National Park Service
U.S. Department of the Interior

Pecos National Historical Park

Pecos National Historical Park Vegetation Management Plan



ON THE COVER
A view of the Pecos Mission Church at Pecos National Historical Park
Photograph by NPS

Pecos National Historical Park Vegetation Management Plan

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August 2024

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1. Purpose and Need

1.1 Introduction

Pecos National Historical Park (NHP) is located in San Miguel and Santa Fe counties in central New Mexico at the southern end of the Sangre de Cristo Mountains. The park consists of 6,694 acres (2,709 hectares) in the Upper Pecos River Valley and Glorieta Pass and is a multicultural crossroads where trade, commerce, settlement, and conflict occurred.

The park consists of two units (Figure 1-1). The main Pecos Unit contains grassland and woodland vegetation and is the largest part of the park, enveloping the original 342-acre national monument set aside to preserve the Pecos Pueblo, the seventeenth century Spanish Missions, and Forked Lightning Ranch (NPS 2015a). The Glorieta Unit consists of two subunits, the Pigeon's Ranch and Cañoncito subunits, and preserves part of the battlefield of the Battle of Glorieta Pass. The Pigeon's Ranch Subunit consists of a mosaic of grassland, riparian, woodland, and forest vegetation, and the Cañoncito Subunit consists of grassland, shrubland, and woodland vegetation.

Much of the vegetation in Pecos NHP has a history of both natural and human disturbance. Hence, the vegetation communities have an ecological and historical context. The vegetation in Pecos NHP is part of its cultural heritage. The grasslands, woodlands, forests, and river bottoms provided the setting for the rich history of the Pecos region including that of the ancestral Puebloan peoples, the Santa Fe Trail, the Civil War Battle of Glorieta Pass, the railroad, and the ranching era. Therefore, vegetation management at Pecos NHP needs to reflect both the ecological and cultural significance of vegetation.

1.2 The Plan

The National Park Service (NPS) will implement this vegetation management plan at Pecos NHP to restore, improve, and/or maintain ecological integrity, and to simultaneously preserve the historical setting of the site. Maintenance of the historical setting will largely focus on the visual aspects of the landscape that evoke a sense of place and reflect the settings of the Pecos Pueblo and associated 1600s Spanish

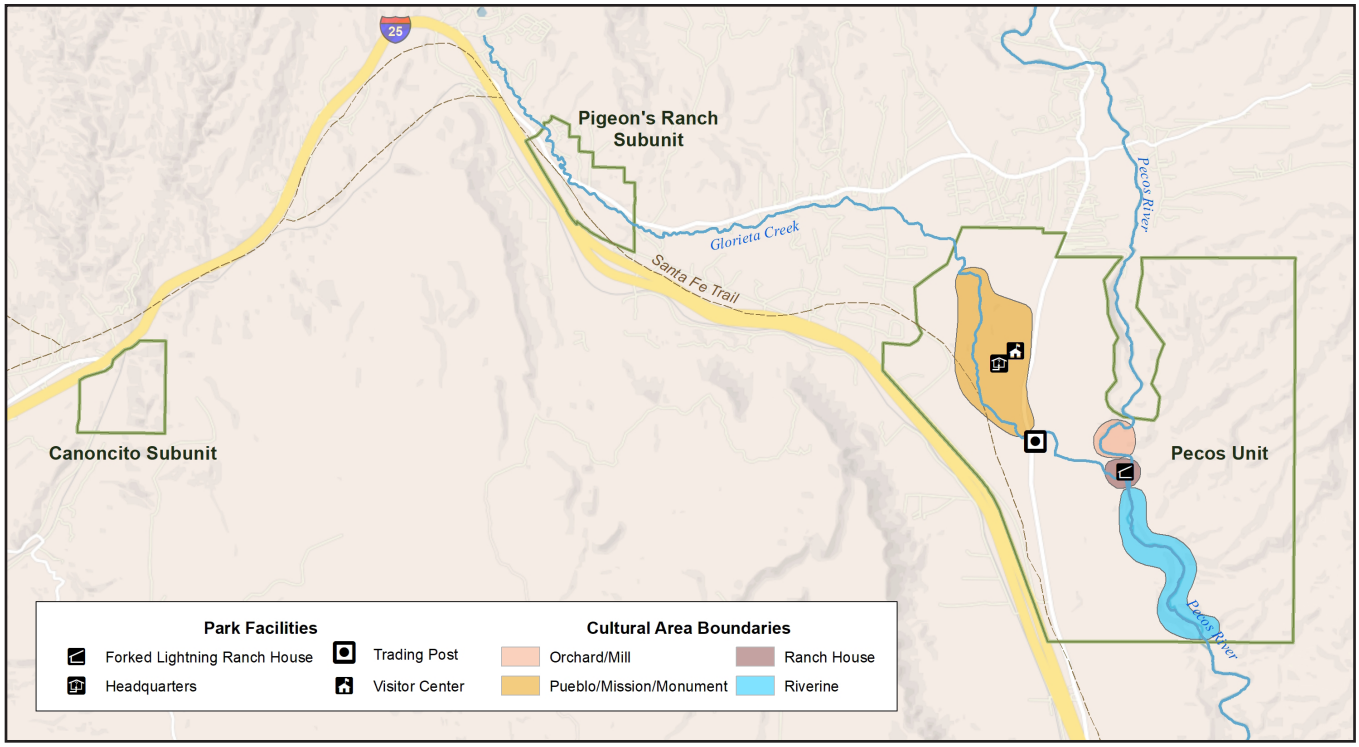


Figure 1-1. Pecos National Historical Park and vicinity.

Missions, the Civil War battle, and Forked Lightning Ranch, along with other events that occurred in the Upper Pecos Valley and Glorieta Pass.

Preserving ecological integrity extends beyond these visible attributes to ensure that species composition and other ecological attributes are consistent with the soil types and native vegetation that would have likely occurred and are well-functioning parts of ecosystems.

1.3 The Need for This Plan

Strategic Approach

The need to maintain, improve, and protect native plant diversity and restore or maintain historical, cultural landscapes requires development of a strategic approach for restoring, improving, and/or maintaining vegetation communities at Pecos NHP. A strategic approach is needed to systematically manage for a progressive and continual improvement of condition, with an emphasis on maintaining sites once they have been treated.

Some of the treatments that are needed are focused primarily on maintaining or restoring natural processes and healthy native plant communities that have high biodiversity, while other needed actions preserve or maintain the historical Forked Lightning Ranch landscape and viewshed as much as possible or reduce hazard fuels.

Specific management actions may include controlling invasive plants, maintaining bank stability in riparian areas, controlling invasive encroaching trees (primarily juniper [*Juniperus* spp.]) in pastures, occasionally augmenting native forbs by seeding or mowing, and using prescribed fire to reduce fuel loads, shrub encroachment, and decadent plant material.

Management actions may also include active restoration focused on specific species, especially along riparian areas where cottonwoods (*Populus* spp.) and willows (*Salix* spp.) are important and may be impacted in the future by climate change. Maintaining and promoting growth of cottonwoods and willows is also crucial for bird habitat and for reducing/maintaining low water temperatures in the Pecos River for fish and macroinvertebrates.

Vegetation and the Purpose and Significance of Pecos NHP

The purpose of Pecos NHP, according to the Foundation Document, is "...to interpret the history of the Pecos area and its "gateway" role between the plains and Rio Grande Valley and to preserve and protect natural and cultural resources of the Pecos Pueblo, Spanish missions, Santa Fe Trail, Civil War Battle of Glorieta Pass, and Forked Lightning Ranch" (NPS 2015a).

Natural resources are recognized in the park's significance; specifically, the role of plant communities that helped create a natural environment that was suitable for settlement of the area by multiple groups (Exec. Order 13112, 1999). The natural resources of the Upper Pecos River Watershed and those associated with Forked Lightning Ranch are also included in the park's fundamental resources and values.

Invasive plants were recognized as a threat to native vegetation and cultural resources. Invasive species are defined as alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health (Exec. Order 13751, 2016). Invasive plants also include non-native (also termed alien or exotic) species that do not occur naturally in an area but are introduced as the result of deliberate or accidental human activities (NPS 2006).

The Foundation Document also noted the significance of invasive species as threats to the viewsheds of the Pecos Pueblo and Spanish Mission Complex and Forked Lightning Ranch, and to the ecological integrity of the Upper Pecos River Watershed (NPS 2015a).

The park's Foundation for Management and Planning (NPS 2009) and Resource Stewardship Strategy (NPS and PLHC 2011) described broad desired conditions of the landscape for the park's fundamental resources and values:

- Natural and cultural landscapes are preserved, protected, and receive treatment consistent with their significance and interpretive value.
- A balance of historical and ecological integrity of the landscape.
- Native plant communities relative to species composition in former range are restored and woody stemmed densities and fuel loading are managed.

- Invasive species are absent in the park's ecosystems, or if present, are effectively controlled.
- Healthy, sustainable, grass dominated communities within the pinyon-juniper (*Pinus edulis-Juniperus* spp.) woodland are restored and will stabilize soils and protect cultural resources.
- Erosion is diminished or under control and the health of the river and surrounding watershed is sustainable and supports a healthy riparian and upland habitat.
- Grasslands within historical pastures are maintained and the biological diversity is enhanced when possible.

The park's landscape consists of the cultural and natural elements associated with heavy human use of the Upper Pecos Valley starting around 1200 CE, including prehistoric and historical sites showing ancestral Puebloan use of the area, Spanish colonial impacts, and ranching activities. Therefore, there is not a "natural" reference condition unrelated to cultural manipulation of the landscape. The park's general topography and landscape is influenced by the Pecos River, Glorieta Creek, Galisteo Creek, Glorieta Pass, and associated grassland, pinyon-juniper woodland, forests, and riparian vegetation.

As an ethnographic landscape, Pecos NHP preserves the interconnection between natural and cultural resources. Glorieta Pass is an example of this intersection. As a topographic feature connecting the southern Great Plains with the northern Rio Grande Valley, the pass funneled human activity, transportation, and commerce over a long time period. This human activity impacted and changed vegetative communities and the landscape creating a unique mosaic and a lack of one overarching reference condition. While the focus of the park is on the remains of the Pecos Pueblo, Spanish Missions, and the Battle of Glorieta Pass, the broader historical cultural landscape, including the pastures and associated open grasslands of Forked Lightning Ranch, adds to the sense of place. Aspects of the historical rangeland of the ranch provide visitors with the opportunity to learn about early ranching in the West, sustainable land use, and environmental impacts from land use and climate change. These resources are also specified in the legislation that added Forked Lightning Ranch to the park, which states, "…and to provide for the preservation and interpretation of the cultural and natural resources of the Forked Lightning Ranch" (PL 101-313, 1990).

Condition of Vegetation in Pecos NHP

Conditions at the park are highly variable and to a large degree reflect the types of disturbance and land-use history that has occurred, as well as environmental fluctuations such as climate, floods, drought, etc. Species composition in many areas of the park has likely changed since the historical period, although many areas retain good ecological site integrity with a healthy mix of native grasses, forbs, and pinyon and juniper trees. The park contains impressive biodiversity, evidenced by the number of pinyon-juniper vegetation types that can be found within the park boundaries (Romme 2020).

Invasive Plants

An increase in invasive species in Pecos NHP is one of the key issues related to park resource management (NPS 2015a). The spread of invasive species is a major factor contributing to undesirable landscape-level change and ecosystem instability in national parks (NPS 2021a). The park's vegetation communities, especially near developed areas like Pecos Pueblo and Spanish Mission Complex (Figure 1-2) and the Forked Lightning Ranch buildings (Figure 1-3), can be dominated by invasive plants that do not reflect the plant communities that would naturally occur given the soils and other site attributes. Some invasive species found in the park, such as kochia (*Bassia scoparia*), were introduced in the late 1800s as forage for livestock. The infestations of kochia totalling more than 50 acres (20 hectares) near the pueblo/mission area and near some ranch buildings are examples of large-scale invasive plant occurrences that reduce biodiversity and impact archeological sites. Patches of invasive plants (grasses, forbs, and trees) are also scattered throughout the riparian areas, and invasive plants continue to spread into riparian bottomlands causing additional concerns for park managers.

Data on the occurrence of invasive plant species in Pecos NHP are available from a survey using a park-wide grid (Figure 1-4; Muldavin and Chauvin 2014) and annual monitoring along high priority vectors by the Southern Plains Inventory and Monitoring Network (Southern Plains Network; Folts-Zettner 2009; Folts-Zettner and Sosinski 2010, 2012a,b; Folts-Zettner et al. 2010, 2012, 2013, 2014).

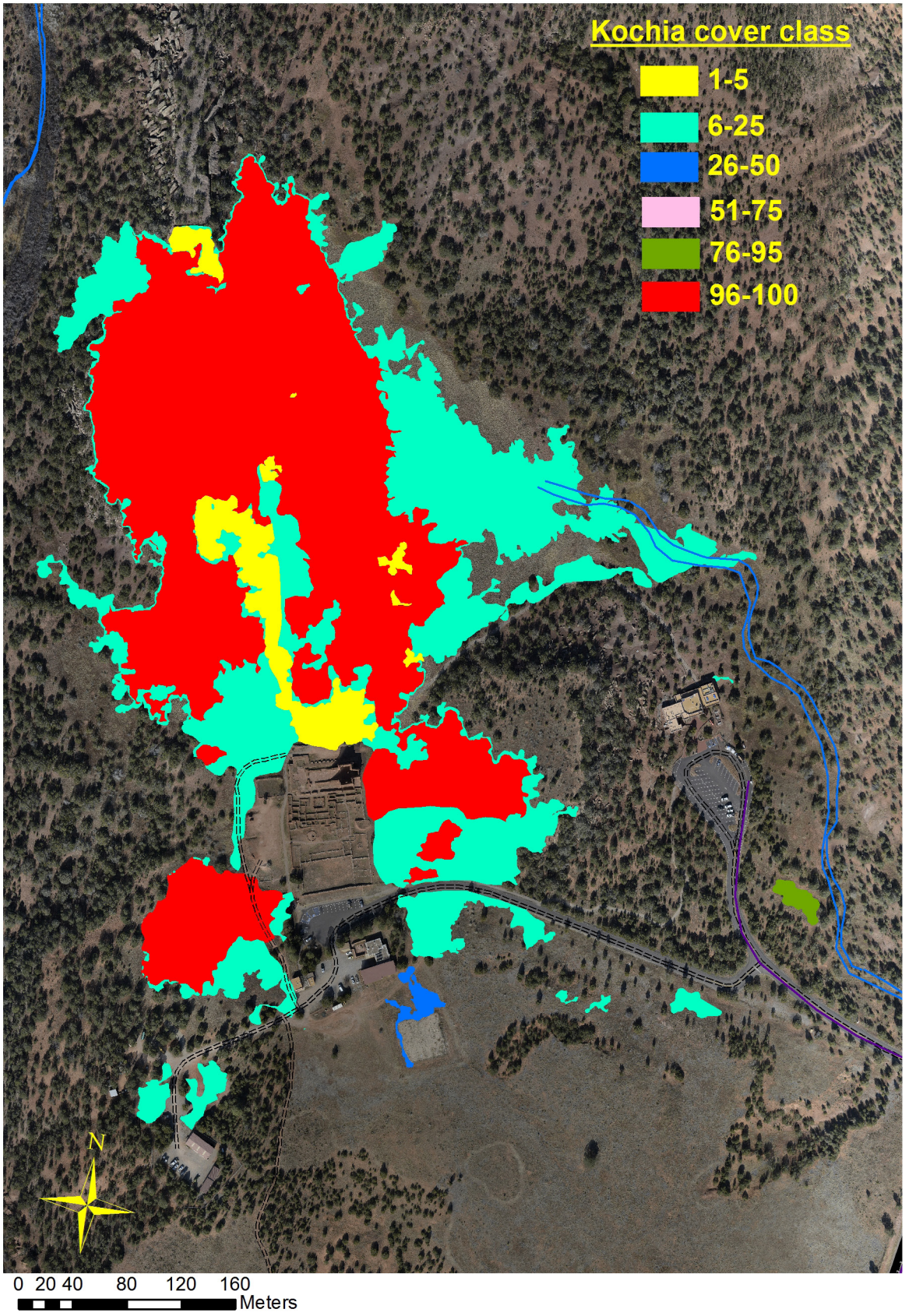


Figure 1-2. Kochia populations around the Pecos Pueblo and Spanish Mission Complex in 2015.

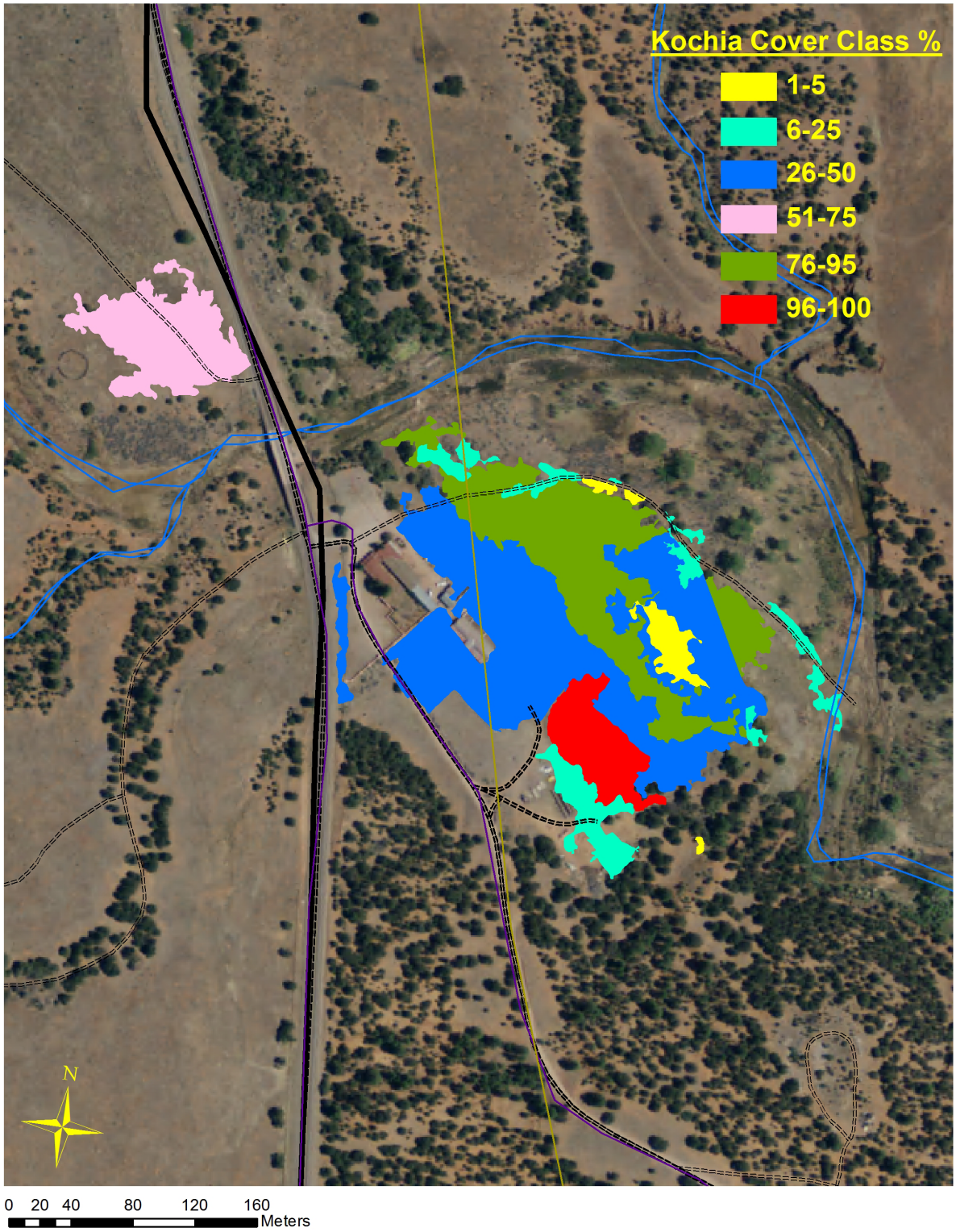


Figure 1-3. Kochia populations around Kozlowski's Trading Post in 2015.

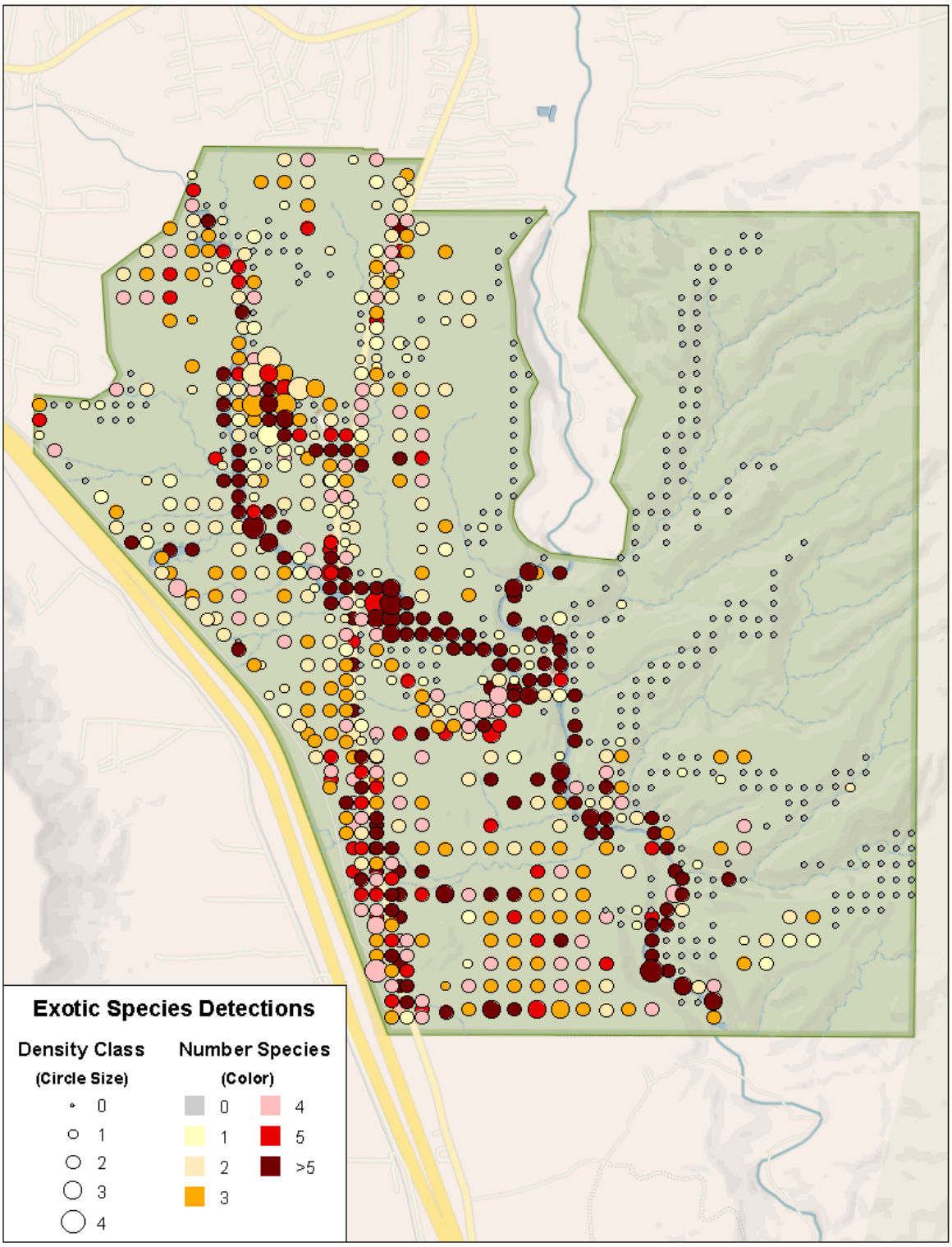


Figure 1-4. Invasive species detected during the 2014 survey by Natural Heritage New Mexico in cooperation with the National Park Service Southern Plains Network and Pecos National Historical Park (Muldavin and Chauvin 2014).

Riparian Areas

The riparian communities are a relatively functional system dominated by reproducing native trees, particularly cottonwoods with stands of varying ages along the riparian corridors (Johnson et al. 2011). The Pecos River reaches were classified as being in Proper Functioning Condition. However, the Glorieta Creek reach is rated as Functional-At Risk. Galisteo Creek banks are incised and lack vegetative structure (Johnson et al. 2011).

Glorieta and Galisteo creeks may need more active management compared to the Pecos River. These areas have undergone some initial restoration actions and are mostly dominated by native species and decent diversity. Cattle has been excluded and invasive plants have been removed at various sites within Glorieta Creek and the Pecos River. Wetland restoration activities have occurred along Glorieta Creek near the artificial levee. Glorieta Creek lacks consistent tree cover and could benefit from more willow and cottonwood growth.

Maintained Pastures, Transitioning Pastures

Although patches of native grassland are scattered throughout the park, most of the native grasses at Pecos NHP are in pasture areas where pinyon-juniper woodland was cleared for grazing (pastures) during the ranching period of 1924 to 1970 (Muldavin et al. 2012; Figure 1-5). The 1990 legislation adding Forked Lightning Ranch to the park required that the NPS "provide for the preservation and interpretation of the cultural and natural resources of the ranch." Although not specifically addressed in the enabling legislation, park management considers the pastures to be resources of the ranch. Further, they are identified as contributing resources within the park's National Register of Historic Places nomination (2022) and pasture clearing treatments are recommended within the Cultural Landscape Report (CLR) for Forked Lightning Ranch (Kerr et al. 2022). However, tree and shrub encroachment is occurring in pastures (Figure 1-6) that are a significant part of the ranch's cultural landscape, and maintaining all the cleared areas as pastures has not been effective in part due to their large extent, the difficulty of treatment, and the propensity for these areas to fill in with trees and shrubs that can only be burned with high intensity fires.

Management of these areas since they were incorporated in the park has been focused on maintaining their open structure as pastures as part of the historical landscape (see Kerr et al. 2022). Between 2004 and 2012, the park actively thinned, masticated, and chipped pinyon pine and juniper trees that had encroached on historical pastures (Figure 1-7). Following thinning operations, prescribed fire was used to limit pinyon-juniper encroachment between 2007 and 2012 (Figure 1-8). Unfortunately, data in postburn reports from a number of pastures indicated that objectives of limiting pinyon-juniper encroachment were not met. (See postburn reports in Attachment 1 for more information).

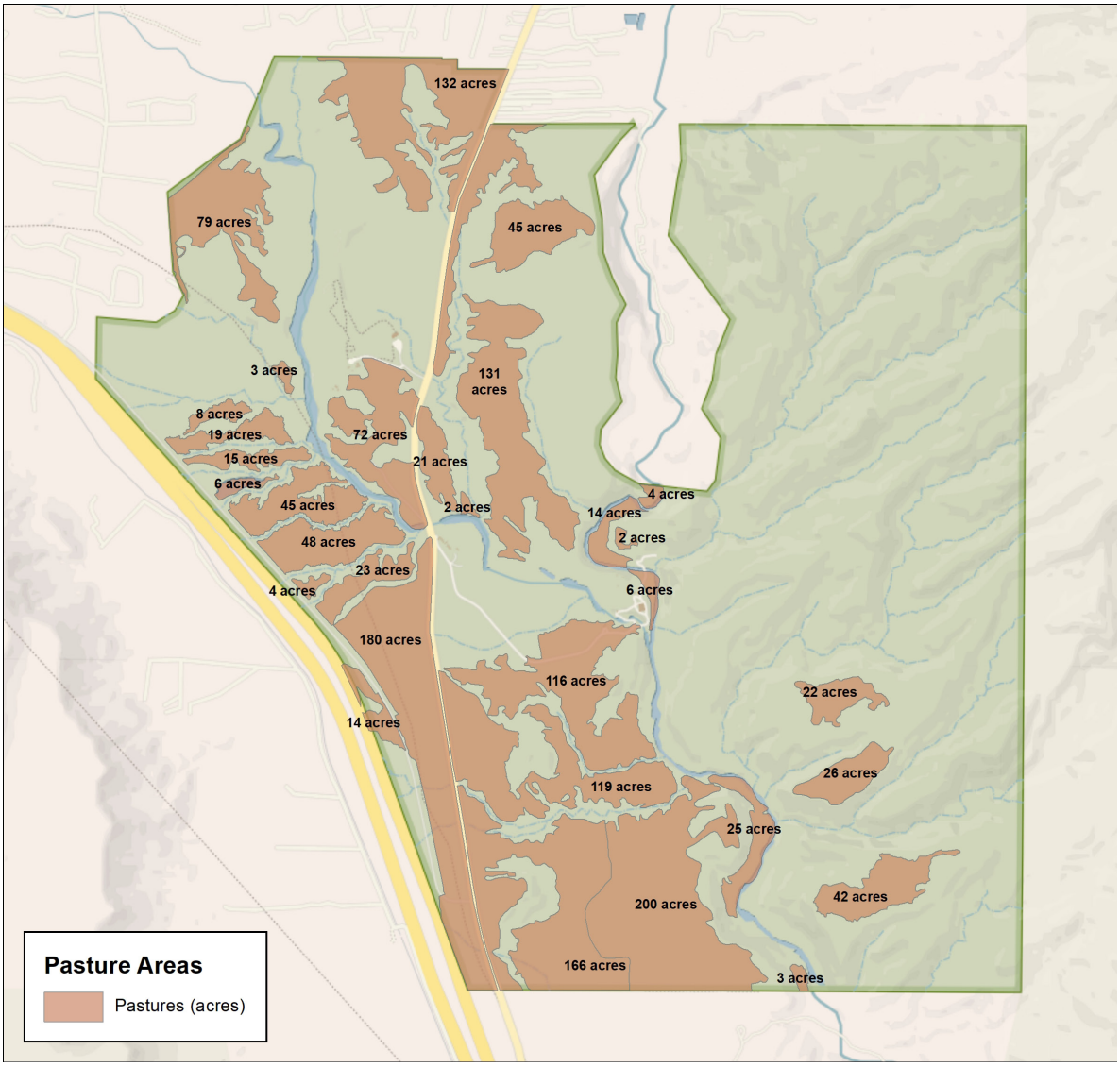


Figure 1-5. Location of pastures in Pecos National Historical Park.



Figure 1-6. Trees are encroaching on some grass-dominated pastures more (right) than others (left).

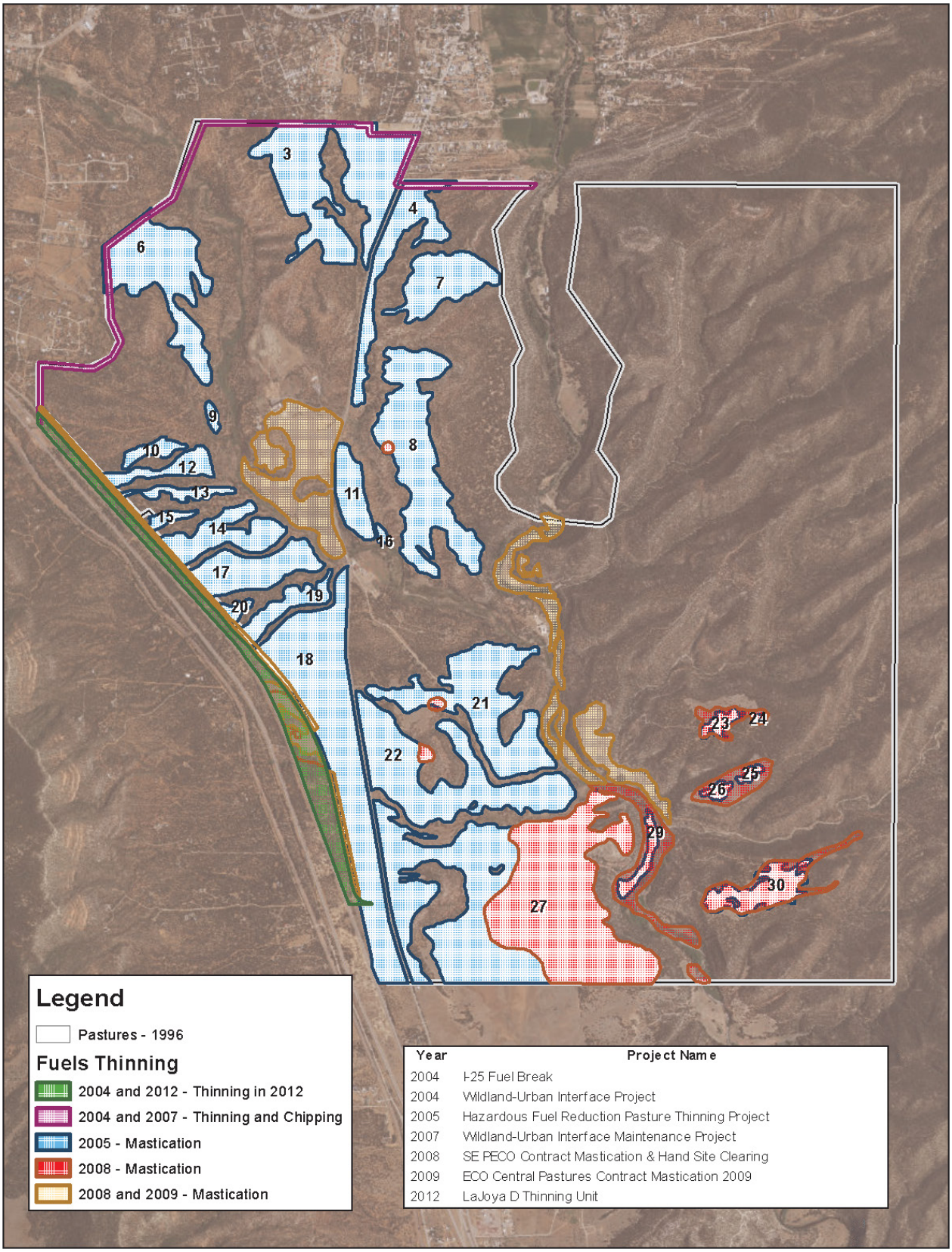


Figure 1-7. History of fuels thinning within pastures at Pecos National Historical Park (2004–2012).

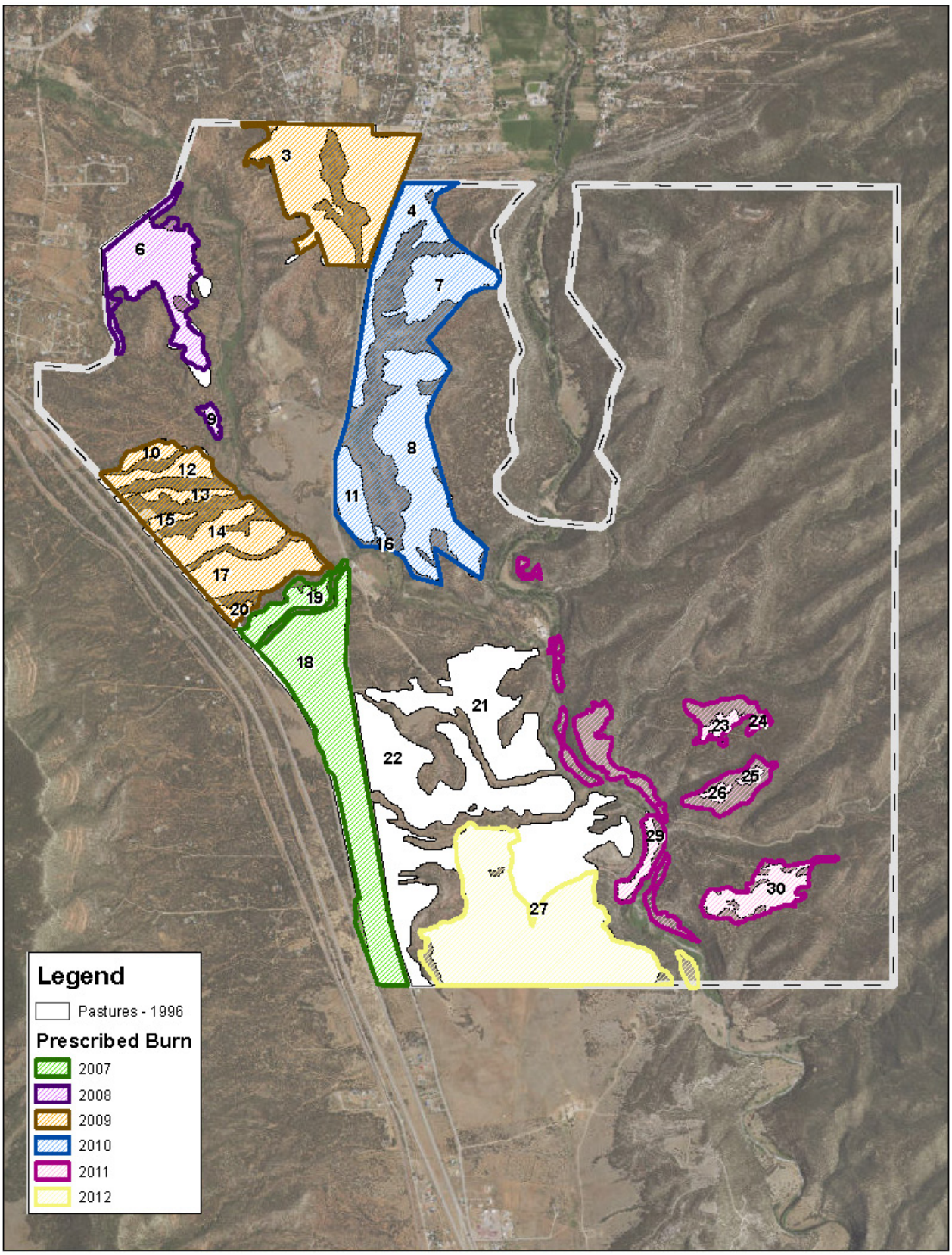


Figure 1-8. History of prescribed burns within pastures at Pecos National Historical Park (2007–2012).

2. The Plan

2.1 Concept

Goals of the Plan

Park staff will implement a comprehensive plan to restore, improve, or maintain the historical setting of Pecos NHP while simultaneously preserving ecological integrity of its native vegetation. Under the plan, park staff will (1) better define desired vegetation conditions; (2) take an adaptive approach to refine the measurability of desired conditions and evaluate the relative effectiveness of management actions to achieve those desired conditions; and (3) strategically plan and prioritize vegetation management for maximum effectiveness and continual improvement.

The staff at Pecos NHP will define desired conditions based on the park's enabling legislation, its significance, and its fundamental resources and values. These desired conditions will be used as general guides and benchmarks for management actions. The enabling legislation (PL l01-313, 1990) states that Pecos NHP was established "(1) to recognize the multithemed history, including the cultural interaction among diverse groups of people, of the Pecos area and its "gateway" role between the Great Plains and the Rio Grande Valley, and (2) to provide for the preservation and interpretation of the cultural and natural resources of the Forked Lightning Ranch by establishing the Pecos National Historical Park." The Pecos National Historical Park Expansion Act (PL 101-536, 1990) established the Glorieta Unit of Pecos NHP "to preserve and interpret the Battle of Glorieta Pass and to enhance visitor understanding of the Civil War and the Far West by establishing a new unit of Pecos National Historical Park."

Fundamental Resources and Values

Pecos NHP is situated in a multicultural crossroads and natural travel corridor that shaped the culture of the region. The Upper Pecos River Valley and Glorieta Pass, the gateway through the southern Sangre de Cristo Mountains, and the region's overall viewshed, landscape, vegetation, and riparian corridors are all part of the distinctive nature of the park (NPS 2009, 2015a).

The park's Foundation Document identifies the following fundamental resources and values (NPS 2015a):

- Pecos Pueblo and Spanish Missions
- Cultural Continuity
- Archeology, Museum Collections, and Archives
- Natural Resources of the Upper Pecos River Watershed
- Features Associated with the Civil War Battle of Glorieta Pass
- Forked Lightning Ranch
- Opportunities for Visitor Understanding

A close interrelationship between natural and cultural resources exists at Pecos NHP. Natural resources invariably have a role in the cultural stories of the park. For example, the area's geography meant that the Pecos Pueblo and Spanish Missions had an advantageous position at the juncture of trade between the people of the Rio Grande Valley and the plains tribes. The landscape and scenery of Pecos NHP provide many descendants of past inhabitants and settlers with a strong connection to the past. The Civil War Battle of Glorieta Pass took place along the Santa Fe Trail, the main military route between Santa Fe and Fort Union, and many sites and remnant features of the battle remain. Forked Lightning Ranch tells the story of ranching in northern New Mexico (Kerr et al 2022; NPS 2015a).

The natural resources of the Upper Pecos River Watershed have nurtured settlement and facilitated multicultural interactions and are critical aspects of the 12,000-year human history of the region. The Pecos River and Glorieta Creek both are reliable water sources, and the riparian/wetland habitat is a rare ecosystem in the arid Southwest (NPS 2015). Vegetation in the region has had a long history of human manipulation and use, including cutting firewood in woodlands and forests, gathering food and traditional medicines, and harvesting plants for building materials. Grasslands and pastures have been maintained for centuries by Pueblo inhabitants to create fields for maize agriculture and possibly grazing for big game (Pannebaker et al. 2017). Areas of woodland were cleared first by Ancestral Pueblo

groups for agricultural fields and more substationally in the Spanish Colonial period for cattle grazing. Clearing continued in the late 1800s/early 1900s with the coming of the railroad and when a trading post and several homesteads were established, and then intensified in the 1950s and 1960s to create more pastures for livestock (Johnson et al. 2011). Overall, the park's vegetation is an integral part of its historical landscapes.

A cultural landscape is "a geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person, or exhibiting other cultural or aesthetic values." (NPS 2006). A Cultural Landscape Report has been completed for the historical period component of Pecos NHP (Kerr et al. 2022), and many of the fundamental resources and values identified in the Foundation Document are considered contributing features relevant to vegetation management for the cultural landscape (Pannebaker et al. 2017). The NPS uses cultural landscape reports as part of the planning process to evaluate the landscape's significance, characteristics, and features. Vegetation management will be an integrated approach that considers cultural resources and the site's fundamental resources and values rather than focusing solely on natural resource values. Moreover, vegetation management techniques/methods will be chosen that minimize impacts to cultural resources and seek beneficial treatments for archaeological site preservation. The Vegetation Management Plan and Cultural Landscape Report (Kerr et al. 2022) and Pecos Ancestral Pueblo Landscape Cultural Landscape Inventory (ARG and NPS 2024) will be used in conjunction to balance cultural and natural resource values and find significant areas of overlap that can inform management.

Spatial Units for Vegetation Management

Spatial units for vegetation management as outlined in this plan are based on major vegetation community types, local site conditions and histories, and current conditions. Spatial units will also be defined for areas that have cultural and historical values that require special vegetation management to protect those resources.

Although vegetation communities can be dynamic, major types generally correspond to ecological sites. Ecological sites are based in part on physical characteristics, such as soils, and are consequently relatively stable. Ecological sites are part of a system developed by the USDA Natural Resources Conservation Service (NRCS) that classifies sites with similar physical characteristics, such as soils, hydrology, and physiographic features, and that supports characteristic plant communities that respond similarly to natural processes, land management, climate, and disturbance. Ecological site descriptions are available for Pecos NHP but are not yet compiled and analyzed at the park level.

Major Vegetation Community Types

The major vegetation community types that we used as the basis of spatial units for vegetation management correspond to Level 1 map units in the vegetation classification and map for Pecos NHP (Muldavin et al. 2012; Figures 2-1a, b). Level 1 map units are complexes of one or more plant associations that correspond to the group level in the National Vegetation Classification Standard (NVCS). NVCS groups possess combinations of relatively narrow sets of diagnostic plant species, 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 (Muldavin et al. 2012).

The Pecos vegetation map consists of eight Level 1 map units, plus two units that are miscellaneous land-cover classes (Muldavin et al. 2012):

- Southern Rocky Mountain White Fir-Douglas-fir Dry Forest
- Southern Rocky Mountain Ponderosa Pine Forest & Woodland
- Southern Rocky Mountain Pinyon-Juniper Woodland
- Rocky Mountain & Great Basin Montane Riparian Forest
- Intermountain Semi-desert Shrubland
- Rocky Mountain & Great Basin Foothill Riparian Shrubland & Alder-Birch Riparian Shrubland
- Great Plains Shortgrass Prairie
- Vancouverian & Rocky Mountain Montane Wet Meadow
- Sparsely Vegetated
- Urban or Built-up Land

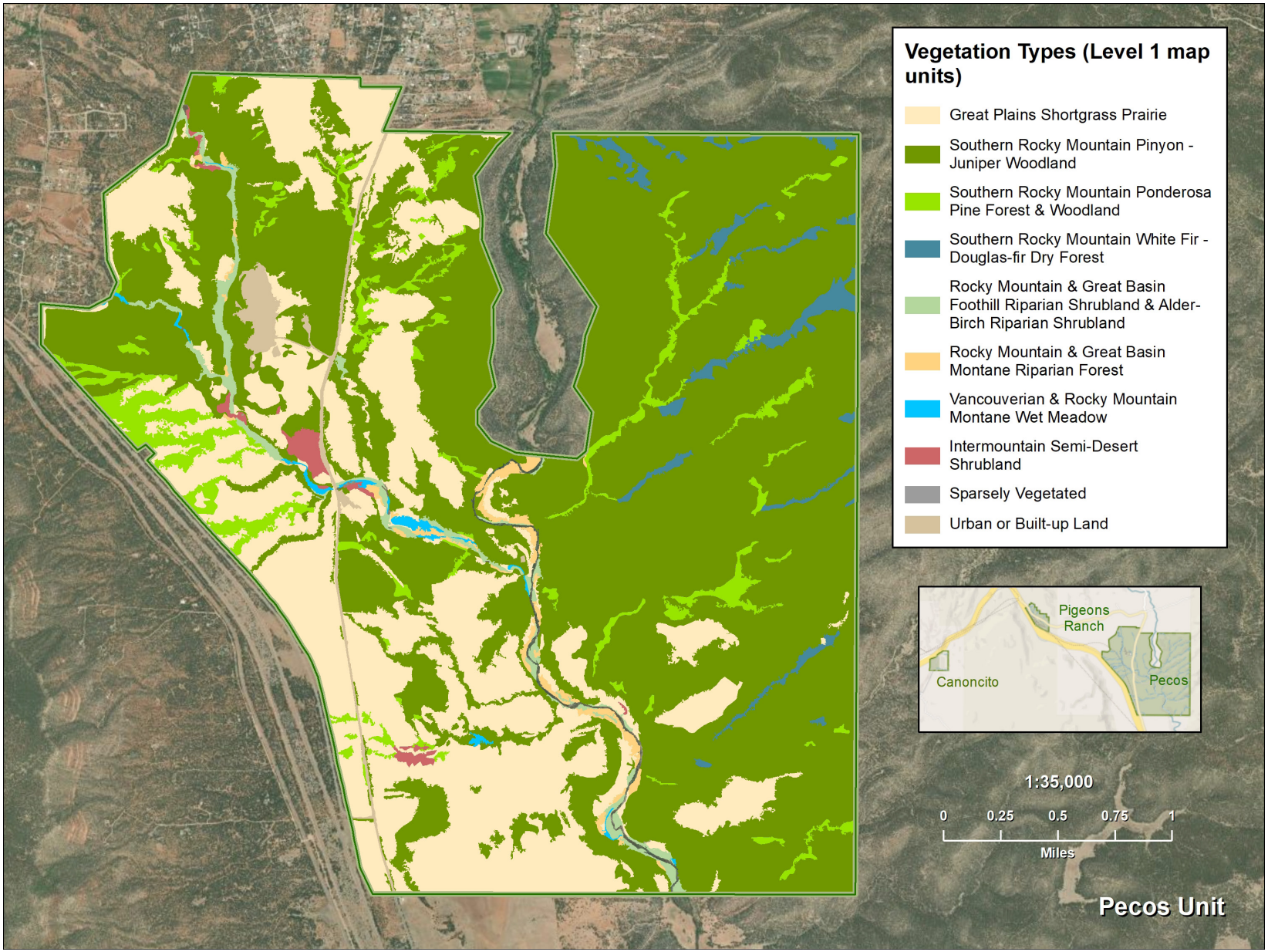


Figure 2-1a. Level I vegetation map units (Muldavin et al. 2012) for the Pecos Unit. The Pecos National Historical Park vegetation map, including geophysical dataset is available from the Vegetation Mapping Inventory Project website. See Figure 2-1b for detailed vegetation map units for the Canoncito and Pigeons Ranch subunits.

