated digital processing (supervised classifications and image segmentation) and direct image interpretation of high-resolution color aerial orthophotography in combination with satellite imagery (Landsat Thematic Mapper). The map legend is hierarchically structured into two levels: (1) an upper Level 1 of 11 map units corresponds to the Group Level in NVCS and (2) 30 Level 2 map units nested within the upper level units are defined by the plant associations or sets of associations per the NVCS.

The vegetation map is at a 1:24,000 scale with a 0.5 ha minimum map unit size and is designed to facilitate ecologically-based natural resource management. Using a census-like approach to evaluate accuracy, we confirmed the composition of 73.8% (298) of the 404 map polygons, which accounted for 88% of the mapped area across all three park units. The remaining 127 polygons not tested were relatively small and isolated. For many natural resource planning and evaluations, Level 1 units will likely be sufficient and most appropriate, while Level 2 units provide additional fine-scale information within major ecological groups. To support the map as a management tool, we provide an annotated map legend, descriptions of each plant association, a corresponding diagnostic key, field forms, and a plant species list. The map was delivered to the Southern Colorado Plateau Network in both hard copy and digital form as part of a geographic information system (GIS), compatible with that used in the park and in the USGS-NPS mapping program. The GIS allows the 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.

Acknowledgments

This project was supported through funds provided by Natural Heritage New Mexico (NHNM) a division of the Museum of Southwestern Biology at the University of New Mexico, and those provided by the USGS-NPS National Vegetation Characterization Program, NPS Fire Program, and the Southern Colorado Plateau Network (SCPN) as part of a cooperative agreement with NHNM. The NHNM technicians Yvonne Chauvin and Amanda Kennedy conducted the majority of the fieldwork and data entry. Rebecca Keeshen provided management support and editorial review. Lisa Thomas of the NPS Southern Colorado Plateau Network provided project management support and review. Tom Forsyth and Lynelle Wright at the NPS Intermountain Region assisted with contract development. From the USGS-NPS Vegetation Mapping Program national office, important guidance and review was provided by Karl Brown, Tammy Hamer, and Chris Lea.

Acronyms and abbreviations

DEM	Digital elevation model
dOQQ	Digital orthophotograph quarter quadrangle
eSRI	Environmental Systems Research Institute
FGDC	Federal Geographic Data Committee
FSO	Feature space optimization
GIS	Geographic information system
GPS	Global positioning system
I&M	Inventory and Monitoring Program
ITIS	Integrated Taxonomic Information System
NGO	Non-governmental organization
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
SAPU	Salinas Pueblo Missions National Monument
SCPN	Southern Colorado Plateau Network
TNC	The Nature Conservancy
UNESCO	United Nations Education, Science, and Cultural Organization
UNM	University of New Mexico
USGS	United States Geological Survey
UTM	Universal Transverse Mercator

1 Introduction

1.1 Background, scope, and products

Salinas Pueblo Missions National Monument (SAPU) is home to a rich archeological history imbedded in an iconic landscape of the Southwest. These mountain foothills, mesas, and plains supported a diverse and productive ecosystem of woodlands, grasslands, and wetlands that provided habitat for a plethora of wildlife, as well as opportunities for agriculture that allowed the Ancestral Pueblo peoples and the Europeans that followed to flourish. The National Park Service (NPS) has sought to manage the biological resources of SAPU with the same care and attention as that given to its archeological resources. Accordingly, in addition to comprehensive biological inventories and monitoring, a key to effective biological management is the development of high-resolution vegetation maps 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)-NPS Vegetation Mapping Program and the NPS Southern Colorado Plateau Network (SCPN), in cooperation with Natural Heritage New Mexico (NHNM, a division of the Museum of Southwestern Biology at the University of New Mexico), and the staff at SAPU, set out to develop vegetation maps that would meet or exceed USGS-NPS standards of 1:24,000-scale and 0.5 ha minimum map unit size. The maps were to be based on high-resolution aerial photography and satellite imagery, along with extensive ground sampling. The project was initiated in 2003, with field surveys of the vegetation communities ensuing from 2005 through 2009. The vegetation survey data was entered into a database and used to develop a park-wide vegetation classification following the National Vegetation Classification System (NVCS) (FGDC 1997 and 2008; Grossman et al. 1998) guidelines. Then, using the vegetation classification and associated ground control points, vegetation maps were generated at a 1:6,000 scale, using a combination of automated image analysis (image segmentation and supervised classifications) and direct image interpretation. Vegetation maps will support ecologically-based natural resource management with an emphasis on uses in fire and wildlife management.

In this report we provide (1) the details on how the maps for SAPU were constructed, (2) an overview of the classification and ecology of the vegetation communities of the park, (3) the vegetation maps with associated map unit descriptions, (4) plant community descriptions and a diagnostic key, and (5) a vouchered species list. The maps are presented in both printed and in digital form as part of a geographic information system (GIS) compatible with that used in the park and the national USGS-NPS mapping program. In addition, all field data were compiled into a relational database compatible with USGS-NPS database guidelines; and all data and report elements were 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 Program

The USGS-NPS Vegetation Characterization Program is a cooperative effort by USGS and 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 all projects supported by this program. The National Vegetation Characterization Program is administered by the USGS Center for Biological Informatics in cooperation with the NPS Inventory & Monitoring (I&M) Program. Implementation of the NPS Natural Resource Challenge (NPS 1999) made significant funding available for completing important natural resource 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 SAPU. 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 the following 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

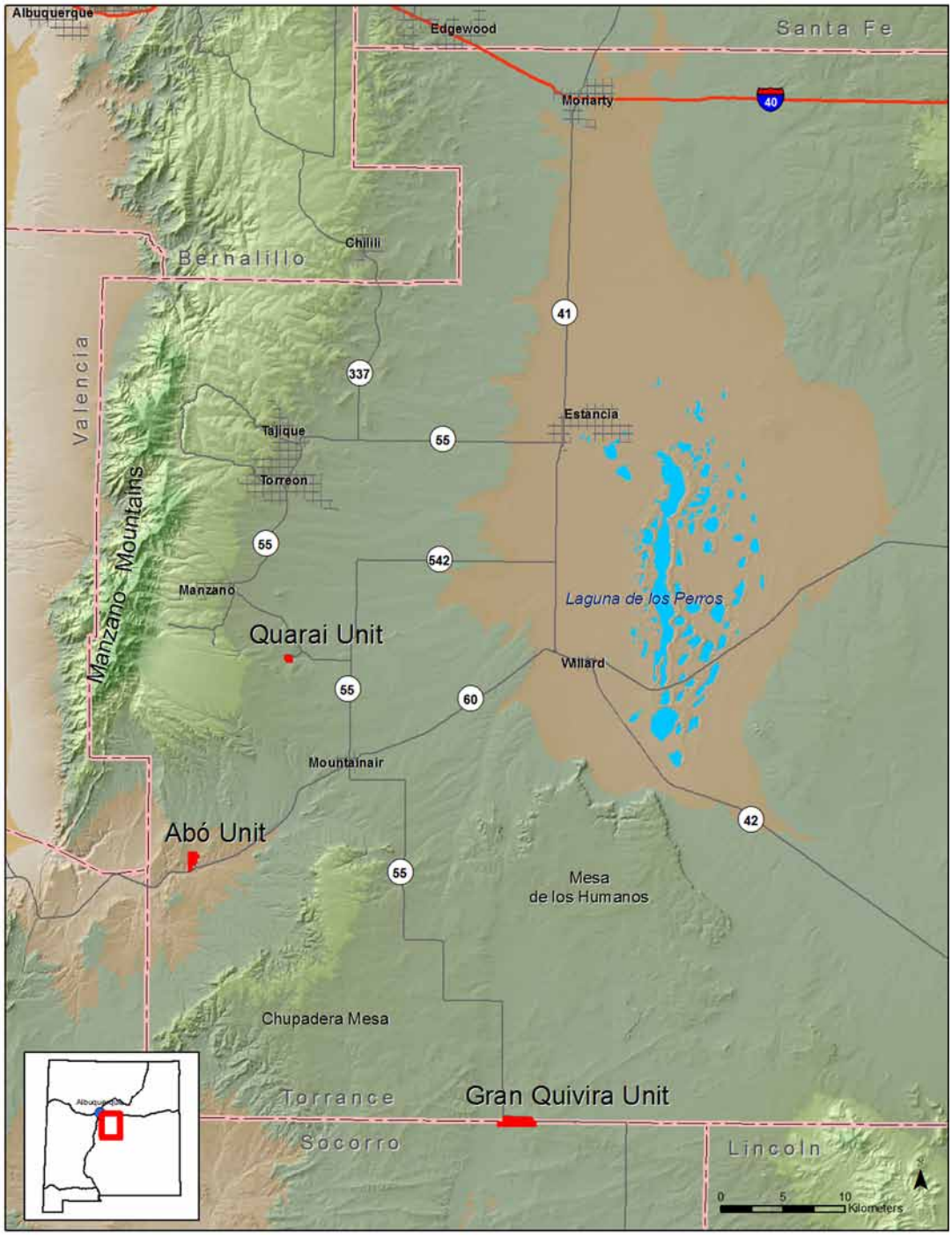

Figure 1. Salinas Pueblo Missions National Monument is located in central New Mexico and composed of three units: Abó and Quarai, located in the foothills of the Manzano Mountains, and Gran Quivira, east of Chupadera Mesa.

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
- program-defined standards for map attribute accuracy and minimum mapping unit

1.3 Park environment

1.3.1 Location and cultural setting

The Salinas Pueblo Missions National Monument was established by Congress in December 1980 ". . . to set apart and preserve for the benefit and enjoyment of the American people the ruins of prehistoric Indian pueblos and associated seventeenth-century Franciscan Spanish mission ruins." (Public Law 96-550). SAPU is comprised of three non-contiguous units—Gran Quivira, Abó, and Quarai—all representative of Spanish colonial times in east central New Mexico (fig. 1). The viewsheds at each of these units still preserve much of the historic scenery as it existed in Spanish colonial times (National Park Service 1984).

The three units lie at the margins of the Estancia Valley (or Estancia Basin), east of the Manzano Mountains and 60-100 km southeast of Albuquerque, New Mexico. The nearest town, Mountainair, lies roughly in the center of a triangle formed by the three units (and is the location of the park headquarters). At the center of the valley are salt-producing playas, including the large Laguna de los Perros. The playas are the most prominent physical feature within the valley and the principal reason for the location of the missions—the production of, and trade in salt and agriculture products. Chupadera Mesa and Mesa de los Humanos escarpments form the southern terminus of the valley, with the Manzano Mountains rising to the west.

1.3.2 Climate

The climate of SAPU is fundamentally semi-arid and continental, with cool-to-cold and predominantly dry winters, followed by warm and usually moist summers. The mean annual precipitation is about 400 mm (15.7 in), as recorded at the stations nearest the three units, and has a definite seasonal pattern (fig. 2). About a third of the annual precipitation occurs in winter as storms out of the Pacific, which follow a southerly path across the continent between November and March. Another third occurs as thunderstorms between July and August during the Arizona monsoon. The remaining moisture occurs as large storms originating in the Pacific and the Gulf of Mexico during autumn and spring (Menking et al. 2004). Locally, there are significant orthographic effects due to the surrounding mountains and hills, which is evident in the relative differences in seasonal and annual precipitation at the three units and regionally (fig. 3).

The mean monthly temperatures at SAPU range between -7°C and 8°C (-19° and 46°F) in January, and between 13°C and 30°C (55° and 86°F) in June, considered the coldest and warmest months of the year, respectively (fig. 4). The coldest recorded daily temperature at Mountainair was -0.5°C (-31°F) and the warmest was 40°C (104°F).

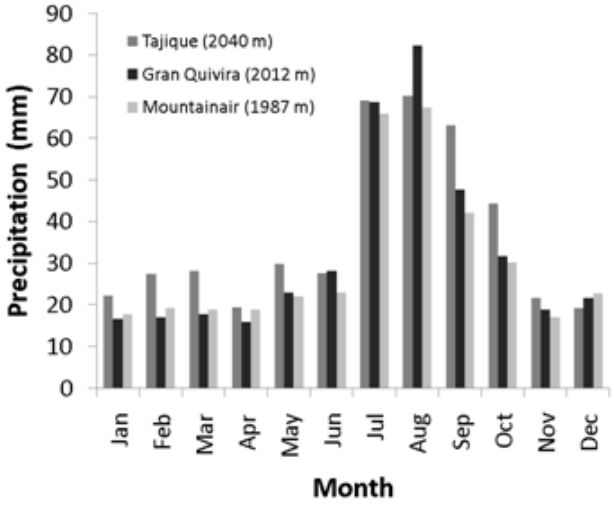

Figure 2. Average monthly precipitation patterns for the weather stations near Salinas Pueblo Missions National Monument units: a) Tajique is 10 km (6 miles) northwest of the Quarai Unit; b) the Gran Quivira unit has its own station; and c) Mountainair is 15 km (9 miles) east of the Abó Unit.

1.3.3 Landscape context

1.3.3.1 Abó Unit

The Abó Unit is 112.8 ha (278.7 ac) and is located in a small stream valley bounded by rolling foothills of the southern Manzano Mountains, 15 km (9 mi) southwest of Mountainair, along U.S. Highway 60 (fig. 5). Elevation ranges from 1817 m (5960 ft) to 1882 m (6176 ft). The stream is perennial through most of its length, but becomes intermittent near the southern boundary. The channel is also subject to ephemeral high flows and flash floods during summer monsoon thunderstorms. Consequently, the channel is entrenched in some areas as much as 5 to 10 m (16 to 33 ft) below what may have been the prehistoric floodplain. Geologically, the hills are underlain primarily by Permian calcitic and arkosic sandstones of the Abó Formation. These rocks are a prominent feature of outcrops in the southern and western portions of the unit, and along the main drainage. Younger sandstones, siltstones, and dolomite of the Yeso Formation lie above the Abó sandstones and occur on the eastern portion of

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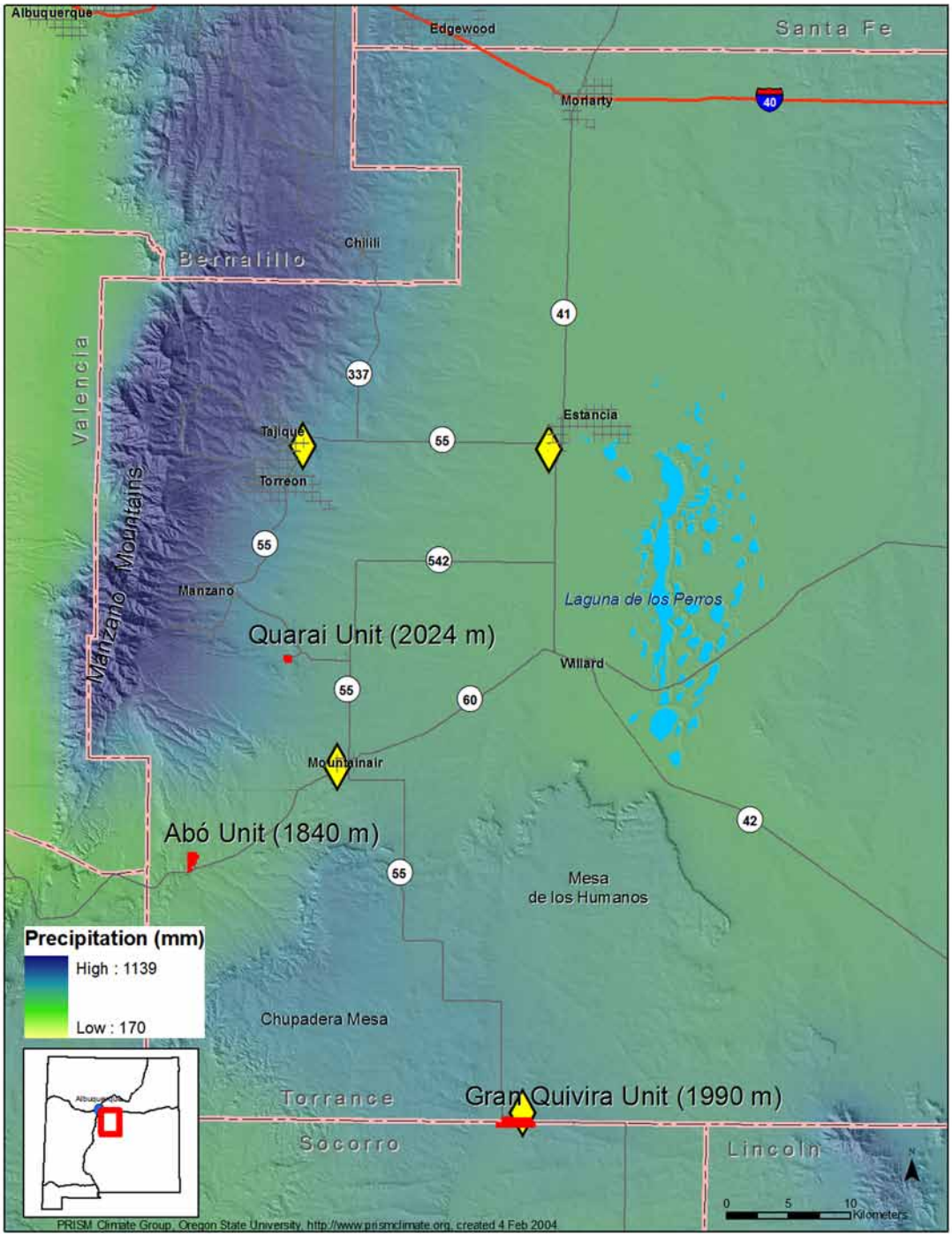

Figure 3. Salinas Pueblo Missions National Monument regional distribution of precipitation (source: PRISM Climate Group, Oregon State University, http://www.prismclimate.org, created 4 Feb 2004). Yellow diamonds indicate the location of nearby weather stations referred to in figure 2 (Tajique, Mountainair, and Gran Quivira).

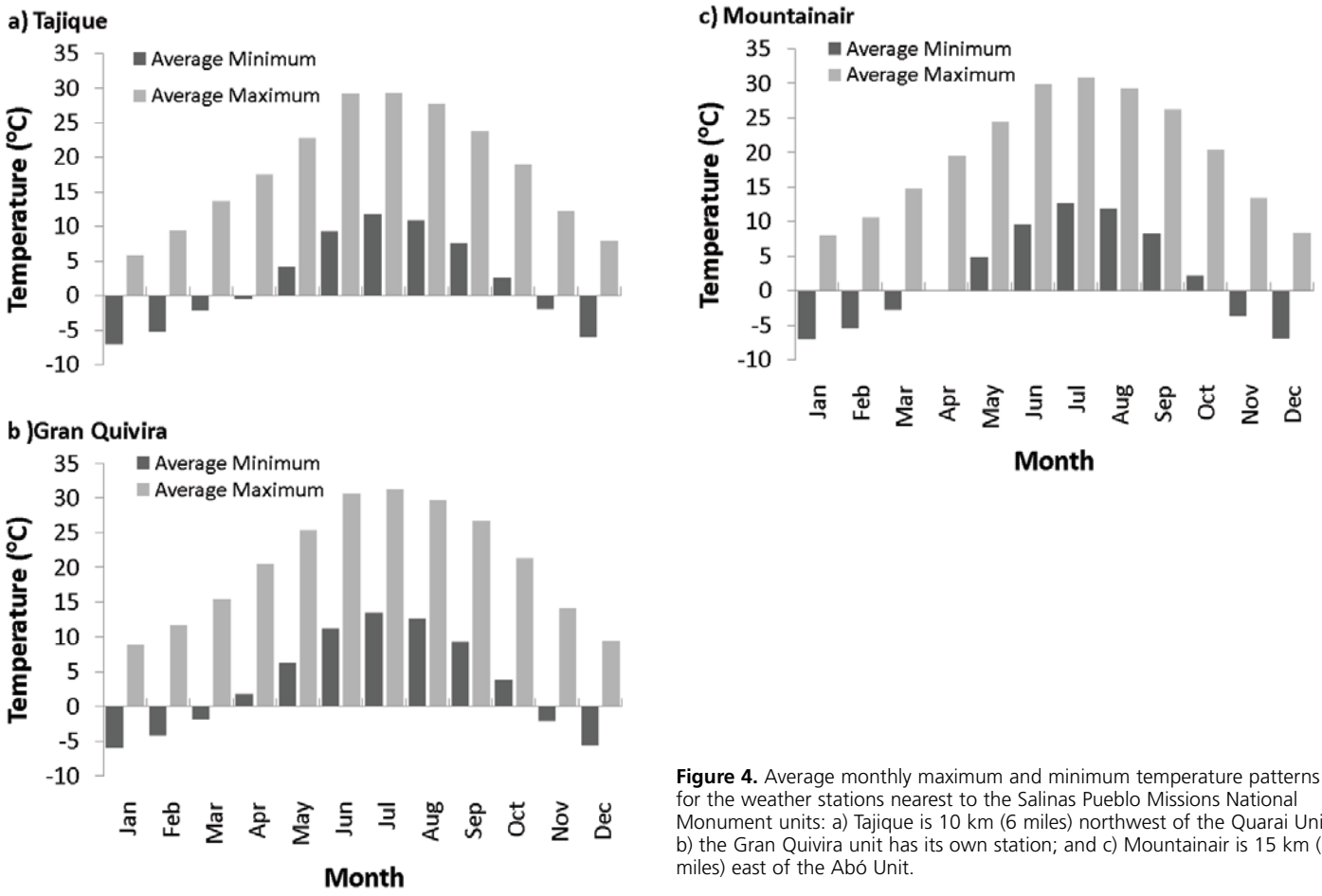

Figure 4. Average monthly maximum and minimum temperature patterns for the weather stations nearest to the Salinas Pueblo Missions National Monument units: a) Tajique is 10 km (6 miles) northwest of the Quarai Unit; b) the Gran Quivira unit has its own station; and c) Mountainair is 15 km (9 miles) east of the Abó Unit.

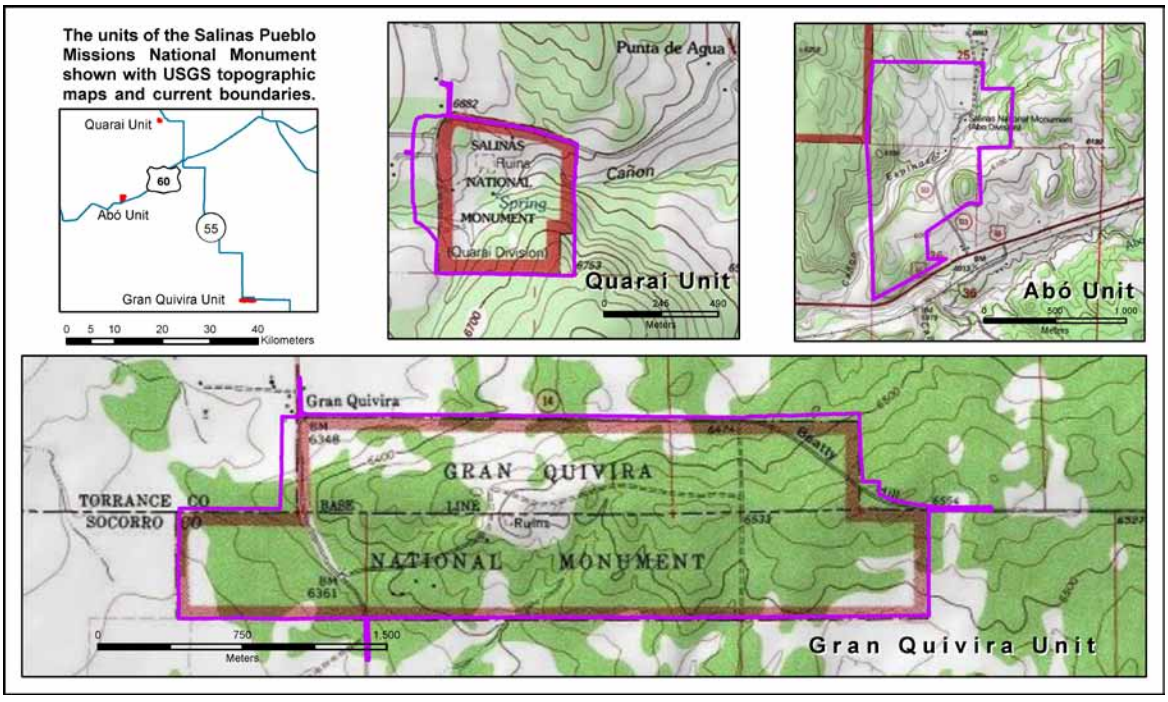

Figure 5. The three units of Salinas Pueblo Missions National Monument: Quarai, 9 km (5.6 miles) northwest of the park headquarters at Mountainair, NM; Abó, 15 km (9 miles) southwest; and Gran Quivira, 31 km (19.3 miles) to the southeast

Table 1. Soil map units for Salinas Pueblo Missions NM by park unit with component soils series and their percent contribution to the unit; percent slope range; soil family, and parent material (rock type). Rock outcrop is indicated with r/o, and does not have a soils family nor parent material explicitly defined by NRCS.

Map unit symbol	Map unit name	Series % of map unit	Soil series	Slope low (%)	Slope high (%)	Soil family	Parent material
Abó Unit							
Al	Alicia loam, 1 to 6 percent slopes	95	Alicia	0	1	Fine-silty, mixed, mesic Ustollic Camborthids	Igneous and sedimentary rock
Cg	Chilton gravelly loam	80	Chilton	8	20	Loamy-skeletal, mixed, calcareous, mesic Ustic Torriorthents	Igneous and sedimentary rock
Ec	Encierro channery loam, 1 to 9 percent slopes	95	Encierro	1	9	Clayey, mixed, mesic Lithic Argiustolls	Sandstone and shale
La	La Fonda loam, 1 to 9 percent slopes	95	La Fonda	1	9	Fine-loamy, mixed, mesic Ustollic Camborthids	Sedimentary rock
Mo	Moriarty clay loam, 2 to 6 percent slopes	95	Moriarty	2	6	Fine, mixed, mesic Mollic Torrerts	Metamorphic and sedimentary rock
Pz	Prewitt and Manzano soils	60	Prewitt	0	3	Fine-loamy, mixed, mesic Fluventic Haplustolls	Igneous and sedimentary rock
		30	Manzano	0	3	Fine-loamy, mixed, mesic Cumulic Haplustolls	Igneous, metamorphic and sedimentary rock
Sc	Scholle gravelly loam, 1 to 9 percent slopes	85	Scholle	1	9	Fine-loamy, mixed, mesic Ustollic Haplargids	Igneous, metamorphic and sedimentary rock
Sm	Steep rock land	45	Steep rock land, r/o	20	80		
		45	Steep rock land, rubble	20	80		
Quarai Unit							
Al	Alicia loam, 1 to 6 percent slopes	95	Alicia	0	1	Fine-silty, mixed, mesic Ustollic Camborthids	Igneous and sedimentary rock
Ec	Encierro channery loam, 1 to 9 percent slopes	95	Encierro	1	9	Clayey, mixed, mesic Lithic Argiustolls	Sandstone and shale
La	La Fonda loam, 1 to 9 percent slopes	95	La Fonda	1	9	Fine-loamy, mixed, mesic Ustollic Camborthids	Sedimentary rock
Ma	Manzano loam, 0 to 1 percent slopes	95	Manzano	0	1	Fine-loamy, mixed, mesic Cumulic Haplustolls	Metamorphic and sedimentary rock
Sm	Steep rock land	45	Steep rock land, r/o	20	80		

Map unit symbol	Map unit name	Series % of map unit	Soil series	Slope low (%)	Slope high (%)	Soil family	Parent material
		45	Steep rock land, rubble	20	80		
Wp	Witt loam, 1 to 6 percent slopes	80	Witt	1	6	Fine-silty, mixed, mesic Ustollic Haplargids	Igneous, metamorphic and sedimentary rock
Gran Quivira Unit							
718	Palma, thick surface-Penistaja-Palma complex, 1 to 5 percent slopes	30	Palma	1	5	Coarse-loamy, mixed, mesic Ustollic Haplargids	Sandstone and shale
		25	Penistaja	1	5	Fine-loamy, mixed, mesic Ustollic Haplargids	Sandstone and shale
		20	Palma	1	5	Coarse-loamy, mixed, mesic Ustollic Haplargids	Sandstone and shale
816	Pirodel-Harvey-Pinon complex, 1 to 15 percent slopes	30	Pirodel	1	15	Sandy, mixed, mesic Ustollic Calciorthids	Limestone
		25	Harvey	1	15	Fine-loamy, mixed, mesic Ustollic Calciorthids	Limestone
		20	Pinon	1	15	Loamy, mixed, mesic Lithic Ustollic Calciorthids	Limestone
818	Mespun fine sand, 1 to 6 percent slopes	90	Mespun	1	6	Mixed, mesic Ustic Torripsamments	Sandstone
Cm	Chupadera loamy fine sand, 5 to 15 percent slopes	95	Chupadera	5	15	Coarse-loamy, mixed, mesic Ustollic Calciorthids	Limestone; Metamorphic and sedimentary rock
Op	Otero and Palma soils	55	Otero	1	9	Coarse-loamy, mixed, calcareous, mesic Ustic Torriorthents	Metamorphic and sedimentary rock
		25	Palma	1	9	Coarse-loamy, mixed, mesic Ustollic Haplargids	Metamorphic and sedimentary rock

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the unit (gypsum was not prevalent here based on our field reconnaissance). Eight soil series (plus rock outcrop) have been mapped for Abó (table 1). They range from fine-textured Mollisols and Vertisols to less-developed Aridisols and Entisols (NRCS 2010).

1.3.3.2 Quarai Unit

The Quarai Unit is 42.5 ha (104.9 ac) and lies about 9 km (5.6 mi) northwest of Mountainair along highway NM 55 (fig. 5). It, too, is nestled in a small valley with a perennial stream in the eastern foothills of the Manzano Mountains. The perennial waters of the stream appear to have their source from springs on the site. The perennial channel is entrenched for much of its length, 5 to 10 m (16 to 33 ft) below what may have been the prehistoric floodplain. West and east of the unit the drainage appears to support only ephemeral flows. Elevations range from 2010 m (6594 ft) to 2060 m (6758 ft). Geologically, this unit is also underlain by Permian calcitic and arkosic sandstones of the Abó Formation, with Quaternary alluvial fill in the valley bottom. five soil series (plus rock outcrop) have been mapped for Quarai (table 1). They range from fine-textured Mollisols to less-developed Aridisols (NRCS 2010).

1.3.3.3 Gran Quivira Unit

The Gran Quivira Unit is 251.3 ha (620.9 ac) and lies about 31 km (19.3 mi) south of Mountainair along highway NM 55 (fig. 5). In contrast to the other units, the central feature here is a mesa-like tableland dominated by the large archeological site on its summit. Elevations range from 1923 m (6309 ft) to 2005 m (6578 ft). No perennial stream drainages or springs are evident. Permian limestone and dolomites of the San Andres Formation are the characteristic geological substrate, with outcrops of gypsum along the mesa slopes to the south. The toeslopes of the mesa give way to Quaternary alluvial flats and plains in the western and southeastern portions of the unit. Eight soil series have been mapped for Gran Quivira (table 1). The drier aspect of this unit is reflected by the dominance of aridisols among the soil series, and a tendency for coarser textures (NRCS 2010).

1.3.3.4 Previous vegetation classification and mapping studies

Previous botanical studies or vegetation maps of SAPU are limited. Relatively coarse resolution vegetation maps were produced for the unit between 1996 and 2002 (per. com. Phil Wilson, Salinas Pueblo Missions N. M.). Each park unit has a unique legend that describes generalized pinyon-juniper woodlands, shrublands, and grasslands. In Table 2, we have provided an approximate crosswalk of these units to the new map presented in this report.

Table 2. Legend crosswalk between the old Salinas Pueblo Missions NM vegetation maps and the new one presented in this report (see table 8 for new map unit names)

Old map unit names	New map unit number
Abó Unit	
Boutelloua gracilis series	8
Excavation on hilltop	10C
Juniperus, Chrysothamnus-Fallugia-Tamarix	2I
Juniperus/Bouteloua-senacio	2F
Juniperus/Senacio-Sporobolus	2G
Mission ruin	11
Opuntia imbricata-ruin mounds	11B
Pictograph alcove	10A
Pinus edulis/Juniperus monosperma	1A
Populus acuminata series (riparian)	3A
Sisneros inholding	11D
Sporobolus-Sitanion-Convolvulus	8E
Visitor center	11C
Gran Quivera Unit	
Deep Sand Shrub-Grassland	7
Juniper Woodland: Subunit A	2
Juniper Woodland: Subunit B	2
Revegetation	11
Sandy Grassland	8
Upland Shrub Grassland	4
Quarai Unit	
Agricultural	11
Agropyron smithii	8E
Artemisia campestris-Agropyron smithii	8E
Atriplex canescens-Artemisia dracunculu	6A
Bouteloua-Melilotus	8E
Bouteloua-Sitanion	8
Bouteloua-Yucca-Berberis	8C
Ceratoides ianatum-Barberis fremontii	6A
Juniperus monosperma/Berberis fremontii	2
Juniperus monosperma/Bouteloua gracilis	2A
Juniperus monosperma/Rosa woodsii	2
Maintained picnic area	11G
Malus plantations	
Mission church ruin	11
Old homestead	11
Pinyon-Juniper/Berberis	1
Populus fremontii series (riparian)	3A
Riparian border-weedy	8E
Ruins mound	11B
Visitor center	11C

2 Vegetation classification

Previous botanical studies or vegetation maps of SAPU have been limited. A relatively coarse resolution vegetation map was produced by Pache (1979) for the Gran Quivira unit. He mapped a Sandy Grassland dominated by *Bouteloua gracilis* (blue grama); an upland shrub-grassland dominated by *B. gracilis* and *Atriplex canescens* (fourwing saltbush); a deep sand shrub grassland dominated by *Schizachyrium scoparium* (little bluestem) and *Andropogon gerardii* (big bluestem); and a juniper woodland with two subunits, one with *B. gracilis* as the grass dominant and the other with *S. Scoparium* and *A. gerardii* as the dominants.

Floyd-Hanna et al. (1993) provided a list of 24 plant associations for the Abó and Quarai units that formed the foundation for generalized vegetation maps of the units developed between 1996 and 2002 (per. com. Phil Wilson, Salinas Pueblo Missions N. M.). Each park unit has a unique legend that describes generalized pinyon-juniper woodlands, shrublands, and grasslands. In Table 2, we have provided an approximate crosswalk of these units to the new map presented in this report. A consistent, ecologically-based vegetation classification forms 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 SAPU, 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 developing the classification and provide an overview of the SAPU classification with discussion.

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 (FGDC) in 1997, and updated in 2008 (FGDC 1997 & 2008). The NVCS evolved from work conducted primarily by The Nature Conservancy (TNC), NatureServe, and the Natural Heritage Program network over more than two decades (Grossman et al. 1998). The structure of the 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

Table 3. 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 4. 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)

is presented in Table 3. 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 that are currently under review (table 4). A crosswalk of hierarchical levels between the two standards from FGDC (1997 & 2008) is given in Table 5. Accordingly, because the NVSC is in transition, we provide the classification following both frameworks in this report.

The NVCS is a hierarchical system that allows vegetation classification to occur at multiple scales. The FGDC (1997) standard incorporates physiognomic characteristics and floristic data to define seven levels of terrestrial vegetation classification (table 3). The five upper levels (class, subclass, group, subgroup, and formation) are based 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 4). 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 largely on biogeographic and habitat factors, along very broad, regional-to-continental topographic, edaphic, and disturbance gradients. The lower two levels—the alliance and association—are used in park mapping, and are currently the same in the first and second versions (substantial revisions of the alliances are expected in the future to improve concordance through the hierar-

Table 5. 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

chy, but at the time of the preparation of this report they had not yet 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 descriptions 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 communities 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). We planned sampling campaigns 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 where a series of daily routes for the sampling crews were designed in a GIS, using the digital ortho-photography and preliminary vegetation maps. The selection of the locations of eight to ten sampling points per route was driven by differences in vegetation, soils, and geologic pattern, plus logistics, i.e., what could be accomplished in one day's travel time by a field crew in a vehicle and on foot (we increased sampling days to ten hours to further increase daily efficiency). Routes were distributed as widely as possible throughout the study area, but the emphasis was on capturing the range of variation within the park. While using the GIS was an excellent planning strategy, decisions about final plot locations were made in the field and based on positioning the sampling points in homogenous stands of vegetation and habitat.

Field crews were composed of two to three people. A senior technician crew chief was responsible for botany and vegetation sampling, while the second and third members were junior technicians responsible for gathering tree and fuels data, taking photographs, and acquiring Global Positioning System (GPS) locations. Plots were established in large stands of vegetation that were representative of the typical vegetation at a site. 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, we compiled a list of all vascular plant species, stratified by lifeform (tree, shrub, subshrub, grass, and forb layers), and estimated cover for each species using a modified Domin-Krajina Scale (table 6) (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. Plot locations were recorded with a Garmin GPS Model 12 with +/- 10 m accuracy. For each plot, at least four photos were taken in the four cardinal 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 were logged for future reference. See Appendix A for NHNM field-survey handbook and examples of sampling forms.

We used standard plots primarily to support vegetation classification development—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 can be established in a day, depending on logistics. In addition, we used reconnaissance observation points, for which we recorded the diagnostic species to be used in determining the plant association using diagnostic keys (see Vegetation Analysis section below), as well as a GPS point and a photograph. Between 2004 and 2008, we established 26 standard plots, 40 quick plots, and 222 observation points across all three park units for a total of 288 sample points (fig. 6).

Plant voucher specimens were collected to confirm field identifications as necessary, and are 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 names were assigned 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. We provide a species list derived from the plot data in Appendix B.

Table 6. 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 400 m^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

2.1.3 Vegetation analysis

To develop the vegetation classification, we analyzed the plot data using standard tabular comparison techniques (Becking 1957, Mueller-Dombois and Ellenberg 1974, Ludwig and Reynolds 1988, McCune and

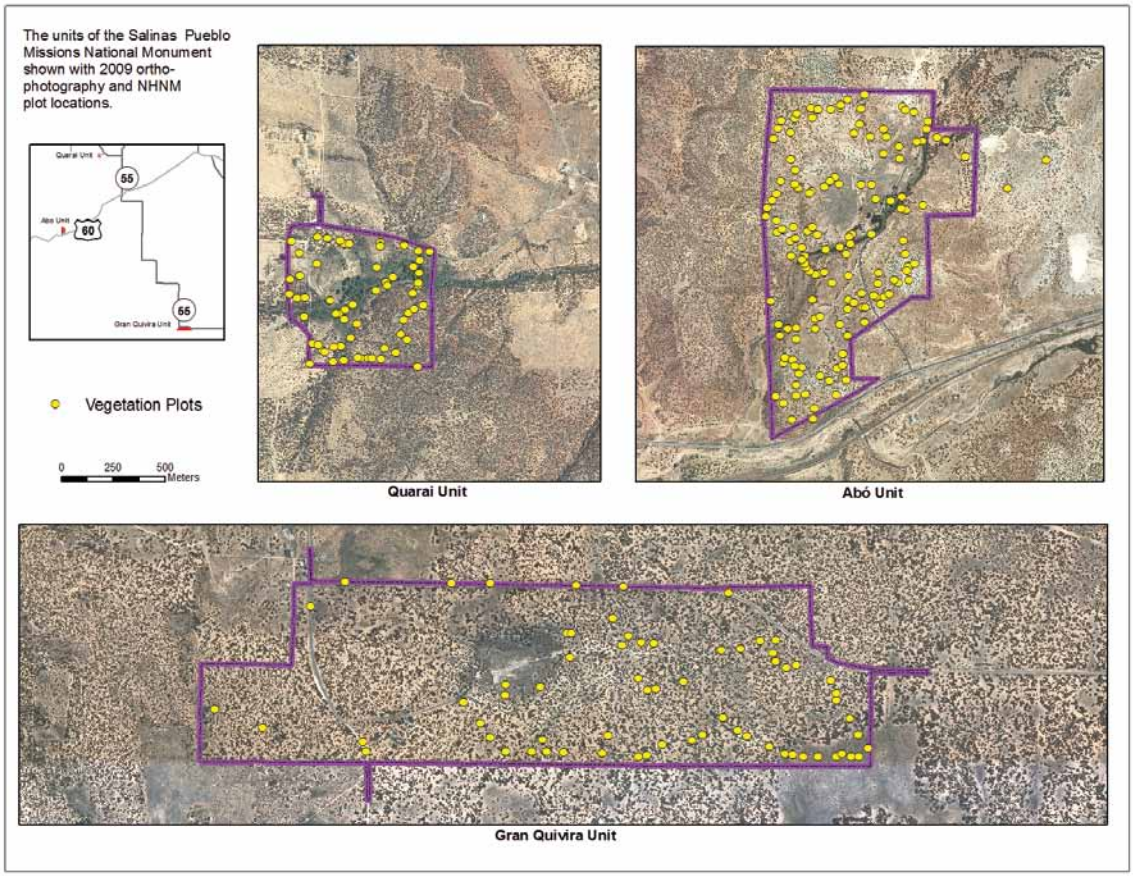


Figure 6. Distribution of sampling plots across the three units of Salinas Pueblo Missions NM (including standard plots, mapping plots, and observation points)

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). Data on site characteristics, such as elevation, slope, aspect, and landform, were also used to supplement the analysis. 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 further define 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. The NVCS continues to be revised to meet the new standard and not all groups have been defined. Hence, we had the opportunity here 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 were the basis for plant association descriptions and dichotomous keys.

2.2 Classification results

For the three units of SAPU, we identified 52 plant associations (PAs) that represented a spectrum of vegetation from riparian woodlands and wetlands to semi-arid grasslands and shrublands. In Table 7, we present the PAs ordered according to the new NVCS hierarchy, along with their classification status, number of SAPU plots, and NatureServe database code. Twenty-five PAs were considered major associations that were well documented in the park or in the region. For these, we provide detailed descriptions of floristic composition and site characteristics in Appendix D, along with diagnostic keys for the major associations plus two of the incidental associations in Appendix C. The remaining 27 PAs were categorized as incidental associations that had minor distributions within the park and limited documentation (semi-quantitative observation points) and, hence, required additional supporting data before they warranted full descriptions. These incidental associations are listed in Appendix D. For some PAs, we recognized phases reflective of variants in floristic composition from the typical or central concept of an association ("Typic Phase"). While phases are not tracked in the NVCS at the national level, they can be important for mapping purposes within a park, and they may later be elevated to PA status. Lastly, we cross-walked each PA to the map units in which they are either a primary or secondary component, related inclusion, or a contrasting inclusion (see Chapter 3 for a description of map-unit structure and table 8).

2.2.1 Classification overview

Here we summarize the information on the composition, structure, and environments of vegetation communities within SAPU 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 composition and distribution (see table 4). Appendix C provides details on plant association composition and environments.

2.2.1.1 Woodlands

The mesas and foothills of SAPU are cloaked with pinyon and juniper woodlands that are represented by two macrogroups within the NVC. One—the Rocky Mountain Two-needle Pinyon - Juniper Woodland Macrogroup—is a southern extension of the mid-elevation Rocky Mountain communities; and the other—the Madrean Warm Lowland Evergreen Woodland Macrogroup—is made up of associations that are near the northern limit of their distribution from the Sierra Madre of Mexico.

continued on page 27...

Table 7. A hierarchical plant association classification for Salinas Pueblo Missions NM (see table 4 for hierarchical level definitions). Plant associations are presented according to the new NVCS hierarchy (2008) under their respective "Groups" (please note that alliances are not included). Under "Classification status", "E" is an established plant association recognized in the 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 either an incidental association known only from one plot or observation point and needs further confirmation within the park, or it was identified during the assessment phase of the project. "Map unit" refers to the vegetation map units in which the plant association is found. 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).