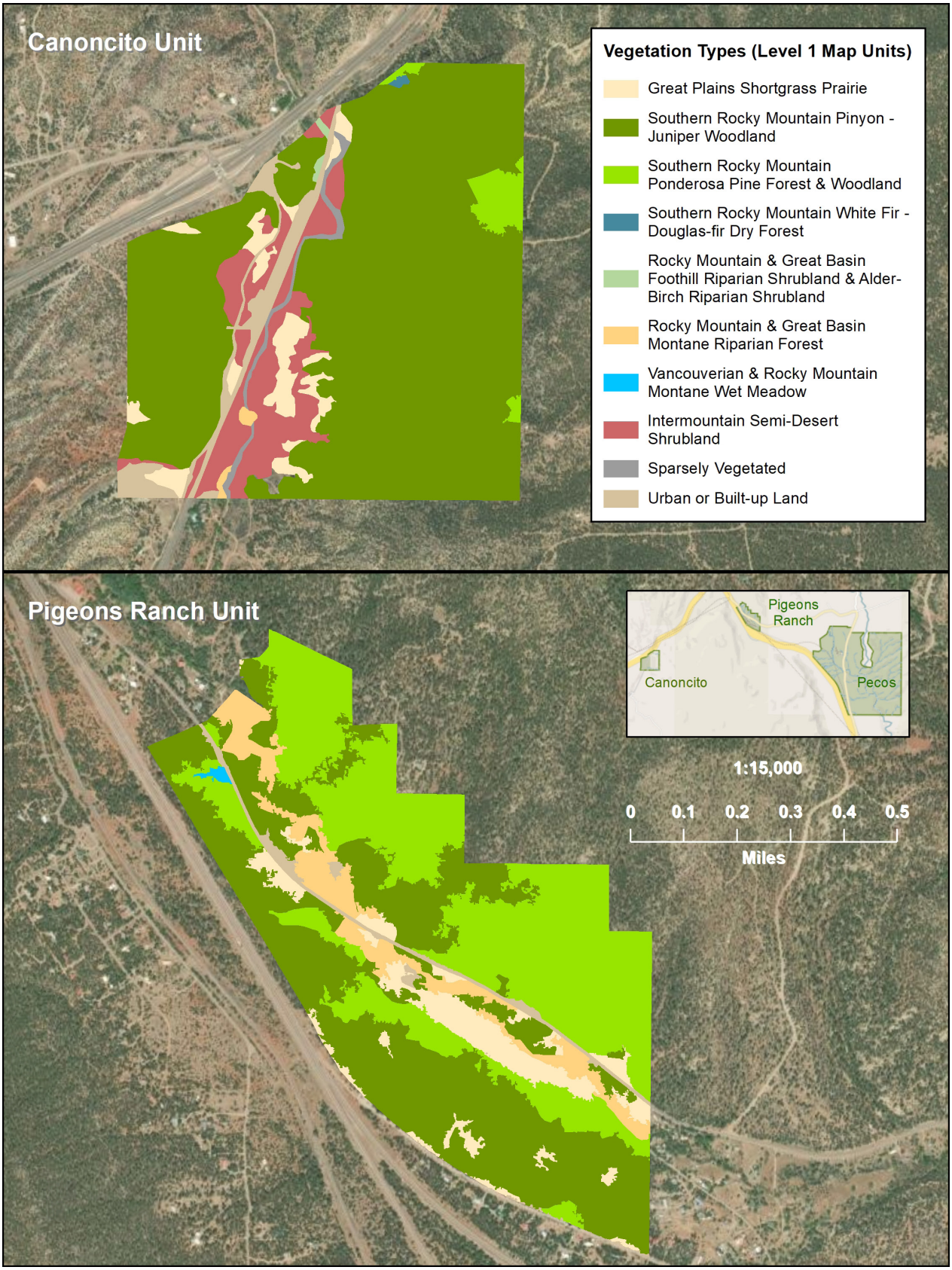


Figure 2-1b. Level I vegetation map units (Muldavin et al. 2012) for the Canoncito and Pigeons Ranch subunits. The Pecos National Historical Park vegetation map, including geophysical dataset is available from the Vegetation Mapping Inventory Project website. See Figure 2-1a for the vegetation map units of the Pecos Unit.

Most spatial units for vegetation management in Pecos NHP will have the same areas as those of the corresponding Level 1 map units for each vegetation type, with a few exceptions due to management considerations and local site conditions for grassland and riparian areas.

Pastures

Large areas within the Pecos Unit have been used for grazing probably beginning in the Spanish colonial period. This use continued on Forked Lightning Ranch until the 1990s. Approximately 1,639 acres (663 hectares) of Pecos NHP have been classified as pastures (Figure 1-5).

While the area of the park to the west of the Pecos River appears to be a mosaic of true forests and true grasslands, this is not the case. Instead, there appears to be a range of alternate ecosystem states (grasslands and woodlands) that depend heavily on the past human land use of the area (Romme 2020). Without periodic disturbance that removes trees (e.g., fire, grazing, timber cutting), the majority of the land west of the river would likely be dominated by trees. However, because of land management for the promotion of cattle grazing throughout the recent history of this area, grassland structures have been maintained in large portions of the park (Romme 2020).

The NPS cannot actively maintain all the pastures to be completely free of trees and would like to reduce labor costs by focusing only on keeping those pastures open that help the NPS interpret the ranching activities and that provide the most important viewsheds. The NPS has determined that the older pastures are sufficient to interpret the story of Forked Lightning Ranch and regional land use without maintaining every pasture that was cleared prior to being incorporated into the park.

Therefore, under this plan, some pastures will be maintained for their historical significance and to facilitate interpretation of the changes in land use and of the ranching era in the Pecos Valley, while others will be allowed to revert to wooded communities (primarily pinyon-juniper woodlands). Pastures cleared after 1965 will no longer be maintained as open pastures since they are less representative of the historical ranching era. These pastures will be allowed to revert to pinyon-juniper woodland, except for pastures adjacent to private land that will be thinned for wildland fire protection.

The criteria used to determine which pre-1965 pastures will be maintained as open pastures included the following:

1. Any special historical significance.
2. Their visibility in viewsheds facilitating interpretation of the ranch and land use patterns.
3. Their ecological propensity to fill in with wooded vegetation.
4. Their ecological condition.
5. The capacity of the park to maintain such areas given the resources of park staff.

Because the NPS will be managing vegetation differently in maintained pastures compared to pastures that will be allowed to infill with trees through natural ecological processes (Figure 2-2), this plan will have separate spatial units for maintained pastures and transitioning pastures.

Riparian Vegetation

This plan will utilize a single Riparian Vegetation spatial unit for the major vegetation types of riparian woodlands, riparian shrubland, and rush and sedge wetlands. This unit will consist of the Rocky Mountain & Great Basin Montane Riparian Forest, Rocky Mountain & Great Basin Foothill Riparian Shrubland & Alder-Birch Riparian Shrubland, and Vancouverian & Rocky Mountain Montane Wet Meadow Level 1 map units in the Pecos vegetation classification and map report (Muldavin et al. 2012). Vegetation in this spatial unit will receive the same prescribed fire treatments and actions to control invasive plants, but cottonwood galleries in the riparian forests will be managed differently.

2.2 Spatial Units

Under this plan, vegetation management actions are tailored to the specific conditions of each spatial unit. Pecos NHP is designating 10 spatial units for vegetation management in this plan (Figure 2-3). Most spatial units are based on the areas mapped as having major vegetation types (Level 1 vegetation map units; Muldavin et al. 2012). But there are separate spatial units for maintained pastures/ grasslands and transitioning pastures in areas mapped as shortgrass prairie.

Spatial units will be designated for areas of the park that have important cultural resources. These areas require special consideration so their management

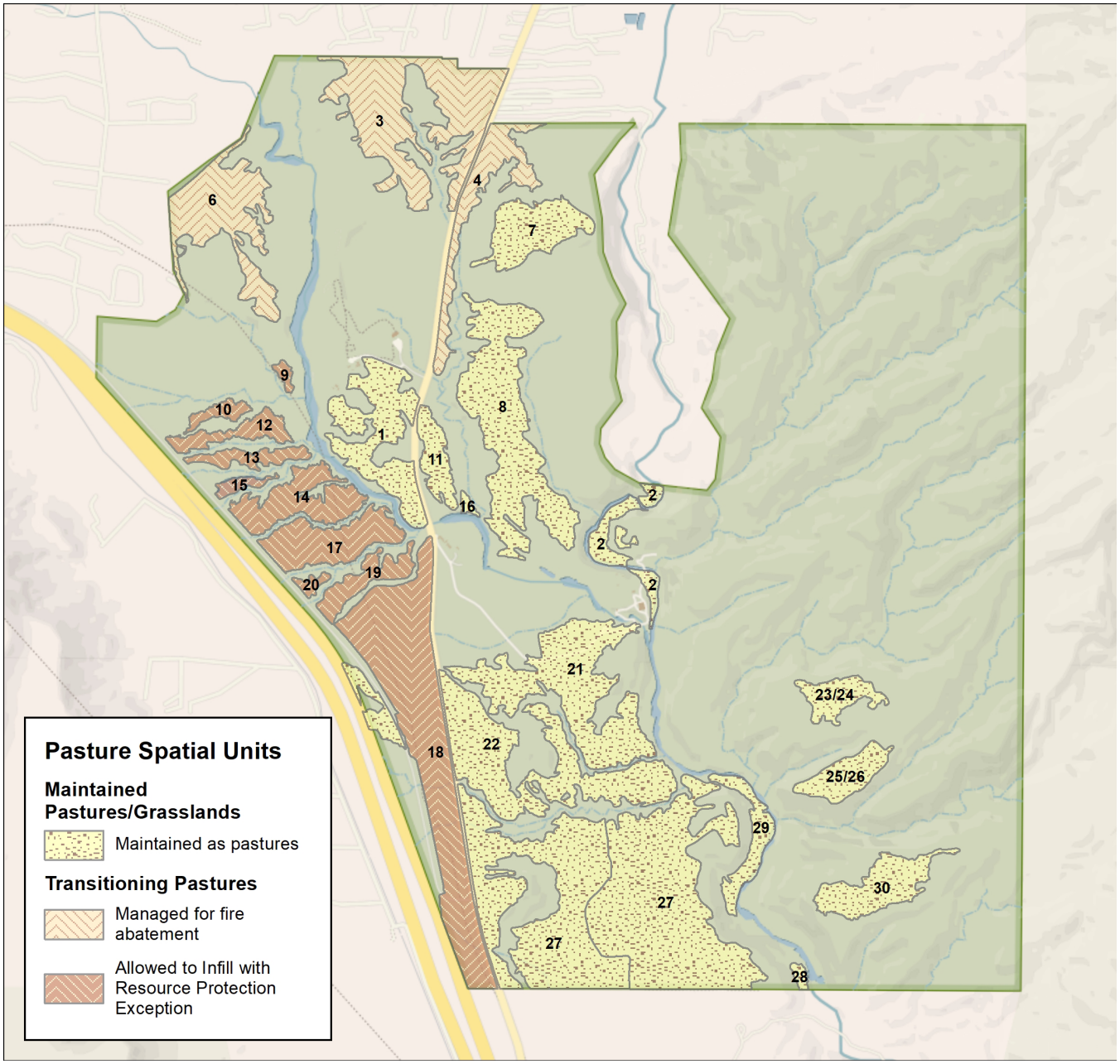


Figure 2-2. Areas in Pecos NHP that have shortgrass prairie as the primary vegetation type (Muldavin et al. 2012) will either be maintained as pastures (in the Maintained Pastures/Grasslands spatial unit) or be allowed to infill with pinyon pine and juniper trees through natural ecological processes (Transitioning Pasture spatial unit). Three pastures (pastures 3, 4, and 6) in the Transitioning Pastures spatial unit will also be managed for fire abatement. See the text in Section 2.2 for further discussion about the Maintained Pastures/Grasslands and Transitioning Pastures spatial units.

does not harm archeological sites, cultural features, or artifacts.

- The Pecos Pueblo and Spanish Mission Complex.
- Other archeological sites.
- The historical orchards on Forked Lightning Ranch associated with the historical Cattanach Mill.

Other Archeological Sites and Historical Orchards spatial units are not shown on Figure 2-3 because of their small geographic areas and cultural sensitivity.

Developed areas that are heavily managed for facilities and for visitor safety (e.g., around administrative buildings) are not included in this vegetation management plan.

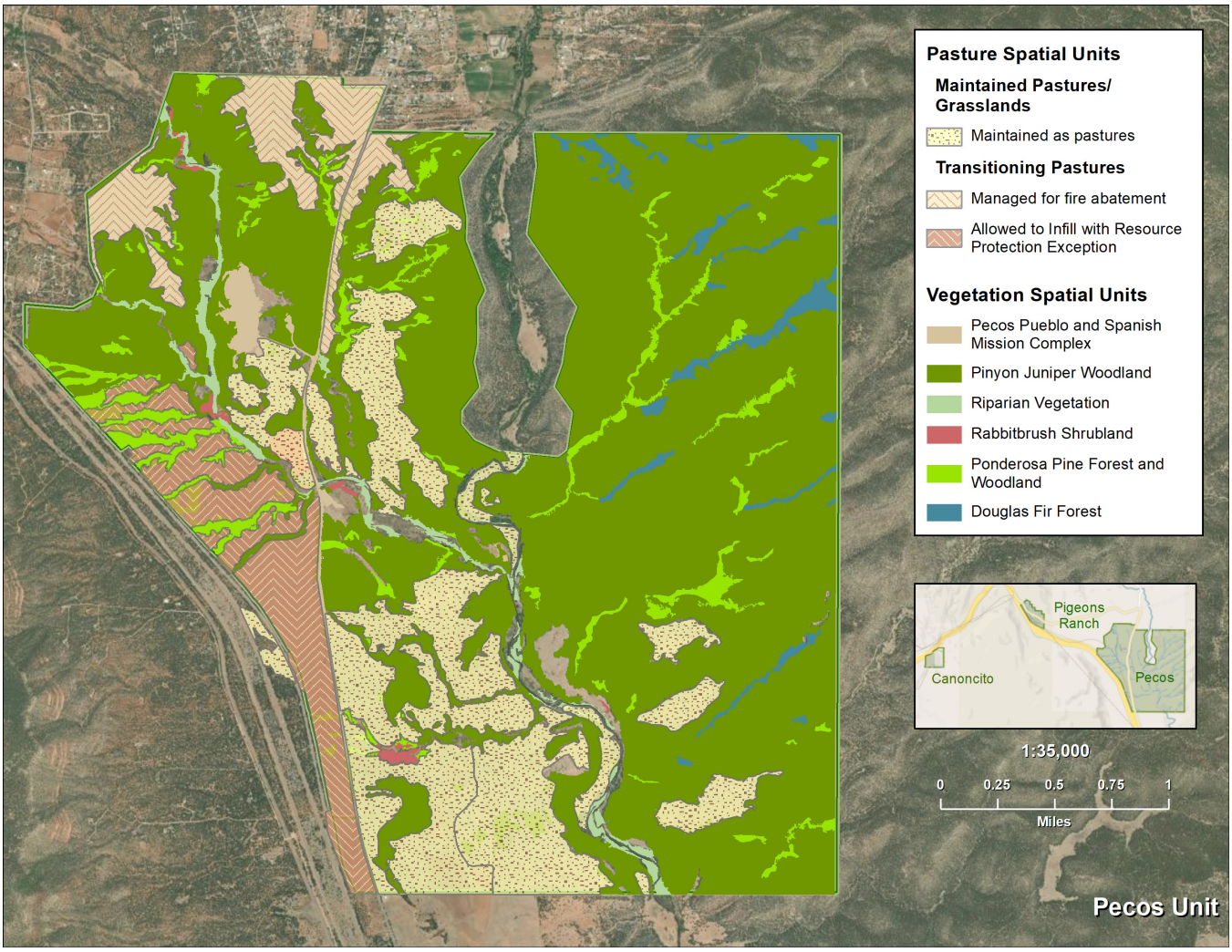


Figure 2-3. Spatial units for vegetation management. The Historical Orchards and Other Archeological Sites spatial units are not shown on this map due to the scale.

Maintained Pastures/Grasslands

Pastures 1, 2, 7, 8, 11, 16, 21, 22, 23/24, 25/26, 27, 28, 29, and 30 (Figures 2-2, 2-3, and 2-4) make up the Maintained Pastures/Grasslands spatial unit and will be managed to maintain an open grassland structure. These pastures are in recovery from long-term grazing but overall are in good condition with a healthy mix of native grasses and forbs. Vegetation is dominated by short, warm- and cool-season grasses and pinyon pine and juniper trees. Landscapes in these areas are relatively flat or gently sloped.

Transitioning Pastures

Pastures 3, 4, 6, 9, 10, 12, 13, 14, 15, 17, 18, 19, and 20 make up the Transitioning Pastures spatial unit (Figures 2-2, 2-3, and 2-5). They appear to have been initially cleared for ranching operations in the 1960s and are the youngest pastures in the park, having been cleared close to the end of the period of significance when ranching was winding down. In addition, their location and viewsheds have less interpretive value.

These pastures will be allowed to transition to pinyon-juniper savanna or woodlands. The south end of Pasture 18 will be allowed to transition to shrubland.

Within the Transitioning Pastures spatial unit, trees will be cleared along the Santa Fe Trail and other high priority archeological sites for resource protection and/or fire mitigation. Fuel reduction along park boundaries may include a buffer of 60–100 ft.

Pastures 3, 4, and 6

Pastures 3, 4, and 6 along the urban park interface will be maintained so that they provide a fire break along the park boundary.



Figure 2-4. Maintained Pastures/Grassland spatial unit at Pecos National Historical Park.



Figure 2-5. Transitioning Pastures spatial unit at Pecos National Historical Park.

Pecos Pueblo and Spanish Mission Complex

The vegetation in the Pecos Pueblo and Spanish Mission Complex spatial unit has been significantly altered by human disturbance associated with the pueblo/mission and modern activities, including large-scale archeological excavations beginning in 1915. These disturbed areas are dominated by ruderal invasive species (Figures 1-2 and 2-6). The most common species is kochia. The most common native species are western wheatgrass (*Pascopyrum smithii*) and sand dropseed (*Sporabolus cryptandrus*). Intense restoration efforts and research have occurred in recent years to increase native plant cover in the area. Treatments have included brush cutting (using a weed eater with a blade attachment) and spraying kochia with herbicide. Seeding, planting, and carbon addition methods have also been deployed. Native grass patches appear to be increasing in size and density from management efforts over the last 10 years.

Other Archeological Sites

The Other Archeological Sites spatial unit consists of areas in Glorieta Pass battlefield, Pigeon's Ranch and sites along the trace of the Santa Fe Trail, and other archeological sites dispersed throughout the park. Kerr et al. (2022) present the important cultural landscape features and resources within the Glorieta and Canoncito subunits, including the battlefield and historical homesteads and ranches. The archeological sites along the edges of existing woodlands see the most tree encroachment and will require the most active management to reduce fuels and protect the sites from tree root impacts.



Figure 2-6. Ruderal grasslands surround ruins at Pecos National Historical Park. These habitats are often dominated by invasive species, such as kochia (*Bassia scoparia*) and Russian wildrye (*Psathyrostachys juncea*). The map (left) is from Muldavin et al. 2012.



Figure 2-7. Left image is an apple tree being inspected for dead limbs prior to pruning in the winter. The middle and right images are examples of apple trees in the orchard.

Historical Orchard

A historical apple orchard of approximately 30 trees is located along the banks of the Pecos River near the very northern boundary of the Pecos Unit (Figure 2-7) below the Forked Lightning Ranch house. Some remains of a grist mill appear to be associated with this orchard and probable agricultural fields along an acequia (irrigation channel). The history of the orchard is not well known, but it has been actively maintained since 2020. In 2019, the trees were in poor condition.

Pinyon-Juniper Woodland

The Pinyon-Juniper Woodland spatial unit covers the greatest area of the park (Figures 2-1, 2-3, 2-8, and 2-9). The park's vegetation classification and map identify 11 pinyon-juniper plant associations and 10 Level 2 pinyon-juniper map units (Muldavin et al. 2012). Romme et al. (2009) identifies three fundamental kinds of pinyon-juniper vegetation: persistent pinyon-juniper woodland, pinyon-juniper savanna, and wooded shrubland. In general, a great deal of variation exists in persistent pinyon-juniper woodlands throughout the Southwest (Romme et al. 2009).

The following information about the ecology and condition of pinyon-juniper woodlands in Pecos NHP is summarized and/or quoted from an assessment of pinyon-juniper woodlands (Romme 2020):

> *Overall, stand densities are within their range of natural variability for their growing conditions. Stand densities and total woodland extent are greater today than they were a century ago, but densities and extent have fluctuated during the last several hundred years, primarily in response to the intensity of human use. The current densities and extent are what would be expected during a period of reduced impact following an episode of intensive use. The age class distributions of the trees are consistent with the expected range of variability for this ecosystem type. Tree and understory plants appear vigorous and healthy. There are some dead and dying trees, as in any woodland of this type, but no more than would be expected.*
>
> *The woodlands east of the Pecos River can be viewed as persistent pinyon-juniper woodlands and are mostly in an old-growth condition. East of the river, pinyon and juniper trees are of all sizes and ages, from small,young saplings to large, gnarled individuals more than 300 years old.*
>
> *There is decades-old evidence of wood-cutting in places along canyon bottoms, which are readily accessible from the Pecos River corridor; but the ridges rise steeply, and on the slopes and tops there is little evidence of wood-cutting or other human activities. Herbaceous and shrub cover are scant on the slopes and ridge tops; most of the ground between trees is bare soil or soil covered in a thin layer of needles. The soils are developed from shale and limestone of the Pennsylvanian Alamitos Formation and appear generally shallow and infertile. Plant diversity of the woodland community appears relatively low, but the plants are almost entirely native and typical of such habitats.*

The woodlands west of the Pecos River do not readily fit any of the three types (persistent pinyon-juniper woodland, pinyon-juniper savanna, and wooded shrubland) described by Romme et al. (2009) and are visually different than those on the east side of the river (Figure 2-9). Like the pastures in the same area, they are dependent on the local history of past land use. Most of the trees in the main park unit west of the Pecos River "are less than 140 years old, which is unusual in a "pristine" woodland of this type, but simply reflects the heavy human impact of the 1800s and earlier in this particular location. In fact, most of the trees west of the Pecos River appear quite robust, in part because most are relatively young. Compared with the east side of the Pecos River, the west-side topography is gentler, the underlying substrate is a mix of different sedimentary rock types, the soils appear more fertile, and plant species diversity appears greater.

Disease and insect levels are quite low and within the normal range for this ecosystem type.

The canopies of persistent pinyon-juniper woodlands range from sparse stands of scattered small trees growing on poor substrates to relatively dense stands of large trees on more productive sites. The canopy may be dominated by either pinyon pine, juniper, or both depending on local conditions. The understories of persistent pinyon-juniper woodlands may be dominated by shrubs, forbs, or less commonly, grasses. However, understories are typically sparse with extensive areas of bare soil or rock. Persistent pinyon-juniper woodlands may occur on a wide variety of substrates and topographic settings, but are mostly associated with rugged uplands with shallow, course-textured, and often rocky soils that support relatively sparse herbaceous cover. Stand-replacing fires typically occur with low frequency, are high intensity, and vary in size and extent. The fire interval in these stands is typically very long (at least multi-decadal), but more often measured in centuries.

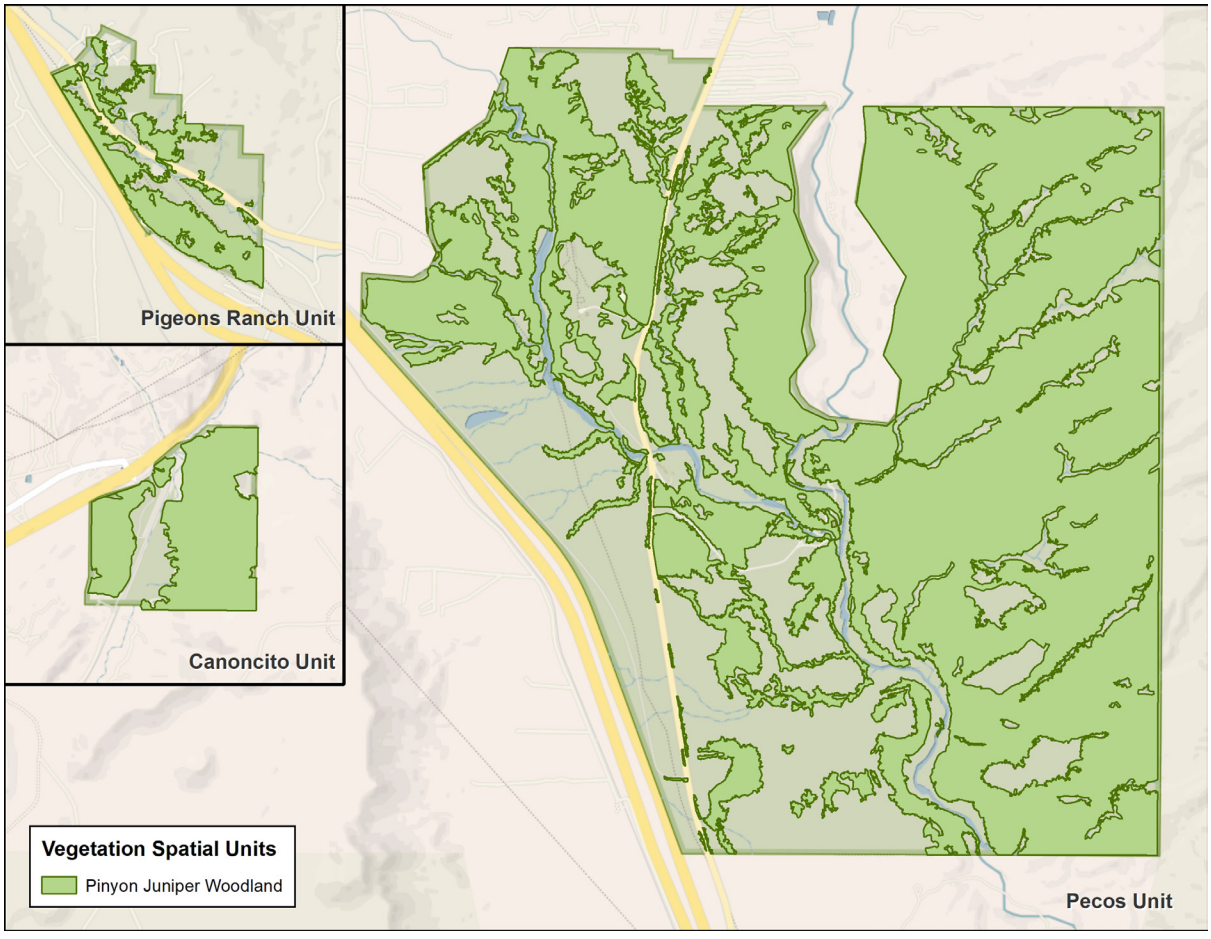


Figure 2-8. Pinyon-Juniper Woodlands spatial unit.



Figure 2-9. Pinyon-juniper vegetation at Pecos National Historical Park can be quite variable: much of the pinyon-juniper in the main unit east of the Pecos River is a more typical persistent woodland (sensu Romme et al. 2009; left image); whereas considerable woodland habitats west of the Pecos River were cleared during the ranching era and have the appearance of pinyon-juniper savanna (right image).

Riparian Vegetation

Riparian vegetation is an important part of the overall ecological dynamic of the riparian system. Roots provide stability to the riparian zone substrate and contribute to bank stability. The plants help cycle nutrients, and they provide diverse structural complexity of overall habitat and microhabitat for animals in the riparian and aquatic portions of the system (Bennett and Simon 2004).

The Riparian Vegetation spatial unit covers three broad types of riparian vegetation (riparian woodland, riparian shrubland, and rush and sedge wetlands) in Pecos NHP (Muldavin et al. 2012; Figures 2-1, 2-3, 2-10a, b, and 2-11).

Riparian woodlands typically occur on alluvial terraces and gravel bars within the active floodplain of perennial streams and rivers (Muldavin et al. 2012). The canopy is dominated by narrowleaf cottonwood (*Populus angustifolia*) and occasionally Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*). The subcanopy is often mixed with box elder (*Acer negundo*) and oneseed juniper (*Juniperus monosperma*). The understory can be shrubby (primarily willow and/or chokecherry [*Prunus virginiana*]), and the herbaceous layer is typically dominated by invasive mesic grasses such as smooth brome (*Bromus inermis*). Riparian woodland species (such as narrowleaf cottonwood and box elder) are common along the Pecos River and Glorieta Creek of the Pecos Unit and the Pigeon's Ranch Subunit. However, there is very little of this habitat type along Galisteo Creek within the Cañoncito Subunit (Muldavin et al. 2012).

Pecos Watershed Tree Populations of Importance consist of the large cottonwoods along the Pecos River and Glorieta Creek. These trees are a significant part of the historical viewshed and are important to the Pecos watershed. These cottonwoods are susceptible to beaver; tree-cutting beavers can travel up to 328 ft (100 m) from a water body to cut and harvest trees, but the probability of harvest decreases exponentially with distance from water. Beavers harvest a wide range of trees and shrubs, but they generally prefer species in the *Populus* or *Salix* genera (cottonwoods, aspen, and willows; Boyle and Owens 2007; Baker and Hill 2003). Beavers also use the base of large trees of both palatable and unpalatable species as gnawing stations to wear down their continually growing teeth, a behavior that can lead to the tree's ultimate demise.

The park wants beaver populations to flourish, but at the same time it must protect these significant cottonwood trees. Some mature cottonwoods in the park have been damaged by beaver. Currently there are cages (beaver exclosures) around most mature cottonwoods (estimated to number in the hundreds) along the Pecos River in the park to prevent further gnawing.

Riparian shrubs typically occur on floodplain gravel bars adjacent to the Pecos River and on arroyo edges (Muldavin et al. 2012). These sites are likely flooded during annual spring runoff. They are primarily coyote willow (*Salix exigua*) associations and thinleaf alder (*Alnus incana*) and peachleaf willow (*Salix amygdaloides*) associations, which can form a dense shrub canopy. The herbaceous layer is typically dominated by mesic, often invasive, grasses. Riparian shrub species (willow and alder) are very common along the Pecos River and Glorieta Creek of the Pecos Unit. However, there is very little of this habitat type along Galisteo Creek within the Cañoncito Subunit. There are patches of this habitat along Glorieta Creek of the Pigeon's Ranch Subunit, but it is not as common as it is along Glorieta Creek and the Pecos River of the Pecos Unit (Muldavin et al. 2012).

Riparian rush and sedge wetlands are typically found in side channels and low-lying areas within perennial stream channels (Muldavin et al. 2012). They are dominated by native wetland species such as Baltic sedge (*Juncus balticus*), softstem bulrush (*Schoenoplectus tabernaemontani*), common spikerush (*Eleocharis macrostachya),* and slender rush *(Juncus dudleyi*). Invasive mesic grasses can be present but tend to be subordinate to the native wetland species. Very little rush and sedge wetlands habitat occurs along Galisteo Creek of the Cañoncito Subunit and Glorieta Creek within the Pigeon's Ranch Subunit. Most of this habitat is found along the Pecos River and Glorieta Creek within the main unit of the park (Muldavin et al. 2012).

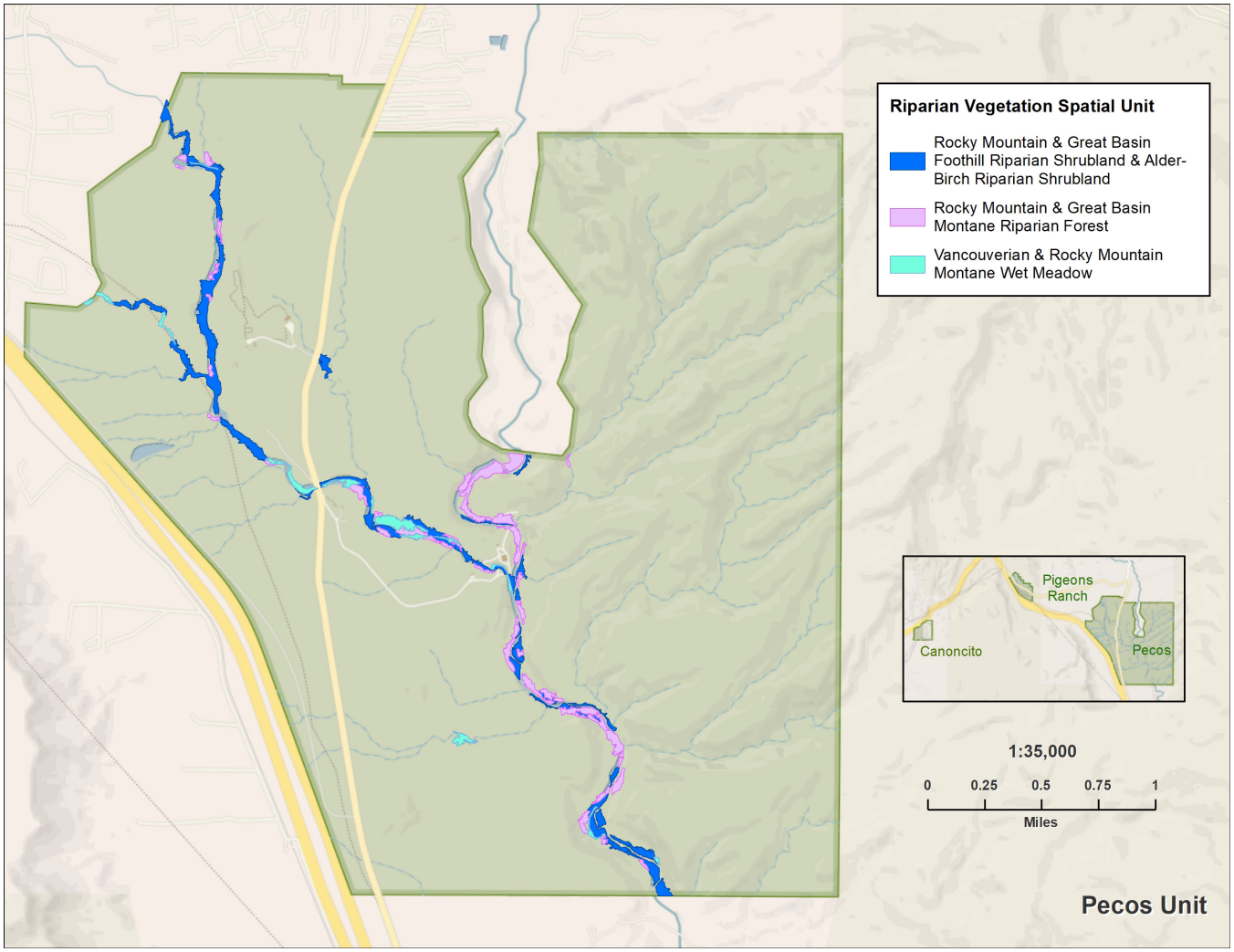


Figure 2-10a. Riparian Vegetation spatial unit, Pecos Unit.

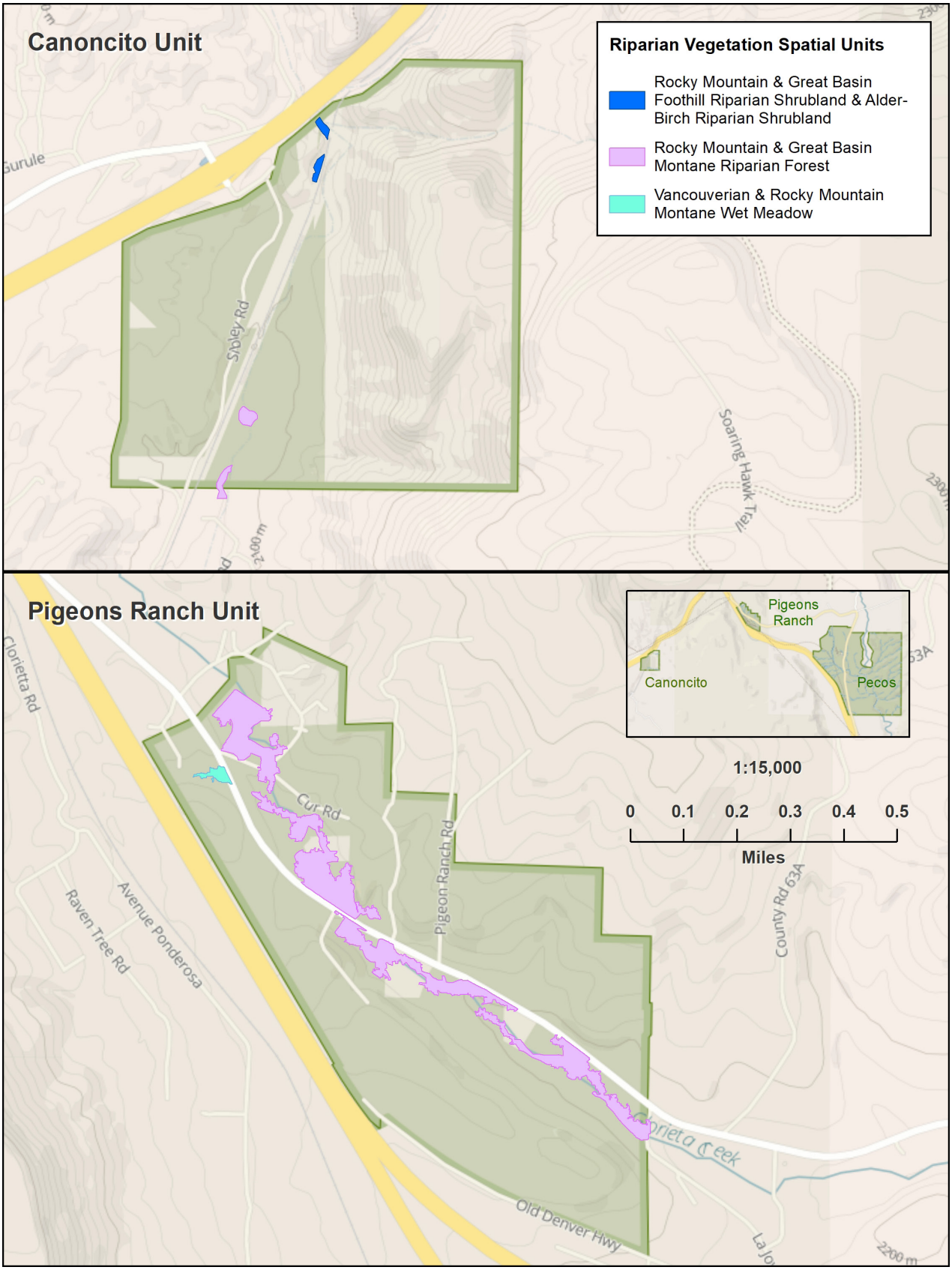


Figure 2-10b. Riparian Vegetation spatial unit, Canoncito and Pigeons Ranch subunits.



Figure 2-11. Riparian Vegetation spatial unit used for vegetation management planning. The three vegetation types are riparian shrubland (left), riparian woodland (center), and rush and sedge wetlands (right).

Rabbitbrush Shrubland

The Rabbitbrush Shrubland spatial unit occurs where Intermountain Semi-desert Shrubland (rabbitbrush shrubland is the only Level 2 map unit within this Level 1 unit) was mapped in Pecos NHP (Muldavin et al. 2012; Figures 2-1, 2-3, 2-12, and 2-13). These shrublands typically occur in association with alluvial terraces along intermittent or ephemeral stream reaches, especially along Glorieta Creek (Muldavin et al. 2012) in the Pecos Unit and near Galisteo Creek in the Cañoncito Subunit. Rubber rabbitbrush (*Ericameria nauseos*a) is the dominant shrub and is typically interspersed with grasses such as blue grama (*Bouteloua gracilis*), western wheatgrass, and sand dropseed. There is often a well-represented forb component.

Rabbitbrush species (*Ericameria* spp.) are subdominant in some communities, but their densities quickly increase after heavy disturbance or high grazing. Pasture 1 across Highway 63 from the trading post and north of the creek/bridge is a typical example of a disturbed area with a lot of rabbitbrush. Disturbances from ranching activities most likely created dense shrubland habitats (Tilley and St. John 2012) as it is unlikely that pastures became rabbitbrush shrublands without heavy grazing and disturbance.

Ponderosa Pine Forest and Woodland

The Ponderosa Pine Forest and Woodland spatial unit typically contains open forests or woodland savanna with an overstory dominated by ponderosa pine (*Pinus ponderosa*; Muldavin et al. 2012; Figures 2-14 and 2-15).

Open, savanna-like ponderosa pine woodlands typically occur on rolling hills and level plains near drainages on the west side of the Pecos Unit (and a few scattered areas in the Pigeon's Ranch Subunit). Many, but not all, of these savanna woodlands are on the gently sloped or near level areas that have been mechanically thinned in the past to create the open stand structure. Because of this, habitat is more open and there are higher densities of native grass ground cover compared to the other ponderosa pine forest habitats within the park (Muldavin et al. 2012).

The ponderosa pine forest habitat east of the Pecos River is associated with its side drainages. There is ponderosa pine/Gambel oak (*Quercus gambelii*) dominated forest on cooler aspects and along canyon drainages. Ponderosa pine/wavyleaf oak (*Quercus welshii*) dominated stands occur mostly on south facing and steeper slopes. Other areas are dominated by ponderosa pine and pinyon-juniper understories. Overall, these communities have very little shrub and grass components (Muldavin et al. 2012).

There is very little ponderosa pine forest within the Cañoncito Subunit where it typically occurs on steep slopes, at the tops of drainages, and along some drainage bottoms. Common associated species are pinyon pine, Rocky Mountain juniper (*Juniperus scopulorum*), wavyleaf oak, and some Fendler's muttongrass (*Poa fendleriana*; Muldavin et al. 2012).

Ponderosa pine forest is one of the major vegetation types within the Pigeon's Ranch Subunit and is largely associated with north facing slopes south of highway 50 and the cliffs, slopes, and side drainages of Glorieta Creek (Muldavin et al. 2012).

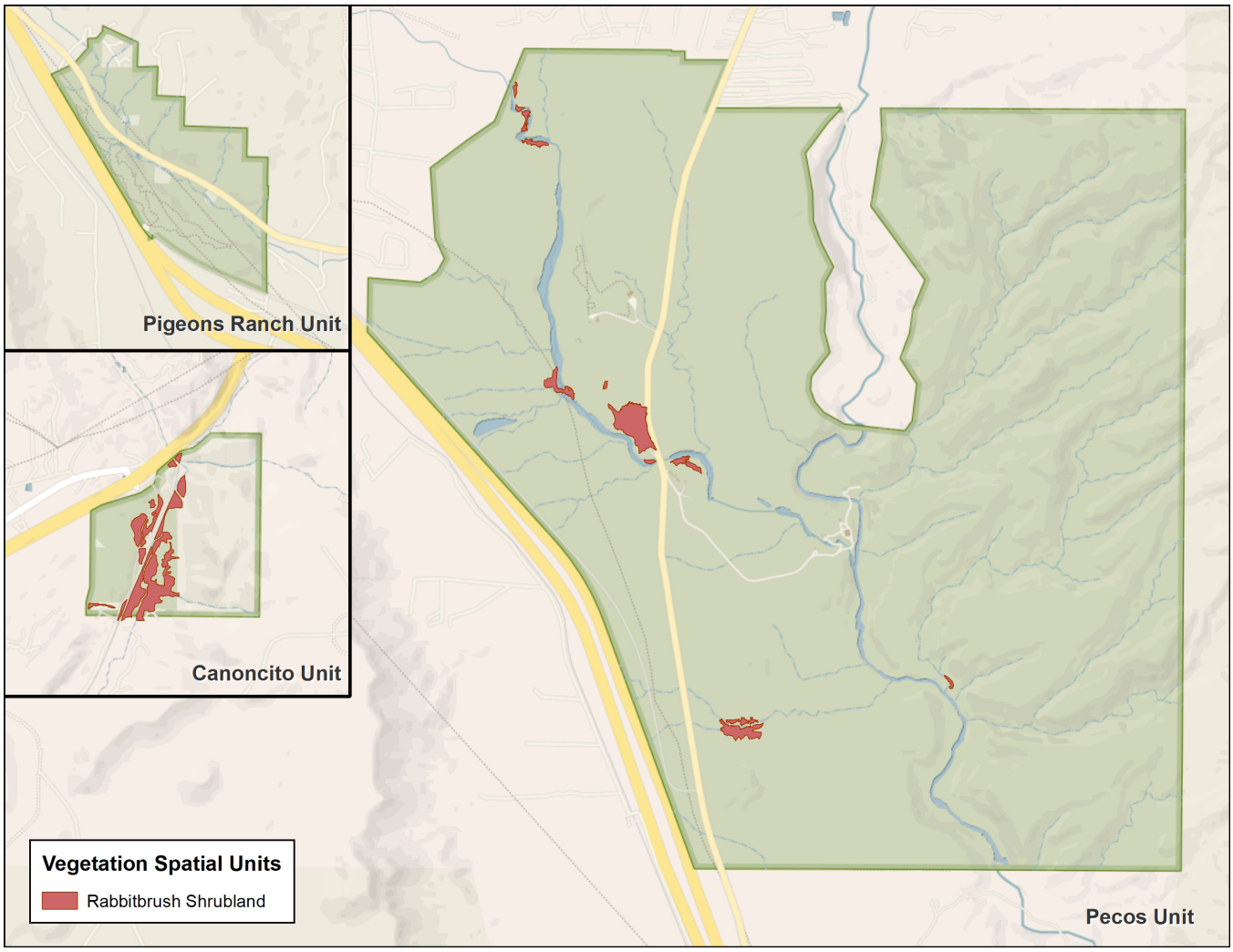


Figure 2-12. Rabbitbrush Shrubland spatial unit.



Figure 2-13. Rabbitbrush at Pecos National Historical Park.

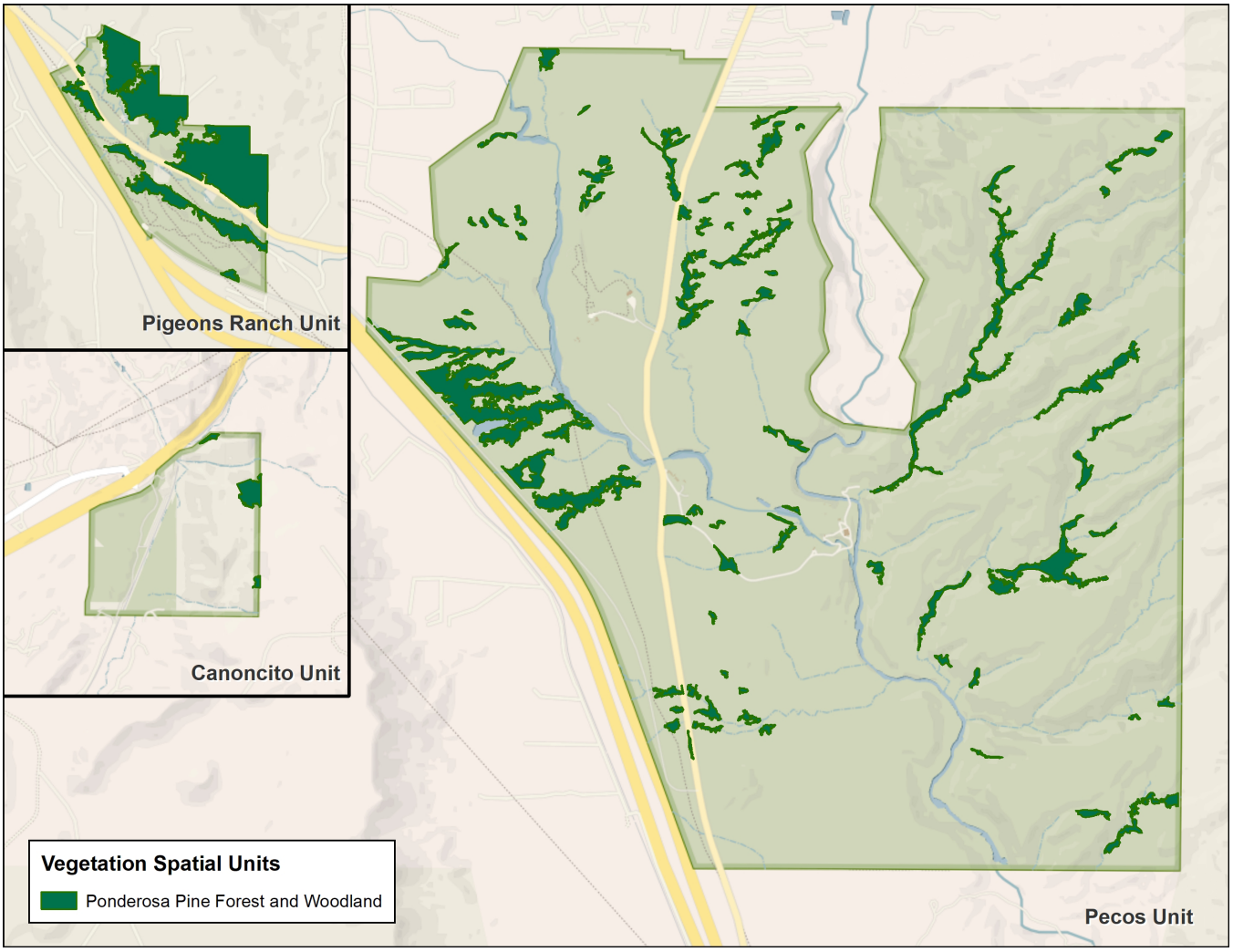


Figure 2-14. Ponderosa Pine Forest and Woodland spatial unit.



Figure 2-15. Sloped ponderosa pine forest at Pecos National Historical Park.

Douglas-fir Forest

The Douglas-fir Forest spatial unit typically occurs as part of open mixed-conifer forests dominated by Douglas-fir (*Pseudotsuga menziesii*) with scattered ponderosa pine, pinyon pine, and Rocky Mountain juniper (Muldavin et al. 2012; Figures 2-16 and 2-17). These associations occur primarily in the east side of the main unit in the upper portions of rocky and steep canyons along northeast-facing lower slopes (Figures 2-16 and 2-17). The subcanopy often has moderate to high cover of Gambel and/or wavyleaf oak, with an understory of scattered grasses.

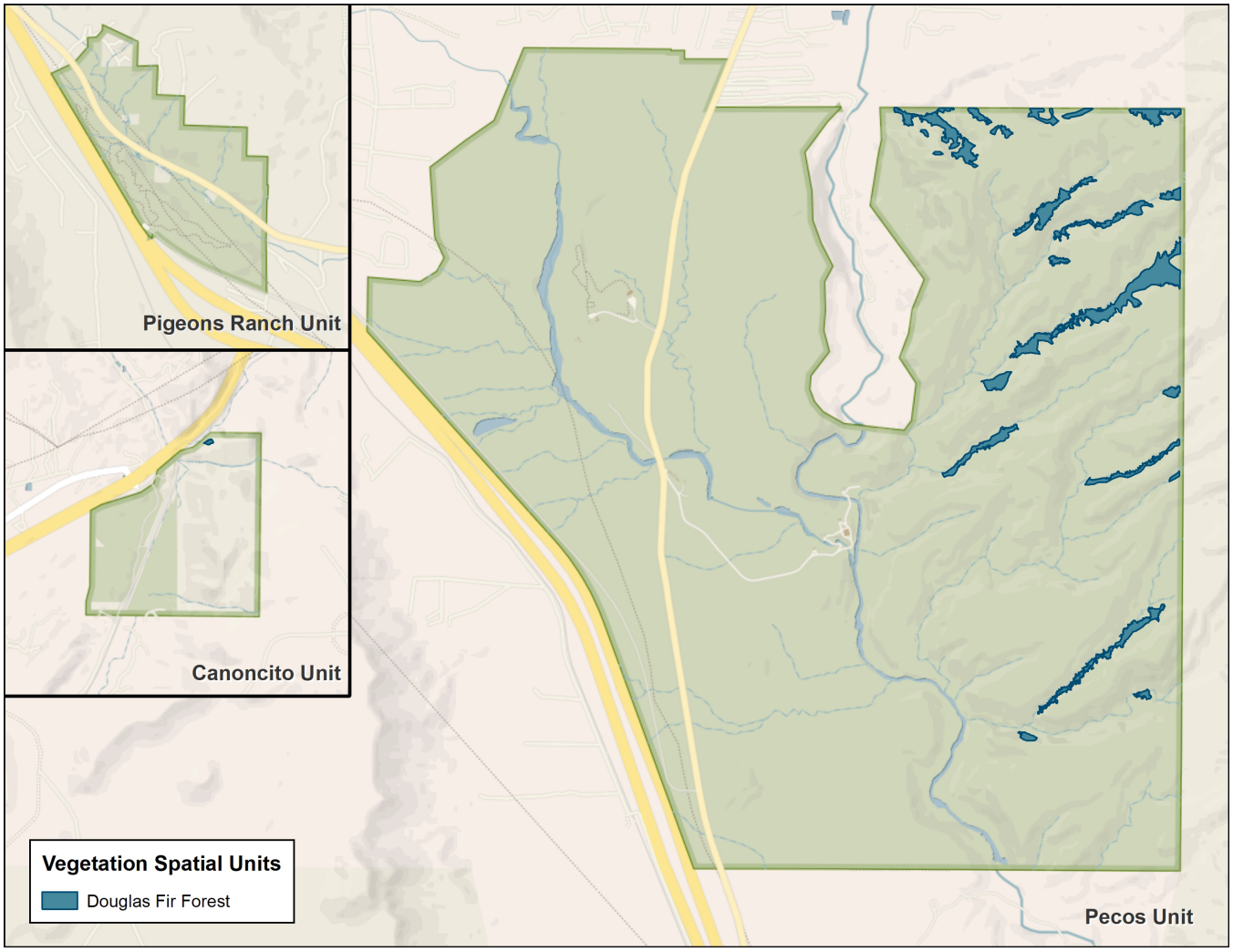


Figure 2-16. Douglas-fir Forest spatial unit.



Figure 2-17. Douglas-fir forest at Pecos National Historical Park.

2.3 Desired Conditions

Desired conditions for Pecos NHP are conditions intended to maintain the integrity of the cultural landscape as well as the ecological integrity of the vegetation communities. Desired conditions are presented for each spatial unit, the viewshed, and for fire. Desired conditions for all locations are also presented. General statements of the rationale for desired conditions are made followed by statements of specific desired conditions.

Throughout section 2.3 there are various discussions of desired conditions for spatial units, viewsheds, and fire. Frequently there is mention of measurable limits being refined adaptively over time. There is further discussion of the concept of adaptive management within section 2.5 "A Strategic and Adaptive Approach to Vegetation Management" and section 3 "Vision and Strategy for Vegetation Management." Reviews of vegetation monitoring data will be an ongoing part of our management and will occur through consultation with collaborative partners such as the Southern Plains Network. Reviews will include an analysis of the effectiveness of previous year's treatments and management actions to better inform potential changes to the measurable limits within the Desired Ecological Condition descriptions that follow.

Desired Condition of Maintained Pastures/ Grasslands

Pastures are a significant component of the cultural and natural landscape as they represent the history of the area and are indicative of historical agriculture and grazing, especially during the ranching era.

Desired Condition of Native Grass Cover

Pastures at Pecos NHP are dominated by native grass species expected to occur in the vegetation community type. Based on the vegetation community type and consultation with subject matter experts (see Table A1-2), the NPS proposes that native grass cover is at least 50% of the total vegetative cover. However, specific percentages can vary and measurable limits for each site will be refined adaptively over time and informed by the review of grassland vegetation monitoring data. To avoid monocultures, no individual species should occur at >85% cover.

Desired Condition of Native Forb Cover

Pastures at Pecos NHP have a substantial component of native forbs that would be expected to occur. Based on the vegetation community type and consultation with subject matter experts, the NPS proposes that native forb cover is at least 20% of the

total vegetative cover. However, specific percentages can vary and measurable limits for each site will be refined adaptively over time.

Desired Condition of Shrub Cover

No more than 10% of the vegetative cover should be shrubs or subshrubs. However, the specific percentages can vary among vegetation community types and measurable limits for each site will be refined adaptively over time. The species of shrubs should also correspond to those species expected to occur for the given vegetation community type.

There are three desirable species of yucca: banana yucca (*Yucca baccata*), Navajo yucca (*Yucca baileyi*), and soapweed yucca (*Yucca glauca*) at Pecos NHP. These species are fire adapted and have the ability to resprout after fire events. Additionally, there are eight species of desirable cactus species: tree cholla (*Cylindropuntia imbricat*e), scarlet hedgehog cactus (*Echinocereus coccineus*), Fendler's hedgehog cactus (*Echinocereus fendleri*), rainbow cactus (*Echinocereus pectinatus*), nylon hedgehog cactus (*Echinocereus viridiflorus*), common beehive cactus (*Escobaria vivipara*), tulip prickly pear (*Opuntia phaecantha*), and plains prickly pear (*Opuntia polyacantha*) at the park. These species are not fire adapted, and populations should be considered when areas are being managed with fire.

Desired Condition of Tree Cover

In general, no more than 5% of the vegetative cover should be trees. However, the specific percentages can vary among vegetation community types and measurable limits for each site will be refined adaptively over time and informed by the review of grassland vegetation monitoring data.

This desired condition excludes the edges of pastures adjacent to drainages that have pinyon-juniper woodlands or ponderosa pine woodlands. More trees may be allowed to grow along drainages to stabilize soils and slow cut-bank erosion.

Desired Condition of Native Species Richness

Native grass and forb species richness (i.e., number of species) in maintained pastures/grasslands generally corresponds to the richness of native grass and forb species expected to occur. Based on vegetation community types, consultation with subject matter experts, and the fact that it is highly unlikely that the full complement of native species could be restored due to logistical challenges, the NPS proposes that native species richness is at least 60% of the native species historically present. However, the specific percentages can vary and measurable limits for each site will be refined adaptively over time.

Desired Condition of Bare Ground

No more than 30% of the ground cover should be bare ground.

Desired Condition of Transitioning Pastures

These pastures will be allowed to transition back to woodland through natural ecological processes. In southwestern states such as New Mexico, pinyon-juniper woodlands provide a variety of benefits, including ecosystem diversity, providing clean air, filtering water, and beautiful natural viewscapes (Romme et al. 2009). It is desireable for these areas to continue to support native grasses and forbs that will encourage native fauna and stabilize soils by limiting bare ground during this transition. It is expected that tree cover will increase over time, but trees should be managed to prevent high densities that result in too much bare ground. Pastures 3, 4, and 6 (areas of urban interface) will be allowed to be pastures or woodland savanna and a fire break will be maintained along the park boundary. In transitioning pastures that contain ponderosa pine groves, the park will maintain the current open stand conditions needed for healthy fire response. In transitioning pastures with high crown densities and potential for high severity fire, maintaining lower density should be considered to reduce the risk of high severity wildfire. Some areas of transitioning pastures will need to be managed as savanna woodland to lower crown density and avoid high severity fires. Decreases in tree density may also increase bare ground in these areas. Additionally, fuel reduction along park boundaries may include a buffer of 60–100 ft. Currently, Pecos NHP does not have data to determine the desired percent cover of vegetation types listed in this section. Vegetation plots within pinyon-juniper forest need to be established and monitored in the future to better inform desired conditions.

Desired Condition of Native Grass Cover

No more than 50% ground cover should be grass. Grass cover in transitioning pastures at Pecos NHP is dominated by native grass species expected to occur in grasslands or woodland savanna. This qualitative measure may be refined adaptively over time.

Desired Condition of Native Forb Cover

Transitioning pastures at Pecos NHP have a substantial component of native forbs. This qualitative measure may be refined adaptively over time. Based on the vegetation community type, the NPS proposes that native forb cover is at least 20% of the total vegetative cover.

Desired Condition of Shrub Cover

Shrubs or subshrubs are expected to be around 10% of vegetative cover for the given vegetation community type and will be a minor component of the vegetative cover. This qualitative measure may be refined adaptively over time.

Transitioning pastures have the same three desirable fire-adapted species of yucca and eight non-fire-adapted cactus species as Maintained Pastures/ Grasslands (see a list of these species under the Desired Condition of Maintained Pastures/ Grasslands section). The cactus species should be considered when areas are being managed with fire.

Desired Condition of Tree Cover

In general, more than 5% of the vegetative cover should be trees. The proportion of trees in the vegetative cover will increase through time due to natural ecological processes. Therefore, this qualitative measure may be refined adaptively over time through review of long-term monitoring data and based on experience or observed changes. This type of adapt-and-learn approach allows for the testing of assumptions, especially as it relates to avoiding tree densities and adjusting decisions and management actions on thinning that result in a bare ground understory that may lead to increased erosion or contribute to erosion.

Desired Condition of Native Species Richness

Native grass and forb species richness (i.e., number of species) in transitioning pastures/grasslands generally corresponds to the richness of native grass and forb species expected to occur. Based on vegetation community types, consultation with subject matter experts, and the fact that it is highly unlikely that the full complement of native species could be restored due to logistical challenges, the NPS proposes that native species richness is at least 60% of the native species historically present. However, the specific percentages can vary and measurable limits for each site will be refined adaptively over time.

Desired Condition of Bare Ground

No more than 30% of the ground cover should be bare ground.

Desired Condition of Pecos Pueblo and Spanish Mission Complex

This cultural site has high visitor traffic, which necessitates different vegetation management than the rest of the park. Limiting the height of vegetation improves sight lines, visibility of architectural mounds, and visitor safety. Plant cover helps to stabilize soil surface and prevent erosion, but care must be taken that the roots of surrounding vegetation do not harm cultural "deposits and features" and buried or surficial walls/architecture. Mechanical methods have the potential to damage the archeological records in these locations. The long-term, historically disturbed area encourages the establishment and spread of invasive plants. The Pecos Pueblo and Spanish Mission Complex will be surrounded by low-growing native vegetation that contributes to visitor safety and cultural preservation. No new trees should be allowed to grow within this cultural site.

Desired Conditions of Other Archeological Sites

Some archeological sites within the park will be interpreted to visitors and will require various safety considerations that could affect surrounding vegetation. Limiting the height of vegetation improves sight lines and visitor safety, and keeping trees from growing within cultural sites limits root damage to buried archeological features. Plant cover helps to stabilize soil surface and prevent erosion, but care must be taken that the roots of surrounding vegetation do not harm cultural features or artifacts. Historically disturbed areas can encourage the establishment and spread of invasive plants.

Desired Condition of the Glorieta Battlefield

Viewsheds along park trails will be preserved so that the battlefield can be interpreted to visitors. There will be fuels reduction activities within the urban/wildland interface to prevent high intensity fires. Native forbs and grasses will be encouraged to prevent encroachment of invasive plants and to reduce bare ground and erosion.

Desired Condition of Archeological Sites

Sites will be protected from erosion through selective native plant cover. The potential for medium- to high-intensity fire will be reduced to prevent damage to artifacts. New tree growth within many archeological sites will be limited through active management where possible.

Desired Conditions of Historical Orchard Trees

A small apple orchid near an old mill site is considered a cultural resource of interest. The trees, identified as an old variety of crabapple, are indicative of life in this area of New Mexico. While not currently accessible to visitors, the goal is to ensure that these trees remain for the future. It is desired that these trees remain in good health, resistant to disease, and able to withstand a low-level fire.

Desired Condition of Pinyon-Juniper Woodland

Pinyon-juniper woodland is a key habitat and a dominant vegetation type throughout the area. It also has historical importance as a source of timber and fuel wood. Despite its importance in the landscape, articulating its desired condition is problematic. Its natural structure and density can be highly variable, and periodic disturbances (e.g., fire, insect infestations, and disease) are a natural part of its life history, even if rare. Thus, for desired conditions, we focus on conditions outside of what is believed to be the natural variability (e.g., as a result of climate change), as well as some risk factors associated with the potential to impact other resources. The ongoing reforestation of the Pecos NHP landscape (see Transitioning Pastures above) is a natural ecological process that brings benefits in terms of biodiversity and carbon storage.

Desired Condition of Pinyon-Juniper Health

The overall desired conditions for pinyon-juniper woodland are fully functioning communities of plants (and animals) that each pinyon-juniper community supports. They should be resilient to disturbances that vary in intensity, duration, and size, while maintaining or sustaining the inherent complexity of the pinyon-juniper community type. Various age classes should be distributed throughout the stands. Old-growth persistent pinyon-juniper woodlands found east of the Pecos River should exhibit healthy growth with limited insects/diseases and minimal disturbance (Romme 2020).

Desired Condition of Insects and/or Disease

The desired condition is a level of insects and/or disease within a normal range.

Desired Conditions of Riparian Vegetation

The Pecos River and its tributaries form a riparian/wetland area that is one of the rare ecosystems in the arid southwest (Brown et al. 2018). Riparian areas in this region are of high ecological importance. Native trees, shrubs, and grasses help stabilize riverbanks, especially during high-flow events. Healthy wetlands store water, prevent flooding, improve water quality, and recharge groundwater (Wagner and Martin 2011). Riparian areas also provide unique habitats for a variety of wildlife species. In addition to the ecological importance of riparian vegetation, it is also quite significant in a historical context in Pecos NHP, determining building locations, circulation routes, and agricultural patterns (Brown et al. 2018). Additionally, soils in sandy loam bottomlands along riparian areas, particularly along the Pecos River and Glorieta Creek, were well suited and used historically for agricultural and adobe brickmaking.

Desired Condition of Riparian Woodlands

The desired condition is that an overstory of native vegetation reflects the species composition and age-class distribution of the riparian communities as they existed during the 1990s when the park acquired the land. The distribution of mature trees and associated reproduction rates should be sufficient to sustain the population. However, the specific desired percent cover or density of individual species is not well known. Thus, measurable limits of acceptable conditions will be determined adaptively over time. No more than 10% of the canopy cover should be invasive plant species. Streambanks should exhibit stability.

Desired Condition of Pecos Watershed Tree Populations of Importance

Cottonwoods are an important feature of the Riparian Woodlands and viewshed. They help prevent erosion and reduce damage from flash flooding. Additionally, riparian tree species assist in regulating stream temperature, filtering sediment, and providing a home to a variety of wildlife (Wagner

and Martin 2011). The desired condition of tree populations of importance is that cottonwoods exhibit a range of age classes and be protected from native beaver populations.

Desired Condition of Native Riparian Shrubs

There are a number of shrub species found in the riparian corridor, but native willows are of particular importance because they offer potential nesting sites for imperiled bird species like the Southwest Willow-Flycatcher (*Empidonax traillii extimus*). The desired condition of native willows is that streambank vegetation is comprised of willow communities that have root masses capable of withstanding high streamflow events. No more than 10% of the canopy cover should be invasive plant species. Streambanks should exhibit stability.

Desired Condition of Rush and Sedge Wetlands

The desired condition of rush and sedge wetlands is that native plant communities are restored to their former range and species composition, and woody stemmed densities and fuel loading are managed. Erosion is diminished or is under control and the health of the river and the surrounding watershed is sustainable and supports a healthy riparian and upland habit (NPS and PLHC 2011).

Desired Conditions of Rabbitbrush Shrubland

Rabbitbrush is a native upland shrub species found in drainage ways, alluvial terraces, and dry washes and is associated with long-term heavy disturbance (Muldavin et al. 2012). The desired condition for this spatial unit is to maintain its presence where it would naturally occur based on major vegetation types and in locations where it occurs due to historical Forked Lightning Ranching activities. However, further spread into grassland/pastures should be limited. Specific desired conditions for this spatial unit include those applicable to all areas and that are determined to be appropriate for rabbitbrush shrubland related to their health and natural range of variability.

Desired Conditions of Ponderosa Pine Forest and Woodland and of Douglas-fir Forest

These units in general have closed canopies and are located on steep slopes and in canyons. The desired condition for this spatial unit is to maintain its presence where it would naturally occur based on major vegetation types. Specific desired conditions for this spatial unit include those that are appropriate for ponderosa pine communities related to their health and natural range of variability. Generally, the park does not plan on implementing treatments in this major vegetation type beyond minor thinning for fire protection of ponderosa pine stands.

Desired Condition of the Viewshed

In addition to their scenic quality, the viewsheds at Pecos NHP are essential for visitor understanding of the role of Pecos as a historical "gateway" between the Great Plains and the Rio Grande Valley; and especially for understanding the effects of environmental change and modifications to vegetation communities over different time scales, including the Pueblo, Spanish Colonial, and modern ranching eras. (NPS 2015a).

From a vegetation management standpoint, maintaining the visual landscape to convey the historical setting entails having a mosaic of vegetation communities that reflect the communities that likely would have been present during the periods of significance, although our knowledge of these conditions is poor as we go further back in time. Heavy human use of the Pecos woodlands prior to 1900 (Romme 2020) would have impacted viewsheds and vegetation communities, as would pasture clearing during the Kozlowski/Forked Lightning Ranch era from the 1850s to 1970s.

The Pecos Pueblo was deliberately built on a hilltop, likely in part because it commanded expansive views of the surrounding area, including views between settlement areas and agricultural fields (Cowley et al. 1998). The site has distant views of the Sangre de Cristo Mountains, Tecolate Range, and Rowe Mesa. Similar arguments are made for the views from other key settlements such as Kozlowski's Trading Post and Forked Lightning Ranch. For the latter, a principal feature of the main ranch house is its expansive views south along the Pecos River corridor and north of the Sangre de Cristo Mountains (Brown et al. 2018). Kerr et al. (2022) provide a detailed analysis and identification of important viewsheds that inform the vegetation treatments within this plan. The desired condition is a mosaic of vegetation community types, including pastures and woodlands, that is representative of the periods of significance, understanding that the proportion of grassland to woodland in Pecos NHP varied during different historical eras. Dominant plant species should be

ones expected to be dominant given the vegetation community. In visitor use or interpretive areas associated with Forked Lightning Ranch, the desired condition is for viewsheds of open pastures and woodlands that are representative of the historical ranching era. Within the Glorieta Unit important viewsheds that may need to be maintained or established are associated with the Battle of Glorieta Pass to better interpret the battle to the public.

Desired Condition Related to Fire

The following information about fire as an ecological process in the pinyon-juniper woodlands in Pecos NHP is from an assessment of pinyon-juniper woodlands (Romme 2020):

> *Many southwestern ecosystems have been substantially altered by more than a century of fire exclusion, notably ponderosa pine forests (e.g., Allen 2002; Covington and Moore 1994). It has been suggested that the pinyon-juniper woodlands of Pecos NHP may have been similarly affected by a lack of periodic natural burning, but this may be unlikely, for two reasons. First, most pinyon-juniper ecosystems are not characterized historically by the kinds of frequent, low-severity fires that are so important in ponderosa pine forests (Romme et al. 2009). The fuel structure of Pecos NHP's pinyon-juniper woodlands lacks the abundant grass and other herbaceous fine fuels that carry fires through ponderosa pine forests. Instead, herbaceous fuels in pinyon-juniper woodlands tend to be patchy and discontinuous. Consequently, even if a fire is ignited, it tends to burn only a single tree or only a small group of trees, unless ignition occurs under very dry conditions with very strong winds when the fire may spread from tree crown to tree crown and may kill trees over a large area. Intervals between fires of any substantial extent or severity in pinyon-juniper woodlands like those at PECO tend to be measured in decades or centuries, after which recovery tends to be very slow (decades or centuries; Romme et al. 2009). I saw no evidence of any extensive severe fire having occurred in PECO's woodlands during the last 100+ years.*
>
> *The second reason why I think that 20th-century fire exclusion has not greatly altered the "natural" structure and dynamics of PECO woodlands is that we find no evidence that fire was important historically. I looked for basal fire scars on living trees, snags, and large downed wood wherever I traveled in the park. I found no fire scars; neither did the field workers who produced the park's vegetation map (Muldavin et al. 2012). Of course, the absence of fire scars created by fires prior to the 20th century may not indicate an absence of historical fire in the woodlands of the western part of the main park unit, because nearly all of the old trees and other woody material that would have contained fire scars was harvested by settlers and travelers in the mid to late 1800s and early 1900s. But the absence of fire scars in the old woodlands east of the Pecos River is significant, because that area contains centuries-old trees and very old, downed wood—and almost no evidence of past fire.*

The Romme (2020) assessment also reported:

> *I saw no evidence of fire—no basal fire scars on the trees, no char on old fallen wood, no charred snags, aside from one small charred stump in a canyon bottom at a location where several other stumps had been cut and partially removed, apparently for fuel wood. The ecologists who developed the park vegetation map made the same observation: despite searching specifically for fire-scarred trees, none were found (Muldavin et al. 2012).*

A wildfire that crosses park boundaries could be potentially catastrophic. A fire within the park could spread out of the park and threaten adjacent private lands or a fire ignited outside the park could spread into the park and threaten vulnerable resources (Romme 2020).

Desired Condition of Fire Risk of Adjacent Lands

The desired condition is that fires that started outside the park will not spread into Pecos NHP and vice versa. This can be achieved using fire suppression actions, such as fire breaks along boundaries and around structures. Fire breaks and fuel reduction may include fire suppression actions, such as periodic mowing along park boundaries and roadways.

Desired Condition of Fire Risk to Buildings and Structures

All park buildings and structures that could be damaged by fires will be managed for protection using Firewise standards, which may include a 0–200 ft mixed buffer. The National Fire Protection

Association Firewise standards includes three zones of management. The Immediate Zone (0–5 ft), the Intermediate Zone (5–30 ft), and the Extended Zone (30–200 ft). Each zone has its own management recommendations for influencing fire activity. More information is located at www.NFPA.org. Additionally, information on the International Wildland-Urban Interface codes and guidelines is located at https://codes.iccsafe.org/content/IWUIC2018P3/chapter-6-fire-protection-requirement.

Desired Conditions Applicable to All Locations

Desired Condition of Invasive Species

Invasive species, especially high priority noxious species that are a threat to native plant communities, constitute a small portion of the overall vegetative cover. Based on consultation with subject matter experts, the NPS proposes that no more than 10% of the vegetative cover is invasive species. However, the specific percentages can vary among major vegetation community types and measurable limits for each site will be refined adaptively over time.

Desired Condition of Exposed Bare Ground and Erosion

Little or no soil erosion beyond that which occurs naturally is desired. Minimizing soil erosion is best achieved when there is sufficient vegetative cover to buffer against wind and water erosion. The extent of bare ground is a good indicator of the overall susceptibility to accelerated wind and water erosion (Gutierrez and Hernandez 1996; Pellant et al. 2005). Based on major vegetation types and consultation with subject matter experts, the NPS proposes that less than 30% of cover is exposed bare ground. However, the specific percentages can vary among major vegetation community types and measurable limits for each type will be refined adaptively over time.

2.4 Management to Achieve Desired Conditions

The NPS will implement management actions related to invasive plants, pastures, riparian vegetation, pinyon-juniper woodlands, prescribed fire and fire abatement, restoration, and the historical orchard to achieve and maintain desired conditions for Pecos NHP vegetation.

Archaeological Site Management

Treatment prescriptions (Kvamme 2019) are complete for some priority archeological sites and began in 2021. Each site has its own specific prescription for clearing and/or thinning. Trees and shrubs, regardless of species, that threaten the integrity of the site will be removed. Thinning will be done to reduce the likelihood of medium- to high-intensity fires that could damage sites and reduce their integrity. Seedlings growing within walls and archeological features will also be removed before they damage the sites. All treatment prescriptions are recommendations, and each archeological site is unique. Treatment prescriptions may change based on observations and recommendations from Pecos NHP archeologists or the Pueblo Parks Fire Group.

Invasive Plant Management

This plan uses the federal definition of invasive species per Exec. Order 13751 as discussed in section 1.3: “Invasive species” means, with regard to a particular ecosystem, a non-native organism whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health.

Prevention, early detection, rapid response, and treatment all contribute to invasive plant management.

Prevention

Prevention is the first step in invasive plant management. Methods and best management practices (BMPs) for preventing the spread of invasive plant species have been extensively studied and have been well-documented in the multi-agency report Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers (California Invasive Plant Council 2012). BMPs are the techniques to meet a goal most effectively (such as decreasing introduction and spread of invasive plants) while making the best use of staffing, supplies, etc.

A key principle of prevention is stopping the movement (spread) of new and existing invasive plant materials and/or seeds. It is important to prevent new invasive species from becoming established in the park. It is more cost effective to prevent a new species from becoming established than managing well-established populations. It is also important to prevent existing invasive species

populations from spreading to new areas of the park. To accomplish this, park staff will explicitly use the following techniques to prevent the introduction of new invasive species into the park and the spread of existing populations into new areas of the park:

1. Regularly clean park vehicles and equipment to reduce the movement of weed seeds.
2. Limit the amount of land disturbance during project and construction activities.
3. Conduct revegetation of disturbed areas through hydroseeding and mulching for projects that disturb large areas or are in areas surrounded by invasive plants. Funds for revegetation of disturbed areas must be included in project budgets.
4. Incorporate invasive plant assessments, prevention, and management planning into park projects.
5. Practice Early Detection and Rapid Response to prevent new invasive plant infestations.
6. Use other practices to be determined as opportunities arise.

Effective BMPs can reduce future costs, herbicide use, and protect native plant, wildlife, and insect habitat (California Invasive Plant Council 2012).

Early Detection Rapid Response

Early detection and rapid response is a key prevention principle of invasive plant management. Early detection of new species enables rapid response for species of concern before they become well established.

The following actions will be used for early detection:

1. Systematic monitoring conducted by the Southern Plains Network (Folts-Zettner et al. 2016, 2017; and Gwilliam et al. 2018).
2. Targeted inventories and opportunistic observations by Pecos NHP staff and the Southwest Invasive Plant Management Team.
3. Repeated surveys of known newly disturbed areas to identify and treat new infestations before they take hold. Construction, utility, and other project areas typically have some sort of ground disturbance associated with them.
4. Periodic surveys of known vectors both outside and within the park, such as roadsides and pullouts/parking areas.
5. Reviewing the New Mexico Noxious Weeds List (NMDA 2020) annually to see if there are any new species to look out for in the park.

Once initially detected, invasive species of concern will be treated as soon as possible using methods described in the next section.

Invasive Species Treatments

The following are techniques to control patches of invasive species:

- Chemical treatment (spot treatment with herbicides)
- Mechanical treatment (weed eaters, brush cutters, or chainsaws)
- Manual treatment (hand pulling or hand tools)

The principles of integrated pest management guide the park on which techniques are best for managing an invasive species. All invasive species are considered pests. Pests are defined as organisms (both native and nonnative) that can damage park infrastructure or resources or that threaten human health or safety (NPS 2021a). The principles, listed on the USDA National Invasive Species Information Center (USDA 2022), are the following:

- Identify pests, their hosts, and beneficial organisms before taking action.
- Establish monitoring guidelines for each pest species.
- Evaluate and implement control tactics.
- Monitor, evaluate, and document the results.

Evaluating which control technique to use depends on a variety of factors. Techniques should be weighed against their desirable or undesirable effect on the environment that is being managed (DiTomaso et al. 2013) and on cultural resources including archeological sites, cultural landscapes, and ethnographic resources. Species control options should be researched for effectiveness and be chosen based on which ones have higher chances of success and meeting management goals.

Chemical Measures

Herbicide application is currently a primary treatment for invasive plant management at Pecos NHP. Treatments with herbicide have been used in the park since 2005, primarily by park staff and Invasive Plant Management Teams. Herbicides, rates, and timing are unique to each plant species. Herbicide applications are made based on label and literature recommendations. All herbicides used will be applied under the supervision of a licensed applicator and be approved by the NPS regional office using the Pesticide Use Proposal System (PUPS; NPS 2014). No herbicide will be applied where surface water is present unless directly specified as an appropriate application in the herbicide label.

Tools and Techniques

Tank Spraying: Depending on access to and size of the area to be treated, foliar chemical application will be done with a backpack sprayer. Occasionally, a UTV- or truck-mounted sprayer may be used. A maximum of 150 acres (61 hectares) per year will be treated with herbicide with the assistance of conservation crews and Invasive Plant Management Teams. Otherwise, approximately 20 acres (8 hectares) is likely to be treated by park biologists each year.

Cut Stump: Occasionally, encroaching trees will be cut down with handsaws, chainsaws, or loppers. The stumps of encroaching trees will then be sprayed with herbicide to prevent re-sprouting. Cut stump herbicide treatments will typically occur on less than 1 acre (0.4 hectares) and no more than 3 acres (1.2 hectares) on a yearly basis. This management method will be used periodically.

Hack and Squirt: In instances where a tree is in the backcountry or an area inaccessible to visitors, an encroaching tree will be girdled using a chainsaw, axe, or handsaw. Herbicide will then be sprayed or wiped into the cambium to prevent re-sprouting. Hack and squirt invasive plant control will typically be used on 1 acre (0.4 hectares) or less on a yearly basis. This management method will be uncommonly used.

Timing

The vast majority (>95%) of chemical treatments at Pecos NHP will occur during the early growth stage when plants are <6" tall in April through August. In rare circumstances, such as for invasive winter annual brome species (e.g., cheatgrass [*Bromus tectorum*], etc.), application may occur in late fall/winter in the pre-emergent stage, usually just prior to a rainfall or snow event.

Frequency

The frequency of herbicide application is dependent on species and herbicides. At Pecos NHP, there is typically a spring flush and midsummer flush of plants from the monsoon rains. Therefore, herbicides typically must be applied twice each year.

Site Locations

The most commonly treated areas will be kochia populations within disturbed areas, patches of invasive plants in maintained pastures/grasslands and transitioning pastures, associated roads, near buildings, and invasive plants along the riparian areas. Cut stump and hack and squirt treatments will be applied to individual trees along riparian areas.

> **NOTE:** Foliar application of herbicide should have no effect on Birds of Conservation Concern, as listed by the US Fish and Wildlife Service (see Attachment 1). If any animal breeding activity is observed in riparian areas, work will not occur in the area. No tree or shrub with nesting activity will be removed at any time.

Mechanical Measures

Park staff will continue to use mechanical measures to physically remove invasive plants or plant parts (flowers, stems, seed heads, etc.). Mechanical measures include the following.

Mowing

Mowing is a mechanical treatment used for invasive plant management at Pecos NHP, primarily by facilities division staff around trails, roadsides, parking areas, buildings, and utilities. Mowing is also used for aesthetic purposes, to reduce shrub encroachment, to reduce fire hazards by removing fuels, and to provide for visitor safety by increasing visibility of uneven ground surface features or dangerous wildlife, such as venomous snakes. The specifics of when and how mowing is used depends on a variety of factors, including protection of cultural resources. Therefore, permission must be given by the park archeologist prior to activity.

Tools and Techniques: Equipment may be a mower assembly pulled by a tractor (typically used along roadways), a traditional lawn mower (typically used for lawns in developed areas and sides of the trails), a string trimmer (typically used before seed head production), and a brush cutter (typically used on brushy weeds too thick to use a string trimmer on).

Timing: Mowing typically occurs in late spring through late summer, depending largely on plant growth and phenology. Mowing is based on plant height when done for aesthetics, fuel reduction, and visitor safety. Mowing for invasive plant management is based on plant phenology and is conducted before seeds have matured and become viable.

Frequency: Mowing frequency depends on plant growth. In years of good rainfall and high plant growth, mowing may need to be conducted several (3–4) times per year, whereas once or twice may be enough in years of low rainfall. Mowing in preparation for special events usually takes place throughout the year. Approximately 15 acres (6 hectares) will be mowed each year and no more than 30 acres (12 hectares) will ever be mowed in a year. The potential exists for mowing to occur during the breeding seasons of some Birds of Conservation Concern (see Attachment 1). If breeding activity is observed, work activities will shift to another location. No shrubs will be cut where bird breeding or nesting occurs.

Site Locations: Mowing locations include along roadways, parking areas, interpretive trails, utility systems (leach fields) and lawns associated with the visitor use, historical buildings, and staff facilities. Sites used for special events will be mowed only on an as-needed-basis. Areas of monocultures (or near monocultures) of kochia where past disturbance occurred will also be mowed. Current mowing locations include near the headquarters and maintenance buildings, the pasture south of headquarters (Pasture 1), the Fire Camp Area, around and on utility systems such as pump houses and leach fields, Kozlowski's Trading Post, Pigeon's Ranch structures, the South Pasture Loop Trail, the two-track between headquarters and the trading post, and at the Pecos Pueblo and Spanish Missions Complex area along trails and around the interpreted ruins and structures.

Chainsawing

Chainsawing will be used at Pecos NHP for the removal of invasive trees such as the small populations of Russian olive (*Elaeagnus angustifolia*), saltcedar (*Tamarix ramosissim*a), and Siberian elm (*Ulmus pumila*) throughout the park. (See Cut Stump and Hack and Squirt in the Chemical Measures section.

Tools and Techniques: Chainsaws will be used to cut down or girdle invasive and encroaching trees.

Timing: Removal of invasive and encroaching trees with a chainsaw will occur at any point during the year.

Frequency: Management of invasive and encroaching trees with a chainsaw will occur infrequently, on no more than 15 days per year.

Site Locations: Sporadic invasive and encroaching tree populations along roadsides, riparian areas, disturbed sites, and structures.

Weed Eaters and Brush Cutters

The use of weed eaters and brush cutters are also important in the mechanical treatments used for invasive plant treatment at Pecos NHP, especially for the control of kochia.

Tools and Techniques: Weed eaters and brush cutters will be used to control patches of invasive plants. Brush cutters are primarily used when plants like kochia stems become too thick to be cut with string trimmers. Weed eaters and hand tools will be used in patches of invasive vegetation when terrain limits access by brush cutter or cultural resources could be damaged by heavier equipment. If weed whacking in areas with artifacts or stone features on the surface, hitting the ground with tools should be avoided.

Timing: The timing will depend on the phenology of the selected invasive plant. It's best used when the plant has mature growth but prior to setting seed.

Frequency: Removal of invasive plants with weed eaters and brush cutters will occur no more than 3 weeks per year.

Site Locations: Within all sites as needed.

Manual Measures

Park staff will continue to use manual measures to physically remove invasive plants or plant parts

(flowers, stems, seed heads, roots, etc.). Manual measures include the following techniques.

Hand Tools: The use of hand tools is important in the manual treatments of invasive plants at Pecos NHP. Handsaws and loppers will occasionally be used to control sporadic encroaching tree populations.

Tools and Techniques: Hand tools will be used in patches of invasive vegetation when terrain limits access by brush cutter or cultural resources could be damaged by heavier equipment.

Timing: The timing will depend on the phenology of the selected invasive plant. Its best used when the invasive plant has mature growth but prior to setting seed.

Frequency: Removal of invasive plants with manual measures will occur no more than 2 weeks per year.

Site Locations: Within the landscape in all sites as needed.

Hand Pulling: A few invasive plant species can feasibly be treated via hand pulling in certain circumstances. For example, park staff may pull rare, isolated plants opportunistically. However, these types of activities can disturb archeological sites that are common throughout the park. Permission must be given by the park archeologist prior to this activity.

Tools and Techniques: Hand pulling invasive plants without the use of tools.

Timing: Timing will typically occur from February through September and is largely dependent on plant phenology and monsoon weather conditions.

Frequency: Hand pulling will typically be infrequent and a maximum of 25 acres (10 hectares) will be pulled per year.

Site Locations: Hand pulling could potentially occur anywhere within the park except archeological sites.

Tree Encroachment Management

Historical pastures will be maintained by removing all or nearly all of the encroaching native trees. Archeological sites will also be protected by removing encroaching trees.

When clearing trees within maintained pastures/grasslands, juniper is the priority species for removal regardless of size because pinyon pine trees are more susceptible to climate change impacts than juniper trees. Pinyon pine trees will also be removed from maintained pastures/grasslands unless they are taller than 6 ft. Trees taller than 6 ft are infrequent in the pastures and it takes longer to cut them down, buck them up, and haul the slash off site. Both juniper and pinyon pine trees growing in or around arroyos will not be removed since the roots of these trees help stabilize soils and reduce erosion.

During management actions, ponderosa pine and Douglas-fir trees will be preserved in maintained pastures/grasslands as they have excellent habitat value and are rare in the park. Some pinyon pine and juniper will also be left in pastures to provide bird habitat. If significant encroachment or expansion of ponderosa pine into maintained pastures/grasslands occurs in the future, the park may choose to remove these from this spatial unit.

A variety of tools are available, depending on the size of trees and locations of treatment areas and archeological sites. Prescribed fire, chainsawing, mastication, brush cutting, handsawing, and lopping can be effective at removing encroaching trees. Prescribed fire is described in detail in the Fire Abatement section. However, based on the results of prescribed burns within pastures between 2005 and 2015, it appears that most of these fires did not burn hot enough to kill pinyon pine and juniper trees or stop encroachment.

Herbicide application is generally not necessary during management of colonizing trees since pinyon pine and juniper do not typically resprout.

Mechanical Measures

Park staff will continue to use mechanical measures to physically remove trees encroaching on maintained pastures/grasslands, archeological sites, and firebreaks along the park boundary. Mechanical measures include the following.

Chainsawing

Chainsawing will be used at Pecos NHP for the removal of native trees encroaching on historical pastures and archeological sites.

Tools and Techniques

Chainsaws will be used to cut down colonizing trees as close to the ground as possible.

Timing

Removal of colonizing trees with a chainsaw will occur at any point during the year.

Frequency

Management of trees encroaching on maintained pastures/grasslands or those within maintained archeological sites will occur no more than 60 days per year.

Site Locations

Maintained pastures/grasslands and archeological sites.

Brush Cutters

The use of brush cutters is important in the mechanical treatments of trees encroaching on maintained pastures/grasslands and archeological sites at Pecos NHP.

Tools and Techniques

Brush cutters can be utilized to cut down colonizing trees in the maintained pastures/grasslands before they reach 1 ft tall.

Timing

Removal of colonizing trees will occur at any point during the year.

Frequency

Management of trees enroaching on maintained pastures/grasslands or those on maintained archeological sites will occur no more than 30 days per year.

Site Locations

Maintained pastures/grasslands and archeological sites.

Mastication

Mastication is the removal of trees or shrubs utilizing a forest masticator machine. Trees are typically removed and mulched where they stand. It requires less staffing than removal with saw crews, however, it creates a lot more disturbance to the soil. Masticators should never be used to remove trees in archeological sites. Between 2005 and 2009, most of the park's historical pastures were cleared using masticating machines. There are no current plans to use masticators. However, if they were used again, it will be in the maintained pastures/grasslands spatial unit outside of archeological sites and in fire breaks along the boundary fences and wildland/urban interfaces.

Tools and Techniques

Masticator machines will remove and mulch trees in place.

Timing

Weather permitting, removal of encroaching trees will occur at any point during the year.

Frequency

As needed.

Site Locations

Maintained pastures/grasslands or fire breaks, excluding archeological sites.

Manual Measures

Park staff will continue to use manual measures to physically remove seedlings of encroaching trees in maintained pastures/grassland and archeological sites. Manual measures include the following.

Hand Tools

The use of handsaws and loppers are important in the mechanical treatments of trees encroaching on maintained pastures/grasslands and archeological sites at Pecos NHP.

Tools and Techniques

Handsaws and loppers will occasionally be used to remove colonizing trees from maintained pastures/grasslands and archeological sites.

Timing

Removal of colonizing trees will occur at any point during the year.

Frequency

Management of trees enroaching into maintained pastures/grasslands or those within maintained archeological sites will occur no more than 30 days per year.

Site Locations

Maintained pastures/grasslands and archeological sites.

Tree and Tree Waste Removal

The following are the preferred tree removal techniques in order of priority:

1. Chainsaw removal of trees less than 6 ft tall by crews.
2. Use of handsaws and loppers by crews to remove trees less than 6 ft tall.
3. Brush cutting to remove trees before they reach 1 ft tall.
4. Use of prescribed fire to remove encroaching trees or shrubs in areas that will be maintained as historical pastures (also see Fire Abatement section).
5. Mastication of trees using heavy machinery.

The following are the preferred tree waste removal techniques in order of priority:

1. Chip or pile debris directly into a dumpster and haul away when area is near roads.
2. Burn piled material (when feasible).
3. Lop and Scatter (when debris density is high, scattering on erosive hillsides and banks of eroding riparian areas is preferred). Slash should not be dragged in archeological sites.

Hazard Tree Management

Currently the park biologist oversees detection, assessment, and corrective action of hazard trees in the park's frontcountry and developed areas (buildings, parking areas, commonly used roads, etc.). The main objective of the program is to "protect the safety of park visitors, employees, and property from hazard trees." All information related to the Hazard Tree Plan is in the document titled Standards and Protocols for Hazard Tree Management: 2019 Pecos NHP (NPS 2019).

Tools and Techniques

A variety of tools are available, depending on size and location of the hazard tree. Chainsaws, pole saws, pruners, and reciprocating saws are effective at removing or limbing hazard trees.

Timing

Removal or limbing should happen immediately if the tree is a safety issue. Generally, pruning should occur in late winter for hardwoods and the spring for evergreens. Pruning recommendations of each species will be consulted prior to pruning and limbing.

Frequency

As needed.

Site Locations

All priority locations are identified in the Hazard Tree Plan and are mostly in visitor use areas and near buildings.

Caging Exclosures for Beaver

The NPS will manage beaver exclosure caging to maintain riparian woodlands and beaver habitats. Cottonwood galleries along the Pecos River and Glorieta Creek are a valuable part of the historical viewshed. Beavers are also a part of the landscape, so caging select trees has been chosen as the least impactful method to preserve cottonwood and other trees of value to the park. Exclosure cages will be maintained on all mature cottonwood trees within the viewshed of the ranch house and Colonias bridge (approximately a half-mile stretch), all historical apple orchard trees, and other trees to preserve age class diversity within populations. On all other areas of Glorieta Creek and the Pecos River, only half of existing caging will be maintained, and the rest will be removed. No other species will be enclosed except in cases of cultural or special significance.

Tools and Techniques

Existing exclosure cages around living cottonwoods and historical apple trees will be evaluated and enlarged, repaired, or removed if necessary. Some additional young cottonwoods may also be caged to promote more age class diversity than what currently exists in the mostly mature cottonwood populations. Caging will be removed from dead and down trees.