Group	Association	Classification status[1]	# of plots	NatureServe code	Map unit
Class: 1. Forest and Woodland (Mesomorphic Tree Vegetation)					
Subclass: 1.C Temperate Forest					
Formation: 1.C.1 Warm Temperate Forest					
Division: 1.C.1.c Western North American Warm Temperate Forest					
Macrogroup: MG010. Madrean Warm Lowland Evergreen Woodland					
G487. Madrean Juniper Savanna & Woodland Group	*Juniperus monosperma / Muhlenbergia pauciflora* Woodland	E	2	CEGL005387	2D
	Juniperus monosperma / Muhlenbergia setifolia Woodland	E	15	CEGL005386	2C
Class: 1. Forest and Woodland (Mesomorphic Tree Vegetation)					
Subclass: 1.C Temperate Forest					
Formation: 1.C.2 Cool Temperate Forest					
Division: 1.C.2.c Western North American Cool Temperate Scrub Woodland & Shrubland					
Macrogroup: MG027. Rocky Mountain Two-needle Pinyon - Juniper Woodland					
G252. Southern Rocky Mountain Juniper Woodland & Savanna Group	*Juniperus monosperma / Bouteloua curtipendula* Woodland	I	4	CEGL000708	
	Typic Phase				2D
	Woodland Treatment Phase				2E
	Juniperus monosperma / Bouteloua eriopoda Woodland	E	20	CEGL000709	2B
	Juniperus monosperma / Bouteloua gracilis Woodland	E	58	CEGL000710	
	Typic Phase				2A, 2B
	Andropogon gerardii Phase				2L
	Artemisia filifolia Phase				2J
	Atriplex canescens Phase				2I

Table 7 *continued*

Group	Association	Classification status[1]	# of plots	NatureServe code	Map unit
	Ruderal Forb Phase				2F
	Schizachyrium scoparium Phase				2H
	Sporobolus airoides Phase				2G
	Woodland Treatment Phase				2E
	Juniperus monosperma / *Bouteloua hirsuta* Woodland	I	2	CEGL000711	2C
	Juniperus monosperma / *Pleuraphis jamesii* Woodland	I	1	NPS_NM036	2A
	Juniperus monosperma / *Quercus* X *pauciloba* Woodland	I	2	CEGL000721	2K
	Juniperus monosperma / Rockland Woodland	I	3	CEGL005369	2D
	Juniperus monosperma / *Schizachyrium scoparium* Woodland	P	9	NPS_NM037	2H
	Juniperus monosperma / Sparse Understory Woodland	E	18	CEGL005368	2K, 2A, 2B
G253. Southern Rocky Mountain Pinyon - Juniper Woodland Group	*Pinus edulis* / *Koeleria macrantha* Woodland	I	1	NHNM000581	1A
	Pinus edulis - *(Juniperus monosperma, Juniperus deppeana)* / *Bouteloua gracilis* Woodland	E	6	CEGL002151	1A
	Pinus edulis - *Juniperus monosperma* / *Quercus X pauciloba* Woodland	I	1	CEGL000793	1A
	Pinus edulis - *Juniperus* spp. / *Quercus gambelii* Woodland	I	1	CEGL000791	1A
	Pinus edulis / Rockland Woodland	I	4	CEGL000794	1A
	Pinus edulis / Sparse Understory Woodland	E	5	CEGL000795	1A
Class: 1. Forest and Woodland (Mesomorphic Tree Vegetation)					
Subclass: 1.C Temperate Forest					
Formation: 1.C.3 Temperate Flooded & Swamp Forest					
Division: 1.C.3.c Western North American Flooded & Swamp Forest					
Macrogroup: MG034. Rocky Mountain and Great Basin Flooded & Swamp Forest					
G506. Rocky Mountain & Great Basin Montane Riparian Forest Group	*Populus angustifolia* / *Prunus virginiana* Woodland	E	1	CEGL000651	3A

Table 7 *continued*

Group	Association	Classification status[1]	# of plots	NatureServe code	Map unit
Class: 1. Forest and Woodland (Mesomorphic Tree Vegetation)					
Subclass: 1.C Temperate Forest					
Formation: 1.C.3 Temperate Flooded & Swamp Forest					
Division: 1.C.3.d Western North American Warm Temperate Flooded & Swamp Forest					
Macrogroup: MG036. Warm Mediterranean & Desert Riparian, Flooded & Swamp Forest					
G508. Sonoran-Chihuahuan Lowland Riparian Forest Group	*Populus deltoides* (ssp. *wislizeni,* ssp. *monilifera) - Salix gooddingii* Forest	E	5	CEGL005964	3A
	Populus deltoides (ssp. *wislizeni,* ssp. *monilifera) / Rosa woodsii* Forest	I	1	NPS_NM038	3A
	Salix gooddingii / Salix exigua Woodland	E	5	CEGL003778	3B
	Salix gooddingii Woodland	E	4	CEGL002743	3B
Class: 2. Shrubland & Grassland (Mesomorphic Shrub & Herb Vegetation)					
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: MSW1. Great Plains Ruderal Shrubland & Grassland					
GSW7. Southwest Ruderal Shrubland & Grassland [Placeholder]	*Bouteloua gracilis* / Old Field Herbaceous Vegetation	I	2	NPS_NM042	8C
	Ruderal Disturbance Vegetation	I	5	NPS_NM027	8E
Macrogroup: MG052. Great Plains Sand Grassland & Shrubland					
G069. Great Plains Sand Shrubland Group	*Artemisia filifolia / Bouteloua* (*curtipendula, gracilis*) Shrubland	E	2	CEGL002176	7A
Macrogroup: MG053. Great Plains Shortgrass Prairie & Shrubland					
G144. Great Plains Shortgrass Prairie Group	*Bouteloua gracilis - Sporobolus cryptandrus* Herbaceous Vegetation	I	8	CEGL001761	8B
	Bouteloua gracilis Herbaceous Vegetation	I	7	CEGL001760	
	Typic Phase				8A
	Andropogon gerardii Phase				8A

Table 7 *continued*

Group	Association	Classification status[1]	# of plots	NatureServe code	Map unit
	Bouteloua gracilis - Hesperostipa neomexicana Herbaceous Vegetation	E	2	CEGL001763	8A
	Bouteloua gracilis - Pleuraphis jamesii Herbaceous Vegetation	E	3	CEGL001759	8A
	Gutierrezia sarothrae / Bouteloua gracilis Dwarf-shrub Herbaceous Vegetation	I	2	CEGL005382	8A
	Sporobolus airoides - Bouteloua gracilis Herbaceous Vegetation	E	15	CEGL001686	8B, 8C, 8E
GSW5. Southwest Plains-Mesa Grassland	*Bouteloua gracilis - Muhlenbergia torreyi - Aristida purpurea* Herbaceous Vegetation	E	16	CEGL005389	8A, 8C
	Bouteloua gracilis / Ruderal Herbaceous Vegetation	I	2	NPS_NM043	8C
	Pascopyrum smithii - Bouteloua gracilis Herbaceous Vegetation	E	2	CEGL001578	8B, 8C
	Pascopyrum smithii / Ruderal Herbaceous Vegetation	I	2	NPS_NM045	8E
	Yucca glauca / Bouteloua gracilis Shrub Herbaceous Vegetation	I	4	NPS_NM055	8C
Class: 2. Shrubland & Grassland (Mesomorphic Shrub & Herb Vegetation)					
Subclass: 2.C Temperate & Boreal Shrubland & Grassland					
Formation: 2.C.5 Temperate & Boreal Freshwater Wet Meadow & Marsh					
Division: 2.C.5.b Western North American Freshwater Wet Meadow & Marsh					
Macrogroup: MG073. Western North American Lowland Freshwater Wet Meadow, Marsh & Shrubland					
G518. Western North American Temperate Interior Freshwater Marsh Group	*Typha* (*latifolia, angustifolia*) Western Herbaceous Vegetation	I	3	CEGL002010	9A
Macrogroup: MG075. Western North American Montane Wet Meadow & Low Shrubland					
G527. Rocky Mountain & Great Basin Montane Riparian & Seep Shrubland Group	*Prunus virginiana* - (*Prunus americana*) Shrubland	E	1	CEGL001108	3A, 4B
	Rosa woodsii / Mixed Herbaceous Shrubland	I	4	NHNM000816	3B, 4B
	Salix exigua - Rosa woodsii Shrubland	I	2	NPS_NM041	4A, 4B
G521. Vancouverian & Rocky Mountain Montane Wet Meadow Group	*Carex pellita* Herbaceous Vegetation	I	1	CEGL001809	9A
	Equisetum laevigatum Herbaceous Vegetation	E	2	CEGL002241	9A
	Juncus balticus Herbaceous Vegetation	I	1	CEGL001838	9A

Table 7 *continued*

Group	Association	Classification status[1]	# of plots	NatureServe code	Map unit
Class: 3 Semi-Desert (Xeromorphic Scrub & Herb Vegetation)					
Subclass: 3.A Warm Semi-Desert Scrub & Grassland					
Formation: 3.A.1 Warm Semi-Desert Scrub & Grassland					
Division: 3.A.1.a North American Warm Desert Scrub & Grassland					
Macrogroup: MG087. Chihuahuan Semi-Desert Grassland & Steppe					
G490. Chihuahuan Semi-Desert Grassland Group	*Bouteloua eriopoda - Bouteloua gracilis* Herbaceous Vegetation	E	12	CEGL001748	8B, 8D
G489. Chihuahuan Semi-Desert Lowland Grassland Group	*Panicum obtusum* Herbaceous Vegetation	I	1	CEGL002708	8E
	Sporobolus airoides - Panicum obtusum Herbaceous Vegetation	I	1	CEGL001690	8E
Macrogroup: MG090. North American Warm Desert Alkaline-Saline Semi-Desert Scrub					
G299. Chihuahuan Lowland Basin Semi-Desert Scrub Group	*Atriplex canescens / Muhlenbergia porteri* Shrubland	E	1	CEGL005385	6A
	Atriplex canescens / Panicum obtusum Shrubland	I	1	NPS_NM040	6A
	Atriplex canescens / Sporobolus airoides Shrubland	E	2	CEGL001291	6A
Class: 3 Semi-Desert (Xeromorphic Scrub & Herb Vegetation)					
Subclass: 3.B Cool Semi-Desert Scrub & Grassland					
Formation: 3.B.1 Cool Semi-Desert Scrub & Grassland					
Division: 3.B.1.a Western North American Cool Semi-Desert Scrub & Grassland					
Macrogroup: MG171. Great Basin & Intermountain Dry Shrubland & Grassland					
G310. Intermountain Semi-Desert Shrubland Group	*Ericameria nauseosa / Bouteloua gracilis* Shrub Herbaceous Vegetation	I	1	CEGL003495	8A
	Krascheninnikovia lanata / Bouteloua gracilis Dwarf-shrub Herbaceous Vegetation	E	1	CEGL001321	6A
Macrogroup: MG095. Great Basin & Intermountain Xero-Riparian Scrub					
G559. Cool Semi-Desert Shrub & Herb Wash-Arroyo Group	*Ericameria nauseosa* Desert Wash Shrubland	I	1	CEGL002261	5A
Macrogroup: MG093. Great Basin Saltbrush Scrub					
G300. Intermountain Shadscale - Saltbush Scrub Group	*Atriplex canescens / Bouteloua gracilis* Shrubland	I	2	CEGL001283	6A

Table 7 *continued*

Group	Association	Classification status[1]	# of plots	NatureServe code	Map unit
Class: 6 Nonvascular & Sparse Vascular Rock Vegetation (Lithomorphic Vegetation)					
Subclass: 6.C Semi-Desert Nonvascular & Sparse Vascular Vegetation					
Formation: 6.C.1 Warm Semi-Desert Cliff, Scree & Rock Vegetation					
Division: 6.C.1.a North American Warm Semi-Desert Cliff, Scree & Rock Vegetation					
Macrogroup: MG117. North American Warm Semi-Desert Cliff, Scree & Rock Vegetation					
G569. North American Warm Semi-Desert Cliff, Scree & Rock Vegetation [Placeholder]	Sparse Vegetation / Boulder Rockland	I	3	NPS_NM013	10A
	Sparse Vegetation / Recent Alluvial Deposits	I		NHNM000817	10B
	Sparse Vegetation / Bare Ground	I		NPS_NM073	10C
	Sparse Vegetation / Dry Wash Rockland			NHNM000818	10D
Class: 8 Developed Vegetation (Hortomorphic Vegetation)					
Subclass: 8.1 Herbaceous & Woody Developed Vegetation					
Formation: 8.1.B Other Developed Urban / Built Up Vegetation					
Division: 8.1.B.1 Other Urban / Built Up Vegetation					
Macrogroup: CMGNEW. Other Urban / Built Up Vegetation					
CGNEW. Southwestern Urban / Built Up Vegetation	Disturbed / Archeological Site - Restored	I		NHNM000820	11A
	Disturbed / Archeological Site - Un-restored	I	3	NHNM000819	11B
	Disturbed / Non-vegetated	I	3	NPS_NM047	10C
	Disturbed / Recreation Site	I	2	NPS_NM048	11G
	Total number of plots in SAPU		**288**		

Table 8. A hierarchical legend for the Salinas Pueblo Missions 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		Southern Rocky Mountain Pinyon-Juniper Woodland			**12**	**9.4**	**23.1**
	A	Pinyon-Oneseed Juniper/Blue Grama Woodland			12	9.4	23.1
			Pinus edulis - (Juniperus monosperma, Juniperus deppeana) / Bouteloua gracilis Woodland	1			
			Pinus edulis / Sparse Understory Woodland	2			
			Pinus edulis - Juniperus monosperma / Quercus X pauciloba Woodland	Ri			
			Pinus edulis / Rockland Woodland	Ri			
			Pinus edulis / Koeleria macrantha Woodland	Ri			
			Pinus edulis - Juniperus spp. / *Quercus gambelii* Woodland	Ri			
2		Southern Rocky Mountain Juniper Woodland and Savanna			**190**	**293.2**	**724.6**
	A	Oneseed Juniper/Blue Grama-Galleta Woodland Savanna			48	60.3	149.1
			Juniperus monosperma / Bouteloua gracilis Woodland	1			
			Juniperus monosperma / Pleuraphis jamesii Woodland	2			
			Juniperus monosperma / Sparse Understory Woodland	Ci			
	B	Oneseed Juniper/Black Grama Woodland Savanna			21	19.4	48.0
			Juniperus monosperma / Bouteloua eriopoda Woodland	1			
			Juniperus monosperma / Sparse Understory Woodland	Ci			
			Juniperus monosperma / Bouteloua gracilis Woodland	Ci			
	C	Oneseed Juniper/Curlyleaf Muhly Woodland Savanna			11	11.7	29.0
			Juniperus monosperma / Muhlenbergia setifolia Woodland	1			
			Juniperus monosperma / Bouteloua hirsuta Woodland	2			
	D	Oneseed Juniper/New Mexico Muhly-Black Grama Rockland Woodland			12	11.0	27.1
			Juniperus monosperma / Muhlenbergia pauciflora Woodland	1			
			Juniperus monosperma / Rockland Woodland	2			

Table 8 *continued*

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Juniperus monosperma / *Bouteloua curtipendula* Woodland	Ri			
	E	Oneseed Juniper/Blue Grama Treated Woodland			3	5.3	13.0
			Juniperus monosperma / *Bouteloua gracilis* Woodland, Woodland Treatment Phase	1			
			Juniperus monosperma / *Bouteloua curtipendula* Woodland, Woodland Treatment Phase	2			
	F	Oneseed Juniper/Ruderal Forbs Woodland			15	8.0	19.8
			Juniperus monosperma / *Bouteloua gracilis* Woodland, Ruderal Forb Phase	1			
	G	Oneseed Juniper/Blue Grama-Alkali Sacaton Woodland Savanna			4	2.1	5.2
			Juniperus monosperma / *Bouteloua gracilis* Woodland, *Sporobolus airoides* Phase	1			
	H	Oneseed Juniper/Little Bluestem Woodland Savanna			18	70.0	173.1
			Juniperus monosperma / *Schizachyrium scoparium* Woodland	1			
			Juniperus monosperma / *Bouteloua gracilis* Woodland, *Schizachyrium scoparium* Phase	Ri			
	I	Oneseed Juniper/Fourwing Saltbush Woodland			6	6.5	16.0
			Juniperus monosperma / *Bouteloua gracilis* Woodland, *Atriplex canescens* Phase	1			
	J	Oneseed Juniper/Sand Sagebrush Woodland			2	4.2	10.5
			Juniperus monosperma / *Bouteloua gracilis* Woodland, *Artemisia filifolia* Phase	1			
	K	Oneseed Juniper/Sparse Woodland			32	70.2	173.4
			Juniperus monosperma / Sparse Understory Woodland	1			
			Juniperus monosperma / *Quercus* × *pauciloba* Woodland	Ri			
	L	Oneseed Juniper/Blue Grama-Big Bluestem Woodland Savanna			18	24.4	60.3
			Juniperus monosperma / *Bouteloua gracilis* Woodland, *Andropogon gerardii* Phase	1			
3		Southwest Lowland Riparian Woodland and Shrubland			**22**	**3.0**	**7.4**
	A	Cottonwood/Goodding's Willow/Mixed Shrub Riparian Woodland			13	1.7	4.2
			Populus deltoides (ssp. *wislizeni*, ssp. *monilifera*) - *Salix gooddingii* Forest	1			
			Populus deltoides (ssp. *wislizeni*, ssp. *monilifera*) / *Rosa woodsii* Forest	1			
			Populus angustifolia / *Prunus virginiana* Woodland	2			

Table 8 *continued*

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Prunus virginiana - (Prunus americana) Shrubland	Ci			
	B	Goodding's Willow-Coyote Willow Riparian Woodland			9	1.3	3.2
			Salix gooddingii / Salix exigua Woodland	1			
			Salix gooddingii Woodland	2			
			Rosa woodsii / Mixed Herbaceous Shrubland	Ci			
4		Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland			**10**	**2.6**	**6.3**
	A	Coyote Willow Riparian Shrubland			3	0.1	0.4
			Salix exigua - Rosa woodsii Shrubland	1			
	B	Chokecherry-Woodrose Riparian Shrubland			7	2.4	5.9
			Prunus virginiana - (Prunus americana) Shrubland	1			
			Rosa woodsii / Mixed Herbaceous Shrubland	1			
			Salix exigua - Rosa woodsii Shrubland	Ci			
5		North American Cool Desert Wash			**3**	**0.4**	**1.0**
	A	Rabbitbrush Dry Wash Shrubland			3	0.4	1.0
			Ericameria nauseosa Desert Wash Shrubland	1			
6		Shadscale-Saltbush Cool Semi-Desert Scrub			**8**	**4.0**	**9.9**
	A	Fourwing Saltbush Shrubland			8	4.0	9.9
			Atriplex canescens / Muhlenbergia porteri Shrubland	1			
			Atriplex canescens / Sporobolus airoides Shrubland	1			
			Atriplex canescens / Panicum obtusum Shrubland	Ri			
			Atriplex canescens / Bouteloua gracilis Shrubland	Ri			
			Krascheninnikovia lanata / Bouteloua gracilis Dwarf-shrub Herbaceous Vegetation	Ri			
7		Great Plains Sand Shrubland			**9**	**1.1**	**2.8**
	A	Sand Sagebrush Shrubland			9	1.1	2.8
			Artemisia filifolia / Bouteloua (curtipendula, gracilis) Shrubland	1			
8		Southwest Plains-Mesa Grassland			**77**	**57.2**	**141.5**
	A	Blue Grama Grassland			30	17.1	42.3
			Bouteloua gracilis - Pleuraphis jamesii Herbaceous Vegetation	1			
			Bouteloua gracilis Herbaceous Vegetation, Typic and *Andropogon gerardii* Phase	2			

Table 8 *continued*

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Gutierrezia sarothrae / Bouteloua gracilis Dwarf-shrub Herbaceous Vegetation	2			
			Bouteloua gracilis - Hesperostipa neomexicana Herbaceous Vegetation	Ri			
			Ericameria nauseosa / Bouteloua gracilis Shrub Herbaceous Vegetation	Ri			
			Bouteloua gracilis - Muhlenbergia torreyi - Aristida purpurea Herbaceous Vegetation	Ci			
	B	Blue Grama-Alkali Sacaton-Sand Dropseed Grassland			15	16.5	40.7
			Sporobolus airoides - Bouteloua gracilis Herbaceous Vegetation	1			
			Bouteloua gracilis - Sporobolus cryptandrus Herbaceous Vegetation	2			
			Pascopyrum smithii - Bouteloua gracilis Herbaceous Vegetation	Ri			
			Bouteloua eriopoda - Bouteloua gracilis Herbaceous Vegetation	Ci			
	C	Blue Grama-Threeawn Grassland			11	9.4	23.3
			Bouteloua gracilis - Muhlenbergia torreyi - Aristida purpurea Herbaceous Vegetation	1			
			Bouteloua gracilis / Ruderal Herbaceous Vegetation	1			
			Pascopyrum smithii / Ruderal Herbaceous Vegetation	2			
			Bouteloua gracilis / Old Field Herbaceous Vegetation	Ri			
			Yucca glauca / Bouteloua gracilis Shrub Herbaceous Vegetation	Ri			
			Sporobolus airoides - Bouteloua gracilis Herbaceous Vegetation	Ci			
	D	Blue Grama-Black Grama Grassland			6	10.1	24.9
			Bouteloua eriopoda - Bouteloua gracilis Herbaceous Vegetation	1			
	E	Wet Meadow/Ruderal Vegetation			15	4.1	10.2
			Pascopyrum smithii / Ruderal Herbaceous Vegetation	1			
			Ruderal Disturbance Vegetation	1			
			Sporobolus airoides - Panicum obtusum Herbaceous Vegetation	2			
			Panicum obtusum Herbaceous Vegetation	Ri			
			Sporobolus airoides / Ruderal Herbaceous Vegetation				
			Sporobolus airoides - Bouteloua gracilis Herbaceous Vegetation	Ci			
9		Great Plains Freshwater Marsh			**8**	**1.2**	**2.9**
	A	Cattail and Horsetail Emergent Wetland			8	1.2	2.9

Table 8 *continued*

Map unit L1	Map unit L2	Map unit name	Association	Type	# of polygons	Area (ha)	Area (ac)
			Typha (*latifolia, angustifolia*) Western Herbaceous Vegetation	1			
			Equisetum laevigatum Herbaceous Vegetation	2			
			Carex pellita Herbaceous Vegetation	Ri			
			Juncus balticus Herbaceous Vegetation	Ri			
10		Nonvascular and Sparse Vascular Rock Vegetation			**10**	**2.2**	**5.4**
	A	Sparse Vegetation / Rockland	Sparse Vegetation / Boulder Rockland		2	0.2	0.5
	B	Sparse Vegetation / Recent Alluvial Deposits	Sparse Vegetation / Recent Alluvial Deposits		1	0.1	0.2
	C	Sparse Vegetation / Upland Bare Soil	Disturbed / Non-vegetated		2	0.4	0.9
	D	Sparse Vegetation / Dry Wash Rockland	Sparse Vegetation / Dry Wash Rockland		5	1.6	3.8
11		Urban or Built-up Land			**55**	**32.3**	**79.8**
	A	Ruins-Restored	Disturbed / Archeological Site - Restored		15	2.1	5.2
	B	Ruins-Unrestored	Disturbed / Archeological Site - Unrestored		16	16.4	40.5
	C	Public Building			6	0.1	0.2
	D	Residential			3	1.3	3.1
	E	Road			3	8.0	19.7
	F	Trail			7	3.5	8.6
	G	Recreation Site	Disturbed / Recreation Site		5	1.0	2.6

...continued from page 16

Within the former, the Southern Rocky Mountain Pinyon-Juniper Woodland Group is dominated by *Pinus edulis* (two-needle pinyon), and usually codominant with junipers, in this case *Juniperus monosperma* (one-seed juniper). *P. edulis* accounts for at least 25% of the total canopy relative to *J. monosperma*. These pinyon-dominated communities are found only in the Quarai and Abó units. Among the six associations we identified for the group, the *Pinus edulis* – (*Juniperus monosperma)* / *Bouteloua gracilis* (blue grama) Woodland and the *Pinus edulis* / Sparse Understory Woodland (Two-needle Pinyon / Sparse Understory Woodland) were the most common (fig. 7). The former is characterized by open to moderately closed tree canopies, with grassy inter-tree spaces dominated by *B. gracilis*. As canopies become more dense and/or the soils more gravelly and shallow, and grass cover declines, the association grades into the *Pinus edulis* / Sparse Understory Woodland (generally less than 1% grass, shrub, and forb cover). When the ground surface is composed mostly of exposed bedrock outcrop, boulders and cobbles, with little understory vegetation, the *Pinus edulis* / Rockland Woodland is indicated. The *Pinus edulis - Juniperus* spp. / *Poa fendleriana* Woodland was a minor grassy association dominated by *P. fendleriana* (muttongrass), identified from a side drainage at Abó. The *Pinus edulis* / *Quercus*

Figure 7. Pinyon-dominated woodlands on valley piedmont slope at Quarai is representative of the Southern Rocky Mountain Pinyon-Juniper Woodland Group.

× *pauciloba* Woodland and *Pinus edulis - Juniperus* spp. / *Quercus gambelii* Woodland, while common associations regionally, are minor elements here and occur where the oak shrubs *Q.* × *pauciloba* (wavyleaf oak) or *Q. gambelii* (Gambel's oak) are well-represented (greater than 5% cover).

With respect to other regional classifications, these pinyon-dominated woodland associations would be considered part of the *P. edulis* Series *sensu* Daubenmire (1966, 1976) and Layser and Schubert (1979); the Colorado Pinyon-Oneseed Juniper Series of Dick Peddie (1993); and the *Pinus edulis-Juniperus monosperma* Association of Brown et al. (1979).

The majority of the woodlands on SAPU are dominated by *J. monosperma* and are represented by the Southern Rocky Mountain Juniper Woodland and Savanna, or the Madrean Juniper Savanna and Woodland groups, with nine and two associations, respectively. Of these, eight were savanna types characterized by open to very open canopies (10 to 60%) of *J. monosperma* and grassy inter-canopy spaces with cover between 5 and 50%. The most common association was *Juniperus monosperma* / *Bouteloua gracilis* Woodland, which dominated the hill slopes of all units (fig. 8). For mapping purposes, we further identified eight phases of this association that reflected co-dominance of various grasses or shrubs, or condition (e.g., the Woodland Treatment Phase representing sites that had evidence of tree removals by chaining or other techniques). As in the pinyon associations, as the grass cover declines, and canopies increase in density, and/or the soils grow more gravelly and shallow, this association grades in to the *Juniperus monosperma* / Sparse Understory Woodland (generally less than 1% grass, shrub, and forb cover).

The *Juniperus monosperma* / *Bouteloua eriopoda* (black grama), *Juniperus monosperma* / *Pleuraphis jamesii (galleta*), *Juniperus monosperma* / *Muhlenbergia setifolia* (curly-leaf muhly), and *Juniperus monosperma* / *Bouteloua hirsuta* (hairy grama) PAs were other grassy woodland associations found interspersed with the blue grama type, mostly at Abó. The latter two tend towards more gravelly soils. The *Juniperus monosperma* / *Schizachyrium scoparium* (little bluestem) Woodland is a unique savanna association found in the Gran Quivira Unit and not reported elsewhere in the Southwest. It occurs on the predominantly west- and south-facing slopes of the mesa, and on deeper, loamy to sandy soils. On rockier sites, the *Juniperus monosperma* / *Bouteloua curtipendula* (Sideoats Grama), *Juniperus*

Figure 8. This oneseed juniper woodland savanna on a gentle, south-facing hill slope at Abó is an example of the Southern Rocky Mountain Juniper Woodland and Savanna Group. At this site, the grassy inter-tree spaces are dominated by blue grama and galleta with a scattering of others, such as black grama, purple threeawn, ring muhly and sand dropseed.

monosperma / *Muhlenbergia pauciflora* (New Mexico Muhly) and *Juniperus monosperma* / *Quercus* × *pauciloba* (wavy-leaf oak) PAs may prevail, while on the rockiest sites with rock outcrop and boulders, herbaceous cover can be minimal and the *Juniperus monosperma* / Rockland predominates. These are mostly associated with the Abó and Quarai units.

Regionally, 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. With the exception of the *Juniperus monosperma* / *Schizachyrium scoparium* Woodland, all of the associations have been described elsewhere in New Mexico (Anderson et al. 1998; pers. comm., Wayne Robbie, U.S. Forest Service Terrestrial Ecosystem Survey, unpublished data).

Ecologically, fire is an important disturbance factor in pinyon-juniper woodlands. 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. Dick-Peddie (1993) referred to it as an ecotonal type of vegetation between dense woodlands and true grasslands. 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 at SAPU would be the *Pinus edulis* / Sparse Understory, *Pinus edulis* / Rockland, *Juniperus monosperma* / Sparse, and *Juniperus monosperma* / Rockland PAs.

2.2.1.2 Shrublands and grasslands

At SAPU, a wide variety of grasslands and shrublands are intermixed among the woodlands and reflect floristic affinities with the Great Plains, Colorado Plateau, and Chihuahuan Desert biotic regions. With respect to the Great Plains, there are four groups, one dominated by shrubs and the others by grasses. Among the shrubland groups, the Great Plains Sand Shrubland

Figure 9. This sand sage shrubland is an example of the Great Plains Sand Shrubland Group. It occurs on a sandy plain at the base of the Gran Quivira mesa along the western edge of the unit. Grasses, such as sand dropseed and blue grama, can be common in the intershrub spaces, along with a scattering of forbs.

Figure 10. A blue grama – galleta grassland at Abó that is representative of the Great Plains Shortgrass Prairie Group

Group is represented by *Artemisia filifolia / Bouteloua (curtipendula, gracilis)* Shrubland (Sand Sagebrush / [Sideoats Grama, Blue Grama]Shrubland). This association is known only from the Gran Quivira unit where it occurs on sandy lower slopes and flats (fig. 9). The grass-dominated Great Plains Shortgrass Prairie Group and the provisional Southwest Plains-Mesa Grassland and Southwest Ruderal Shrubland & Grassland groups have six, five, and three associations, respectively. These grassland associations are mainly dominated by short to medium-tall bunch grasses (e.g., *Bouteloua gracilis*, *B. curtipendula, Sporobolus airoides* [alkali sacaton], and *Pascopyrum smithii* [western wheatgrass]). They are often interspersed among *J. monosperma* woodlands and have many species in common. *B. gracilis*-dominated or co-dominated grasslands are most prevalent and occur across all units, usually occupying foothills

Figure 11. Fourwing saltbrush-dominated shrublands, like this one at Gran Quivira, are representative of the Shadscale-Saltbush Cool Semi-Desert Scrub Group. They are often associated with ground disturbance.

and extending out into lowland valleys or plains (fig. 10). Some may have a significant sub-shrub component (e.g., the *Gutierrezia sarothrae* [Broom Snakeweed] / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation, and *Yucca glauca* [soaptree yucca] / *Bouteloua gracilis* Shrub Herbaceous Vegetation).

At SAPU, particularly at Gran Quivera, a small suite of communities are representative of both the cool and warm desert realms. With respect to the former, we identified two associations belonging to the Intermountain Semi-Desert Shrubland Group and one belonging to the Intermountain Shadscale - Saltbush Scrub Group. These associations typically have sparse to open shrub canopies, dominated by *Ericameria nauseosa* (rubber rabbitbrush), *Krascheninnikovia lanata* (winterfat), or *Atriplex canescens* (fourwing saltbush), with significant grass in the inter-shrub spaces (fig. 11). While the group names imply a center of distribution in the Great Basin, these associations occur primarily on the Colorado Plateau and extend south and east into the Great Plains. In particular, *Atriplex canescens* is very widespread in the western U.S. and into Mexico.

Consequently, there are three *Atriplex canescens* associations on SAPU that have more southern floristic affinities and are considered part of the warm-desert Chihuahuan Lowland Basin Semi-Desert Scrub Group. These associations tend to occur in the lower elevations of the landscape, such as valley bottoms and alluvial flats, and they also have grassy inter-shrub spaces (e.g. *Atriplex canescens* / *Panicum obtusum* (vine mesquite) Shrubland and *Atriplex canescens* / *Sporobolus airoides* Shrubland). Stands of *Panicum obtusum* and *Sporobolus airoides* occur on similar sites and lack significant shrub cover. These associations are considered part of a corresponding Chihuahuan Semi-Desert Lowland Grassland Group. The *Bouteloua eriopoda - Bouteloua gracilis* Herbaceous Vegetation occurs on hill slopes and is classified as part of the Chihuahuan Semi-Desert Grassland Group, but it, too, extends well into the southern Great Plains.

Prehistoric and historic human disturbances, including agriculture and high-intensity grazing, are common to these grasslands and they have imparted a legacy of ruderal (weedy) species compositions. Accordingly, under the Southwest Ruderal Shrubland & Grassland Group, we have identified a Ruderal Disturbance Vegetation association, to reflect transient vegetation that can follow fire, or be prevalent on archeological sites or in old fields. These anthropogenic-

Figure 12. Weedy (ruderal) vegetation commonly dominates archeological sites such as this area on Gran Quivira adjacent to the main restored ruin that is representative of a provisional Southwest Ruderal Shrubland & Grassland Group. The site is strongly dominated by exotic horehound (*Marrubium vulgare*) along with a suite of other native and exotic weeds (wild potato, spiny cocklebur, slimseed sandmat, among others).

disturbance communities are represented by a suite of associations, which include: *Bouteloua gracilis - Muhlenbergia torreyi* (ring muhly) - *Aristida purpurea* (purple threeawn) Herbaceous Vegetation, *Bouteloua gracilis* / Old Field Herbaceous Vegetation, and *Pascopyrum smithii* / Ruderal Herbaceous Vegetation PAs. In addition, the *Atriplex canescens* / *Bouteloua gracilis* Shrubland PA is associated with disturbed ground, often on or around undeveloped archeological sites (fig. 11). The disturbed ground of archeological sites can also generate vegetation communities that are a heterogeneous mix of annual and short-lived perennial species that are diverse but variable from site to site (fig. 12).

2.2.1.3 Riparian woodlands and shrublands, and herbaceous wetlands

A suite of riparian and wetland communities occur along the perennial stream channels of Abó and Quarai. As with the woodlands, these associations reflect both montane Rocky Mountain affinities from the north, and warm-temperate elements out of the Chihuahuan Desert to the south. The lower montane riparian woodlands and shrublands are represented by the Rocky Mountain & Great Basin Montane Riparian Forest and Rocky Mountain & Great Basin Montane Riparian & Seep Shrubland groups. The *Populus angustifolia* / *Prunus virginiana* Woodland (Narrowleaf Cottonwood / Chokecherry) PA belongs to the former group, and is characterized by an open to closed canopy of broadleaf deciduous *P. angustifolia,* or the closely related *P. acuminata* (lanceleaf cottonwood), the hybrid between *P. angustifolia* and *P. deltoides* (plains cottonwood). The understory is shrubby and dominated by obligate and facultative wetland, deciduous shrubs, such as *Prunus virginiana*, and *Salix exigua* (coyote willow), along with *Rosa woodsii* (Woods' rose) (fig. 13). Where trees are absent, we have identified corresponding *Prunus virginiana - (Prunus americana)* Shrubland and *Rosa woodsii* / Mixed Herbaceous Shrubland associations, which can occur intermixed in some stands, both along stream channels and on upland terraces.

The montane groups as a whole are at their lower elevation limit here and are often found adjacent to associations of the Sonoran-Chihuahuan Lowland Riparian Forest Group. These are typically lower elevation, deciduous riparian woodlands and shrublands that occur in canyon-bottom floodplains or on terraces along low-gradient (1 to 2%), perennial-stream channels of the Abó and Quarai units (fig. 14). Within this group, we have identified five associations. Two forest associations

are dominated by *Populus deltoides* ssp. *wislizeni* (Rio Grande cottonwood), a western subspecies of the plains cottonwood. The *Populus deltoides* (ssp. *wislizeni*, ssp. *monilifera*) / *Rosa woodsii* (Woods' rose) Forest occurs on upper terraces and has a shrubby understory dominated by *Rosa woodsii*, *Prunus virginiana*, and *Toxicodendron radicans*. The *Populus deltoides* (ssp. *wislizeni*, ssp. *monilifera*) - *Salix gooddingii* (Goodding's willow) Forest is more prevalent in the active channel, and is characterized by a subcanopy of *S. gooddingii,* along with the shrubby *Salix exigua*. *S. amygdaloides* (peachleaf willow), which closely resembles *S. gooddingii*, can also occur in these stands. Where the overstory cottonwoods are absent, we have described small tree and shrub analogs: *Salix exigua - Rosa woodsii*, *Salix gooddingii* / *Salix exigua*, and a *Salix gooddingii* Woodland.

Within the riparian zones, we identified four herbaceous wetland associations belonging to the Western North American Temperate Interior Freshwater Marsh and the Vancouverian & Rocky Mountain Montane Wet Meadow groups. These are small-patch communities that are dominated by obligate wetland species, which include *Carex pellita* (woolly sedge), *Eleocharis palustris* (spikerush), *Equisetum*

Figure 13. A mixture of narrowleaf cottonwood and Rio Grande cottonwood line the drainage at Abó. The narrowleaf component is representative of the Rocky Mountain & Great Basin Montane Riparian Forest Group.

Figure 14. This Rio Grande cottonwood-dominated woodland in an incised perennial channel at Quarai is an example of the provisional Sonoran-Chihuahuan Lowland Riparian Forest Group. The understory is dominated by Goodding's and coyote willow, along with a diverse grass and forb layer.

Figure 15. Cattail, horsetail, and sedge wetland vegetation like this along the drainage at Quarai is representative of the Western North American Temperate Interior Freshwater Marsh Group.

Figure 16. Rubber Rabbitbrush Desert Wash Shrubland, a member of the Cool Semi-Desert Shrub & Herb Wash-Arroyo Group. It occurs along the main drainage at Abó near the southern border where stream flows are typically ephemeral, in response to summer thunderstorms.

laevigatum (smooth horsetail), *Juncus balticus* (Baltic rush), and *Typha* spp. (cattail) (fig. 15).

While officially classified as an upland association as part of the Cool Semi-Desert Shrub & Herb Wash-Arroyo Group, the *Ericameria nauseosa* Desert Wash Shrubland occurs in the ephemeral, mostly dry lower reach of the main channel in Abó (fig. 16).

2.2.1.4 Sparse Cliff, Scree & Rock Vegetation and miscellaneous land types

This Southwest Cliff, Scree & Rock Vegetation Group represents sparsely vegetated ground and includes Sparse Vegetation / Boulder Rockland and Sparse Vegetation / Recent Alluvial Deposits (fig. 17). In addition, for mapping purposes we have included three, essentially barren, land cover types: Disturbed / Non-vegetated, Disturbed / Recreation Site, and Sparse

Vegetation / Unclassified.

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 understanding 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 result of grouping land areas based on the ability to support similar associations is that 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, for SAPU, we suggest that further work is needed in describing edge-of-range associations from the Colorado Plateau, Great Plains, and perhaps the Chihuahuan Desert. In addition, more data are needed on the riparian woodlands, shrublands and wetlands, particularly since these associations are often the target for active management of exotics and invasive species. Lastly, several of the groups described here under the new FGDC (2008) NVCS hierarchy are provisional. More work will be needed on delineating understory patterns and species distributions of the groups and on revising the alliances within groups.

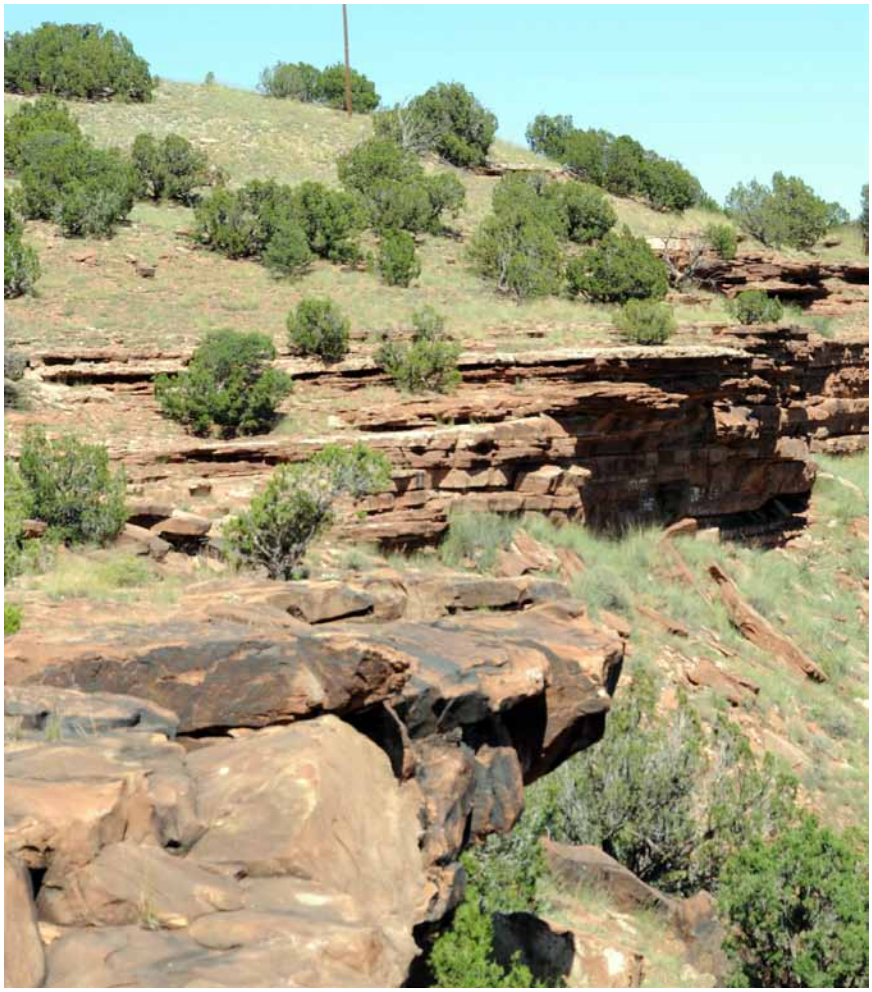


Figure 17. Rock outcrop, such as this at Abó, is representative of the sparsely vegetated Southwest Cliff, Scree & Rock Vegetation Group. These sites may have scattered trees, shrubs, and grasses but total vegetation cover is less than 10% and usually less than 1%.

3 Salinas Pueblo Missions National Monument Vegetation Map

3.1 Mapping process overview

We developed the vegetation map for Salinas Pueblo Missions National Monument using a combination of automated digital image classification and direct analog image interpretation of aerial photography and satellite imagery. Initially, we processed the aerial photography and satellite imagery and entered the data, along with ancillary spatial layers, into a GIS. A working 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. Using the provisional legend and ground-control points provided by the field-plot data (the same data used to develop the vegetation classification), we conducted a series of automated image segmentations and supervised image classifications. This process was 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 physical characteristics.

Per the guidance of the National Vegetation Mapping Program (http://biology.usgs.gov/npsveg/), the key mapping standards 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., that each well-defined object in the spatial database be within 1/50-inch display scale, or within 12.2 m (40 ft) of its actual location).

3.2 Mapping methods

3.2.1 Data sources and processing

Aerial digital ortho-photography was the foundation imagery for map development. For Abó, the photography was acquired on April May 15, 2002 at a scale of approximately 1:3,000; for Quarai and Gran Quivira it was flown on April 2, 2003 at scales of 1:3,600 and 1:3000, respectively. The 2002-03 digital imagery has a base pixel resolution of 1.0 m. We also made use of statewide 1-meter resolution, true-color imagery from 2005 that became available in 2006 through the New Mexico Resource Geographic Information System (http://rgis.unm.edu/intro.cfm). 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. All imagery and other spatial data layers were compiled into a geodatabase and GIS using ArcGIS 9.3 (ESRI 2008). To support the mapping process, we acquired a standard set of relevant spatial data layers (e.g. roads, building, topographic maps, etc.; see project GIS geodatabase metadata for sources)

3.2.2 Vegetation map unit 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, the desired target is the development of map units that correspond to the plant-association level of the national classification, but this is contingent on being able to discern differences in the available imagery at that level using various remote-sensing techniques.

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. Each map unit is defined in terms of component plant associations and, where possible, upper levels of the NVC. In several cases though, con-

formance with the NVC upper levels, such as the "Group", was not feasible because the on-the-ground mosaic of plant associations crossed groups. These associations were not mappable as separate units (at the group level). The primary components associations are those that dominate the map unit (i.e., spatially occupying 50% or more of the unit) collectively, and are typically used to name the map unit. Secondary component plant associations collectively occupy less than 50%. Related inclusions are those minor plant associations that make up less than 10% of the area and are not primary or secondary components of other map units. Lastly, contrasting inclusions also make up less than 10% of a unit, but they are primary or secondary components in other units. Detailed map unit descriptions that include plant association composition and distribution were developed and are presented in Appendix E.

3.2.3 Image analysis and base map development

To efficiently develop a base map with a polygon structure (versus raster/pixel), per NPS specifications, we employed eCognition, Definiens Cognition Network Technology® object-oriented classification software (http://www.definiens.com). This software employs 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. In this automated polygon delineation framework, the level of detail is controlled by a unitless scale parameter, an abstract term that determines the maximum allowable heterogeneity for the resulting image 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 data (image) dependent "scale parameter" control, you can vary the size of the polygons based on the homogeneity of color and shape sub-factors, each of which is weighted from zero to one. The smaller the scale parameter, the more detail is represented, and the more the image is segmented into polygon objects, with a scale parameter value 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. With respect to sub-factor weighting, 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, at 0.1. The shape sub-factors of smoothness and compactness were weighted equally (0.5). This process generated a set of raw polygons with sizes ranging from .25 ha to 50 ha.

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 were assigned to their respective map units, feature statistics were gathered on each map unit. In eCognition, with the three air photo layers, multiple possible feature statistics can be used to discriminate among map units. The feature statistics 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. In fact, they 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-up 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 necessary, 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 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, thereby reducing the chance of misclassification. There are separate layers at each division, which are integrated at the end and exported as a shapefile for further heads-up editing in ArcGIS 9.3.

3.2.4 Final map classification and ancillary layers

We imported the image object maps as a feature dataset polygon layer in ESRI ArcGIS (v. 9.3) and built a topology. The polygons were individually checked and annotated using auxiliary layers such as elevation and the field-data points, and the boundaries modified as necessary. Through this process, map units were evaluated for coherence and the legend modified accordingly.

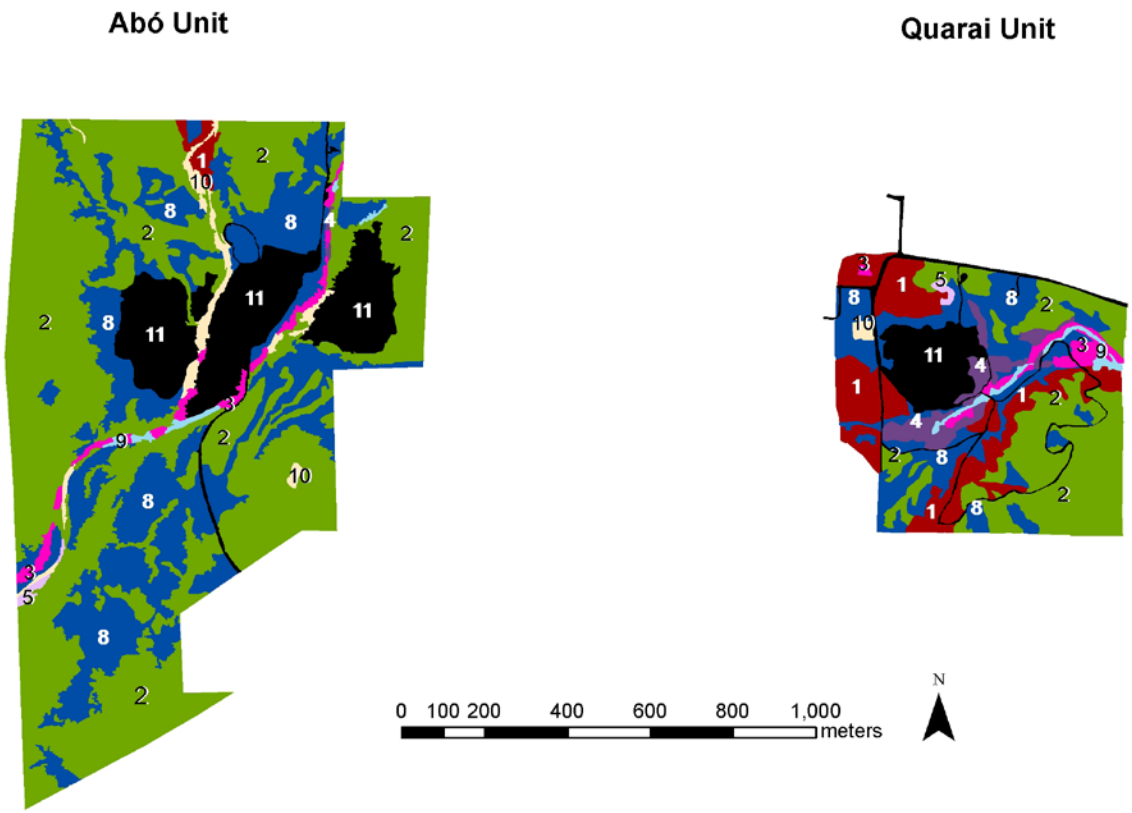
3.3 Mapping results

3.3.1 Vegetation map and map legend

The vegetation map for SAPU is presented in Figure 18, and an abbreviated legend in Table 8. We also produced a 1:12,000-scale poster map that is available as both a PDF and shape file for GIS use at http://biology.usgs.gov/npsveg/products/parkname.html. Nine Level 1 map units reflect general patterns of the vegetation across all three park units. In addition, a "Nonvascular and Sparse Vascular Rock Vegetation" unit contains various units where vegetation cover is exceptionally low or absent. A set of land-cover units under "Urban or Built-up Land" reflects human land uses, including archeological sites, water, and recently burned or otherwise disturbed areas. At Level 2, 30 vegetation units are hierarchically structured under Level 1 units that are defined by one or more plant associations per the SAPU vegetation classification (see table 7). Each association is identified as either a primary or secondary component, or a related or contrasting inclusion of a given Level 2 map unit. While some units were more heterogeneous than others, we attempted 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 E.