Timing

This activity can occur at any time of the year.

Frequency

Assess yearly to ensure proper sizing and need for additional exclosures. Caging needs to be removed or adjusted once the caging is too small for the tree to prevent injury to the tree.

Site Locations

Beavers are currently active along the Pecos River and inactive along Glorieta Creek, but beaver exclosures will be managed along both drainages.

Fire Mitigation

Site Locations

Primarily in maintained pastures, urban interface pastures, and possibly transitioning pastures if needed for fire abatement and archeological site protection.

Managers will consider anthropogenic changes in disturbance regimes due to climate change, most notably changes in fire regimes, diseases and pathogens, and insects, as well as excessive risk to historical features and adjacent lands from fuel buildup and fire potential in planning fuels treatments

Fuel Breaks

Fuel breaks create and maintain a certain stand density and their locations can be selected strategically.

Pasture Fuel Breaks: Some areas, such as the mostly open pastures near urban interface areas may require some thinning of existing trees 60–100 ft from the boundary or a broader range as needed. These fence lines have been clear-cut in the past by NPS fire crews and will continue to be managed as such due to their proximity to urban areas. Examples of these areas are the northern boundaries of pastures 3 and 4 (northern boundary of the Pecos Unit) and the western boundary of pasture 6.

All park (including Pigeon's Ranch and Canoncito subunits) buildings and structures that could be damaged by fires will be managed for protection, which may include clearing a 0–200 ft buffer around structures/buildings.

Shaded Fuel Break: More heavily timbered areas near urban interface and park boundary fences or other priority areas may be managed as shaded fuel breaks where trees are thinned and/or limbed to reduce fire potential. Examples of this include the following:

- Pinyon-Juniper Forest along the fence line of Highway 63.
- Along both sides of Old Denver Highway and the park property between Old Denver Highway and Interstate 25.
- Along both sides of Highway 50 within the Pigeon's Ranch Subunit.
- Portions of boundary fence line near pastures 3, 4, and 6 that are urban interface and are not being maintained as pastures.
- Pigeon's Ranch and Canoncito subunit boundary fence lines and inholding boundaries.
- Overall thinning of juniper within the Ponderosa Pine Forest within the Pigeon's Ranch Subunit.
- A shaded fuel break along the main unit of the park boundary is potentially feasible, but it will require a brush disposal and maintenance plan.

In all other boundary areas of the park and along trails and interior roads, trees will be thinned to maintain the fence line, trail, or road only. Fuel breaks along the NE, E, and SE portions of the Pecos Unit are not practical to implement clear-cut or shaded fuel breaks. Fuel breaks would not necessarily be effective in preventing a fire from spreading into those areas due to high tree density and canopy density. For the Canoncito and Pigeon's Ranch subunits, trees will only be thinned to maintain fence lines except in areas with park structures and that are urban interface. The Pigeon's Ranch Subunit will most likely utilize more shaded fuel breaks compared to the other units due to terrain, dense forests, and patchwork of private inholdings.

Thick stands of pinyon-juniper within the interior of the park will remain, except around culturally important areas or where density and size warrant management.

In some areas, fire management will utilize natural features (slope, aspect, and vegetation), natural fuel breaks, and existing roads and trails for perimeter control.

Tools and Techniques

Saw crews, and to a lesser degree, mastication machines, will be utilized for tree removal and limbing. Slash will be disposed of by pile burning or chipping and hauling away.

Timing

Weather allowing, removal and thinning can occur at any time of the year.

Frequency

As needed.

Site Locations

Structures/buildings, interior fence lines, along highways, urban interface, some boundary fence areas.

Prescribed Burns

The plan includes adoption of the general approach of using prescribed fire to restore and maintain upland vegetation and will be adaptively refined to ensure that objectives for vegetation management and cultural resource protection are met. Prior to any ignition of burn units, a burn plan will be developed by the Pueblo Parks Fire Group, and the Pecos NHP Superintendent will approve prescribed burn plans. Prescribed fire unit boundaries will utilize natural features (slope, aspect, and vegetation), natural fuel breaks, and existing roads and trails for perimeter control.

Whenever possible, burning will be conducted outside the nesting season of Birds of Conservation Concern. If breeding or nesting activities are observed, vegetation/trees will not be burned. Burning will not be done within known archeological sites or within cultural landscapes without approval by the park archeologist and additional NHPA compliance or SHPO consultations.

Tools and Techniques

Construction of perimeter fire control lines will be evaluated for impacts to natural and cultural resources. Ignitions will be primarily conducted with hand drip torches.

Timing

Ignition will occur throughout the year under specified conditions that allow resource objectives to be met.

Frequency

The frequency of prescribed fire will be based on the condition of the resource as indicated above. Given the typical rate of resource condition change, burns are unlikely to be more frequent than every 5 to 10 years. Prescribed burning will be limited to a maximum of 400 acres (162 hectares) per year.

Site Locations

Prescribed burns are very unlikely at the park because of fuel carrying limitations of the vegetation/bare ground but are more likely to be used in historical pastures or the few natural meadows that exist within the park.

Resource Conditions That May Warrant the Use of Prescribed Fire

Risk to Other Resources

The amount of downed fuel and/or standing biomass has reached a point where the risk of an unacceptable wildfire damage to historical features, structures, or adjacent lands outweighs the risks of a prescribed fire.

Shrub and/or Tree Encroachment

Excessive tree or shrub encroachment into maintained historical pastures that are targeted to be maintained as open pastures to preserve historical viewsheds.

Rejuvenation/Decadence

When excessive lack of vigor and/or dead centers are present in grasses in pastures/grasslands. Also, when dead standing biomass, particularly from invasive plants, is high enough to preclude effective light penetration for native plants or otherwise limits native plant vigor or recovery.

Excessive Litter Accumulation

Litter buildup exceeds that expected for a given major vegetation type.

Other Considerations

The three desirable, fire-adapted species of yucca and eight desirable, non-fire-adapted cactus species should be considered when planning any prescribed burns (see a list of these species under the Desired Condition of Maintained Pastures/Grasslands subheading in section 2.3).

Restoration

The park will restore areas of degraded vegetation to native plant communities. Restoration of native vegetation is often a complex process that typically begins with conceptional planning, site assessment, and identification of reference conditions (Pannebaker et al. 2017). It may entail multiple applications of the treatments, as well as long-term

maintenance and monitoring of the restoration site. Together, the entirety of a restoration project may take decades (Pannebaker et al. 2017).

Collection, seeding, and transplanting are the three restoration activities that may be used at Pecos NHP. This could be done anywhere needed within the park. Restoration activities will have little or no negative effect on Birds of Conservation Concern and could have benefits for bird species.

Seeding will typically be used for restoration activities associated with disturbance or removal of invasive plants. Seeding is typically done as part of a restoration effort but can also be done to augment existing communities to increase plant species diversity. Seeding can be done in smaller areas via hand broadcasting. Seeding may also be done in patches ("islands") so that native species may spread out from the seeded island (Pannebaker et al. 2017). Recently, hydroseeding has proven to be the most effective way to restore accessible, disturbed sites with native seed. Hydroseeding is an alternative to direct seeding that utilizes a wet slurry of seed and mulch. The Trading Post courtyard and leach field are examples of successful restoration with hydroseeding at the park. Supplemental watering may be needed to ensure seeding success.

Transplanting may be used on occasion and will typically be done by hand using seedlings transplanted from the site or propagated in greenhouses. Planting and transplanting will typically be done in the fall to take advantage of cooler temperatures.

Tree Management in the Historical Orchard

A historical apple orchard of approximately 30 trees is located along the banks of the Pecos River near the northern boundary of the main Pecos Unit of the park. Aside from its association with a historical mill site, its history is not fully known. It has been actively maintained since 2020. The apple trees in the orchard have been evaluated by Santa Fe County NMSU Extension Agent Tom Dominguez who made several recommendations to revitalize the population and maintain them as part of the historical landscape. The historical orchard trees will be maintained by watering, pruning, and fertilizing (Tom Dominguez, NMSU Santa Fe County Cooperative Extension, personal communication). Recommendations include the following:

- Prune all dead branches and any branches rubbing into each other. Pruning can be done in winter during tree dormancy, usually up until March.
- Trees should be watered several times between May and August each year. Build berms around trees, if possible, to hold water.
- Focus on watering and pruning healthier trees at the southern end of the orchard.
- Consider adding fertilizer high in nitrogen in the spring and adding fertilizer high in phosphorus in the fall.
- Consider propagation from cuttings on the oldest trees that are dying (northernmost trees) and graft onto rigorous root stock.
- Remove shrub and tree competition around each tree (approximately 10 ft radius).
- Collect apples in the fall for identification.
- Create a detailed Orchard Inventory documenting location, health, etc.

2.5 A Strategic and Adaptive Approach to Vegetation Management

Management of Spatial Units and Vegetation Community Types

Under this plan, vegetation management actions will be tailored to the specific conditions of each spatial unit (Table 2-1). Table 2-1 also describes how each spatial unit currently differs fromt the desired condition and presents potential management actions that will be considered to move the unit toward the desired condition.

Table 2-1. Vegetation management spatial units planned for Pecos National Historical Park. Attributes of each unit that depart from desired conditions are identified along with a description of the departures and potential management actions that will be considered to move the unit toward the desired condition. This table is meant to aid assessment of how an area departs from a desired condition and how to address the departure. This table may need editing over time depending on present and future conditions.

Spatial Unit	Departures from Desired Conditions	Description of Departures	Potential Management Actions to Meet Desired Conditions
Maintained Pastures	Invasive Plants	Scattered patches of invasive plants like Russian thistle (*Salsola tragus*), kochia (*Bassia scoparia*), yellow sweetclover (*Melilotus officinalis*), Scotch thistle (*Onopordum acanthium*), common mullein (*Verbascum thapsus*), hoary cress (*Cardaria draba*), Russian knapweed (*Acroptilon repens*) and Russian wildrye (*Psathyrostachys junce*a).	Techniques to control invasive species: • Chemical treatment (spot treatment with herbicides). • Mechanical treatment (weed eaters or brush cutters). • Manual treatment (handpulling or handtools).
	Native Tree Encroachment	Invasion of juniper (*Juniperus* spp.), pinyon pine (*Pinus edulis*), and to a lesser degree ponderosa pine (*Pinus ponderosa*).	Tree removal techniques in order of priority: 1. Chainsaw removal of trees less than 6 ft tall by crews. 2. Use of handsaws and loppers by crews to remove trees less than 6 ft tall. 3. Brush cutting to remove trees before they reach 1 ft tall. 4. Use of prescribed fire to remove encroaching trees or shrubs in areas to be maintained as historical pastures. 5. Mastication of trees using heavy machinery. Tree waste removal techniques in order of priority: 1. Chip debris into a dumpster and haul away when area is near roads. Slash should not be dragged in archeological sites. 2. Burn piled material (when feasible). 3. Lop and Scatter (when debris density is high, scattering on erosive hillsides and banks of eroding riparian areas is preferred). Slash should not be dragged in archeological sites.
	Native Grass Cover	Decadent plant material build-up.	Prescribed fire — to remove decadent plant material.
Transitioning Pastures	Invasive Plants	Scattered patches of invasive plants like Russian thistle, kochia, yellow sweetclover, Scotch thistle, common mullein, hoary cress, Russian knapweed, and Russian wildrye.	Techniques to control invasive species: • Chemical treatment (spot treatment with herbicides). • Mechanical treatment (weed eaters or brush cutters). • Manual treatment (handpulling or handtools).
	Native Tree Encroachment (in transitioning pastures, this is desired)	Invasion of juniper, pinyon pine, and, to a lesser degree, ponderosa pine.	Allow pine and juniper trees to encroach pastures.

Table 2-1 (continued). Vegetation management spatial units planned for Pecos National Historical Park. Attributes of each unit that depart from desired conditions are identified along with a description of the departures and potential management actions that will be considered to move the unit toward the desired condition. This table is meant to aid assessment of how an area departs from a desired condition and how to address the departure. This table may need editing over time depending on present and future conditions.

Spatial Unit	Departures from Desired Conditions	Description of Departures	Potential Management Actions to Meet Desired Conditions
Pecos Pueblo and Spanish Mission Complex	Invasive Plants	Large continuous patches of kochia and Russian wildrye. Scattered patches of invasive disturbance plants like, Scotch thistle, common mullein, horehound (*Marrubium vulgare*), field bindweed (*Convolvulus arvensis*), and Dalmatian toadflax (*Linaria dalmatica*).	Techniques to control invasive species: • Chemical treatment (spot treatment with herbicides). • Mechanical treatment (weed eaters or brush cutters). • Manual treatment (handpulling or handtools) only in non-sensitive areas approved by the park archeologist.
	Native Tree Encroachment/ Defensible Space	Invasion of trees threatening structure or integrity of sites.	Tree removal techniques in order of priority: 1. Handsaws and loppers to remove trees less than 3 ft tall—to protect sites. 2. Chainsaw removal or limbing of trees—to protect sites. Tree waste removal techniques: • Haul away. Do not drag.
	Erosion	Erosion of soil on or away from sites.	Preferred management techniques to control erosion in order of priority: 1. Seeding with non-disturbing plant species. 2. Erosion control netting and/or waddles. 3. Erosion control water diversion structures.
Other Archeological Sites	Invasive Plants	Scattered patches of invasive plants like Russian thistle, kochia, yellow sweetclover, Scotch thistle, common mullein, Russian knapweed, and hoary cress.	Techniques to control invasive species: • Chemical treatment (spot treatment with herbicides). • Mechanical treatment (weed eaters or brush cutters). • Manual treatment (handpulling or handtools) only in non-sensitive areas approved by the park archeologist.
	Native Tree Encroachment/ Defensible Space	Invasion of trees threatening structure or integrity of sites.	Tree removal techniques in order of priority: 1. Handsaws and loppers to remove trees less than 3 ft tall—to protect sites. 2. Chainsaw removal or limbing of trees—to protect sites. Tree waste removal techniques in order of priority: 1. Chip debris into a dumpster and haul away when area is near roads. Slash should not be dragged in archeological sites. 2. Burn piled material (when feasible). 3. Lop and Scatter (when debris density is high, scattering on erosive hillsides and banks of eroding riparian areas is preferred). Slash should not be dragged in archeological sites.

Table 2-1 (continued). Vegetation management spatial units planned for Pecos National Historical Park. Attributes of each unit that depart from desired conditions are identified along with a description of the departures and potential management actions that will be considered to move the unit toward the desired condition. This table is meant to aid assessment of how an area departs from a desired condition and how to address the departure. This table may need editing over time depending on present and future conditions.

Spatial Unit	Departures from Desired Conditions	Description of Departures	Potential Management Actions to Meet Desired Conditions
Other Archeological Sites (continued)	Erosion	Erosion of soil on or away from sites.	Preferred management techniques to control erosion in order of priority: 1. Seeding with non-disturbing plant species. 2. Erosion control netting and or waddles. 3. Erosion control water diversion structures.
Pinyon-Juniper Woodland	Invasive Plants	Scattered patches of invasive plants like cheatgrass (*Bromus tectorum*), Russian thistle, kochia, yellow sweetclover, common mullein, hoary cress, and Russian knapweed.	Techniques to control invasive species: • Chemical treatment (spot treatment with herbicides). • Mechanical treatment (weed eaters or brush cutters). • Manual treatment (handpulling or handtools).
	Native Tree Encroachment/ Defensible Space	Closed Canopy woodlands need defensible space between property, boundary, and the urban interface. In certain areas, pasture fuel breaks and shaded fuel breaks will be utilized. Pasture Fuel Breaks: Some areas, such as the mostly open pastures near urban interface areas may require some thinning of all existing trees 50 ft from the boundary. These fence lines have been clear-cut in the past by NPS fire crews and will continue to be managed in that way due to their proximity to urban areas. Shaded Fuel Breaks: More heavily timbered areas near urban interface and park boundary fences or other priority areas may be managed as shaded fuel breaks where trees are thinned and/or limbed to reduce fire potential. NOTE: Thick stands of pinyon-juniper within the interior of the park will remain, except around culturally important areas or where density and size warrant management.	Tree removal techniques: • Chainsaw removal or limbing of trees—to maintain defensible space. Tree waste removal techniques in order of priority: 1. Chip debris into a dumpster and haul away when area is near roads. Slash should not be dragged in archeological sites. 2. Burn piled material (when feasible). 3. Lop and Scatter (when debris density is high, scattering on erosive hillsides and banks of eroding riparian areas is preferred). Slash should not be dragged in archeological sites.

Table 2-1 (continued). Vegetation management spatial units planned for Pecos National Historical Park. Attributes of each unit that depart from desired conditions are identified along with a description of the departures and potential management actions that will be considered to move the unit toward the desired condition. This table is meant to aid assessment of how an area departs from a desired condition and how to address the departure. This table may need editing over time depending on present and future conditions.

Spatial Unit	Departures from Desired Conditions	Description of Departures	Potential Management Actions to Meet Desired Conditions
Historical Orchards	Predation of Apple Trees by Beavers	Beaver predation of apple orchard trees near Pecos River.	Install and maintain exclosure cages on all historical apple orchard trees.
	Unmanaged Orchard	The approximately 30 trees are old and have not received consistent management. The implementation of standard orchard management should increase tree health.	Techniques to manage apple orchard: • Create a detailed orchard Inventory documenting location, health, etc. • Prune all dead branches and any branches rubbing into each other from December–March. • Water several times between May and August. Berm around trees to hold water. • Apply high nitrogen fertilizer in spring and high phosphorus fertilizer in fall. • Propagate oldest trees from cuttings and graft onto rigorous root stock. • Remove shrub and tree competition around each tree (approximately 10 ft radius).
Riparian Vegetation: Riparian Woodlands, Riparian Shrubs, and Rush and Sedge Wetlands	Invasive Plants	Scattered patches of hoary cress, oxeye daisy (*Leucanthemum vulgare*), yellow sweetclover, Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), and yellow toadflax (*Linaria vulgaris*)l	Techniques to control invasive species: • Chemical treatment (spot treatment with herbicides). • Mechanical treatment (weed eaters or brush cutters). • Manual treatment (handpulling or handtools).
	Invasive Trees	Invasive tree species such as Siberian elm (*Ulmus pumila*) and to a lesser degree, Russian olive (*Elaeagnus angustifolia*) and saltcedar (*Tamarix ramosissima*) invading the Pecos River, Glorieta Creek, and associated drainages.	Techniques to control invasive species: • Foliar spray with herbicide if trees are small enough. • Cut stump and herbicide spray. • Girdle and herbicide spray.
	Beaver Damage to Pecos Watershed Trees of Importance	Beaver predation of large cottonwoods and other trees of significance in the Pecos watershed.	Techniques to manage exclosure caging: • Exclosure cages will be maintained on all mature cottonwood trees within the viewshed of the ranch house and Colonias bridge (approximately a half-mile stretch). • For all other areas of Glorieta Creek and the Pecos River, only half of existing caging will be maintained and the rest will be removed. • Caging will be removed from dead and down trees.
Rabbitbrush Shrublands	Invasive Plants	Scattered patches of invasive plants like Russian thistle, kochia, yellow sweetclover, Scotch thistle, common mullein, and hoary cress.	Techniques to control invasive species: • Chemical treatment (spot treatment with herbicides). • Mechanical treatment (weed eaters or brush cutters). • Manual treatment (handpulling or handtools).

Table 2-1 (continued). Vegetation management spatial units planned for Pecos National Historical Park. Attributes of each unit that depart from desired conditions are identified along with a description of the departures and potential management actions that will be considered to move the unit toward the desired condition. This table is meant to aid assessment of how an area departs from a desired condition and how to address the departure. This table may need editing over time depending on present and future conditions.

Spatial Unit	Departures from Desired Conditions	Description of Departures	Potential Management Actions to Meet Desired Conditions
Ponderosa Pine Forest and Woodland and Douglas-fir Forest	Invasive Plants	Scattered patches of invasive plants like Russian thistle, kochia, yellow sweetclover, Scotch thistle, common mullein, hoary cress, Russian knapweed, and saltcedar.	Techniques to control invasive species: • Chemical treatment (spot treatment with herbicides). • Mechanical treatment (weed eaters or brush cutters). • Manual treatment (handpulling or handtools).
	Forest Tree and Shrub Species Density Too High	Density of forest increases to a level where the probability of catastrophic burning is high.	Tree removal techniques: • Thinning and prescribed fire to decrease tree density. • Chainsaw removal of trees to decrease tree density. Tree waste removal techniques in order of priority: 1. Chip debris into a dumpster and haul away when area is near roads. Slash should not be dragged in archeological sites. 2. Burn piled material (when feasible). 3. Lop and Scatter (when debris density is high, scattering on erosive hillsides and banks of eroding riparian areas is preferred). Slash should not be dragged in archeological sites.

Strategic Planning and Prioritization

This approach is discussed in greater detail in section 3, but is based on four primary components:

1. A clear understanding of objectives for a given management effort based on a goal of achieving the desired condition.
2. Prioritization of management actions based on established criteria (listed below).
3. An emphasis on incremental improvements by prioritizing maintenance of areas after they have been treated (to avoid areas reverting to prior conditions).
4. An emphasis on learning how to improve effectiveness of management (via an adaptive approach).

This approach views vegetation and invasive plant management as an integrated, ongoing, long-term project that places as much emphasis on maintenance of areas after they have been treated as it does the initial treatment, emphasizing a strategic approach (Figure 2-18) and ongoing, incremental improvements. These *maintained* areas require considerably less upkeep and effort than what is required for treating areas that are already in a degraded state and have received no active management.

Prioritization of Management Units and Invasive Species

This plan prioritizes management activities for spatial units as well as for invasive species targeted for treatment based on clearly defined and regularly reviewed criteria. These priorities will guide annual work planning, although special circumstances may warrant some departure from those priorities on a case-by-case basis.

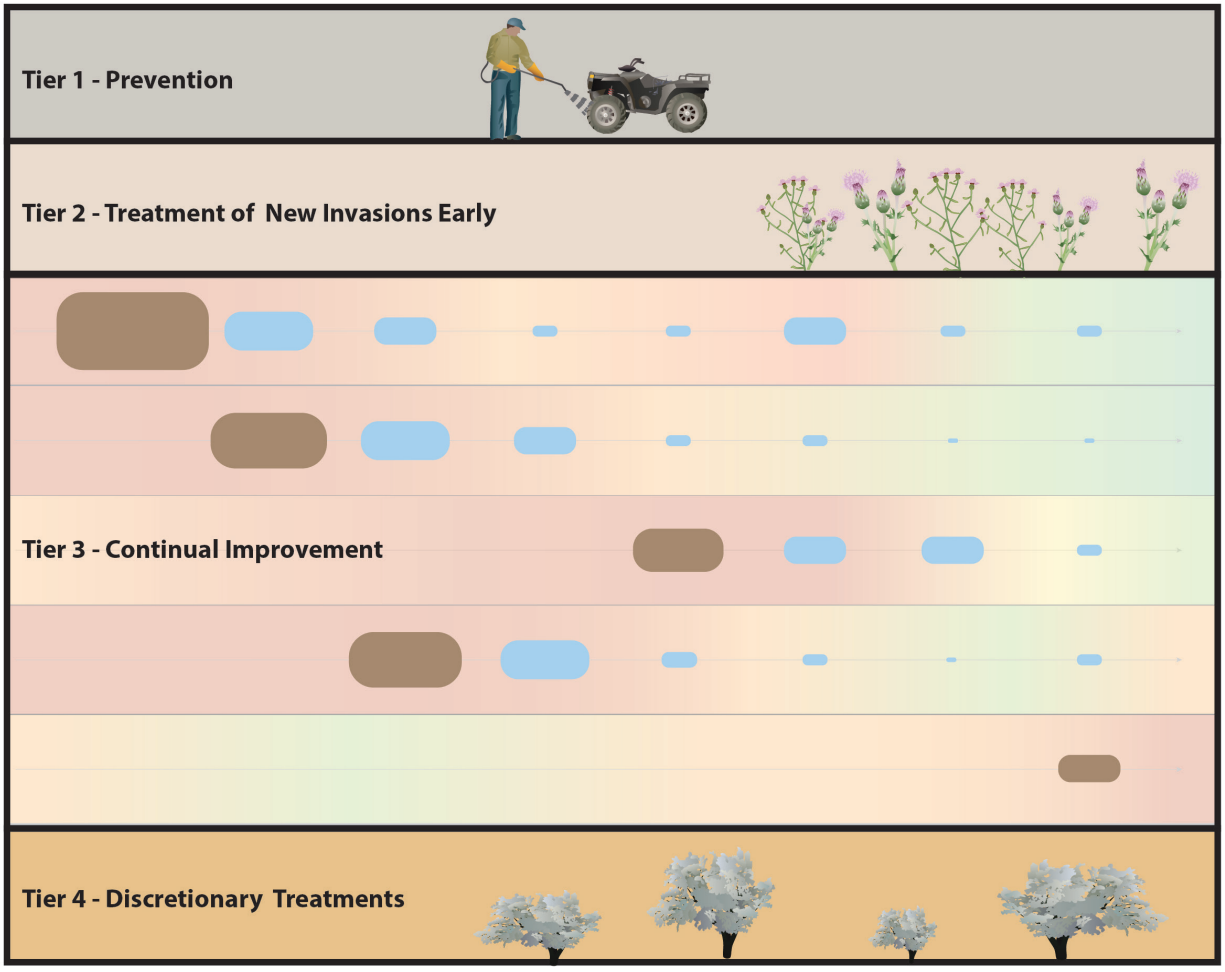


Figure 2-18. The NPS will employ a four-tiered strategic approach for invasive plant management aimed at preventing problems from becoming bigger and will emphasize continual improvement by maintaining areas once they have been treated.

Criteria for Prioritizing among Spatial Units

Strategic planning will prioritize treatment in spatial units based on the following criteria:

- The historical and/or ecological significance of the unit relative to the park mission.
- The importance of the unit for visitor experience.
- The long-term departure from desired conditions in the unit (e.g., areas that had experienced significant disturbance such as grazing or agricultural use, etc.) rather than short-term conditions that are responses to local disturbance (e.g., fire, flood, or single- or multi-year drought).

Each unit will be assigned a priority of high, moderate, or low (Table 2-2). This prioritization does not mean that management will strictly adhere to the rank order; but it implies that units with a higher priority will receive preference during strategic planning. Other factors, such as priorities given to invasive species infestations, special or unique circumstances, and emerging threats, will also be considered when deciding which units to treat in a given year.

Table 2-2. General priorities for managing vegetation types at Pecos National Historical Park. This prioritization does not imply strict adherence to a rank order, rather it's a general guide based on specific criteria.

Spatial Unit/Community Type	Priority
Maintained Pastures	High
Transitioning Pastures	Moderate
Pecos Pueblo and Spanish Mission Complex	High
Other Archeological Sites	High
Pinyon-Juniper Woodland	Moderate
Historical Orchards	Moderate
Riparian Vegetation	High
Rabbitbrush Shrublands	Moderate
Ponderosa Pine Forest and Woodland	Low
Douglas-fir Forest	Low

Criteria for Prioritizing Among Invasive Plant Species

The following guiding principles will be used to prioritize among invasive plant species:

- Invasive plants species that have the potential to dramatically alter broader plant communities and archeological sites are given higher priority.
- New occurrences of invasive plants are easier to treat immediately than infestations that are allowed to become more substantial.
- Invasive species occurrence that is sufficiently inconsistent with desired condition or park purpose and diminishes visitor experience and a sense of place.
- An emphasis on maintenance of areas once they are treated (to avoid areas reverting to prior conditions).
- Prevention is the primary defense against invasive plant invasions. A variety of best management practices can prevent invasive plants from invading the park (California Invasive Plant Council 2012).

A total of 80 invasive species have been detected within Pecos NHP from floristic surveys and monitoring by qualified botanists (Attachment 2; Sivinski 1995; Folts-Zettner et al. 2010; Folts-Zettner and Sosinski 2010, 2012a, b; Folts-Zettner et al. 2010, 2012, 2013, 2014; Muldavin and Chauvin 2014; Muldavin et al. 2012; Gwilliam, unpublished data). These data were collected while monitoring grassland plots, stream-associated riparian areas, and systematic searches along focused introduction pathways (Folts-Zettner et al. 2016, 2017; Gwilliam, unpublished data). Sixteen of these species were identified, in consultation with park staff and subject matter experts, as highest priority based on the potential for significant impact to native plant communities (Table 2-3). Other species will generally be treated opportunistically or in conjunction with treatment of higher priority species.

Invasive species of particular concern include New Mexico Class A, B, and C noxious weed list species such as hoary cress (*Cardaria draba*), Dalmatian toadflax (*Linaria dalmatica*), oxeye daisy (*Leucanthemum vulgare*), yellow toadflax (*Linaria vulgaris*), and cheatgrass. Kochia, and Russian thistle (*Salsola tragus*) are also of concern, particularly around high visitor use areas. Scattered patches of invasive plants like Russian thistle, kochia, yellow sweetclover (*Melilotus officinalis*), common mullein (*Verbascum thapsus*), Scotch thistle (*Onopordum acanthium*), and western salsify (*Tragopogon dubius*) that favor disturbed areas are found in pastures and along historical roads.

Table 2-3. Invasive species found within Pecos National Historical Park that are considered to have the most impact to native habitats.

Priority	Scientific Name	Common Name	Rationale for Rating
Highest	*Acroptilon repens*	Russian knapweed	It can form dense single species stands once established due to allelopathy.
	Bromus arvensis	Japanese brome	A noxious weed that occurs in prairies and competes with native perennials for water and nutrients.
	Bromus tectorum	cheatgrass	Cheatgrass is one of the highest ranked invasives for both ecological impact and management difficulty.
	Cardaria draba	hoary cress	It is known to rapidly crowd out native plants and moves rapidly into undisturbed riparian areas. Hoary cress can completely displace desirable vegetation by forming dense monocultures.
	Carduus nutans	musk thistle	This plant's seed is wind-dispersed and is known to spread quickly. Seed may remain viable in the soil for over 10 years.
	Cirsium arvense	Canada thistle	This plant is difficult to control and prefers moist riparian areas. Its rhizomatous roots will eventually exclude all other plants, resulting in dense monocultures.
	Conium maculatum	poison hemlock	Tap-rooted biennial. More tolerant of soils containing heavy metals (arsenic, cadmium, lead). Can spread quickly in disturbed riparian and marsh areas and is highly competitive, preventing the establishment of native grasses and forbs by shading and competing for space.
	Dipsacus fullonum	common teasel	Common teasel is another species of concern that has been documented along the Pecos River. Although it is only categorized as a New Mexico Class B species, the plant thrives in riparian areas, is an aggressive invader, and has been documented as spreading rapidly throughout the west.
	Elaeagnus angustifolia	Russian olive	A riparian species that outcompetes native plants and reduces biodiversity. It is difficult to control and has a high ecological impact to riparian systems.
	Leucanthemum vulgare	oxeye daisy	Oxeye daisy forms dense colonies displacing native plants and modifying existing communities. It is difficult to control or eradicate since a new plant can regenerate from rhizome fragments.
	Linaria dalmatica	Dalmatian toadflax	One Dalmatian toadflax plant can produce 500,000 seeds per year. It is known to rapidly crowd out native plants and often moves rapidly into undisturbed riparian areas.
	Linaria vulgaris	yellow toadflax	Yellow toadflax is an aggressive invader, disturbing communities from rangelands to riparian communities to roadside and graded areas. The problem with this plant is that, once established, yellow toadflax suppresses other vegetation mainly by intense competition for limited soil water.
	Onopordum acanthium	Scotch thistle	Scotch thistle can compete with most species and displace them from their natural habitats. The seed is wind dispersed. It can tolerate adverse environmental conditions and adapt to different habitats. It forms monocultures and creates long lasting seeds.
	Tamarix spp.	saltcedar	A riparian species that utilizes a great deal of water, outcompetes native plants, and reduces biodiversity. It is one of the most difficult plants to control and has a high ecological impact to riparian systems.
	Tribulus terrestris	punturevine	Found mainly along the Ancestral Sites Trail and the associated parking areas. It is readily spread by hitchhiking on visitor's footwear.
	Ulmus pumila	Siberian elm	It is moderately difficult to manage, with a moderate ecological impact. Seedlings have the ability to spread rapidly if allowed to persist, changing grassland to shrub/woodland.

Table 2-3 (continued). Invasive species found within Pecos National Historical Park that are considered to have the most impact to native habitats.

Priority	Scientific Name	Common Name	Rationale for Rating
Moderate	*Convolvulus arvensis*	bindweed	This is a difficult plant to manage once established, and even though it is not ranked as a high ecological risk, it has been observed quickly dominating areas throughout Southern Plains parks (Tomye Folts-Zettner, Southern Plains Network Biologist, pers. comm.).
	Bassia scoparia	kochia	Kochia can form monocultures that resist the establishment of preferred natives (Tomye Folts-Zettner, Southern Plains Network Biologist, pers. comm.). Once established, it is difficult to control.
	Marrubium vulgare	horehound	Perennial tap-rooted plant that can form monocultures and is difficult to control. It can produce 20,000 seeds a year that can survive in the soil for 7–10 years.
	Melilotus officinalis	yellow sweet clover	It is persistent once established and is competitive for resources. It is a nitrogen fixer, which is not optimal for short-grass areas, and makes a lot of seed.
	Psathyrostachys juncea	Russian wildrye	Cool-season, long-lived perennial bunchgrass that is highly competitive and has a high germination rate. It has a seed bank of 5–6 years and wide-spreading roots that compete for water.
Lower	*Lactuca serriola*	prickly lettuce	This plant is considered to be ecologically impactful, and its management difficulty is unknown but its presence has been increasing (Tomye Folts-Zettner, Southern Plains Network Biologist, pers. comm).
	Salsola tragus	Russian thistle	It is highly drought tolerant and is competitive in drought conditions. It has great seed dispersal potential, and the seeds germinate readily in disturbed or open areas.
	Verbascum thapsus	common mullien	It exhibits vigorous growth once established and displaces native plants. Each individual can produce 100,000–175,000 seeds that can remain viable for more than 100 years, making established populations difficult to eradicate.

An Adaptive Management Framework

Adaptive management is a systematic approach for improving resource management by learning from changes in the resource conditions and outcomes following resource management treatments. This plan's use of adaptive management includes four primary elements:

- Clearly stating desired conditions.
- Defining the initial management actions aimed at achieving those desired conditions.
- Monitoring changes in the resource to determine effectiveness of achieving desired conditions via ongoing assessments by the Southwest Network Collaboration (SWNC), a partnership between the Southern Plains Network, the Chihuahuan Desert Network, and the Sonoran Desert Network (Folts-Zettner et al. 2016, 2017; Gwilliam, unpublished data).
- Adjusting management when monitoring indicates that desired conditions are not being achieved or could be achieved more efficiently or effectively.

The park will explicitly use an adaptive approach to (1) refine the measurability of desired conditions, (2) evaluate the relative effectiveness of management actions in achieving the desired conditions, and (3) adapt management considering the uncertainties of environmental response to climate change. Each of these components will be incorporated into strategic planning to achieve maximum effectiveness and continual improvement.

Measurability of Desired Conditions

Measurable benchmarks for evaluating and achieving desired conditions are needed to evaluate the effectiveness of vegetation management. Unfortunately, measurable limits have not been fully determined for Pecos NHP, and these may also vary depending on site characteristics. For example, susceptibility of soils to wind erosion increases when the percentage of bare ground is high, but it is not well known if there is a threshold (15%, 20%, or 30%) for bare ground above which erosion is higher than background or natural levels. Therefore, this plan includes monitoring for changes in the indicators used to describe qualitative desired conditions and to define the limits of what is acceptable for each of ecological site types over time. The approach for this is described in greater detail in section 3.

Relative Effectiveness of Management Actions

Having measurable benchmarks for desired conditions also enables the NPS to evaluate the relative effectiveness of alternative management approaches. For example, do chemical or mechanical treatments more effectively reduce kochia, or is mowing early in the season when plants are small as effective as mowing later in the season when plants are larger?

In conjunction with ongoing monitoring by the Southwest Network Collaboration (Folts-Zettner et al. 2016, 2017; Gwilliam, unpublished data) and park staff, the NPS plans to monitor changes in the indicators for desired conditions and to evaluate the relative effectiveness for alternative management actions. These findings will be incorporated into future strategic planning to be most effective and continually improve vegetation management. This approach is described in greater detail in Chapter 3.

Adapting to the Uncertainty of Climate Change

Climate change is already having significant effects on the nation's native species and ecosystems, and these effects are projected to increase considerably over time. As a result, climate change must now be a primary consideration in conservation and natural resource management decisions. Stein et al. (2014, pg. 1) stated the following in Climate-Smart Conservation: Putting Adaptation Principles into Practice.

> *Addressing the growing threats brought about or accentuated by rapid climate change requires a fundamental shift in the practice of natural resource management and conservation. Traditionally, conservationists have focused their efforts on protecting and managing systems to maintain their current state, or to restore degraded systems back to a historical state regarded as more desirable. Conservation planners and practitioners will need to adopt forward-looking goals and implement strategies specifically designed to prepare for and adjust to current and future climatic changes, and the associated impacts on natural systems and human communities—an emerging discipline known as climate change adaptation.*

Making a transition to such forward-looking and climate-smart conservation requires that we pay attention to the following paraphrased, overarching themes outlined by Stein et al. (2014, pg. 22–33):

- *Act with Intentionality. We must directly include the effects of climate change in our management and conservation decision making and be transparent about our decision-making processes.*
- *Manage for change, not just persistence. As the effects of climate change become more apparent, it is clear that change, not persistence, will be the new "normal" moving forward. We must account for this new state of change and plan accordingly. We can no longer expect to maintain natural resources at historical reference levels and assume that the effects of climate change can continuously be resisted. We must plan for this change and account for it in our management practices, which may likely include practices that manage ecosystems for the maintenance of ecosystem functions rather than historical species assemblages. The Resist-Accept-Direct framework (Schuurman et al. 2020) can help to direct management responses in a rapidly changing climate. Where ecosystem changes cannot be resisted, we must either accept the change or direct it to a more desirable state.*
- *Reconsider goals, not just strategies. As we adapt to a new "normal" of change instead of persistence, it is possible that previous natural resource and conservation goals may no longer be feasible. As such, we must consider changing management goals in addition to strategies considering a changing climate.*
- *Integrate adaptation into existing work. Rather than implementing completely new strategies in response to climate change, try to integrate climate adaptation into existing policies and management strategies.*

Because adapting conservation and management strategies to incorporate climate change can be highly context specific, broad, sweeping strategies and policies will not work for all resource managers. Instead, resource managers should determine their specific project scope and incorporate it into the NPS 6-step climate adaptation management process (NPS 2021b). The six steps of the process are as follows (NPS 2021b):

1. Inform the planning process.
2. Assess climate vulnerabilities and risks.
3. Evaluate climate implications for management goals.
4. Identify potential adaptation strategies.
5. Evaluate and select priority adaptation strategies.
6. Implement strategies; track effectiveness and changing conditions. Return to Step 1 as necessary.

By considering the broad themes outlined in Stein et al. (2014), focusing on park-specific climate change effects, and incorporating both into the climate adaptation management process (NPS 2021b), resource managers at Pecos NHP can consider the effects of climate change in management goals and adapt management strategies accordingly.

Climate Change Scenario Planning

Climate change is considered one of the greatest threats to the protection of NPS resources (Gonzalez et al. 2018). Management implications of climate change extend from protections for species of conservation concern to management of entire biological communities and from protections of cultural resources to maintenance of park infrastructure; for the NPS these implications are "complex and without precedent" (Jarvis 2009). In Pecos NHP, mean annual temperatures have been increasing since the early 1900s and particularly during 2003–2012. (Monahan and Fisichelli 2014, pages 1–2).

A recent report highlights the acceleration of climatic change and shows that mean annual temperatures and total annual precipitation differed significantly between a recent 20-year period (2000–2019) and the 20 years prior to that (1980–1999). Between these two 20-year periods, mean annual temperatures increased (20-yr means went from 49.0 F to 50.3 F) and total annual precipitation decreased (20-yr means went from 18.1 in to 15.2 in; Tercek et al. 2021). Further, that study showed the climatic water deficit (CWD), a measure of dryness that represents the unmet evaporative demand due to water limitations, increased dramatically between these two time periods (Tercek et al. 2021). Climatic water deficit is an important metric for managers and better predicts behaviors of wildfire (Kane et al. 2015) and vegetation stress (Stephenson 1998) because it

integrates the timing and amount of precipitation events simultaneously with temperature-driven changes to evaporation. Over the last 20 years, San Miguel County which includes much of the main Pecos Unit of Pecos NHP has been classified as abnormally dry with several extended periods of moderate to severe drought (e.g., the years 2011 to 2014 were classified as severe drought, and November 2020 through May 2021 was classified as exceptional drought; Figure 2-19; National Integrated Drought Information System 2021). Documentation of recent climate changes and forecasts for future change at Pecos NHP confirm that climate considerations should be part of future resource management plans.

Pinyon-juniper and ponderosa pine forest are two common vegetation types at Pecos NHP, and predicting how climate change will impact these vegetation types will depend on the degree of change and how climate, soils, and different plant species interact. Average annual temperatures in the western United States have increased, primarily in winter, with minimum temperatures increasing more than maximum temperatures (Miller et al. 2019).

In regard to pinyon-juniper, higher temperatures generally will accelerate the development of insect infestations. Increases in temperature accelerate insect metabolism and increase insect herbivory (Miller et al. 2019). It is reasonable to plan that rising temperatures may result in increases in insect outbreaks that could contribute to pinyon-juniper die off.

Drought is probably the single greatest cause of pinyon-juniper woodland mortality (Miller et al. 2019). Drought can kill pinyon-juniper woodland trees directly or, more commonly, facilitate the occurrence of insect outbreaks, wildfires, or the spread of invasive annual grasses (Miller et al. 2019). It is possible that a climate-change-related drought driven by warmer temperatures could result in mass mortality of trees at Pecos NHP.

As discussed above, drought, temperature increases, and insect outbreaks can lead to tree mortality, sometimes on a large scale. Tree mortality can also increase the likelihood of wildfires. Wildfire and climate change can alter both environmental conditions and species interactions. For example, invasive annual grasses (such as cheatgrass) can increase with wildfire and disturbance. Once established, these invasive grasses can increase the fire frequency and prevent the reestablishment of pinyon-juniper (Miller et al. 2019). This is concerning because cheatgrass is present in Pecos NHP and it is reasonable to predict that wildfire would increase cheatgrass populations within the park.

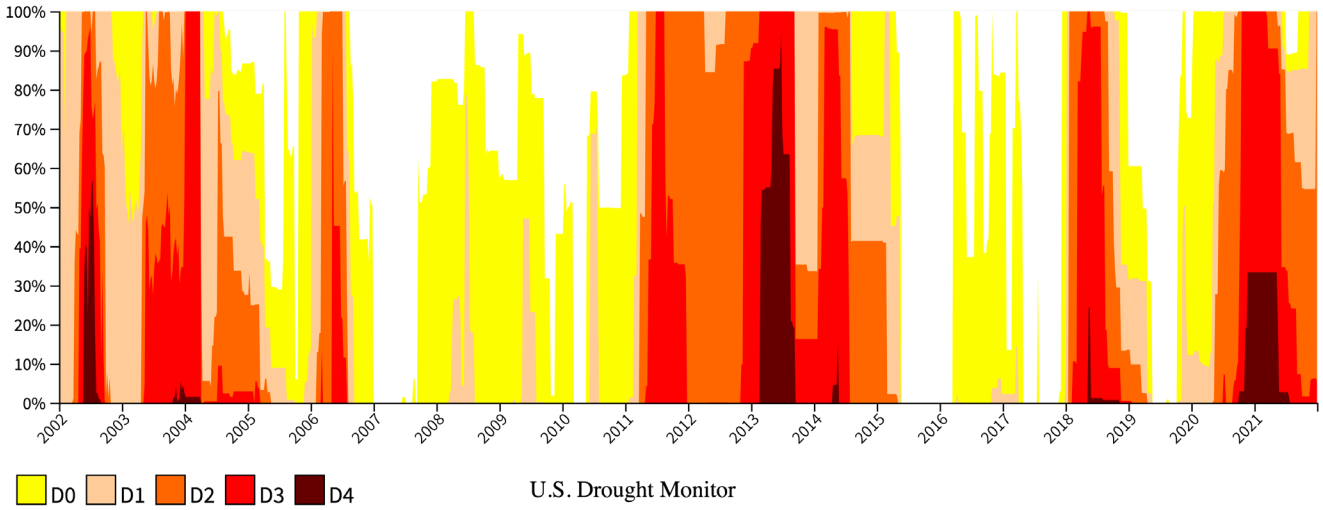


Figure 2-19. Percentage of the area of San Miquel County, New Mexico, that experienced drought conditions from 2002 through 2021 according to the U.S. Drought Monitor. The U.S. Drought Monitor is a national map released every Thursday showing parts of the U.S. that are in drought. Key: D0 = Abnormally Dry; D1 = Moderate Drought; D2 = Severe Drought; D3 = Extreme Drought; D4 = Exceptional Drought). Source: National Integrated Drought Information System 2021 (accessed 13 January 2022).

Severe drought could have some devastating implications on ponderosa pine forest, including disappearance of this vegetation community from large areas of the park. A severe drought in northern New Mexico in the 1950s caused a mile upward shift/die-off of the ponderosa pine forest. This dramatic die-off occurred rapidly over the course of just five years and persisted for 40 years (Miller et al. 2019). It is likely that if drought conditions had remained after a shift like that, the ponderosa pines may not have returned. It is possible that a similar drought-driven ponderosa pine mortality event like this could occur at Pecos NHP in the future.

The above examples are some of the climatic factors to be considered while managing the resources of the park. Pecos NHP may need to use a planning framework such as Resist-Accept-Direct (RAD) as a tool for managing resources being affected by climate change. In the example of managing large tree die-off events, such as large pinyon-juniper die-offs from drought, would the park accept this and not do anything due to a variety of factors such as budget or lack of staffing or would the park direct some activities toward active change such as thinning to limit risks from wildfire but also free up resources for a smaller density forest? Or would the park consider some sort of management activity to resist pinyon-juniper die off (Schuurman et al. 2020)?

3. Vision and Strategy for Vegetation Management

Strategic vision and planning are major components of the Pecos NHP approach to vegetation management. Strategies, and priorities of this Vegetation Management Plan are based on the NPS Mission, Park Purpose, Park Significance, and Fundamental Resources and Values. This Vegetation Management Plan (1) better defines desired vegetation conditions, (2) takes an adaptive approach to refining the measurability of desired conditions, (3) evaluates the relative effectiveness of management actions to achieve desired conditions and incorporates that assessment into management planning, (4) plans and prioritizes vegetation management for maximum effectiveness and continual improvement, and (5) provides an institutional history that will inform future park managers about past management actions, why they were implemented, and how effective they were. As more management decisions are made in future years, information will be added to this Vegetation Management Plan to keep it up-to-date and inform future management actions.

3.1 A Shared Vision for Vegetation Management

The strategic vision for vegetation management at Pecos NHP begins with collaboration. Organizationally, the NPS is made up of numerous divisions and programs at the national or regional level, each with their own areas of programmatic responsibility, in addition to staff assigned to parks. Together, all entities contribute to the NPS mission to preserve unimpaired the natural and cultural resources and values. Although some collaboration takes place at the present time, each discipline or unit typically views resource management through their own disciplinary lens (Figure 3-1), which can result in inconsistent, inefficient, and sometimes even conflicting views on management. This plan's approach recognizes that park stewardship and management require multiple perspectives and mandates. Therefore, vegetation management at Pecos NHP is based on both ecological and historical integrity and works toward a shared vision that integrates natural and cultural landscape goals and resource conservation. While different disciplines may have areas of overlap and common agreement, a shared vision must seek agreement on goals and priorities that are often not well aligned.

3.2 A Collaborative Framework

Achieving a shared vision for resource management would be difficult, if not impossible, if all the responsible units worked independently in their planning, management efforts, assessments, and decisions. In contrast, collaboration can increase efficiency and improve park management by reducing redundancy and increasing the quality of information provided to parks. A collaborative approach brings multiple perspectives, experiences, and expertise working in concert on resource management. Presenting varying perspectives and experiences together enables interaction that often leads to new ideas and an examination of any given issue from a broader foundation.

The Southwest Network Collaboration (Southern Plains, Chihuahuan Desert, and Sonoran Desert networks), the Southern Plains Fire Group, the Pueblo Parks Fire Group, Bandelier National Monument, and the Southwest Invasive Plant Management Team have established a collaborative working relationship with Pecos NHP. This collaboration has yielded more consistent guidance, management, monitoring, assessment, and decision support to the park. The partners' collaborative efforts have led to this vegetation management plan, and they will continue to support vegetation management at Pecos NHP through the following:

- All partners will continue to contribute to the shared vision and overall planning of vegetation management for Pecos NHP, including but not limited to this Vegetation Management Plan.
- All partners will continue to contribute to management actions to achieve the desired conditions in accordance with their respective programmatic goals and objectives.
- All partners will continue to contribute to the preparation of annual collaborative vegetation summaries that iteratively inform subsequent work plans. This regular review of monitoring data will support regular and interdisciplinary interpretation of results and changes in vegetation, support an iterative process for adaptive management, and provide an institutional history of vegetation resource management actions with information on the effectiveness of those actions.

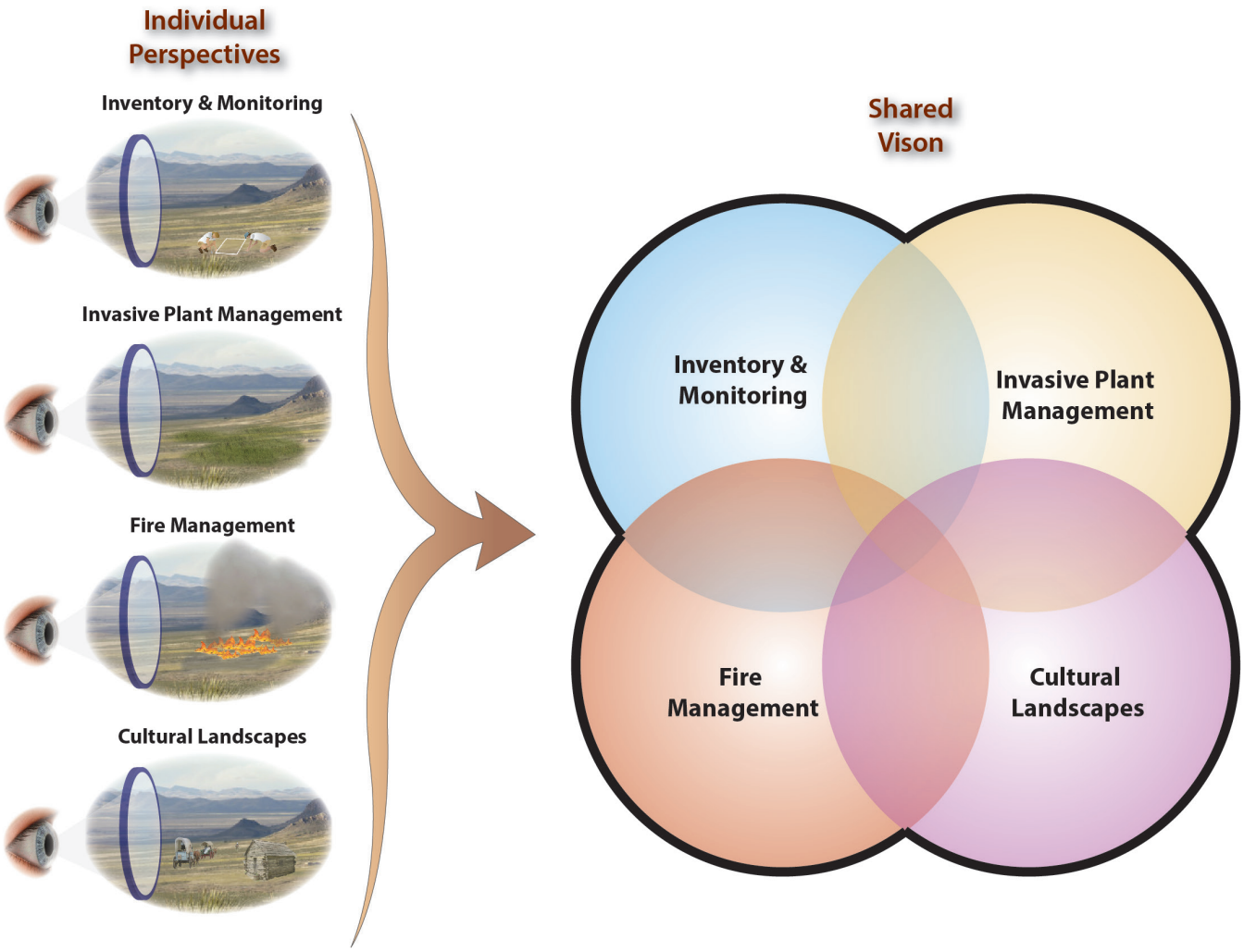


Figure 3-1. It is commonplace for individual disciplines or units to view resource management through a lens that reflects that discipline. This plan promotes the integration of those perceptions into a shared vision for vegetation management that recognizes areas of common agreement among disciplines or units and negotiates a consensus of priorities where perspectives are not well aligned.

The annual review of vegetation monitoring data will include information on (1) what vegetation management actions have been taken, (2) where those actions have been taken, (3) how effective those actions have been, and (4) the condition of the resource relative to desired conditions. The collaborating partners will provide the information on their respective efforts. The Southern Plains Network will be responsible for sharing and visualizing monitoring data each year. Every three to five years, the network will carry out a more comprehensive multi-year synthesis of data that integrates vegetation and climate data with known management actions. The synthesis report will be prepared using a format agreed upon by the collaborating partners and is designed to evaluate assumptions about the effectiveness of management alternatives and to suggest management adaptations based on the monitoring data and documented changes in system (e.g., climate) drivers.

After analyzing the results and effectiveness of the previous year's management, collaborating partners will collectively interpret the results to provide input to the workplan for the subsequent year. The workplan will be based on desired conditions and the management actions intended to achieve them (Table 3-1). The park compliance office will also participate in the preparation of the annual report and work plan to ensure that it meets requirements of the vegetation management plan and other approved park plans and that necessary compliance takes place before implementation.

Table 3-1. Proposed initial format of vegetation management workplan based on hypothetical information.

Spatial Unit	Desired Condition with Departures	Management Treatment Used	Description of Treatment	Effectiveness of Treatment	Recommended Change in Management (if any)
SU-1	Invasive plants (excessive kochia on a 7-acre patch in the southern portion of the unit)	Mowing	Mowing was conducted between June 2–5 on approximately 7 acres in the southern portion of the unit.	Qualitative assessment shows that invasives are less prevalent.	No change recommended at this time.
SU-2	Invasive plants (Tamarisk re-sprouts)	Chemical	Spot sprayed individual re-sprouts using (Chem name) on May 30 over a 3-acre area	Chemical treatment does not seem to be effective (<7% kill).	Need to consider mechanical treatment (cutting) in combination with chemical treatment, but funds are currently lacking.
SU-3	Invasive plants (patches of kochia occur throughout the unit)	Mowing followed by chemical treatment	Mowing of kochia patches was conducted on May 31 over the entire unit, followed by spot spraying patches on June 16 using (Chem name)	Southern Plains Network Monitoring Plot (BEOL-02) within the treatment area indicates a 17% decrease in kochia cover, but this may be due in part to lower spring rainfall in 2018.	Repeat treatment in 2018.

3.3 Annual Schedule and Responsible Parties

Vegetation management will have a general annual cycle (Figure 3-2). The cooperative nature of the proposed approach necessitates some dependency among partners. For example, analyses cannot be completed if data have not been submitted and verified, and monitoring needs to be coordinated with treatments, etc. An annual schedule will help define when tasks should be completed and by whom. The annual schedule is not, however, intended to represent a strict prescription for all tasks. For example, even though most treatments and monitoring will be conducted during the summer, some fire treatments may occur throughout the year depending on objectives and conditions at the time of treatment. Such departures should be addressed within annual work plans.

Annual Work Plans

As part of the adaptive process, a work plan will be submitted each year to ensure efforts are consistent with this environmental assessment and that any necessary compliance will be completed prior to implementation. Proposed management actions for a given year will take into account the effectiveness of actions taken in the previous year(s).

Cooperative & Adaptive Vegetation Managment Annual Project Schedule

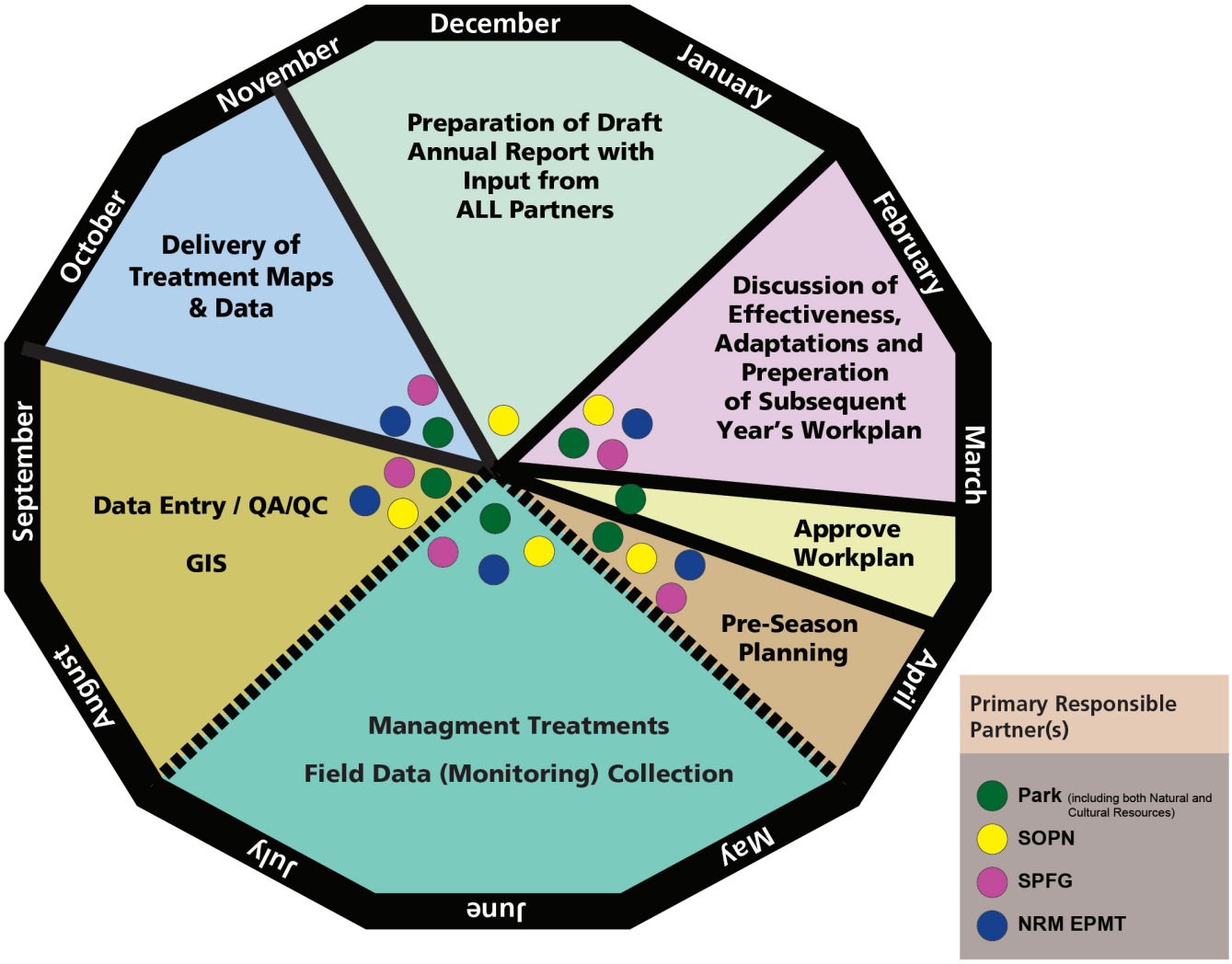


Figure 3-2. Primary tasks and milestones that will take place within an annual cycle. Also shown are the approximate time periods within which those tasks or milestones will occur, as well as the primary responsible parties who will complete them. Dashed lines indicate that the task or milestone may not occur strictly within the defined boundary.

3.4 A Strategic and Adaptive Framework

The strategic approach in the planning and implementation of vegetation management emphasizes progressive and continual improvement in condition. This approach is based on four primary components:

- A clear understanding of objectives for a given management effort based on the difference between current condition and desired conditions.
- Prioritization of management actions based on established criteria (listed below).
- An emphasis on maintenance of areas once they are treated (to avoid areas reverting to prior conditions).
- An emphasis on learning to improve effectiveness of management (via adaptive management). This approach requires Pecos NHP to consider vegetation and invasive plant management as ongoing, long-term investments that place as much emphasis on maintenance of areas after they have been treated as they do on the initial treatment. A key principle is to get areas into a "maintenance" condition that requires considerably less effort and expense to keep up than is required for treating degraded areas. Following this principle requires maintenance so that treated areas do not revert to a degraded state.

Continual Improvement

The aim of strategic vegetation management is a regime of continual improvement (Figure 2-18). If vegetation and invasive plant management treatments are applied without the necessary subsequent maintenance treatments, conditions often revert to a deteriorated state. In this case, treatment becomes an endless game of "whack-a-mole" without steady progress toward improved conditions. Strategic vegetation management is an ongoing, long-term investment that requires constant maintenance.

Tiered Strategy for Invasive Plants

Invasive plant management requires a four-tiered strategy, including prevention, treating new invasions when they arise but before they become problematic, continual improvements in sites affected by invasive plants via maintenance treatments, and discretionary and opportunistic treatments (Figure 2-18).

Prevention

Prevention is the primary defense against invasive plant invasions. A variety of best management practices can prevent invasive plants from invading the park (California Invasive Plant Council 2012).

Treating New Invasions

The best way to minimize treatment cost and impact from invasive plant infestations is early treatment. When new invasive plants are detected, they should be treated before they become established, especially for species that pose serious threats to the historical or ecological integrity of the park.

Strategic Continual Improvement

The bulk of invasive plant management will entail the effort toward continual improvement in the condition of native vegetation with an emphasis on maintaining areas in improved condition once they have been treated.

Discretionary Treatments

Although the emphasis will be on preventing invasions before they arise and strategically addressing the existing invasive plant infestations, the NPS may pursue other treatment programs based on special problems or funding opportunities.

Adaptive Management

Adaptive management was described in section 2.5 of this plan. Briefly, it is a systematic approach for improving resource management by learning from management outcomes. An adaptive approach addresses three key uncertainties: (1) the measurable and acceptable limits of qualitative desired conditions (which help to define specific and measurable objectives), (2) the uncertainties of environmental response to climate change, and (3) the effectiveness of alternative management actions for achieving desired conditions.

The Measurable and Acceptable Limits of our Desired Conditions

Although desired conditions for vegetation management are qualitative, the boundary between what should be considered acceptable and unacceptable is not always clear (Figure 3-3). For example, susceptibility of soils to wind erosion increases when the percentage of bare ground is high due to increased exposure to wind. But there is still uncertainty on the actual percentage of bare ground

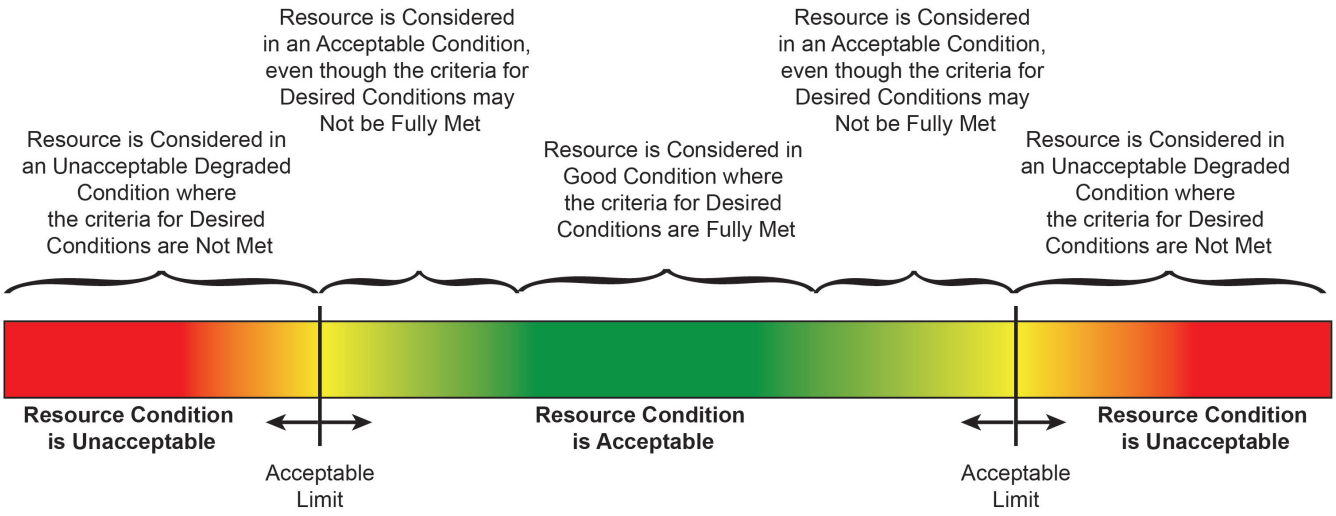


Figure 3-3. There is typically a gradient from where desired conditions of a resource are fully met and where they are fully unmet. The acceptable limits help to determine the point at which the departure from desired conditions represents an unacceptable resource condition.

(e.g., 15%, 20%, or 30%) that contributes to or accelerates unnatural levels of erosion. Given the site variability, simply relying on general values from the literature or other areas can lead to quantifying desired conditions that do not meet the desired intent. Thus, the limits of acceptability (i.e., the boundary between what would be considered as acceptable or unacceptable) will be evaluated for each desired condition to adaptively refine them. Evaluation of conditions at different points will help to determine if potential negative effects (e.g., erosion) are occurring and if positive effects (e.g., increased vegetation cover) are being observed. The points at which negative effects are no longer observed or positive effects are observed should provide an indication of what will be considered acceptable.

Management Assessment Points

Management assessment points (Bennetts et al. 2007) are used as a tool to aid in the adaptive process for determining acceptable limits of resource condition when there is uncertainty regarding what those limits should be. These points represent initial estimates by park staff, in consultation with the collaborating parties, of what the acceptable limits are likely to be and usually err on the conservative side. For example, if it is believed that soil erosion likely occurs when the proportion of bare ground exceeds 20%, then a conservative value (e.g., 15%) might be used as an assessment point. When (if) that assessment point is reached, the condition of the resource needs to be assessed to determine if it is acceptable or unacceptable. For example, if monitoring indicates that the percentage of bare ground has reached the assessment point (15%), an assessment is made as to whether soil erosion is occurring. If soil erosion is occurring, a more conservative (lower percentage) assessment point might be warranted, and if not, a higher value might be justified. The use of assessment points provides an explicit mechanism to ensure that the adaptive process is taking place.

The Uncertainty of Climate Change

In addition to the uncertainty regarding what constitutes acceptable limits of the desired condition, there are also potential changes in the environment due to changing climate. The uncertainty of how and when specific impacts will become evident makes responding to climate change challenging. As conditions and ecological relationships shift, effective decision-making will require flexible, climate-informed approaches and the incorporation of new and relevant science. Using an adaptive approach to define the acceptable limits of the desired condition will also enable the flexibility to account for the uncertainty associated with climate change.

The Effectiveness of Management for Achieving Desired Conditions

Having measurable acceptable limits for desired conditions enables evaluation of the effectiveness of alternative management approaches through monitoring. For example, is the reduction of kochia better achieved by chemical or mechanical measures, or does mowing early in the season when plants are small achieve the same results as mowing later in the season when plants are larger? Acceptable limits serve as a benchmark for comparison to current condition. Thus, annual evaluation of the overall effectiveness of management actions as well as the relative effectiveness of alternative management actions should occur.

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Attachment 1. Materials in Support of a Categorical Exclusion

A1.1 Compliance with NEPA and NHPA

Park staff conducted an analysis of the proposed action under the assumption that the new vegetation management plan would require an environmental assessment (EA). However, after analysis and discussing the issues with NPS Environmental Quality (EQ) staff in the Intermountain Region, it was determined that the plan and resulting actions fall under an existing categorical exclusion. The categorical exclusion that fits best with the project is the following:

> E.2: Restoration of noncontroversial native species into suitable habitats within their historical range and elimination of exotic species (NPS 2015).

Even though this plan is not an EA we have included some of our analysis as documentation and to show that we considered possible impacts of proposed actions. This analysis is also a useful reference for any future consultation with state or federal wildlife agencies.

Some of the analysis in this plan addresses compliance for the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA). However, park staff will still need to conduct a complete analysis for individual projects. If disturbance of cultural sites is avoided, then the vegetation management actions outlined in this plan should not impact cultural resources and will be beneficial for many cultural landscapes.

A1.2 Issues and Impact Topics Considered

The Pecos NHP staff, in consultation with the Southern Plains Inventory and Monitoring Network (Southern Plains Network), Southern Plains Fire Group, Pueblo Parks Fire Group, and Southwest Invasive Plant Management Team, considered a broad suite of topics to determine if there were likely to be significant impacts from implementing a vegetation management plan. The following criteria for each topic as outlined in the NPS NEPA Handbook (NPS 2015b) determined whether an issue or topic should be retained for further consideration:

- Are the environmental impacts associated with the issue central to the proposal or of critical importance?
- Is a detailed analysis of environmental impacts related to the issue necessary to make a reasoned choice between alternatives?
- Are the environmental impacts associated with the issue a big point of contention among the public or other agencies?
- Are there potentially significant impacts to resources associated with the issue?

Impact Topics Retained for Further Analysis

The following impact topics met one or more of the criteria and are further analyzed:

- Vegetation
- Cultural Landscapes
- Archeological Resources
- Visitor Use and Experience

Impact Topics Dismissed From Further Analysis

The following topics are dismissed from further analysis in this plan for the reasons provided.

Air Quality

Pecos NHP is designated as a Class II air quality area under the Clean Air Act. Short-term use (i.e. a few hours a day) of various types of equipment (e.g., tractors and chainsaws) scattered over a few days (less than 10) each season will produce emissions that are very small relative to those produced from visitor vehicles and the adjacent highway and will be an inconsequential contribution to the park's overall emissions profile.

There will also be short-term reductions in air quality from smoke during prescribed fires. Prescribed fires will primarily be conducted in the Maintained Pastures spatial unit. Because most these fuels are fine fuels, the amount of smoke released into the air should be low and smoke dispersal should be rapid (typically 2–12 hours). Mitigating measures (strict climatic windows and/or closure of adjacent roads) can also limit the visual and safety intrusions from smoke.

Wildlife and Special Status Species

Several bird and reptile species and mammals, such as coyotes, rabbits, and deer, inhabit or pass through the park. Management-related activities may cause wildlife to temporarily avoid areas where they are taking place, but species inhabiting the area are acclimated to human activity and should quickly return (typically within hours). Animals displaced by prescribed fire may be an exception. However, given the modest size of anticipated burns (typically <150 acres), it is unlikely that animals will leave the vicinity, nor will such displacement likely have any effect on populations within the project area. In the long term, wildlife habitat is expected to be improved by this plan.

According to the US Fish and Wildlife Service, there are five federal threatened, endangered, or candidate species that may occur at Pecos NHP (consultation code 02ENNM00-2020-E-02806, USFWS 2020; Table A1-1). There are no designated critical habitats for these species, nor are there likely suitable habitats within potential project areas. Habitat is so marginal at Pecos NHP that it is highly unlikely that any of the species will ever occur in the park. They have never been observed within the park boundary. If any of these species are detected in the future, management activities will be immediately stopped and reassessed.

A Biological Assessment was completed on June 18, 2019, and concluded that there was no effect (Table A1-1). The NPS sent a letter to the USFWS on July 27, 2020, with this finding. The USFWS replied by letter on July 27, 2020.

Table A1-1. Threatened, endangered, and candidate/proposed species rationale for exclusion from further consideration. The USFWS species list (USFWS Consultation Code: 02ENNM00-2019-SLI-0252) was obtained from the IPaC website on July 27, 2020, and reviewed (USFWS 2020). Species/critical habitat not having the potential to occur were excluded from further review with a no effect determination with the below rationale.

Category	Species Common and Scientific Name	Status	Potential to Occur	Critical Habitat	Rationale for Exclusion	Habitat Description and Range in Action Area	Comments
Birds	Mexican Spotted Owl *Strix occidentalis lucida*	Threatened	No	No	No habitat present in action area	The Mexican spotted owl is found primarily within a forest structure containing a range of tree species, including mixed conifer, pine-oak, and riparian forest types, composed of different tree sizes reflecting different ages of trees and moderate to high canopy closure. The spotted owl prefers cool, mesic canyons with steep slopes (Cartron 2010). Forests used for roosting or nesting require high volumes of fallen trees and other woody debris and high plant species richness with adequate levels of residual plant cover to maintain fruits, seeds, and regeneration to provide for the needs of prey species.	Suitable habitat for this species is not located within the action area, and the species has not been observed or reported in the area. The nearest critical habitat is located at least 4 miles away from the project area. The Mexican spotted owl is therefore not likely to occur other than as a vagrant or casual occurrence. No further analysis.
	Southwestern Willow Flycatcher *Empidonax trillii extimus*	Endangered	No	No	No habitat present in action area	Habitat for the southwestern willow flycatcher consists of dense riparian habitats along rivers, streams, or other wetlands, where its diet consists primarily of insects. Vegetation includes dense growth of willows (*Salix* spp.), arrowweed (*Pluchea sericea*), alder (*Alnus* spp.), saltcedar (*Tamarix ramosissima*), and other riparian vegetation. The species is a habitat specialist in that it requires moist, microclimatic, and vegetative conditions and breeds only in dense riparian vegetation near surface water or saturated soil.	No positive ID for the subspecies at Pecos NHP has been made, and Sogge et al. (1997) determined habitat conditions at present do not appear suitable for breeding willow flycatchers. The nearest critical habitat is approximately 49 miles to the northeast of the project area. The southwestern willow flycatcher is therefore not likely to occur within the project area other than as a casual occurrence. No further analysis.
	Yellow-billed Cuckoo *Coccyzus americanus*	Threatened	No	No	No habitat present in action area	Habitat for this species includes wooded habitat with dense cover and water nearby, including woodlands with low, scrubby, vegetation, overgrown orchards, abandoned farmland, and dense thickets along streams and marshes	Suitable habitat for this species is not located within the action area, and the species has not been observed or reported in the area. No further analysis.
Mammals	New Mexico Meadow Jumping Mouse *Zapus hudsonius luteus*	Endangered	No	No	No habitat present in action area	The New Mexico jumping mouse preferred habitat conditions include herbaceous vegetation that is present and dense, a diversity of forbs, grasses, and sedges. It prefers being adjacent to perennial flowing water and soil moisture to be saturated or nearly saturated.	Suitable habitat for this species is not located within the action area, and the species has not been observed or reported in the area. No further analysis.

Table A1-1 (continued). Threatened, endangered, and candidate/proposed species rationale for exclusion from further consideration. The USFWS species list (USFWS Consultation Code: 02ENNM00-2019-SLI-0252) was obtained from the IPaC website on July 27, 2020, and reviewed (USFWS 2020). Species/critical habitat not having the potential to occur were excluded from further review with a no effect determination with the below rationale.

Category	Species Common and Scientific Name	Status	Potential to Occur	Critical Habitat	Rationale for Exclusion	Habitat Description and Range in Action Area	Comments
Flowering Plants	Holy Ghost Ipomopsis *Ipomopsis sancti-spritus*	Threatened	No	No	No habitat present in action area	The holy ghost ipomopsis is found in only one canyon in the upper Pecos River drainage of the southern Sangre de Cristo Mountains. The species is best adapted to openings in forests typically caused by recurrent low-intensity fires that were once normal occurrences in ponderosa pine (*Pinus ponderosa*) and mixed conifer forests.	Suitable habitat for this species is not located within the action area and the only naturally occurring population is limited to Holy Ghost Canyon in the Santa Fe Forest. No further analysis.

The following species are listed by the state of New Mexico as State Threatened or State Endangered (San Miguel and Santa Fe counties). Pecos National NHP staff will address impacts to state-listed species on a project-by project basis and further analysis is not included here. However, for any project, if work has the potential to affect populations, breeding behavior, and/or nesting sites, work will be reevaluated and potentially paused, moved, or discontinued.

State Threatened

- Peregrine falcon (*Falco pergrinus*)
- Bald eagle (*Haliaeetus leucocephalus*)
- Boreal owl (*Aegolus funereus*)
- Least tern (*Stemula antillarum*)
- Baird's sparrow (*Ammodramus bairdi*)
- Gray vireo (*Vireo vicinior*)
- Broad-billed hummingbird (*Cynanthus latirostris*)
- White-eared hummingbird (*Basilinna leucotis*)
- Violet-crowned hummingbird (*Amazilia violicep*s)
- Common black hawk (*Buteogallus anthracinus*)
- Spotted bat (*Euderma maculatum*)
- Pacific marten (*Martes caurina*)
- Lilljeborg's peaclam (*Psidium lilljeborgi*)
- Lake fingernailclam (*Musculium lacustre*)
- Long fingernailclam (*Musculium transversum*)
- Wood lilly (*Lilium philadelphicum*)
- Lady tresses orchid (*Spiranthes magnicamporum*)
- Santa Fe cholla (*Cylindropuntia viridiflora*)
- Suckermouth minnow (*Phenacobius mirabili*s)
- Arkansas River shiner (*Notropis girardi*)

State Endangered

- White-tailed ptarmigan (*Lagopus leucura*)
- Paper pondshell (*Utterbackia imbecillis*)
- Least tern (*Sternula antillarum*)
- Brown pelican (*Pelecanus occidentalis*)

Birds of Conservation Concern

Actions under the purview of the vegetation management plan may affect the following Birds of Conservation Concern:

- Bald eagle: The preferred habitat of bald eagles is along rivers, and they typically remain close to water. Management actions along the Pecos River will mostly be limited to infrequent invasive plant removal and should not adversely affect their habitat. However, during breeding season park staff will look for breeding behavior along the Pecos River and will not work in that area if breeding activity is observed.
- Pinyon jay: Pinyon jay (*Gymnorhinus cyanocephalus*)is a common migratory bird in the park. During a 2016 survey, 237 individuals were observed, which accounted for 4% of the birds observed (Ali et al. 2017). The preferred habitat of pinyon jays is pinyon pine trees in pinyon-juniper woodland. The proposed management plan will increase habitat for the pinyon jay by increasing the acreage of pinyon-juniper over time by allowing the 656 acres in the Transitioning Pastures spatial unit to convert back to pinyon-juniper woodlands. Thinning and burn operations, particularly in the Maintained Pastures spatial unit, could potentially have adverse effects on pinyon jay populations. However, these treatments will be infrequent. Burning will not likely take place during the breeding season. Areas scheduled to be thinned during the breeding season will be monitored for breeding activity. If any activity is found, work will not occur in those areas.
- Brewer's sparrow: Brewer's sparrow (*Spizella breweri*) has been infrequently documented within the park (Ali et al. 2017). Brewer's sparrow prefers a variety of habitats that include open prairie and pinyon-juniper woodland. This management plan should benefit the Brewer's sparrow by increasing the amount of pinyon-juniper woodland by allowing transitioning pastures to convert back to pinyon-juniper. Additionally, maintained pastures will be thinned and burned to sustain open areas that they also prefer.
- Lewis's woodpecker: Only two Lewis's woodpeckers (*Melanerpes lewis*) have been documented at the park since 2016 (Ali et al. 2017). They occur erratically and are hard to monitor. These woodpeckers prefer a wide variety of habitats, including open country, burned areas, thinned areas, large trees for nest sites, and cottonwood groves along the rivers. Although allowing areas in the Transitioning Pastures spatial unit to convert to pinyon-juniper woodland may negatively affect the Lewis's woodpecker, the Maintained Pastures/Grasslands will benefit the species. Thinning and burning operations in the Pinyon-Juniper Woodland spatial unit should increase its preferred habitats in the park.
- Rufous hummingbird: In 2016, one rufous hummingbird (*Selasphorus rufus*) was documented in the park (Ali et al. 2017). In 2020, three rufous hummingbird individuals were observed at the "3 wooden cabins site" in July and August. Its preferred habitat includes forest edges, stream sides, and clearings. Although allowing the area in the Transitioning Pastures spatial unit to convert to pinyon-juniper woodland may negatively affect the species, habitat in the Maintained Pastures/Grasslands spatial unit will be sustained. Burning and thinning operations may create preferred habitat.

Natural Soundscapes

Pecos NHP is situated in a topographic bowl that traps and accentuates sound (Johnson et al. 2011). Sounds in the park are a mix of natural and man-made sounds, including those generated from wind, the Pecos River, wildlife, humans, cultural demonstrations, restoration work on cultural sites, highway noise, trains, and aircraft (Johnson et al. 2011). The most significant source of human-caused noise is traffic from Interstate 25. The periodic use of motorized tools and equipment associated with this plan will continue during ongoing vegetation management activities, but this should typically occur for durations of 1–6 hours 1–3 times per month during spring and summer. Such limited noise should likely be less intrusive than that which already occurs as part of the existing human sounds associated with adjacent transportation and visitor activities.

Environmental Justice

Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations) tasked federal agencies to ensure no racial, ethnic, cultural, or socioeconomic group disproportionately bears the negative environmental consequences resulting from governmental programs,

policies, or activities. The impacts that could result from implementation of the proposed alternative should be few and should not be disproportionately high regarding human health or environmental impacts on minorities or low-income populations. The vegetative landscape is available for use by all visitors without any regard to race or income. Since federal funding is involved in the vegetation management, resource management employees also must be hired without regard to race, ethnicity, or income. Therefore, these topics were not considered further.

A1.3 Mitigation Measures

Since all alternatives include the use of potentially hazardous chemicals or potentially dangerous equipment, potentially causing negative impacts to the condition of the park's natural and cultural resources, Pecos NHP will use Best Management Practices to mitigate the risks, hazards, and potential negative environmental impacts associated with the implementation of the proposed alternatives. These mitigation measures will also ensure the health of staff, contractors, and visitors.

Mitigation of Vegetation Treatments:

- All herbicides will be applied by appropriately trained personnel following certification and rules outlined by the National Park Service and New Mexico Department of Agriculture.
- All herbicides will be applied in a manner as specified on the Herbicide Manufacturers Label. The Label is Law.
- All revegetation and restoration projects will use weed-free seed.
- All equipment and clothing will be regularly cleaned to remove all invasive plant materials.
- All seed mixtures used for revegetation and restoration activities will be based on native genotypes using local sources as much as possible. All seed mixtures must be appropriately certified and will be inspected to ensure appropriate mixture and absence of weed seed prior to planting.
- Fill sites and rock quarries need to be inspected for invasive plants prior to use by Pecos NHP Natural Resources staff. Highly infested fill and rock are not to be used.
- Park equipment used for mowing, brush cutting, and moving rock/soil must be cleaned after use at specific project sites so as not to spread seed.
- Contractors must have cleaned equipment prior to starting project work to ensure that invasive plants are not spread from off site. If equipment is taken way from the park to work on other projects and then returns at a later time, the equipment must be cleaned and approved again.
- No invasive plant species with potential for spread will be introduced into park landscaping per NPS Management Policies (NPS 2006).
- The NPS will follow Integrated Pest Management guidelines for herbicide use, including determination of appropriate circumstances for herbicide use, herbicide type, amount of herbicide to use, and guidance on when and how to apply it.
- Only highly experienced personnel are to conduct prescribed burns on park lands.
- Prescribed fires will only be conducted under guidance of the Pecos NHP Fire Management Plan and under advisement/supervision of the Pueblo Parks Fire Group.
- Prescribed burns will only occur during periods of suitable meteorological conditions.
- Archeological sites must be avoided or protected during all prescribed burns under the supervision of an archeologist.
- Care and precautionary measures will be taken for prescribed fire events in riparian areas to protect native cottonwoods and willows from damage due to fire. Debris at the base of mature trees will be removed and supplementary fire lines built to protect patches of vegetation at risk.
- When thinning in an archeological site, debris must be moved out of site but not dragged on the ground and must be supervised by the park biologist or archeologist.

Human Health and Safety

- A Job Hazard Analysis (JHA) will be completed for all tasks. Safety documents, Standard Operating Procedures (SOP), and Accident Plans will be reviewed and revised prior to any fieldwork.
- Safety protocols for storing, mixing, and transporting herbicide, as well as for handling spills and disposing of unused herbicides and containers, will be developed and followed.
- Herbicide will only be applied by trained personnel who are supervised by a park-approved person.
- All herbicide labels will be followed to ensure safe application.
- Visitors will not be allowed in treatment areas during operations. All federal, state, and local regulations regarding herbicide use will always be followed.
- Prescribed fire events will only be carried out during periods of suitable meteorological conditions and with an approved smoke management plan.

Cultural Resources (Visitor Experience)

- Areas will be archeologically surveyed prior to management actions.
- Ground disturbing activities will be prohibited, unless approved by an archeologist.
- All vegetation management work will be coordinated with the park's cultural resource staff.
- If new or unexpected cultural resources are identified within a treatment area, all work will be halted immediately until an appropriate investigation can take place and/or documentation can be completed.

A1.4 A Consideration of the Affected Environment and Environmental Consequences

Vegetation

Vegetation—Affected Environment

Vegetation in the Pecos Unit is comprised of mostly pinyon-juniper woodland and pasture/grassland communities with the occasional element of rabbitbrush shrubland. Riparian and floodplain plant communities are associated with the Pecos River. Ponderosa pine forest and Douglas-fir forest mostly occur at higher elevations (Figure 2-1).

The Cañoncito Subunit contains mostly pinyon-juniper (*Pinus edulis-Juniperus* spp.) woodland and riparian vegetation along Galisteo Creek. This riparian vegetation resembles arroyo riparian habitat with rabbitbrush (*Ericameria* spp.), few scattered relict cottonwoods (*Populus* spp.), and small willows (*Salix* spp.; Johnson et al. 2011).

The Pigeon's Ranch Subunit consists of grassland, pinyon-juniper woodland, and ponderosa pine (*Pinus ponderosa*) woodland, with riparian vegetation along Glorieta Creek.

Conditions at the park are highly variable and to a large degree reflect the types of disturbance and landuse history that has occurred at the site over the last 700 years, as well as environmental fluctuation. Species composition in many areas of the park has likely changed over the various periods of significance. Although threats exist, the site retains a relatively high degree of ecological integrity. However, invasive plant species are widespread across the landscape and are a major threat to integrity and diversity.

Recent data providing information on the conditions of vegetation in Pecos NHP are available from the following sources:

- Report summaries by the Bandelier Interagency Fire Ecology Program for prescribed burns ignited between 2007 and 2013 to try to maintain the open grasslands in historical pastures by stopping or limiting encroachment by pinyon pine and juniper trees (Trader 2011, 2014a, 2014b, 2016; Trader et al. 2008) .

- The Southern Plains Network and Southern Plains Fire Group (SPFG) has monitored grasslands and fire effects plots since 2010 (Folts-Zettner et al. 2012, 2013, 2014a, 2014b).
- The Southern Plains Network also monitors high priority vectors (roads, trails, and park boundaries) for the presence of invasive plants (Folts-Zettner et al. 2010, 2016; Folts-Zettner and Sosinski 2010, 2012a;).
- Romme (2020) conducted a condition assessment and ecological study and identified management strategies for pinyon-juniper woodlands and historical pastures in Pecos NHP.

Unfortunately, vegetation monitoring programs do not exist for other areas of the park, except for monitoring for invasive plants along high priority vectors (roads, trails, and park boundary; Folts-Zettner et al. 2016).

The majority of the treatments that will be applied under this Vegetation Management Plan will take place in the Maintained Pastures, Transitioning Pastures, Pecos Pueblo and Spanish Mission Complex, Other Archeological Sites, Riparian Vegetation, and Historical Orchards spatial units.

Previous Thinning and Prescribed Fire Management Actions

In an effort to maintain pastures at Pecos NHP, pinyon pine and juniper trees were mechanically thinned and masticated in spring 2005. The resulting landscape consisted of areas with occasional pinyon pine and juniper trees; areas with stringers of pinyon pine, juniper, and ponderosa pine trees; sparse to moderately continuous bunchgrasses, forbs, patches of wood chips (from mastication), and bare ground.

From 2007–2013, the Bandelier Interagency Fire Ecology Program and Pecos NHP resource managers used prescribed fire at periodic intervals to maintain the open pastures. The effects of those fire treatments on the vegetation composition and structure were monitored through data collection to determine if fire and resource management objectives were being met. Ultimately, the objective of decreasing the spread of pinyon-juniper into historical pastures was not met. Data collection began in 2006 prior to burning activities. At its peak, the program included a network of 120 monitoring plots distributed throughout the park in areas where fire management treatments were implemented. Figure A1-1 shows prescribed fire locations, year burned, and fire effects plot locations.

Pecos NHP worked with the Bandelier Interagency Fire Ecology Program to develop or maintain existing short-term and long-term monitoring objectives to assess fire management accomplishments and to determine effects of fire management activities on vegetation communities. In the past, levels 1, 2, 3, and 4 monitoring occurred at Pecos NHP using the NPS Fire Monitoring Handbook as a basic guideline (NPS 2003). The following are the levels of fire monitoring:

- Level 1 is environmental monitoring and includes the collection of baseline historical data, such as weather, terrain, and socio-political factors.
- Level 2 is fire behavior monitoring and includes collecting data on fire behavior, weather, smoke, and other factors during fire operations.
- Level 3 monitoring provides information on fuel reduction and vegetative changes resulting from management actions and is primarily collected on permanent monitoring plots.
- Level 4 monitoring is long term and includes monitoring of short-term change variables sampled at the same permanent monitoring plots but over a longer period. Long-term monitoring provides information on significant trends that can help to guide management decisions.

Future monitoring beyond Level 2 at Pecos NHP will have to be individually designed and tailored to Pecos NHP objectives, dependent on available funding. Monitoring will be determined and documented in the treatment/burn plan for all treatments and will be based upon specific treatment objectives.

The most recent data collection by the Bandelier Interagency Fire Ecology Program was in 2016. Summaries of data collected by the Bandelier Interagency Fire Ecology Program in burn areas 3, 13, 14, 17, 18, 19, 21, 22, and 27 are presented below:

Bandelier Interagency Fire Ecology Program Burn Area Project Report Summaries

Burn Areas 18 and 19

Information below summarizes data collected before and after a prescribed fire in Burn Areas 18 & 19 in Pecos NHP (Trader 2016). Burn Area numbers correspond to Pecos NHP pasture labeled numbers. In 2006, twenty vegetation plots were installed and preburn data were collected (Figure A1-1). The prescribed fire occured on March 29, 2007. Data at 1 year postburn were collected in 2007, at 2 years postburn in 2008, at 5 years postburn in 2011, and at 10 years postburn in 2016.

Data suggest that objectives 1 and 3 were met, however objectives 2 and 4 were not met in Burn Areas 18 and 19.

The following treatment objectives and corresponding data results for Burn Areas 18 and 19 are taken directly from the report (Trader 2016):

> **Objective 1: Maintain or increase native species richness and percent cover within 2 years postburn.** The average species richness was higher in all postburn time periods than preburn, except in 2011. The highest average species richness across all time periods was at 10 years postburn (14.1 species). Preburn species richness was 9.9 species (2006).
>
> **Objective 2: No increase in invasive species richness and percent cover within 5 years postburn**. Invasive species richness appears to increase for all data collection periods after the fire. Although the increase in number of species is small—from 3 species at preburn to 5 species at 10 years postburn, the percent increase is large at 66.7%.
>
> **Objective 3: No more than a 10% decrease in shrub density within 5 years postburn**. Using the shrub percent cover information, it appears that shrub average percent cover decreased from 0.2% at preburn (2006) to 0.1% at 1 year postburn (2007). At 2 years postburn (2008), the shrub percent cover decreased to 0%. In 2011 at 5 years postburn, shrub cover had increased to 0.4%. In 2016 at 10 years postburn, shrub cover remained similar to 2011 levels at 0.3%. Across all time periods, the shrub average percent cover has been very low at less then 0.5%.
>
> **Objective 4: Maintain pinyon and juniper seedling, pole, and overstory tree density at less than 10 trees/acre**. Tree seedling density preburn (2006) was 58.0 tree species per acre and increased dramatically to 178.7 seedlings at 2 years postburn (2011). At 10 years postburn (2016), seedlings were at 107.9 seedlings per acre for all species. Live pole tree density remained relatively flat from preburn (2006) to 10 years postburn (2016). There were 0 trees/acre in 2006 and 1.3 trees per acre in 2016. Live overstory density did not change from preburn to 10 years postburn.