3.3.2. Discussion

While grasslands and woodland savannas dominate the vegetation of SAPU, mapping them can be challenging because of a lack of spectral signature that easily differentiates among grass species (even if many spectral bands had been available) and the relatively low spatial resolution (one meter) of the available aerial photo imagery. Hence, much of our interpretation was based on modeling soil signatures in relation to grassland composition as sampled in the field. It was further complicated by the long land-use history, both historic and prehistoric, that shapes much of the vegetation pattern of a cultural park such as SAPU, and which may or may not correspond to either vegetation or soil signatures. For example, long-term use of grasslands was indicated by the presence of ruderal (weedy), grasses such as *Aristida purpurea* (purple threeawn),


Abó Unit
Quarai Unit
0 100 200 400 600 800 1,000
meters
N

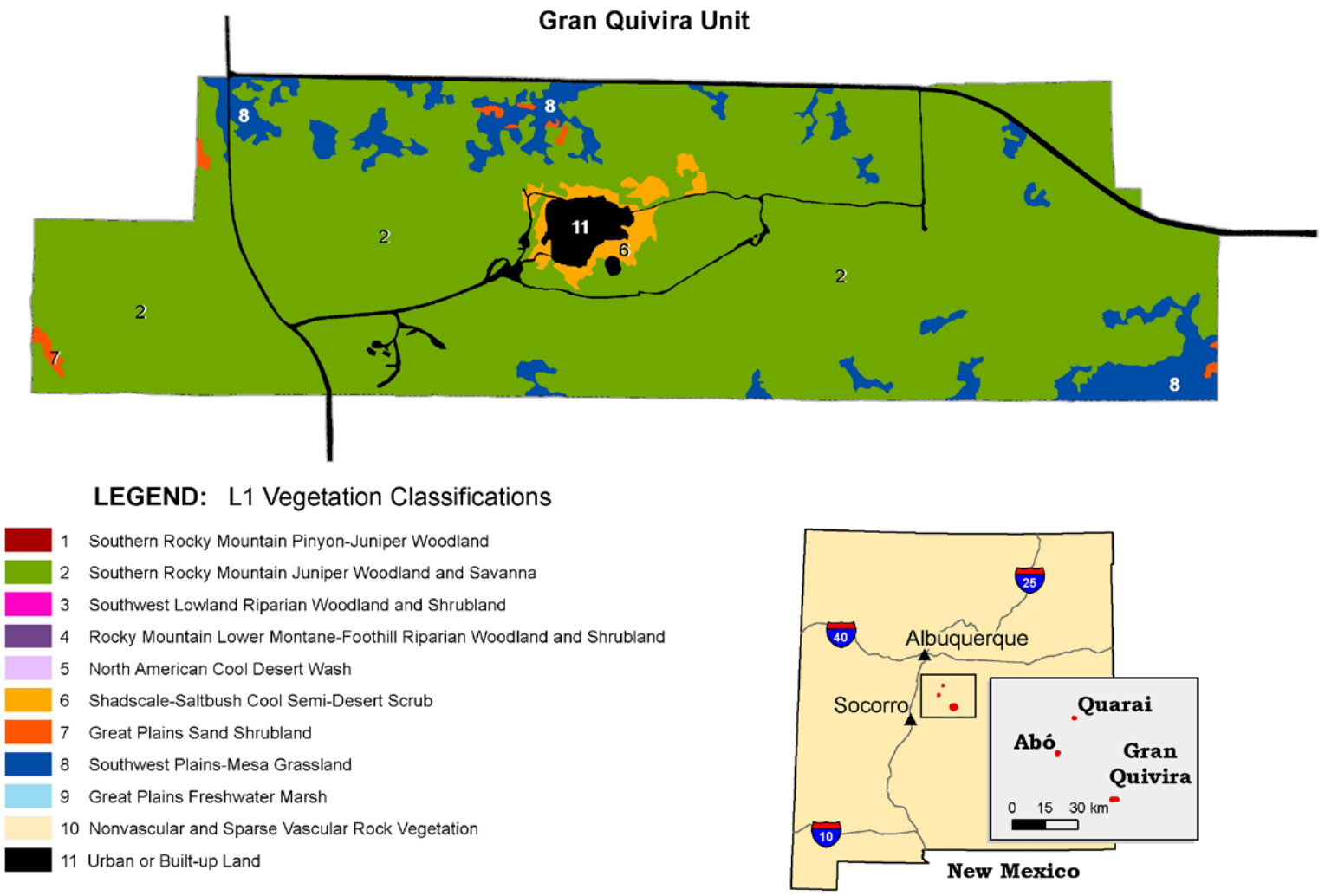
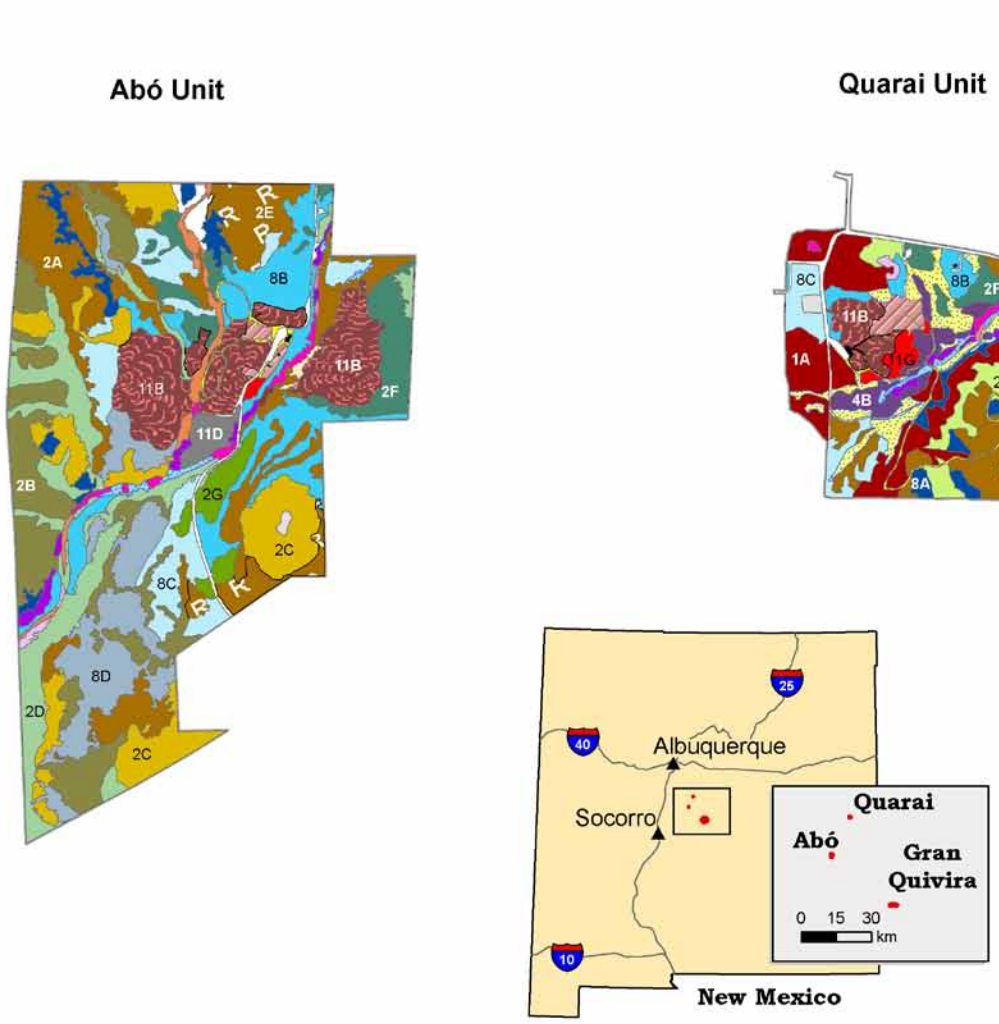


Figure 18. A vegetation map of Salinas Pueblo Missions National Monument based on 2002 and 2005 1:12.000 color aerial photography. This map portrays Level 1 units only at a scale reduced from 1:24,000 to approximately 1:150,000. See Table 8 and Appendix E for legend details. For the full scale 1:24,000 map with Level 2 units see: http://biology.usgs.gov/npsveg/products/parkname.html.


Abó Unit
2A
2E
8B
11B
2F
11B
11D
2B
2G
2C
8C
8D
2D
2C
Quarai Unit
8C
8B
2F
11B
1A
11C
2K
4B
2A
8A
25
40
Albuquerque
Socorro
Quarai
Abó
Gran
Quivira
0 15 30
km
10
New Mexico

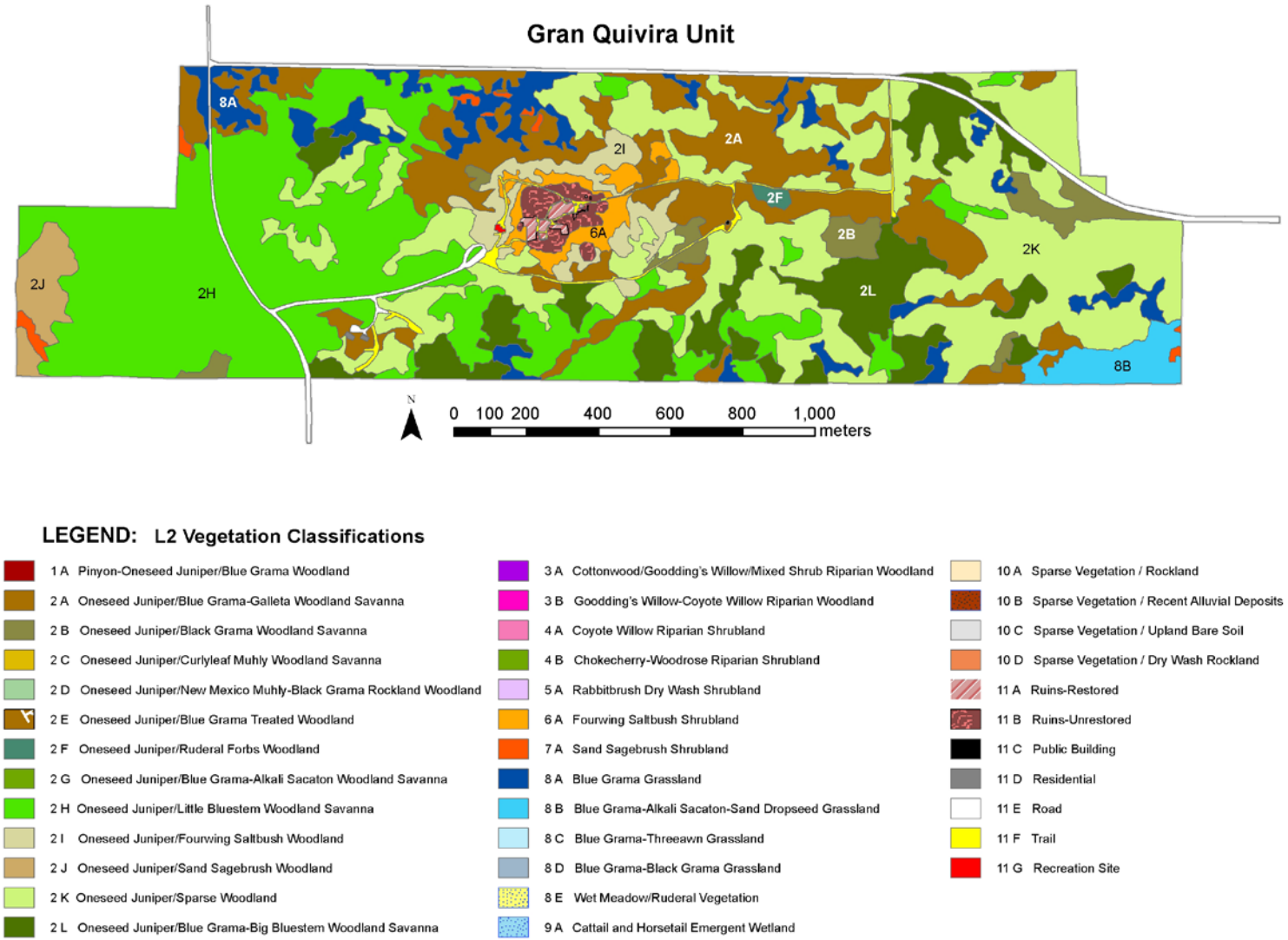


Figure 19. A vegetation map of Salinas Pueblo Missions National Monument based on 2002 and 2005 1:12.000 color aerial photography. This map portrays Level 2 units only at a scale reduced from 1:24,000 to approximately 1:150,000. See Table 8 and Appendix E for legend details. For the full scale 1:24,000 map with Level 2 units see: http://biology.usgs.gov/npsveg/products/parkname.html.

Muhlenbergia torreyana (ring muhly), and dwarf shrubs such as *Gutierrezia sarothrae* (broom snakeweed), and *Yucca glauca* (soapweed yucca) (i.e., map units 2E, 2F, 6C, and 7B, see appendix E). While the target scale of the map was 1:24,000, per NPS national standards, much of the interpretation required work at a scale of 1:6,000 and below to be effective. Lastly, detecting these species remotely is subtle at best and we relied heavily on ground surveys to confirm polygon assignments (see Accuracy Assessment section below).

Landscapes are in constant flux with respect to vegetation, particularly in areas under active resource management. The SAPU vegetation map represents a snapshot in time based on the 2006 imagery. Since then, the park has actively treated shrubs and trees at Quarai using mechanical methods and fire, and has limited vegetation management on unexcavated archeology sites at all units. However, because the map is high-resolution and has a well-defined and detailed legend that can be used in the GIS platform that the park uses, ideally, polygons should be updated to reflect the ongoing changes. Overall, the combination of the annotated legend (appendix E) and the detailed floristic and site descriptions of individual plant associations (appendix D) contribute to a vegetation map that is ecologically rich in information and one that can serve multiple purposes in the management of the park and in the broader network of parks.

4 Accuracy assessment

4.1 Methods

Due to the smaller area of SAPU and the limited resources provided by the project for accuracy assessment, we used a simplified census-like approach to address accuracy. Much of the development of the map itself required that individual polygons be visited on the ground, and that polygon attribution be confirmed. Confirmation could take the form of (1) a vegetation plot and a full quantitative dataset with GPS locations, or (2) a simple observation point where the plant associations were listed, along with a GPS point, or (3), by charting vegetation in the field on to paper maps with notes. We aggregated this field data and noted whether each polygon of the final had been visited and its composition confirmed. We then summarized the percent of polygons visited and the percent of the map-unit area represented by those visited polygons. The goal was to visit at least 80% of the mapped area to confirm the composition, as an alternative to achieving 80% accuracy using a high-density random sampling scheme employed in large parks where census-like methods are not feasible.

In addition, we conducted map walk-throughs with SAPU staff at each park unit and solicited their input on the accuracy and precision of map units and their overall confidence in the map product (an analog-to-user accuracy).

4.2 Results and discussion

We confirmed the composition of 298 of the 404 map polygons (73.8%), which accounted for 88% of the mapped areas across all park units (fig. 20, table 9). While this exceeded our 80% overall area coverage goal, some map units were under-represented (<80% of the map unit area). Only 75.5% of the area of MU 2F (Oneseed Juniper/Ruderal Forbs Woodland) was evaluated. The unvisited polygons were mostly to the north and west of the unrestored ruins area at Abó, and we expect that because of their proximity to the ruins, the designation of ruderal versions of juniper woodlands had a high probability of being correct. With respect to the 50% area coverage of MU 4A (Coyote Willow Riparian Shrubland), this is a minor unit (only 0.2 ha) in the park and the one unconfirmed polygon

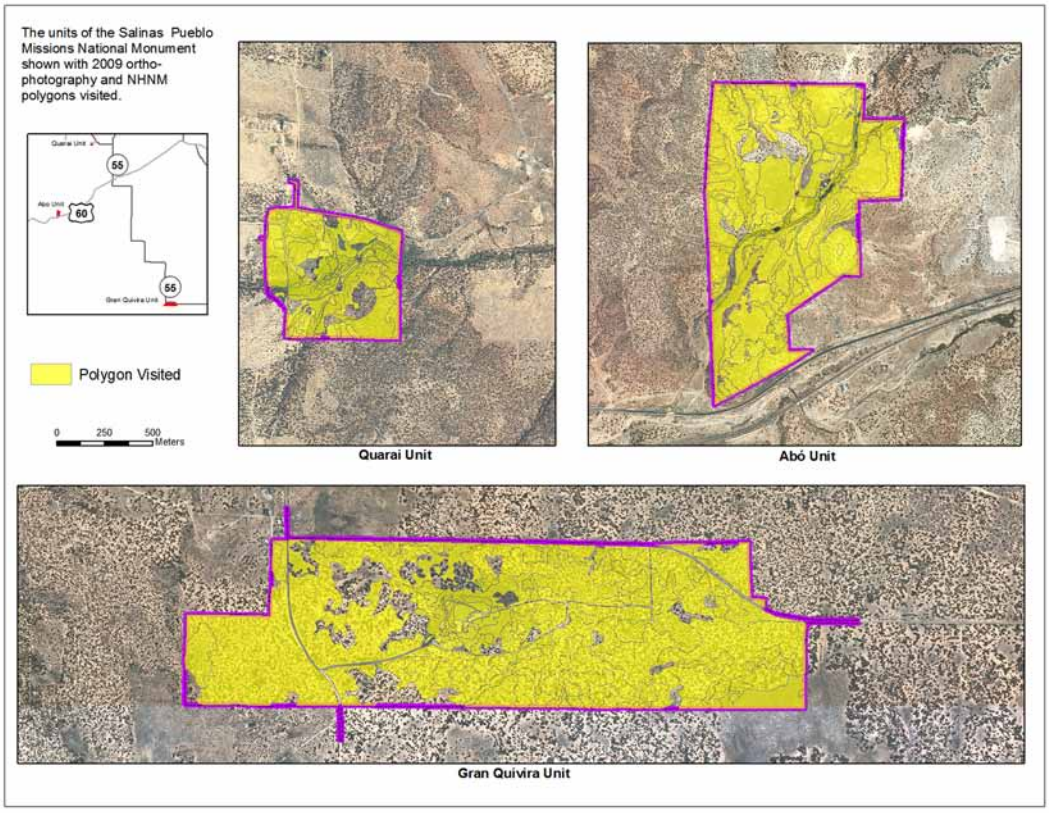


Figure 20. As part of the accuracy assessment at Salinas Pueblo Missions NM, the polygons visited and confirmed with respect to vegetation composition were cataloged and are shown here in yellow.

Table 9. Salinas Pueblo Missions NM vegetation map accuracy assessment summary table. L1 and L 2 refer to map units as defined in Table 8. The table presents the number of polygons for each map unit (MU); the percentage of all polygons represented by a given map unit's polygons; the number of polygons visited for that map unit; the percentage of the total number of polygons in a map unit visited; the area comprised by that map unit and its percentage of total area; the assessed area, or the area of the visited polygons; and the percentage of the map unit area assessed. The overall values are totaled at the bottom of the table.

		Polygons				Area			
L1	L2	# of polygons	% of all polygons	Polygons visited	% of MU polygons visited	MU area (ha)	% of total area	MU area assessed (ha)	% MU area assessed
1	A	12	3.0	10	83.3	9.3	2.3	8.6	92.5
2	A	48	11.9	30	62.5	60.3	14.8	48.5	80.4
2	B	21	5.2	19	90.5	19.4	4.8	18.3	94.3
2	C	11	2.7	9	81.8	11.7	2.9	10.8	92.3
2	D	12	3.0	9	75.0	11	2.7	10	90.9
2	E	3	0.7	3	100.0	5.3	1.3	5.3	100
2	F	15	3.7	6	40.0	8.1	2	6.2	76.5
2	G	4	1.0	4	100.0	2.1	0.5	2.1	100
2	H	18	4.5	14	77.8	70.1	17.2	68.2	97.3
2	I	6	1.5	6	100.0	6.5	1.6	6.5	100
2	J	2	0.5	1	50.0	4.3	1.1	3.6	83.7
2	K	32	7.9	20	62.5	70.2	17.3	62.1	88.5
2	L	18	4.5	16	88.9	24.4	6	21.5	88.1
3	A	13	3.2	10	76.9	1.7	0.4	1.5	88.2
3	B	9	2.2	7	77.8	1.3	0.3	1.2	92.3
4	A	3	0.7	2	66.7	0.2	0	0.1	50
4	B	7	1.7	6	85.7	2.4	0.6	2.1	87.5
5	A	3	0.7	2	66.7	0.5	0.1	0.4	80
6	A	8	2.0	7	87.5	4	1	3.4	85
7	A	9	2.2	2	22.2	1.1	0.3	0.1	9.1
8	A	30	7.4	19	63.3	`	4.2	12.6	73.7
8	B	15	3.7	11	73.3	16.5	4.1	14.7	89.1
8	C	11	2.7	9	81.8	9.4	2.3	8.9	94.7
8	D	6	1.5	6	100.0	10.1	2.5	10.1	100
8	E	15	3.7	14	93.3	4.1	1	4	97.6
9	A	8	2.0	7	87.5	1.1	0.3	1.1	100
10	A	2	0.5	1	50.0	0.2	0	0.2	100
10	B	1	0.2		0.0	0.1	0	0	0
10	C	2	0.5	2	100.0	0.4	0.1	0.4	100
10	D	5	1.2	3	60.0	1.6	0.4	1.4	87.5
11	A	15	3.7	14	93.3	2.1	0.5	2	95.2
11	B	16	4.0	14	87.5	16.4	4	15.3	93.3
11	C	6	1.5	4	66.7	0.1	0	0.1	100
11	D	3	0.7	1	33.3	1.3	0.3	1.2	92.3
11	E	3	0.7	1	33.3	8	2	2.4	30
11	F	7	1.7	5	71.4	3.5	0.9	2.2	62.9
11	G	5	1.2	4	80.0	1.1	0.3	0.9	81.8
Overall		404	100%	298	73.8%	407	100%	358	88%

is at Quarai in the drainage. The only likely alternative designation for this polygon is as one of the "Southwest Lowland Riparian Woodland and Shrubland" (3A, or 3B) or the other closely related shrubland 4B (Chokecherry-Woodrose Riparian Shrubland) of upper alluvial terraces. The remaining underrepresented units were a minor unvegetated channel bottom unit (10B) plus roads or trails (11E, and 11F).

The responses to the map in our park unit walk-throughs were generally positive (per. com. Derek Toms, Integrated Resource Specialist, SAPU and Anne Cully, Inventory & Monitoring Ecologist, NPS Southern Colorado Plateau Network). In the process, we discussed the composition, site, and distribution characteristics of each map unit, how they were related to one another, and our confidence in them as mappers. In return, the users suggested that the differences between 2A (Oneseed Juniper/Blue Grama-Galleta Woodland Savanna) and 2K (Oneseed Juniper/Sparse Woodland) were perhaps too subtle and that there was likely not much difference with respect to management. Regardless, the attention to detail among the various flavors of juniper woodland was appreciated because it will permit specific woodland management questions to be addressed, particularly with respect to restoration. Overall, the map was well received and it is expected to be used extensively in park management.

5 Literature cited

Anderson, M., P. Bourgeron, M. T. Bryer, R. Crawford, L. Engelking, D. Faber-Langendoen, M. Gallyoun, K. Gooodin, D. H. Grossman, S. Landaal, K. Metzler, K. D. Patterson, M. Reid, L. Sneddon, and A. S. Weakley. 1998. Vol. II. International Classification of Ecological Communities: terrestrial vegetation of the United States. The Nature Conservancy, Arlington, Virginia.

Becking, R.W. 1957. The Zurich-Montpellier School of Phytosociology. Botanical Review 23:411-488.

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979. A digitized classification system for the biotic communities of North America, with community (series) and association examples for the Southwest. Arizona-Nevada Academy of Science 14:1-16.

Clark, D., M. Dela Cruz, T. Clark, J. Coles, S. Topp, A. Evenden, A. Wight, G. Wakefield, and J. Von Loh. 2009. Vegetation classification and mapping project report, Capitol Reef National Park. Natural Resource Technical Report NPS/NCPN/NRTR—2009/187. National Park Service, Fort Collins, Colorado.

Daubenmire, R. 1966. Vegetation: identification of typal communities. Science **151**:291-298.

Daubenmire, R. 1974. Plants and environment: a textbook of plant autecology. John Wiley & Sons, New York, New York.

Daubenmire, R. 1976. The use of vegetation in assessing the productivity of forest lands. Botanical Review. 42: 115-143.

Dick-Peddie, W. A. 1993. New Mexico vegetation: Past, present, and future. University of New Mexico Press, Albuquerque, New Mexico.

Driscoll, R. S., D. L. Merkel, D. L. Radloff, D. E. Snyder, and J. S. Hagihara. 1984. An ecological land classification framework for the United States. USDA Forest Service. Miscellaneous Publication No. 1439. Washington, D.C.

ESRI (Environmental Systems Research Institute). 2008. ArcGIS version 9.3.1. ESRI, Redlands, California.

Federal Geographic Data Committee (FGDC). 1997. Vegetation Classification Standard, FGDC-STD-005. Washington, D.C.

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

Federal Geographic Data Committee (FGDC). 1998b. Spatial data transfer standard, FGDC-STC-002 (modified version ANSI NCITS 20:19998). Web address: http://www.fgdc.gov/standards/status/textstatus.html.

Federal Geographic Data Committee (FGDC). 2008. Vegetation Classification Standard, version 2 FGDC-STD-005, v2. Washington, D.C.

Floyd-Hanna, Lisa, David Hanna, and Ken Heil. 1993. Vegetation of Salinas National Monument: Abo and Quarai Units; Semi-annual report. Unpublished report to the National Park Service.

Grossman, D. H., D. Faber-Langendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, M. Metzler, K. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. Vol. I. International Classification of Ecological Communities: terrestrial vegetation of the United States. The Nature Conservancy, Arlington, Virginia.

Larson, M. and W. H. Moir. 1987. Forest and woodland habitat types of northern New Mexico and northern Arizona. Edition 2. USDA Forest Service, South-

western Region, Albuquerque, New Mexico.

Layser, E. F. and G. H. Schubert. 1979. Preliminary classification for the coniferous forest and woodland series of Arizona and New Mexico. Research Paper RM-208. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Ludwig, J. A. and J. F. Reynolds. 1988. Statistical Ecology: A Primer on Methods and Computing. J. Wiley and Sons, New York, New York.

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

Menking, K. M., R. Y. Anderson, N. G. Shafike, K. H. Syed, and B. D. Allen. 2004. Wetter or colder during the Last Glacial Maximum? Revisiting the pluvial lake question in southwestern North America. Quaternary Research 62: 280-288.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and Methods of Vegetation Ecology. John Wiley and Sons, New York, New York.

National Park Service. 1984. General management plan/development concept plan: Salinas National Monument. Southwest Regional Office, National Park Service. Santa Fe, New Mexico.

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

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

Natural Resources Conservation Service (NRCS). 2010. Web Soil Survey (WSS) Salinas Pueblo Missions National Monument Custom Report. Available online at: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.

Pache, Peter H. 1979. Vegetation of Gran Quivera National Monument. Unpublished report to the National Park Service. Albuquerque, New Mexico.

Romme, R. H., C. D. Allen, J. D. Bailey, W. L. Baker, B. T. Bestelmeyer, P. M. Brown, K. S. Eisenhart, M. L. Floyd Hanna, D. W. Huffman, B. F. Jacobs, R. F. Miller, E. H. Muldavin, T. W. Swetnam, R. J. Tausch, and P. J. Weisberg. 2009. Historical and Modern Disturbance Regimes, Stand Structures, and Landscape Dynamics in Piñon-Juniper Vegetation of the Western U.S. Range Ecology and Management 62:203-222.

Shimwell, D.W. 1971. The description and classification of vegetation. University of Washington Press. Seattle, Washington.

Thomas, K. A., M. L. McTeague, L. Ogden, M. L. Floyd, K. Schulz, B. Friesen, T. Fancher, R. Waltermire, and A. Cully. 2008. Vegetation classifi cation and distribution mapping report: Mesa Verde National Park. Natural Resource Technical Report NPS/SCPN/NRTR–2008/112. National Park Service, Fort Collins, Colorado.

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

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

The Nature Conservancy (TNC). 1996. Final Draft Methodology for Assessing the

Utility of Existing Data for Vegetation Mapping. NBS/NPS Vegetation Mapping Program. Prepared for the United States Department of Interior, Biological Resources Division and National Park Service. December 1996.

UNESCO [United Nations Educational, Scientific and Cultural Organization]. 1973. International classification and mapping of vegetation. Series 6, Ecology and Conservation. United Nations Educational, Scientific, and Cultural Organization. Paris, France.

USDA, NRCS. 2009. The PLANTS Database (http://plants.usda.gov). National Plant Data Center, Baton Rouge, Louisiana, 70874-4490, USA.

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

Appendix A: 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 Salinas Pueblo Missions 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). One 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 Salinas Pueblo Missions 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 0.3 m.

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	<0.2 m^2
1	0.05–0.124%	very scattered	0.0875	0.1	0.2m^2 – <0.5 m^2
2	0.125–0.99%	scattered	0.56	0.5	0.5 m^2– <4 m^2
3	1.0–4.9%	common	3.0	3.0	4m^2– <20 m^2
4	5.0–9.9%	well-represented	7.5	7.5	20m^2– <40 m^2
5	10.0–24.9%		17.5	17.5	40m^2– <100 m^2
6	25.0–32.9%	abundant	29.0	29.0	100m^2– <132 m^2
7	33.0–49.9%		41.5	41.5	132m^2– <200 m^2
8	50.0–74.9%	luxuriant	62.5	62.5	200m^2– <300 m^2
9	75.0–94.9%		85.0	85.0	300m^2– <380 m^2
10	95.0–100.0%	full cover	97.5	97.5	380m^2–400 m^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
Salinas Pueblo Missions 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			

USGS-NPS Vegetation Mapping Program
Salinas Pueblo Missions National Monument

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
Salinas Pueblo Missions 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 B: Salinas Pueblo Missions National Monument Plant Species List

Appendix B lists the plant species recorded on vegetation plots at Salinas Pueblo Missions National Monument between 2004 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 Salinas Pueblo Missions National Monument during the vegetation mapping project

Family	Scientific name	Common name
Agavaceae	*Yucca baccata*	banana yucca
	Yucca elata	soaptree yucca
	Yucca glauca	soapweed yucca
Amaranthaceae	*Amaranthus retroflexus*	redroot pigweed
	Tidestromia lanuginosa	wooly tidestromia
Anacardiaceae	*Rhus trilobata*	skunkbush sumac
Apiaceae	*Berula erecta*	cutleaf waterparsnip
Asclepiadaceae	*Asclepias latifolia*	broadleaf milkweed
	Asclepias subverticillata	whorled milkweed
Asteraceae	*Ambrosia psilostachya*	Cuman ragweed
	Artemisia bigelovii	Bigelow's sagebrush
	Artemisia campestris	field sagewort
	Artemisia campestris ssp. *caudata*	field sagewort
	Artemisia carruthii	Carruth's sagewort
	Artemisia dracunculus	tarragon
	Artemisia filifolia	sand sagebrush
	Artemisia frigida	fringed sagewort
	Artemisia ludoviciana	white sagebrush
	Centaurea americana	American basketflower
	Chaetopappa ericoides	rose heath
	Cirsium neomexicana	New Mexico thistle
	Cirsium ochrocentrum	yellowspine thistle
	Conyza canadensis	Canadian horseweed
	Dieteria canescens	hoary aster
	Engelmannia peristenia	Engelmann's daisy
	Ericameria nauseosa	rubber rabbitbrush
	Erigeron divergens	spreading fleabane
	Gaillardia pulchella	firewheel
	Grindelia squarrosa	curlycup gumweed
	Gutierrezia sarothrae	broom snakeweed

Family	Scientific name	Common name
Asteraceae (*cont.*)	*Heliomeris multiflora*	showy goldeneye
	Heterotheca villosa	hairy goldenaster
	Hymenopappus flavescens var. *canotomentosus*	collegeflower
	Lactuca serriola	prickly lettuce
	Laennecia spp.	laennicia
	Lorandersonia pulchella	southwestern rabbitbrush
	Machaeranthera tanacetifolia	tanseyleaf aster
	Melampodium leucanthum	plains blackfoot
	Pectis angustifolia	narrowleaf pectis
	Ratibida columnifera	upright prairie coneflower
	Ratibida tagetes	green prairie coneflower
	Senecio flaccidus var. *flaccidus*	threadleaf ragwort
	Stephanomeria pauciflora	brownplume wirelettuce
	Symphyotrichum spp.	aster
	Taraxacum officinale	common dandelion
	Thelesperma megapotamicum	Hopi tea greenthread
	Townsendia annua	annual townsend daisy
	Tragopogon pratensis	meadow salsify
	Verbesina encelioides	golden crownbeard
	Xanthisma spinulosum	lacy tansyaster
	Xanthium strumarium	rough cocklebur
	Zinnia grandiflora	Rocky Mountain zinnia
Berberidaceae	*Mahonia haematocarpa*	red barberry
Bignoniaceae	*Catalpa speciosa*	northern catalpa
Boraginaceae	*Cryptantha cinerea* var. *jamesii*	James' catseye
	Cryptantha crassisepala	hiddenflower
	Lappula occidentalis	flatspine stickseed
	Lithospermum incisum	narrowleaf gromwell
Brassicaceae	*Brassicaceae family*	Mustard family
	Descurainia spp.	tansymustard
	Dimorphocarpa wislizeni	spectacle pod
	Draba reptans	Carolina draba
	Erysimum capitatum	sanddune wallflower
	Lepidium alyssoides var. *angustifolium*	mountain pepperweed
	Physaria fendleri	Fendler's bladderpod
	Schoenocrambe linearifolia	slimleaf plainsmustard
	Sisymbrium spp.	hedgemustard
Cactaceae	*Cylindropuntia imbricata*	tree cholla
	Echinocereus fendleri var. *fendleri*	Fendler's hedgehog cactus
	Echinocereus triglochidiatus	kingcup cactus
	Escobaria vivipara	spinystar
	Grusonia clavata	club cholla
	Opuntia phaeacantha	tulip pricklypear

Family	Scientific name	Common name
Cactaceae (*cont.*)	*Opuntia polyacantha*	plains pricklypear
Chenopodiaceae	*Atriplex canescens*	fourwing saltbush
	Chenopodium graveolens	fetid goosefoot
	Chenopodium leptophyllum	narrowleaf goosefoot
	Chenopodium pratericola	desert goosefoot
	Kochia scoparia	common kochia
	Krascheninnikovia lanata	winterfat
	Salsola tragus	prickly Russian thistle
Convolvulaceae	*Convolvulus arvensis*	field bindweed
Cucurbitaceae	*Cucurbita foetidissima*	buffalo gourd
Cupressaceae	*Juniperus monosperma*	oneseed juniper
Cyperaceae	*Carex praegracilis*	clustered field sedge
	Cyperus schweinitzii	Schweinitz's flatsedge
	Eleocharis rostellata	beaked spikerush
	Schoenoplectus pungens	common threesquare
Elaeagnaceae	*Elaeagnus angustifolia*	Russian olive
Ephedraceae	*Ephedra torreyana*	Torrey's jointfir
Equisetaceae	*Equisetum laevigatum*	smooth horsetail
Euphorbiaceae	*Chamaesyce fendleri*	Fendler's sandmat
	Chamaesyce stictospora	slimseed sandmat
	Euphorbia davidii	David's spurge
Fabaceae	*Astragalus brandegeei*	Brandegee's milkvetch
	Astragalus lentiginosus var. *diphysus*	freckled milkvetch
	Dalea candida	slender white prairieclover
	Dalea formosa	featherplume
	Dalea lanata	woolly prairieclover
	Dalea nana	dwarf prairieclover
	Glycyrrhiza lepidota	American licorice
	Lupinus kingii	King's lupine
	Melilotus officinalis	yellow sweetclover
	Robinia pseudoacacia	black locust
Fagaceae	*Quercus ×pauciloba*	wavyleaf oak
Geraniaceae	*Erodium cicutarium*	redstem stork's bill
	Geranium caespitosum var. *caespitosum*	pineywoods geranium
Grossulariaceae	*Ribes aureum*	golden currant
	Ribes cereum	wax currant
Hydrophyllaceae	*Nama hispidum*	bristly nama
	Phacelia integrifolia	gypsum scorpionweed
Juncaceae	*Juncus arcticus* var. *balticus*	Baltic rush
Lamiaceae	*Marrubium vulgare*	horehound
	Monarda punctata	spotted beebalm
Linaceae	*Linum lewisii*	prairie flax
	Linum puberulum	plains flax
Loasaceae	*Mentzelia multiflora* var. *multiflora*	Adonis blazingstar

Family	Scientific name	Common name
Malvaceae	*Sphaeralcea coccinea*	scarlet globemallow
	Sphaeralcea hastulata	spear globemallow
	Sphaeralcea incana	gray globemallow
Nyctaginaceae	*Mirabilis linearis*	narrowleaf four o'clock
	Mirabilis multiflora	Colorado four o'clock
	Mirabilis oxybaphoides	smooth spreading four o'clock
Oleaceae	*Menodora scabra*	rough menodora
Onagraceae	*Gaura coccinea*	scarlet beeblossom
	Gaura mollis	velvetweed
	Oenothera pallida	pale eveningprimrose
Pinaceae	*Pinus edulis*	pinyon pine
Poaceae	*Achnatherum hymenoides*	Indian ricegrass
	Andropogon hallii	sand bluestem
	Aristida divaricata	poverty threeawn
	Aristida purpurea	purple threeawn
	Aristida purpurea var. *purpurea*	purple threeawn
	Bouteloua barbata	sixweeks grama
	Bouteloua curtipendula	sideoats grama
	Bouteloua eriopoda	black grama
	Bouteloua gracilis	blue grama
	Bouteloua hirsuta	hairy grama
	Bromus catharticus	rescuegrass
	Bromus japonicus	Japanese brome
	Bromus tectorum	cheatgrass
	Dactylis glomerata	orchardgrass
	Dasyochloa pulchella	fluffgrass
	Distichlis spicata	inland saltgrass
	Elymus elymoides	bottlebrush squirreltail
	Erioneuron pilosum	hairy woollygrass
	Festuca arundinacea	tall fescue
	Hesperostipa neomexicana	New Mexico needlegrass
	Koeleria macrantha	prairie junegrass
	Lycurus setosus	bristly wolfstail
	Muhlenbergia asperifolia	alkali muhly
	Muhlenbergia pauciflora	New Mexico muhly
	Muhlenbergia porteri	bush muhly
	Muhlenbergia pungens	sandhill muhly
	Muhlenbergia repens	creeping muhly
	Muhlenbergia setifolia	curlyleaf muhly
	Muhlenbergia torreyi	ring muhly
	Pascopyrum smithii	western wheatgrass
	Piptatherum micranthum	littleseed ricegrass
	Pleuraphis jamesii	galleta
	Poa fendleriana	muttongrass

Family	Scientific name	Common name
Poaceae (*cont.*)	*Poa pratensis*	Kentucky bluegrass
	Schedonnardus paniculatus	tumblegrass
	Schizachyrium scoparium	little bluestem
	Scleropogon brevifolius	burrograss
	Sporobolus airoides	alkali sacaton
	Sporobolus contractus	spike dropseed
	Sporobolus cryptandrus	sand dropseed
	Vulpia octoflora	sixweeks fescue
Polemoniaceae	*Ipomopsis aggregata*	skyrocket gilia
	Ipomopsis longiflora	flaxflowered gilia
	Ipomopsis multiflora	manyflowered gilia
Polygalaceae	*Polygala alba*	white milkwort
	Eriogonum annuum	annual buckwheat
	Eriogonum hieraciifolium	hawkweed buckwheat
	Rumex crispus	curly dock
Portulacaceae	*Portulaca oleracea*	common purslane
	Portulaca pilosa	kiss me quick
	Portulaca spp.	hogweed
Pteridaceae	*Cheilanthes feei*	slender lipfern
Ranunculaceae	*Clematis ligusticifolia*	western white clematis
Rosaceae	*Fallugia paradoxa*	Apacheplume
	Malus pumila	apple
	Prunus virginiana	common chokecherry
	Rosa woodsii	Woods' rose
Rubiaceae	*Houstonia rubra*	red bluet
Salicaceae	*Populus angustifolia*	narrowleaf cottonwood
	Populus deltoides ssp. *wislizeni*	Rio Grande cottonwood
	Populus x *acuminata*	lanceleaf cottonwood
	Salix amygdaloides	peachleaf willow
	Salix exigua	coyote willow
	Salix gooddingii	Goodding's willow
Scrophulariaceae	*Castilleja integra*	wholeleaf Indian paintbrush
	Cordylanthus wrightii	Wright's birdbeak
	Penstemon virgatus	upright blue beardtongue
Solanaceae	*Chamaesaracha arida*	greenleaf five eyes
	Lycium pallidum	pale wolfberry
	Physalis hederifolia var. *fendleri*	Fendler's groundcherry
	Solanum elaeagnifolium	silverleaf nightshade
	Solanum jamesii	wild potato
Tamaricaceae	*Tamarix ramosissima*	saltcedar
Typhaceae	*Typha domingensis*	southern cattail
	Typha latifolia	broadleaf cattail
Ulmaceae	*Ulmus pumila*	Siberian elm
Verbenaceae	*Glandularia bipinnatifida*	Dakota mock vervain

Family	Scientific name	Common name
Verbenaceae (*cont.*)	*Verbena macdougalii*	MacDougal verbena
Vitaceae	*Parthenocissus vitacea*	thicket creeper
Zygophyllaceae	*Tribulus terrestris*	puncturevine

Appendix C: Plant Association Key

Appendix C presents dichotomous keys to the 25 plant associations and two incidental associations (Lithomorphic Vegetation) at Salinas Pueblo Missions National Monument. The key uses either explicitly specified cover values for indicator species as part of the decision rules in each step or specific adjectives that relate to species canopy cover as shown in Table C-1. There are separate keys for the major classes (e.g., forests and woodlands, shrublands, etc.) as specified in the first key. Descriptions for each association can be found in Appendix D.

Table C-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, Lithomorphic Vegetation, page C-4**

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 C-2**

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 C-3**

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

Key 1: Forests and Woodlands

1. *Populus angustifolia* abundant, dominant: ***Populus angustifolia* / *Prunus virginiana* Woodland**

1. *Populus angustifolia* absent: (2)

2 (1). *Populus deltoides* well represented, dominant: ***Populus deltoides*** (ssp. ***wislizeni***, ssp. ***monilifera***) - ***Salix gooddingii*** **Forest**

2. *Populus deltoides* absent: (3)

3 (2). *Salix gooddingii* common to well represented: (4)

3. *Salix gooddingii* absent: (5)

4 (3). *Salix exigua* well represented to abundant: ***Salix gooddingii / Salix exigua*** **Woodland**

4. *Salix exigua* poorly represented or absent: ***Salix gooddingii*** **Woodland**

5 (3). *Pinus edulis* well represented to abundant, dominant or codominant: (6)

5. *Pinus edulis* poorly represented, or absent or clearly subordinate to *Juniperus monosperma*: (7)

6 (5). *Bouteloua gracilis* common to well represented: ***Pinus edulis*** - (***Juniperus monosperma***) / ***Bouteloua gracilis*** **Woodland**

6. *Bouteloua gracilis* poorly represented or absent: ***Pinus edulis*** / **Sparse Understory Woodland**

7 (5). Shrubs well represented, dominant over herbs: ***Juniperus monosperma*** / ***Quercus*** × ***pauciloba*** **Woodland**

7. Shrubs poorly represented, graminoids and herbs dominant: (8)

8 (7). *Schizachyrium scoparium* well represented to abundant, dominant: ***Juniperus monosperma / Schizachyrium scoparium*** **Woodland**

8. *Schizachyrium scoparium* poorly represented or absent: (9)

9 (8). *Muhlenbergia setifolia* common to well represented, dominant or codominant: ***Juniperus monosperma / Muhlenbergia setifolia*** **Woodland**

9. *Muhlenbergia setifolia* scarce or absent: (10)

10 (9). *Muhlenbergia pauciflora* well represented, dominant: ***Juniperus monosperma / Muhlenbergia pauciflora*** **Woodland**

10. *Muhlenbergia pauciflora* poorly represented or absent: (11)

11 (10). *Bouteloua eriopoda* common to abundant, dominant or codominant: ***Juniperus monosperma / Bouteloua eriopoda*** **Woodland**

11. *Bouteloua eriopoda* poorly represented or absent: (12)

12 (11). *Bouteloua gracilis* well represented to luxuriant, dominant: ***Juniperus monosperma / Bouteloua gracilis*** **Woodland**

12. *Bouteloua gracilis* poorly represented or accidental: (13)

13 (12). Understory sparse, shrubs, sub-shrubs, or herbaceous species uncommon or absent, ground surface primarily exposed soil or gravel: ***Juniperus monosperma*** / **Sparse Understory Woodland**

13. Other shrubs, sub-shrubs, or herbaceous species well represented to abundant, and dominant in the

understory, or if sparse, then ground surface of boulders and rock outcrop: Incidental woodland association (see report table 2.5) or new.

Key 2: Shrublands

1. *Prunus virginiana* well represented: ***Prunus virginiana* Shrubland**

1. *Prunus virginiana* absent: (2)

2 (1). *Artemisia filifolia* abundant, dominant: ***Artemisia filifolia / Bouteloua* (*curtipendula, gracilis*) Shrubland**

2. *Artemisia filifolia* poorly represented or absent: (3)

3 (2). *Atriplex canescens* well represented to abundant: (4)

3. *Atriplex canescens* poorly represented or absent: (5)

4 (3). *Muhlenbergia porteri* abundant: ***Atriplex canescens / Muhlenbergia porteri* Shrubland**

4. *Sporobolus airoides* well represented: ***Atriplex canescens / Sporobolus airoides* Shrubland**

5 (3). Other shrubs or sub-shrubs common to well represented but clearly subordinate in cover to grasses: **Key 3, Herbaceous Vegetation**

5. Other shrubs or sub-shrubs well represented to abundant, dominant, and grasses clearly subordinate, accidental, or absent: Incidental shrub association (see report table 2.5) or new.

Key 3: Herbaceous Vegetation

1. *Hesperostipa neomexicana* well represented, dominant or codominant: ***Bouteloua gracilis - Hesperostipa neomexicana* Herbaceous Vegetation**

1. *Hesperostipa neomexicana* poorly represented or absent: (2)

2 (1). *Bouteloua eriopoda* abundant, dominant or codominant: ***Bouteloua eriopoda - Bouteloua gracilis* Herbaceous Vegetation**

2. *Bouteloua eriopoda* poorly represented or absent: (3)

3 (2). *Bouteloua gracilis* well represented to luxuriant: (4)

3. *Bouteloua gracilis* absent: (8)

4 (3). *Krascheninnikovia lanata* abundant: ***Krascheninnikovia lanata / Bouteloua gracilis* Dwarf-Shrub Herbaceous Vegetation**

4. *Krascheninnikovia lanata* poorly represented or absent: (5)

5 (4). *Pascopyrum smithii* well-represented to luxuriant and codominant: ***Pascopyrum smithii - Bouteloua gracilis* Herbaceous Vegetation**

5. *Pascopyrum smithii* poorly represented or absent: (6)

6 (5). *Pleuraphis jamesii* well represented, codominant: ***Bouteloua gracilis - Pleuraphis jamesii* Herbaceous Vegetation**

6. *Pleuraphis jamesii* poorly represented or absent: (7)

7 (6). *Sporobolus airoides* well represented to abundant, codominant: ***Sporobolus airoides -Bouteloua gracilis* Herbaceous Vegetation**

7. *Sporobolus airoides* poorly represented or absent: ***Bouteloua gracilis - Muhlenbergia torreyi - Aristida purpurea* Herbaceous Vegetation**

8 (3). Wetland and riparian graminoids and forbs well-represented to luxuriant in cover (e.g. *Equisetum laevigatum*, *Typha* spp.): ***Equisetum laevigatum* / Herbaceous Vegetation**

8. Other herbaceous species well represented and dominant, trees and shrubs clearly subordinate, accidental, or absent: Incidental herbaceous association (see report table 7) or new.

Key 4: Lithomorphic Vegetation

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

1. Substrate dominated by stream channel alluvial deposits: **Sparse Vegetation / Recent Alluvial Deposits**

Appendix D: Plant Association Descriptions for Salinas Pueblo Missions National Monument

As part of the Salinas Pueblo Missions National Monument (SAPU) vegetation mapping project, 52 plant associations were provisionally identified, and of these, 25 were considered major associations of the park. These latter associations had sufficient data to warrant full descriptions on a local basis, and to having that information added to the global descriptions maintained in the NatureServe national database. 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 SAPU. 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. In this appendix, the arrangement of the plant associations follows the original hierarchy structure of the 1997 NVCS 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 D-1.