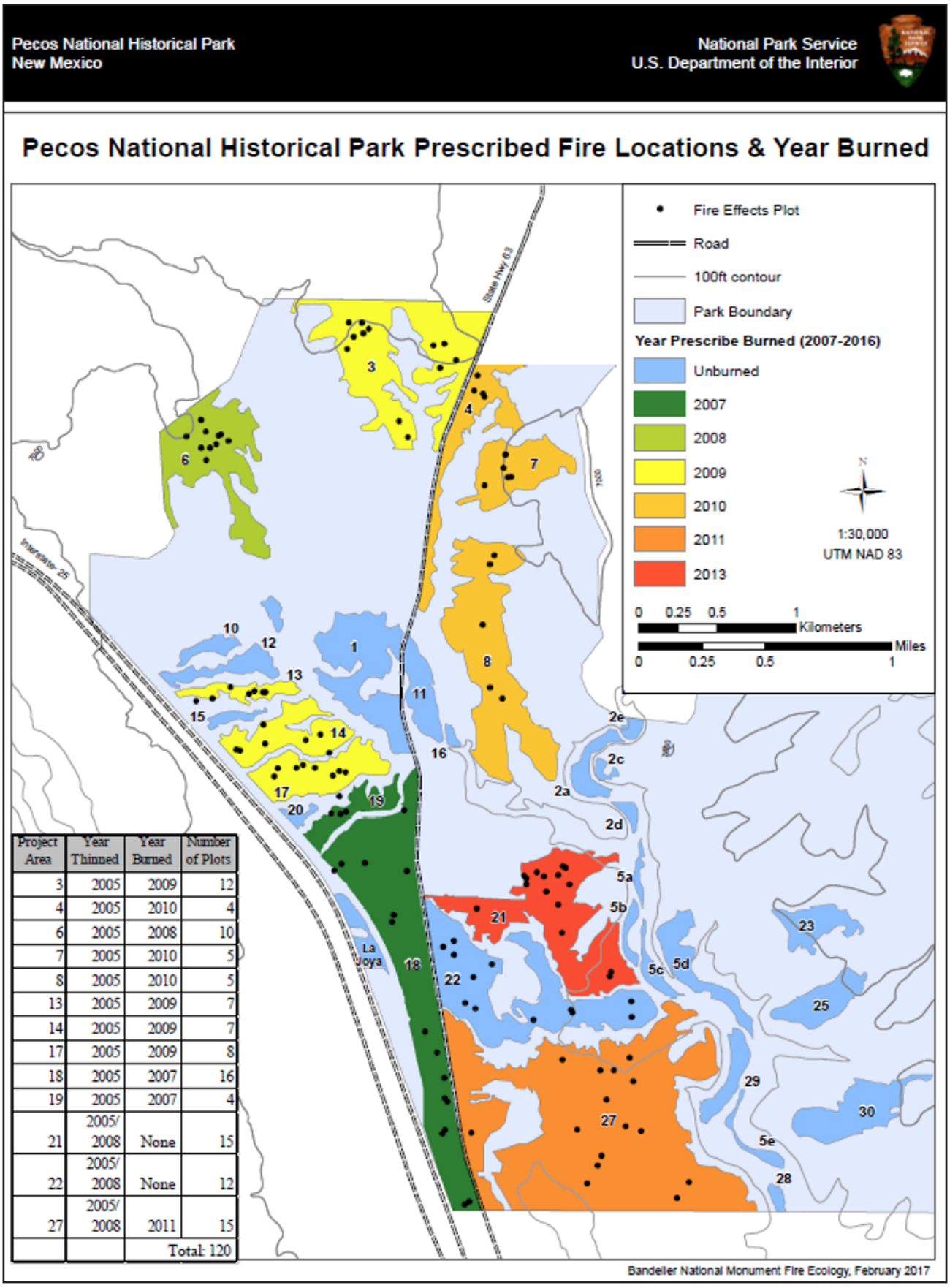
Data suggests that objectives 1 and 3 were met, however objectives 2 and 4 were not met in Burn Areas 18 and 19.

Burn Area 27

In 2009 and 2010, fifteen vegetation plots were installed and preburn data were collected in Burn Area 27 (Figure A1-1). The pasture 27 prescribed burn occurred on April 17, 2012. Data at one year postburn were collected in 2013 and at 2 years postburn in 2014. Data at 5 years postburn were not collected in 2017, and data at 10 years postburn were not collected in 2022.

The following treatment objectives and corresponding data results for Burn Area 27 are taken directly from the report (Trader 2014a):

> **Objective 1: No increase in invasive vegetation percent cover within 5 years postburn.**
> **Objective 2: Increase herbaceous vegetation percent cover by at least 5% within 2 years postburn**. The objective to increase herbaceous vegetation cover by at least 5% within 2 years postburn appears to have been met. The preburn (2009/2010) herbaceous vegetation percent cover was 86.6%, increasing to 92.9% at 2 years postburn. It should be noted that other environmental factors, such as precipitation, influence the percent cover of vegetation.



Project Area	Year Thinned	Year Burned	Number of Plots
3	2005	2009	12
4	2005	2010	4
6	2005	2008	10
7	2005	2010	5
8	2005	2010	5
13	2005	2009	7
14	2005	2009	7
17	2005	2009	8
18	2005	2007	16
19	2005	2007	4
21	2005/ 2008	None	15
22	2005/ 2008	None	12
27	2005/ 2008	2011	15
		Total: 120	

Figure A1-1. Prescribed fire locations, year burned, and fire effects plot locations at Pecos National Historical Park.

In future analyses, precipitation data should also be evaluated. It should be noted that although the objective was met, it appears the increase in herbaceous vegetation is largely due to an increase in invasive vegetation cover, from 1.3% at the preburn period to 8.9% cover at 2 years postburn. However, this increase in invasive plant cover should not be alarming. Invasive vegetation typically increases after a disturbance, such as fire, but native vegetation will often recover and thrive later. Further investigation shows that the increase in invasive vegetation is primarily in the forb category; invasive forb cover increased from 1.2% at preburn to 7.4% at 2 years postburn. Invasive grasses increased from 0.1% at preburn to 1.4% at 2 years postburn. There were no increases in invasive shrubs or trees. Native vegetation average percent cover appears to have stayed about the same, from a preburn cover of 85% to 84.1% at 2 years postburn. Further investigation shows that although the average percent cover remained nearly the same from preburn to 2 years postburn, there was a shift in composition, where native forb cover increased from preburn levels of 9.2% to 27.1% at 2 years postburn, and native grass cover decreased from preburn levels of 70.6% to 51.3% at 2 years postburn.

Objective 3: Decrease shrub percent cover by at least 5% within 2 years postburn. The objective to decrease shrub percent cover by at least 5% within 2 years postburn was not met. The average shrub percent cover was 4.6% at preburn, decreasing to 2.7% at 1 year postburn, and returning to 5.2% at 2 years postburn. This return to preburn levels should not be alarming. A low shrub percent cover can be beneficial to wildlife, and it is recommended that this objective be re-evaluated to consider maintenance and/or increases in shrub cover in this project area.

Objective 4: Maintain pinyon and juniper seedling, pole, and overstory tree density at less than 2 trees/acre. It appears that the objective to maintain pinyon and juniper seedling, pole, and overstory tree density at less than 2 trees per acre was met for pole and overstory-sized trees (none present for all data collection periods), but not for seedling trees. Pinyon pine and juniper seedling tree density was recorded at 21 trees per acre at preburn, and 3 trees per acre at 2 years postburn. It is recommended that this objective be evaluated and adjusted for future prescribed fires. For example, maintaining pinyon pine and juniper trees at less than 10 trees per acre may be more reasonable, while still maintaining the pastures.

Data suggests that objective 2 was met, however objectives 3 and 4 were not met in Burn Area 27. It is inconclusive whether objective 1 was met since there is not a 5-year-postburn data set.

Burn Areas 3, 13, 14, 17

In 2006–2008, 34 vegetation plots were installed and preburn data were collected from Burn Areas 3, 13, 14, and 17 (Figure A1-1). A prescribed fire occured in these areas on November 10, 2009. Data at 1 year postburn were collected in 2010 and at 2 year postburn in 2011. Data were not collected at 5 and 10 years postburn (2014 and 2019, respectively).

The following treatment objectives and corresponding data results for Burn Areas 3, 13, 14, and 17 are taken directly from the report (Trader 2011):

Objective 1: No increase in invasive vegetation percent cover within 5 years postburn. The average percent cover of invasive herbaceous vegetation remained at nearly the same levels throughout the data collection periods preburn (69.9%) to 2 years postburn (68.7% at 1 year postburn and 65.5% at 2 years postburn). Although the data show a very small reduction from preburn to 2 years postburn, this difference is not significant. The invasive herbaceous vegetation average percent cover showed an increase at 1 year postburn (3%), but at 2 years postburn cover was 0.3%, which was slightly below the preburn level of 0.7%.

Objective 2: Increase herbaceous vegetation percent cover by at least 5% within 2 years postburn. The objective to increase herbaceous vegetation percent cover by at least 5% within

2 years postburn was not met. However, there does not appear to be a significant reduction in herbaceous vegetation percent cover. The values across all time periods appear to remain at approximately the same level, 70.4% at preburn, 70.2% at 1 year postburn, and 65.8% at 2 years postburn. Any differences in cover may also be linked to moisture (precipitation).

Objective 3: Decrease shrub percent cover by at least 5% within 2 years postburn. The objective to decrease shrub percent cover by at least 5% within 2 years postburn was met. Shrub average percent cover was reduced from 0.4% at preburn to 0.3% at 2 years postburn, a 25% reduction. However, it should be noted that shrub percent cover was very low at the preburn data collection period, and reduction of shrub density in these project areas may not be necessary. Shrubs add to the diversity on the landscape and provide benefits to wildlife.

Objective 4: Maintain pinyon pine and juniper seedling, pole, and overstory tree density at less than 2 trees/acre. It appears that the objective to maintain pinyon pine and juniper overstory tree density at less than 2 trees/acre has not been met. Average overstory tree density was recorded at 0.4 trees/acre at preburn, and 0.8 trees/acre at 1 year and 2 years postburn. The objective has not been met for both pole-sized and seedling trees. Average pole-sized tree density was recorded at 3.8 trees/acre at preburn and remained at 3.8 trees/acre for each time period. Seedling tree density appears to have increased slightly over time, from 75.5 trees/acre at preburn to 79.7 trees/acre at 1 year postburn, and 82.6 trees/acre at 2 years postburn. These project areas contain a high density of pinyon pine and juniper seedling trees. It is recommended that this objective, at least in terms of seedlings, be re-evaluated for these project areas.

The data suggest that objective 3 was met, however objectives 2 and 4 were not met. It is inconclusive whether objective 1 was met since there is not a 5-year-postburn data set.

Burn Areas 21 and 22

Seventeen vegetation plots were installed and preburn data were collected in Burn Areas 21 and 22 (Figure A1-1). Preburn data were collected once in 2009/2010 and once again in 2012. A prescribed fire was planned for 2014, but ultimately never happened. Currently there are only preburn data available for Burn Area 21.

The following data results for Burn Areas 21 and 22 are taken directly from the report (Trader 2014b). The data results were intended to assist the park with establishing objectives for Burn Areas 21 and 22.

The average vegetation and substrate percent cover varies greatly from 2009/2010 to 2012. No fire and resource management treatments were implemented during this time period; therefore, it is likely that multiple environmental factors contributed to the difference in average percent cover between the two time periods. The primary factor appears to be precipitation. A weather station located near Pecos NHP headquarters recorded precipitation as 18.54 inches in water year (WY) 2009, 17.47 inches in WY 2010, and 8.39 inches in WY 2012, less than half of the previous years.

Low precipitation in WY 2012 appears to have caused or contributed to the decrease in the average vegetation percent cover. The difference between the average percent cover of graminoids (23.9%) over the two time periods is larger than the difference between forb percent cover (11.0%). However, forbs appear to be more affected by the variation in precipitation, as the percent change is larger with forbs (58.73% decrease from 2009/10 to 2012). Graminoids show a 37.52% change (decrease) from 2009/10 to 2012. The average percent cover of shrubs is consistent between the two time periods. It appears that the establishment and growth of shrubs may be less sensitive to variations in precipitation than forbs and graminoids.

Forb species richness decreased from 39 species in WY 2010 to 27 species in 2012, a 30.8% decrease. The species richness of graminoids and shrubs remained the same across the two time periods. Precipitation also likely affected species richness.

Most of the herbaceous vegetation for both time periods is native. The average native percent cover was 82.6% in 2009/2010 and 49.6% in 2012, compared to an invasive component of 3.3% in 2009/10 and 0.9% in 2012. Native grasses have a higher average percent cover than forbs for both time periods.

Herbaceous perennial plants have a higher average percent cover than plants with other lifecycles (annual and biannual) in both 2009/10 (74.4%) and 2012 (49.1%). Because graminoids have a higher average percent cover than forbs for both time periods, we can assume that there is a higher average percent cover of perennial grasses than perennial forbs.

Viewshed

Although invasive plant species are widespread at Pecos NHP, they are generally in low densities except in areas with high disturbance (Southern Plains Network, unpublished data). The primary factor that affects views is pinyon-juniper presence and urban encroachment. While they are part of a natural succession, pinyon-juniper woodlands can interrupt vistas; conversely, they can be an effective screen for anthropogenic impacts. At Pecos NHP, the value of viewsheds is mostly related to the contrast between pinyon-juniper woodland and open pastures. The most important viewsheds are those from which the history of land use can be interpreted to visitors as a connection to the area's ranching lifestyle. These critical viewsheds are those that are most visible as the public travels to the park, to tour locations, and from specific vantage points like the Pecos Pueblo and Spanish Mission Complex, the Forked Lightning Ranch house, and along Ranger Lane and Highway 63.

Maintained Pastures/Grasslands Spatial Unit

The most recent data that provide information on the current condition of vegetation in Pecos NHP is from grasslands and fire effects monitoring in 2015–2018, conducted by the Southern Plains Network (unpublished data). Monitoring of eight representative transects, originally established in 2010 (LT04, LT05, LT07, LT10, LT12, LT16, LT17, and LT19) within the five grassland monitoring units (GMU1-5) provides insights into the condition of each grassland unit (Figure A1-2; Folts-Zettner et al. 2017).

Between 2010 and 2015, grasslands transects were monitored each year, and starting in 2016, they were sampled once every three years.

Native Grass Cover

Table A1-2 summarizes the last 10 years of native grass cover of each long-term transect (GMU1-GMU5) along with the desired amount of cover. All the transects monitored in the spatial unit had one or more sample transects outside of the proposed interim desired value of at least 50% cover of native grasses at least once. Environmental conditions can cause an obvious and natural fluctuation in native grass cover. This is reflected in stable populations in most units. Only transect LT-04 within GMU4 and LT-17 within GMU3 have consistently been below the desired condition. All other transects have recently fluctuated above and below the 50% desired condition, likely corresponding with rainfall. Desired conditions are based on the ecological site descriptions and a comparison of the grasses that are expected for that site to the species actually occurring. In general, within a transect that is outside of the desired condition, the expected grass species are present, but only in limited abundance. Blue grama (*Bouteloua gracilis*) is by far the dominant grass, indicating (along with other species) prolonged overgrazing throughout Pecos NHP in the past. It is possible that the seedbank in some areas may have been depleted of more desirable grasses because of these grazing regimes. It is likely that the grass cover is in a recovery phase after hundreds of years of grazing impacts.

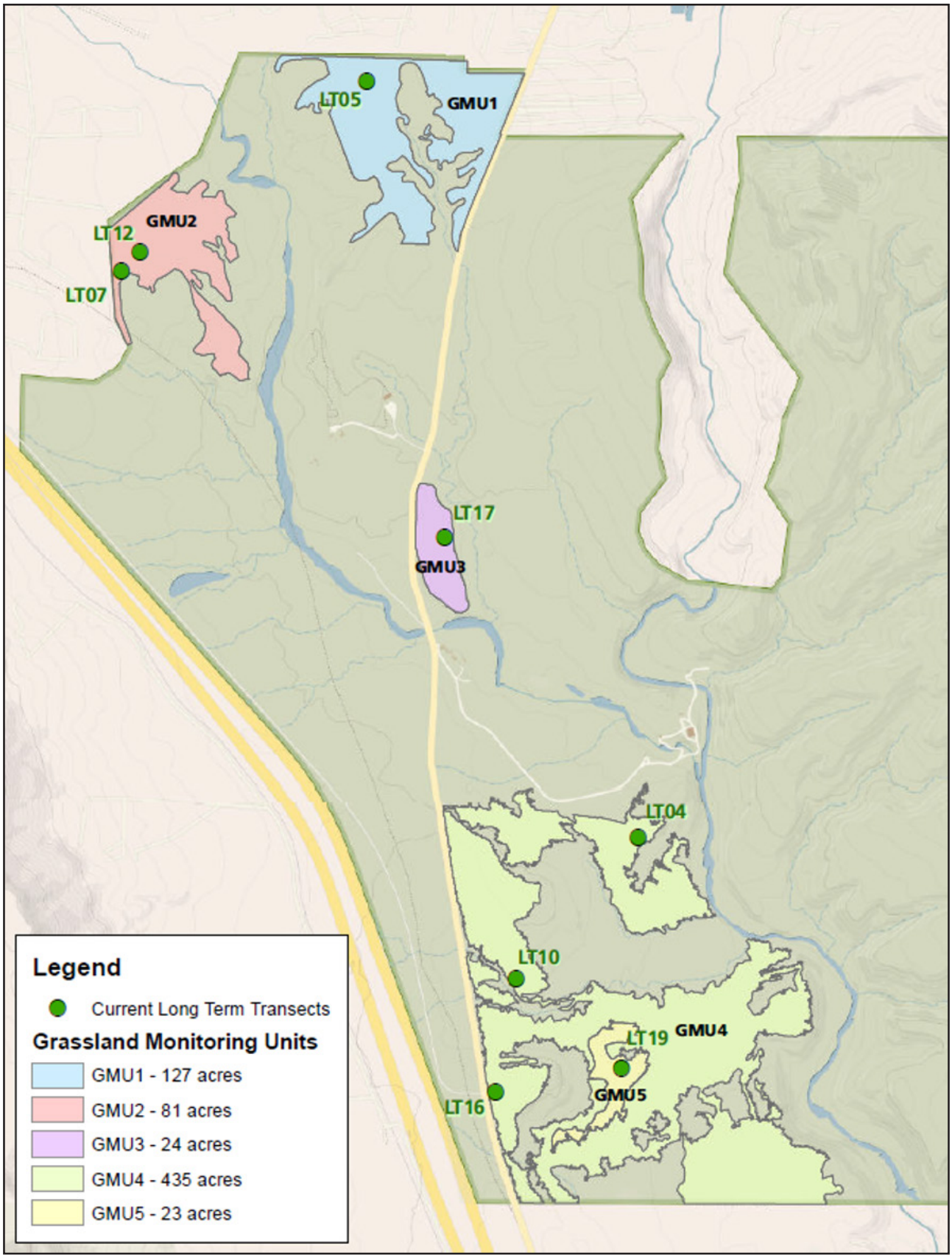


Figure A1-2. Grassland monitoring units and transects.

Table A1-2. Native grass cover of each long-term monitoring unit by year with corresponding desired percent cover. Cells marked with "–" indicate that the transect was not monitored that year. There was an extended drought from 2011–2013.

Field Season	LT-04 (GMU4)	LT-05 (GMU1)	LT-07 (GMU2)	LT-10 (GMU4)	LT-12 (GMU2)	LT-16 (GMU4)	LT-17 (GMU3)	LT-19 (GMU5)	Desired % Cover
2010	48%	51%	71%	65%	72%	62%	67%	77%	50%
2011	–	–	8%	–	–	6%	2%	10%	50%
2012	34%	39%	36%	23%	39%	37%	43%	21%	50%
2013	18%	13%	13%	12%	10%	13%	8%	11%	50%
2014	–	26%	–	47%	42%	60%	45%	–	50%
2015	37%	47%	–	50%	–	62%	33%	91%	50%
2016	21%	–	40%	–	38%	40%	–	64%	50%
2017	–	43%	–	50%	51%	54%	36%	77%	50%
2018	22%	50%	68%	63%	–	–	36%	–	50%
2019	36%	–	48%	–	56%	67%	–	68%	50%

Native Forb Cover

Table A1-3 summarizes the last 10 years of native forb cover of each grasslands transect along with the desirable percent cover. All five monitoring units had one or more transects outside of the proposed interim desired value of at least 20% cover of native forbs. Forb percent cover within a single transect fluctuated widely year-to-year. Forb diversity, however, is quite high. As grasslands mature, forbs diminish unless the area experiences periodic natural disturbance such as wildfire or grazing. Non-natural disturbances that have occurred in the past include fire camps and prescribed burns. Forb abundance at Pecos NHP also appears to fluctuate with annual rainfall, experiencing a burst of bloom the year following the end of drought, then slowly decreases again. As pastures transition from grasslands to pinyon-juniper, forbs may increase.

Table A1-3. Native forb cover of each long-term grassland monitoring unit by year with corresponding desired percent cover. Cells marked with "–" indicate the transect was not monitored that year. There was also an extended drought from 2011–2013.

Field Season	LT-04 (GMU4)	LT-05 (GMU1)	LT-07 (GMU2)	LT-10 (GMU4)	LT-12 (GMU2)	LT-16 (GMU4)	LT-17 (GMU3)	LT-19 (GMU5)	Desired % Cover
2010	8%	12%	15%	21%	40%	28%	28%	3%	20%
2011	–	–	7%	–	–	2%	3%	1%	20%
2012	1%	14%	10%	4%	2%	4%	4%	0%	20%
2013	1%	12%	1%	5%	5%	5%	0%	1%	20%
2014	–	21%	–	31%	25%	37%	26%	–	20%
2015	13%	21%	–	10%	–	30%	20%	3%	20%
2016	4%	–	26%	–	23%	22%	–	10%	20%
2017	–	18%	–	6%	1%	8%	12%	0%	20%
2018	18%	17%	16%	17%	–	–	10%	–	20%
2019	14%	–	20%	–	16%	12%	–	0%	20%

Shrub Cover

Table A1-4 summarizes the last 10 years of native shrub cover of each transect along with the desirable percent cover. Shrubs can invade and degrade a grassland, causing a change in the plant community. There are small patches of rabbitbrush, box elder (*Acer negundo*), and Gambel oak (*Quercus gambelii*) in respective shrubland, riparian, and ponderosa pine units, however these areas are not currently monitored. Shrub cover appears to be increasing in all monitored units, however most of this increase is because of sub-shrubs (fringed sage [*Artemesia frigida*], broom snakeweed [*Gutierrezia sarothrae*], yucca [*Yucca* spp.], and prickly pear [*Opunt*ia spp.]), which are not as concerning as larger shrubs like rabbitbrush. Larger shrubs (rabbitbrush, saplings, etc.) are not increasing or only slowly increasing. GMU1 and GMU4 show an overabundance of sub-shrubs while GMU2 is well within the desired condition of 15% or less cover. GMU3 and GMU5 have been within the desirable range in recent years.

Table A1-4. Native shrub cover of each long-term grasslands monitoring unit by year with corresponding desired percent cover. Cells marked with "–" indicate the transect was not monitored that year. There was also an extended drought from 2011–2013.

Field Season	LT-04 (GMU4)	LT-05 (GMU1)	LT-07 (GMU2)	LT-10 (GMU4)	LT-12 (GMU2)	LT-16 (GMU4)	LT-17 (GMU3)	LT-19 (GMU5)	Desired % Cover
2010	19%	17%	9%	36%	3%	12%	0%	0%	15%
2011	–	–	3%	–	–	4%	0%	0%	15%
2012	3%	9%	4%	15%	6%	6%	2%	0%	15%
2013	1%	2%	2%	8%	1%	2%	1%	0%	15%
2014	–	17%	–	12%	7%	4%	13%	–	15%
2015	37%	36%	–	23%	–	6%	26%	7%	15%
2016	31%	–	7%	–	6%	8%	–	6%	15%
2017	–	21%	–	16%	21%	13%	23%	17%	15%
2018	33%	23%	4%	34%	–	–	14%	–	15%
2019	41%	–	4%	–	7%	15%	–	19%	15%

Native Species Richness

The number of native species expected for ecological site types at Pecos NHP is up to 24 for grass species and 20 for forb species (NRCS 2018). Grasslands monitoring units had between 9 and 15 grass species and between 23 and 55 forb species, generally within the expected species richness for these ecological sites. The NPS proposes an interim desired condition for native species richness of at least 60% of the native species historically present. However, the specific percentages can vary among ecological site types and measurable limits for each site will be refined adaptively over time.

Invasive Species

Table A1-5 summarizes the 2010 to 2019 invasive plant cover data of each grasslands monitoring unit along with the desirable percent cover. Two transects in GMU4 had single measures over the 10% threshold for desired condition for the past decade due to the presence of the invasive plant common purslane (*Portulaca oleracea*). Common purslane is of minor concern because it is a fairly benign invasive species. High-priority invasive species were not observed in the monitoring transects (Table 2-3). Within the grassland landscape, however, monitoring transects have been surprisingly free of invasive species.

Table A1-5. Invasive plant cover of each long-term grassland monitoring unit by year with corresponding desired percent cover. Cells marked with "–" indicate the transect was not monitored that year. There was also an extended drought from 2011–2013.

Field Season	LT-04 (GMU4)	LT-05 (GMU1)	LT-07 (GMU2)	LT-10 (GMU4)	LT-12 (GMU2)	LT-16 (GMU4)	LT-17 (GMU3)	LT-19 (GMU5)	Desired % Cover
2010	1%	7%	1%	2%	0%	3%	0%	0%	<10%
2011	–	–	1%	–	–	0%	0%	0%	<10%
2012	0%	0%	0%	0%	0%	0%	1%	0%	<10%
2013	0%	1%	1%	2%	1%	5%	0%	0%	<10%
2014	–	1%	–	8%	3%	19%	4%	–	<10%
2015	0%	0%	–	0%	–	7%	0%	0%	<10%
2016	0%	–	0%	–	0%	1%	–	0%	<10%
2017	–	0%	–	0%	0%	4%	0%	0%	<10%
2018	2%	4%	3%	11%	–	–	0%	–	<10%
2019	2%	–	0%	–	0%	6%	–	0%	<10%

Exposed Bare Ground

Table A1-6 summarizes the last 10 years of bare ground cover of each grassland monitoring unit along with the desirable percent cover. GMU3 has had numerous readings outside of the proposed desired value of < 30% for exposed bare ground. All other transects had spikes in the percentage of bare ground following a prolonged drought but have recovered well and are now well within the desired condition. Too much bare, unprotected ground facilitates erosion from wind and rain and invites invasion of invasive plants. Some soil pedestaling (an early indicator of erosion) has been observed within the park.

Table A1-6. Bare ground cover of each long-term grassland monitoring unit by year with corresponding desired percent cover. Cells marked with "–" indicate the transect was not monitored that year. There was also an extended drought from 2011–2013.

Field Season	LT-04 (GMU4)	LT-05 (GMU1)	LT-07 (GMU2)	LT-10 (GMU4)	LT-12 (GMU2)	LT-16 (GMU4)	LT-17 (GMU3)	LT-19 (GMU5)	Desired % Cover
2010	17%	13%	6%	9%	11%	11%	13%	12%	<30%
2011	–	–	23%	–	–	35%	49%	37%	<30%
2012	26%	21%	14%	20%	29%	10%	33%	57%	<30%
2013	41%	36%	27%	43%	48%	51%	71%	34%	<30%
2014	–	35%	–	23%	18%	12%	26%	–	<30%
2015	17%	12%	–	10%	–	17%	18%	7%	<30%
2016	25%	–	4%	–	19%	27%	–	16%	<30%
2017	–	18%	–	21%	23%	14%	30%	10%	<30%
2018	22%	18%	12%	10%	–	–	36%	–	<30%
2019	20%	–	24%	–	18%	14%	––	15%	<30%

Pinyon-Juniper Woodland and Transitioning Pastures Spatial Units

Very little project work and monitoring has been done in these spatial units except for management of the pastures associated with Forked Lightning Ranch. In those areas over time there has been periodic removal of trees through mastication, saw crews, and prescribed burns.

Periodically some archeological sites located within the Pinyon-Juniper Forest have been managed for fire abatement. In these areas trees have been thinned or removed to protect the sites.

Riparian Vegetation Spatial Unit

In 2011 and 2016, stream monitoring data (water quantity, water quality, and aquatic macroinvertebrates) were collected on the Pecos River following the Southern Plains Network Streams Monitoring Protocol (Gwilliam et al. 2018). The biggest takeaway from the data were changes in vegetation structure along the river (Gwilliam, unpublished data), particularly increases in shrub type vegetation (especially *Salix exigua*) in the herbaceous, subcanopy and canopy layers. Monitoring data also showed that all size classes of *Populus* spp. were present within the plots along the Pecos River. Previously it had been believed that there was a lack of recruitment of middle-aged cottonwoods (Gwilliam, unpublished data).

The most recent monitoring visit (2021) documented vegetation cover along 20 m transects. Information collected included the following: species/life form frequency, aquatic macrophytes, tree density, DBH, basal diameter, seedling/sapling density, and shrub cover. This was the first resampling since the initial visit in 2011. These plots will next be resampled in 2026 (5-year cycle; Gwilliam et al. 2018). The survey area covers the stretch of the Pecos River that runs from the confluence of Glorieta Creek and the Pecos River near the ranch house to the southern border of the Pecos Unit. A total of 35 invasive plant species were documented. Three new species were discovered: panicles bulrush (*Scirpus microcarpus)*, cloaked bulrush (*Scirpus pallidus*), and invasive curly pondweed (*Potamogeton crispus*).

Pecos Pueblo and Spanish Mission Complex and Other Archeological Sites Spatial Units

The University of Nevada Las Vegas (UNLV) studies on kochia (*Bassia scoparia*) in the Pecos Pueblo and Spanish Mission Complex have been ongoing on since 2016. By October 2020, several studies were concluded. Six different studies consisting of plots and/or transects in the area around the Pueblo and Mission trail were conducted to test management of kochia infestations and re-establish native plants as the dominant cover (Chiquoine and Abella 2023).

UNLV Kochia Study 1 started in July 2016 and continued for two growing seasons (2017 and 2018) in spring, summer, and early fall; the study concluded in the fall 2018. Study 1 tested native seeding application methods: single species direct seeding vs. single species seed balls for establishment of native wildflowers and grasses (Chiquoine and Abella, 2023).

UNLV Kochia Study 2 began in July 2016 and continued through July 2018. Since September 2018, a subset of Study 2 plots has been monitored along with a change in kochia maintenance activities. Plots received factorial combinations of native seeding (4 levels), laboratory-cultivated biocrust inoculation (2 levels), and carbon addition (2 levels) in the form of dry sucrose (i.e., table sugar), totaling 16 treatment combinations. Kochia was weed whacked/brush cut or hand cut from plots during the study period. From 2018 to 2020 the entire area in and around transects 3 and 4 were brush cut and kochia in and around transects 1 and 2 were sprayed with E-2 herbicide in the spring and then brush cut throughout the summer (Chiquoine and Abella 2023).

UNLV Kochia Study 3 began in July 2016 and monitoring concluded in October of 2019 (flagging was also removed). In a 13,750 m^2 area around the Pueblo and Mission trail, forty-eight 3 m × 3 m plots were established. A combination of treatments involving planting nursery-propagated plants (4 levels) and soil treatments (3 levels) were applied to plots (Chiquoine and Abella 2023).

UNLV Kochia Study 4 began in May 2016 and monitoring concluded in September of 2018. Study 4 focused on carbon addition using sucrose at multiple application levels (doses) and weed whacking kochia. Half of a 3,250 m^2 treatment area was weed whacked each growing season (2016–2018) to reduce kochia cover, while kochia was left standing in the other half (Chiquoine and Abella 2023).

The original native plant encouragement Study 5 was implemented in July 2016 and concluded in the spring of 2019. There was a total of 40 plots monitored that had already established native grass patches with the following combination of treatments: no treatment, carbon addition only, herbicide only (2016, 2017: Vista; 2018: E-2), weed whacking only, carbon addition and herbicide, weed whacking and carbon addition, weed whacking and herbicide, weed whacking and carbon addition and herbicide. Overall, 20 of the 40 plots had weed whacking kochia as part of management. Results from the study of the effects of kochia removal (mechanical removal only) on native grasses was published in the journal *Invasive Plant Science and Management* in 2020 (Abella et al. 2020).

Historical Orchards Spatial Unit

Along the east bank of the Pecos River between the Forked Lightning Ranch house and the northern park boundary is the site of the historical Catanach Grist Mill. In addition to the historical structures remaining from the mill period, there are living individuals from an apple orchard that was a part of the mill site. These living apple trees are estimated to be over 100 years old and have the potential to be heritage varieties that are currently rare in the southwest. Because of the important historical context and the potential for the trees to be rare heritage varieties, park staff determined the orchard to be an important resource for preservation and began the management process in 2019 with a basic inventory and by repairing caging around the trees to protect them from beaver damage.

Ponderosa Pine Woodland and Forest and Douglas-fir Forest Spatial Units

Very little project work and monitoring has been done in these spatial units. From 2006 to 2011 there was a vegetation survey to classify vegetation communities of the entire park, which included field surveys of these spatial units (Muldavin et al. 2012).

Rabbitbrush Shrubland Spatial Unit

Periodic management of invasive species using herbicide and hand pulling have been done in the Rabbitbrush Shrubland Unit located within Pasture 1 next to Highway 63. Species removed have included primarily hoary cress (*Cadaria draba*) and Scotch thistle (*Onopordum acanthium*).

Invasive Plants

There are highly invaded areas in some of the spatial units due to a long history of human disturbance. These areas are summarized in Table A1-7. There are limited monitoring data on these infestations.

The Southern Plains Network conducts regular surveys for the presence of invasive plant species along roads, trails, and the park boundary, all vectors for the spread of invasive plants (Folts-Zettner et al. 2016). Each vector is divided into a series of 50 m blocks along its length, with separate blocks designated on either side of the vector (right [R] and left [L] sides). Within each block, a transect is walked parallel to the vector. This transect is set in from the edge of the vector and, when possible, located along the interior edge of the mow strip. Any topographic feature that precludes observation from the transect is noted as unobservable within each block (Folts-Zettner et al. 2016). Sampling has occurred since 2009 and has mainly occurred in the Pecos Unit. Sample locations (Figure A1-3) include roads M1 (Ranger Lane), M6 (Pasture 3 Road), M10 (Well Road), W7 (Headquarters/VC Road, and W5 (paved Visitor Center Road). The Glorieta Battlefield Trail was also surveyed in 2016.

Table A1-7. Highly invaded invasive plant areas of the park.

Area	Species
Pecos Pueblo and Spanish Mission Complex	kochia (*Bassia scoparia*)
Forked Lightning Ranch pastures	Scotch thistle (*Onopordum acanthium*), common mullein (*Verbascum thapsus*)
Roadsides	Scotch thistle, common mullein, yellow sweetclover (*Melilotus officinalis*)
Pecos River	Scotch thistle, common mullein, Canada thistle (*Cirsium arvens*e), oxeye daisy (*Leucanthemum vulgare*), teasel (*Dipsacus fullonum*), yellow sweetclover
Structures	yellow sweetclover, Scotch thistle, common mullein, kochia, Russian thistle (*Salsola tragus*)
Glorieta Creek	yellow sweetclover, musk thistle (*Carduus nut*ans), everlasting peavine (*Lathyrus latifolius*), Scotch thistle, common mullein

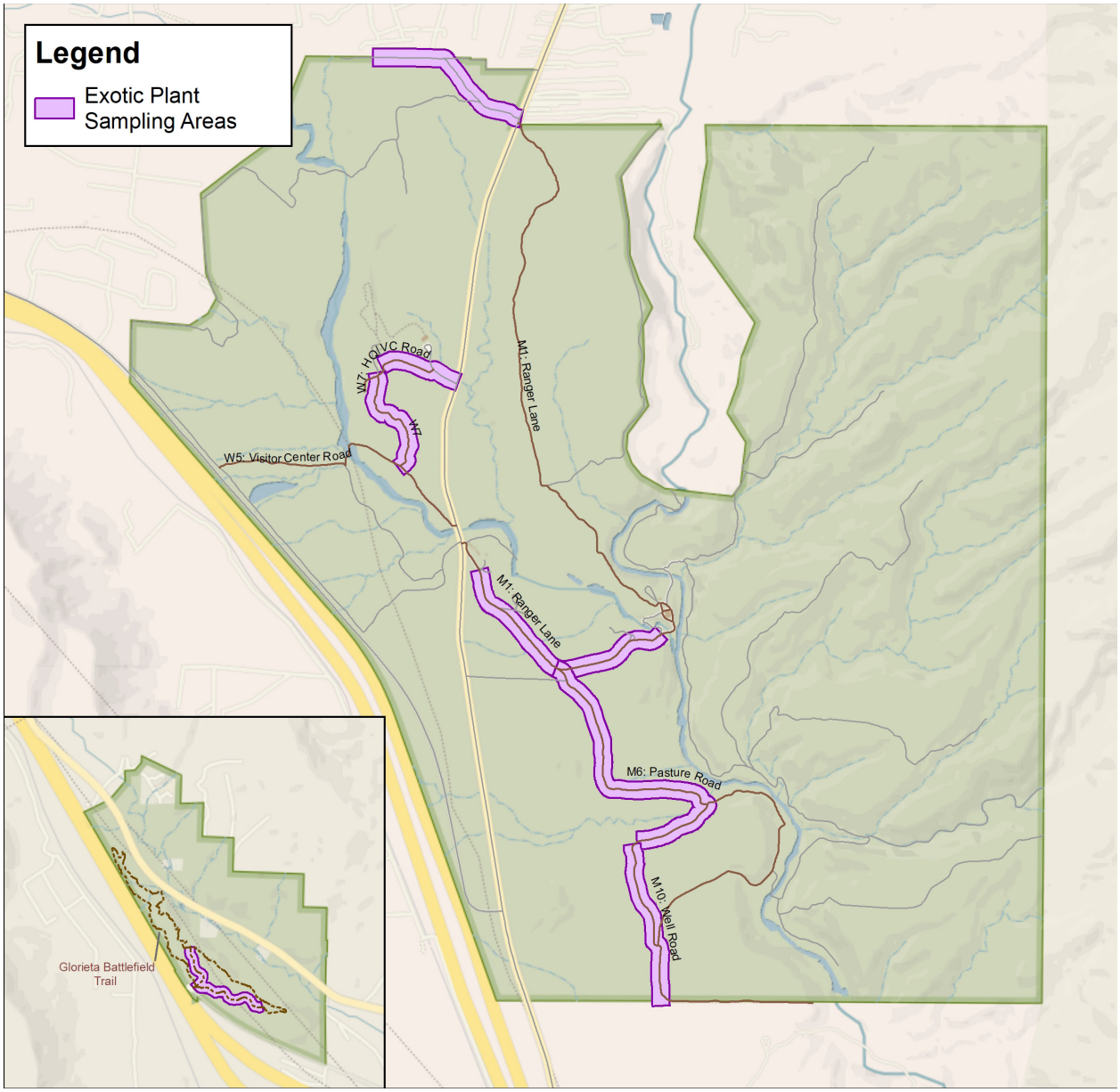


Figure A1-3. Map of exotic plant sampling areas at Pecos National Historical Park.

Impacts of the Vegetation Management Plan

Vegetation—Positive Impacts of the Plan

The desired condition under the plan is for plant communities to correspond to the types and locations where they have historically occurred based on major vegetative communities. Areas may be partially restored over an approximately 20-year period, but the specific timing and degree of restoration depends on many factors including annual rainfall, disturbance events, availability of funds, etc. It is unrealistic to expect complete success because (a) there are several different periods of significance where vegetation exhibited different forms so it isn't possible to precisely define all desired conditions and (b) some areas have been so highly impacted by repeated human use that soils may not support historical plant communities.

Maintained Pastures/Grasslands Spatial Unit

Native Grass Cover

The expected impact of the plan is that maintained pastures at Pecos NHP are dominated by the appropriate native grass species. Blue grama will still be the dominant grass but will have a cohort of other grass species (sideoats grama [*Bouteloua curtipendula*], western wheatgrass [*Pascopyrum smithi*i], muhly species [*Muhlenbergia* sp.], etc.) mixed throughout the site.

Native Forb Cover

The expected impact of the plan is that maintained pastures have the substantial native forb cover that is expected to occur. Achieving this goal may take decades. Most invasive plants at Pecos NHP are forbs and native forbs can typically only become established after invasive forbs have been well-controlled since control methods may also affect native forbs.

Native Species Richness

The expected impact of the plan on species richness is for the number of species to generally correspond to the species richness expected to occur. Achieving the full diversity of expected plant species is probably unrealistic because of some inherent difficulties, including seed availability and climate conditions required. However, achieving an increase of at least 50% of the plant species richness is expected over the next 20 years with active management.

Invasive Plant Species

The expected impact of the plan on invasive plant species in maintained pastures is that they constitute a small portion of the overall vegetative cover (typically <10%). The NPS aims to get all units to the desired condition, but invasive species are well established in the seed bank, commonly occur on private lands surrounding the park (which provides a source of new infestations), and are expensive and require significant manpower to treat. The more realistic expectation is that half of the spatial units may reach this goal in 10–20 years.

Tree Encroachment

Under the plan the desired condition for tree encroachment is that tree density does not exceed 5%.

Shrub Encroachment

Under the plan the desired condition for shrub encroachment is that shrubs and sub-shrubs (e.g., cacti & succulents) do not expand outside their current area and increase in density.

Pinyon-Juniper

Pinyon-juniper woodland will continue to be the dominant vegetation type throughout the park. Its natural structure and density will continue to be highly variable, and periodic disturbances (e.g., fire, insect infestations, and disease) are expected in the future. Under the plan it is expected that tree canopies will vary from very open to nearly closed (10% to 60% cover) and be dominated by pinyon pine with one seed juniper and/or Rocky Mountain juniper as either codominant or subordinate associates. Shrubs in these associations should be scattered and seldom exceed 5% total cover. (NPS and CSU Public Lands History Center 2011).

Under this plan, nearly all trees will be removed from selected historical pastures from the 20th century ranching period and the park will maintain those pastures as trees continue to fill in. For the rest of the park, the ongoing reforestation of the Pecos NHP landscape is a natural ecological process that brings benefits in terms of biodiversity, carbon storage, and the like. No more than 10% of the canopy cover should be invasive plant species.

Riparian Vegetation

Woodland Riparian Vegetation

Under this plan it is expected that overstory of native vegetation will reflect the species composition and age-class distribution of the riparian communities as they existed during the 1990s when the park acquired the land. The distribution of mature trees and associated reproduction rates should be sufficient to sustain the population. However, the specific desired percentage cover or density of individual species is not well known. No more than 10% of the canopy cover will be invasive plant species.

Beaver exclosures (e.g., wire mesh cages) will be utilized and maintained to protect many of the mature cottonwoods (estimated to be in the hundreds) along the Pecos River in the park. Exclosures around living cottonwoods will be evaluated and enlarged or repaired if necessary. Some young cottonwoods may also be caged to promote a diversity of age classes; currently, mostly mature cottonwoods are present.

At this time, the desired condition is either met or natural recruitment is already occurring, and the desired condition is expected to be met without park management intervention.

Shrub Riparian Vegetation

Under this plan it is expected that streambank vegetation is comprised of willow communities that have root masses capable of withstanding high streamflow events. Populations are expected to continue expanding. No more than 10% of the canopy cover should be invasive plant species. If erosion and deposition along the streambed become problematic, bank stabilization efforts may be needed.

Rush and Sedge Wetland Riparian Vegetation

Under the plan, it is expected that rush and sedge wetlands native plant communities will be restored to their former range and woody stem densities. Fuel loads will be managed when they become excessive and pose a fire risk. Rush and sedge wetlands provide benefits such as limiting erosion and increasing plant and wildlife diversity at the park.

Ponderosa Pine Woodland and Forest and Douglas-fir Forest

Under this plan it is expected that younger age classes of both ponderosa pine and Douglas-fir will become more prevalent. This can create ladder fuels in the understory that favor crown fires and a commensurate decrease in fine fuels that support surface fires. Hence, for dry, mixed conifer and ponderosa pine forests, a shift may occur from a mixed-surface/crown-fire fire regime to a greater prevalence of larger stand-replacement fires. Similarly, ponderosa pine savannas may undergo a reduction in grass cover and may shift to a mixed- or stand-replacement fire regime.

There is a lack of information about the increase in young ponderosa pine density within the woodlands and savanna, but saplings and poles have been observed in these areas. These stands need to be evaluated if the density is high enough to pose an increased risk of crown fire.

Rabbitbrush Shrubland

Under this plan, rabbitbrush shrubland is expected to continue to be a minor component of the vegetation types at Pecos NHP and mostly limited to areas where it is already established.

Soil Stability, Erosion, and Bare Ground

The extent of bare ground is used as an indicator of the potential for excessive soil erosion. Only one area had a value in line with the interim desired condition (GMU 3). A reduction in proportion of bare ground for this area over the next 10–20 years is anticipated and will likely continue over the next several decades. Overall bare soil should never exceed 30%

Vegetation—Negative Impacts of the Vegetation Management Plan

The primary negative impacts of the plan are (1) the potential to affect non-target species with chemical treatments for invasives, (2) the potential for seeds of invasive plants to be transported by equipment, and (3) the potential for surface disturbance from mechanical treatments enabling an increase of invasive plants and/or erosion.

Potential to Affect Non-Target Species Using Chemical Measures

Most of the herbicides used to control invasive species are broad-leaf herbicides that tend to kill forbs, including native species, while grasses remain unharmed. Herbicide use will affect very few native forbs when herbicide spot application is done carefully. When broadcast spraying monocultures of invasive species, some native forbs will likely be affected. Native forbs may be impacted when they receive an indirect application from overspray or wind drift; however, it is possible for partially sprayed native forbs to recover after chemical treatments.

Potential for Invasive Seed Transport

Propagules of invasive plant species are easily transported by equipment, vehicles, and even boots. This is a problem for any restoration or other management action. To combat unintentional introduction of any plant propagule, good sanitation is mandatory. Equipment and vehicles should be washed prior to moving into new areas and all personal apparel and gear should be inspected for seed presence. Areas that are disturbed from maintenance or construction activities should be monitored during and after work is completed so that new infestations can be treated.

The Potential for Surface Disturbance from Mechanical Treatments to Increase Invasive Plants and/or Erosion

Mechanical treatment (mastication, light surface disking, furrowing, drill seeding) can result in the invasion and/or increase of some invasive species, increased potential for wind and/or water erosion, and disturbance to archeological sites. Because mechanical treatments often occur as part of a larger restoration effort, such treatments typically occur in conjunction with planting native vegetation and treatment of invasive plants. Thus, impacts of mechanical treatments should be of short duration (1–3 months for an increase in erosion potential and 1–2 years for the potential for invasive species). Consequently, the impact on native vegetation should likely be negligible.

Vegetation—Importance of the Positive and Negative Impacts of the Plan

Maintaining, and restoring where necessary, native vegetation communities that comprise the historical and prehistorical setting contributes to park significance because it preserves the interconnectedness between the natural and cultural environments. While any effort to restore, improve, or maintain the vegetation communities is subject to varying natural conditions (rainfall, droughts, disturbance events, etc.) the plan, and its adaptive nature, offers an ongoing process of continual improvement that should ultimately help sites reach desired conditions. Fully achieving desired conditions may realistically take several decades.

In contrast, the negative impacts to native vegetation of the plan are likely to affect very few non-target native plants, occur over a very small area, and be very short in duration. Thus, the negative impacts are largely inconsequential.

Cultural Landscapes—Impacts of the Plan

Cultural Landscapes—Affected Environment

The National Register, which maintains the official list of the nation's historic places worthy of preservation, recognizes a district boundary at Pecos NHP containing 6,703 acres (2,713 hectares) across the three units (Figure 1-1). The period of significance for the historic district spans from 6,000 years before present to 1970 CE, but there is evidence of use as far back as 12,000 years ago (one Folsom point fragment has been found within the park). While the park's cultural landscapes are still being studied and defined, a few major contributors of the Pecos Unit are the buildings and landscape features of Forked Lightning Ranch, including historical pastures and roads; the archeological sites and features in the Pecos Pueblo/Spanish Mission Complex area; the Santa Fe Trail ruts; and other historical roads that are remnants of circulation features. In the Glorieta Unit, there are the archeological sites, historical buildings, viewsheds, and circulation features associated with the Civil War Battle of Glorieta Pass.

Based on the Cultural Landscape Inventory (Mardorf 2013), the contributing features that are most relevant to vegetation management are (1) views of the historical pastures from visitor use or interpretive areas, (2) the shortgrass prairie/grassland vegetation in certain historically grazed areas (maintained pastures), (3) circulation and access features related to human movement such as roads or trails that are visible, and some are open for continued use, (4) the riparian vegetation associated with the Pecos River and Glorieta Creek, and (5) the viewsheds, topographic features, and archeological sites associated with the Battle of Glorieta Pass.