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

Canopy cover description	Definition
Absent	Individuals 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

Round-crowned temperate or subpolar needle-leaved evergreen forest

Pinus edulis Forest Alliance

Temporarily flooded cold-deciduous forest

Populus deltoides Temporarily Flooded Forest Alliance

II. Woodland

Rounded-crowned temperate or subpolar needle-leaved evergreen woodland

Juniperus monosperma Woodland Alliance

Pinus edulis (*Juniperus* spp.) Woodland Alliance

Temporarily-flooded cold-deciduous woodland

Populus angustifolia Temporarily Flooded Woodland Alliance

Salix gooddingii / *Salix exigua* Temporarily Flooded Woodland Alliance

III. Shrubland

Lowland microphyllous evergreen shrubland

Artemisia filifolia Shrubland Alliance

Facultatively deciduous extremely xeromorphic subdesert shrubland

Atriplex canescens Shrubland Alliance

I. Forest

Pinus edulis / Sparse Understory Woodland

Two-needle Pinyon / Sparse Understory Woodland

CODE	CEGL000795
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	Rounded-crowned temperate or subpolar needle-leaved evergreen forest (I.A.8.N.b.)
ALLIANCE	*PINUS EDULIS* FOREST ALLIANCE (A.152) Two-needle Pinyon Forest 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

These forests and woodlands occur in foothills, mesas, plateaus and mountains of New Mexico, Arizona, Colorado and Utah. Sites are flat to moderately sloping. Stands frequently occur on less xeric, northern and eastern exposures, but can occur on all aspects. Elevations range from 1850-2290 m (6065-7500 feet). Substrates are variable, but often include eroded, shallow, coarse-textured substrates such as cinder (but not rock outcrops) that limit understory growth. Cover of tree litter is dense in some stands, but in others the ground surface is characterized by exposed soil and gravel with widely scattered grass patches and litter. A moderately dense (over 25% cover) to dense tree canopy with little or no understory characterizes the vegetation. The tree canopy is dominated by *Pinus edulis*. Other trees may codominate especially one or more of several species of *Juniperus* that vary with geography. If other species of *Pinus* are present they do not codominate. The sparse understory (<10% cover and usually <2%) may include scattered shrubs, dwarf-shrubs, succulents, grasses and forbs, such as *Ageratina herbacea, Cercocarpus montanus, Fallugia paradoxa, Rhus trilobata, Gutierrezia sarothrae, Achnatherum hymenoides*, and species of *Poa, Opuntia, Yucca, Penstemon*, and *Phlox*. The original concept of this association was of a nearly closed, *Pinus edulis*-dominated tree canopy that shaded out understory vegetation and often occurred on relatively mesic sites with high tree growth potential. However, the association also now includes fire-suppressed stands, woodlands growing on eroded or "badlands" substrates, and/or over-grazed stands that lack understory vegetation.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This association is known from the Abó unit of the Monument.

Globally

These forests and woodlands occur in foothills, mesas, plateaus and mountains of New Mexico, Arizona, Colorado and Utah.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblos Mission National Monument

This association is known from a site at 1850 m (6065 feet) in elevation on a gentle, northwest-facing slope of a low hill. Soils are developed colluvium derived from sandstone of the Permian Abó Formation. The ground sur-

face is characterized by exposed soil and gravel with widely scattered grass patches and litter.

Globally

These forests and woodlands occur in foothills, mesas, plateaus and mountains of New Mexico, Arizona, Colorado and Utah. Sites are flat to moderately sloping at elevations that range from 1850-2290 m (6065-7500 feet). Stands frequently occur on less xeric, northern and eastern exposures but can occur on all aspects. Substrates are variable but often include eroded, shallow or coarse-textured substrates, such as cinder (but not rock outcrops), that limit the growth of understory shrubs and herbaceous plants. Cover of tree litter is dense in some stands (Kennedy 1983). In others, the ground surface is characterized by exposed soil and gravel with widely scattered grass patches and litter. The original concept of this association included stands on relatively mesic sites with high tree growth potential that produced a dense tree canopy which shades out the understory vegetation. However, the association now also includes fire-suppressed stands and woodlands growing on eroded or "badlands" substrates and/or over-grazed stands that lack understory vegetation (Baker et al. 1995, Stuever and Hayden 1997).

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This Rocky Mountain woodland savanna is characterized by an open canopy of mature *Pinus edulis,* with *Juniperus monosperma* as a codominant along with scattered saplings or seedlings of both species. These stands are characterized by a sparse herbaceous layer with only scattered graminoids such as *Bouteloua gracilis* and *Muhlenbergia setifolia* (less than 1% total cover). Shrubs and forbs are also poorly represented.

Globally

This plant association is characterized by a moderate (over 25% cover) to dense tree canopy with little or no understory. The tree canopy is dominated by *Pinus edulis*. Other trees may codominate, especially one or more of several species of *Juniperus* that vary with geography, such as *Juniperus monosperma, Juniperus osteosperma, Juniperus scopulorum* or *Juniperus deppeana*. If other species of *Pinus* are present, they do not codominate. The sparse understory (<10% cover and usually <2%) may include scattered shrubs, dwarf-shrubs, succulents, grasses, and forbs, such as *Ageratina herbacea*, *Bouteloua gracilis*, *Cercocarpus montanus*, *Fallugia paradoxa, Muhlenbergia setifolia, Rhus trilobata, Gutierrezia sarothrae, Achnatherum hymenoides*, and species of *Opuntia, Yucca, Poa, Penstemon*, and *Phlox*.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma, Pinus edulis*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma, Juniperus osteosperma, Pinus edulis*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (01 Feb 1996).

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

The original concept of this plant association had a nearly closed tree canopy with a sparse, shaded understory growing on relatively mesic sites. These forests may actually be a product of fire suppression, livestock grazing, removal of fine fuels, and/or soil erosion, and may be present in degraded examples of other *Pinus edulis* associations (Stuever and Hayden 1997). The association concept has been expanded to include more open-growing stands by Muldavin et al. (2000b) who included stands under 20% tree cover.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: The description is based on 1 field plot (standard plot) from 2007: (Plot: 07AR011).

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K. A. Schulz, mod. K. S. King

REFERENCES

Baker et al. 1995, Bourgeron and Engelking 1994, Bradley et al. 1992, Cedar Creek Associates, Inc. 1987, Donart et al. 1978a, Driscoll et al. 1984, Hansen et al. 2004c, Kennedy 1983a, Larson and Moir 1987, Little 1987, Muldavin and Mehlhop 1992, Muldavin et al. 1998a, Muldavin et al. 2000b, Powell 1988a, Stuever and Hayden 1997, Western Ecology Working Group n.d., Wright et al. 1979

***Populus deltoides* (ssp. *wislizeni*, ssp. *monilifera*) - *Salix gooddingii* Forest**

(Rio Grande Cottonwood, Plains Cottonwood) - Goodding's Willow Forest

CODE	CEGL005964
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):

North American Warm Desert Riparian Woodland and Shrubland (CES302.753)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This mature riparian forest association is found in the middle Pecos and Rio Grande basins of New Mexico and extreme southwestern Colorado. It occurs along low-gradient rivers of wide lowland valleys at elevations from 990 to 2025 m (3250–6650 feet). Stream gradients are generally low (<1%), and riverbeds tend to be mostly sandy. Gravels and cobbles are more frequent as the gradient increases. Sites typically are elevated sidebars and low terraces that

are situated above the active channel (discharge ratios range from 2 to 6). Flooding frequency ranges widely, from as low as every two years on lower bars to more than 50 years on elevated terraces. Soils of young fluvial landforms are poorly developed Entisols. Soils may be coarse-loamy throughout or overlain by a sandy layer. Gravels and cobbles are generally scattered throughout the profile. Soils are dry within 1 m but, upon approaching the groundwater, become moist, particularly during seasonal flooding events. Middle-aged to mature stands of *Populus deltoides* ssp. *wislizeni, Populus deltoides* (and *Populus* × *acuminata*, the incipient hybrid with *Populus angustifolia*), or *Populus deltoides* ssp. *monilifera* and *Salix gooddingii* form closed canopies (85% or greater cover) that reach heights of 20 to 25 m (65-82 feet). Other deciduous trees are generally absent. *Elaeagnus angustifolia* and *Tamarix ramosissima* can become invasive and reproduce in the understory. Smaller cottonwood and willow saplings may be present in the understory, but seedlings are absent. The shrub layer may be dominated by *Rosa woodsii, Ribes aureum*, and *Salix exigua*. However, the understory shrub and herbaceous layers are often sparse, not well-represented, and low in diversity. There may be scattered *Salix exigua* or *Baccharis* spp. and patches of grass, but generally the forest floor is sparse and covered with leaf litter. Six wetland indicator species are known to occur. 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

Salinas Pueblo Missions National Monument

This association is known from the Quarai unit

Globally

This association is found in the Pecos and Rio Grande basins of central New Mexico but may occur farther west in Utah and Arizona.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This riparian association is found at about 2025 m (6650 feet) in elevation along the upper alluvial terraces of a perennial stream.

Globally

Elevations range from 990 to 2025 m (3250-6650 feet). Stream gradients are generally low (<1%), and riverbeds tend to be mostly sandy. Gravels and cobbles are more frequent as the gradient increases. The type is found on elevated sidebars and low terraces that are situated above the active channel (discharge ratios range from 2 to 6). Flooding frequency ranges widely, from as low as every two years on lower bars to more than 50 years on elevated terraces. Soils of young fluvial landforms are poorly developed Entisols. Soils may be coarse-loamy throughout or overlain by a sandy layer. Gravels and cobbles are generally scattered throughout the profile. Soils are dry within 1 m but, upon approaching the ground water, become moist, particularly during seasonal flooding events.

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This closed-canopied riparian forest is dominated by *Populus deltoides* (and *Populus* × *acuminata*, the incipient hybrid with *Populus angustifolia*) with an understory of *Salix gooddingii*. The shrub layer is characteristically shrubby and dominated by *Rosa woodsii, Ribes aureum*, and *Salix exigua*.

Globally

Middle-aged to mature stands of *Populus deltoides* ssp. *wislizeni, Populus deltoides* (and *Populus* × *acuminata,* the incipient hybrid with *Populus angustifolia*), or *Populus deltoides* ssp. *monilifera* and *Salix gooddingii* typically form closed canopies (85% or greater cover) that reach heights of 20 to 25 m (65–82 feet). Other deciduous trees are generally absent. *Elaeagnus angustifolia* and *Tamarix ramosissima* can become invasive and reproduce in the understory. Smaller cottonwood and willow saplings may be present in the understory, but seedlings are absent. The shrub layer may be dominated by *Rosa woodsii, Ribes aureum*, and *Salix exigua*. However, the understory shrub and herbaceous layers are often sparse, not well-represented, and low in diversity. There may be scattered *Salix exigua* or *Baccharis* spp. and

patches of grass, but generally the forest floor is sparse and covered with leaf litter. Six wetland indicator species are known to occur, i.e., *Salix gooddingii, Baccharis salicifolia, Salix exigua, Carex aquatilis, Distichlis spicata*, and *Populus deltoides*.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Tree canopy	*Populus deltoides, Salix gooddingii*
Shrub/sapling (tall and short)	*Ribes aureum, Rosa woodsii, Salix amygdaloides, Salix exigua*

Globally

Stratum	Species
Tree canopy	*Salix gooddingii*
Shrub/sapling (tall and short)	*Salix exigua*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15 Feb 2008). This major association of the Rio Grande and Pecos basins has undergone significant declines as a result of impoundments and subsequent river regulation along with agricultural conversion and urban development. It requires low-gradient floodplain habitats in which natural hydrological processes are operational to ensure reproduction and maintenance of *Populus deltoides* and other key wetland species. Hence, while geographically widespread, the most viable occurrences are found in the middle reaches of the Rio Grande in central New Mexico, where the hydrological regimes are at least marginally intact or water flows are sometimes regulated to simulate the natural hydrological regime. Many extant occurrences are approaching senescence and loss without replacement due to the lack of natural floods. Others are declining because minimum in-stream base flows are not being maintained. In addition, many occurrences are significantly invaded by alien species. The number of viable occurrences is very low, and trends suggest a possible G2 ranking in the near future without a significant restoration effort.

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

In eastern Arizona and eastern Utah, *Populus deltoides* ssp. *wislizeni* and *Populus fremontii* hybridize. Stands in New Mexico's San Juan River basin are attributed to *Populus deltoides* ssp. *wislizeni*. Stands in Arizona and Utah are attributed to *Populus fremontii*, but there are likely stands that are a mix of the two with the hybrid.

Due to large-scale alterations of the floodplain (i.e., flow regulations and diversions), the extent of this community type's natural distribution is limited and, therefore, considered highly threatened. Much of its former habitat in the southern reaches of New Mexico's larger rivers is now occupied by vast areas of homogeneous stands of *Tamarix ramosissima* or farmland. In these areas, cottonwoods are very scarce. Alternatively, communities in the northern reaches of these rivers are threatened by invasion of *Elaeagnus angustifolia*. River controls and alterations that limit the movement of the river within the floodplain have minimized areas available for cottonwood-willow reproduc-

tion. Where reproduction does occur in the spring, subsequent flows remove seedlings before their root systems are established. The community type may be critical habitat for several bird species. Effective restoration of these stands to enhance biodiversity, quality, and condition requires emulating a natural hydrological regime.

Although this *Populus deltoides* ssp. *monilifera* type has not been previously described, Laurenzi et al. (1983) and Szaro (1989) describe a *Populus fremontii* / *Salix gooddingii* Community Type which is probably similar and perhaps inclusive of the type described here. Dick-Peddie (1993) also refers to a *Populus fremontii* / *Salix gooddingii* / Mesic Grass - Forb type as part of his Cottonwood-Willow Series. These are similar communities and may have been intended to be inclusive of the association described here because *Populus deltoides* ssp. *wislizeni* has been previously referred to as *Populus fremontii* var. *wislizeni*. Campbell and Dick-Peddie (1964) describe a cottonwood type with *Salix gooddingii* (Class IV) for the Rio Grande.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plots: 04SQ008.

Local Description Authors: E. Muldavin and A. Kennedy

Global Description Authors: E. Muldavin et al., mod. K.S. King

REFERENCES

Campbell and Dick-Peddie 1964, Dick-Peddie 1993, Laurenzi et al. 1983, Muldavin et al. 2000a, New Mexico Natural Heritage Progarm (NMNHP) unpubl. data, Szaro 1989, Western Ecology Working Group n.d.

II. Woodland

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 occurs in north-central to south-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. Stands occur on gentle hillslopes and rolling plains, on moderate to very steep foothills, canyon slopes and escarpments (26–65%) and lower elevation mountain escarpments. It can also extend down onto the upper piedmont slopes of the lower valleys and occasionally into basins. Elevation ranges from 1460–2100 m (4800–6900 feet) on all aspects; however, lower elevation slopes are generally restricted to cooler north-facing slopes, and higher elevation stands are restricted to warmer southerly aspects. Soils are typically shallow, gravelly or rocky and derived from basalt, rhyolitic tuff, sandstone, limestone, and occasionally granitic or pumice parent materials. The ground surface is rocky and/or gravelly with scattered grass bunches and litter. Vegetation is characterized by an open to very open tree canopy (10–40% cover) of mature *Juniperus monosperma* forming a woodland or savanna. Saplings or seedlings are also common. Occasionally mature individuals, seedlings or saplings of *Pinus edulis* can be present. The herbaceous layer is characteristically grassy with the diagnostic *Bouteloua eriopoda* dominant and well-represented to abundant. *Bouteloua gracilis, Bouteloua curtipendula*, or *Bouteloua hirsuta* may be present but clearly not dominant. Forbs are scattered and variable; the most common species are *Astragalus lentiginosus, Ipomopsis longiflora, Mirabilis multiflora*, and herbaceous species of *Artemisia*. Shrubs are poorly represented or absent; the ruderal subshrub *Gutierrezia sarothrae* and succulents such as *Opuntia imbricata (= Cylindropuntia imbricata), Opuntia phaeacantha, Opuntia polyacantha*, and *Yucca elata* are the most frequent.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This association is known from the Gran Quivira and Abó units.

Globally

This association occurs in north-central to south-central and southwestern New Mexico. Specific locations include Salinas Pueblo Missions National Monument, Bandelier National Monument and White Sands Missile Range. 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.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association occurs between 1830 and 1985 m (6000–6510 feet) in elevation on moderately warm southerly aspects of gentle hillslopes and rolling plains. Stands mainly occur on soils derived from sandstones of the Permian Abó Formation, and occasionally on limestone of the Permian San Andres Formation. The ground surface is typically gravelly with scattered grass patches and litter.

Globally

This association is known to occur in north-central, south-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 Salinas Pueblo Missions National Monument in central New Mexico, this association occurs between 1830 and 1985 m (6000–6510 feet) in elevation on moderately warm southerly aspects of gentle hillslopes and rolling plains. Stands mainly occur on soils derived from sandstones of the Permian Abó Formation, and occasionally on limestone of the Permian San Andres Formation. The ground surface is typically gravelly with scattered grass patches and litter. 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

Salinas Pueblo Missions National Monument

This Madrean woodland/savanna is characterized by an open to very open canopy of mature *Juniperus monosperma*; saplings or seedlings are also common. Occasionally mature individuals, seedlings or saplings of *Pinus edulis* can be present. The herbaceous layer is characteristically grassy with the diagnostic *Bouteloua eriopoda* dominant and well-represented to abundant. *Bouteloua gracilis* or *Bouteloua hirsuta* may be present but clearly not dominant. Forbs are scattered and variable; the most common species are *Astragalus lentiginosus* var. *diphysus, Mirabilis multiflora*, and *Ipomopsis longiflora*. Shrubs are poorly represented or absent; the ruderal subshrub *Gutierrezia sarothrae* and succulents such as *Opuntia imbricata* (= *Cylindropuntia imbricata*) are the most frequent.

Globally

Within Salinas Pueblo Missions National Monument, this Madrean woodland/savanna is characterized by an open to very open canopy of mature *Juniperus monosperma*; saplings or seedlings are also common. Occasionally mature individuals, seedlings or saplings of *Pinus edulis* can be present. The herbaceous layer is characteristically grassy with the diagnostic *Bouteloua eriopoda* dominant and well-represented to abundant. *Bouteloua gracilis* or *Bouteloua hirsuta* may be present but clearly not dominant. Forbs are scattered and variable; the most common species are *Astragalus lentiginosus* var. *diphysus, Ipomopsis longiflora*, and *Mirabilis multiflora*. Shrubs are poorly represented or absent; the ruderal subshrub *Gutierrezia sarothrae* and succulents such as *Opuntia imbricata* (= *Cylindropuntia imbricata*) are the most frequent. 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 imbricata* 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

Salinas Pueblo Missions 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

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: The description is based on 11 field plots (1 standard and 10 rapid plots) from 2004 and 2007: (Plots: 04EA009, 04SG010, 07AR013, 07AR020, 07AR021, 07AR030, 07AR042, 07AR050, 07AR051, 07AR053 and 07AR057).

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz

REFERENCES

Bourgeron and Engelking 1994, Colorado Natural Heritage Program (CONHP) unpubl. data 2003, Driscoll et al. 1984, Dwyer and Pieper 1967, Fischer and Bradley 1987, Muldavin and Mehlhop 1992, Muldavin et al. 2000b, Muldavin et al. 2000c, Western Ecology Working Group n.d., Wright et al. 1979

Juniperus monosperma / Bouteloua gracilis Woodland

One-seed Juniper / Blue Grama Woodland

CODE	CEGL000710
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 occurs 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*, S*porobolus 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., *Townsendia* spp., and *Thelesperma megapotamicum*.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This common association is known from the Abó, Quarai and Gran Quivira units.

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

Salinas Pueblo Missions National Monument

Sites of this association occur between 1835 and 2035 m (6020-6680 feet) in elevation on gently rolling slopes on a variety of aspects with a tendency of increasing southerly slopes with increasing elevation. Soils are developed in piedmont alluvial and slope colluvial deposits derived from sandstones and limestones of the Permian Abó, Yeso, and San Andres formations. The ground surface is characterized by scattered grass patches and litter amid an equal amount of exposed soil and gravel.

Globally

This widespread open woodland / savanna association occurs on valleys, plains, piedmont alluvial fans, mesas and foothills between 1372 and 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

Salinas Pueblo Missions National Monument

This Rocky Mountain woodland/savanna is characterized by an open canopy of mature *Juniperus monosperma*; saplings or seedlings are also common. Occasionally seedling or sapling *Pinus edulis* can be present, commonly under the canopy of *Juniperus monosperma*. Shrub species are poorly represented or absent; the ruderal subshrub *Gutierrezia sarothrae* and 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 among 18 graminoid species reported for the association. Forbs are diverse but variable. Among the 45 species reported, *Penstemon virgatus, Heterotheca villosa, Ipomopsis multiflora, Astragalus brandegeei, Cordylanthus wrightii, Schoenocrambe linearifolia, Artemisia dracunculus, Ipomopsis longiflora, Erigeron divergens, Townsendia annua, Menodora scabra,* and *Thelesperma megapotamicum* are the most frequent species, but cover is generally low.

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). Shrubs species are poorly represented or absent; the ruderal subshrub *Gutierrezia sarothrae* and 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

Salinas Pueblo Missions National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma*
Herb (field)	*Bouteloua gracilis*

Globally

Tree canopy	*Juniperus monosperma*
Herb (field)	*Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23 Feb 1994)

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Five phases were identified from this association when either *Andropogon gerardii, Aristida purpurea, Sporobolus airoides*, or *Pleuraphis jamesii* are well-represented (>5% cover). In addition a Ruderal Herbaceous Vegetation phase occurs in areas of historical disturbance, resulting in high cover of weedy herbaceous species, and Treatment phase where portions of the tree canopy were mechanically removed

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

Salinas Pueblo Missions National Monument Inventory Notes: Data not available.

Salinas Pueblo Missions National Monument plots:

The description is based on 17 field plots (6 standard and 11 rapid plots) from 2004, 2005 and 2007: (Plots: 04SG003, 04SG011, 04SQ003, 04SQ005, 04SQ009, 05AR002, 05AR007, 07AR003, 07AR007, 07AR008, 07AR024, 07AR028, 07AR037, 07AR038, 07AR039, 07AR040 and 07AR061).

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 Peddie 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. 1993, 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 / Muhlenbergia pauciflora* Woodland**

One-seed Juniper / New Mexico Muhly Woodland

CODE	CEGL005387
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)

Not determined

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This Madrean woodland or savanna occurs in central and south-central New Mexico and is a major association of the San Andres Mountains. Sites are typically found on cool aspects of steep scarp slopes at elevations of 1700 to 2150 m (5500–7000 feet). Occasionally it is found on more gentle dipslopes or along the toeslopes of mountain valleys. Soils are mostly shallow and loamy with significant gravel, cobble and even a stony component (50% or more of the profile can be made up of coarse fragments). Vegetation is characterized by an open canopy of mature *Juniperus monosperma*; saplings or seedlings are also common. Occasionally seedling or sapling *Pinus edulis* can be present, commonly under the canopy of *Juniperus monosperma*. The understory is characterized by scattered bunches of *Muhlenbergia pauciflora* with a scattering of forbs. Other grasses may be well-represented or abundant, including *Bouteloua curtipendula, Muhlenbergia setifolia, Tridens muticus*, and *Achnatherum scribneri (= Stipa scribneri)*. A wide variety of forbs can occur, but forb species richness and abundance on a stand-by-stand basis are low; *Lesquerella fendleri, Melampodium leucanthum*, and *Viguiera dentata* are most constant. Shrubs are usually present and may form an open layer (>5% cover) with *Gutierrezia sarothrae*, *Rhus trilobata*, and *Yucca baccata* being the most abundant and constant.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This association is found in the Abó unit of the monument.

Globally

This association is known to occur within Salinas Pueblo Missions National Monument in central New Mexico and White Sands Missile Range in south-central New Mexico. It is a major association of the San Andres Mountains.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association occurs at 1830 m (6010 feet) in elevation on a steep, northwest-facing slope. Soils are developed in rocky colluvium derived from sandstone of the Permian Abó Formation. The ground surface is typically rocky and gravelly with scattered grass patches and litter.

Globally

Within Salinas Pueblo Missions National Monument in central New Mexico, this association occurs at 1830 m (6010 feet) in elevation on a steep, northwest-facing slope. Soils are developed in rocky colluvium derived from sandstone of the Permian Abó Formation. The ground surface is typically rocky and gravelly with scattered grass patches and litter. Within White Sands Missile Range, this association is typically found on cool aspects of steep scarp slopes at elevations of 1700 to 2150 m (5500–7000+ feet). Occasionally it is found on more gentle dipslopes or along the toeslopes of mountain valleys. Soils are mostly shallow Inceptisols or weakly developed Alfisols. They are usually loamy with significant gravel, cobble and even a stony component (50% or more of the profile can be made up of coarse fragments). Calcium carbonate accumulations are also common lower in the profile (Muldavin et al. 2000b).

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This Madrean woodland/savanna is characterized by an open canopy of mature *Juniperus monosperma*; saplings or seedlings are also common. Occasionally seedling or sapling *Pinus edulis* can be present, commonly under the canopy of *Juniperus monosperma*. The understory is characterized by scattered bunches of *Muhlenbergia pauciflora* with a scattering of forbs.

Globally

Within Salinas Pueblo Missions National Monument in central New Mexico, this Madrean woodland or savanna is characterized by an open canopy of mature *Juniperus monosperma*; saplings or seedlings are also common. Occasionally seedling or sapling *Pinus edulis* can be present, commonly under the canopy of *Juniperus monosperma*. The understory is characterized by scattered bunches of *Muhlenbergia pauciflora* with a scattering of forbs. Within White Sands Missile Range in south-central New Mexico, this woodland is dominated by abundant *Juniperus monosperma*, with a grassy understory dominated by *Muhlenbergia pauciflora*. Scattered mature *Pinus edulis* may also be present. The shrub layer can be well-represented by a wide variety of species (38 species), with *Gutierrezia sarothrae, Rhus trilobata*, and *Yucca baccata* being the most abundant and constant. *Cercocarpus montanus* may also be present but is not dominant. In addition to *Muhlenbergia pauciflora*, other grasses may be well-represented or abundant, including *Bouteloua curtipendula, Muhlenbergia setifolia*, *Tridens muticus*, and *Achnatherum scribneri (= Stipa scribneri)*. A wide variety of forbs can occur, but forb species richness and abundance on a stand-by-stand basis are low; *Lesquerella fendleri, Melampodium leucanthum*, and *Viguiera dentata* are most constant (Muldavin et al. 2000b).

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma*
Herb (field)	*Muhlenbergia pauciflora*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma*
Herb (field)	*Muhlenbergia pauciflora*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (13-May-2009)

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

This association is also known from the San Andres Mountains, 65 miles to the south.

Globally

Data are not available.

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: The description is based on 1 field plot (rapid plot) from 2007: (Plot: 07AR018).

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King, mod. K.A. Schulz

REFERENCES

Dwyer and Pieper 1967, Fischer and Bradley 1987, Muldavin et al. 2000b, Muldavin et al. 2000c, Western Ecology Working Group n.d., Wright et al. 1979

***Juniperus monosperma / Muhlenbergia setifolia* Woodland**

One-seed Juniper / Curly-leaf Muhly Woodland

CODE	CEGL005386
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 (I.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)

Not determined

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This Madrean woodland or savanna occurs in central and south central New Mexico and is a major association of the Oscura and San Andres mountains. Sites are found on gentle dipslopes, moderately steep sideslopes of low hills and rolling plains and steep escarpments, mostly on warmer southerly aspects at elevations ranging from 1700 to 2150 m (5500–7000 feet). Soils are commonly relatively fertile Mollisols with well developed surface horizons, sub surface caliche layers, and a significant amount of gravel and cobble derived from sandstones or limestone. The ground surface is typically gravelly with scattered grass patches and litter. Vegetation is characterized by an open canopy of mature *Juniperus monosperma*; saplings or seedlings are also common. Occasionally seedling or sapling *Pinus edulis* can be present, commonly under the canopy of *Juniperus monosperma*. The grassy understory is characterized by dominance of *Muhlenbergia setifolia*, often in scattered bunches along with *Bouteloua gracilis*. Other

grasses may be well represented or abundant, including *Bouteloua eriopoda, Bouteloua hirsuta, Aristida purpurea*, and *Bouteloua curtipendula*, but not dominant. A wide variety of forbs can occur, generally with low cover. *Dalea formosa, Ipomopsis aggregata, Lesquerella fendleri, Melampodium leucanthum*, and *Physalis hederifolia* var. f*endleri* are most constant. Shrubs are present but low in cover and may include a wide variety of species; *Gutierrezia sarothrae, Nolina microcarpa, Opuntia phaeacantha, Rhus trilobata*, and *Yucca baccata* are constant associates.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This association is commonly found in the Abó unit of the monument.

Globally

This association is known to occur within Salinas Pueblo Missions National Monument in central New Mexico and White Sands Missile Range in south central New Mexico.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association occurs between 1820 and 1875 m (5970–6155 feet) in elevation mostly on warmer southerly aspects. Sites occur on gentle to moderately steep (10–30%) sideslopes of low hills and rolling plains. Soils are developed in slope colluvium derived from sandstones of the Permian Abó or Yeso formations. The ground surface is typically gravelly with scattered grass patches and litter.

Globally

Sites of this association within Salinas Pueblo Missions National Monument in central New Mexico occur between 1820 and 1875 m (5970–6155 feet) in elevation, mostly on warmer southerly aspects. Sites occur on gentle to moderately steep (10–30%) sideslopes of low hills and rolling plains. Soils are developed in slope colluvium derived from sandstones of the Permian Abó or Yeso formations. The ground surface is typically gravelly with scattered grass patches and litter. Within White Sands Missile Range in south central New Mexico, this association is found at elevations ranging from 1700 to 2070 m (5600–6800 feet) on both gentle dipslopes and steep escarpments of either limestone or sandstone. Soils are commonly relatively fertile Mollisols with well developed surface horizons, sub surface caliche layers, and a significant amount of gravel and cobble (Muldavin et al. 2000b).

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This Madrean woodland/savanna is characterized by an open canopy of mature *Juniperus monosperma*; saplings or seedlings are also common. Occasionally seedling or sapling *Pinus edulis* can be present, commonly under the canopy of *Juniperus monosperma*. The understory is characteristically grassy and dominated by *Muhlenbergia setifolia* along with *Bouteloua gracilis*. *Bouteloua eriopoda, Bouteloua hirsuta, Aristida purpurea*, and *Bouteloua curtipendula* may also be common, but not dominant. Forbs and shrubs are scattered and variable and may include *Physalis hederifolia* var. *fendleri, Ipomopsis aggregata, Melampodium leucanthum, Dalea formosa*, and *Gutierrezia sarothrae*.

Globally

Within Salinas Pueblo Missions National Monument in central New Mexico, this Madrean woodland/savanna is characterized by an open canopy of mature *Juniperus monosperma;* saplings or seedlings are also common. Occasionally seedling or sapling *Pinus edulis* can be present, commonly under the canopy of *Juniperus monosperma*. The understory is characteristically grassy and dominated by *Muhlenbergia setifolia* along with *Bouteloua gracilis*. *Bouteloua eriopoda, Bouteloua hirsuta, Aristida purpurea*, and *Bouteloua curtipendula* may also be common, but not dominant. Forbs and shrubs are scattered and variable and may include *Physalis hederifolia* var. *fendleri*, *Ipomopsis aggregata*, *Melampodium leucanthum, Dalea formosa*, and *Gutierrezia sarothrae*. Within White Sands Missile Range in south central New Mexico, this woodland association is distinguished by a very open to moderately open tree canopy dominated by *Juniperus monosperma*. Scattered *Pinus edulis* may also be present. The grassy understory is dominated by *Muhlenbergia setifolia* that is abundant to luxuriant. Shrubs are present but low in cover and may include a wide variety of species; *Nolina microcarpa, Opuntia phaeacantha, Rhus trilobata*, and Y*ucca baccata* are constant associates. The herbaceous layer is also highly diverse. *Aristida purpurea, Bouteloua curtipendula*, and *Bouteloua gracilis*

are often present, though at much lower cover than *Muhlenbergia setifolia*. Common forb species, although scarce, include *Lesquerella fendleri* and *Melampodium leucanthum* (Muldavin et al. 2000b).

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma*
Herb (field)	*Muhlenbergia setifolia*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma*
Herb (field)	*Muhlenbergia setifolia*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (13 May 2009)

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

This association is also known from the San Andres Mountains, 65 miles to the south.

Globally

Data are not available.

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: The description is based on 7 field plots (1 standard and 6 rapid plots) from 2004 2005 and 2007: (Plots: 04EA007, 05AR008, 07AR005, 07AR012, 07AR016, 07AR017 and 07AR027).

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King, 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. 2000b, NMNHP unpubl. data, Peet 1975, Peet 1981, Wasser and Hess 1982, Western Ecology Working Group n.d.

Juniperus monosperma / *Quercus* × *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 forest (I.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 is known to occur in the Rocky Mountains in central New Mexico, and locally in northern New Mexico on gentle to moderate (15–40%) rocky slopes. It intergrades to scarp woodland with increasing steepness and rocky outcrop terrain. Elevations range from 1830 to 1980 m (6000–6500 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 t*rees with scattered saplings or seedlings. In the shrub layer, *Quercus* × *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., Q*uercus 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

Salinas Pueblo Missions National Monument

This association is found in the Gran Quivira unit of the monument and is uncommon.

Globally

This woodland association is known to occur in the Rocky Mountains in central New Mexico, and locally in northern New Mexico.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association is known from 1990 m (6520 feet) in elevation on a gentle, south facing slope of a low hill. 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.

Globally

This woodland is known to occur in the Rocky Mountains in central New Mexico, and locally in northern New Mexico on gentle to moderate (15–40%) rocky slopes. It intergrades to scarp woodland with increasing steepness and rocky outcrop terrain. Elevations range from 1830 to 1980 m (6000 to 6500 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.

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This Rocky Mountain woodland/savanna is characterized by an open canopy of mature *Juniperus monosperma* with scattered saplings or seedlings. *Quercus* × *pauciloba* is well represented in the intercanopy spaces. In the herbaceous layer, graminoids can be well represented and dominated by *Bouteloua gracilis* along with *Bouteloua eriopod*a and *Schizachyrium scoparium*. Forbs are scarce.

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* × *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.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma*
Shrub/sapling (tall & short)	*Quercus* × *pauciloba*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma*
Shrub/sapling (tall & short)	*Quercus* × *pauciloba*
Herb (field)	*Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23 Feb 1994)

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: The description is based on 1 field plot (standard plot) from 2004: (Plot: 04SG007).

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, 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* / 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, short statured woodland has been described from Bandelier National Monument in north central New Mexico and Salinas Pueblo Missions National Monument in central New Mexico. The majority of sites occur on summits and undulating plateaus with gentle to moderate slopes (4–20%). Occasionally, stands can be found on sideslopes of plateaus with rockier soils and gentle sideslopes of low hills in the plains. Aspects are variable, although solar exposure tends to go from low to high with increasing elevation. Soils are variable, being composed of eolian material, alluvium or colluvium derived from rhyolitic tuff or pumice. There is usually high cover of bare ground. Vegetation is characterized by an open to moderately dense woodland dominated by *Juniperus monosperma* with tree canopies that range from 10 to 40% cover. *Juniperus* regeneration is common along with scattered *Pinus edulis* seedlings and saplings. This understory is typically sparse (<10% total cover) and has only scattered graminoids, such as *Aristida purpurea* or *Bouteloua gracilis*, and few forbs. Shrubs and dwarf shrubs are also scattered and most commonly represented by *Yucca glauca, Opuntia polyacantha*, and *Gutierrezia sarothrae*.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This common association is known from the Abó and Gran Quivira units of the monument.

Globally

This lower elevation Rocky Mountain woodland has been described from Bandelier National Monument in north central New Mexico, Salinas Pueblo Missions National Monument in central New Mexico, and White Sands Missile Range in south central New Mexico.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association occurs on sites between 1830 and 1990 m (6000–6530 feet) in elevation on moderately warm southeasterly aspects of gentle sideslopes of low hills. Soils are developed in piedmont alluvial and colluvial deposits derived from sandstones and limestones of the Permian Abó, Yeso, and San Andres formations. The ground surface is characterized by exposed soil and gravel with widely scattered grass patches and litter.

Globally

This lower elevation Rocky Mountain woodland association has been described from Bandelier National Monument in north central New Mexico and Salinas Pueblo Missions National Monument in central New Mexico. It is also a minor association found within White Sands Missile Range in south central New Mexico. Within Bandelier National Monument, 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. Within Salinas Pueblo Missions National Monument, this association occurs on sites between 1830 and 1990 m (6000–6530 feet) in elevation on moderately warm southeasterly aspects of gentle sideslopes of low hills. Soils are developed in piedmont alluvial and colluvial deposits derived from sandstones and limestones of the Permian Abó, Yeso, and San Andres formations. The ground surface is characterized by exposed soil and gravel with widely scattered grass patches and litter. Within the northern San Andres Mountains and Chupadera Mesa area of White Sands Missile Range, this association occurs at higher elevations (1850–2450 m [6000–8000 feet]) on cool aspects of gentle to moderate slopes (Muldavin et al. 2000b).

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This Rocky Mountain woodland/savanna is characterized by an open canopy of mature *Juniperus monosperma* with scattered saplings or seedlings. Occasionally seedling or sapling *Pinus edulis* can be present, commonly under the canopy of *Juniperus monosperma*. These stands are characterized by a sparse herbaceous layer with only scattered graminoids such as *Aristida purpurea* or *Bouteloua gracilis* present and typically poorly represented as are forbs. Shrubs are also scattered and most commonly represented by *Yucca glauca*, *Opuntia polyacantha*, and *Gutierrezia sarothrae*.

Globally

Within 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 to 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*). Within Salinas Pueblo Missions National Monument, vegetation is characterized by an open canopy of mature *Juniperus monosperma* with scattered saplings or seedlings. Occasionally seedling or sapling *Pinus edulis* can be present, commonly under the canopy of *Juniperus monosperma*. These stands are characterized by a sparse herbaceous layer with only scattered graminoids such as *Aristida purpurea* or *Bouteloua gracilis* present and typically poorly represented as are forbs. Shrubs are also scattered and most commonly represented by *Yucca glauca*, *Opuntia polyacantha*, and *Gutierrezia sarothrae*. Within White Sands Missile Range, this moderately open woodland is

characterized by *Juniperus monosperma*. Pinus edulis can be a subdominant associate or may be absent. Understory shrub, grass and forb cover is very low and usually does not exceed 1 to 2% cover. Diversity is also exceptionally low, particularly among the grasses and forbs. *Yucca baccata* and *Opuntia phaeacantha* are the most constant shrub species (Muldavin et al. 2000b).

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma*

Globally

Stratum	Species
Tree canopy	*Juniperus monosperma*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23 Jan 2009)

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 Moderate

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: The description is based on 8 field plots (2 standard and 6 rapid plots) from 2004 2005 and 2007: (Plots: 04SG009, 05AR006, 07AR004, 07AR029, 07AR045, 07AR054, 07AR055 and 07AR059).

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King after A. Browder and E. Muldavin, mod. K.A. Schulz

REFERENCES

Dwyer and Pieper 1967, Fischer and Bradley 1987, Muldavin et al. 2000b, Western Ecology Working Group n.d., Wright et al. 1979.

Juniperus monosperma / Schizachyrium scoparium Woodland [Park Special]

One-seed Juniper / Little Bluestem Woodland [Park Special]

CODE	Not applicable
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 Pinyon-Juniper Woodland (CES306.835), Southern Rocky Mountain Juniper Woodland and Savanna (CES306.834)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This open woodland/savanna association is only known from the Gran Quivira unit of the monument on northerly aspects of slopes of low hills and rolling plains between 1930 and 1990 m (6340–6530 feet) in elevation. Soils are developed in slope colluvium derived from limestones and occasionally on Quaternary alluvium. The ground surface is characterized by scattered grass patches and litter amid an equal amount of exposed soil and gravel. The vegetation is characterized by an open canopy of mature *Juniperus monosperma*; saplings or seedlings are also common. Occasionally seedling or sapling *Pinus edulis* can be present, commonly under the canopy of *Juniperus monosperma*. The understory is characteristically grassy and dominated by abundant *Schizachyrium scoparium* with *Bouteloua gracilis* and *Sporobolus cryptandrus* as common associates. Forbs are variable and with low cover represented. Shrubs and succulents are also scattered and most commonly represented by *Gutierrezia sarothrae*, *Opuntia polyacantha*, *Opuntia phaeacantha*, and *Yucca glauca*.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This association is only known from the Gran Quivira unit of the monument.

Globally

Data are not available.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association occurs between 1930 and 1990 m (6340–6530 feet) in elevation on northerly aspects of slopes of low hills and rolling plains. Soils are developed in slope colluvium derived from limestones of the Permian San Andres Formation and occasionally on Quaternary alluvium. The ground surface is characterized by scattered grass patches and litter amid an equal amount of exposed soil and gravel.

Globally

Data are not available.

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This Rocky Mountain woodland savanna is characterized by an open canopy of mature *Juniperus monosperma*; saplings or seedlings are also common. Occasionally seedling or sapling *Pinus edulis* can be present, commonly under the canopy of *Juniperus monosperma*. The understory is characteristically grassy and dominated by abundant *Schizachyrium scoparium* with *Bouteloua gracilis* and *Sporobolus cryptandrus* as common associates, among nine graminoid species reported for the association. Forbs are variable and poorly represented; the most frequent species include *Eriogonum hieraciifolium*, *Mirabilis multiflora*, and *Schoenocrambe linearifolia*. Shrubs are also scattered and most commonly represented by *Gutierrezia sarothrae*, *Yucca glauca* and succulents such as *Opuntia polyacantha* and *Opuntia phaeacantha*.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma*
Herb (field)	*Schizachyrium scoparium*

Globally

Stratum	Species
Data are not available	

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Bouteloua gracilis, Eriogonum hieraciifolium, Mirabilis multiflora, Schoenocrambe linearifolia, Sporobolus cryptandrus, Yucca elata, Yucca glauca

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: Not applicable

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

This association is only known from the Gran Quivira unit of Salinas Pueblo Missions National Monument and is being treated as a local type [Park Special], until more stands are found.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: Not applicable

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: The description is based on 3 field plots (1 standard and 2 rapid plots) from 2004: (Plots: 04SG008, 04SG012 and 04SG013).

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: Not applicable

REFERENCES

Not applicable

***Pinus edulis* - (*Juniperus monosperma, Juniperus deppeana*) / *Bouteloua gracilis* Woodland (CEGL002151)**

Two-needle Pinyon (One-seed Juniper, Alligator Juniper) / Blue Grama Woodland

CODE	CEGL002151
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	*PINUS EDULIS* (*JUNIPERUS* SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S)

Colorado Plateau Pinyon Juniper Woodland (CES304.767), Southern Rocky Mountain Pinyon Juniper Woodland (CES306.835)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This widespread woodland association occurs in Colorado, Oklahoma, New Mexico, and possibly Texas and east central Arizona. It is known from the foothills and mountains of the southern Colorado Front Range, New Mexico, and the hills, canyons, escarpments and other breaks in the southwestern Great Plains. Elevations range from 1525 2445 m (5000–8000 feet), but may be higher in stands in southern New Mexico. Stands occur on gently sloping low hills and plains, on flat to moderate slopes along drainages and on mesa tops, and on moderate to steep rocky slopes of foothills, mountains and canyons. The soils are variable but are typically shallow, gravelly calcareous, finer textured soils (clay loam or silty clay) with a caliche layer or bedrock outcrops not uncommon. Parent materials include limestone, sandstone, and basalt. The ground surface is may be characterized by scattered grass patches and litter amid an equal amount of exposed soil and gravel. The vegetation is characterized by an open to moderately dense tree canopy (10–60% cover) codominated by *Pinus edulis* and *Juniperus monosperma* with a grassy understory dominated by *Bouteloua gracilis*. *Pinus edulis* may be present with relatively small cover in some stands. *Juniperus deppeana* or *Juniperus coahuilensis* may replace *Juniperus monosperma* in southern stands. Other species of *Juniperus* such as *Juniperus scopulorum* may be present at upper elevations. The shrub layer is sparse. If *Quercus gambelii* is present, it has less than 5% cover. Scattered *Agave* spp., *Cercocarpus montanus, Dasylirion wheeleri, Gutierrezia sarothrae, Opuntia* spp., or *Yucca* spp. may be present. The herbaceous layer is moderately dense to dense and is dominated by the warm season, perennial short grass *Bouteloua gracilis*. Associated graminoids include *Aristida spp.*, *Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Elymus elymoides, Koeleria macrantha, Hesperostipa comata* (= *Stipa comata*), *Hesperostipa neomexicana* (= *Stipa neomexicana*), *Muhlenbergia torreyi*, and *Pleuraphis jamesii* (= *Hilaria jamesii*). *Muhlenbergia montana* is absent or scarce (<1% cover). Forb cover is typically low, but may be moderately diverse. Species such as *Cryptantha cinerea* var. *jamesii* (= *Cryptantha jamesii*), *Eriogonum jamesii, Hymenopappus filifolius,* and *Mentzelia* spp. are common.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This association is known from the Abó and Quarai units of the monument.

Globally

This widespread woodland association occurs in southern Colorado, western Oklahoma, New Mexico, and possibly Texas and east central Arizona.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

Sites of this association are known to occur at 1845 m (6060 feet) elevation on a northerly aspect and 2035 m (6685 feet) on a southerly aspect. Stands are found on gently sloping low hills and plains. Soils are developed in slope alluvial and colluvial deposits of Permian Abó or Yeso formation sandstones. The ground surface is characterized by scattered grass patches and litter amid an equal amount of exposed soil and gravel.

Globally

This widespread woodland association occurs in Colorado, Oklahoma, New Mexico, and possibly Texas and east central Arizona. It is known from the foothills and mountains of the southern Colorado Front Range, New Mexico, and the hills, canyons, escarpments and other breaks in the southwestern Great Plains. Elevations range from 1525 to 2444 m (5000–8000 feet), but may be higher in stands in southern New Mexico. Stands occur on gently sloping low hills and plains, on flat to moderate slopes along drainages and on mesa tops, and on moderate to steep rocky slopes of foothills, mountains and canyons. The soils are variable but are typically shallow, gravelly calcareous, finer textured soils (clay loam, silty clay) with a caliche layer or bedrock outcrops not uncommon. Parent materials include limestone, sandstone, and basalt. The ground surface is may be characterized by scattered grass patches and litter amid an equal amount of exposed soil and gravel.

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This Rocky Mountain woodland is characterized by moderate canopies dominated by mature *Pinus edulis* with *Juniperus monosperma* as a subdominant. Saplings or seedlings of both species can be common. Shrubs species are poorly represented or absent; the ruderal subshrub *Gutierrezia sarothrae* and succulents such as *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* as common associates. Forbs are variable and low in cover and may include *Ipomopsis multiflora, Astragalus* sp., and *Erigeron divergens*.

Globally

This plant association is characterized by an open to moderately dense tree canopy (10–60% cover) codominated by *Pinus edulis* and *Juniperus monosperma* with a grassy understory dominated by *Bouteloua gracilis*. *Pinus edulis* may be present with relatively small cover in some stands. *Juniperus deppeana* or *Juniperus coahuilensis* may replace *Juniperus monosperma* in southern stands. Other species of *Juniperus* such as *Juniperus scopulorum* may be present at upper elevations. The shrub layer is sparse. If *Quercus gambelii* is present, it has less than 5% cover. Scattered *Agave* spp., *Cercocarpus montanus, Dasylirion wheeleri, Gutierrezia sarothrae, Opuntia* spp., or *Yucca* spp. may be present. The herbaceous layer is moderately dense to dense and is dominated by the warm season, perennial short grass *Bouteloua gracilis*. Associated graminoids include *Aristida* spp., *Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Elymus elymoides, Koeleria macrantha, Hesperostipa comata* (=*Stipa comata*), *Hesperostipa neomexicana* (=*Stipa neomexicana*), *Muhlenbergia torreyi*, and *Pleuraphis jamesii* (=*Hilaria jamesii*). *Muhlenbergia montana* is absent or scarce (<1% cover). Forb cover is typically low, but may be moderately diverse. Species such as *Cryptantha cinerea* var. *jamesii* (=*Cryptantha jamesii*), *Eriogonum jamesii*, *Hymenopappus filifolius*, and *Mentzelia* spp. are common. Other forbs may include *Ipomopsis multiflora*, *Astragalus* spp., and *Erigeron divergens*.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Tree canopy	*Juniperus monosperma, Pinus edulis*
Herb (field)	*Bouteloua gracilis*

Globally

Stratum	Species
Tree canopy	*Juniperus deppeana, Juniperus monosperma, Juniperus scopulorum, Pinus edulis*
Herb (field)	*Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G5?(15 Dec 1994)

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

The two *Pinus edulis* / *Bouteloua gracilis* plant associations are treated as phases in Stuever and Hayden (1997a). In the USNVC we are including stands with southern Great Plains, Chihuahua Desert floristic affinities in *Pinus edulis* (*Juniperus monosperma*) / *Bouteloua gracilis* Woodland (CEGL002151), and stands with the Colorado Plateau and Great Basin floristic affinities in *Pinus edulis* (*Juniperus osteosperma*) / *Bouteloua gracilis* Woodland (CEGL000778). Both of these associations may include stands codominated by *Juniperus deppeana* in their southern extent. Stuever and Hayden (1997a) also described a *Juniperus deppeana* phase (recognized by its dominance in the stand) and hill-slope phase, which occurs on slopes >15% and may have low cover of grasses (<5% cover). More survey is needed to fully understand the distribution and ecological relationships between these 3 species of *Juniperus*.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: The description is based on 4 field plots (1 standard and 3 rapid plots) from 2004 and 2007: (Plots: 04EA006, 04EA011, 04SQ001 and 07AR026).

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz, mod. K.S. King

REFERENCES

Barnes 1987, Blair and Hubbell 1938, Bourgeron and Engelking 1994, Bruner 1931, CONHP unpubl. data 2003, Caire 1989, Dick Peddie 1993, Duck and Fletcher 1945, Dwyer and Pieper 1967, Francis 1986, Hoagland 2000, Jameson 1962, Kennedy 1983, Ladyman and Muldavin 1996, Larson and Moir 1987, Little 1987, Moir and Carleton 1987,

Muldavin and Mehlhop 1992, Muldavin et al. 1994, Muldavin et al. 1998a, Muldavin et al. 2000b, Powell 1988a, Rogers 1949, Rogers 1953, Rogers 1954, Shaw et al. 1989, Stuever and Hayden 1997a, Western Ecology Working Group n.d., Wright et al. 1979.

***Populus angustifolia / Prunus virginiana* Woodland**

Narrowleaf Cottonwood / Chokecherry Woodland

CODE	CEGL000651
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*POPULUS ANGUSTIFOLIA* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.641) Narrowleaf Cottonwood Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S)

Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This is a riparian woodland of low elevation (1600–2500 m [5240–8200 feet]) foothills in Colorado, New Mexico, and Wyoming, along the western edge of the Great Plains and in the intermountain basins. Stands of this association occur in narrow to moderately broad stream valleys and narrow canyons in the foothills on narrow, elevated, or steeply sloping streambanks and benches. On these higher terraces, stands are infrequently flooded (10 to 100 year estimated recurrence interval). Stream channels are broad, low to medium gradient, and slightly sinuous. Soils are typically shallow sandy clay loams with many fine layers from fluvial deposition. The vegetation is characterized by a moderately dense (>50% cover) overstory canopy dominated by *Populus angustifolia* (or in some stands *Populus* × *acuminata*) with a moderately dense to very dense shrub layer dominated by *Prunus virginiana*. Other trees occasionally present with low cover include *Juniperus scopulorum, Pinus ponderosa, Pseudotsuga menziesii, Populus tremuloides*, and *Quercus gambelii*, especially at on the fringes of stands. *Acer negundo* may also be present in substantial amounts. The shrub layer may also include substantial amounts of *Acer glabrum, Alnus incana, Amelanchier alnifolia, Cornus sericea* ssp. *sericea, Betula occidentalis, Ribes* spp., *Rosa woodsii, Symphoricarpos* spp., tree saplings, and the woody vine *Parthenocissus vitacea*. *Salix* spp. are typically poorly represented or absent. *Prunus virginiana* is considered a non obligate riparian species because it typically grows on the outer edge of the riparian area. The herbaceous cover is moderate to dense and frequently dominated by introduced perennial grasses such as *Poa pratensis*, *Agrostis gigantea, Agrostis stolonifera, Bromus inermis, Bromus tectorum*, and *Phleum pratense*. Native graminoids C*arex geyeri, Carex pellita, Carex praegracilis, Elymus canadensis, Elymus trachycaulus, Juncus arcticus*, and wet or mesic forbs, such as *Equisetum arvense, Galium* spp., *Hydrophyllum fendleri, Heracleum maximum*, and *Solidago canadensis*, are also common.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This association is known from the Quarai unit.

Globally

This foothill riparian woodland association occurs from the San Juan and Canadian river watersheds in northern and central New Mexico, north along the Colorado Front Range and on tributaries of the Gunnison River on the western slope of Colorado to north central Wyoming.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This riparian association is recorded from about 2025 m (6650 feet) elevation along the upper alluvial terraces of a perennial stream.

Globally

This is a riparian woodland of low elevation (1600–2642 m [5240–8200 feet]) foothills in Colorado, New Mexico, and Wyoming, along the western edge of the Great Plains as well as into the intermountain basins. Stands of this association occur in narrow to moderately broad stream valleys and narrow canyons in the foothills on narrow, elevated, or steeply sloping streambanks and benches. On these higher terraces, stands are infrequently flooded (10 to 100 year estimated recurrence interval) (Muldavin et al. 2000a). Stream channels are broad, low to medium gradient, and slightly sinuous (Girard et al. 1997, Kittel et al. 1999b, Carsey et al. 2003a). Soils are typically shallow sandy loams or sandy clay loams with many fine layers from fluvial deposition and vary from wet and rocky Fluvaquentic Endoaquolls to drier Fluventic Ustochrepts (Muldavin et al. 2000a).

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This is a closed canopied riparian forest dominated by *Populus angustifolia* with a shrubby understory dominated by *Prunus virginiana*, along with *Rosa woodsii, Ribes aureum*, and the woody vine *Parthenocissus vitacea* as well represented shrub associates. Herbaceous vegetation is graminoid, dominated by facultative and obligate wetland species such as *Juncus arcticus* and *Carex praegracilis*.

Globally

This riparian woodland association is characterized by a moderately dense (>50% cover) overstory canopy dominated by *Populus angustifolia* (or in some stands *Populus* × *acuminata*), with a moderately dense to very dense shrub layer dominated by *Prunus virginiana*. Other trees occasionally present with low cover include *Juniperus scopulorum, Pinus ponderosa*, *Pseudotsuga menziesii, Populus tremuloides*, and *Quercus gambelii*, especially on the fringes of stands. *Acer negundo* may also be present in substantial amounts. The shrub layer may also include substantial amounts of *Acer glabrum, Alnus incana, Amelanchier alnifolia*, *Cornus sericea* ssp. *sericea, Betula occidentalis, Ribes* spp., *Rosa woodsii, Symphoricarpos* spp., tree saplings, and the woody vine *Parthenocissus vitacea*. *Salix* spp. are typically poorly represented or absent. *Prunus virginiana* is considered a non obligate riparian species because it typically grows on the outer edge of the riparian area. The herbaceous cover is moderate to dense and frequently dominated by introduced grasses, such as *Poa pratensis, Agrostis gigantea, Agrostis stolonifera, Bromus inermis, Bromus tectorum*, and *Phleum pratense*. Native graminoids *Carex geyeri, Carex pellita, Carex praegracilis, Elymus canadensis*, *Elymus trachycaulus*, *Juncus arcticus*, and wet or mesic forbs, such as *Equisetum arvense*, *Galium* spp., *Hydrophyllum fendleri, Heracleum maximum*, and *Solidago canadensis*, are also common.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Tree canopy	*Populus angustifolia*
Shrub/sapling (tall & short)	*Prunus virginiana*

Globally

Stratum	Species
Tree canopy	*Populus angustifolia*
Tall shrub/sapling	*Prunus virginiana*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G2Q (30 Nov 1998). The range of this association apparently extends from central Colorado, north to north central Wyoming, a distance of ca. 400 miles. So far, the range appears very narrow (<100 miles) from east to west. Exotic species (especially *Poa pratensis* and *Agrostis stolonifera*) are common in the herbaceous layer of the stands described to date. Stands in Colorado are threatened by development and alterations in stream flow. The rank has been changed from G2G3 to G2Q based on the assumptions that the range of this association contains about a dozen stands, and that a high proportion of those stands face little threat because they grow in inaccessible locations. The "Q" portion is based on the uncertainty about whether the Wyoming stands and the Colorado stands belong to the same association, as well as some uncertainty about the range and number of stands.

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

This type is similar to some stands of *Populus angustifolia* / *Cornus sericea* Woodland (CEGL002664), *Acer negundo Populus angustifolia* / *Cornus sericea* Forest (CEGL000627), and *Populus angustifolia Acer negundo* Woodland (CEGL005992), when stands include patches of *Prunus virginiana* or are codominated by *Acer negundo*. The type needs further survey and classification work to insure it is distinct from these other similar association. Medina (1986) describes a *Populus angustifolia* / *Prunus serotina Salix bonplandiana* community type from southern New Mexico which shares some similarities to this type.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plot: 04SQ007.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: G.P. Jones, mod. E. Muldavin, K.A. Schulz, K.S. King

REFERENCES

Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Carsey et al. 2003a, Carsey et al. 2003b, Driscoll et al. 1984, Girard et al. 1997, Gom and Rood 1999, Jones 1992b, Kittel et al. 1999a, Kittel et al. 1999b, Marriott and Jones 1989, Medina 1986, Muldavin et al. 2000a, Walford 1996, Western Ecology Working Group n.d.

Salix gooddingii / Salix exigua Woodland

Goodding's Willow / Coyote Willow Woodland

CODE	CEGL003778
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*SALIX GOODDINGII* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.640) Goodding's Willow Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S)

Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This riparian woodland is known from the Colorado Plateau in southeastern Utah and occurs on sandy wash bottoms in narrow slickrock canyons and intermittently flooded terraces of the Colorado River. Water tables remain at or near the surface throughout the growing season. Sampled sites are gently sloping and occur at 1293–1835 m elevation. The unvegetated surface has high cover of litter and generally sparse cover of bare soil and large rocks. Soils are intermittently moist to saturated loamy sands to poorly drained sandy clay derived from alluvium. The vegetation is characterized by an open to moderately dense tree canopy (up to 85% cover) that is dominated by 10 to 35 m tall *Salix gooddingii* trees. Scattered *Celtis laevigata* var. r*eticulata* (= *Celtis reticulata*) and emergent *Populus fremontii* or *Populus angustifolia* trees may be present in or above the tree canopy. The tall shrub understory is dominated by *Salix exigua*, usually with 35 to 45% cover, but *Forestiera pubescens* and exotic *Tamarix chinensis* can contribute significant cover. Native herbaceous species may include obligate and facultative wetland species such as *Eleocharis rostellata, Equisetum laevigatum, Juncus arcticus, Schoenoplectus pungens*, and *Typha* sp. The herbaceous layer often consists largely of weedy or exotic forbs such as *Ambrosia acanthicarpa, Salsola tragus*, and *Xanthium strumarium*, or the introduced pasture grass *Lolium arundinaceum* (= *Festuca arundinacea*).

DISTRIBUTION

Salinas Pueblo Missions National Monument

This association is known from the Abó unit.

Globally

This association is known from Arches and Canyonlands national parks in southeastern Utah and from Salinas Pueblo Missions National Monument in New Mexico, but likely occurs elsewhere in the southwestern U.S. along rivers and streams with periodic flooding.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association is found at an elevation of around 1835 m (6000 feet) elevation on the alluvial terraces of a perennial stream.

Globally

This riparian woodland occurs on sandy wash bottoms in narrow slickrock canyons and intermittently flooded terraces of the Colorado River in the Colorado Plateau. Water tables remain at or near the surface throughout the growing season. Sampled sites are gently sloping and occur at 1293–1835 m elevation. The unvegetated surface has high

cover of litter, sparse to moderate cover of sand or bare soil, and sparse cover of large rocks. Soils are intermittently moist to saturated loamy sands to poorly drained sandy clay derived from alluvium.

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This riparian forest is characterized by a moderate canopy (60% cover) of *Salix gooddingii* with a characteristically shrubby understory dominated by *Salix exigua*. The herbaceous layer is represented by obligate and facultative wetland species such as *Juncus arcticus, Schoenoplectus pungens, Eleocharis rostellata*, and *Equisetum laevigatum* along with the introduced pasture grass *Lolium arundinaceum* (= *Festuca arundinacea*). *Populus angustifolia* is occasionally present in the canopy.

Globally

This riparian woodland is characterized by an open to moderately dense tree canopy (up to 85% cover) that is dominated by 10 to 35 m tall S*alix gooddingii* trees. Scattered *Celtis laevigata* var. *reticulata* (= *Celtis reticulata*) and emergent *Populus fremontii* or *Populus angustifolia* trees may be present in or above the tree canopy. The tall shrub understory is dominated by *Salix exigua*, usually with 35 to 45% cover, but *Forestiera pubescens* and exotic *Tamarix chinensis* can contribute significant cover. Native herbaceous species may include obligate and facultative wetland species such as *Eleocharis rostellata, Equisetum laevigatum, Juncus arcticus, Schoenoplectus pungens*, and *Typha* sp. The herbaceous layer often consists largely of weedy or exotic forbs such as *Ambrosia acanthicarpa, Salsola tragus*, and *Xanthium strumarium*, or the introduced pasture grass *Lolium arundinaceum* (= F*estuca arundinacea*). Seedling *Populus fremontii* may also be present in the ground layer.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Tree canopy	*Salix gooddingii*
Shrub/sapling (tall & short)	*Salix exigua*

Globally

Stratum	Species
Tree canopy	*Salix gooddingii*
Tall shrub/sapling	*Salix exigua*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (20 Mar 2006).

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plots: 04EA001 05AR003 07AR001 and 07AR043.

Local Description Authors: E. Muldavin and A. Kennedy

Global Description Authors: K.A. Schulz, mod. K.S. King

REFERENCES

Western Ecology Working Group n.d.

***Salix gooddingii* Woodland**

Goodding's Willow Woodland

CODE	CEGL002743
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
ALLIANCE	*SALIX GOODDINGII* TEMPORARILY FLOODED WOODLAND ALLIANCE (A.640) Goodding's Willow Temporarily Flooded Woodland Alliance

ECOLOGICAL SYSTEM(S)

North American Warm Desert Lower Montane Riparian Woodland and Shrubland (CES302.748), North American Warm Desert Riparian Woodland and Shrubland (CES302.753)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This palustrine woodland is found in the Trans-Pecos of western Texas, New Mexico, southern Arizona and possibly north of the Mogollon Rim, and Nevada. It is also found in the Mexican states of Chihuahua and Coahuila and possibly Sonora. Elevation range is wide, from 239–2210 m (780 –7245 feet), but stands generally occur below 1300 m (4260 feet). Sites are flat to gently sloping and occur along the alluvial terraces of streams in mesic desert canyons and floodplains on basin floors. Stands also occur in isolated pockets in canyons and rocky floodplains of small, intermittent streams associated with seeps and springs. Alluvial substrates are variable but are often fine textured loams or clays. The vegetation is characterized by abundant *Salix gooddingii* that dominates or codominates the open to moderately dense (20–60% cover) tree canopy. *Prosopis velutina, Prosopis glandulosa*, or *Fraxinus velutina* may codominate the 5 to 15 m tall tree canopy. *Populus fremontii* is generally absent or uncommon (<1%). *Populus angustifolia* is occasionally present in the canopy. Shrubs may be present but seldom form a stratum. Other tree and shrub species present may include *Baccharis salicifolia, Celtis laevigata* var. *reticulata, Juglans microcarpa, Mahonia haematocarpa* (= *Berberis haematocarpa*), *Quercus* spp., *Sapindus saponaria* var. *drummondii, Ungnadia speciosa*, and *Ziziphus obtusifolia*, depending on location and hydrology. The herbaceous layer is typically moderately dense to dense, often diverse and composed of mesic forbs and graminoids. Common species include *Ambrosia confertiflora, Berula erecta, Eleocharis palustris, Equisetum laevigatum, Ipomoea* spp., *Juncus arcticus, Juncus balticus, Muhlenbergia asperifolia, Physalis longifolia, Polygonum* spp., *Schoenoplectus* spp., *Veronica anagallis aquatica*, and *Xanthium strumarium*. Disturbance is common in this woodland, and introduced species such as *Echinochloa crus galli, Lactuca serriola, Lolium arundinaceum* (= *Festuca arundinacea*), *Rumex crispus, Sorghum halepense*, and *Tamarix* spp. are present in many stands. Diagnostic of the woodland is the dominance or codominance of *Salix gooddingii* in the tree canopy with *Populus fremontii* absent or uncommon.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This association is known from the Abó unit.

Globally

This palustrine woodland is found in the Trans-Pecos of western Texas, New Mexico, southern Arizona and possibly north of the Mogollon Rim, and Nevada. It is also found in the Mexican states of Chihuahua and Coahuila and possibly Sonora.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association is found at an elevation of around 1835 m (6000 feet) along the alluvial terraces of a perennial stream.

Globally

This palustrine woodland is found in the Trans-Pecos of western Texas, New Mexico, southern Arizona and possibly north of the Mogollon Rim, and Nevada. It is also found in the Mexican states of Chihuahua and Coahuila and possibly Sonora. Elevation range is wide, from 239–2210 m (780–7245 feet), but stands generally occur below 1300 m (4260 feet). Sites are flat to gently sloping and occur along the alluvial terraces of streams in mesic desert canyons and floodplains on basin floors. Stands also occur in isolated pockets in canyons and rocky floodplains of small, intermittent streams associated with seeps and springs. Alluvial substrates are variable but are often fine textured loams or clays.

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This riparian forest is characterized by a moderate canopy (60% cover) of *Salix gooddingii* with an understory dominated by facultative wetland herbaceous species such as *Juncus arcticus* and *Equisetum laevigatum* along with the introduced pasture grass *Lolium arundinaceum* (= *Festuca arundinacea*). *Populus angustifolia* is occasionally present in the canopy.

Globally

The vegetation is characterized by abundant *Salix gooddingii* that dominates or codominates the open to moderately dense (20–60% cover) tree canopy. *Prosopis velutina, Prosopis glandulosa*, or *Fraxinus velutina* may codominate the 5 to 15 m tall tree canopy. *Populus fremontii* is generally absent or uncommon (<1%). *Populus angustifolia* is occasionally present in the canopy. Shrubs may be present but seldom form a stratum. Other tree and shrub species present may include *Baccharis salicifolia*, *Celtis laevigata* var. *reticulata, Juglans microcarpa, Mahonia haematocarpa* (= *Berberis haematocarpa*), *Quercus* spp., *Sapindus saponaria* var. *drummondii, Ungnadia speciosa*, and *Ziziphus obtusifolia*, depending on location and hydrology. The herbaceous layer is typically moderately dense to dense, often diverse and composed of mesic forbs and graminoids. Common species include *Ambrosia confertiflora, Berula erecta, Eleocharis palustris, Equisetum laevigatum, Ipomoea* spp., *Juncus arcticus, Juncus balticus, Muhlenbergia asperifolia, Physalis longifolia, Polygonum* spp., *Schoenoplectus* spp., V*eronica anagallis aquatica,* and *Xanthium strumarium*. Disturbance is common in this woodland, and introduced species such as *Echinochloa crus galli, Lactuca serriola, Lolium arundinaceum* (= *Festuca arundinacea*), *Rumex crispus, Sorghum halepense,* and *Tamarix* spp. are present in many stands. Diagnostic of the woodland is the dominance or codominance of *Salix gooddingi*i in the tree canopy with *Populus fremontii* absent or uncommon.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Tree canopy	*Salix gooddingii*
Herb (field)	*Juncus arcticus*
Herb (field)	*Equisetum laevigatum*

Globally

Stratum	Species
Tree canopy	*Populus tremuloides*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Lolium arundinaceum

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (1May 2000)

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

This association has a limited distribution. Remaining examples have had many large trees removed, contain exotic species, and have been impacted by overgrazing. Disruption of the natural flooding regime, through damming, water diversions and stream channelization, is also a major threat to these woodlands.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plots: 07AR022, 07AR048 and 07AR049.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz, mod. K.S. King

REFERENCES

Barber pers. comm., Muldavin et al. 2000a, Szaro 1989, Western Ecology Working Group n.d.

III. Shrubland

Artemisia filifolia / *Bouteloua* (*curtipendula, gracilis*) Shrubland

Sand Sagebrush / (Sideoats Grama, Blue Grama) Shrubland

Sand Sagebrush / Grama Grass Shrubland

CODE	CEGL002176
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)

Western Great Plains Sandhill Steppe (CES303.671)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This sagebrush shrubland is found on sandy rolling hills in the southern Great Plains of the United States. It is also known to occur at 1930 m (6325 feet) elevation on gently rolling hills and sandy alluvial plains within the Salinas Pueblo Missions National Monument in New Mexico. Soils are loamy fine sand to sandy, excessively drained, and formed in loamy or sandy eolian sediments. The ground surface is characterized by large patches of exposed soil and scattered areas of grass and litter. The shrub layer is between 0.5 and 1 m tall. The canopy is dominated by *Artemisia filifolia*. Short to medium grasses dominate the ground layer, including *Bouteloua curtipendula* and *Bouteloua gracilis*. Other graminoids include A*ndropogon hallii, Aristida purpurea, Cyperus schweinitzii, Paspalum setaceum, Pascopyrum smithii, Schizachyrium scoparium*, and *Sporobolus cryptandrus*, among others. Herbs may include *Erigeron annuus, Helianthus petiolaris*, and *Grindelia papposa* (= *Prionopsis ciliata*). Prairie forb species such as *Gaillardia pulchella, Linum lewisii, Machaeranthera tanacetifolia, Melampodium leucanthum, Mirabilis linearis*, and *Oenothera pallida* may be common and characteristic

DISTRIBUTION

Salinas Pueblo Missions National Monument

This minor association is known from the Gran Quivira unit.

Globally

This community is found in the southern Great Plains of the United States, ranging from Kansas south to Texas. It is also known to occur within the Salinas Pueblo Missions National Monument in New Mexico.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association is known to occur at 1930 m (6325 feet) in elevation on gently rolling hills and sandy alluvial plains. The ground surface is characterized by large patches of exposed soil and scattered areas of grass and litter.

Globally

This sagebrush shrubland is found on sandy rolling hills in the southern Great Plains of the United States. It is also known to occur at 1930 m (6325 feet) elevation on gently rolling hills and sandy alluvial plains within the Salinas

Pueblo Missions National Monument in New Mexico. Soils are loamy fine sand to sandy, excessively drained, and formed in loamy or sandy eolian sediments (Lauver et al. 1999). The ground surface is characterized by large patches of exposed soil and scattered areas of grass and litter.

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This Great Plains shrubland is dominated by abundant *Artemisia filifolia* with *Bouteloua gracilis* well represented in the intershrub spaces along with other scattered prairie grasses such as *Aristida purpurea*, *Pascopyrum smithii*, *Schizachyrium scoparium*, *Andropogon hallii*, and *Sporobolus cryptandrus*, among others. Forbs are variable in composition and scattered. Among the 32 species reported, prairie species are the most common and characteristic and include *Gaillardia pulchella*, *Linum lewisii*, *Machaeranthera tanacetifolia, Melampodium leucanthum*, *Mirabilis linearis*, and *Oenothera pallida*.

Globally

The shrub layer is between 0.5 and 1 m tall. The canopy is dominated by *Artemisia filifolia*. Short to medium grasses dominate the ground layer, including *Bouteloua curtipendula* and *Bouteloua gracilis*. Other graminoids may include *Andropogon hallii, Aristida purpurea, Cyperus schweinitzii, Paspalum setaceum, Pascopyrum smithii, Schizachyrium scoparium*, and S*porobolus cryptandrus*, among others. Herbs may include *Erigeron annuus*, *Helianthus petiolaris*, *and Grindelia papposa* (= *Prionopsis ciliata*) (Lauver et al. 1999). Prairie forb species such as *Gaillardia pulchella, Linum lewisii, Machaeranthera tanacetifolia, Melampodium leucanthum, Mirabilis linearis,* and *Oenothera pallida* may be common and characteristic.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Short shrub/sapling	*Artemisia filifolia*
Herb (field)	*Bouteloua gracilis*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia filifolia*
Herb (field)	*Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (3 Oct 1996)

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plot: 04SG014.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: D. Faber Langendoen, mod. K.S. King

REFERENCES

Baalman 1965, Blair and Hubbell 1938, Bruner 1931, Diamond 1993, Duck and Fletcher 1945, Harlan 1957, Hoagland 2000, Jones 1963, Lauver et al. 1999, Osborn 1941, Osborn and Kellogg 1943, Sherwood 1980, Sherwood and Risser 1980, Smith 1998a, Southeastern Ecology Working Group n.d., Zanoni et al. 1979

***Atriplex canescens / Muhlenbergia porteri* Shrubland**

Fourwing Saltbush / Bush Muhly Shrubland

CODE	CEGL005385
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*ATRIPLEX CANESCENS* SHRUBLAND ALLIANCE (A.869) Fourwing Saltbush Shrubland Alliance

ECOLOGICAL SYSTEM(S):

Chihuahuan Mixed Salt Desert Scrub (CES302.017)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association is only known to occur within Salinas Pueblo Missions National Monument in New Mexico. The information below is based on data collected there and will be updated when additional inventory data are available. This association is reported from 1980 m (6490 feet) in elevation on a gentle, southwest facing slope of a low hill. The substrate is derived from limestone of the Permian San Andres Formation. The ground surface is characterized by exposed soil and litter. The reported site is in close proximity to pueblo ruins, and soils appear to have been disturbed. This desert shrubland is dominated by *Atriplex canescens* with a luxuriant grass understory dominated by *Muhlenbergia porteri*, which can reach 40% total cover underneath shrubs and in the intershrub spaces. *Bouteloua gracilis* and *Sporobolus contractus* are also common associates. A ruderal vegetation phase is indicated by the presence of *Erysimum capitatum, Marrubium vulgare, Phacelia integrifolia, Portulaca oleracea*, and *Solanum jamesii.*

DISTRIBUTION

Salinas Pueblo Missions National Monument

This minor association is known from the Gran Quivira unit.

Globally

This association is only known to occur within Salinas Pueblo Missions National Monument in New Mexico.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association is reported from 1980 m (6490 feet) in elevation on a gentle, southwest facing slope of a low hill. The substrate is derived from limestone of the Permian San Andres Formation. The ground surface is characterized by exposed soil and litter. The reported site is in close proximity to pueblo ruins and soils appear to have been disturbed.

Globally

Data are not available.

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This desert shrubland is dominated by *Atriplex canescens* with a luxuriant grass understory dominated by *Muhlenbergia porteri*, which can reach 40% total cover underneath shrubs and in the intershrub spaces. *Bouteloua gracilis* and *Sporobolus contractus* are also common associates. A Ruderal Vegetation phase is indicated by the presence of *Erysimum capitatum*, *Marrubium vulgare*, *Phacelia integrifolia*, *Portulaca oleracea*, and *Solanum jamesi*i.

Globally

Data are not available.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Shrub/sapling (tall & short)	*Atriplex canescens*
Herb (field)	*Muhlenbergia porteri*

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Marrubium vulgare

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (12 May 2009)

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plots: 04SG002.

Local Description Authors: A. Kennedy and E. Muldavin

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

REFERENCES

Muldavin et al. 2000b, Western Ecology Working Group n.d.

***Atriplex canescens / Sporobolus airoides* Shrubland**

Fourwing Saltbush / Alkali Sacaton Shrubland

CODE	CEGL001291
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	*ATRIPLEX CANESCENS* SHRUBLAND ALLIANCE (A.869) Fourwing Saltbush Shrubland Alliance

ECOLOGICAL SYSTEM(S)

Inter Mountain Basins Mixed Salt Desert Scrub (CES304.784), Chihuahuan Mixed Salt Desert Scrub (CES302.017)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This shrubland occurs in the northern Chihuahua Desert extending into the Trans-Pecos of Texas, southwestern Great Plains, and Colorado Plateau. Stands are found in washes, floodplains and on alluvial flats, extending up lower slopes of alluvial fans or bajadas. Sites are level to gently sloping. Substrates are typically moderately deep, alkaline, calcareous, fine textured soils or calcareous sands. Cover of bare soil can be high (>50%). The vegetation is characterized by an open to moderately dense (10–50% cover) short-shrub layer dominated by *Atriplex canescens* with a perennial graminoid layer dominated by *Sporobolus airoides*. The shrub layer has greater cover than the herbaceous layer, which may include other scattered shrubs and dwarf shrubs, such as *Artemisia filifolia, Atriplex confertifolia, Atriplex obovata, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae, Isocoma pluriflora, Krascheninnikovia lanata, Lycium* spp., *Opuntia* spp., *Prosopis glandulosa*, and *Sarcobatus vermiculatus*. Associated herbaceous species, such as *Achnatherum hymenoides, Ambrosia psilostachya, Artemisia campestris, Elymus elymoides, Pascopyrum smithii, Pleuraphis jamesii, Sphaeralcea coccinea, Sporobolus cryptandrus, Sporobolus nealleyi*, and *Suaeda* spp., may be present. *Bouteloua gracilis* cover is typically minor and inconsistent. Diagnostic of this *Atriplex canescens* dominated shrubland is a *Sporobolus airoides* dominated herbaceous layer.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This minor association is known from the Quarai unit.

Globally

This shrubland occurs in the northern Chihuahua Desert extending into Trans-Pecos Texas, the southwestern Great Plains and Colorado Plateau in Colorado, New Mexico, Arizona, and Utah. It is reported from California and likely also occurs in Nevada and Mexico.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association is found at 2030 m (6650 feet) in elevation on a gentle, northeast facing slope of a low hill. The sub-

strate is derived from sandstone of the Permian Abó Formation. The ground surface is characterized by large patches of tussock grasses intermixed with exposed soil and litter.

Globally

This shrubland occurs on alkaline sites in the northern Chihuahua Desert extending into the Trans-Pecos of Texas, southwestern Great Plains, and Colorado Plateau. Sites are in washes, floodplains and on alluvial flats, extending up lower slopes of alluvial fans or bajadas. Elevation ranges from 915–2030 m (3000–6650 feet). Sites are level to gently sloping (1–5%), and soils are typically moderately deep, alkaline, calcareous, fine textured soils, such as silt loam, loamy clay, or clay (Francis 1986, Shaw et al. 1989, Muldavin et al. 2000b), although some sites in active floodplains may be rapidly drained sandy soils. The ground surface is characterized by large patches of tussock grasses intermixed with exposed soil and litter. Cover of bare soil may be high (>50%) (Francis 1986). Evidence of overland flow and erosion, e.g., gullies, rills, plant pedestalling, is common (Soil Conservation Service n.d.).

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This desert shrubland is dominated by *Atriplex canescens* with a luxuriant grass understory dominated by *Sporobolus airoides*. *Bouteloua gracilis* with *Sporobolus cryptandrus* is well represented. Forbs are limited and scattered; *Sphaeralcea incana, Ambrosia psilostachya*, and *Artemisia campestris* are the most abundant. Trees are accidental or absent.

Globally

The association is characterized by an open to moderately dense (10–50% cover) short shrub layer dominated by *Atriplex canescens* with a perennial graminoid layer dominated by *Sporobolus airoides* but includes sparse *Atriplex canescens Sporobolus airoides* dominated stands (<10% total vegetation cover). The shrub layer generally has greater cover than the herbaceous layer and may include other scattered shrubs and dwarf shrubs, such as *Artemisia filifolia, Atriplex confertifolia, Atriplex obovata, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae, Isocoma pluriflora, Krascheninnikovia lanata, Lycium berlandieri, Lycium pallidum, Opuntia imbricata, Opuntia leptocaulis, Opuntia phaeacantha, Prosopis glandulosa*, and *Sarcobatus vermiculatus*. Associated herbaceous species, such as *Achnatherum hymenoides, Ambrosia psilostachya, Artemisia campestris, Elymus elymoides, Pascopyrum smithii, Pleuraphis jamesii, Sphaeralcea* spp., *Sporobolus cryptandrus, Sporobolus nealleyi,* and *Suaeda* spp., may be present. *Bouteloua gracilis* cover is typically minor and inconsistent (Francis 1986, Shaw et al. 1989, Muldavin et al. 2000b). However, *Bouteloua gracilis* with *Sporobolus cryptandrus* is well represented within Salinas Pueblo Missions National Monument in New Mexico. Introduced species such as S*alsola kali, Bromus tectorum*, or *Marrubium vulgare* may be common. Trees are accidental or absent.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Shrub/sapling (tall & short)	*Atriplex canescens*
Herb (field)	*Sporobolus airoides*

Globally

Stratum	Species
Shrub/sapling (tall & short)	*Atriplex canescens*
Herb (field)	*Sporobolus airoides*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Bromus tectorum, Marrubium vulgare, Salsola kali

CONSERVATION STATUS RANK

Global Rank & Reasons: G5? (9 Nov 2005). Although this type is widespread, it usually occurs in relatively small patches. Both of the diagnostic species are resistant to moderate grazing, but this association has likely been converted to semi-natural shrublands in heavily grazed areas.

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Stands with relatively low cover of *Atriplex canescens* (10–25%) are included in this association because the shrub density is often variable within stands, but species composition and ecological processes do not change significantly. Several similar associations vary according to the abundance of different codominants, especially graminoids. Range-wide review of these types is needed to clarify their extent..

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plot: 04SG010.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz, mod. J. Coles and K.S. King

REFERENCES

Baker 1984a, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Diamond 1993, Dick Peddie 1986, Donart et al. 1978a, Driscoll et al. 1984, Francis 1986, Hansen et al. 2004b, Muldavin et al. 2000b, Shaw et al. 1989, Soil Conservation Service n.d., USFS 1937, Vest 1962a, Western Ecology Working Group n.d

***Prunus virginiana - (Prunus americana*) Shrubland**

Chokecherry - (American Plum) Shrubland

CODE	CEGL001108
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural cold deciduous shrubland (III.B.2.N.)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a.)
ALLIANCE	*PRUNUS VIRGINIANA* SHRUBLAND ALLIANCE (A.919) Chokecherry Shrubland Alliance

ECOLOGICAL SYSTEM(S)

Northern Rocky Mountain Montane Foothill Deciduous Shrubland (CES306.994), Rocky Mountain Lower Montane Foothill Shrubland (CES306.822), Western Great Plains Wooded Draw and Ravine (CES303.680)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This widespread small patch shrubland is known from the Columbia Plateau of eastern Washington and eastern Oregon, throughout much of the western Great Plains, Rocky Mountain and interior western U.S. It occurs in the foothills and lower slopes of mountain ranges, along higher creeks and upper alluvial terraces of perennial streams, and in draws and ravines of high plateaus and the Great Plains. The elevational range is 680 to 2652 m (2234–8700 feet). This association grows at the interface between larger riparian areas and the adjacent upland and occurs as small dense thickets, narrow bands, or irregular patches. It often occupies draws, ephemeral creeks in steep narrow bottomed canyons, and shallow ravines. It can occur on slopes below seeps and springs and on high slopes where snow collects. Shrub cover ranges from 100% to more open stands of 30%. Shrub cover is generally greater in drainage bottoms and on lowermost slopes, and less on upper slopes. *Prunus virginiana* is usually the dominant shrub species, but *Prunus americana* may be solely present to codominant as well. Stands can be dominated by one species but are often a mix of three to six other shrub species, which can be as abundant and even more abundant than the *Prunus*. Other shrubs include *Rhus trilobata, Ribes aureum, Ribes cereum, Ribes lacustre, Ribes inerme, Salix exigua, Sambucus* spp., *Amelanchier* spp., *Amorpha canescens, Ericameria nauseosa, Symphoricarpos oreophilus, Symphoricarpos occidentalis, Juniperus scopulorum, Rosa woodsii,* and *Toxicodendron rydbergii*. In drainage bottoms, herbaceous cover is usually sparse, less than 10%. On slopes, the shrubs typically occur in some grassland type, and graminoid cover can be greater than 75%. Herbaceous species may include *Achnatherum lettermanii, Achnatherum nelsonii, Carex vallicola, Erigeron flagellaris, Leymus cinereus, Geranium caespitosum* var. *caespitosum, Heracleum maximum* (= *Heracleum lanatum)*, *Juncus arcticus, Maianthemum stellatum* (= S*milacina stellata*), *Muhlenbergia montana*, and *Potentilla hippiana*. Exotic species *Bromus inermis, Cirsium arvense, Poa pratensis*, and *Bromus tectorum* are common on disturbed sites.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This association is known from the Quarai unit.

Globally

This widespread small patch shrubland is known from the Columbia Plateau of eastern Washington and eastern Oregon, throughout much of the western Great Plains, Rocky Mountain and interior western U.S.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This riparian association is found at about 2025 m (6650 feet) elevation along in the upper alluvial terraces of a perennial stream.

Globally

This widespread small-patch shrubland occurs from the Columbia Plateau of eastern Washington, eastern Oregon, throughout much of the western Great Plains, Rocky Mountain and interior western U.S. It occurs in the foothills and lower slopes of mountains, along higher creeks and upper alluvial terraces of perennial streams, in moist soils that receive bedrock runoff in the Colorado Plateau, and in draws and ravines of plateaus and the Great Plains. The elevational range is 716 to 2846 m (2234–9330 feet), and slopes are gentle to steep (to 20 degrees). This association often grows at the interface between larger riparian areas and the adjacent upland, as well as on higher ridges where snow collects, and occurs as small dense thickets, narrow bands or irregular patches. It often occupies draws, ephemeral creeks in steep narrow bottomed canyons, and shallow ravines. It can occur on slopes below seeps and springs. Stands can also occur as small pockets on higher terraces or as narrow bands along the high water mark of steep banks and incised channels. It also grows at the base of cliffs adjacent to rivers. Slope varies from flat to very steep, with variable aspects, and can be associated with rock outcrops and talus. Stands are typically on very well drained, rocky soils but occasionally have finer soils. Soil texture ranges from sandy loam to clay loam.

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This riparian shrubland is dominated by *Rosa woodsii* and *Prunus virginiana* with *Ribes aureum* and *Ribes cereum* well represented associates. A *Populus* spp. tree canopy is absent. The herbaceous layer is represented by *Geranium caespitosum* var. *caespitosum*.

Globally

Shrub cover ranges from total coverage (>90%) to more open stands of 30% canopy cover, with the higher values tending to occur in sites located in drainage bottoms and on lowermost slopes, and the lower values on higher slopes. *Prunus virginiana* is usually the dominant shrub species, but *Prunus americana* may be solely present to codominant. Stands can be dominated by one species but are often a mix of three to six other shrub species, which can be as abundant and sometimes more abundant than *Prunus*. Other shrubs include *Rhus trilobata, Ribes aureum, Ribes cereum, Ribes lacustre, Ribes inerme, Rosa* spp., *Salix exigua, Sambucus* spp., *Amelanchier* spp., *Amorpha canescens, Artemisia tridentata, Ericameria nauseosa, Symphoricarpos oreophilus, Symphoricarpos occidentalis, Juniperus scopulorum, Rosa woodsii, Mahonia repens*, and *Toxicodendron* spp. The tree *Populus tremuloides* may provide sparse cover. In drainage bottoms, herbaceous cover is usually sparse, less than 10%. On slopes, the shrubs typically occur in a matrix of other shrubland or grassland types, and graminoid cover can be greater than 75%. Herbaceous species are variable. Graminoids include *Achnatherum lettermanii, Achnatherum nelsonii, Artemisia frigida, Bromus carinatus, Carex vallicola, Elymus lanceolatus, Elymus trachycaulus, Juncus balticus, Leymus cinereus, Muhlenbergia montana, Pascopyrum smithii*, and *Poa fendleriana*. Forb species are often diverse but are often relatively mesic. Common species include *Achillea millefolium, Agastache urticifolia, Balsamorhiza sagittata, Delphinium nuttallianum, Erigeron flagellaris, Eriogonum umbellatum, Geranium caespitosum* var. *caespitosum, Geranium viscosissimum, Heracleum maximum* (= *Heracleum lanatum*), *Heterotheca villosa, Maianthemum stellatum* (= *Smilacina stellata*), *Mertensia oblongifolia, Osmorhiza berteroi* (= *Osmorhiza chilensis*), *Potentilla hippiana*, and *Psoralidium lanceolatum*. Exotic herbaceous species may be present, including *Bromus inermis, Cirsium arvense, Poa pratensis*, and *Bromus tectorum*, especially on disturbed sites.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Tree canopy	*Prunus virginiana*
Shrub/sapling (tall & short)	*Rosa woodsii*

Globally

Stratum	Species
Short shrub/sapling	*Prunus americana, Prunus virginiana*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Bromus inermis, Bromus tectorum, Cirsium arvense, Pascopyrum smithii, Poa pratensis, Prunus americana, Symphoricarpos occidentalis

CONSERVATION STATUS RANK

Global Rank & Reasons: G4Q (1 Feb 1996). This type is widespread, but it represents a broadly defined dominance type, with little information on the associated species or habitats that might help define the type more precisely. If, for example, a Great Plains type was separated out from the other types, such a type could be relatively rare.

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

This is a widespread and highly variable, yet distinct, type. In semi-arid regions, it is restricted to mesic and wet areas that often occur as small patches or limited to streambanks. Kovalchik (1987) briefly describes a similar type called Mixed Shrub Canyon Bottom Association from four plots. It occurs in low elevation canyons below U.S. Forest Service ownership in eastern Oregon. Tall shrubs include *Prunus virginiana*, *Amelanchier alnifolia, Rosa woodsii, Cornus sericea, Salix* spp., *Prunus subcordata*, and/or *Alnus incana*. This may be the same concept.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plots: 04SQ006.

Local Description Authors: E. Muldavin and A. Kennedy

Global Description Authors: D. Faber Langendoen, mod. G. Kittel, J. Coles, K.A. Schulz, K.S. King

REFERENCES

Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Caicco and Wellner 1983n, Carsey et al. 2003a, Copeland 1980a, Driscoll et al. 1984, Evans 1989a, Evans 1989b, Hall and Hansen 1997, Hansen et al. 1988b, Hansen et al. 1991, Hansen et al. 1995, IDCDC 2005, Johnston 1987, Jones 1992b, Jones and Walford 1995, Kagan et al. 2000, Kittel et al. 1996, Kittel et al. 1999b, Kovalchik 1987, Kudray et al. 2004, MTNHP 2002b, Manning and Padgett 1995, Marriott pers. comm., Von Loh et al. 1999, Western Ecology Working Group n.d.

IV. Herbaceous vegetation

Pascopyrum smithii - Bouteloua gracilis Herbaceous Vegetation

Western Wheatgrass - Blue Grama Herbaceous Vegetation

Western Wheatgrass - Blue Grama Mixedgrass Prairie

CODE	CEGL001578
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Medium-tall sod temperate or subpolar grassland (V.A.5.N.c.)
ALLIANCE	*PASCOPYRUM SMITHII* HERBACEOUS ALLIANC*E (A.1232)* Western Wheatgrass Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Central Mixedgrass Prairie (CES303.659), Southern Rocky Mountain Montane-Subalpine Grassland (CES306.824)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This western wheatgrass -blue grama prairie of the southern Great Plains and Chihuahuan Desert of the United States was once an extensive grassland. Stands occur within montane swales or along upland valley bottoms. It generally occurs on northerly or northeasterly aspects at elevations between 915 and 2440 m (3000–8000 feet). Slopes are typically gentle with fine textured and well-developed soils that are predominantly from eroded Paleozoic sandstone and limestone. Ground cover is characterized by scattered bunch grasses and patches of the rhizomatous grasses and litter with exposed soil and gravel in the intergrass spaces. Luxuriant cover that can be dominated by either *Bouteloua gracilis* or *Pascopyrum smithii* typifies this grassland. *Juniperus monosperma* or *Pinus edulis* communities usually surround this swale association. Graminoid diversity is usually low, with scattered grasses such as *Elymus elymoides*, *Koeleria macrantha*, and *Muhlenbergia repens* often present. In Kansas, *Bouteloua curtipendula* and *Buchloe dactyloides* may also be present. The shrub layer is very open and moderate in diversity and generally includes *Atriplex canescens* and *Krascheninnikovia lanata* (which both occur as phases and can become dominant in disturbed areas), as well as *Opuntia imbricata* and *Opuntia phaeacantha*. Forb diversity and cover are generally low.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This minor association is known from the Quarai unit.

Globally

This western wheatgrass - blue grama grassland is found in the Southern Great Plains and Chihuahuan Desert in the United States, ranging from Colorado and Kansas south to New Mexico.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association is found at 2030 m (6670 feet) in elevation on a northeasterly aspect of a gently sloping low hill. Soils are derived from sandstone of the Permian Abó Formation. Ground cover is characterized by scattered bunch grasses and patches of the rhizomatous grasses and litter with exposed soil and gravel in the intergrass spaces.

Globally

Stands occur within montane swales or along upland valley bottoms. It generally occurs on northerly or northeasterly aspects at elevations between 915 and 2500 m (3000–8000 feet). Slopes are typically gentle with fine textured and well developed soils that are predominantly from eroded Paleozoic sandstone and limestone. In Kansas, stands are common on nearly level uplands or shallow depressions in uplands. Soils are silty clay loam with an impermeable or slowly permeable claypan subsoil layer (Lauver et al. 1999). Ground cover is characterized by scattered bunch grasses and patches of the rhizomatous grasses and litter with exposed soil and gravel in the intergrass spaces.

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This plains grassland is dominated by *Bouteloua gracilis* and *Pascopyrum smithii*, which form a dense grass layer that can reach 90% cover. Forbs are common but variable. The most abundant are *Penstemon virgatus*, *Engelmannia peristenia, Artemisia campestris* ssp. *caudata*, and *Glandularia bipinnatifida*. Trees and shrubs are accidental or absent.

Globally

Luxuriant cover that can be dominated by either *Bouteloua gracilis* or *Pascopyrum smithii* typifies this grassland. *Juniperus monosperma* or *Pinus edulis* communities usually surround this swale association. Graminoid diversity is usually low, with scattered grasses such as *Elymus elymoides, Koeleria macrantha*, and *Muhlenbergia repen*s often present. In Kansas, *Bouteloua curtipendula* and *Buchloe dactyloides* may also be present (Lauver et al. 1999). The shrub layer is very open and moderate in diversity and generally includes *Atriplex canescens* and *Krascheninnikovia lanata* (which both occur as phases and can become dominant in disturbed areas), as well as *Opuntia imbricata* and *Opuntia phaeacantha*. Forb diversity and cover are generally low. In New Mexico, forbs are common but variable; the most abundant are *Artemisia campestris* ssp. *caudata, Engelmannia peristenia*, *Glandularia bipinnatifida*, and *Penstemon virgatus*. Trees and shrubs are accidental or absent.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Herb (field)	*Bouteloua gracilis, Pascopyrum smithii*

Globally

Stratum	Species
Herb (field)	*Bouteloua gracilis, Pascopyrum smithii*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Poa pratensis

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23 Feb 1994). This western wheatgrass blue grama prairie was once an extensive grassland of the Southern Great Plains and Chihuahuan Desert. Its current range and condition are not well understood.