Views of the Historical Pasture Grasslands Associated with the Forked Lightning Ranch

Views of the open pasture grasslands associated with Forked Lightning Ranch are critical for interpreting the history of ranching in the area. The natural and cultural resources of the ranch are specified in the enabling legislation that added the property. Several viewsheds of pasture areas are important including the following:

1. Views from Highway 63 to the east extending to the Pecos River, and at the north end of the highway both east and west to the edge of Glorieta Creek (Figure A1-4).
2. Views from the porch of the Forked Lightning Ranch house to the south, southwest, and west (Figure A1-5).
3. Views from vantage points along the main interpretive ruins trail at the Pecos Pueblo and Spanish Mission Complex, mainly looking to the east towards the Pecos River and Tecolote Range (Figure A1-6).
4. Views of pastures visible from Ranger Lane since ranch tours interpret the ranch landscape along this drive (Figure A1-7).

The views of the open pasture areas provide opportunities to educate visitors about livestock use and ranching, but also about environmental change, historical changes in land use, economy and subsistence, Spanish colonial influences and introductions, and climate change. If not for centuries of clearing of pinyon-juniper woodlands to create these open pasture grasslands, the entire area would be dense pinyon-juniper woodlands.



Figure A1-4. Views of pastures to the east of Highway 63 towards the Pecos River.



Figure A1-5. Views of pastures from the front porch of the Forked Lightning Ranch house looking south.



Figure A1-6. Views looking east (left) and south (right) from the main interpretive ruins trail.



Figure A1-7. Views to the south (left) and north (right) of Ranger Lane.

Views of the Pecos Pueblo and Spanish Mission

Views of the pueblo and mission are presently available from many different locations and under the plan will be maintained. Management will involve cutting of trees to maintain these important viewsheds but these cuts should be minor since the Pecos Pueblo and Spanish Mission are on the small mesa (Figure A1-6, right photograph) above the pinyon-juniper tree line. The open area to the east of the pueblo and mission, often called the "Trade Fair" (Figure A1-6, left photograph) should remain open naturally, but if trees do begin to encroach on this area, they will be removed to preserve this important cultural landscape and viewscape.

Views of the Riparian Vegetation Associated with The Pecos River

The affected environment of the cultural landscape for riparian vegetation is essentially the same as was previously discussed under the impacts to vegetation. Significant views include from the Ranger Lane bridge (Figure A1-8) and from the ranch house looking south (Figure A1-5).



Figure A1-8. View of riparian vegetation at the confluence with the Pecos River and Glorieta Creek from Ranger Lane bridge in fall 2020.

Cultural Landscapes—Positive Impacts of the Proposed Alternative

Views of the Historical Pasture Grasslands Associated with Forked Lightning Ranch

Most of the vegetation management related to historical pastures and viewsheds should be beneficial to significant cultural landscapes associated with Forked Lightning Ranch. The most important viewsheds will be maintained and kept mostly free of trees so their value can be maximized to help tell the story of the historical era ranching in the area and land use in general.

Views of the Pecos Pueblo and Spanish Mission

Vegetation management surrounding Pecos Pueblo and Spanish Mission will continue as in the past, resulting in the maintenance of viewsheds of the pueblo and mission. The Forked Lightning Ranch pastures seen from the interpretive trail at the ruins will be maintained as well, so that the story of land use and change can be told from this location.

Views of the Riparian Vegetation Associated with the Pecos River

Riparian vegetation and the views associated with riparian areas will be maintained by promoting healthy riparian and wetland ecosystems and the vegetation community, consisting of an overstory of cottonwoods and willows and an understory of native shrubs, grasses, and forbs.

Cultural Landscapes—Negative Impacts of the Proposed Alternative

Views of the Historical Pasture Grasslands Associated with Forked Lightning Ranch

The views of the pasture grasslands associated with Forked Lightning Ranch will largely be maintained as part of the plan. However, the park will let the pastures in the Transitioning Pastures spatial unit revert to juniper savanna or woodlands.

The pastures in the Transitioning Pasture spatial unit are all located west of Highway 63. These pastures are not located in actively interpreted areas and are less iconic and less informative to visitors (Figure A1-9 and A1-10).



Figure A1-9. View to the northwest of pastures west of Highway 63 that will receive fewer treatments.

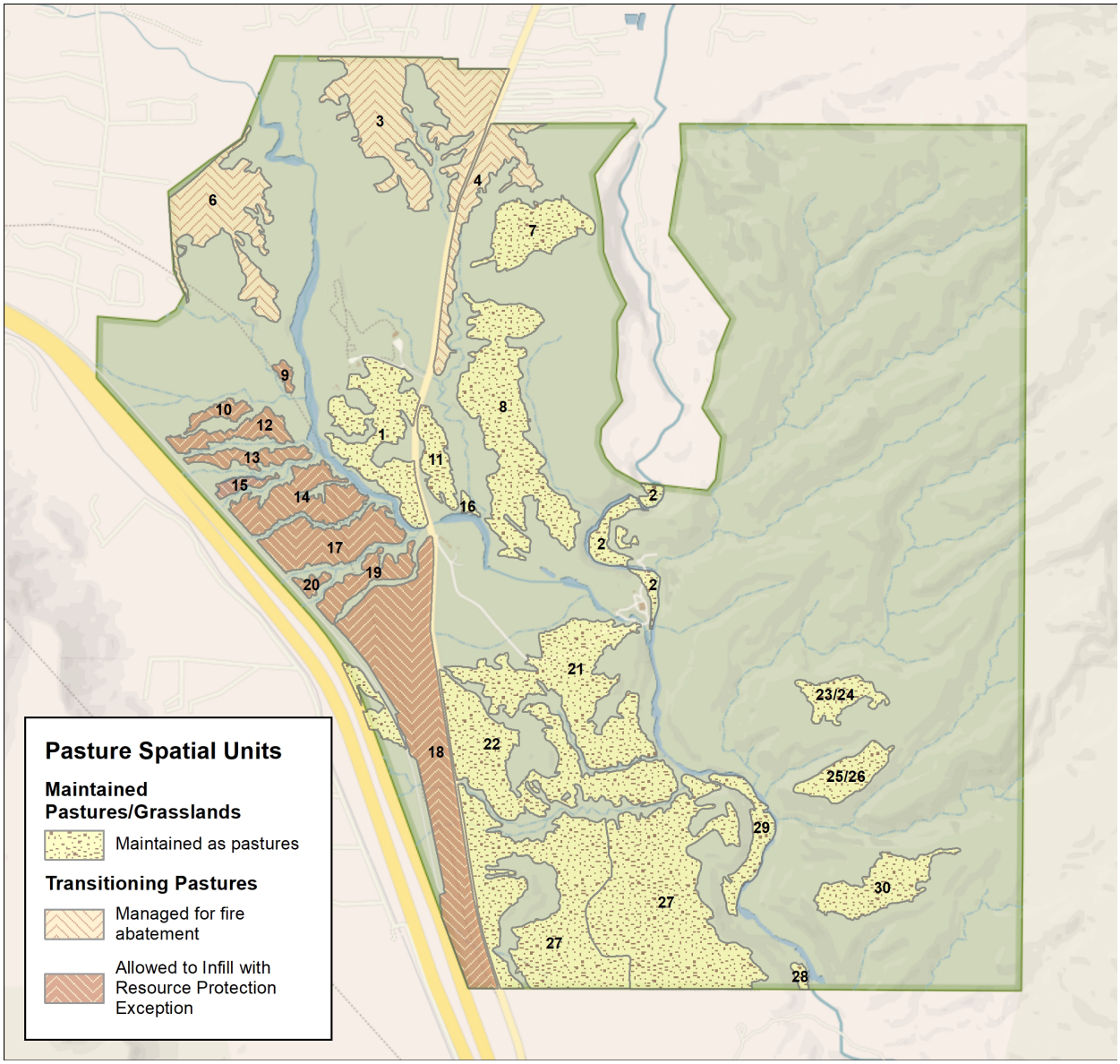


Figure A1-10. Location of Pastures/Grasslands and Transitioning Pastures spatial units.

Tree density in Pasture 18 is low as this area is transitioning to shrubland (Figure A1-11). Future tree growth should not obscure the view of Glorieta Mesa and the Sangre de Cristo Mountains. Pasture 18 also has some small groves of ponderosa pine trees that are 60 cm in diameter and more than 100 years old. The park will maintain the current open stand condition in and near these ponderosa pine groves for visual and ecological diversity (Figure A1-12).

The park recognizes that letting the grasslands in the Maintained Pastures spatial unit fill in will change a small portion of the character of the landscape, especially the viewshed looking west along Highway 63 approaching the park from I-25.



Figure A1-11. View from the parks southern boundary from Highway 63 looking northwest towards Glorieta Pass across Pasture 18. Fewer treatments will be done in this area; however, tree density is low as this area is transitioning to shrubland. Future tree growth should not obscure the view of Florieta Mesa and the Sangre de Cristo Mountains.



Figure A1-12. Ponderosa pine stand in Pasture 18 that will be preserved; looking northwest, west of Highway 63.

Views of the Pecos Pueblo and Spanish Mission

Negative impacts on views of the Pecos Pueblo and Spanish Mission in the context of a cultural landscape are not anticipated.

Views of the Riparian Vegetation Associated with the Pecos River

Negative impacts on riparian vegetation in the context of the cultural landscape are not anticipated.

Archeological Sites — Impact Assessment

Affected Environment

The park preserves over 800 archeological sites that occur in every major vegetation type. These sites range from highly visible prehistoric structural rubble mounds to artifact scatters. Archeological sites are protected under National Historic Preservation Act (NHPA) Section 106 and Section 110 and should be considered in the context of this plan and during implementation of all types of treatments.

Archeological Sites – Positive Impacts

The positive impacts of this plan to archeological sites are mostly related to keeping trees from growing within them and reducing the fuel loads in surrounding woodlands so that wildland fires should not severely damage archeological sites. In addition, restoration work (seeding, planting, erosion control, etc) and control of invasive plants may help stabilize some archeological sites, depending on the root systems involved. Keeping archeological sites free of trees may also assist with their active management, condition assessments, and interpretation.

Archeological Sites – Negative Impacts

Negative impacts of some of the actions considered in this plan are mostly related to whether the park can achieve the objectives of keeping trees out of archeological sites (funding and staffing), especially in the Transitioning Pastures spatial unit. As this in-filling occurs, some archeological sites, including the Santa Fe Trail ruts/swales, may be damaged and obscured by tree growth if trees are not actively removed. Also, hazardous fuels conditions are possible in some areas if vegetation and trees are not thinned on schedule, which could contribute to high intensity fires that damage archeological sites.

The use of machinery like masticators to remove trees may also damage archeological sites if mitigations measures are not taken or if sites are not avoided. Weed whacking to cut invasive plants may damage or displace artifacts if done too close to the ground. Also, in some locations invasive plants may be stabilizing soils with cultural material. If these are treated and no other growth is anticipated for restoration to native plants, then increased erosion could cause loss of cultural materials. Use of ATVs off established roads to conduct invasive plant treatments may also damage sites if they are not flagged and avoided.

In general, most of the proposed vegetation management actions will require project and site specific NHPA S106 compliance and possibly consultation with SHPO to make sure sites are protected. Negative impacts should mostly result from a lack of project planning or a wildland fire that burns at high intensity. All projects should be planned and monitored in collaboration with cultural resource staff.

Visitor Experience

This plan has considered aspects of the desired visitor experience at Pecos NHP, specifically those related to interpretation of the cultural landscapes of Forked Lightning Ranch and significant viewsheds. The park is committed to helping the public understand the history of the ranch, general ranching in New Mexico, and how land use has affected the natural environment. These topics are also a useful nexus for discussing climate change. The park is also interested in having diverse and healthy riparian areas to bring visitors to these locations and conduct educational programs focused on these important systems. Therefore, vegetation management for desired conditions, as outlined in this plan, facilitates many visitor experiences related to land use and environmental education and stewardship fulfilling the NPS mission of stewardship and education.

Visitor Experience – Positive Impacts

This plan should result in positive impacts to visitor experience by giving the park flexibility to manage pastures, viewsheds, and ecosystems for interpretation and education. Managing for diversity and with a consideration of cultural landscapes and education will also offer a richer experience and more educational opportunities focused on stewardship and land use.

Keeping trees from growing in and obscuring archeological sites that are visited by the public during tours will protect resources and improve and sustain positive visitor experiences and a deeper connection with archeological resources. This is especially the case within the Pecos Pueblo and Spanish Mission Complex area and other sites, like Forked Lightning Pueblo, Arrowhead, and the Lost Church.

Visitor Experience – Negative Impacts

Some of the actions in this plan could have negative short-term impacts to visitors, primarily from the use of machinery and prescribed fire near visitor use areas. Noise and smoke could negatively impact visitors for a short period of time; however, the long-term benefits of managing vegetation for diversity and resiliency should improve visitor experiences.

A1.5 Consultation and Coordination

This vegetation management plan was developed in consultation with

1. Park staff, including Jeremy Moss (Chief of Resource Stewardship and Science), Eric Lassance (Park Biologist), Karl Cordova (Superintendent), Kris Whitbeck (Former Park Biologist), Kevin Lash (Former Biological Science Technician)
2. The NPS Pueblo Parks Fire Group (Marla Rodgers and Fabian Montano)
3. The NPS Southern Plains Fire Group (Richard Gatewood and Jeremiah Bonilla)
4. The NPS Southwest Invasive Plant Management Team (Frankie Foley and Jeffery Conn)
5. The Southern Plains Inventory and Monitoring Network (Andy Ray, Tomye Folts-Zettner, and Heidi Sosinski)
6. The NPS Inventory and Monitoring Division (Robert Bennetts)
7. Scientists at University of Oregon (Robert Melnick and Tim Seastadt)
8. Intermountain Region Cultural Landscape Program (Julie McGilvray; currently Cultural Resources Program Manager at Guadalupe Mountains National Park)
9. Intermountain Region, Environmental Quality Division (Heather Rice)
10. Intermountain Region, Wildlife Division (Kristen Philbrook)
11. Colorado State University (William H. Romme)

Attachment 2. Plant Species List

Table A2-1. Plant species list for Pecos National Historical Park. Veg Code: six letter abbreviation of the scientific name. Nativity: N = native plant, Ex = exotic (non-native) plant. Synonyms: other scientific names used for the species. Abundance in Pecos NHP: A = abundant, C = common, U = uncommon, R = rare, P = present. Voucher: Yes or No indicates if there is a vouchered specimen collected by Natural Heritage New Mexico (Chauvin 2015).

Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Aceraceae	ACENEG	N	*Acer negundo*	*Negundo mexicanum; Rulac negundo; Rulac texana*	P	Y
Agavaceae	YUCBAC	N	*Yucca baccata*	–	U	Y
Agavaceae	YUCBAI	N	*Yucca baileyi*	*Yucca intermedia*	P	Y
Agavaceae	YUCGLA	N	*Yucca glauca*	*Yucca angustifolia; Yucca glauca* var. *glauca; Yucca glauca* var. *gurneyi*	C	Y
Amaranthaceae	ALTCAR	N	*Alternanthera caracasana*	*Achyranthes peploides; Alternanthera peploides*	P	–
Amaranthaceae	AMAALB	Ex	*Amaranthus albus*	–	–	–
Amaranthaceae	AMAARE	N	*Amaranthus arenicola*	*Amaranthus torreyi*	P	–
Amaranthaceae	AMAHYB	Ex	*Amaranthus hybridus*	–	–	–
Amaranthaceae	AMARET	Ex	*Amaranthus retroflexus*	–	–	–
Amaranthaceae	AMASPI	N	*Amaranthus spinosus*	–	P	–
Anacardiaceae	RHUTRI	N	*Rhus trilobata*	*Rhus aromatica*	C	Y
Anacardiaceae	TOXRYD	N	*Toxicodendron rydbergii*	*Rhus radicans* var. *rydbergii; Rhus radicans* var. *vulgaris; Rhus toxicodendron* var. *vulgaris; Toxicodendron desertorum; Toxicodendron radicans* var. *rydbergii*	R	–
Apiaceae	ALEFIL	N	*Aletes filifolius*	–	P	Y
Apiaceae	CICMAC	N	*Cicuta maculata*	–	P	Y
Apiaceae	CONMAC	Ex	*Conium maculatum*	–	P	Y
Apiaceae	CYMACA	N	*Cymopterus acaulis*	–	C	–
Apiaceae	HARTRA	N	*Harbouria trachypleura*	–	U	–
Apiaceae	PSEMON	N	*Pseudocymopterus montanus*	*Cymopterus lemmonii; Pseudocymopterus tidestromii; Thaspium montanum*	P	Y
Apocynaceae	APOCAN	N	*Apocynum cannabinum*	*Apocynum cannabinum* var. *angustifolium; Apocynum cannabinum* var. *glaberrimum; Apocynum cannabinum* var. *greeneanum; Apocynum cannabinum* var. *hypericifolium; Apocynum cannabinum* var. *nemorale; Apocynum cannabinum* var. *pubescens; Apocynum cannabinum* var. *suksdorfii; Apocynum hypericifolium; Apocynum pubescens; Apocynum sibiricum; Apocynum cannabinum* var. *cordiferum; Apocynum cannabinum* var. *farwellii; Apocynum cannabinum* var. *salignum; Apocynum suksdorfii; Apocynum suksdorfii* var. *angustifolium; Apocynum suskdorfii*	U	–

Table A2-1 (continued). Plant species list for Pecos National Historical Park. Veg Code: six letter abbreviation of the scientific name. Nativity: N = native plant, Ex = exotic (non-native) plant. Synonyms: other scientific names used for the species. Abundance in Pecos NHP: A = abundant, C = common, U = uncommon, R = rare, P = present. Voucher: Yes or No indicates if there is a vouchered specimen collected by Natural Heritage New Mexico (Chauvin 2015).

Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Asclepiadaceae	ASCINV	N	*Asclepias involucrata*	*Asclepias macrosperma*	R	Y
Asclepiadaceae	ASCMAC	N	*Asclepias macrotis*	–	P	–
Asclepiadaceae	ASCSUB	N	*Asclepias subverticillata*	*Asclepias galioides*	R	Y
Asclepiadaceae	ASCTUB	N	*Asclepias tuberosa*	*Acerates floridana*	R	–
Asclepiadaceae	ASCUNC	N	*Asclepias uncialis*	–	R	–
Asclepiadaceae	ASCVIR2	N	*Asclepias viridiflora*	*Acerates viridiflora*; *Acerates viridiflora* var. *ivesii*; *Acerates viridiflora* var. *linearis*; *Asclepias viridiflora* var. *lanceolata*; *Asclepias viridiflora* var. *linearis*	P	–
Asteraceae	ACHMIL	N	*Achillea millefolium*	*Achillea millefolium* var. *occidentalis*	C	Y
Asteraceae	ACRREP	Ex	*Acroptilon repens*	*Rhaponticum repens*	P	–
Asteraceae	AGEHER	N	*Ageratina herbacea*	*Eupatorium herbaceum*	P	Y
Asteraceae	AGOPAR	N	*Agoseris parviflora*	–	–	–
Asteraceae	AMBART	N	*Ambrosia artemisiifolia*	*Ambrosia artemisiifolia* var. *artemisiifolia*' *Ambrosia artemisiifolia* var. *elatior*; *Ambrosia artemisiifolia* var. *paniculata*; *Ambrosia elatior*; *Ambrosia glandulosa*; *Ambrosia maritima*; *Ambrosia monophylla*; *Ambrosia paniculata*	P	Y
Asteraceae	AMBPSI	N	*Ambrosia psilostachya*	*Ambrosia californica*; *Ambrosia coronopifolia*; *Ambrosia cumanensis*; *Ambrosia psilostachya* var. *californica*; *Ambrosia psilostachya* var. *coronopifolia*; *Ambrosia psilostachya* var. *lindheimeriana*; *Ambrosia rugelii*	P	Y
Asteraceae	ANTPAR2	N	*Antennaria parvifolia*	–		–
Asteraceae	ANTROS	N	*Antennaria rosulata*	–	R	–
Asteraceae	ARCMIN	Ex	*Arctium minus*	*Lappa minor*	P	–
Asteraceae	ARTCAR	N	*Artemisia carruthii*	*Artemisia carruthii* var. *wrightii*; *Artemisia kansana*	P	Y
Asteraceae	ARTDRA	N	*Artemisia dracunculus*	*Artemisia dracunculus* ssp. *dracunculus*; *Artemisia dracunculoides*; *Artemisia dracunculoides* var. *dracunculina*; *Artemisia dracunculus* var. *glauca*; *Artemisia dracunculus* ssp. *glauca*; *Artemisia glauca*; *Artemisia glauca* var. *dracunculina*; *Oligosporus dracunculus*; *Oligosporus dracunculus* ssp. *dracunculinus*; *Oligosporus dracunculus* ssp. *glaucus*	C	–
Asteraceae	ARTFIL	N	*Artemisia filifolia*	*Oligosporus filifolius*	C	–
Asteraceae	ARTFRI	N	*Artemisia frigida*	*Artemisia frigida* var. *williamsiae*	P	Y
Asteraceae	ARTLUD	N	*Artemisia ludoviciana*	–	P	Y

Table A2-1 (continued). Plant species list for Pecos National Historical Park. Veg Code: six letter abbreviation of the scientific name. Nativity: N = native plant, Ex = exotic (non-native) plant. Synonyms: other scientific names used for the species. Abundance in Pecos NHP: A = abundant, C = common, U = uncommon, R = rare, P = present. Voucher: Yes or No indicates if there is a vouchered specimen collected by Natural Heritage New Mexico (Chauvin 2015).

Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Asteraceae	BACWRI	N	*Baccharis wrightii*	–	P	–
Asteraceae	BAHDIS	N	*Bahia dissecta*	*Amauria dissecta*	P	Y
Asteraceae	BRIBRA	N	*Brickellia brachyphylla*	*Brickellia brachyphylla* var. *brachyphylla*	P	Y
Asteraceae	BRIEUP	N	*Brickellia eupatorioides*	–	U	Y
Asteraceae	BRIGRA	N	*Brickellia grandiflora*	*Brickellia grandiflora* var. *petiolaris; Coleosanthus grandiflorus*	C	–
Asteraceae	BRIFEN	N	*Brickelliastrum fendleri*	*Brickellia fendleri; Eupatorium fendleri; Steviopsis fendleri*	P	Y
Asteraceae	CARNUT	Ex	*Carduus nutans*	–	–	–
Asteraceae	CHAERI	N	*Chaetopappa ericoides*	*Aster arenosus; Aster hirtifolius; Aster leucelene; Inula ericoides; Leucelene ericoides*	P	Y
Asteraceae	CIRNEO	N	*Cirsium neomexicanum*	*Cirsium arcuum; Cirsium humboldtense; Cirsium neomexicanum* var. *neomexicanum; Cirsium neomexicanum* var. *utahense; Carduus nevadensis; Cirsium utahense*	U	–
Asteraceae	CIROCH	N	*Cirsium ochrocentrum*	*Cnicus ochrocentrus*	P	Y
Asteraceae	CIRUND	N	*Cirsium undulatum*	–	P	–
Asteraceae	CIRVUL	Ex	*Cirsium vulgare*	*Carduus lanceolatus; Carduus vulgaris; Cirsium lanceolatum; Cirsium lanceolatum* var. *hypoleucum*	P	Y
Asteraceae	CONCAN	N	*Conyza canadensis*	*Conyza canadensis* var. *canadensis; Conyza canadensis* var. *glabrata; Conyza canadensis* var. *pusilla; Conyza parva; Erigeron canadensis; Erigeron canadensis* var. *glabratus; Erigeron canadensis* var. *pusillus; Erigeron pusillus; Leptilon canadense; Leptilon pusillum*	P	Y
Asteraceae	CYCXAN	N	*Cyclachaena xanthiifolia*	*Iva xanthifolia*	P	–
Asteraceae	DIECAN	N	*Dieteria canescens*	*Machaeranthera canescens; Aster canescens*	C	–
Asteraceae	DYSPAP	N	*Dyssodia papposa*	–		–
Asteraceae	ERINAU	N	*Ericameria nauseosa*	–	C	Y
Asteraceae	ERICAN	N	*Erigeron canus*	–	R	Y
Asteraceae	ERIDIV	N	*Erigeron divergens*	*Erigeron divergens* var. *typicus*	C	Y
Asteraceae	ERIFLA	N	*Erigeron flagellaris*	*Erigeron flagellaris* var. *typicus; Erigeron nudiflorus*	C	Y
Asteraceae	ERIFOR	N	*Erigeron formosissimus*	*Erigeron formosissimus* var. *formosissimus; Erigeron formosissimus* var. *typicus; Erigeron formosissimus* var. *viscidus; Erigeron glabellus* var. *viscidus; Erigeron viscidus*	R	Y
Asteraceae	ERIPHI	N	*Erigeron philadelphicus*	–	P	Y

Table A2-1 (continued). Plant species list for Pecos National Historical Park. Veg Code: six letter abbreviation of the scientific name. Nativity: N = native plant, Ex = exotic (non-native) plant. Synonyms: other scientific names used for the species. Abundance in Pecos NHP: A = abundant, C = common, U = uncommon, R = rare, P = present. Voucher: Yes or No indicates if there is a vouchered specimen collected by Natural Heritage New Mexico (Chauvin 2015).

Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Asteraceae	ERISPE	N	*Erigeron speciosus*	*Erigeron conspicuus; Erigeron macranthus; Erigeron speciosus* var. *conspicuus; Erigeron speciosus* var. *macranthus; Erigeron speciosus* var. *speciosus; Erigeron speciosus* var. *typicus; Erigeron subtrinervis* ssp. *conspicuus; Erigeron subtrinervis* var. *conspicuus*	R	Y
Asteraceae	GAIARI	N	*Gaillardia aristata*	–	P	–
Asteraceae	GAIPIN	N	*Gaillardia pinnatifida*	*Gaillardia flava; Gaillardia gracilis; Gaillardia mearnsii; Gaillardia pinnatifida* var. *linearis; Gaillardia pinnatifida* var. *pinnatifida*	P	Y
Asteraceae	GAIPUL	N	*Gaillardia pulchella*	*Gaillardia drummondii; Gaillardia neomexicana; Gaillardia picta; Gaillardia pulchella* var. *australis; Gaillardia pulchella* var. *picta; Gaillardia pulchella* var. *pulchella; Gaillardia villosa*	P	Y
Asteraceae	GRISQU	N	*Grindelia squarrosa*	*Grindelia aphanactis; Grindelia nuda; Grindelia nuda* var. *aphanactis; Grindelia nuda* var. *nuda; Grindelia serrulata; Grindelia squarrosa* var. *nuda; Grindelia squarrosa* var. *serrulata; Grindelia squarrosa* var. *squarrosa*	P	Y
Asteraceae	GUTSAR	N	*Gutierrezia sarothrae*	*Gutierrezia diversifolia; Gutierrezia lepidota; Gutierrezia linearifolia; Gutierrezia linearis; Gutierrezia linoides; Gutierrezia longipappa; Gutierrezia pomariensis; Gutierrezia sarothrae* var. *pomariensis; Gutierrezia tenuis; Solidago sarothrae; Xanthocephalum sarothrae; Xanthocephalum sarothrae* var. *pomariense; Xanthocephalum tenue*	A	Y
Asteraceae	HELANN	N	*Helianthus annuus*	*Helianthus annuus* ssp. *jaegeri; Helianthus annuus* ssp. *lenticularis; Helianthus annuus* var. *lenticularis; Helianthus annuus* var. *macrocarpus; Helianthus annuus* var. *texanus; Helianthus annuus* ssp. *texanus; Helianthus aridus; Helianthus lenticularis*	P	Y
Asteraceae	HELCIL	N	*Helianthus ciliaris*	*Helianthus canescens; Helianthus canus; Helianthus niveus* ssp. *Canescens; Helianthus petiolaris* var. *canescens*	P	Y
Asteraceae	HELPET	N	*Helianthus petiolaris*	*Helianthus canescens; Helianthus canus; Helianthus niveus* ssp. *canescens; Helianthus petiolaris* var. *canescens*	P	Y
Asteraceae	HELHEL	N	*Heliopsis helianthoides*	*Heliopsis helianthoides* ssp. *scabra; Heliopsis minor; Heliopsis scabra*	R	–
Asteraceae	HETFUL	N	*Heterotheca fulcrata*	*Chrysopsis fulcrata*	P	Y
Asteraceae	HETVIL	N	*Heterotheca villosa*	–	C	Y
Asteraceae	HYMFIL	N	*Hymenopappus filifolius*	–	P	Y
Asteraceae	HYMRIC	N	*Hymenoxys richardsonii*	*Tetraneuris richardsonii*	P	Y
Asteraceae	LACSER	Ex	*Lactuca serriola*	*Lactuca scariola*	P	Y

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Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Asteraceae	LACTAT	Ex	*Lactuca tatarica*	*Lactuca oblongifolia; Lactuca pulchella; Lactuca tatarica* ssp. *pulchella; Lactuca tatarica* var. *heterophylla; Lactuca tatarica* var. *pulchella; Mulgedium oblongifolium; Mulgedium pulchellum; Sonchus tataricus*	P	–
Asteraceae	LAESCH	N	*Laennecia schiedeana*	*Conyza schiedeana; Erigeron schiedeanus; Leptilon integrifolium*	P	–
Asteraceae	LEUVUL	Ex	*Leucanthemum vulgare*	*Chrysanthemum leucanthemum; Chrysanthemum leucanthemum* var. *boecheri; Chrysanthemum leucanthemum* var. *pinnatifidum; Leucanthemum leucanthemum; Leucanthemum vulgare* var. *pinnatifidum*	P	Y
Asteraceae	LIAPUN	N	*Liatris punctata*	–	P	–
Asteraceae	LYGJUN	N	*Lygodesmia juncea*	–	R	–
Asteraceae	MACCAN	N	*Machaeranthera canescens*	*Machaeranthera angustifolia; Machaeranthera canescens* ssp. *canescens* var. *ambigua; Machaeranthera oxylepis; Machaeranthera scoparia; Dieteria canescens* var. *ambigua*	P	–
Asteraceae	MACTAN	N	*Machaeranthera tanacetifolia*	*Aster tanacetifolius; Machaeranthera coronopifolia; Machaeranthera parthenium*	P	Y
Asteraceae	MELLEU	N	*Melampodium leucanthum*	–	C	Y
Asteraceae	ONOACA	Ex	*Onopordum acanthium*	–	P	Y
Asteraceae	PACFEN	N	*Packera fendleri*	*Senecio fendleri; Senecio fendleri* var. *lanatus*	C	Y
Asteraceae	PACNEO	N	*Packera neomexicana*	–	U	–
Asteraceae	PACPSE	N	*Packera pseudaurea*	*Senecio flavulus; Senecio pseudaureus* ssp. *flavulus; Senecio pseudaureus* var. *flavulus*	P	Y
Asteraceae	PICOPP	N	*Picradeniopsis oppositifolia*	*Bahia oppositifolia*	P	Y
Asteraceae	PSEVIS	N	*Pseudognaphalium viscosum*	*Gnaphalium viscosum*	R	–
Asteraceae	PSIVIL	N	*Psilostrophe villosa*	*Psilostrophe tagetina* var. *cerifera*	P	–
Asteraceae	RATCOL	N	*Ratibida columnifera*	*Lepachys columnifera; Ratibida columnaris; Ratibida columnaris* var. *pulcherrima; Rudbeckia columnaris; Rudbeckia columnifera*	P	Y
Asteraceae	RATTAG	N	*Ratibida tagetes*	*Rudbeckia globosa; Rudbeckia tagetes*	P	Y
Asteraceae	RUDLAC	N	*Rudbeckia laciniata*	*Rudbeckia ampla; Rudbeckia laciniata* ssp. *ampla*	P	Y
Asteraceae	SANABE	N	*Sanvitalia abertii*	–	R	–
Asteraceae	SCHMUL	N	*Schkuhria multiflora*	*Bahia neomexicana*	P	Y
Asteraceae	SCOLAC	Ex	*Scorzonera laciniata*	*Podospermum lacniatum*	P	Y

Table A2-1 (continued). Plant species list for Pecos National Historical Park. Veg Code: six letter abbreviation of the scientific name. Nativity: N = native plant, Ex = exotic (non-native) plant. Synonyms: other scientific names used for the species. Abundance in Pecos NHP: A = abundant, C = common, U = uncommon, R = rare, P = present. Voucher: Yes or No indicates if there is a vouchered specimen collected by Natural Heritage New Mexico (Chauvin 2015).

Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Asteraceae	SENFLA	N	*Senecio flaccidus*	–	P	Y
Asteraceae	SENSPA	N	*Senecio spartioides*	*Senecio multicapitatus; Senecio spartioides* var. *granularis; Senecio spartioides* var. *multicapitatus; Senecio spartioides* var. *spartioides; Senecio toiyabensis*	P	Y
Asteraceae	SOLALTA	N	*Solidago altissima*	*Solidago altissima* var. *pluricephala; Solidago altissima* var. *procera; Solidago hirsutissima; Solidago lunellii*	P	–
Asteraceae	SOLCAN	N	*Solidago canadensis*	–	P	–
Asteraceae	SOLSIM	N	*Solidago simplex*	*Solidago glutinosa; Solidago neomexicana; Solidago simplex* ssp. *simplex* var. *simplex; Solidago spathulata* ssp. *glutinosa; Solidago spathulata* var. *neomexicana*	P	Y
Asteraceae	SOLWRI	N	*Solidago wrightii*	*Solidago bigelovii* var. *wrightii*	P	Y
Asteraceae	SONASP	Ex	*Sonchus asper*	*Sonchus asper* ssp. *Asper; Sonchus asper* ssp. *Glaucescens; Sonchus nymanii*	P	–
Asteraceae	STEPAU	N	*Stephanomeria pauciflora*	*Lygodesmia pauciflora; Ptiloria pauciflora; Stephanomeria cinerea; Stephanomeria neomexicana; Stephanomeria pauciflora* var. *parishii*	P	Y
Asteraceae	SYMFAL	N	*Symphyotrichum falcatum*	–	P	–
Asteraceae	SYMLAN	N	*Symphyotrichum lanceolatum*	*Aster lanceolatus* ssp. *hesperius; Aster hesperius; Aster hesperius* var. *laetevirens; Aster hesperius* var. *wootonii; Aster laetevirens; Aster osterhoutii; Aster wootonii; Symphyotrichum hesperium; Symphyotrichum lanceolatum* ssp. *hesperium* var. *hesperium*	P	–
Asteraceae	TAROFF	Ex	*Taraxacum officinale*	*Taraxacum kok-saghyz; Taraxacum officinale* ssp. *vulgare; Taraxacum palustre* var. *vulgare; Taraxacum vulgare*	P	Y
Asteraceae	TETACA	N	*Tetraneuris acaulis*	–	P	Y
Asteraceae	TETARG	N	*Tetraneuris argentea*	*Actinella argentea; Hymenoxys argentea*	C	–
Asteraceae	THEFIL	N	*Thelesperma filifolium*	*Thelesperma filifolium* var. *filifolium; Thelesperma filifolium* var. *intermedium; Thelesperma intermedium; Thelesperma trifidum*	R	Y
Asteraceae	THEMEG	N	*Thelesperma megapotamicum*	*Bidens megapotamica; Thelesperma gracile*	C	Y
Asteraceae	TOWEXI	N	*Townsendia eximia*	*Townsendia eximia*	U	Y
Asteraceae	TOWEXS	N	*Townsendia exscapa*	*Aster exscapus; Townsendia intermedia; Townsendia sericea*	U	Y
Asteraceae	TRADUB	Ex	*Tragopogon dubius*	*Tragopogon dubius* ssp. *major; Tragopogon major*	P	Y
Asteraceae	TRAPRA	Ex	*Tragopogon pratensis*	*Tragopogon lamottei; Tragopogon orientalis; Tragopogon pratensis* ssp. *orientalis; Tragopogon pratensis* ssp. *Pratensis*	P	Y

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Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Asteraceae	VERENC	N	*Verbesina encelioides*	*Verbesina encelioides* ssp. *encelioides; Verbesina encelioides* ssp. *exauriculata; Verbesina encelioides* var. *exauriculata; Verbesina exauriculata; Verbesina microptera; Ximenesia encelioides; Ximenesia encelioides* var. *cana; Ximenesia encelioides* var. *exauriculata; Ximenesia exauriculata*	P	–
Asteraceae	XANSPI	N	*Xanthisma spinulosum*	*Amellus spinulosus; Aster pinnatifidus; Dieteria spinulosa; Diplopappus pinnatifidus; Eriocarpum australe; Eriocarpum spinulosum; Eriocarpum wootonii; Haplopappus coulteri; Haplopappus spinulosus; Haplopappus spinulosus* ssp. *australis; Haplopappus spinulosus* var. *canescens; Haplopappus spinulosus* var. *glaber; Haplopappus spinulosus* ssp. *laevis; Haplopappus spinulosus* var. *turbinellus; Machaeranthera australis; Machaeranthera laevis; Machaeranthera pinnata; Machaeranthera pinnatifida; Machaeranthera pinnatifida* ssp. *pinnatifida; Machaeranthera pinnatifida* ssp. *pinnatifida* var. *pinnatifida; Machaeranthera pinnatifida* var. *pinnatifida; Sideranthus australis; Sideranthus cotula; Sideranthus laevis; Sideranthus machaerantherus; Sideranthus puberulus; Sideranthus spinulosus; Sideranthus wootonii; Starkea pinnata*	P	Y
Asteraceae	XANSTR	N	*Xanthium strumarium*	*Xanthium acerosum; Xanthium americanum; Xanthium californicum; Xanthium californicum* var. *rotundifolium; Xanthium calvum; Xanthium campestre; Xanthium canadense; Xanthium cavanillesii; Xanthium cenchroides; Xanthium chasei; Xanthium chinense; Xanthium commune; Xanthium curvescens; Xanthium cylindraceum; Xanthium echinatum; Xanthium echinellum; Xanthium glanduliferum; Xanthium globosum; Xanthium inflexum; Xanthium italicum; Xanthium macounii; Xanthium macrocarpum* var. *glabratum; Xanthium occidentale; Xanthium oligacanthum; Xanthium orientale; Xanthium oviforme; Xanthium pensylvanicum; Xanthium saccharatum; Xanthium speciosum; Xanthium strumarium* ssp. *italicum; Xanthium strumarium* var. *canadense; Xanthium strumarium* var. *glabratum; Xanthium strumarium* var. *oviforme; Xanthium strumarium* var. *pensylvanicum; Xanthium strumarium* var. *strumarium; Xanthium strumarium* var. *wootonii; Xanthium varians; Xanthium wootonii*	P	Y
Asteraceae	ZINGRA	N	*Zinnia grandiflora*	*Crassina grandiflora*	U	–
Berberidaceae	BERFEN	N	*Berberis fendleri*	–	P	Y
Betulaceae	ALNINC	N	*Alnus incana*	*Alnus americana; Alnus incana* var. *occidentalis; Alnus incana* var. *virescens; Alnus x purpusii; Alnus rugosa rugosa; Alnus tenuifolia; Betula rugosa*	P	Y

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Bignoniaceae	CAMRAD	N	*Campsis radicans*	*Bignonia radicans; Tecoma radicans*	P	–
Boraginaceae	CRYCIN	N	*Cryptantha cinerea*	–	P	Y
Boraginaceae	CRYFEN	N	*Cryptantha fendleri*	–	–	–
Boraginaceae	CRYMIN	N	*Cryptantha minima*	–	U	–
Boraginaceae	CRYTHY	N	*Cryptantha thyrsiflora*	*Oreocarya thyrsiflora*	P	–
Boraginaceae	HACBES	N	*Hackelia besseyi*	*Hackelia grisea*	R	Y
Boraginaceae	LAPOCC	N	*Lappula occidentalis*	*Lappula echinata* var. *occidentalis; Lappula redowskii; Lappula redowskii* var. *desertorum; Lappula redowskii* var. *occidentalis; Lappula redowskii* var. *redowskii*	A	Y
Boraginaceae	LITMUL	N	*Lithospermum multiflorum*	–	U	Y
Brassicaceae	ALYSIM	Ex	*Alyssum simplex*	*Alyssum minus; Alyssum minus* var. *micranthum; Alyssum parviflorum; Alyssum parviflorum* var. *micranthum; Clypeola minus*	P	Y
Brassicaceae	BARVUL	Ex	*Barbarea vulgaris*	*Barbarea arcuata; Barbares stricta; Barbarea vulgaris* var. *arcuta; Barbarea vulgaris* var. *brachycarpa; Barbarea vulgaris* var. *longisiliquosa; Barbarea vulgaris* var. *sylvestris; Barbarea vulgaris brachycarpa; Barbarea vulgaris longisiliquosa; Barbarea vulgarissylvestris; Campe barbarea; Campe stricta*	P	Y
Brassicaceae	BOEFEN	N	*Boechera fendleri*	*Arabis fendleri; Arabis fendleri* var. *fendleri; Arabis holboellii* var. *fendleri*	P	Y
Brassicaceae	CAMMIC	Ex	*Camelina microcarpa*	*Camelina sativa* ssp. *microcarpa*	P	Y
Brassicaceae	CAPBUR	Ex	*Capsella bursa-pastoris*	*Bursa bursa-pastoris; Bursa bursa-pastoris* var. *bifida; Bursa gracilis; Capsella rubella; Thlaspi bursa-pastoris*	P	–
Brassicaceae	DESOBT2	N	*Descurainia obtusa*	*Descurainia obtusa* ssp. *brevisiliqua; Descurainia obtusa* ssp. *typica*	P	Y
Brassicaceae	DESSOP	Ex	*Descurainia sophia*	*Sisymbrium sophia; Sophia sophia*	R	–
Brassicaceae	DRABRA	N	*Draba brachycarpa*	–	P	–
Brassicaceae	DRACUN	N	*Draba cuneifolia*	–		–
Brassicaceae	DRAHEL	N	*Draba helleriana*	*Draba helleriana* var. *helleriana; Draba helleriana* var. *patens; Draba neomexicana*	P	Y
Brassicaceae	ERYINC	N	*Erysimum inconspicum*	*Cheirinia inconspicua; Erysimum parviflorum*	P	Y
Brassicaceae	HESLIN	N	*Hesperidanthus linearifolius*	*Schoenocrambe linearifolia; Sisymbrium linearifolium; Thelypodiopsis linearifolia*	C	Y

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Brassicaceae	LEPDEN	N	*Lepidium densiflorum*	*Lepidium densiflorum* var. *densiflorum; Lepidium densiflorum* var. *elongatum; Lepidium densiflorum* var. *macrocarpum; Lepidium densiflorum* var. *pubecarpum; Lepidium densiflorum* var. *ramosum; Lepidium densiflorum* var. *typicum; Lepidium elongatum; Lepidium neglectum; Lepidium pubecarpum; Lepidium ramosum*	P	Y
Brassicaceae	LEPDRA	Ex	*Lepidium draba*	*Cardaria draba; Cardaria draba* ssp. *Draba; Lepidium draba* ssp. *Draba*	P	Y
Brassicaceae	NOCFEN	N	*Noccaea fendleri*	*Noccaea cochleariformis; Noccaea coloradensis; Noccaea montana* var. *montana; Thlaspi alpestre; Thlaspi alpestre* var. *glaucum; Thlaspi australe; Thlaspi arvense; Thlaspi cochleariforme; Thlaspi fendleri* var. *coloradense; Thlaspi fendleri* var. *glaucum; Thlaspi fendleri* var. *hesperium; Thlaspi fendleri* var. *tenuipes; Thlaspi glaucum; Thlaspi glaucum* var. *hesperium; Thlaspi glaucum* var. *pedunculatum; Thlaspi hesperium; Thlaspi montanum; Thlaspi montanum* var. *montanum*	P	Y
Brassicaceae	PENMIC	N	*Pennellia micrantha*	*Streptanthus micranthus; Thelypodium longifolium* var. *catalinense; Thelypodium micranthum*	R	–
Brassicaceae	PHYREC	N	*Physaria rectipes*	*Lesquerella rectipes*	P	Y
Brassicaceae	RORNAS	N	*Rorippa nasturtium-aquaticum*	*Nasturtium officinale; Nasturtium nasturtium-aquaticum; Nasturtium officinale; Nasturtium officinale* var. *siifolium; Sisymbrium nasturtium-aquaticum*	R	Y
Brassicaceae	RORSYL	Ex	*Rorippa sylvestris*	*Radicula sylvestris*	P	Y
Brassicaceae	SISALT	Ex	*Sisymbrium altissimum*	*Norta altissima*	P	Y
Brassicaceae	THEWRI	N	*Thelypodium wrightii*	*Stanleyella wrightii; Thelypodium wrightii* ssp. *oklahomense; Thelypodium wrightii* ssp. *Wrightii*	P	Y
Cactaceae	CYLIMB	N	*Cylindropuntia imbricata*	*Opuntia imbricata; Opuntia imbricata* var. *imbricata; Cereus imbricatus; Opuntia arborescens; Opuntia imbricata* var. *arborescens; Opuntia imbricata* var. *vexans*	C	Y
Cactaceae	ECHCOC	N	*Echinocereus coccineus*	–	P	Y
Cactaceae	ECHFEN	N	*Echinocereus fendleri*	*Cereus fendleri*	R	Y
Cactaceae	ECHPEC	N	*Echinocereus pectinatus*	–	P	Y
Cactaceae	ECHVIR	N	*Echinocereus viridiflorus*	–	U	Y

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Cactaceae	ESCVIV	N	*Escobaria vivipara*	*Cactus viviparus; Coryphantha aggregata; Coryphantha arizonica;Coryphantha bisbeeana; Coryphantha columnaris; Coryphantha chlorantha; Coryphantha deserti; Coryphantha fragrans; Coryphantha neomexicana; Coryphantha radiosa; Coryphantha vivipara; Coryphantha vivipara* var. *arizonica; Coryphantha vivipara* var. *bisbeeana; Coryphantha vivipara* var. *buoflama; Coryphantha vivipara* var. *deserti; Coryphantha vivipara* var. *kaibabensis; Coryphantha vivipara* var. *neomexicana; Coryphantha vivipara* var. *radiosa; Coryphantha vivipara* var. *rosea; Escobaria bisbeeana; Escobaria deserti; Escobaria neomexicana; Escobaria vivipara* var. *arizonica; Escobaria vivipara* var. *bisbeeana; Escobaria vivipara* var. *buoflama; Escobaria vivipara* var. *deserti; Escobaria vivipara* var. *kaibabensis; Escobaria vivipara* var. *neomexicana; Escobaria vivipara* var. *radiosa; Escobaria vivipara* var. *rosea; Escobaria vivipara* var. *vivipara; Mammillaria arizonica; Mammillaria deserti; Mammillaria fragrans; Mammillaria neomexicana; Mammillaria vivipara; Mammillaria vivipara* var. *arizonica; Mammillaria vivipara* var. *borealis; Mammillaria vivipara* var. *deserti; Mammillaria vivipara* var. *neomexicana; Mammillaria vivipara* var. *radiosa*	U	Y
Cactaceae	OPUPHA	N	*Opuntia phaeacantha*	*Opuntia arizonica; Opuntia azurea; Opuntia camanchica; Opuntia canada; Opuntia chihuahuensis; Opuntia dulcis; Opuntia engelmannii* var. *cycloides; Opuntia gilvescens; Opuntia laevis; Opuntia mojavensis; Opuntia phaeacantha* var. *brunnea; Opuntia phaeacantha* var. *mojavensis; Opuntia phaeacantha* var. *nigricans; Opuntia phaeacantha* var. *superbospina; Opuntia superbospina; Opuntia woodsii*	C	Y
Cactaceae	OPUPOL	N	*Opuntia polyacantha*	*Opuntia polyacantha* var. *trichophora; Opuntia missouriensis* var. *trichophora; Opuntia trichophora*	P	Y
Caryophyllaceae	ARELAN	N	*Arenaria lanuginosa*	–	–	–
Caryophyllaceae	DRYGLA	N	*Drymaria glandulosa*	*Drymaria fendleri*	P	–
Caryophyllaceae	SILSCO	N	*Silene scouleri*	*Silene scouleri* ssp. *pringlei* var. *eglandulosa; Silene scouleri* ssp. *pringlei* var. *grisea; Silene scouleri* ssp. *pringlei* var. *leptophylla; Silene scouleri* ssp. *pringlei* var. *pringlei; Silene scouleri* var. *eglandulosa; Silene scouleri* var. *grisea; Silene scouleri* var. *leptophylla; Silene scouleri* var. *pringlei*	R	–
Celastraceae	PAXMYR	N	*Paxistima myrsinites*	*Pachystima myrsinites*	P	Y
Chenopodiaceae	ATRCAN	N	*Atriplex canescens*	–	P	–