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plot: 04SQ002.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: mod. J. Drake and K.S. King

REFERENCES

Bourgeron and Engelking 1994, Boutton et al. 1980, Branson et al. 1961, Branson et al. 1964, Branson et al. 1965, Bujakiewicz 1975, Bunin 1985, CONHP unpubl. data 2003, Cacek 1973, Costello 1944b, Culwell and Scow 1982, Dick Peddie 1986, Donart et al. 1978a, Driscoll et al. 1984, Hadley and Branson 1965, Hanson 1957, Hanson and Ball 1928, Hanson and Dahl 1956, Hanson et al. 1931, Hyder et al. 1966, Kahler 1973, Keammerer and Stoecker 1975, Lauver et al. 1999, Moir 1969b, Muldavin and Mehlhop 1992, Mutel 1976, Ramaley 1927, Rogers 1953, Shantz 1906, Shantz 1911, Shantz 1923, Soil Conservation Service 1978, Vestal 1913, Vestal 1914, Vestal 1919, Weaver and Albertson 1956, Western Ecology Working Group n.d., Wooten 1980

***Sporobolus airoides - Bouteloua gracilis* Herbaceous Vegetation**

Alkali Sacaton - Blue Grama Herbaceous Vegetation

CODE	CEGL001686
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Medium-tall sod temperate or subpolar grassland (V.A.5.N.c.)
ALLIANCE	*SPOROBOLUS AIROIDES* SOD HERBACEOUS ALLIANCE (A.1241) Alkali Sacaton Sod Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Inter Mountain Basins Semi Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This grassland association occurs in basins of the northern Chihuahuan Desert in south central New Mexico, within Salinas Pueblo Missions National Monument in central New Mexico, and in the southern Colorado Plateau in northwestern New Mexico and northern Arizona at 1570 to 2240 m (5160–7370 feet) elevation. Stands occur on gently sloping (<1%) depressions or swales in alluvial flats and alluvial plains, on gentle slopes of low hills in central New Mexico, on lower piedmont slopes in southern New Mexico, and on mesas, lower slopes, sand deposits/sandsheets, and terraces in northern Arizona. In desert sites, soils are typically deep and fine silty loams, but not clayey. In other sites, soils range from silty clay loam to clay on alluvial plains to sand. The ground surface is largely bare soil, but may be characterized by bunch grasses intermixed with exposed soil and gravel in the intergrass spaces. The vegetation is characterized by an open to dense (14–70% cover) herbaceous layer dominated by *Sporobolus airoides* and *Bouteloua gracilis*. Scattered shrubs may be present with low cover (<10%), such as *Atriplex confertifolia, Atriplex canescens,*

Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia imbricata, Opuntia polyacantha, and the characteristic desert species *Yucca elata*. Other common graminoid species may include *Achnatherum hymenoides, Aristida* spp., *Elymus elymoides, Muhlenbergia torreyi, Pleuraphis jamesii, Scleropogon brevifolius*, and *Sporobolus cryptandrus*. Forb cover is usually low and often diverse.

Distribution

Salinas Pueblo Missions National Monument

This association is known from the Abó unit.

Globally

This grassland association occurs in the northern Jornada del Muerto and Tulerosa basins in south central New Mexico, within Salinas Pueblo Missions National Monument in central New Mexico, and in the southern Colorado Plateau in the upper Rio Puerco watershed in northwestern New Mexico, and at Petrified Forest National Park in northern Arizona

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association occurs around 1840 m (6000 feet) in elevation on gentle slopes of low hills. Substrates are derived from sandstones of the Permian Abó and Yeso formations. Ground cover is characterized by bunch grasses intermixed with exposed soil and gravel in the intergrass spaces. The sites are often in close proximity to pueblo ruins or are treated (chained) juniper woodlands where the soils were possibly cultivated, with trees uprooted or otherwise disturbed.

Globally

This grassland association occurs in basins in the northern Chihuahuan Desert in south central New Mexico, within Salinas Pueblo Missions National Monument in central New Mexico, and in the southern Colorado Plateau in northwestern New Mexico and northern Arizona at 1570 to 2240 m (5160–7370 feet) elevation. Stands occur on gently sloping (<1%) depressions or swales in alluvial flats and alluvial plains, on gentle slopes of low hills in central New Mexico, on lower piedmont slopes in southern New Mexico, and on mesas, lower slopes, sand deposits/sandsheets, and terraces in northern Arizona (Francis 1986, Muldavin et al. 2000b). Substrates are typically deep and fine textured soils. In desert stands, soils are fine silty loams, but not clayey (Muldavin et al. 2000b). In stands in the Colorado Plateau, soils range from silty clay loam to clay on alluvial flats to sand. The ground surface is largely bare soil, but may be characterized by bunch grasses intermixed with exposed soil and gravel in the intergrass spaces.

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This Great Plains-related grassland is characterized by an abundant to luxuriant cover of *Bouteloua gracilis* and *Sporobolus airoides*. *Muhlenbergia torreyi* and *Aristida purpurea* are also frequent associates. Tall shrubs are absent or accidental, but ruderal subshrubs or succulents such as *Gutierrezia sarothrae* and *Opuntia imbricata*, respectively, are common. The ruderal character of the association in this locale is indicated by the presence of *Bassia scoparia* (= *Kochia scoparia*) and *Solanum elaeagnifolium*.

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

Salinas Pueblo Missions National Monument

Stratum	Species
Herb (field)	*Bouteloua gracilis, Sporobolus airoides*

Globally

Stratum	Species
Herb (field)	*Bouteloua gracilis, Sporobolus airoides*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Bassia scoparia

Globally

Salsola tragus

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

A Woodland/Shrubland Removal Treatment or Chain Treatment phase was identified from this association in areas where *Juniperus monosperma* was historically removed.

Globally

In desert basins in the northern Chihuahuan Desert, this association is restricted to relatively mesic, non-clayey swales or depressions in desert basins and plains (Muldavin et al. 2000b). The dominant species that characterize this association are widespread in the western U.S. but typically occur in different habitats, e.g., *Bouteloua gracilis* in upland sites and *Sporobolus airoides* in bottomland sites or on sandy substrates. The species codominate in relatively specific habitats (desert swales) in southern New Mexico (Muldavin et al. 2000b), but occur in broader habitats in the Colorado Plateau (Francis 1986). More survey and classification work are needed to clarify the concept of this association.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plots: 04EA004 04EA005 05AR001 07AR002 07AR015 07AR023 07AR062 07AR063 07AR064 and 07AR065.

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, Francis 1986, Muldavin and Mehlhop 1992, Muldavin et al. 2000b, Western Ecology Working Group n.d.

***Bouteloua eriopoda - Bouteloua gracilis* Herbaceous Vegetation**

Black Grama - Blue Grama Herbaceous Vegetation

Black Grama - Blue Grama Shortgrass Prairie

CODE	CEGL005370
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, within Salinas Pueblo Missions National Monument in 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

Salinas Pueblo Missions National Monument

This is a common association in the Abó unit.

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, within Salinas Pueblo Missions National Monument in central New Mexico, and in the Chihuahuan Desert in southern New Mexico. It likely extends into adjacent Texas and northern Mexico.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association occurs between 1830 and 1860 m (6000–6110 feet) in elevation on westerly aspects of low lying hills. The soils are derived from sandstones of the Permian Abó or Yeso formations.

Globally

This association occurs on low- to mid-elevation mountain slopes and foothills, but can form more extensive stands on upper alluvial fan piedmonts. Elevation ranges from 1490 to 1860 m (4900–6110 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

Salinas Pueblo Missions National Monument

This plains grassland is dominated by *Bouteloua eriopoda* and *Bouteloua gracilis*, which can reach total canopy cover as high as 70%. Tall shrubs are absent or accidental, but ruderal subshrubs or succulents such as *Gutierrezia sarothrae* and *Opuntia imbricata* (= *Cylindropuntia imbricata*), respectively, are common. Forbs are variable and scattered and include *Senecio flaccidus* and *Astragalus* spp. Trees are accidental or absent.

Globally

This plains grassland is dominated by *Bouteloua eriopoda* and *Bouteloua gracilis*, which can reach total cover as high as 70%. Tall shrubs are absent or accidental, but ruderal subshrubs or succulents such as *Gutierrezia sarothrae* and *Opuntia imbricata* (= *Cylindropuntia imbricata*), respectively, are common. Forbs are variable and scattered and include *Senecio flaccidus* and *Astragalus* spp. Trees are accidental or absent. 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 B*othriochloa 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

Salinas Pueblo Missions National Monument

Stratum	Species
Herb (field)	*Bouteloua eriopoda, Bouteloua gracilis*

Globally

Stratum	Species
Herb (field)	*Bouteloua eriopoda, Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions 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

Salinas Pueblo Missions National Monument

Data are not available.

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

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plots: 04EA010, 07AR014, 07AR044, 07AR047 and 07AR058.

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, Buffington and Herbel 1965, DeOliviera 1961, Diamond 1993, Dick Peddie 1986, Donart et al. 1978a, Driscoll et al. 1984, Francis 1986, Gardner 1950, Gardner 1951, Gibbens et al. 1983, Hennessy et al. 1983, Herbel et al. 1972, Hibner 2009, Humphrey 1974, McLaughlin and Bowers 1982, McPherson 1995, Muldavin and Mehlhop 1992, Muldavin and Wood 1998, Muldavin et al. 1998a, Muldavin et al. 1998d, Muldavin et al. 1999, Muldavin et al. 2000b, Muldavin et al. 2000c, Muldavin et al. 2003, Nelson 1934, Schlesinger et al. 1990, Western Ecology Working Group n.d., Whitfield and Anderson 1938

Bouteloua gracilis - Hesperostipa neomexicana Herbaceous Vegetation

Blue Grama - New Mexico Needlegrass Herbaceous Vegetation

Blue Grama - Mexican Feathergrass Shortgrass Prairie

CODE	CEGL001763
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Short sod temperate or subpolar grassland (V.A.5.N.e.)
ALLIANCE	*BOUTELOUA GRACILIS* HERBACEOUS ALLIANCE (A.1282) Blue Grama Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Apacherian-Chihuahuan Semi-Desert Grassland and Steppe (CES302.735)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This desert grassland occurs in the northern San Andres Mountains and the Oscura Mountains in the northern Chihuahuan Desert and extends into the southwestern Great Plains and south-central and central New Mexico. Stands occur on generally cool aspects on gentle dipslopes and moderately steep escarpments at elevations ranging from 1670–2130 m (5500–7000 feet). Soils range from loam to silty clays, but can be shallow and rocky and contain caliche layers derived from limestone and/or sandstones. The ground surfaces are generally gravelly, with scattered rocks and little exposed soil. Vegetation is characterized by a dense grass layer of both *Hesperostipa neomexicana* and *Bouteloua gracilis*, with sparsely scattered shrubs. Other grass species include *Aristida purpurea*, *Bouteloua eriopoda*, *Bouteloua curtipendula*, and *Lycurus setosus*. The forb layer can be variable and commonly includes *Lesquerella fendleri* and *Melampodium leucanthum*. Subshrubs or succulents such as *Artemisia bigelovii, Gutierrezia sarothrae*, and *Opuntia polyacantha* are common. Taller shrubs include *Chrysothamnus pulchellus, Dalea formosa, Nolina microcarpa, Opuntia imbricata*, *Opuntia phaeacantha, Rhus trilobata*, *Thymophylla acerosa*, and *Yucca baccata*. Occasional *Juniperus monosperma* (live or standing dead) are common. The presence of desert species is characteristic of this grassland.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This association is known from the Gran Quivira unit.

Globally

This desert grassland occurs in the northern Chihuahuan Desert in the northern San Andres Mountains and the Oscura Mountains within White Sands Missile Range in south-central New Mexico and extends into the southwestern Great Plains on low hills and central New Mexico within Salinas Pueblo Missions National Monument.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association is found at 1975 m (6480 feet) elevation on a northeasterly aspect of a moderately sloped low hill. Soils are derived from limestones of the Permian San Andres Formation. Ground cover is characterized by scattered bunch grasses and associated litter intermixed with soil and gravel.

Globally

This association is found at 1975 m (6480 feet) elevation on a northeasterly aspect of a moderately sloped low hill

within Salinas Pueblo Missions National Monument in central New Mexico. Soils are derived from limestones of the Permian San Andres Formation. Ground cover is characterized by scattered bunch grasses and associated litter intermixed with soil and gravel. A related type, *Hesperostipa neomexicana* / *Bouteloua gracilis*, is a minor association found in the northern San Andres Mountains and the Oscura Mountains within White Sands Missile Range in south-central New Mexico. However, it is an established, widespread association in the Southwest and across the Short Grass Prairie states. Within White Sands Missile Range, stands typically occur on gentle dipslopes and moderately steep escarpments. Aspects are generally cool, and elevations range from 1670–2130 m (5500–7000 feet). Substrates are Paleozoic limestone and/or sandstones (Abó Formation). Surface soils range from loam to silty clays, but can be shallow and rocky and contain caliche layers. The ground surfaces are generally gravelly, with scattered rocks and little exposed soil. (Muldavin et al. 2000b).

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This plains grassland is codominated by *Hesperostipa neomexicana* and *Bouteloua gracilis* with *Bouteloua eriopoda* also well-represented. Tall shrubs are absent or accidental, but subshrubs or succulents such as *Gutierrezia sarothrae, Artemisia bigelovii*, and *Opuntia polyacantha* are common. Trees such as *Juniperus monosperma* are accidental or absent.

Globally

Within Salinas Pueblo Missions National Monument, this plains grassland is codominated by *Hesperostipa neomexicana* and *Bouteloua gracilis* with *Bouteloua eriopoda* also well-represented. Tall shrubs are absent or accidental, but subshrubs or succulents such as *Artemisia bigelovii, Gutierrezia sarothrae*, and *Opuntia polyacantha* are common. Trees such as *Juniperus monosperma* are accidental or absent. Within White Sands Missile Range, stands are characterized by a dense grass layer of both *Hesperostipa neomexicana* and *Bouteloua gracilis*, with sparsely scattered shrubs. Other grass species include *Aristida purpurea, Bouteloua eriopoda, Bouteloua curtipendula*, and *Lycurus setosus*. The shrub layer contains *Chrysothamnus pulchellus, Dalea formosa, Nolina microcarpa, Opuntia imbricata, Opuntia phaeacantha, Rhus trilobata, Thymophylla acerosa*, and *Yucca baccata*. *Juniperus monosperma* (live or standing dead) are common, although usually sparsely scattered. The species composition of the forb layer can be variable and commonly includes *Lesquerella fendleri* and *Melampodium leucanthum*.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Short shrub sapling	*Gutierrezia sarothrae*
Short shrub sapling	*Artemisia bigelovii*
Short shrub sapling	*Opuntia polyacantha*
Herb (field)	*Bouteloua gracilis, Hesperostipa neomexicana*

Globally

Stratum	Species
Herb (field)	*Bouteloua gracilis, Hesperostipa neomexicana*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNRQ (23-Feb-1994)

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

The related concept, *Stipa neomexicana* / *Bouteloua gracilis* (Muldavin et al. 2000b), is a minor association found in the northern San Andres Mountains and the Oscura Mountains within White Sands Missile Range in south-central New Mexico and is considered synonymous. This association is closely related with two similar associations described in the NVC: *Hesperostipa neomexicana* Mixed Prairie Herbaceous Vegetation (CEGL001711), which occurs in New Mexico plains but differs in that it is more species-rich and generally not so heavily dominated by *Hesperostipa neomexicana*, and *Hesperostipa neomexicana* Herbaceous Vegetation (CEGL001708), which occurs on breaks in the Great Plains in southeastern Colorado and along the adjacent Rocky Mountain foothills, and in the San Luis Valley of south-central Colorado; it is also dominated by *Hesperostipa neomexicana* with *Bouteloua gracilis* nearly always present.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plots: 04SG006.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.S. King, mod. K.A. Schulz

REFERENCES

Bourgeron and Engelking 1994, Driscoll et al. 1984, Muldavin and Mehlhop 1992, Muldavin et al. 2000b, Western Ecology Working Group n.d.

***Bouteloua gracilis - Pleuraphis jamesii* Herbaceous Vegetation**

Blue Grama - James' Galleta Herbaceous Vegetation

Blue Grama - Galleta Shortgrass Prairie

CODE	CEGL001759
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Short sod temperate or subpolar grassland (V.A.5.N.e.)
ALLIANCE	*BOUTELOUA GRACILIS* HERBACEOUS ALLIANCE (A.1282) Blue Grama Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Inter-Mountain Basins Semi-Desert Grassland (CES304.787), Western Great Plains Shortgrass Prairie (CES303.672)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

These grasslands occur on alluvial flats, mesas and plains in the semi-arid southwestern Great Plains and the Colorado Plateau in southeastern Colorado, New Mexico, northern Arizona and southern Utah. Elevation ranges from 1625–1860 m (5330–6110 feet) in central New Mexico and on the Colorado Plateau and extends below 1525 m (5000 feet) in the southwestern Great Plains. Sites are flat to undulating, with shallow to moderately deep, loam to silty clay loam-textured soils. The ground surface is characterized by scattered bunch grasses intermixed with exposed soil and litter. Stands are codominated by the graminoids *Bouteloua gracilis* and *Pleuraphis jamesii* (= *Hilaria jamesii*). These short and medium-tall perennial bunch grasses may form a sod-like ground cover with patches of bare ground, especially where grazing by livestock encourages a prostrate growth form. Canopy cover is relatively sparse to moderately dense (20–80% cover). Other grasses include *Buchloe dactyloides, Muhlenbergia torreyi, Sporobolus cryptandrus, Aristida* spp., *Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Pascopyrum smithii*, *Hesperostipa comata* (= *Stipa comata*), or *Hesperostipa neomexicana* (= *Stipa neomexicana*). Forb cover is generally sparse but may be diverse. Characteristic species include *Cryptantha* spp., *Grindelia squarrosa, Machaeranthera pinnatifida, Ratibida* spp., *Sphaeralcea coccinea*, and *Zinnia grandiflora*. Scattered dwarf-shrubs, shrubs and cacti, such as *Artemisia bigelovii, Artemisia frigida, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia imbricata* (= *Cylindropuntia imbricata*), *Opuntia polyacantha, Prosopis glandulosa* (southern stands), and *Yucca glauca*, are not uncommon. Codominance of *Bouteloua gracilis* and *Pleuraphis jamesii* distinguishes this vegetation from several closely related grasslands.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This minor association is known from the Abó unit.

Globally

These grasslands are found in the southern shortgrass steppe of southeastern Colorado and eastern New Mexico, and alluvial flats and mesas of the Colorado Plateau in New Mexico and Utah, south to Sevilleta National Wildlife Refuge and Salinas Pueblo Missions National Monument in central New Mexico.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association is found between 1850 and 1860 m (6060–6110 feet) in elevation on gently sloping low hills. Soils are derived from sandstones of the Permian Abó or Yeso formations. The ground surface is characterized by scattered bunch grasses intermixed with exposed soil and litter.

Globally

These grasslands occur on alluvial flats, mesas and plains in the semi-arid southwestern Great Plains and the Colorado Plateau in southeastern Colorado, New Mexico, northern Arizona and southern Utah. Elevation ranges from 1625–1860 m (5330–6110 feet) in central New Mexico and on the Colorado Plateau and extends below 1525 m (5000 feet) in the southwestern Great Plains. Sites are flat to undulating, with shallow to moderately deep, loam to silty clay loam-textured soil. The ground surface is characterized by scattered bunch grasses intermixed with exposed soil and litter.

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

Salinas Pueblo Missions National Monument

This plains grassland is dominated by *Bouteloua gracilis* with *Pleuraphis jamesii* as a well-represented codominant. Tall shrubs are absent or accidental, but ruderal subshrubs or succulents such as *Gutierrezia sarothrae* and *Opuntia imbricata* (= *Cylindropuntia imbricata*), respectively, are common.

Globally

This association is characterized by an open to moderately dense (20–80% cover) herbaceous layer that is codomi-

nated by the graminoids *Bouteloua gracilis* and *Pleuraphis jamesii* (= *Hilaria jamesii)*. These short and medium-tall perennial bunch grasses may form a sod-like ground cover with patches of bare ground, especially where grazing by livestock encourages a prostrate growth form. Other grasses include *Buchloe dactyloides*, *Muhlenbergia torreyi*, *Sporobolus cryptandrus*, *Aristida* spp., *Achnatherum hymenoides* (= *Oryzopsis hymenoides)*, *Pascopyrum smithii*, *Hesperostipa comata (= Stipa comata),* or *Hesperostipa neomexicana* (= *Stipa neomexicana*). Forb cover is generally sparse but may be diverse. Characteristic species include *Cryptantha* spp., *Grindelia squarrosa*, *Machaeranthera pinnatifida*, *Ratibida* spp., *Sphaeralcea coccinea*, and *Zinnia grandiflora*. Scattered dwarf-shrubs, shrubs and cacti, such as *Artemisia bigelovii*, *Artemisia frigida*, *Gutierrezia sarothrae*, *Krascheninnikovia lanata*, *Opuntia imbricata* (= *Cylindropuntia imbricata)*, *Opuntia polyacantha*, *Prosopis glandulosa* (southern stands), and *Yucca glauca* are not uncommon. Codominance of *Bouteloua gracilis* and *Pleuraphis jamesii* distinguishes this vegetation from several closely related grasslands.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Herb (field)	*Bouteloua gracilis, Pleuraphis jamesii*

Globally

Stratum	Species
Herb (field)	*Bouteloua gracilis*, *Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G2G4 (15-Oct-1999). Historically, most sites supporting this association have been converted to dryland or irrigated cropland in the plains. Overgrazing by livestock has changed some of these grasslands to sparse desert grasslands or desert scrubland. In addition, the reduction of fire frequency, either by livestock grazing the fine fuels that carry fires or by active suppression, has allowed the invasion of trees and shrubs. Loss to urban development has been significant in recent decades. Transformation to pinyon/juniper woodlands or desert grassland/scrubland, and urban development continue the negative trend. More classification and survey work are needed to distinguish this type from closely related grasslands over its relatively broad geographic range, and to inventory its extent and condition.

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

More classification and survey work is needed to distinguish this type from closely related grasslands over its relatively broad geographic range, and to inventory its extent and condition.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plots: 07AR010 and 07AR056.

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz, mod. 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.

***Bouteloua gracilis – Muhlenbergia torreyi – Aristida purpurea* Herbaceous Vegetation**

Blue Grama - Ring Muhly - Purple Three-awn Herbaceous Vegetation

Blue Grama - Ring Muhly - Purple Three-awn Shortgrass Prairie

CODE	CEGL005389
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Short sod temperate or subpolar grassland (V.A.5.N.e.)
ALLIANCE	*BOUTELOUA GRACILIS* HERBACEOUS ALLIANCE (A.1282) Blue Grama Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Inter-Mountain Basins Semi-Desert Grassland (CES304.787), Western Great Plains Shortgrass Prairie (CES303.672)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This ruderal shortgrass association is described in eastern and central New Mexico, but likely extends into eastern Colorado and throughout much southern shortgrass steppe. This association occurs between 6,000 and 6,630 feet (1,835–2,020 m) in elevation on gentle slopes of low-lying hills of variable aspect. Stands typically occur on substrates derived from sandstones, though occasionally on limestone or Quaternary alluvium. Ground cover is characterized by scattered bunch grasses with exposed soil and gravel in the inter-grass spaces. The vegetation is characterized by a short, moderately dense (25–60% cover) grass layer dominated by *Bouteloua gracilis* with the ruderal *Aristida purpurea* and/or *Muhlenbergia torreyi* codominant. Tall shrubs are absent or accidental, but ruderal subshrubs or succulents such as *Gutierrezia sarothrae* and *Cylindropuntia imbricata* common, but with low cover (usually <5%). Forbs are variable and generally low in cover. The most frequent and abundant forbs are *Ratibida tagetes, Heterotheca villosa, Gaura coccinea, Stephanomeria pauciflora, Astragalus* spp., and *Sphaeralcea coccinea*. Trees such as *Juniperus monosperma* are accidental or absent.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This is a common association found in the Abó, Quarai, and Gran Quivira units.

Globally

This shortgrass association is described in the eastern and central New Mexico, but likely extends into eastern Colorado and throughout much southern shortgrass steppe. Stands have been sampled in Fort Union National Monument, Pecos National Historic Park, Salinas Pueblo Missions National Monument, Sevilleta National Wildlife Refuge and White Sands Missile Range.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association occurs between 6,000 and 6,630 feet (1,835–2,020 m) in elevation on gentle slopes of low-lying hills of variable aspect. Stands typically occur on substrates derived from sandstones of the Permian Yeso formation, though occasionally on limestone of the Permian San Andres formation or Quaternary alluvium. Ground cover is characterized by scattered bunch grasses with exposed soil and gravel in the inter-grass spaces.

Globally

This ruderal shortgrass association are described in the eastern and central New Mexico, but likely extend into eastern Colorado and throughout much southern shortgrass steppe. This association occurs between 6,000 and 6,630 feet (1,835–2,020 m) in elevation on gentle slopes of low-lying hills of variable aspect. Stands typically occur on substrates derived from sandstones, though occasionally on limestone or Quaternary alluvium. Ground cover is characterized by scattered bunch grasses with exposed soil and gravel in the inter-grass spaces.

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This plains grassland is dominated by *Bouteloua gracilis* with the ruderal *Aristida purpurea* and/or *Muhlenbergia torreyi* as a codominant. Although there is a distinctive composition to the grass layer, graminoid canopy cover still ranges from 25 to 60%. Tall shrubs are absent or accidental, but ruderal subshrubs or succulents such as *Gutierrezia sarothrae* and *Cylindropuntia imbricata,* respectively, are common. Forbs are variable and generally low in cover. Among the 32 species reported, the most frequent and abundant are *Ratibida tagetes, Heterotheca villosa, Gaura coccinea, Stephanomeria pauciflora, Astragalus* spp., and *Sphaeralcea coccinea*. Trees such as *Juniperus monosperma* are accidental or absent.

Globally

This association is characterized by a short, moderately dense (25–60% cover) grass layer dominated by *Bouteloua gracilis* with the ruderal *Aristida purpurea* and/or *Muhlenbergia torreyi* codominant. Tall shrubs are absent or accidental, but ruderal subshrubs or succulents such as *Gutierrezia sarothrae* and *Cylindropuntia imbricata* common, but with low cover (usually <5%). Forbs are variable and generally low in cover. The most frequent and abundant forbs are *Ratibida tagetes, Heterotheca villosa, Gaura coccinea, Stephanomeria pauciflora, Astragalus* spp., and *Sphaeralcea coccinea*. Trees such as *Juniperus monosperma* are accidental or absent.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Herb (field)	*Bouteloua gracilis, Aristida purpurea, Muhlenbergia torreyi*

Globally

Stratum	Species
Herb (field)	*Bouteloua gracilis, Aristida purpurea, Muhlenbergia torreyi*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Gutierrezia sarothrae, Opuntia imbricata

Globally
Gutierrezia sarothrae

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR

CLASSIFICATION COMMENTS
Salinas Pueblo Missions National Monument
Although the ruderal dwarf-shrub *Gutierrezia sarothrae* may be present in this disturbed grassland, it does not dominate or form a layer and usually has <5% cover.

Globally
This is seral shortgrass prairie type that is common on disturbed ranges. This association is similar to *Gutierrezia sarothrae* / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation (CEGL005382), in that it is seral; although *Gutierrezia sarothrae* may be present it does not dominate or form a distinct dwarf-shrub layer and is usually <5% cover and always <10% cover. More classification and survey work is needed to distinguish this type from closely related grasslands over its relatively broad geographic range, and to inventory its extent and condition.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES
Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plots: NHNM plots

04SG005, 04SQ004, 05AR004, 07AR009, 07AR025, and 07AR031.

Local Description Authors: A. Kennedy and E. Muldavin, mod by K.A. Schulz

Global Description Authors: K.A. Schulz

REFERENCES
Western Ecology Working Group n.d.

***Krascheninnikovia lanata / Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation**

Winterfat / Blue Grama Dwarf-shrub Herbaceous Vegetation

Winterfat / Blue Grama Shrub Prairie

CODE	CEGL001321
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland with a sparse dwarf-shrub layer (V.A.8.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland with a sparse dwarf-shrub layer (V.A.8.N.)
FORMATION	Short temperate or subpolar lowland grassland with a sparse needle-leaved or microphyllous dwarf-shrub layer (V.A.8.N.a.)
ALLIANCE	*KRASCHENINNIKOVIA LANATA* DWARF-SHRUB HERBACEOUS ALLIANCE (A.1565) Winterfat Dwarf-shrub Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Inter Mountain Basins Semi Desert Shrub Steppe (CES304.788), Central Mixedgrass Prairie (CES303.659)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This widespread, open dwarf-shrub type is found in the western Great Plains from eastern Wyoming, western Kansas, Colorado, and New Mexico to the Colorado Plateau and semi-desert mountains in the northern Chihuahuan Desert. This shrub herbaceous association occurs on alluvial flats, plains, mesas, and desert mountains. Stands occupy flat to moderate slopes between 1630 and 2080 m (5360–6820 feet) elevation. The sometimes rocky soils are typically shallow, alkaline, calcareous, and loamy or clayey in soil texture and are derived from shale or alluvium. Ground cover ranges from bare soil to scattered bunch grasses and litter with exposed soil and gravel in the intergrass spaces. In Colorado Plateau stands, there is often significant cover of biotic crusts (to 30% cover). This community contains open shrub and graminoid layers dominated by the shrub *Krascheninnikovia lanata* with a sparse to dense herbaceous understory dominated by *Bouteloua gracilis*. Other shrubs may be present with very low cover, including *Artemisia nova, Atriplex* spp., *Ephedra viridis, Gutierrezia sarothrae, Opuntia imbricata*, and *Opuntia polyacantha*. Associated graminoids present may include *Achnatherum hymenoides, Aristida purpurea, Elymus elymoides, Hesperostipa comata, Muhlenbergia torreyi, Pascopyrum smithii, Pleuraphis jamesii, Sporobolus airoides,* and *Sporobolus cryptandrus*. Forb cover is typically low but may be diverse.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This minor association is known from the Gran Quivira unit.

Globally

This widespread, open dwarf-shrub type is found in the western Great Plains from western Kansas and eastern Colorado, to semi-desert mountains (Oscura and San Andres mountains) in south central New Mexico, within Salinas Pueblo Missions National Monument in central New Mexico, and the Colorado Plateau (northern Arizona and southern Utah). This associations is likely more widespread as the dominant/diagnostic species are common in the western U.S.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association occurs at 1960 m (6440 feet) in elevation on the moderate slope of a low hill with a northerly aspect. Soils are derived from limestone of the Permian San Andres Formation. Ground cover is characterized by scattered bunch grasses and litter with exposed soil and gravel in the intergrass spaces.

Globally

This widespread, open dwarf-shrub type is found in the western Great Plains from eastern Wyoming, western Kansas, Colorado, and New Mexico semi-desert mountains (Oscura and San Andres mountains in south central New Mexico; Salinas Pueblo Missions National Monument in central New Mexico) and the Colorado Plateau. This shrub herbaceous association occurs on alluvial flats, plains, mesas, and desert mountains. Stands occupy flat to moderate slopes between 1630 and 2080 m (5360–6820 feet) elevation. The sometimes rocky soils are typically shallow, alkaline, calcareous, and loamy or clayey in soil texture and are derived from shale or alluvium (Francis 1986, Lauver et al. 1999, Muldavin et al. 2000b). In Kansas, stands occur in areas with sparse vegetation on uplands and flats. Soils are shallow, rocky, and alkaline (Lauver et al. 1999). Ground cover ranges from bare soil to scattered bunch grasses and litter with exposed soil and gravel in the intergrass spaces. In Colorado Plateau stands, there is often significant cover of biotic crusts (to 30% cover).

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This shrubland is dominated by the tall shrub *Krascheninnikovia lanata* with *Bouteloua gracilis* dominating the

understory. *Lycium pallidum* is a common associate, possibly indicating disturbance. Forbs are common but variable; the most abundant are *Physalis hederifolia* var. *fendleri, Solanum jamesii, Sphaeralcea incana*, and *Erysimum capitatum*.

Globally

This community contains open shrub and graminoid layers dominated by the shrub *Krascheninnikovia lanata* with a sparse to dense herbaceous understory dominated by *Bouteloua gracilis*. The dwarf shrub layer is about 0.5 m tall, containing annual stems from a woody rootstock, and microphyllous leaves. Other shrubs may be present with very low cover, including *Artemisia nova, Atriplex* spp., *Ephedra viridis, Gutierrezia sarothrae, Opuntia imbricata*, and *Opuntia polyacantha*. Associated graminoids present may include *Achnatherum hymenoides, Aristida purpurea, Elymus elymoides, Hesperostipa comata, Muhlenbergia torreyi, Pascopyrum smithii, Pleuraphis jamesii, Sporobolus airoides*, and *Sporobolus cryptandrus* (Francis 1986, Muldavin et al. 2000b). Forb cover is typically low but may be diverse. Common species in the Colorado Plateau are *Chaetopappa ericoides, Cryptantha crassisepala, Gilia leptomeria, Helianthus petiolaris, Machaeranthera canescens, Mentzelia albicaulis, Plantago patagonica, Senecio spartioides*, and *Sphaeralcea coccinea; Glandularia bipinnatifida* is the most constant in mountains of south central New Mexico. In central New Mexico, *Lycium pallidum* is a common associate, possibly indicating disturbance. Forbs are common but variable; the most abundant are *Erysimum capitatum, Physalis hederifolia* var. *fendleri, Solanum jamesii,* and *Sphaeralcea incana*. In Kansas, *Stanleya pinnata*, a subshrubby perennial from a woody base, can be over 1 m tall and is often present; *Echinacea angustifolia* and *Liatris punctata* are often codominant with *Bouteloua gracilis* in the herbaceous layer. Exotic annual grass *Bromus tectorum* is frequently present in disturbed stands.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Shrub/sapling (tall & short)	*Krascheninnikovia lanata*
Herb (field)	*Bouteloua gracilis*

Globally

Stratum	Species
Shrub/sapling (tall & short)	*Krascheninnikovia lanata*
Herb (field)	*Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Bromus tectorum

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (1 Feb 1996)

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: The description is based on one field plot (standard plot) from 2004: (Plot: 04SG004).

Local Description Authors: A. Kennedy and E. Muldavin

Global Description Authors: K.A. Schulz, mod. K.S. King

REFERENCES

BIA 1979, Bourgeron and Engelking 1994, Daubenmire 1970, Driscoll et al. 1984, Francis 1986, Johnston 1987, Lauver et al. 1999, Muldavin and Mehlhop 1992, Muldavin et al. 1998d, Muldavin et al. 2000b, Rasmussen and Brotherson 1986, Soil Conservation Service 1978, Western Ecology Working Group n.d.

***Equisetum laevigatum* Herbaceous Vegetation**

Smooth Horsetail Herbaceous Vegetation

CODE	CEGL002241
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial forb vegetation (V.B.)
PHYSIOGNOMIC GROUP	Temperate or subpolar perennial forb vegetation (V.B.2.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar perennial forb vegetation (V.B.2.N.)
FORMATION	Semipermanently flooded temperate perennial forb vegetation (V.B.2.N.e.)
ALLIANCE	*EQUISETUM LAEVIGATUM* SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.2648) Smooth Horsetail Semipermanently Flooded Herbaceous Alliance

ECOLOGICAL SYSTEM(S)

Rocky Mountain Lower Montane Foothill Riparian Woodland and Shrubland (CES306.821), Rocky Mountain Alpine Montane Wet Meadow (CES306.812)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This association occurs on the narrow valley floors and low to upper alluvial terraces adjacent to the riparian zone of small perennial streams that are subject to periodic scouring from flooding. This type is restricted to small streams in the Colorado Plateau of Colorado and Utah, as well as within Salinas Pueblo Missions National Monument in central New Mexico, that are subject to flooding and scouring from flooding. Elevations range from 1603 to 2030 m (5260–6650 feet), slopes do not exceed 8%, and aspect varies. The alluvial soils vary in texture from clay or silt to sand, and the soil surface may be bare if flooding has occurred recently, or covered by a mat of older *Equisetum* stems. Total vegetation cover in this association may exceed 100%, but it is dominated by the fern ally *Equisetum laevigatum* with between 20 and 75% cover. Graminoids may provide up to 25% cover and include *Agrostis gigantea, Juncus balticus,* or *Muhlenbergia asperifolia*. Forbs are generally also present and are variable, but usually indicate disturbance. Riparian trees and shrubs, such as T*amarix ramosissima, Populus* spp., and *Salix* spp., may occur at the margins of the association. Deep rhizome growth allows *Equisetum* plants to survive environmental disturbances such as burial, flooding, fire and drought. As riparian terraces become isolated from flooding and the water table, *Equisetum laevigatum* will persist thanks to its system of rhizomes, but other herbaceous and woody species will tend to become dominant.

DISTRIBUTION

Salinas Pueblo Missions National Monument

This association is known from the Quarai unit.

Globally

This type is restricted to small streams in the Colorado Plateau of Colorado and Utah, as well as within Salinas Pueblo Missions National Monument in central New Mexico, that are subject to flooding and scouring from flooding.

ENVIRONMENTAL DESCRIPTION

Salinas Pueblo Missions National Monument

This association is found at an elevation of around 2030 m (6650 feet) along upper alluvial terraces adjacent to the riparian zone.

Globally

This association occurs on narrow valley floors and low to upper alluvial terraces adjacent to the riparian zone of small perennial streams that are subject to periodic scouring from flooding. Elevations range from 1603 to 2030 m (5260–6650 feet), slopes do not exceed 8%, and aspect varies. Soils are alluvium derived from shales, sandstones or igneous rocks. The soil surface may be bare if flooding has occurred recently, or covered by a mat of older *Equisetum* stems.

VEGETATION DESCRIPTION

Salinas Pueblo Missions National Monument

This herbaceous wet meadow association is dominated by *Equisetum laevigatum* along with a mix of ruderal herbaceous species such as *Grindelia squarrosa, Cucurbita foetidissima, Artemisia dracunculus, Tragopogon pratensis*, and *Conyza canadensis*.

Globally

This herbaceous association is dominated by the fern ally *Equisetum laevigatum* with between 20 and 75% cover. Graminoids may provide up to 25% cover and include *Agrostis gigantea*, *Juncus balticus,* or *Muhlenbergia asperifolia*. Forbs are generally also present and are variable, but usually indicate disturbance and may include *Artemisia dracunculus, Cirsium arvense, Conyza canadensis, Cucurbita foetidissima, Grindelia squarrosa, Plantago lanceolata*, *Tragopogon dubius*, and *Tragopogon pratensis*. Riparian trees and shrubs, such as *Tamarix ramosissima, Populus* spp., and *Salix* spp., may occur at the margins of the association.

MOST ABUNDANT SPECIES

Salinas Pueblo Missions National Monument

Stratum	Species
Herb (field))	*Equisetum laevigatum*

Globally

Stratum	Species
Herb (field))	*Equisetum laevigatum*

OTHER NOTEWORTHY SPECIES

Salinas Pueblo Missions National Monument

Tragopogon pratensis

Globally

Tragopogon pratensis

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (10 Jan 2005)

CLASSIFICATION COMMENTS

Salinas Pueblo Missions National Monument

Data are not available.

Globally

Data are not available.

CLASSIFICATION CONFIDENCE: 3 - Weak

ELEMENT SOURCES

Salinas Pueblo Missions National Monument Inventory Notes: Data are not available.

Salinas Pueblo Missions National Monument Plots: NHNM plots: 04SQ011.

Local Description Authors: E. Muldavin and A. Kennedy

Global Description Authors: J. Coles

REFERENCES

Hauke 1993, Page 1977, Western Ecology Working Group n.d

V. Incidental associations

Incidental associations are usually known only from one plot or observation point, or they may have been identified during the accuracy assessment phase of the project. They are listed below pending the aquistion of additional data on their distribution, composition, and environment. Codes in parentheses are the provisionally assigned database codes for the plant associations (those beginning with CEGL refer to the NatureServe database and those that begin with NPS_NM are those from NHNM state database).

Woodlands

Juniperus monosperma / *Bouteloua hirsuta* Woodland (CEGL000711)

Juniperus monosperma / *Bouteloua curtipendula* Woodland (CEGL000708)

Juniperus monosperma / *Pleuraphis jamesii* Woodland (NPS_NM036)

Juniperus monosperma / Rockland Woodland (CEGL005369)

Pinus edulis - Juniperus spp. / *Quercus gambelii* Woodland (CEGL000791)

Pinus edulis / *Koeleria macrantha* Woodland (NHNM000581)

Pinus edulis - Juniperus monosperma / *Quercus* × *pauciloba* Woodland(CEGL000793)

Pinus edulis / Rockland Woodland (CEGL000794)

Populus deltoides (ssp. *wislizeni*, ssp. *monilifera*) / *Rosa woodsii* Forest (NPS_NM038)

Shrublands

Atriplex canescens / *Bouteloua gracilis* Shrubland (CEGL001283)

Atriplex canescens / *Panicum obtusum* Shrubland (NPS_NM040)

Ericameria nauseosa Desert Wash Shrubland (CEGL002261)

Rosa woodsii / Mixed Herbaceous Shrubland (NHNM000816)

Salix exigua - Rosa woodsii Shrubland (NPS_NM041)

Grasslands

Bouteloua gracilis Herbaceous Vegetation (CEGL001760)

Typic and *Andropogon gerardii* Phase

Bouteloua gracilis / Ruderal Herbaceous Vegetation (NPS_NM043)

Bouteloua gracilis - Sporobolus cryptandrus Herbaceous Vegetation (CEGL001761)

Bouteloua gracilis / Old Field Herbaceous Vegetation (NPS_NM042)

Ericameria nauseosa / *Bouteloua gracilis* Shrub Herbaceous Vegetation (CEGL003495)

Gutierrezia sarothrae / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation (CEGL005382)

Panicum obtusum Herbaceous Vegetation (CEGL002708)

Pascopyrum smithii / Ruderal Herbaceous Vegetation (NPS_NM045)

Sporobolus airoides - Panicum obtusum Herbaceous Vegetation (CEGL001690)

Yucca glauca / *Bouteloua gracilis* Shrub Herbaceous Vegetation (NPS_NM055)

Riparian/Wetlands

Typha (*latifolia, angustifolia*) Western Herbaceous Vegetation (CEGL002010)

Carex pellita Herbaceous Vegetation (CEGL001809)

Juncus balticus Herbaceous Vegetation (CEGL001838)

Miscellaneous

Disturbed / Archeological Site - Restored (NHNM000820)

Disturbed / Archeological Site - Un-restored (NHM000819)

Disturbed / Non-vegetated (NPS_NM047)

Disturbed / Recreation Site (NPS_NM048)

Ruderal Disturbance Vegetation (NPS_NM027)

Sparse Vegetation / Boulder Rockland (NPS_NM013)

Sparse Vegetation / Dry Wash Rockland (NHNM000818)

Sparse Vegetation / Recent Alluvial Deposits (NHNM000817)

Sparse Vegetation / Upland Bare Soil (NPS_NM073)

VI. Bibliography

Arbetan, P., E. Muldavin, P. Neville, and Y. Chauvin. 2002. The vegetation of the New Mexico Army National Guard Camel Tracks Training Site. Final report to New Mexico Army National Guard, Santa Fe, New Mexico.

Bureau of Indian Affairs (BIA), U.. 1979. The secretarial land use plan for the addition to the Havasupai Indian Reservation. Unpublished draft Environmental Statement INT DES 79 42. Prepared by USDI Bureau of Indian Affairs, Phoenix Area Office with the assistance of Office of Arid Land Studies, University of Arizona, Tucson, Arizona.

Baalman, R. J. 1965. Vegetation of the Salt Plains National Wildlife Refuge, Jet, Oklahoma. Unpublished Ph.D. dissertation, University of Oklahoma, Norman.

Baker M. B. J., L. F. DeBano, and P. F. Ffolliott. 1995. Soil loss in pinon juniper ecosystems and its influence on site productivity and desired future condition. Pages 9–15 in: D. W. Shaw, E. F. Aldon, and C. LoSapio, technical coordinators. Desired future conditions for Pinon Juniper Ecosystems. General Technical Report RM 258. USDA Forest Service, Rocky Mountain Forest and Range Experimental Station, Fort Collins, Colorado.

Baker, W. L. 1984a. A preliminary classification of the natural vegetation of Colorado. Great Basin Naturalist 44(4):647–676.

Barber, M. Personal communication. Ecologist.

Barnes, F.J. 1983. Habitat types in piñon-juniper woodland of the Pajarito Plateau and range conditions in Bandelier National Monument. Final report to the Southwest Region., National Park Service from the Dept. of Biology, New Mexico State University, Las Cruces, New Mexico.

Barnes, F. J. 1987. Carbon and water relations across a pinyon juniper habitat gradient. Unpublished dissertation, New Mexico State University, Las Cruces.

Baxter, C. 1977. A comparison between grazed and ungrazed juniper woodland. Pages 25–27 in: Ecology, uses and management of pinyon juniper woodlands. General Technical Report RM 39. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Beavis, W. D., J. C. Owens, J. A. Ludwig, and E. W. Huddleston. 1982. Grassland communities of east central New Mexico and density of the range caterpillar, Hemileuca oliviae (Lepidoptera: Saturnidae). Southwestern Naturalist 27(3):335–343.

Blair, W. F., and T. H. Hubbell. 1938. The biotic districts of Oklahoma. The American Midland Naturalist 20:425–454.

Bourgeron, P. S., L. D. Engelking, H. C. Humphries, E. Muldavin, and W. H. Moir. 1993b. Assessing the conservation value of the Gray Ranch: Rarity, diversity and representativeness. Unpublished report prepared for The Nature Conservancy by the Western Heritage Task Force, Boulder, Colorado. (Volume I and II).

Bourgeron, P. S., L. D. Engelking, H. C. Humphries, E. Muldavin, and W. H. Moir. 1995. Assessing the conservation value of the Gray Ranch: Rarity, diversity and representativeness. Desert Plants 11:2–3.

Bourgeron, P. S., and L. D. Engelking, editors. 1994. A preliminary vegetation classification of the western United States. Unpublished report. The Nature Conservancy, Western Heritage Task Force, Boulder, Colorado.

Boutton, T. W., A. T. Harrison, and B. N. Smith. 1980. Distribution of biomass of species differing in photosynthetic pathway along an altitudinal transect in southwestern Wyoming grasslands. Oecologia 45:287–298.

Bradley, A. F., N. V. Noste, and W. C. Fischer. 1992. Fire ecology of forests and woodlands in Utah. General Technical Report INT 287. USDA Forest Service, Intermountain Research Station, Ogden, Utah.

Branson, F. A., R. F. Miller, and I. S. McQueen. 1961. Soil water availability and use by grasslands on adjacent stony and shale derived soils in Colorado. Short papers in geologic and hydrologic sciences. U.S. Geological Survey Professional Paper 424C:251–253.

Branson, F. A., R. F. Miller, and I. S. McQueen. 1964. Effects of two kinds of geologic materials on plant communities and soil moisture. American Society of Agronomy Special Publication 5:165–175.

Branson, F. A., R. F. Miller, and I. S. McQueen. 1965. Plant communities and soil moisture relationships near Denver, Colorado. Ecology 46(3):311–319.

Bruner, W. E. 1931. The vegetation of Oklahoma. Ecological Monographs 1:99–188.

Buffington, L. C., and C. H. Herbel. 1965. Vegetational changes on a semidesert grassland range from 1858 to 1963. Ecological Monographs 35(2):139–164.

Bujakiewicz, A. 1975. Vegetational zonation in the Front Range of the Rocky Mountains, Colorado. USA. Fragmenta Floristica et Geobotanica 21:99–142.

Bunin, J. E. 1985. Vegetation of the City of Boulder, Colorado open space lands. Report prepared for the City of Boulder, Real Estate/Open Space, Boulder, Colorado.

Colorado Natural Heritage Program [CONHP]. 2003. Unpublished data. List of Elements and Elcodes converted and entered into Biotics Tracker 4.0. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

Cacek, T. L. 1973. An ecological interpretation of north central Colorado. Unpublished dissertation, Colorado State University, Fort Collins.

Caicco, S. L., and C. A. Wellner. 1983n. Research Natural Area recommendation for Little Jacks Creek. Unpublished report prepared for USDI Bureau of Land Management, Boise District, Idaho by Idaho Natural Areas Coordinating Committee.

Caire, W. 1989. Physiognomic regions of Oklahoma. Pages 12–25 in: W. Caire, J. D. Tyler, B. P. Glass, and M. A. Mares. Mammals of Oklahoma. University of Oklahoma Press, Norman.

Campbell, C. J., and W. A. Dick Peddie. 1964. Comparison of phreatophyte communities on the Rio Grande in New Mexico. Ecology 45:492–501.

Carsey, K., D. Cooper, K. Decker, D. Culver, and G. Kittel. 2003b. Statewide wetlands classification and characterization: Wetland plant associations of Colorado. Prepared for Colorado Department of Natural Resources, Denver, by Colorado Natural Heritage Program, College of Natural Resources, Colorado State University, Fort Collins. [http://www.cnhp.colostate.edu/documents/2003/wetland_classification_final_report_2003.pdf]

Carsey, K., G. Kittel, K. Decker, D. J. Cooper, and D. Culver. 2003a. Field guide to the wetland and riparian plant associations of Colorado. Colorado Natural Heritage Program, Fort Collins, Colorado.

Cedar Creek Associates, Inc. 1987. Draft vegetation in formation for the Alton Coal Mining Project. Volume 6, Chapter 3, Appendix 3.6 B, pages 1–41 in: Mining & Reclamation Plan for Alton Mine, Utah International, Inc., Utah Division of Oil, Gas & Mining ACT/025/003.

Copeland, W. N. 1980a. The Lawrence Memorial Grassland Preserve, a biophysical inventory with management recommendations. June 1980. Unpublished report prepared by The Nature Conservancy Field Office, Portland, Oregon.

Costello, D. F. 1944b. Important species of the major forage types in Colorado and Wyoming. Ecological Monographs 14:107–134.

Culwell, L. D., and K. L. Scow. 1982. Terrestrial vegetation inventory: Dominy Project Area, Custer County, Montana 1979 1980. Unpublished technical report for Western Energy Company by Westech, Helena, Montana.

Daubenmire, R. F. 1970. Steppe vegetation of Washington. Washington State University Agricultural Experiment Station Technical Bulletin No. 62.

DeOliviera, R. R. 1961. Survey of the vegetation of the eastern base of San Augustin Peak and vicinity, San Augustin Moun-

tains, Dona Ana County, New Mexico. Unpublished thesis, New Mexico State University, Las Cruces.

Diamond, D. D. 1993. Classification of the plant communities of Texas (series level). Unpublished document. Texas Natural Heritage Program, Austin.

Dick Peddie, W. A. 1986. Draft manuscript for book on vegetation of New Mexico to be published by University of New Mexico Press.

Dick Peddie, W. A. 1993. New Mexico vegetation: Past, present, and future. University of New Mexico Press, Albuquerque.

Dick Peddie, W. A., J. K. Meents, and R. Spellenberg. 1984. Vegetation resource analysis for the Velarde Community Ditch Project, Rio Arriba and Santa Fe counties, New Mexico. Unpublished final report prepared for the USDI Bureau of Reclamation, Southwestern Region, Amarillo, Texas.

Donart, G. B., D. Sylvester, and W. Hickey. 1978a. A vegetation classification system for New Mexico, USA. Pages 488–490 in: Rangeland Congress, Denver, CO, 14 18 August 1978. Society for Range Management, Denver.

Driscoll, R. S., D. L. Merkel, D. L. Radloff, D. E. Snyder, and J. S. Hagihara. 1984. An ecological land classification framework for the United States. USDA Forest Service. Miscellaneous Publication No. 1439. Washington, D.C.

Duck, L. G., and J. B. Fletcher. 1945. A survey of the game and furbearing animals of Oklahoma; chapter 2, The game types of Oklahoma. Oklahoma Game and Fish Commission, Division of Wildlife Restoration and Research, Oklahoma City.

Dwyer, D. D., and R. D. Pieper. 1967. Fire effects on blue gramma pinyon juniper rangeland in New Mexico. Journal of Range Management 20:359–362.

Evans, S. 1989a. Riparian survey of Washington's Columbia Basin. Unpublished report prepared for The Nature Conservancy Washington Natural Heritage Program, Olympia, Washington.

Evans, S. 1989b. Provisional riparian and aquatic wetland plant communities on the Columbia Plateau. Unpublished report prepared under Contract No. C0089098, with Washington State Department of Ecology.

Fischer, W. C., and A. F. Bradley. 1987. Fire ecology of western Montana forest habitat types. General Technical Report INT 223. USDA Forest Service, Intermountain Research Station, Ogden, Utah.

Francis, R. E. 1986. Phyto edaphic communities of the Upper Rio Puerco Watershed, New Mexico. Research Paper RM 272. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Gardner, J. L. 1950. Effects of thirty years of protection from grazing in desert grassland. Ecology 31(1):44–50.

Gardner, J. L. 1951. Vegetation of the creosotebush area of the Rio Grande Valley in New Mexico. Ecological Monographs 21:379–403.

Gibbens, R. P., J. M. Tromble, J. T. Hennessy, and M. Cardenas. 1983. Soil movement in mesquite dunelands and former grasslands of southern New Mexico. Journal of Range Management 36(2):145–148.

Girard, M., D. L. Wheeler, and S. B. Mills. 1997. Classification of riparian communities on the Bighorn National Forest. R2 RR 97 02. USDA Forest Service, Rocky Mountain Region, Sheridan, Wyoming.

Gom, L. A., and S. B. Rood. 1999. Patterns of clonal occurrence in a mature cottonwood grove along the Oldman River, Alberta. Canadian Journal of Botany 77:1095–1105.

Hadley, R. F., and F. A. Branson. 1965. Surficial geology and microclimatic effects on vegetation, soils and geomorphology in the Denver, Colorado, area. Pages 56–63 in: Guidebook for 1 day field conferences Boulder area, Colorado. 7th International Association for Quaternary Research Congress. Nebraska Academy of Science.

Hall, J. B., and P. L. Hansen. 1997. A preliminary riparian habitat type classification system for the Bureau of Land Management districts in southern and eastern Idaho. Riparian and Wetland Research Program, School of Forestry, Univer-

sity of Montana. Idaho Bureau of Land Management, Technical Bulletin No. 97–11.

Hansen, M., J. Coles, K. A. Thomas, D. Cogan, M. Reid, J. Von Loh, and K. Schulz. 2004b. USGS NPS Vegetation Mapping Program: Wupatki National Monument, Arizona, vegetation classification and distribution. U.S. Geological Survey Technical Report. Southwest Biological Science Center, Flagstaff, Arizona.

Hansen, M., J. Coles, K. A. Thomas, D. Cogan, M. Reid, J. Von Loh, and K. Schulz. 2004c. USGS NPS Vegetation Mapping Program: Sunset Crater National Monument, Arizona, vegetation classification and distribution. U.S. Geological Survey Technical Report. Southwest Biological Science Center, Flagstaff, Arizona.

Hansen, P. L., R. D. Pfister, K. Boggs, B. J. Cook, J. Joy, and D. K. Hinckley. 1995. Classification and management of Montana's riparian and wetland sites. Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Miscellaneous Publication No. 54.

Hansen, P. L., S. W. Chadde, and R. D. Pfister. 1988b. Riparian dominance types of Montana. University of Montana Miscellaneous Publication 49. Montana Forest and Conservation Experiment Station, Missoula.

Hansen, P., K. Boggs, and R. Pfister. 1991. Classification and management of riparian and wetland sites in Montana. Unpublished draft version prepared for Montana Riparian Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula.

Hanson, H. C. 1957. The use of basic principles in the classification of range vegetation. Journal of Range Management 10:26–33.

Hanson, H. C., L. D. Love and M. S. Morris. 1931. Effects of different systems of grazing by cattle upon a western wheat grass type of range near Fort Collins, Colorado. Colorado Agricultural Experiment Station Bulletin 377.

Hanson, H. C., and W. S. Ball. 1928. An application of Raunkiaer's law of frequency to grazing studies. Ecology 9:467–473.

Hanson, H. C., and E. Dahl. 1956. Some grassland communities in the mountain front zone in northern Colorado. Vegetatio 7:249–270.

Harlan, J. R. 1957. Grasslands of Oklahoma. Oklahoma State University, Stillwater.

Hauke, R. L. 1993. Equisetaceae Michaux ex DeCandolle: Horsetail Family. Pages 76–84 in: Flora of North America Editorial Committee, editors. Flora of North America, North of Mexico. Volume 2. Oxford University Press, New York.

Hendricks, B. A. 1934. Soil erosion in relation to vegetation on certain soil type areas in Arizona and New Mexico. Unpublished dissertation, University of Arizona, Tucson.

Hennessy, J. T., R. P. Gibbens, J. M. Tromble, and M. Cardenas. 1983. Vegetation changes from 1935 to 1980 in mesquite dunelands and former grasslands of southern New Mexico. Journal of Range Management 36(3):370–374.

Herbel, C. H., F. N. Ares, and R. Wright. 1972. Drought effects on a semidesert grassland range. Ecology 53:1084–1093.

Hibner, C. D. 2009. Special project soil survey of Bandelier National Monument. Natural Resources Conservation Science. In cooperation with the USDI National Park Service and the New Mexico Agricultural Experiment Station. [in review]

Hoagland, B. 2000. The vegetation of Oklahoma: A classification for landscape mapping and conservation planning. The Southwestern Naturalist 45(4):385–420.

Humphrey, R. R. 1974. Fire in the deserts and desert grassland of North America. Pages 365–400 in: T. T. Kozlowski and C. E. Ahlgren, editors. Fire and Ecosystems. Academic Press, New York.

Hyder, D. N., R. E. Bement, E. E. Remmenga, and C. Terwilliger, Jr. 1966. Vegetation soils and vegetation grazing relations from frequency data. Journal of Range Management 19:11–17.

IDCDC [Idaho Conservation Data Center]. 2005. Wetland and riparian plant associations in Idaho. Idaho Conservation

Data Center, Idaho Department of Fish and Game, Boise. [http://fishandgame.idaho.gov/tech/CDC/ecology/wetland_riparian_assoc.cfm] (accessed 14 June 2005).

Jameson, D. A. 1962. Effects of burning on a galleta black grama range invaded by juniper. Ecology 43:760–763.

Johnsen, T. N., Jr. 1962. One seed juniper invasion of northern Arizona grasslands. Ecological Monographs 32:187–207.

Johnston, B. C. 1987. Plant associations of Region Two: Potential plant communities of Wyoming, South Dakota, Nebraska, Colorado, and Kansas. R2 ECOL 87 2. USDA Forest Service, Rocky Mountain Region. Lakewood, Colorado.

Jones, G. 1992b. Wyoming plant community classification (Draft). Wyoming Natural Diversity Database, Laramie, Wyoming.

Jones, G. P., and G. M. Walford. 1995. Major riparian vegetation types of eastern Wyoming. Submitted to Wyoming Department of Environmental Quality, Water Quality Division. Wyoming Natural Diversity Database, Laramie, Wyoming.

Jones, R. E. 1963. Identification and analysis of lesser and greater prairie chicken habitat. Journal of Wildlife Management 27:758–778.

Kagan, J. S., J. A. Christy, M. P. Murray, and J. A. Titus. 2000. Classification of native vegetation of Oregon. Oregon Natural Heritage Program, Portland.

Kahler, L. J. 1973. Correlation of slope exposure with differences in the composition of the vegetation community at 7000 feet in Clear Creek Canyon west of Golden, Colorado. Unpublished thesis, University of Colorado, Boulder.

Keammerer, W. R., and R. E. Stoecker. 1975. Vegetation and wildlife studies along proposed corridors for oil shale tract C b. Unpublished report prepared for Shell Oil Co., Denver, by Stoecker Keammerer and Associates, Boulder, Colorado.

Kennedy, K. L. 1983a. A habitat type classification for the pinyon juniper woodlands of the Lincoln National Forest. Unpublished thesis, New Mexico State University, Las Cruces.

Kittel, G., E. Van Wie, M. Damm, R. Rondeau, S. Kettler, A. McMullen, and J. Sanderson. 1999b. A classification of riparian and wetland plant associations of Colorado: A user's guide to the classification project. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

Kittel, G., E. Van Wie, M. Damm, R. Rondeau, S. Kettler, and J. Sanderson. 1999a. A classification of the riparian plant associations of the Rio Grande and Closed Basin watersheds, Colorado. Unpublished report prepared by the Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Kittel, G., R. Rondeau, and A. McMullen. 1996. A classification of the riparian vegetation of the Lower South Platte and parts of the Upper Arkansas River basins, Colorado. Submitted to Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Prepared by Colorado Natural Heritage Program, Fort Collins.

Kovalchik, B. L. 1987. Riparian zone associations Deschutes, Ochoco, Fremont, and Winema national forests. USDA Forest Service Technical Paper 279 87. Pacific Northwest Region, Portland, Oregon.

Kudray, G., P. Hendricks, E. Crowe, and S. Cooper. 2004. Riparian forests of the Wild and Scenic Missouri River: Ecology and management. Report to the Lewistown Field Office, Bureau of Land Management. Montana Natural Heritage Program, Helena, Montana.

Ladyman, J. A. R., and E. Muldavin. 1996. Terrestrial cryptograms of pinyon juniper woodlands in the southwestern United States: A review. General Technical Report RM GTR 280. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Larson, M., and W. H. Moir. 1986. Forest and woodland habitat types (plant associations) of southern New Mexico and central Arizona (north of the Mogollon Rim). USDA Forest Service, Southwestern Region, Albuquerque, New Mexico.

Larson, M., and W. H. Moir. 1987. Forest and woodland habitat types of northern New Mexico and northern Arizona. Edi-

tion 2. USDA Forest Service, Southwestern Region, Albuquerque, Nw Mexico.

Laurenzi, A. W., R. D. Ohmart, and N. C. Hink. 1983. Classification of mixed broadleaf riparian forests in Tonto National Forest. Pages 72–81 in: Proceedings of the workshop on Southwestern habitat types. USDA Forest Service, Southwestern Region.

Lauver, C. L., K. Kindscher, D. Faber Langendoen, and R. Schneider. 1999. A classification of the natural vegetation of Kansas. The Southwestern Naturalist 44:421–443.

Little, E. L. 1987. Pinyon trees (Pinus edulis) remeasured after 47 years. Pages 65–68 in: Proceedings pinyon juniper conference. General Technical Report INT 215. USDA Forest Service, Intermountain Research Station, Ogden, Utah.

MTNHP [Montana Natural Heritage Program]. 2002b. List of ecological communities for Montana. Montana Natural Heritage Program, Montana State Library, Helena, Montana.

Manning, M. E., and W. G. Padgett. 1995. Riparian community type classification for Humboldt and Toiyabe national forests, Nevada and eastern California. USDA Forest Service, Intermountain Region.

Marriott, H. J., and G. P. Jones. 1989. Special status plant surveys and plant community surveys in the Trapper Creek and Medicine Lodge Wilderness Study Areas and the Spanish Point Karst ACEC. Report submitted to the Bureau of Land Management, Worland District Office, under Cooperative Agreement Task Order No. WY910 CA9 001TQE1. Wyoming Natural Diversity Database, Laramie.

Marriott, Hollis J. Personal communication. Former Heritage Botanist, WYNDD, and former Public Lands Coordinator, The Nature Conservancy. 655 N. Cedar, Laramie, Wyoming 82070. (307) 721–4909.

McLaughlin, S. P., and J. E. Bowers. 1982. Effects of wildfire on a Sonoran Desert plant community. Ecology 63(1):246–248.

McPherson, G. R. 1995. The role of fire in the desert grasslands. Pages 130–151 in: M. P. McClaran and T. R. Van Devender, editors. The Desert Grassland. University of Arizona Press, Tucson.

Medina, A. L. 1986. Riparian plant communities of the Fort Bayard watershed in southwestern New Mexico. Southwestern Naturalist 31(3):345–359.

Moir, W. H. 1969b. Steppe communities in the foothills of the Colorado Front Range and their relative productivities. The American Midland Naturalist 81(2):331–340.

Moir, W. H., and J. O. Carleton. 1987. Classification of pinyon juniper (P J) sites on national forests in the Southwest. Pages 216–226 in: R. L. Everett, editor. Proceedings of the Pinyon Juniper Conference, Reno, NV, 13 16 January 1986. General Technical Report. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah.

Muldavin, E., G. Harper, P. Nivelle, and Y. Chauvin. 2000c. The vegetation of White Sands Missile Range, New Mexico. Volume II: Vegetation map. U.S. Fish and Wildlife Service, Cooperative Agreement No. 14-16-002-91-233. Final Report to Environmental Directorate, White Sands Missile Range, New Mexico.

Muldavin, E., G. Shore, K. Taugher, and B. Milne. 1998d. A vegetation map classification and map for the Sevilleta National Wildlife Refuge, New Mexico. Final report submitted to USDI, U.S. Fish and Wildlife Service, Sevilleta National Wildlife Refuge, Socorro, New Mexico, by the New Mexico Natural Heritage Program, University of New Mexico, Albuquerque.

Muldavin, E., P. Durkin, M. Bradley, M. Stuever, and P. Mehlhop. 2000a. Handbook of wetland vegetation communities of New Mexico: Classification and community descriptions (volume 1). Final report to the New Mexico Environment Department and the Environmental Protection Agency prepared by the New Mexico Natural Heritage Program, University of New Mexico, Albuquerque, New Mexico.

Muldavin, E., P. Mehlhop, and E. DeBruin. 1994a. A survey of sensitive species and vegetation communities in the Organ Mountains of Fort Bliss. Volume III: Vegetation communities. Report prepared for Fort Bliss, Texas, by New Mexico Natural Heritage Program, Albuquerque.

Muldavin, E., P. Neville, P. Arbetan, Y. Chauvin, A. Browder, and T. Neville. 2003. A vegetation map of Carlsbad Caverns National Park, New Mexico. Final report submitted in partial fulfillment of CooperativeAgreement No. Ca 7170 99 004. New Mexico Natural Heritage Program at the University of New Mexico, Albuquerque.

Muldavin, E., V. Archer, Y. Chauvin, and E. Milford. 1999. Post fire ecological studies in the Organ Mountains. Volume 3. Post fire vegetation map, vegetation and stream channel monitoring. Final Report to U.S. Army Corps of Engineers and Fort Bliss Military Reservation, Texas.

Muldavin, E., V. Archer, and P. Neville. 1998a. A vegetation map of the Borderlands Ecosystem Management Area. Final report submitted to USDA Forest Service, Rocky Mountain Experiment Station, Flagstaff, Arizona, by the New Mexico Natural Heritage Program, University of New Mexico, Albuquerque, New Mexico.

Muldavin, E., Y. Chauvin, and G. Harper. 2000b. The vegetation of White Sands Missile Range, New Mexico: Volume I. Handbook of vegetation communities. Final report to Environmental Directorate, White Sands Missile Range. New Mexico Natural Heritage Program, University of New Mexico, Albuquerque.

Muldavin, E., and P. Mehlhop. 1992. A preliminary classification and test vegetation map for White Sands Missile Range and San Andreas National Wildlife Refuge, New Mexico. University of New Mexico, New Mexico Natural Heritage Program.

Muldavin, E., and S. Wood. 1998. Plant community inventory for Fort Bliss. Unpublished report in preparation by the New Mexico Natural Heritage Program, Albuquerque, New Mexico.

Mutel, C. F. 1976. From grassland to glacier: An ecology of Boulder County, Colorado. Johnson Publishing Company, Boulder.

New Mexico Natural Heritage Program [NMNHP]. No date. Unpublished data on file. Albuquerque, New Mexico.

Nelson, C. A., and J. S. Redders. 1982. Terrestrial ecosystem inventory, Heber Ranger District, Apache Sitgreaves national forests. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, New Mexico.

Nelson, E. W. 1934. The influence of precipitation and grazing upon black grama grass range. USDA Technical Bulletin 409. Washington, D.C.

Osborn, B. 1941. Biotic type mapping of Oklahoma watersheds. Proceedings of the Oklahoma Academy of Science 22:31–33.

Osborn, B., and W. H. Kellogg. 1943. Wildlife occurrence and habitat conditions in Roger Mills and Custer counties, Oklahoma. Proceedings of the Oklahoma Academy of Science 23:41–43.

Page, C. N. 1997. The ferns of Britain and Ireland. Second edition. Cambridge University Press.

Pettit, R., R. S. Sosebee, and W. Dahl 1980. Vegetation support document. McGregor range grazing environmental impact statement. USDI Bureau of Land Management, Las Cruces, New Mexico.

Pieper, R. D., J. R. Montoya, and V. L. Groce. 1971. Site characteristics on pinyon juniper and blue grama ranges in south central New Mexico. New Mexico State University Agricultural Experiment Station. Bulletin 573. Las Cruces, New Mexico.

Powell, A. M. 1988b. Trees and shrubs of Trans Pecos Texas including Big Bend and Guadalupe Mountains national parks. Big Bend Natural History Assoc., Inc.

Powell, D. C. 1988a. Aspen community types of the Pike and San Isabel national forests in south central Colorado. USDA Forest Service, Rocky Mountain Region, Report R2 ECOL 88-01.

Ramaley, F. 1927. Colorado plant life. University of Colorado Semicentennial series 1877–1927. Volume II.

Rasmussen, L. L., and J. D. Brotherson. 1986. Response of winterfat (Ceratoides lanata) communities to release from grazing pressure. Great Basin Naturalist 46(1):148–156.

Rippel, P., Pieper, R. D., and G. H. Lymbery. 1983. Vegetational evaluations of pinyon juniper cabling in south central New Mexico. Journal of Range Management 36:13–15.

Rogers, C. M. 1949. The vegetation of the Mesa de Maya region of Colorado, New Mexico, and Oklahoma. Unpublished Ph.D. dissertation, University of Michigan, Ann Arbor.

Rogers, C. M. 1953. The vegetation of the Mesa de Maya region of Colorado, New Mexico, and Oklahoma. Lloydia 16(4):257–290.

Rogers, C. M. 1954. Some botanical studies in the Black Mesa region of Oklahoma. Rhodora 56(670):205–212.

Schlesinger, W. H., J. F. Reynolds, G. L. Cunningham, L. F. Huenneke, W. M. Jarrell, R. A. Virginia, and W. G. Whitford. 1990. Biological feedbacks in global desertification. Science 247:1043–1048.

Shantz, H. L. 1906. A study of the vegetation of the mesa region east of Pike's Peak, the Bouteloua formation. II. Development of the formation. Botanical Gazette 42:179–207.

Shantz, H. L. 1911. Natural vegetation as an indicator of the capabilities of land for crop production in the Great Plains area. USDA Bureau of Plant Industry Bulletin 201.

Shantz, H. L. 1923. The natural vegetation of the Great Plains region. Annals of the Association of American Geographers 13:81–107.

Shaw, R. B., S. L. Anderson, K. A. Schultz, and V. E. Diersing. 1989. Plant communities, ecological checklist, and species list for the U.S. Army Pinon Canyon Maneuver Site, Colorado. Colorado State University, Department of Range Science, Science Series No. 37, Fort Collins.

Sherwood, R. T. 1980. Vegetation of the Woods County, Oklahoma sand dunes. Unpublished Ph.D. dissertation, University of Oklahoma, Norman.

Sherwood, R. T., and P. G. Risser. 1980. Annotated checklist of the vascular plants of Little Sahara State Park, Oklahoma. Southwestern Naturalist 25:323–338.

Smith, A. L. 1998a. Environmental and management effects on plant species composition within ecological sites of the Black Kettle National Grassland in western Oklahoma. Unpublished M.S. thesis, Oklahoma State University, Stillwater.

Soil Conservation Service. 1978. Range site descriptions for Colorado. Technical Guide, Section II E. USDA Soil Conservation Service, Colorado State Office, Denver.

Soil Conservation Service. No date. Range site descriptions of vegetation in Colorado. Unpublished report series MLRA dating from 1975 to 1989. Soil Conservation Service, Colorado Field Office, Denver.

Southeastern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Durham, North Carolina.

Stuever, M. C., and J. S. Hayden. 1997a. Plant associations of Arizona and New Mexico. Edition 3. Volume 2: Woodlands. USDA Forest Service, Southwestern Region, Habitat Typing Guides.

Szaro, R. C. 1989. Riparian forest and scrubland community types of Arizona and New Mexico. Desert Plants Special Issue 9(3-4):70–139.

Terwilliger, C., K. Hess, and C. Wasser. 1979a. Key to the preliminary habitat types of Region 2. Addendum to initial progress report for habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, Colorado.

USFS [U.S. Forest Service]. 1937. Range plant handbook. Dover Publications Inc., New York.

USFS [U.S. Forest Service]. 1981a. TES 7, South La Luz grazing allotment. Unpublished report prepared for USDA Forest

Service, Southwestern Region, Albuquerque, New Mexico.

USFS [U.S. Forest Service]. 1983c. TES 10, Alura Mesa and Strayhorse allotments. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM.

USFS [U.S. Forest Service]. 1985f. TES 8, Smokey Bear District. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM.

USFS [U.S. Forest Service]. 1985g. Key to woodland plant associations and plant communities, Lincoln National Forest. Unpublished materials. USDA Forest Service, Southwestern Region, Albuquerque, New Mexico.

Van Pelt, N. S. 1978. Woodland parks in southeastern Utah. Unpublished thesis, University of Utah, Salt Lake City.

Vest, E. D. 1962a. Biotic communities in the Great Salt Lake Desert. Institute of Environmental Biological Research, Ecology and Epizoology Series 73. Division of Biological Science, University of Utah.

Vestal, A. G. 1913. Plains vegetation adjoining the mountains: The region about Boulder in Colorado. Unpublished thesis, University of Colorado, Boulder.

Vestal, A. G. 1914. Prairie vegetation of a mountain front area in Colorado. Botanical Gazette 58(5):377–400.

Vestal, A. G. 1919. Phytogeography of the eastern mountain front in Colorado. I. Physical geography and distribution of vegetation. Botanical Gazette 68(3):153–193.

Von Loh, J., D. Cogan, D. Faber Langendoen, D. Crawford, and M. Pucherelli. 1999. USGS NPS Vegetation Mapping Program, Badlands National Park, South Dakota. USDI Bureau of Reclamation. Technical Memorandum No. 8260 99 02. Denver, Colorado.

Walford, G. M. 1996. Statewide classification of riparian and wetland dominance types and plant communities Bighorn Basin segment. Report submitted to the Wyoming Department of Environmental Quality, Land Quality Division by the Wyoming Natural Diversity Database.

Weaver, J. E., and F. W. Albertson. 1956. Grasslands of the Great Plains: Their nature and use. Johnsen Publishing Co., Lincoln, Nebraska.

Western Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Boulder, Colorado.

Whitfield, C. L., and H. L. Anderson. 1938. Secondary succession in the desert plains grassland. Ecology 19:171–180.

Wooten, S. A. 1980. Vegetation recovery following disturbance on the Central Plains Experimental Range. Unpublished thesis, Colorado State University, Fort Collins.

Wright, H. A., L. F. Neuenschwander, and C. M. Britton. 1979. The role and use of fire in sagebrush grass and pinyon juniper plant communities: A state of the art review. General Technical Report INT 58. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah.

Wright, H. E., Jr., A. M. Bent, B. S. Hansen, and L. J. Mahar, Jr. 1973. Present and past vegetation of the Chuska Mountains, northwestern New Mexico. Geological Society of America Bulletin 84:1155–1179.

Zanoni, T. A., P. G. Risser, and I. H. Butler. 1979. Natural areas for Oklahoma. Oklahoma Natural Heritage Program, Norman.

Appendix E: Level 2 Map Unit Summaries for Salinas Pueblo Missions National Monument

Appendix E contains the map unit summaries for the vegetation map of Salinas Pueblo Missions National Monument based on Table 8 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 with black polygons shown for each unit
- An image map showing the delineation of a representative polygon(s) in the 2009 color aerial photography
- The total hectares and acres of the unit and number of polygons as derived from the GIS

1 Southern Rocky Mountain Pinyon-Juniper Woodland

A Pinyon-Oneseed Juniper / Blue Grama Woodland

Area	9.4 ha, 23.1 ac
Polygons	12
Primary component associations	*Pinus edulis - (Juniperus monosperma, Juniperus deppeana) / Bouteloua gracilis* Woodland
Secondary component associations	*Pinus edulis* / Sparse Understory Woodland
Related inclusions	*Pinus edulis - Juniperus monosperma / Quercus X pauciloba* Woodland *Pinus edulis / Rockland* Woodland *Pinus edulis / Koeleria macrantha* Woodland *Pinus edulis - Juniperus* spp. */ Quercus gambelii* Woodland
Elevation	6,049 to 6,697 ft (1,844 to 2,041 m)
Summary	These moderately open woodlands are dominated by two-needle pinyon with oneseed juniper as a codominant and occur on rocky hill slopes and plains. Inter-tree spaces are typically grassy and dominated by blue grama with other grama grasses, galleta, and mutton blue grass often present. Stands can also be sparse, with extensive exposed soil or rock outcrop. Succulents and subshrubs such as plains pricklypear and broom snakeweed can be abundant, and on the rockiest and coolest sites, scrub Gambel oak may be common.

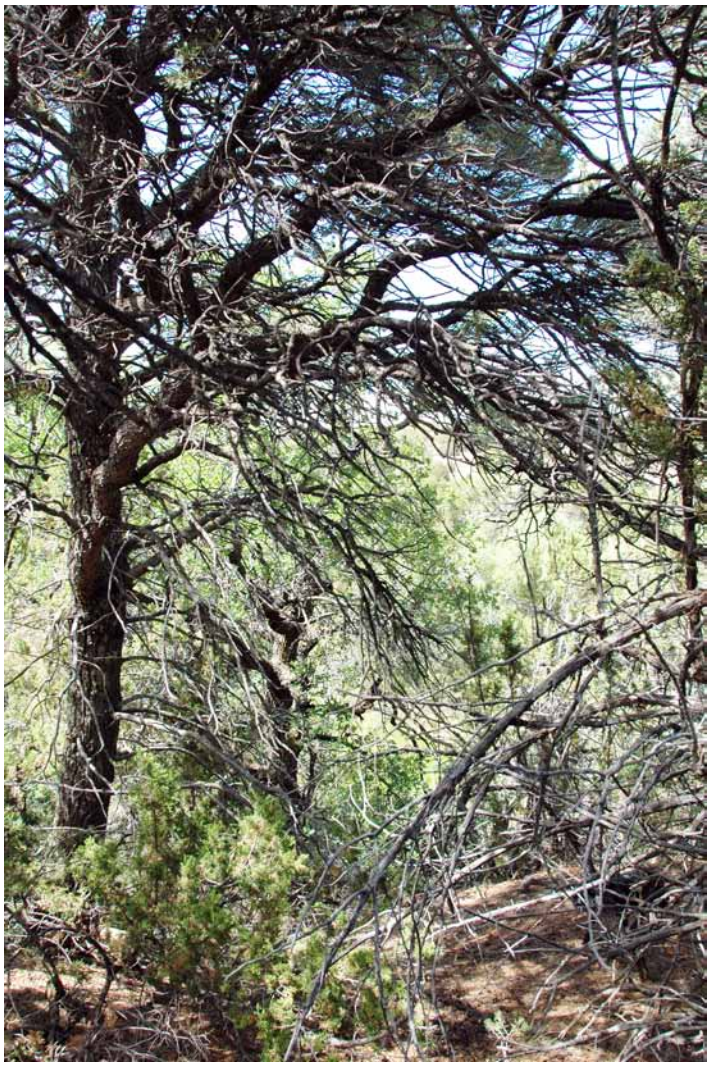

Figure E-1. Ground photo of map unit 1A

Figure E-2. Aerial photo of a representative polygon of map unit 1A

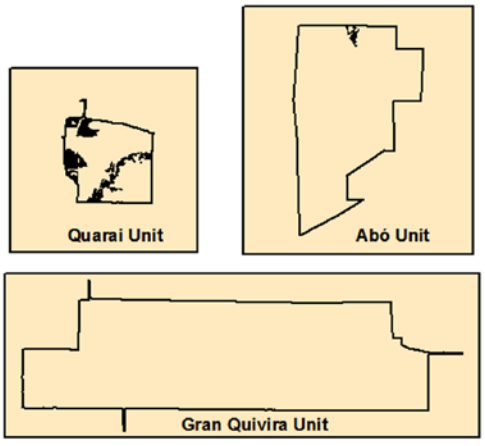

Figure E-3. Distribution of the polygons of map unit 1A

2 Southern Rocky Mountain Juniper Woodland and Savanna

A Oneseed Juniper / Blue Grama-Galleta Woodland Savanna

Area	60.3 ha, 149.1 ac
Polygons	48
Primary component associations	*Juniperus monosperma* / *Bouteloua gracilis* Woodland
Secondary component associations	*Juniperus monosperma* / *Pleuraphis jamesii* Woodland
Contrasting inclusions	*Juniperus monosperma* / Sparse Woodland
Elevation	5,996 to 6,757 ft (1,828 to 2,060 m)
Summary	This common unit is found on rolling hills and mesas of all park units. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper (pinyon pine is less than 25% of canopy cover). 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 E-4. Ground photo of map unit 2A

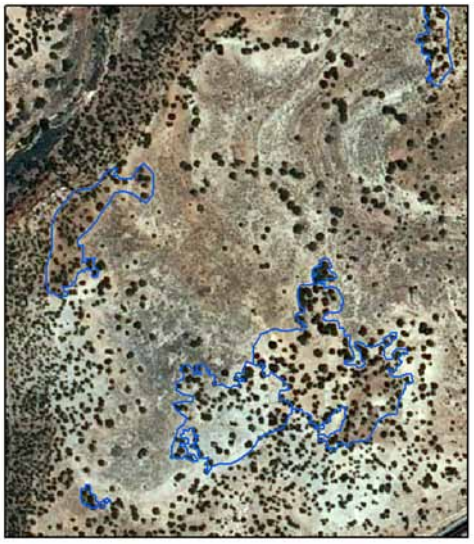

Figure E-5. Aerial photo of a representative polygon of map unit 2A

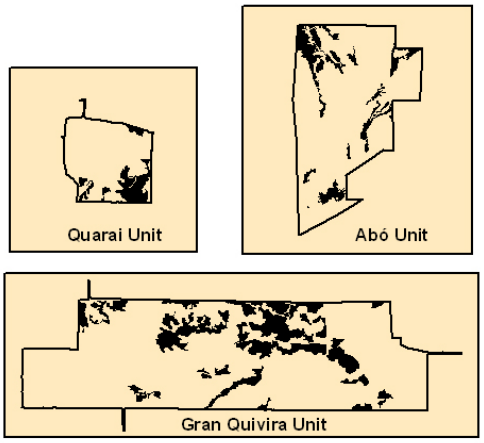

Figure E-6. Distribution of the polygons of map unit 2A

2 Southern Rocky Mountain Juniper Woodland and Savanna

B Oneseed Juniper / Black Grama Woodland Savanna

Area	19.4 ha, 48.0 ac
Polygons	21
Primary component associations	*Juniperus monosperma* / *Bouteloua eriopoda* Woodland
Contrasting inclusions	*Juniperus monosperma* / Sparse Woodland *Juniperus monosperma* / *Bouteloua gracilis* Woodland
Elevation	5,978 to 6,577 ft (1,822 to 2,005 m)
Summary	This unit is found within the Gran Quivira and Abó units on rolling hills and mesa slopes and tops. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper (pinyon pine is less than 25% of canopy cover). Inter-tree spaces are grassy with black grama grass as the dominant; blue or hairy grama and other grasses are clearly subordinate, or absent. Succulents and subshrubs such as tree cholla and broom snakeweed are common, along with scattered forbs such as freckled milkvetch, Colorado four o'clock, and spectacle pod.

Figure E-7. Ground photo of map unit 2B

Figure E-8. Aerial photo of a representative polygon of map unit 2B

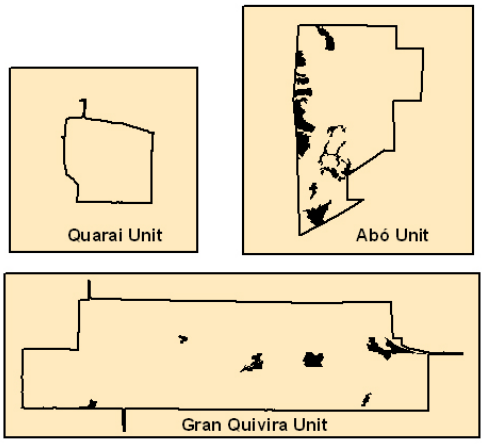

Figure E-9. Distribution of the polygons of map unit 2B

2 Southern Rocky Mountain Juniper Woodland and Savanna

C Oneseed Juniper / Curlyleaf Muhly Woodland Savanna

Area	11.7 ha, 29.0 ac
Polygons	11
Primary component associations	*Juniperus monosperma* / *Muhlenbergia setifolia* Woodland
Secondary component associations	*Juniperus monosperma* / *Bouteloua hirsuta* Woodland
Elevation	5,978 to 6,177 ft (1,822 to 1,883 m)
Summary	This unit is found within the Abó unit on gravelly hill slopes and mesa edges where soils are thinner. Stands are typically open-canopied (>10% cover) and dominated by oneseed juniper (pinyon pine is less than 25% of canopy cover). Inter-tree spaces are grassy and dominated by curlyleaf muhly; grama grasses may be present but clearly subordinate. Sub-shrubs such as featherplume, soapweed yucca, and broom snakeweed can be common. Forbs tend to be scattered and inter-grass spaces dominated by exposed gravels and soil.

Figure E-10. Ground photo of map unit 2C

Figure E-11. Aerial photo of a representative polygon of map unit 2C

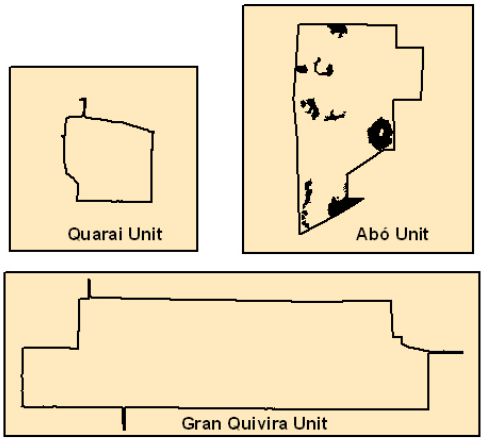

Figure E-12. Distribution of the polygons of map unit 2C

2 Southern Rocky Mountain Juniper Woodland and Savanna

D Oneseed Juniper / New Mexico Muhly-Black Grama Rockland Woodland

Area	11.0 ha, 27.1 ac
Polygons	12
Primary component associations	*Juniperus monosperma* / *Muhlenbergia pauciflora* Woodland
Secondary component associations	*Juniperus monosperma* / Rockland Woodland
Related inclusions	*Juniperus monosperma* / *Bouteloua curtipendula* Woodland
Elevation	5,968 to 6,137 ft (1,819 to 1,870 m)
Summary	This unit is found primarily at the Abó unit on rocky hill slopes and escarpments and along drainages. Stands are typically open-canopied (>10% cover) and dominated by oneseed juniper (pinyon pine is less than 25% of canopy cover) growing amongst cobbles, boulders and rock outcrop with scattered grasses such as New Mexico muhly and sideoats grama often common but seldom abundant.

Figure E-13. Ground photo of map unit 2D

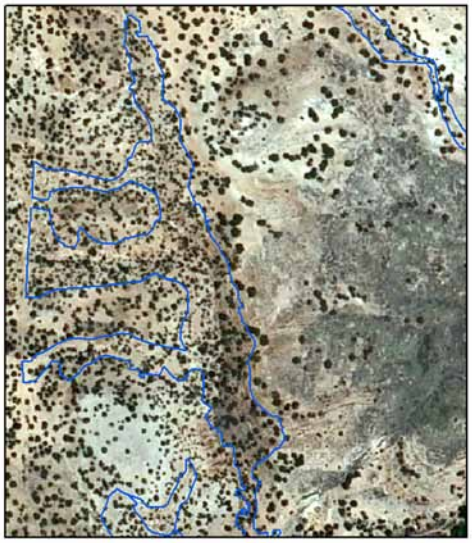

Figure E-14. Aerial photo of a representative polygon of map unit 2D

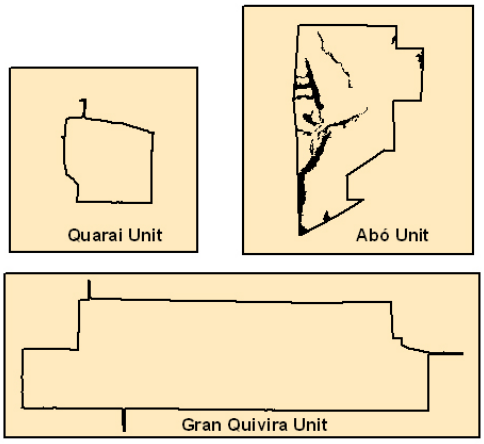

Figure E-15. Distribution of the polygons of map unit 2D

2 Southern Rocky Mountain Juniper Woodland and Savanna

E Oneseed Juniper / Blue Grama Treated Woodland

Area	5.3 ha, 13.0 ac
Polygons	3
Primary component associations	*Juniperus monosperma* / *Bouteloua gracilis* Woodland, Woodland Treatment Phase
Secondary component associations	*Juniperus monosperma* / *Bouteloua curtipendula* Woodland, Woodland Treatment Phase
Elevation	6,055 to 6,132 ft (1,846 to 1,869 m)
Summary	This unit is found primarily on open plains at the Quarai and Abó units. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper (pinyon pine is less than 25% of canopy cover). Understories vary from very sparse with exposed soil in inter-tree spaces to grassy and dominated by blue grama. This is a variant of 2A where many junipers were mechanically removed, likely using the "chaining" method where trees are completely uprooted to clear space for herbaceous growth. Typically, these sites have a higher abundance of ruderal weedy species such as purple threeawn, ring muhly, and yellowspine thistle.

Figure E-16. Ground photo of map unit 2E

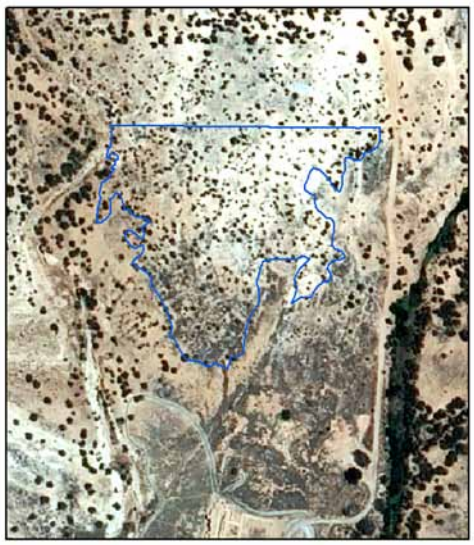

Figure E-17. Aerial photo of a representative polygon of map unit 2E

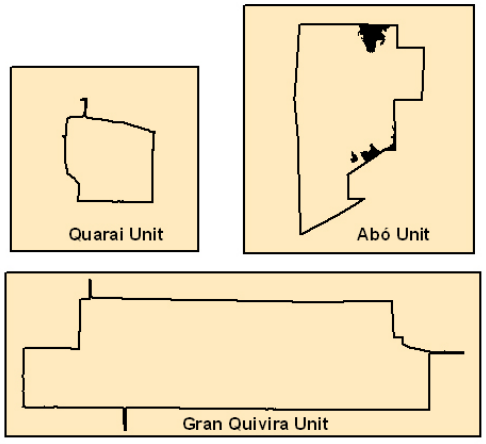

Figure E-18. Distribution of the polygons of map unit 2E

2 Southern Rocky Mountain Juniper Woodland and Savanna

F Oneseed Juniper / Ruderal Forbs Woodland

Area	8.0 ha, 19.8 ac
Polygons	15
Primary component associations	*Juniperus monosperma* / *Bouteloua gracilis* Woodland, Ruderal Forb Phase
Elevation	6,035 to 6,648 ft (1,839 to 2,026 m)
Summary	This unit is found primarily on archeological sites of open plains and mesa on all units. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper (pinyon pine is less than 25% of canopy cover). This is a variant of 2A where ruderal, weedy forbs are conspicuous and reflect the underlying disturbance of the soils. Common weedy forbs include redroot pigweed, greenleaf five eyes, David's spuge, common kochia, common purslane, silverleaf nightshade, gray globemallow, golden crownbeard, and horehound.

Figure E-19. Ground photo of map unit 2F

Figure E-20. Aerial photo of a representative polygon of map unit 2F

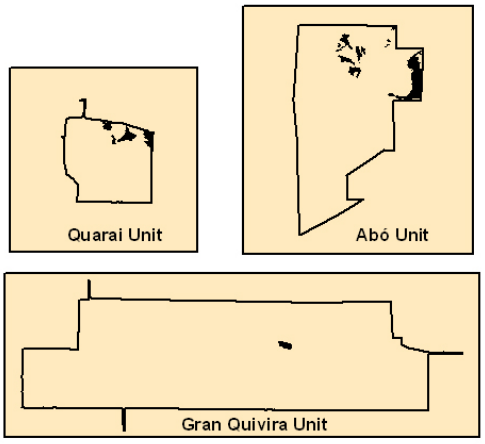

Figure E-21. Distribution of the polygons of map unit 2F

2 Southern Rocky Mountain Juniper Woodland and Savanna

G Oneseed Juniper / Blue Grama-Alkali Sacaton Woodland Savanna

Area	2.1 ha, 5.2 ac
Polygons	4
Primary component associations	*Juniperus monosperma* / *Bouteloua gracilis* Woodland, *Sporobolus airoides* Phase
Elevation	6,022 to 6,090 ft (1,836 to 1,856 m)
Summary	This unit is found on open plains at Abó. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper (pinyon pine is less than 25% of canopy cover). This is a variant of 2A where alkali sacaton is codominant with blue grama and may reflect the underlying disturbance of the soils by past agriculture or grazing.

Figure E-22. Ground photo of map unit 2G

Figure E-23. Aerial photo of a representative polygon of map unit 2G

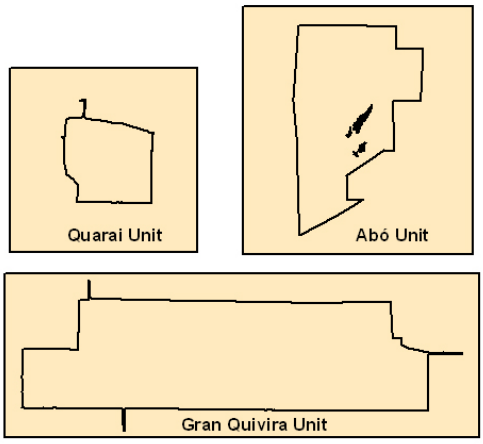

Figure E-24. Distribution of the polygons of map unit 2G

2 Southern Rocky Mountain Juniper Woodland and Savanna

H Oneseed Juniper / Little Bluestem Woodland Savanna

Area	70.0 ha, 173.1 ac
Polygons	18
Primary component associations	*Juniperus monosperma* / *Schizachyrium scoparium* Woodland
Related inclusions	*Juniperus monosperma* / *Bouteloua gracilis* Woodland, *Schizachyrium scoparium* Phase
Elevation	6,310 to 6,565 ft (1,923 to 2,001 m)
Summary	This unit is found on hill slopes and mesa slopes and tops at Gran Quivira. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper (pinyon pine is less than 25% of canopy cover). Inter-tree spaces are grassy with little bluestem the clear dominant and blue grama as a common associate but clearly subordinate. Succulents and subshrubs such as broom snakeweed, tulip pricklypear, and plains pricklypear are common, along with scattered forbs such as slender white prairieclover, Colorado four o'clock, and spectacle pod.

Figure E-25. Ground photo of map unit 2H

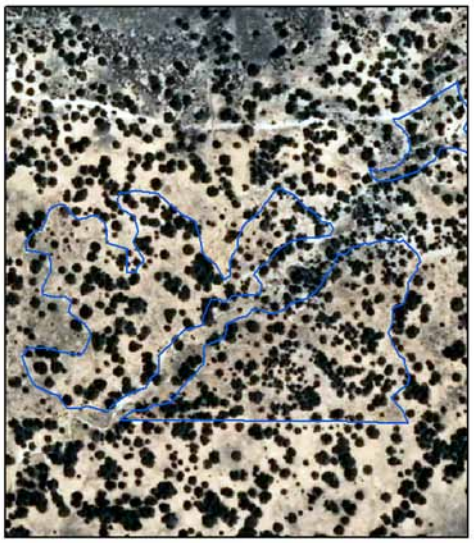

Figure E-26. Aerial photo of a representative polygon of map unit 2H

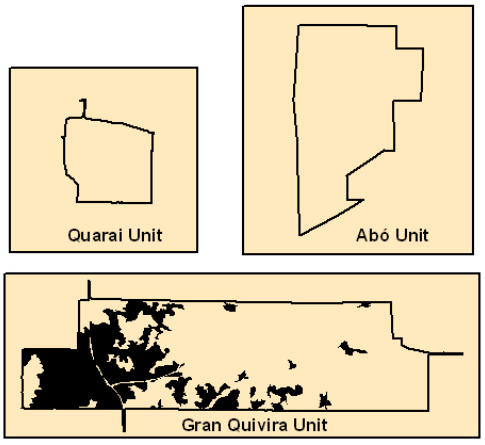

Figure E-27. Distribution of the polygons of map unit 2H

2 Southern Rocky Mountain Juniper Woodland and Savanna

I Oneseed Juniper / Fourwing Saltbush Woodland

Area	6.5 ha, 16.0 ac
Polygons	6
Primary component associations	*Juniperus monosperma* / *Bouteloua gracilis* Woodland, *Atriplex canescens* Phase
Elevation	6,453 to 6,521 ft (1,967 to 1,987 m)
Summary	This unit is found on mesa slopes and tops at Gran Quivira in close proximity to the main archeological site. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper (pinyon pine is less than 25% of canopy cover). This is a variant of 2A where fourwing saltbrush is well represented as shrub in the inter-tree spaces, along with scattered grasses, primarily blue grama.

NO GROUND PHOTOS AVAILABLE

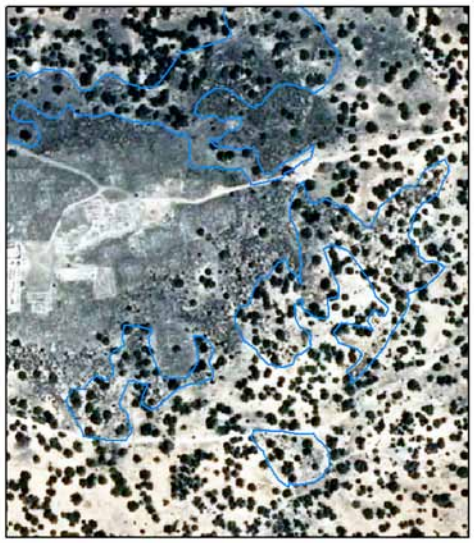

Figure E-28. Aerial photo of a representative polygon of map unit 2I

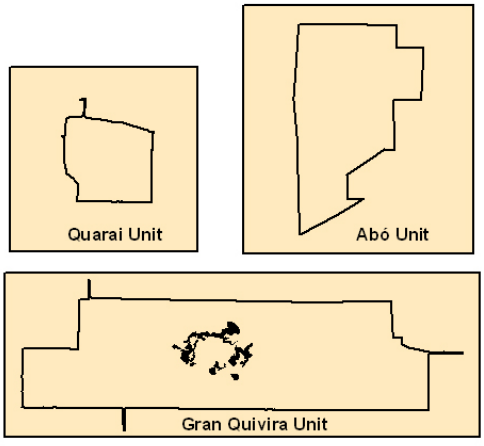

Figure E-29. Distribution of the polygons of map unit 2I

2 Southern Rocky Mountain Juniper Woodland and Savanna

J Oneseed Juniper / Sand Sagebrush Woodland

Area	4.2 ha, 10.5 ac
Polygons	2
Primary component associations	*Juniperus monosperma* / *Bouteloua gracilis* Woodland, *Artemisia filifolia* Phase
Elevation	6,314 to 6,327 ft (1,924 to 1,928 m)
Summary	This woodland unit is found on the western sandy piedmont at Gran Quivira. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper (pinyon pine is less than 25% of canopy cover). This is a variant of 2A where sand sagebrush is well represented as shrub in the inter-tree spaces along with scattered grasses, primarily blue grama. The photo shows a sand sagebrush shrubland (see 7A) with the Oneseed Juniper/ Sand Sagebrush Woodland in the background.

Figure E-30. Ground photo of map unit 2J

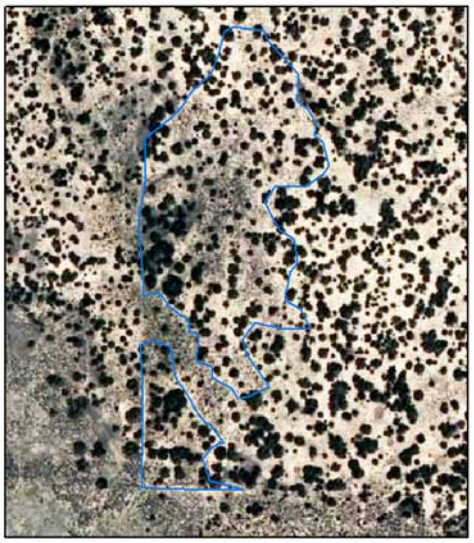

Figure E-31. Aerial photo of a representative polygon of map unit 2J

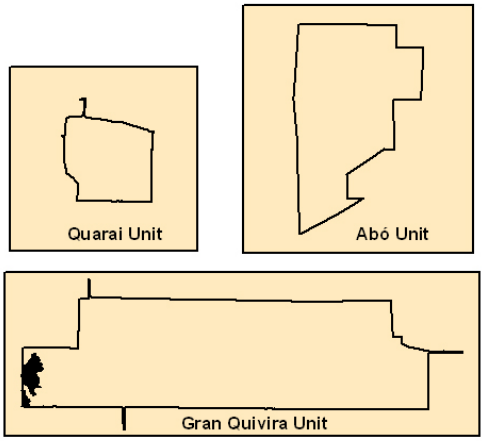

Figure E-32. Distribution of the polygons of map unit 2J

2 Southern Rocky Mountain Juniper Woodland and Savanna

K Oneseed Juniper / Sparse Woodland

Area	70.2 ha, 173.4 ac
Polygons	32
Primary component associations	*Juniperus monosperma* / Sparse Woodland
Related inclusions	*Juniperus monosperma* / *Quercus X pauciloba* Woodland
Elevation	6,366 to 6,758 ft (1,940 to 2,060 m)
Summary	This woodland unit is found on hillslopes at Quarai and mesa slopes and tops at Gran Quivira. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper (pinyon pine is less than 25% of canopy cover). Understories are very sparse with mostly exposed soil or gravels in the inter-tree spaces with grass and forb cover seldom exceeding 1%.

Figure E-33. Ground photo of map unit 2K

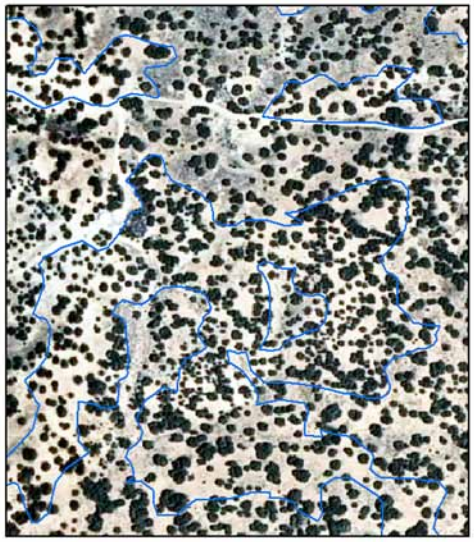

Figure E-34. Aerial photo of a representative polygon of map unit 2K

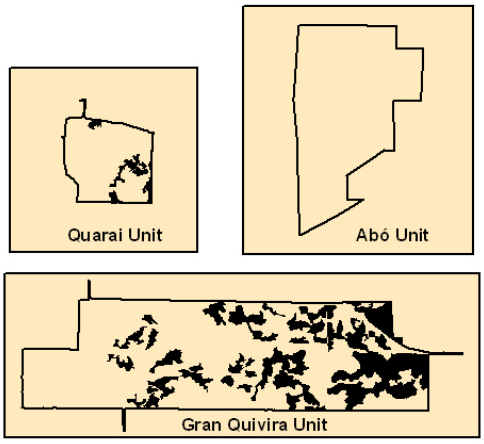

Figure E-35. Distribution of the polygons of map unit 2K

2 Southern Rocky Mountain Juniper Woodland and Savanna

L Oneseed Juniper / Blue Grama-Big Bluestem Woodland Savanna

Area	24.4 ha, 60.3 ac
Polygons	18
Primary component associations	*Juniperus monosperma* / *Bouteloua gracilis* Woodland, *Andropogon gerardii* Phase
Elevation	6,353 to 6,549 ft (1,936 to 1,996 m)
Summary	This woodland unit is found on mesa slopes and tops at Gran Quivira. Stands are typically very open-canopied (>10% cover) and dominated by oneseed juniper (pinyon pine is less than 25% of canopy cover). Inter-tree spaces are grassy and codominated by blue grama and big bluestem. Among shrubs, yuccas are most common; forbs are scattered and can include dwarf prairieclover, spectacle pod, sanddune wallflower, hairy goldenaster, and flaxflowered gilia.

Figure E-36. Ground photo of map unit 2L

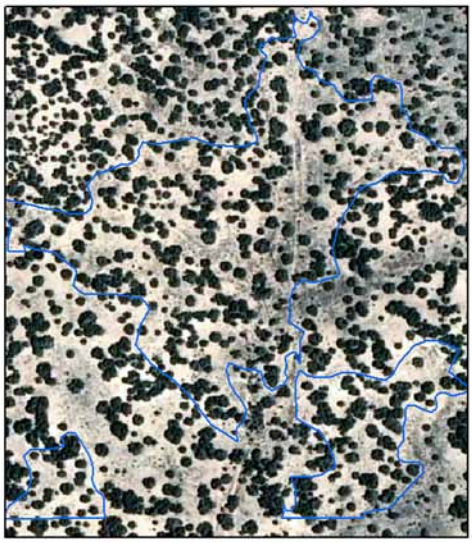

Figure E-37. Aerial photo of a representative polygon of map unit 2L

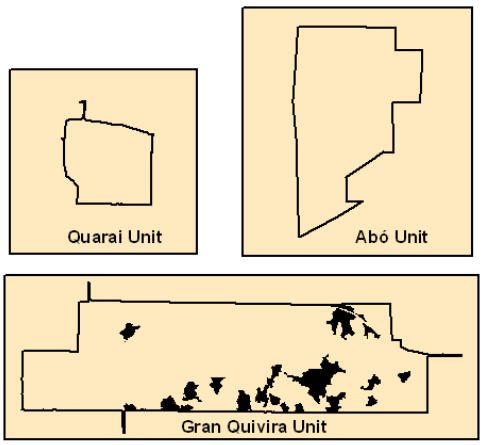

Figure E-38. Distribution of the polygons of map unit 2L

3 Southwest Lowland Riparian Woodland and Shrubland

A Cottonwood / Goodding's Willow/Mixed Shrub Riparian Woodland

Area	1.7 ha, 4.2 ac
Polygons	13
Primary component associations	*Populus deltoides* (ssp. *wislizeni,* ssp. *monilifera) - Salix gooddingii* Forest *Populus deltoides* (ssp. *wislizeni,* ssp. *monilifera) / Rosa woodsii* Forest
Secondary component associations	*Populus angustifolia / Prunus virginiana* Woodland
Contrasting inclusions	*Prunus virginiana - (Prunus americana)* Shrubland
Elevation	5,972 to 6,649 ft (1,820 to 2,027 m)
Summary	These riparian woodlands occur along perennial stream reaches or ephemeral reaches with near-surface ground water at Abó and Quarai. They are dominated by broadleaf deciduous trees such as Rio Grande cottonwood or narrowleaf cottonwood (or lanceleaf cottonwood, the hybrid between the two). Small trees and tall shrubs include Goodding's willow, and common chokecherry. The herbaceous layer is rich and diverse and may include facultative and obligate wetland species such as smooth horsetail, sedges, spikerush, cutleaf water-parsnip, and cattails.

Figure E-39. Ground photo of map unit 3A

Figure E-40. Aerial photo of a representative polygon of map unit 3A

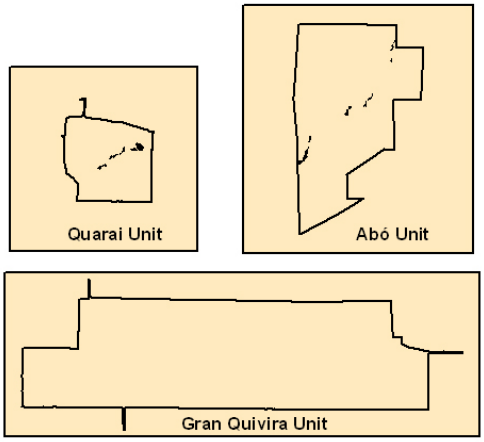

Figure E-41. Distribution of the polygons of map unit 3A

3 Southwest Lowland Riparian Woodland and Shrubland

B Goodding's Willow-Coyote Willow Riparian Woodland

Area	1.3 ha, 3.2 ac
Polygons	9
Primary component associations	*Salix gooddingii* / *Salix exigua* Woodland
Secondary component associations	*Salix gooddingii* Woodland
Contrasting inclusions	*Rosa woodsii* / Mixed Herbaceous Shrubland
Elevation	5,975 to 6,692 ft (1,821 to 2,040 m)
Summary	These riparian woodlands occur along perennial stream reaches or ephemeral reaches with near-surface ground water at Abó and Quarai. It is similar to 3A except that cottonwoods are few or absent. Instead Goodding's willow dominates the tree layer with coyote willow as a common shrub element. The herbaceous layer is rich and diverse and may include facultative and obligate wetland species such as Baltic rush, common threesquare, smooth horsetail, and cattail.

Figure E-42. Ground photo of map unit 3B

Figure E-43. Aerial photo of a representative polygon of map unit 3B

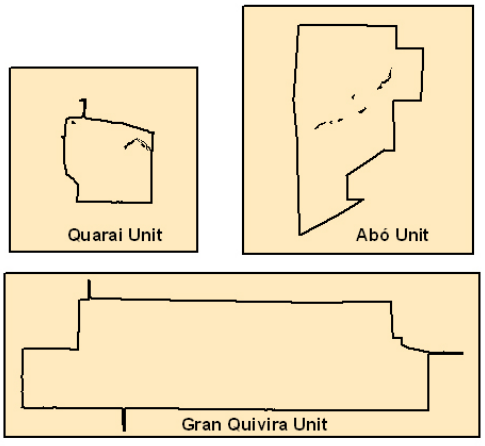

Figure E-44. Distribution of the polygons of map unit 3B

4 Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland

A Coyote Willow Riparian Shrubland

Area	0.1 ha, 0.4 ac
Polygons	3
Primary component associations	*Salix exigua* - *Rosa woodsii* Shrubland
Elevation	6,034 to 6,622 ft (1,839 to 2,018 m)
Summary	This minor riparian willow shrubland unit is scattered along perennial stream reaches or ephemeral reaches with near-surface ground water at Abó and Quarai. It is dominated by coyote willow with Wood's rose as a codominant.

Figure E-45. Ground photo of map unit 4A

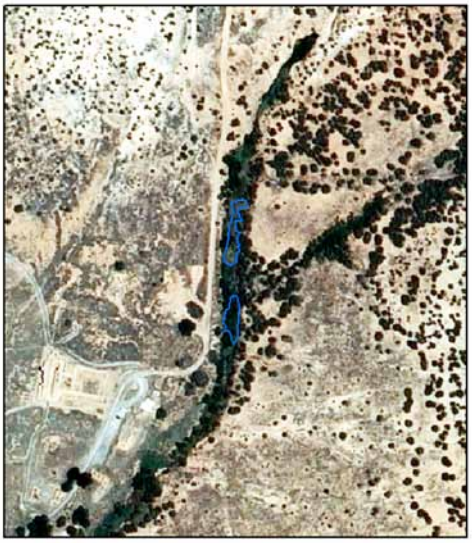

Figure E-46. Aerial photo of a representative polygon of map unit 4A

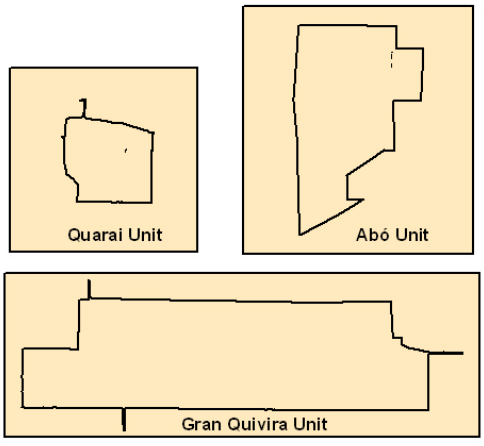

Figure E-47. Distribution of the polygons of map unit 4A

4 Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland

B Chokecherry-Woodrose Riparian Shrubland

Area	2.4 ha, 5.9 ac
Polygons	7
Primary component associations	*Prunus virginiana - (Prunus americana)* Shrubland *Rosa woodsii* / Mixed Herbaceous Shrubland
Contrasting inclusions	*Salix exigua - Rosa woodsii* Shrubland
Elevation	6,608 to 6,663 ft (2,014 to 2,031 m)
Summary	This riparian shrubland unit occurs along a perennial stream and upper terraces at Abó. It is dominated by common chokecherry and Wood's rose with golden currant, and wax currant as other common shrub associates.

Figure E-48. Ground photo of map unit 4B

Figure E-49. Aerial photo of a representative polygon of map unit 4B

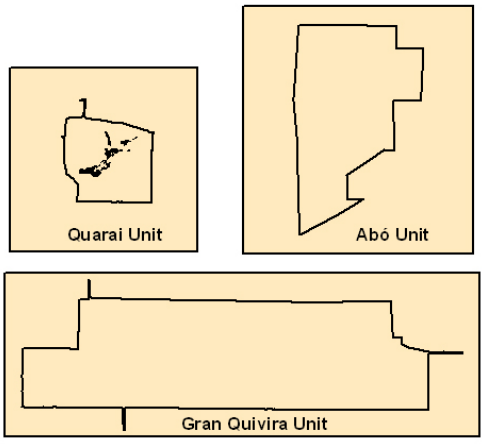

Figure E-50. Distribution of the polygons of map unit 4B

5 North American Cool Desert Wash

A Rabbitbrush Dry Wash Shrubland

Area	0.4 ha, 1.0 ac
Polygons	3
Primary component associations	*Ericameria nauseosa* Desert Wash Shrubland
Elevation	5,964 to 6,667 ft (1,818 to 2,032 m)
Summary	This dry wash (arroyo) shrubland unit occurs along the lower, ephemeral main stream channel at Abó. It is dominated by rubber rabbitbrush than can form a dense canopy along the channel. These shrublands also occur as a small lower slope stand at Quarai that is associated with disturbed ground.

Figure E-51. Ground photo of map unit 5A

Figure E-52. Aerial photo of a representative polygon of map unit 5A

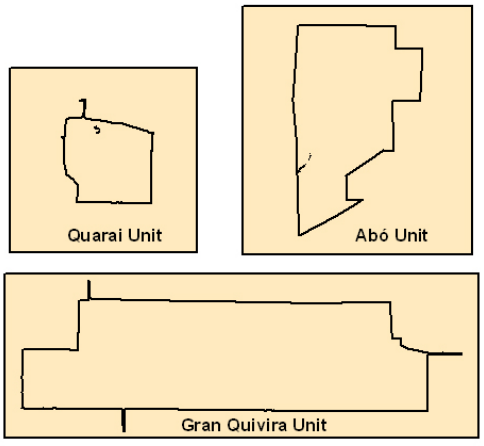

Figure E-53. Distribution of the polygons of map unit 5A

6 Shadscale-Saltbush Cool Semi-Desert Scrub

A Fourwing Saltbush Shrubland

Area	4.0 ha, 9.9 ac
Polygons	8
Primary component associations	*Atriplex canescens* / *Muhlenbergia porteri* Shrubland *Atriplex canescens* / *Sporobolus airoides* Shrubland
Related inclusions	*Atriplex canescens* / *Panicum obtusum* Shrubland *Atriplex canescens* / *Bouteloua gracilis* Shrubland *Krascheninnikovia lanata* / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation
Elevation	6,472 to 6,523 ft (1,973 to 1,988 m)
Summary	This shrubland unit is found on the mesa top at Gran Quivira in close proximity to the main archeological site. Fourwing saltbrush dominates with blue grama and ring muhly in the understory; cheat grass can be common. Ruderal forbs are also common and are indicative of the historic and prehistoric disturbance at the site—these include curlycup gumweed, cuman ragweed, silverleaf nightshade, and horehound. These shrublands are intermixed with oneseed juniper woodlands with saltbrush (see 2I).

Figure E-54. Ground photo of map unit 6A

Figure E-55. Aerial photo of a representative polygon of map unit 6A

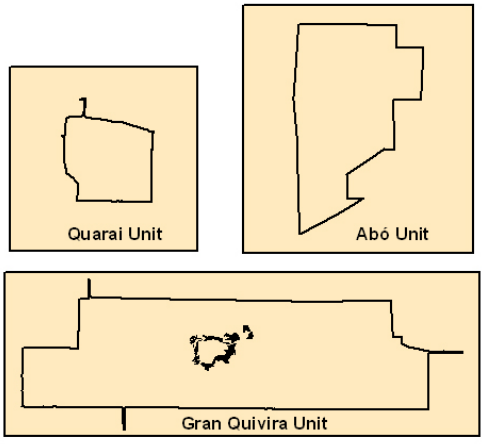

Figure E-56. Distribution of the polygons of map unit 6A

7 Great Plains Sand Shrubland

A Sand Sagebrush Shrubland

Area	1.1 ha, 2.8 ac
Polygons	9
Primary component associations	*Artemisia filifolia / Bouteloua (curtipendula, gracilis)* Shrubland
Elevation	6,312 to 6,501 ft (1,924 to 1,982 m)
Summary	This minor shrubland unit is found on the western sandy piedmont at Gran Quivira. Sand sagebrush is the dominant shrub along with scattered grasses and forbs. The photo shows the sage shrubland in the foreground with the Oneseed Juniper/Sand Sagebrush Woodland in the background (see 2J).

Figure E-57. Ground photo of map unit 7A

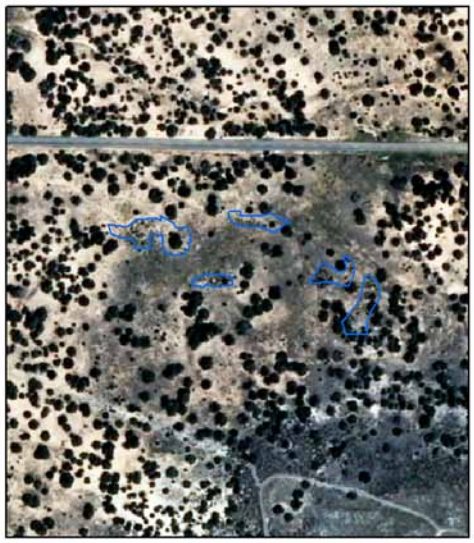

Figure E-58. Aerial photo of a representative polygon of map unit 7A

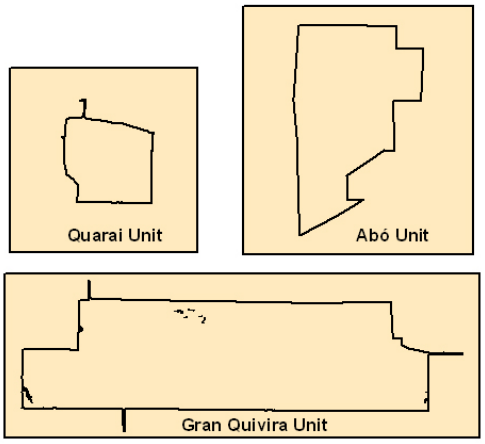

Figure E-59. Distribution of the polygons of map unit 7A

8 Southwest Plains-Mesa Grassland

A Blue Grama Grassland

Area	17.1 ha, 42.3 ac
Polygons	30
Primary component associations	*Bouteloua gracilis - Pleuraphis jamesii* Herbaceous Vegetation
Secondary component associations	*Bouteloua gracilis* Herbaceous Vegetation, Typic and *Andropogon gerardii* Phase *Gutierrezia sarothrae / Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation
Related inclusions	B*outeloua gracilis - Hesperostipa neomexicana* Herbaceous Vegetation *Ericameria nauseosa / Bouteloua gracilis* Shrub Herbaceous Vegetation
Contrasting inclusions	*Bouteloua gracilis - Muhlenbergia torreyi - Aristida purpurea* Herbaceous Vegetation
Elevation	5,981 to 6,719 ft (1,823 to 2,048 m)
Summary	These grasslands are found on slopes and piedmonts at all three units and are usually associated with loamy soils. They are dominated by blue grama with galleta often as a common to abundant associate. Other grasses such as black grama, ring muhly, purple threeawn, alkali sacaton may be present but clearly subordinate. Shrubs are minor but may include tree cholla and broom snakeweed. Scattered oneseed junipers may be present, but tree cover does not exceed 10%.

Figure E-60. Ground photo of map unit 8A

Figure E-61. Aerial photo of a representative polygon of map unit 8A

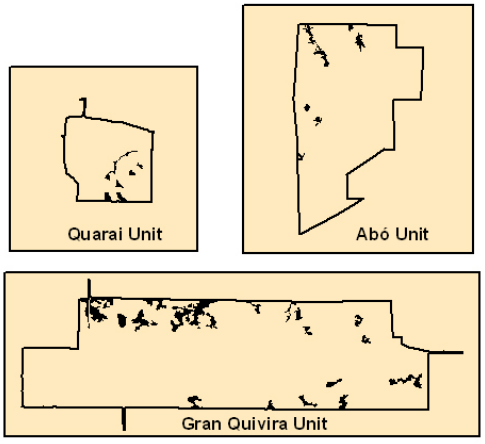

Figure E-62. Distribution of the polygons of map unit 8A

8 Southwest Plains-Mesa Grassland

B Blue Grama-Alkali Sacaton-Sand Dropseed Grassland

Area	16.5 ha, 40.7 ac
Polygons	15
Primary component associations	*Sporobolus airoides - Bouteloua gracilis* Herbaceous Vegetation
Secondary component associations	B*outeloua gracilis - Sporobolus cryptandrus* Herbaceous Vegetation
Related inclusions	*Pascopyrum smithii - Bouteloua gracilis* Herbaceous Vegetation
Contrasting inclusions	*Bouteloua eriopoda - Bouteloua gracilis* Herbaceous Vegetation
Elevation	5,962 to 6,689 ft (1,817 to 2,039 m)
Summary	These grasslands are found on lower slopes and piedmonts and bottom lands at all three units and are usually associated with archeological sites. They are dominated by blue grama with alkali sacaton or sand dropseed as codominants. Other grasses such as black grama, ring muhly, purple threeawn, alkali sacaton may be present but clearly subordinate. Shrubs are minor but may include tree cholla and broom snakeweed. Ruderal, weedy forbs can be prevalent and may include yellowspine thistle, common Kochia, flatspine stickseed, prickly Russian thistle, silverleaf nightshade, among others. Scattered oneseed junipers may be present, but tree cover does not exceed 10%.

Figure E-63. Ground photo of map unit 8B

Figure E-64. Aerial photo of a representative polygon of map unit 8B

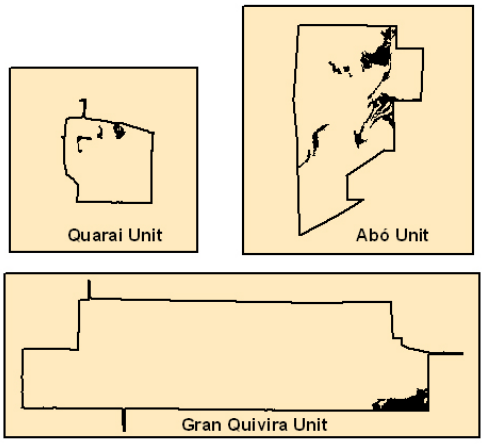

Figure E-65. Distribution of the polygons of map unit 8B

8 Southwest Plains-Mesa Grassland

C Blue Grama-Threeawn Grassland

Area	9.4 ha, 23.3 ac
Polygons	11
Primary component associations	*Bouteloua gracilis - Muhlenbergia torreyi - Aristida purpurea* Herbaceous Vegetation *Bouteloua gracilis* / Ruderal Herbaceous Vegetation
Secondary component associations	*Pascopyrum smithii* / Ruderal Herbaceous Vegetation
Related inclusions	*Bouteloua gracilis* / Old Field Herbaceous Vegetation *Yucca glauca* / *Bouteloua gracilis* Shrub Herbaceous Vegetation
Contrasting inclusions	*Sporobolus airoides - Bouteloua gracilis* Herbaceous Vegetation
Elevation	6,025 to 6,689 ft (1,836 to 2,039 m)
Summary	These grasslands are found on slopes and piedmonts at Abó and Quarai, often in association with archeological sites. They are dominated by blue grama with ring muhly and purple threeawn as ruderal codomominants. Succulents and subshrubs may be prevalent and include broom snakeweed, tulip pricklypear, and featherplume. Forbs are variable and scattered but include field sagewort, yellowspine thistle, broadleaf milkweed, and scarlet beeblossom. Scattered oneseed junipers may be present, but tree cover does not exceed 10%.

Figure E-66. Ground photo of map unit 8C

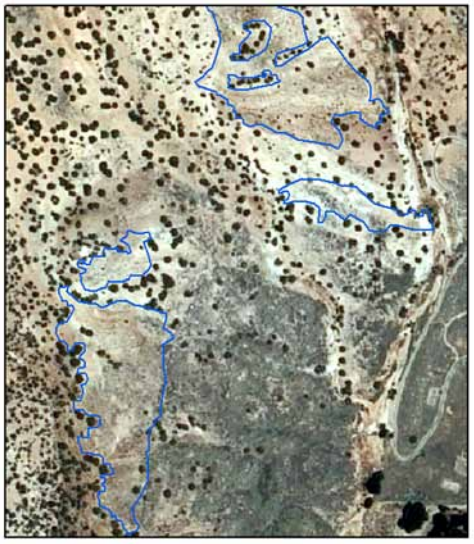

Figure E-67. Aerial photo of a representative polygon of map unit 8C

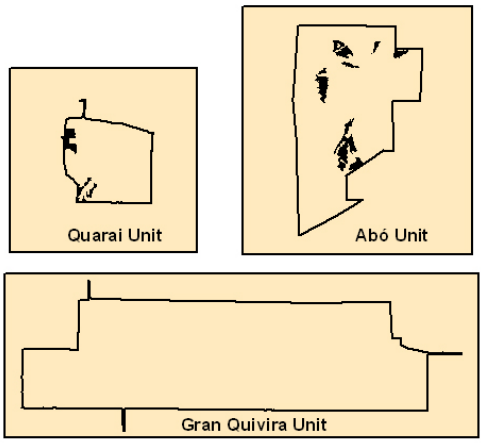

Figure E-68. Distribution of the polygons of map unit 8C

8 Southwest Plains-Mesa Grassland

D Blue Grama-Black Grama Grassland

Area	10.1 ha, 24.9 ac
Polygons	6
Primary component associations	*Bouteloua eriopoda - Bouteloua gracilis* Herbaceous Vegetation
Elevation	5,996 to 6,097 ft (1,828 to 1,858 m)
Summary	These grasslands are found on plains and piedmonts at Abó. They are dominated by black grama with blue grama as a codominant. Other grasses such as ring muhly, purple three-awn, or galleta may be present but clearly subordinate. Shrubs are minor but may include tree cholla and broom snakeweed. Scattered oneseed junipers may be present, but tree cover does not exceed 10%.

Figure E-69. Ground photo of map unit 8D

Figure E-70. Aerial photo of a representative polygon of map unit 8D

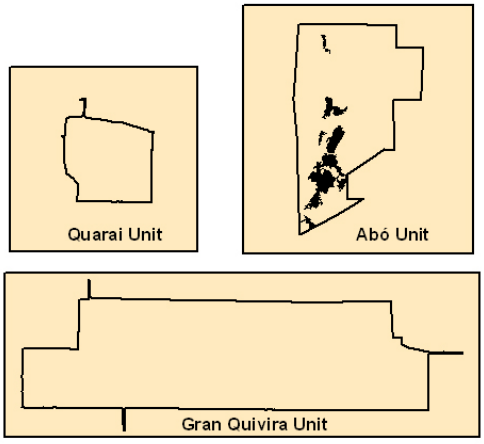

Figure E-71. Distribution of the polygons of map unit 8D

8 Southwest Plains-Mesa Grassland

E Wet Meadow/Ruderal Vegetation

Area	4.1 ha, 10.2 ac
Polygons	15
Primary component associations	*Pascopyrum smithii* / Ruderal Herbaceous Vegetation Ruderal Disturbance Vegetation
Secondary component associations	*Sporobolus airoides* - *Panicum obtusum* Herbaceous Vegetation
Related inclusions	*Panicum obtusum* Herbaceous Vegetation
Contrasting inclusions	*Sporobolus airoides* - *Bouteloua gracilis* Herbaceous Vegetation
Elevation	6,600 to 6,680 ft (2,012 to 2,036 m)
Summary	This ruderal, weedy meadow unit is found in low-lying areas at Quarai, and is associated with historic and prehistoric archeological site disturbance. While grasses such as western wheatgrass, Kentucky bluegrass, spike dropseed, or blue grama may be prevalent, it is the abundant admixture of ruderal forbs associated with ground disturbance that is characteristic. These may include, among others, yellowspine thistle, Canadian horseweed, buffalo gourd, American licorice, common Kochia, golden crownbeard, and wild potato. Scattered trees may be present, but tree cover does not exceed 10%.

Figure E-72. Ground photo of map unit 8E

Figure E-73. Aerial photo of a representative polygon of map unit 8E

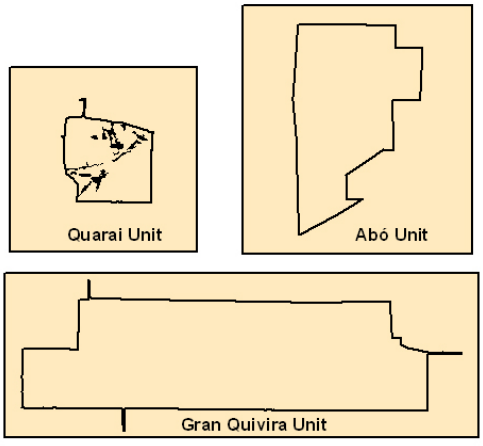

Figure E-74. Distribution of the polygons of map unit 8E

9 Great Plains Freshwater Marsh

A Cattail and Horsetail Emergent Wetland

Area	1.2 ha, 2.9 ac
Polygons	8
Primary component associations	*Typha (latifolia, angustifolia)* Western Herbaceous Vegetation
Secondary component associations	*Equisetum laevigatum* Herbaceous Vegetation
Related inclusions	*Carex pellita* Herbaceous Vegetation *Juncus balticus* Herbaceous Vegetation
Elevation	5,986 to 6,651 ft (1,825 to 2,027 m)
Summary	These emergent herbaceous wetlands are scattered along perennial stream reaches at Abó and Quarai. They are dominated by an admixture of facultative and obligate wetland species such as smooth horsetail, sedges, spikerush, cutleaf waterparsnip, and cattails.

Figure E-75. Ground photo of map unit 9A

Figure E-76. Aerial photo of a representative polygon of map unit 9A

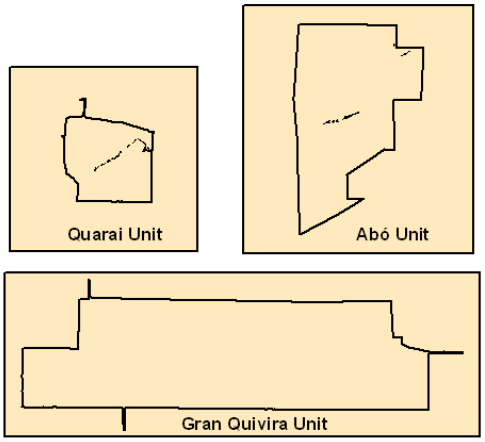

Figure E-77. Distribution of the polygons of map unit 9A

10 Nonvascular and Sparse Vascular Rock Vegetation

A-D Sparse Vegetation / Rockland; Sparse Vegetation / Recent Alluvial Deposits; Sparse Vegetation / Upland Bare Soil; Sparse Vegetation / Dry Wash Rockland

Area	2.2 ha, 5.4 ac
Polygons	10
Elevation	5,962 to 6,680 ft (1,817 to 2,036 m)
Summary	This unit is found at Abó and represents sparsely vegetated rock out crop along escarpments, bedrock and sparsely vegetated alluvial deposits in stream channels, and bare ground (usually disturbed).

Figure E-78. Ground photo of map units 10 A-D

Figure E-79. Aerial photo of a representative polygon of map units 10 A-D

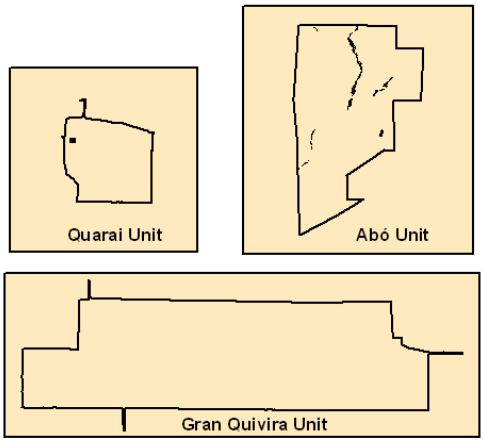

Figure E-80. Distribution of the polygons of all map units 10 A-D, combined

11 Urban or Built-up Land

A-G Ruins-Restored; Ruins-Unrestored; Public Building; Residential; Road; Trail; Recreation Site

Area	32.3 ha, 79.8 ac
Polygons	55
Primary component associations	Disturbed / Non-vegetated Disturbed / Archeological Site - Restored Disturbed / Archeological Site - Unrestored Disturbed / Recreation Site
Elevation	6,046 to 6,714 ft (1,830 to 2,046 m)
Summary	Included here is the suite of map units referring directly to human activity past and present. Ruins-Restored are sites which typically have active vegetation control. Unrestored ruin sites typically have ruderal, weedy vegetation cover that is not maintained.

Figure E-81. Ground photo of map units 11 A-G

Figure E-82. Aerial photo of a representative polygon of map units 11 A-G

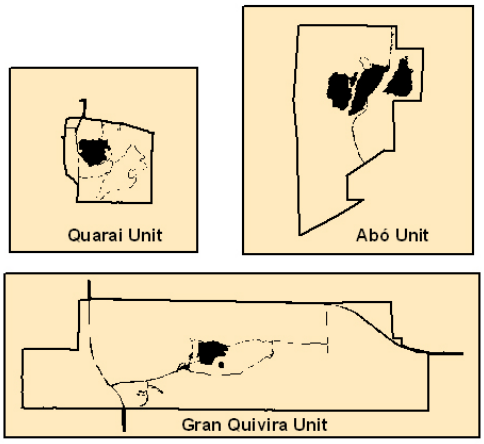

Figure E-83. Distribution of the polygons of map units 11 A-G, combined

Appendix F: NVC Association Lookup Table, Organized by Macrogroup, for Salinas Pueblo Missions National Monument

Plant associations are grouped by NVCS Macro Group. Each plant association is designated either as a primary component (1), secondary component (2), Related Inclusion (Ri), or Contrasting Inclusion (Ci).

Table F-1

Rocky Mountain Two-needle Pinyon - Juniper Woodland (MG027)
- Colorado Plateau Pinyon - Juniper Woodland Group (G250)
- Southern Rocky Mountain Juniper Woodland & Savanna Group (G252)
- Southern Rocky Mountain Pinyon - Juniper Woodland Group (G253)

	Map unit name	Pinyon-Oneseed Juniper/Blue Grama Woodland	Oneseed Juniper/Blue Grama-Galleta Woodland Savanna	Oneseed Juniper/Black Grama Woodland Savanna	Oneseed Juniper/Curlyleaf Muhly Woodland Savanna	Oneseed Juniper/New Mexico Muhly-Black Grama Rockland Woodland	Oneseed Juniper/Blue Grama Treated Woodland	Oneseed Juniper/Ruderal Forbs Woodland	Oneseed Juniper/Blue Grama-Alkali Sacaton Woodland Savanna	Oneseed Juniper/Little Bluestem Woodland Savanna	Oneseed Juniper/Fourwing Saltbush Woodland	Oneseed Juniper/Sparse Woodland	Oneseed Juniper/Blue Grama-Big Bluestem Woodland Savanna
NVCS Association	**Map unit**	1A	2A	2B	2C	2D	2E	2F	2G	2H	2I	2K	2L
Juniperus monosperma / *Bouteloua curtipendula* Woodland						1, Ri	1, 2						
Juniperus monosperma / *Bouteloua eriopoda* Woodland				1, Ci									
Juniperus monosperma / *Bouteloua gracilis* Woodland			1, 2, Ci	1, Ci			1, 2	1	1	1, Ri	1		1
Juniperus monosperma / *Bouteloua hirsuta* Woodland					1, 2								
Juniperus monosperma / *Quercus* × *pauciloba* Woodland												1, Ri	
Juniperus monosperma / Rockland Woodland						1, Ri							
Juniperus monosperma / Sparse Understory Woodland			1, 2, Ci	1, Ci								1, Ri	
Pinus edulis - (*Juniperus monosperma, Juniperus deppeana*) / *Bouteloua gracilis* Woodland		1, 2, Ri											
Pinus edulis - *Juniperus monosperma* / *Quercus* × *pauciloba* Woodland		1, 2, Ri											
Pinus edulis - *Juniperus* spp. / *Quercus gambelii* Woodland		1, 2, Ri											
Pinus edulis / Rockland Woodland		1, 2, Ri											

F-1

Table F-2

Madrean Warm Lowland Evergreen Woodland (MG010) • Madrean Juniper Savanna & Woodland Group (G487)			
	Map unit name	Oneseed Juniper/New Mexico Muhly-Black Grama Rockland Woodland	Oneseed Juniper/Curlyleaf Muhly Woodland Savanna
NVCS Association	**Map unit**	2D	2C
Juniperus monosperma / *Muhlenbergia pauciflora* Woodland		1, Ri	
Juniperus monosperma / *Muhlenbergia setifolia* Woodland			1,2

Table F-3

Warm Mediterranean & Desert Riparian, Flooded & Swamp Forest (MG036) • Sonoran-Chihuahuan Warm Desert Riparian Scrub Group (G508) • Warm Mediterranean Coast, Valley & Lower Foothill Flooded & Swamp Forest Group (G509)			
	Map unit name	Cottonwood/Goodding's Willow/ Mixed Shrub Riparian Woodland	Goodding's Willow-Coyote Willow Riparian Woodland
NVCS Association	**Map unit**	3A	3B
Populus deltoides (ssp. *wislizeni*, ssp. monilifera) - *Salix gooddingii* Forest		1, 2, Ci	
Salix gooddingii / ***Salix exigua*** Woodland			1, 2, Ci
Salix gooddingii Woodland			1, 2, Ci

Table F-4

Rocky Mountain and Great Basin Flooded & Swamp Forest (MG034) • Rocky Mountain & Great Basin Montane Riparian Forest Group (G506)		
	Map unit name	Cottonwood/Goodding's Willow/Mixed Shrub Riparian Woodland
NVCS Association	**Map unit**	3A
Populus angustifolia / Prunus virginiana Woodland		1, 2, Ci

Table F-5

Northern Rocky Mountain-Vancouverian Montane & Foothill Grassland & Shrubland (MG048) • Northern Rocky Mountain Montane-Foothill Mesic Deciduous Shrubland Group (G275)		
	Map unit name	Chokecherry-Woodrose Riparian Shrubland
NVCS Association	**Map unit**	4B
Rosa woodsii Shrubland		1, Ci

Table F-6

Great Plains Mixedgrass Prairie & Shrubland (M0G51) • Central Great Plains Mixedgrass Mesic Prairie Group (G133)		
	Map unit name	Blue Grama-Alkali Sacaton-Sand Dropseed Grassland
NVCS Association	**Map unit**	8B
Pascopyrum smithii - Bouteloua gracilis Herbaceous Vegetation		1, 2, Ci, Ri

Table F-7

Western North American Lowland Freshwater Wet Meadow, Marsh & Shrubland (MG073) • Western North American Temperate Interior Freshwater Marsh Group (G518)		
	Map unit name	Cattail and Horsetail Emergent Wetland
NVCS Association	**Map unit**	9A
Typha (*latifolia, angustifolia*) Western Herbaceous Vegetation		1, 2

Table F-8

Western North American Montane Wet Meadow & Low Shrubland (MG075) • Vancouverian & Rocky Mountain Montane Wet Meadow Group (G521)		
	Map unit name	Cattail and Horsetail Emergent Wetland
NVCS Association	**Map unit**	9A
Carex pellita Herbaceous Vegetation		1, 2
Equisetum laevigatum Herbaceous Vegetation		1, 2
Juncus balticus Herbaceous Vegetation		1, 2

Table F-9

North American Warm Desert Alkaline-Saline Semi-Desert Scrub (MG090) • Chihuahuan Lowland Basin Semi-Desert Scrub Group (G299)		
	Map unit name	Fourwing Saltbush Shrubland
NVCS Association	**Map unit**	6A
Atriplex canescens / *Muhlenbergia porteri* Shrubland		1, Ri

Table F-10

Great Basin Saltbrush Scrub (MG093) • Intermountain Shadscale - Saltbush Scrub Group (G300)		
	Map unit name	Fourwing Saltbush Shrubland
NVCS Association	**Map unit**	6A
Atriplex canescens / *Bouteloua gracilis* Shrubland		1, Ri
Atriplex canescens / *Sporobolus airoides* Shrubland		1, Ri

Table F-11

Apacherian-Chihuahuan Semi-Desert Grassland & Steppe (MG087)
- Apacherian-Chihuahuan Semi-Desert Lowland Grassland Group (G489)
- Apacherian-Chihuahuan Semi-Desert Grassland & Steppe Group (G490)

	Map unit name	Blue Grama Grassland	Blue Grama Grassland	Blue Grama-Alkali Sacaton-Sand Dropseed Grassland	Blue Grama-Threeawn Grassland	Wet Meadow/Ruderal Vegetation
NVCS Association	**Map unit**	8A	8B	8C	8D	8E
Bouteloua eriopoda - Bouteloua gracilis Herbaceous Vegetation			1, 2, Ci, Ri		1	
Bouteloua gracilis - Hesperostipa neomexicana Herbaceous Vegetation		1, 2, Ci, Ri				
Panicum obtusum Herbaceous Vegetation						1, 2, Ci, Ri
Sporobolus airoides - Bouteloua gracilis Herbaceous Vegetation			1, 2, Ci, Ri	1, 2, Ci, Ri		1, 2, Ci, Ri

Table F-12

Northern Great Plains Woodland (MG151)
- Great Plains Wooded Draw & Ravine Group (G145)

	Map unit name	Cottonwood/Goodding's Willow/ Mixed Shrub Riparian Woodland	Chokecherry-Woodrose Riparian Shrubland
NVCS Association	**Map unit**	3A	4B
Prunus virginiana - (*Prunus americana*) Shrubland		1, 2, Ci	1, Ci

Table F-13

Great Basin & Intermountain Dry Shrubland & Grassland (MG171)
- Intermountain Semi-Desert Shrubland & Steppe Group (G310)
- Intermountain Semi-Desert Grassland Group (G311)

	Map unit name	Fourwing Saltbush Shrubland	Blue Grama Grassland	Blue Grama-Alkali Sacaton-Sand Dropseed Grassland
NVCS Association	**Map unit**	6A	8A	8B
Bouteloua gracilis - Pleuraphis jamesii Herbaceous Vegetation			1, 2, Ci, Ri	
Bouteloua gracilis - Sporobolus cryptandrus Herbaceous Vegetation				1, 2, Ci, Ri
Bouteloua gracilis Herbaceous Vegetation			1, 2, Ci, Ri	
Ericameria nauseosa / Bouteloua gracilis Shrub Herbaceous Vegetation			1, 2, Ci, Ri	
Gutierrezia sarothrae / Bouteloua gracilis Dwarf-shrub Herbaceous Vegetation			1, 2, Ci, Ri	
Krascheninnikovia lanata / Bouteloua gracilis Dwarf-shrub Herbaceous Vegetation		1, Ri		

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