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Chenopodiaceae	CHEALB	Ex	*Chenopodium album*	*Chenopodium acerifolium; Chenopodium album* ssp. *album; Chenopodium album* ssp. *dacoticum; Chenopodium album* ssp. *fallax; Chenopodium album* var. *album; Chenopodium album* var. *candicans; Chenopodium album* var. *centrorubrum; Chenopodium album* var. *lanceolatum; Chenopodium album* var. *missouriense; Chenopodium album* var. *polymorphum; Chenopodium album* var. *stevensii; Chenopodium lanceolatum; Chenopodium missouriense; Chenopodium missouriense* var. *bushianum; Chenopodium paganum; Chenopodium suecicum*	P	Y
Chenopodiaceae	CHEINC	N	*Chenopodium incanum*	–	P	Y
Chenopodiaceae	CHELEP	N	*Chenopodium leptophyllum*	*Chenopodium album* var. *leptophyllum*	P	Y
Chenopodiaceae	CHEPAL	N	*Chenopodium pallescens*	–	P	–
Chenopodiaceae	CHEPRA	N	*Chenopodium pratericola*	*Chenopodium albescens; Chenopodium desiccatum* var. *leptophylloides; Chenopodium pratericola* ssp. *eupratericola; Chenopodium pratericola* var. *leptophylloides*	P	Y
Chenopodiaceae	CHEWAT	N	*Chenopodium watsonii*	*Chenopodium dacoticum; Chenopodium glabrescens; Chenopodium olidum*	P	Y
Chenopodiaceae	KOCSCO	Ex	*Kochia scoparia*	*Bassia scoparia; Bassia sieversiana; Kochia alata; Kochia scoparia* var. *culta; Kochia scoparia* var. *pubescens; Kochia scoparia* var. *subvillosa; Kochia scoparia* var. *trichophila; Kochia sieversiana; Kochia trichophila*	C	Y
Chenopodiaceae	KRALAN2	N	*Krascheninnikovia lanata*	*Ceratoides lanata; Ceratoides lanata* var. *ruinina; Ceratoides lanata* var. *subspinosa; Eurotia lanata; Eurotia lanata* var. *subspinosa*	C	–
Chenopodiaceae	SALTRA	Ex	*Salsola tragus*	*Salsola australis; Salsola iberica; Salsola kali* ssp. *tragus; Salsola kali* ssp. *ruthenica; Salsola kali* ssp. *tenuifolia; Salsola pestifer; Salsola ruthenica*	U	Y
Commelinaceae	COMDIA	N	*Commelina dianthifolia*	*Commelina dianthifolia* var. *dianthifolia; Commelina dianthifolia* var. *longispatha; Commelina linearis* var. *longispatha*	P	Y
Convolvulaceae	CONARV	Ex	*Convolvulus arvensis*	*Convolvulus ambigens; Convolvulus incanus; Strophocaulos arvensis*	P	Y
Convolvulaceae	CONEQU	N	*Convolvulus equitans*	*Convolvulus hermannioides; Convolvulus simulans*	P	–
Crassulaceae	SEDCOC	N	*Sedum cockerellii*	*Cockerellia cockerellii; Sedum griffithsii; Sedum wootonii*	R	Y
Cucurbitaceae	CUCFOE	N	*Cucurbita foetidissima*	*Pepo foetidissima*	P	Y
Cupressaceae	JUNDEP	N	*Juniperus deppeana*	*Juniperus deppeana* var. *pachyphlaea; Juniperus deppeana* ssp. *sperryi; Juniperus deppeana* var. *sperryi; Juniperus mexicana; Juniperus pachyderma*	P	Y
Cupressaceae	JUNMON	N	*Juniperus monosperma*	*Juniperus occidentalis* var. *gymnocarpa; Sabina monosperma*	A	Y

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Cupressaceae	JUNSCO	N	*Juniperus scopulorum*	*Juniperus scopulorum* var. *columnaris; Juniperus virginiana* var. *montana; Juniperus virginiana* ssp. *scopulorum; Juniperus virginiana* var. *scopulorum; Sabina scopulorum*	U	Y
Cyperaceae	CARAQU	N	*Carex aquatilis*	–	P	Y
Cyperaceae	CARHYS	N	*Carex hystericina*	–	P	Y
Cyperaceae	CARINO	N	*Carex inops*	*Carex erxlebeniana; Carex heliophila; Carex pensylvanica* var. *digyna; Carex pensylvanica* ssp. *heliophila*	P	Y
Cyperaceae	CARNEB	N	*Carex nebrascensis*	–	U	Y
Cyperaceae	CAROCC	N	*Carex occidentalis*	*Carex neomexicana*	P	Y
Cyperaceae	CARPEL	N	*Carex pellita*	*Carex lanuginosa; Carex lasiocarpa* var. *latifolia*	P	Y
Cyperaceae	CARPRA	N	*Carex praegracilis*	*Carex camporum*	P	Y
Cyperaceae	CARSTI	N	*Carex stipata*	–	P	Y
Cyperaceae	CARVUL	N	*Carex vulpinoidea*	*Carex setacea; Carex vulpinoidea* var. *pycnocephala; Carex vulpinoidea* var. *vulpinoidea*	P	Y
Cyperaceae	CYPFEN	N	*Cyperus fendlerianus*	*Mariscus fendlerianus*	P	Y
Cyperaceae	CYPROT	Ex	*Cyperus rotundus*	–	P	–
Cyperaceae	CYPSCH	N	*Cyperus schweinitzii*	–		–
Cyperaceae	ELEMAC	N	*Eleocharis macrostachya*	*Eleocharis palustris; Eleocharis smallii* var. *major; Eleocharis xyridiformis; Eleocharis palustris* var. *australis; Eleocharis palustris* var. *major; Eleocharis palustris* var. *vigens; Eleocharis perlonga; Eleocharis mamillata; Eleocharis calva* var. *australis; Eleocharis smallii*	R	Y
Cyperaceae	ELEPAL	N	*Eleocharis palustris*	–	–	–
Cyperaceae	ELEPAR1	N	*Eleocharis parishii*	*Eleocharis montevidensis* var. *disciformis; Eleocharis montevidensis* var. *parishii; Eleocharis disciformis*	P	Y
Cyperaceae	SCHACU	N	*Schoenoplectus acutus*	–	R	Y
Cyperaceae	SCHAME	N	*Schoenoplectus americanus*	*Scirpus olneyi; Scirpus pungens* var. *longisetus; Scirpus conglomeratus; Scirpus chilensis; Scirpus americanus*	R	–
Cyperaceae	SCHPUN	N	*Schoenoplectus pungens*	–	P	Y

Table A2-1 (continued). Plant species list for Pecos National Historical Park. Veg Code: six letter abbreviation of the scientific name. Nativity: N = native plant, Ex = exotic (non-native) plant. Synonyms: other scientific names used for the species. Abundance in Pecos NHP: A = abundant, C = common, U = uncommon, R = rare, P = present. Voucher: Yes or No indicates if there is a vouchered specimen collected by Natural Heritage New Mexico (Chauvin 2015).

Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Cyperaceae	SCHTAB	N	*Schoenoplectus tabernaemontani*	*Scirpus validus; Scirpus validus* var. *creber; Scirpus lacustris* ssp. *creber; Scirpus lacustris* ssp. *glaucus; Scirpus lacustris* ssp. *tabernaemontani; Scirpus lacustris* ssp. *validus; Scirpus tabernaemontani; Schoenoplectus lacustris* ssp. *creber; Schoenoplectus lacustris* ssp. *validus; Schoenoplectus validus; Schoenoplectus validus* ssp. *creber; Schoenoplectus validus* ssp. *luxurians; Schoenoplectus lacustris* ssp. *tabernaemontani*	P	Y
Dipsacaceae	DIPFUL	Ex	*Dipsacus fullonum*	*Dipsacus fullonum* ssp. *sylvestris; Dipsacus sylvestris; Dipsacus fullonum* ssp. *Fullonum*	P	Y
Dryopteridaceae	CYSFRA	N	*Cystopteris fragilis*	*Filix fragilis; Cystopteris fragilis* var. *woodsioides; Cystopteris fragilis* ssp. *dickieana; Cystopteris dickieana; Cystopteris fragilig* var. *angustata*	P	–
Dryopteridaceae	WOONEO	N	*Woodsia neomexicana*	–	P	Y
Elaeagnaceae	ELAANG	Ex	*Elaeagnus angustifolia*	*Elaeagnus angustifolia* var. *orientalis; Elaeagnus argentea; Elaeagnus orientalis*	P	Y
Equisetaceae	EQUARV	N	*Equisetum arvense*	*Equisetum arvense* var. *alpestre; Equisetum arvense* var. *boreale; Equisetum arvense* var. *riparium; Equisetum calderi; Equisetum arvense* var. *campestre*	P	Y
Equisetaceae	EQULAE	N	*Equisetum laevigatum*	*Hippochaete laevigata; Equisetum funstonii; Equisetum kansanum; Equisetum laevigatum* ssp. *funstonii*	P	Y
Euphorbiaceae	CROMON	N	*Croton monanthogynus*	–	P	–
Euphorbiaceae	CROTEX	N	*Croton texensis*	*Croton texensis* var. *texensis; Croton texensis* var. *utahensis*	C	Y
Euphorbiaceae	EUPALB	N	*Euphorbia albomarginata*	*Chamaesyce albomarginata*	C	–
Euphorbiaceae	EUPBRA	N	*Euphorbia brachycera*	*Euphorbia brachycera* var. *robusta; Euphorbia lurida; Euphorbia montana; Euphorbia odontadenia; Euphorbia robusta; Pyrenula leucoplaca; Tithymalus montanus; Tithymalus robustus; Tithymalus brachycera*	R	Y
Euphorbiaceae	EUPDAV	Ex	*Euphorbia davidii*	*Euphorbia dentata; Euphorbia dentata* var. *gracillima; Euphorbia dentata* var. *lancifolia*	P	Y
Euphorbiaceae	EUPFEN	N	*Euphorbia fendleri*	*Chamaesyce fendleri; Chamaesyce fendleri* var. *fendleri; Euphorbia fendleri* var. *typica*	P	Y
Euphorbiaceae	EUPSER2	N	*Euphorbia serpyllifolia*	–	–	–
Euphorbiaceae	TRARAM	N	*Tragia ramosa*	*Tragia angustifolia; tragia nepetifolia* var. *ramosa; Tragia stylaris*	P	Y
Fabaceae	AMOCAN	N	*Amorpha canescens*	–	–	–
Fabaceae	APIAME	N	*Apios americana*	*Apios americana* var. *turrigera; Glycine apios*	P	–

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Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Fabaceae	ASTBRA	N	*Astragalus brandegeei*	–	–	–
Fabaceae	ASTFLE	N	*Astragalus flexuosus*	–	P	–
Fabaceae	ASTHUM	N	*Astragalus humistratus*	*Astragalus datilensis*	U	Y
Fabaceae	ASTLON	N	*Astragalus lonchocarpus*	–	P	Y
Fabaceae	ASTLOT	N	*Astragalus lotiflorus*	*Astragalus lotiflorus* var. *nebraskensis; Astragalus lotiflorus* var. *revershonii; Batidophaca lotiflorus*	C	Y
Fabaceae	ASTMIS2	N	*Astragalus miser*	–	P	–
Fabaceae	ASTMIS1	N	*Astragalus missouriensis*	–	P	Y
Fabaceae	ASTMOL	N	*Astragalus mollissimus*	–	P	Y
Fabaceae	ASTPRA	N	*Astragalus praelongus*	–	P	Y
Fabaceae	CHANIC	N	*Chamaecrista nictitans*	–	P	–
Fabaceae	DALAUR	N	*Dalea aurea*	*Parosela aurea*	P	–
Fabaceae	DALCAN	N	*Dalea candida*	–	P	Y
Fabaceae	DALENN	N	*Dalea enneandra*	*Dalea enneandra* var. *pumilla; Dalea laxiflora; Dalea laxiflora* var. *pumilla; Parosela enneandra*	P	–
Fabaceae	DALJAM	N	*Dalea jamesii*	*Parosela jamesii*	P	Y
Fabaceae	DALPUR	N	*Dalea purpurea*	–	P	–
Fabaceae	DESCOO	N	*Desmanthus cooleyi*	–	P	Y
Fabaceae	GLYLEP	N	*Glycyrrhiza lepidota*	*Glycyrrhiza glutinosa; Glycyrrhiza lepidota* var. *glutinosa*	R	Y
Fabaceae	LATEUC	N	*Lathyrus eucosmus*	*Lathyrus brachycalyx* ssp. *eucosmus; Lathyrus brachycalyx* var. *eucosmus*	R	Y
Fabaceae	LATLAT	Ex	*Lathyrus latifolius*	*Lathyrus latifolius* var. *splendens*	P	Y
Fabaceae	LUPARG	N	*Lupinus argenteus*	*Lupinus argentus*	P	–
Fabaceae	LUPKIN	N	*Lupinus kingii*	*Lupinus capitatus; Lupinus sileri*	P	Y
Fabaceae	MEDLUP	Ex	*Medicago lupulina*	*Medicago lupulina* var. *cupaniana; Medicago lupulina* var. *glandulosa*	P	Y
Fabaceae	MEDSAT	Ex	*Medicago sativa*	–	P	Y
Fabaceae	MELIND	Ex	*Melilotus indicus*	*Melilotus indica*	P	Y
Fabaceae	MELOFF	Ex	*Melilotus officinalis*	*Melilotus albus; Melilotus albus* var. *annuus*	P	Y
Fabaceae	OXYLAM	N	*Oxytropis lambertii*	–	C	–
Fabaceae	OXYSER	N	*Oxytropis sericea*	–	U	Y

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Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Fabaceae	PSOTEN	N	*Psoralidium tenuiflorum*	*Psoralea floribunda; Psoralea obtusifolia; Psoralea tenuiflora; Psoralea tenuiflora* var. *bigelovii; Psoralea tenuiflora* var. *floribunda; Psoralidium batesii*	P	Y
Fabaceae	TRIPRA	Ex	*Trifolium pratense*	*Trifolium pratense* var. *frigidum; Trifolium pratense* var. *sativum*	P	Y
Fabaceae	TRIREP	Ex	*Trifolium repens*	*Trifolium occidentale; Trifolium repens* var. *biasolettii; Trifolium repens* var. *giganteum; Trifolium repens* var. *repens*	P	Y
Fabaceae	VICAME	N	*Vicia americana*	–	P	Y
Fagaceae	QUEGAM	N	*Quercus gambelii*	*Quercus eastwoodiae; Quercus gambelii* var. *bonina; Quercus gambelii* var. *gambelii; Quercus gunnisonii; Quercus leptophylla; Quercus nitescens; Quercus novomexicana; Quercus submollis; Quercus utahensis; Quercus vreelandii*	C	Y
Fagaceae	QUEPAU	N	*Quercus X pauciloba*	*Quercus X andrewsii; Quercus fendleri; Quercus undulata; Quercus venustula*	A	Y
Geraniaceae	EROCIC	Ex	*Erodium cicutarium*	–	P	Y
Geraniaceae	EROTEX	N	*Erodium texanum*	–	P	Y
Geraniaceae	GERCAE	N	*Geranium caespitosum*	*Geranium atropurpureum; Geranium atropurpureum* var. *atropurpureum; Geranium atropurpureum* var. *cowenii; Geranium caespitosum* ssp. *atropurpureum; Geranium caespitosum* var. *caespitosum; Geranium caespitosum* var. *eremophilum; Geranium caespitosum* var. *fremontii; Geranium caespitosum* var. *parryi; Geranium cowenii; Geranium eremophilum; Geranium fremontii; Geranium fremontii* var. *cowenii; Geranium fremontii* var. *parryi; Geranium marginale; Geranium parry; Geranium toquimense*	U	Y
Grossulariaceae	RIBAUR	N	*Ribes aureum*	–	P	Y
Grossulariaceae	RIBCER	N	*Ribes cereum*	–	P	–
Hydrangeaceae	PHIMIC	N	*Philadelphus microphyllus*	*Philadelphus microphyllus* var. *linearis; Philadelphus microphyllus* var. *minutus; Philadelphus microphyllus* var. *ovatus; Philadelphus microphyllus* ssp. *stramineus; Philadelphus microphyllus* ssp. *typicus; Philadelphus stramineus*	P	Y
Iridaceae	IRIMIS	N	*Iris missouriensis*	*Iris longipetala; Iris missouriensis* var. *arizonica; Iris missouriensis* var. *pelogonus; Iris pariensis; Iris tolmieana*	P	–
Iridaceae	SISDEM	N	*Sisyrinchium demissum*	*Sisyrinchium demissum* var. *amethystinum; Sisynchium longipedunculatum*	P	Y
Iridaceae	SISIDA	N	*Sisyrinchium idahoense*	*Sisyrinchium occidentale*	P	–

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Juncaceae	JUNARC	N	*Juncus arcticus*	*Juncus balticus*	P	Y
Juncaceae	JUNART	N	*Juncus articulatus*	*Juncus articulatus* var. *obtusatus; Luzula hyperborea*	P	Y
Juncaceae	JUNBUF	N	*Juncus bufonius*	*Juncus bufonius* var. *bufonius; Juncus bufonius* var. *congestus; Juncus bufonius* var. *occidentalis; Juncus sphaerocarpus*	R	–
Juncaceae	JUNDID	N	*Juncus dudleyi*	*Juncus tenuis* var. *dudleyi; Juncus tenuis* var. *uniflorus*	P	Y
Juncaceae	JUNLON	N	*Juncus longistylis*	*Juncus longistylus; Juncus longistylis* var. *longistylis*	R	Y
Juncaceae	JUNSAX	N	*Juncus saximontanus*	*Juncus ensifolius* var. *brunnescens; Juncus ensifolius* var. *montanus; Juncus saximontanus* var. *robustior; Juncus tracyi; Juncus xiphioides* var. *montanus*	R	–
Juncaceae	JUNTEN	N	*Juncus tenuis*	*Juncus macer; Juncus tenuis* var. *anthelatus; Juncus tenuis* var. *multicornis; Juncus tenuis* var. *williamsii*	R	–
Juncaceae	JUNTOR	N	*Juncus torreyi*	–	R	Y
Lamiaceae	HEDDRU	N	*Hedeoma drummondii*	*Hedeoma campora; Hedeoma ciliata; Hedeoma drummondii* var. *crenulata; Hedeoma longiflora; Hedeoma ovata*	U	Y
Lamiaceae	MARVUL	Ex	*Marrubium vulgare*	–	P	Y
Lamiaceae	MENARV	N	*Mentha arvensis*	*Mentha arvensis* ssp. *borealis; Mentha arvensis* ssp. *haplocalyx; Mentha arvensis* var. *canadensis; Mentha arvensis* var. *glabrata; Mentha arvensis* var. *lanata; Mentha arvensis* var. *sativa; Mentha arvensis* var. *villosa; Mentha canadensis; Mentha gentilis; Mentha glabrior; Mentha penardii*	P	Y
Lamiaceae	MONPEC	N	*Monarda pectinata*	–	R	Y
Lamiaceae	NEPCAT	Ex	*Nepeta cataria*	–	R	–
Lamiaceae	PRUVUL	N	*Prunella vulgaris*	–	P	–
Lamiaceae	SALREF	N	*Salvia reflexa*	*Salvia lancifolia*	P	–
Lamiaceae	SALSUB	N	*Salvia subincisa*	–	–	–
Liliaceae	ALLCAN	N	*Allium canadense*	*Allium allegheniense; Allium cernuum* var. *cernuum; Allium cernuum* var. *neomexicanum; Allium cernuum* var. *obtusum; Allium natans; Allium neomexicanum; Allium oxyphilum; Allium recurvatum*	P	–
Liliaceae	ALLCER	N	*Allium cernuum*	–	P	Y
Liliaceae	ALLGEY	N	*Allium geyeri*	–	R	–
Liliaceae	ASPOFF	Ex	*Asparagus officinalis*	*Asparagus officinalis* ssp. *officinalis*	P	Y
Liliaceae	COOPED	N	*Cooperia pedunculata*	*Zephyranthes drummondii*	P	–

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Liliaceae	MAISTE	N	*Maianthemum stellatum*	*Convallaria stellata; Smilacina liliacea; Smilacina sessilifolia; Smilacina stellata; Smilacina stellata* var. *crassa; Smilacina stellata* var. *mollis; Smilacina stellata* var. *sessilifolia; Smilacina stellata* var. *sylvatica; Vagnera illiacea; Vagnera sessillifolia; Vagnera stellata*	P	–
Linaceae	LINLEW	N	*Linum lewisii*	–	P	–
Linaceae	LINPUB	N	*Linum puberulum*	*Cathartolinum puberulum; Linum rigidum* var. *puberulum; Mesynium puberulum*	P	Y
Loasaceae	MENMUL	N	*Mentzelia multiflora*	–	P	Y
Loasaceae	MENPUM	N	*Mentzelia pumila*	–	P	–
Malvaceae	MALNEG	Ex	*Malva neglecta*	*Malva pusilla; Malva rotundifolia*	P	–
Malvaceae	SIDCAN	N	*Sidalcea candida*	*Sidalcea candida* var. *candida; Sidalcea candida* var. *glabrata*	P	Y
Malvaceae	SPHCOC	N	*Sphaeralcea coccinea*	–	C	Y
Malvaceae	SPHFEN	N	*Sphaeralcea fendleri*	*Aster adsurgens; Aster commutatus; Aster commutatus* var. *crassulus; Aster cordineri; Aster crassulus; Aster commutatus* var. *polycephalus; Aster elegantulus; Aster ericoides* var. *commutatus; Aster falcatus; Aster falcatus* var. *commutatus; Aster falcatus* ssp. *commutatus; Aster falcatus* var. *crassulus; Aster multiflorus* var. *commutatus; Aster ramulosus; Lasallea falcata; Symphyotrichum falcatum* var. *crassulum; Virgulus falcatus*	U	Y
Monotropaceae	PTEAND	N	*Pterospora andromedea*	–	P	–
Najadaceae	NAJGUA	N	*Najas guadalupensis*	–	R	–
Nyctaginaceae	MIRLIN	N	*Mirabilis linearis*	*Allionia decumbens; Allionia gausapoides; Allionia linearis; Calymenia decumbers; Mirabilis decumbens; Mirabilis diffusa; Mirabilis gausapoides; Mirabilis hirsuta* var. *linearis; Mirabilis lanceolata; Mirabilis linearis* var. *subhispida; Oxybaphus angustifolius; Oxybaphus decumbens; Oxybaphus diffusus; Oxybaphus gausapoides; Oxybaphus lanceolatus; Oxybaphus linearis; Oxybaphus linearis* var. *subhispidus*	U	Y
Nyctaginaceae	MIROXY	N	*Mirabilis oxybaphoides*	*Allioniellia oxybaphoides*	U	–
Oleaceae	FRAPEN	N	*Fraxinus pennsylvanica*	*Fraxinus campestris; Fraxinus darlingtonii; Fracinus lanceolata; Fraxinus pennsylvanica* var. *austinii; Fraxinus pennsylvanica* var. *integerrima; Fraxinus pennsylvanica* var. *lanceolata; Fraxinus pennsylvanica* var. *subintegerrima; Fraxinus smallii*	P	Y
Oleaceae	FRAVEL	N	*Fraxinus velutina*	*Fraxinus pennsylvanica* ssp. *Velutina; Fraxinus velutina* var. *coriacea; Fraxinus velutina* var. *glabra; Fraxinus velutina* var. *toumeyi*	P	–

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Oleaceae	MENSCA	N	*Menodora scabra*	*Menodora scabra* var. *glabrescens; Menodora scabra* var. *laevis; Menodora scabra* var. *longituba; Menodora scabra* var. *ramosissima; Menodora scoparia*	R	Y
Onagraceae	EPICIL	N	*Epilobium ciliatum*	–	P	–
Onagraceae	OENALB	N	*Oenothera albicaulis*	*Anogra albicaulis; Oenothera ctenophylla*	P	–
Onagraceae	OENBER	N	*Oenothera berlandieri*	*Calylophus berlandieri*	U	–
Onagraceae	OENCOR	N	*Oenothera coronopifolia*	*Anogra coronopifolia*	P	Y
Onagraceae	OENCUR	N	*Oenothera curtifolia*	*Gaura mollis; Gaura parviflora; Gaura parviflora* var. *lachnocarpa; Gaura parviflora* var. *typica*	P	Y
Onagraceae	OENELA	N	*Oenothera elata*	–	P	–
Onagraceae	OENHAR	N	*Oenothera hartwegii*	–	–	–
Onagraceae	OENPAL	N	*Oenothera pallida*	–	P	–
Onagraceae	OENSUF	N	*Oenothera suffrutescens*	*Gaura coccinea; Gaura coccinea* var. *arizonica; Gaura coccinea* var. *epilobioides; Gaura coccinea* var. *glabra; Gaura coccinea* var. *parvifolia; Gaura coccinea* var. *typica; Gaura glabra; Gaura odorata*	P	Y
Orchidaceae	PLAHUR	N	*Platanthera huronensis*	*Habenaria huronensis; Habenaria hyperborea* var. *huronensis; Platanthera hyperborea* var. *huronensis; Platanthera hyperborea* var. *major*	P	Y
Orobanchaceae	CONALP	N	*Conopholis alpina*	*Conopholis alpina* var. *mexicana; Conopholis mexicana; Orobanche multiflora* var. *xanthochroa; Orobanche xanthochroa*	C	Y
Orobanchaceae	OROLUD	N	*Orobanche ludoviciana*	–	P	Y
Oxalidaceae	OXAALP	N	*Oxalis alpina*	*Oxalis metcalfei; Oxalis monticola*	P	–
Pinaceae	PINEDU	N	*Pinus edulis*	*Pinus cembroides* var. *edulis*	A	Y
Pinaceae	PINPON	N	*Pinus ponderosa*	–	U	Y
Pinaceae	PSEMEN	N	*Pseudotsuga menziesii*	*Abies menziesii; Pseudotsuga mucronata*	U	Y
Plantaginaceae	LINDAL	Ex	*Linaria dalmatica*	–	P	–
Plantaginaceae	LINVUL	Ex	*Linaria vulgaris*	–	P	–
Plantaginaceae	PLAARG	N	*Plantago argyraea*	*Plantago purshii* var. *argyraea*	P	–
Plantaginaceae	PLALAN	Ex	*Plantago lanceolata*	*Plantago altissima; Plantago lanceolata* var. *sphaerostachya*	P	–

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Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Plantaginaceae	PLAMAJ	N	*Plantago major*	*Plantago asiatica; Plantago halophila; Plantago major* ssp. *intermedia; Plantago major* var. *asiatica; Plantago major* var. *intermedia; Plantago major* var. *pachyphylla; Plantago major* var. *pilgeri; Plantago major* var. *scopulorum*	P	–
Plantaginaceae	PLAPAT	N	*Plantago patagonica*	*Plantago patagonica* var. *breviscapa; Plantago patagonica* var. *gnaphalioides; Plantago patagonica* var. *oblonga; Plantago patagonica* var. *spinulosa; Plantago picta; Plantago purshii; Plantago purshii* var. *brevispica; Plantago purshii* var. *oblonga; Plantago purshii* var. *picta; Plantago purshii* var. *spinulosa; Plantago spinulosa; Plantago wyomingensis*	P	Y
Poaceae	ACHHYM	N	*Achnatherum hymenoides*	*Eriocoma cuspidata; Oryzopsis hymenoides; Stipa hymenoides*	U	Y
Poaceae	ACHROB	N	*Achnatherum robustum*	*Stipa robusta; Stipa vaseyi*	P	Y
Poaceae	ACHSCR	N	*Achnatherum scribneri*	*Stipa scribneri*	P	Y
Poaceae	AEGCYL	Ex	*Aegilops cylindrica*	*Aegilops cylindrica* var. *rubiginosa; Aegilops tauschii; Cylindropyrum cylindricum; Triticum cylindricum*	P	–
Poaceae	AGRDES	Ex	*Agropyron desertorum*	*Agropyron cristatum* ssp. *desertorum; Agropyron cristatum* var. *desertorum*	P	Y
Poaceae	AGREXA	N	*Agrostis exarata*	–	–	–
Poaceae	AGRGIG	Ex	*Agrostis gigantea*	*Agrostis alba; Agrostis alba alba; Agrostis gigantea* var. *dispar; Agrostis nigra; Agrostis stolonifera* ssp. *gigantea; Agrostis stolonifera* var. *major*	P	Y
Poaceae	ANDGER	N	*Andropogon gerardii*	*An*dropogon chrysocomus; Andropogon furcatus; Andropogon gerardii *var. chrysocomus; Andropogon provincialis*	U	Y
Poaceae	ARIARI	N	*Aristida arizonica*	–	P	Y
Poaceae	ARIDIV	N	*Aristida divaricata*	–	–	–
Poaceae	ARIHAV	N	*Aristida havardii*	–	–	–
Poaceae	ARIPUR	N	*Aristida purpurea*	–	P	Y
Poaceae	BOTISC	Ex	*Bothriochloa ischaemum*	–	–	–
Poaceae	BOTLAG	N	*Bothriochloa laguroides*	–	A	–

Table A2-1 (continued). Plant species list for Pecos National Historical Park. Veg Code: six letter abbreviation of the scientific name. Nativity: N = native plant, Ex = exotic (non-native) plant. Synonyms: other scientific names used for the species. Abundance in Pecos NHP: A = abundant, C = common, U = uncommon, R = rare, P = present. Voucher: Yes or No indicates if there is a vouchered specimen collected by Natural Heritage New Mexico (Chauvin 2015).

Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Poaceae	BOUCUR	N	*Bouteloua curtipendula*	*Andropogon curtipendulus; Aristida secunda; Atheropogon curtipendulus; Bouteloua brasiliensis; Bouteloua curtipendula* var. *aristosa; Bouteloua meliciformis; Bouteloua melicoides; Bouteloua racemosa; Bouteloua racemosa* var. *aristosa; Chloris curtipendula; Chloris secunda; Cynodon curtipendulus; Cynodon melicoides; Cynosurus secundus; Dinebra curtipendula; Dinebra melicoides; Dinebra secunda; Eutriana affinis; Eutriana curtipendula; Heterostega curtipendula*	P	Y
Poaceae	BOUDAC	N	*Bouteloua dactyloides*	*Buchloe dactyloides; Bulbilis dactyloides; Sesleria dactyloides; Anthephora axilliflora; Bouteloua mutica; Calanthera dactyloides; Casiostega dactyloides; Casiostega hookeri; Lasiostega humilis; Melica mexicana*	P	–
Poaceae	BOUGRA	N	*Bouteloua gracilis*	*Bouteloua gracilis* var. *stricta; Bouteloua oligostachya; Chondrosum gracile; Chondrosum oligostachyum*	P	Y
Poaceae	BOUHIR	N	*Bouteloua hirsuta*	*Actinochloa hirsuta; Bouteloua hirta; Bouteloua hirta* var. *minor; Bouteloua hirsuta* var. *minor; Bouteloua hirsuta* var. *palmeri; Bouteloua palmeri; Chondrosum aschenbornianum; Chondrosum drummondii; Chondrosum foeneum; Chondrosum hirsutum; Chondrosum hirtum; Eutriana hirta*	P	Y
Poaceae	BROANO	N	*Bromus anomalus*	*Bromopsis anomala*	P	Y
Poaceae	BROARV	Ex	*Bromus arvensis*	*Bromus erectus* var. *arvensis; Forasaccus arvensis; Serrafalcus arvensis*	P	Y
Poaceae	BROCAT	N	*Bromus catharticus*	–		–
Poaceae	BROFRO	N	*Bromus frondosus*	*Bromopsis frondosa*	P	–
Poaceae	BROINE	Ex	*Bromus inermis*	*Bromus inermis* ssp. *inermis; Bromus inermis* ssp. *inermis* var. *divaricatus; Bromus inermis* ssp. *inermis* var. *inermis; Bromus inermis* var. *aristatus; Bromus inermis* var. *divaricatus; Bromus inermis* var. *inermis; Bromus inermis* var. *villosus; Bromus inopinatus; Bromopsis inermis; Bromopsis inermis* var. *aristata; Festuca inermis; Festuca inermis* var. *inermis; Festuca inermis* var. *villosa; Forasaccus inermis; Poa bromoides; Schedonorus inermis; Zerna inermis*	P	Y
Poaceae	BROJAP	Ex	*Bromus japonicus*	*Bromus japonicus* var. *porrectus; Bromus patulus*	P	Y
Poaceae	BROLAN1	N	*Bromus lanatipes*	*Bromopsis lanatipes; Bromus anomalus* var. *lanatipes; Bromus poeteri* var. *lanatipes*	P	Y

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Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Poaceae	BRORAC	Ex	*Bromus racemosus*	*Bromus commutatus; Bromus commutatus* var. *apricorum; Bromus neglectus; Bromus popovii; Bromus tuzsonii; Forasaccus racemosus; Serrafalcus neglectus; Serrafalcus racemosus; Bromus arvensis* var. *racemosus; Bromus hordeaceus* var. *racemosus; Bromus mollis* var. *neglectus; Bromus mollis* var. *racemosus; Bromus squarrosus* var. *racemosus*	P	–
Poaceae	BROTEC	Ex	*Bromus tectorum*	*Anisantha tectorum; Bromus tectorum* var. *glabratus; Bromus tectorum* var. *hirsutus; Bromus tectorum* var. *nudus; Bromus tectorum* var. *tectorum; Bromus nutans; Bromus setaceus; Genea tectorum; Schedonorus tectorum; Zerna tectorum*	P	Y
Poaceae	CHLCUC	N	*Chloris cucullata*	–	P	–
Poaceae	DACGLO	Ex	*Dactylis glomerata*	*Bromus glomeratus; Dactylis glomerata* var. *vivipara; Festuca glomerata; Limnetis glomerata; Phalaris glomerata; Trachypoa vulgaris*	P	Y
Poaceae	DISSPI	N	*Distichlis spicata*	*Distichlis stricta; Uniola spicata; Distichlis spicata* ssp. *stricta; Distichlis spicata* var. *borealis; Distichlis sprciata* var. *divaricata; Distichlis spicata* var. *nana; Distichlis spicata* var. *stolonifera; Distichlis spicata* var. *stricta; Distichlis stricta* var. *dentata*	P	Y
Poaceae	ECHMUR	N	*Echinochloa muricata*	*Echinochloa microstachya; Echinochloa occidentalis; Echinochloa wiegandii; Echinochloa muricata* var. *wiegandii; Echinochloa crus-galli* var. *mitis; Echinochloa muricata* var. *occidentalis; Echinochloa pungens* var. *microstachya; Echinochloa pungens* var. *multiflora*	P	–
Poaceae	ELYCAN	N	*Elymus canadensis*	*Elymus brachystachys; Elymus crescendus; Elymus philadelphicus; Elymus robustus; Elymus canadensis* var. *brachystachys; Elymus canadensis* var. *hirsutus; Elymus canadensis* var. *robustus; Elymus philadelphicus* var. *hirsutus*	U	Y
Poaceae	ELYELY	N	*Elymus elymoides*	*Aegilops hystrix; Chretomeris trichoides; Elymus difformis; Elymus glaber; Elymus hystrix; Elymus insularis; Elymus minor; Elymus pubiflorus; Elymus sitanion; Hordeum elymoides; Polyantherix hystrix; Sitanion albescens; Sitanion basalticola; Sitanion brevifolium; Sitanion caespitosum; Sitanion ciliatum; Sitanion cinereum; Sitanion elymoides; Sitanion glabrum; Sitanion hystrix; Sitanion hystrix* var. *hystrix; Sitanion insulare; Sitanion latifolium; Sitanion marginatum; Sitanion minus; Sitanion molle; Sitanion montanum ; Sitanion pubiflorum; Sitanion rigidum; Sitanion strigosum; Sitanion velutinum*	C	Y
Poaceae	ELYLAN	N	*Elymus lanceolatus*	–	P	–

Table A2-1 (continued). Plant species list for Pecos National Historical Park. Veg Code: six letter abbreviation of the scientific name. Nativity: N = native plant, Ex = exotic (non-native) plant. Synonyms: other scientific names used for the species. Abundance in Pecos NHP: A = abundant, C = common, U = uncommon, R = rare, P = present. Voucher: Yes or No indicates if there is a vouchered specimen collected by Natural Heritage New Mexico (Chauvin 2015).

Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Poaceae	ELYREP	Ex	*Elymus repens*	*Agropyron repens; Agropyron repen* var. *subulatum; Elytrigia repens; Elytrigia repens* var. *vaillantiana; Elytrigia vaillantiana; Triticum repens; Triticum vaillantianum*	P	Y
Poaceae	ELYTRA	N	*Elymus trachycaulus*	*Agropyron caninum* var. *mitchellii; Agropyron caninum* var. *tenerum; Agropyron pauciflorum* var. *novae-angliae; Agropyron repens* var. *tenerum; Agropyron trachycaulon; Agropyron trachycaulum; Agropyron trachycaulum* var. *fernaldii; Agropyron trachycaulum* var. *glaucescens; Crithopyrum trachycaulum; Elymus trachycaulis; Roegneria trachycaulon; Triticum pauciflorum; Triticum repens* var. *tenerum; Triticum trachycaulum; Zeia tenera*	P	Y
Poaceae	ELYPSE	N	*Elymus X pseudorepens*	*Agropyron pseudorepens; Agropyron pseudorepens* var. *magnum; Agrpopyron pseudorepens* var. *sennii; Agropyron vaillantianum; Elymus pseudorepens*	P	Y
Poaceae	ERABAR	Ex	*Eragrostis barrelieri*	*Eragrostis poaeoides* var. *barrelieri; Eragrostis vulgaris* ssp. *barrelieri*	P	–
Poaceae	ERACIL	Ex	*Eragrostis cilianensis*	*Eragrostis major; Eragrostis megastachya; Poa cilianensis*	P	–
Poaceae	FESRUB	N	*Festuca rubra*	*Festuca diffusa; Festuca duriuscula; Festuca duriuscula* var. *rubra; Festuca egena; Festuca glaucescens; Festuca ovina* ssp. *duriuscula; Festuca ovina* ssp. *rubra; Festuca ovina* var. *duriuscula; Festuca ovina* var. *rubra; Festuca rubra* ssp. *glaucodea; Festuca rubra* ssp. *megastachya; Festuca rubra* ssp. *megastachys*	P	Y
Poaceae	GLYGRA	N	*Glyceria grandis*	*Glyceria americana; Glyceria arundinacea* ssp. *grandis; Glyceria flavescens; Glyceria grandis f. pallescens; Glyceria maxima* ssp. *grandis; Glyceria maxima* var. *americana; Glyceria maxima* var. *grandis; Glyceria maxima f. pallescens; Panicularia americana; Panicularia grandis; Poa aquatica* var. *americana*	P	Y
Poaceae	HESCOM	N	*Hesperostipa comata*	*Stipa comata*	C	Y
Poaceae	HILJAM	N	*Hilaria jamesii*	*Pleuraphis jamesii*	A	Y
Poaceae	HOPOBT	N	*Hopia obtusa*	*Panicum obtusum; Brachiaria obtusa; Oplismenus obtusum; Panicum repente*	R	Y
Poaceae	HORJUB	N	*Hordeum jubatum*	*Critesion geniculatum; Critesion jubatum; Elymus jubatus; Hordeum caespitosum; Hordeum jubatum* var. *caespitosum; Hordeum jubatum* var. *pampeanum; Hordeum jubatum* var. *tomentellum; Hordeum pampeanum; Hordeum pubiflorum* var. *pampeanum*	P	Y
Poaceae	HORPUS	N	*Hordeum pusillum*	Critesion pusillum; Hordeum pusillum var. pubens	P	–

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Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Poaceae	KOEMAC	N	*Koeleria macrantha*	*Koeleria notoda; Koeleria pyramidata; Koeleria cristata; Koeleria gracilis; Koeleria yukonensis; Koeleria cristata* var. *longifolia; Koeleria cristata* var. *pinetorum*	U	Y
Poaceae	LOLPER	Ex	*Lolium perenne*	*Festuca perrenis; Lolium brasilianum; Lolium canadense; Lolium latum; Lolium marschallii; Lolium montevidens; Lolium multiflorum* ssp. *ramosum; Lolium multiflorum* var. *ramosum; Lolium perenne* ssp. *perenne; Lolium perenne* var. *brasilianum; Lolium perenne* var. *compressum; Lolium perenne* var. *cristatum; Lolium perenne* var. *pacyi; Lolium perenne* var. *perenne; Lolium perenne* var. *tenue; Lolium tenue*	P	–
Poaceae	MONSQU	N	*Monroa squarrosa*	*Monroa squarrosa* var. *floccuosa*	P	–
Poaceae	MUHALO	N	*Muhlenbergia alopecuroides*	*Lycurus alopecuroides; Lycurus phleoides* var. *glaucifolius; Lycurus setosus; Pleopogon setosum; Pleopogon setosus*	C	Y
Poaceae	MUHASP	N	*Muhlenbergia asperifolia*	*Sporobolus asperifolius*	R	Y
Poaceae	MUHMON	N	*Muhlenbergia montana*	*Calycodon montanus; Muhlenbergia enervis; Muhlenbergia gracilis* var. *breviaristata; Muhlenbergia gracilis* var. *enervis; Muhlenbergia gracilis* var. *major; Muhlenbergia subalpina; Muhlenbergia trifida*	U	Y
Poaceae	MUHPAU	N	*Muhlenbergia pauciflora*	*Muhlenbergia neomexicana; Muhlenbergia pringlei; Muhlenbergia sylvatica* var. *pringlei*	U	Y
Poaceae	MUHRAC	N	*Muhlenbergia racemosa*	*Agrostis racemosa*	R	–
Poaceae	MUHREP	N	*Muhlenbergia repens*	*Muhlenbergia abata; Muhlenbergia subtilis; Sporobolus repens; Vilfa repens*	U	Y
Poaceae	MUHRIC	N	*Muhlenbergia richardsonis*	*Muhlenbergia squarrosa*	P	Y
Poaceae	MUHTOR	N	*Muhlenbergia torreyi*	*Muhlenbergia gracillima*	A	Y
Poaceae	MUHTRI	N	*Muhlenbergia tricholepis*	*Blepharoneuron tricholepis; Muhlenbergia tricholepis; Sporobolus tricholepis; Vilfa tricholepis*	P	Y
Poaceae	MUHWRI	N	*Muhlenbergia wrightii*	*Muhlenbergia coloradensis; Muhlenbergia wrightii* var. *annulata*	P	Y
Poaceae	PANCAP	N	*Panicum capillare*	*Panicum barbipulvinatum; Panicum capillare* ssp. *barbipulvinatum; Panicum capillare* var. *agreste; Panicum capillare* var. *barbipulvinatum; Panicum capillare* var. *brevifolium; Panicum capillare* var. *occidentale*	P	–
Poaceae	PASSMI	N	*Pascopyrum smithii*	*Agropyron smithii; Agropyron molle; Elymus smithii; Elytrigia smithii; Agropyron smithii* var. *molle; Agropyron smithii* var. *palmeri; Elytrigia smithii* var. *mollis*	A	Y
Poaceae	PHAARU	N	*Phalaris arundinacea*	Phalaroides arundinacea; Phalaris arundinacea var. picta	P	Y

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Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Poaceae	PHLPRE	Ex	*Phleum pratense*	Phleum nodosum; Phleum pratense ssp. nodosum; Phleum pratense var. nodosum	P	Y
Poaceae	PIPMIC	N	*Piptatheropsis micrantha*	*Oryzopsis micrantha; Piptatherum micranthum; Stipa divaricata*	P	Y
Poaceae	POABIG	N	*Poa bigelovii*	*Poa annua* var. *stricta*	R	Y
Poaceae	POACOM	Ex	*Poa compressa*	*Paneion compressum; Poa compressa* var. *sylvestris; Poa compressa f. depauperata*	P	Y
Poaceae	POAFEN	N	*Poa fendleriana*	*Atropis fendleriana; Eragrostis fendleriana; Panicularia fendleriana; Uralepis poaeoides*	U	Y
Poaceae	POAPRA	Ex	*Poa pratensis*	*Poa angustifolia* ssp. *costata; Poa attica; Poa bourgeaei; Poa costata; Poa intermedia; Poa macounii; Poa magensiana; Poa oligeria; Poa pratensis* ssp. *attica; Poa pratensis* var. *attica; Poa pratensis* var. *costata; Poa pratensis* var. *laxiflora; Poa pratensis* var. *macounii; Poa pratensis* var. *stricta; Poa pratensis* var. *subglabriflora; Poa pratensis* var. *urjanchaica; Poa urjanchaica; Poa viridis*	P	Y
Poaceae	PSAJUN	Ex	*Psathyrostachys juncea*	*Elymus junceus; X Leymostachys korovinii*	P	Y
Poaceae	PUCNUT	N	*Puccinellia nuttalliana*	*Puccinellia airoides; Puccinellia cusickii*	P	–
Poaceae	SCHPAN	N	*Schedonnardus paniculatus*	*Lepturus paniculatu; Muhlenbergia paniculata; Rottboellia paniculata; Schedonnardus texanus; Spartina dissitiflora; Spirochloe paniculata*	P	Y
Poaceae	SCHARU	Ex	*Schedonorus arundinaceus*	*Avena secunda; Bromus arundinaceus; Bromus elatior; Bucetum elatius; Festuca arundinacea; Festuca elatior; Festuca elatior* ssp. *arundinacea; Festuca elatior* var. *arundinacea; Festuca fenas; Festuca mediterranea; Festuca orientalis; Festuca phoenix; Gnomonia elatior; Lolium arundinaceum; Poa elatior; Poa kunthii; Poa phoenix; Poa remota; Poa uliginosa; Schedonorus elatior; Schedonorus phoenix; Tragus elatior*	P	Y
Poaceae	SCHSCO	N	*Schizachyrium scoparium*	*Andropogon scoparius*	U	Y
Poaceae	SETVIR	Ex	*Setaria viridis*	*Chaetochloa viridis; Chaetochloa viridis* var. *breviseta; Chaetochloa viridis* var. *minor; Chaetochloa viridis* var. *weinmanni; Chamaeraphis italica* var. *viridis; Chamaeraphis viridis; Ixophorus viridis; Panicum italicum* var. *viride; Panicum viride; Panicum viride* var. *brevisetum; Panicum viride* var. *weinmanni; Panicum viride* var. *weinmennii; Pennisetum italicum* var. *viride; Pennisetum viride; Pennisetum viride* var. *brevisetum; Setaria italica* ssp. *viridis; Setariopsis viridis; Setaria viridis f. viridis; Setaria viridis* var. *breviseta; Setaria viridis* var. *robustapurpurea; Setaria viridis* var. *robusto-alba; Setaria viridis* var. *robusto-purpurea; Setaria viridis* var. *weinmannii; Setaria weinmannii*	P	–

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Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Poaceae	SORNUT	N	*Sorghastrum nutans*	*Andropogon nutans; Sorghastrum avenaceum*	U	–
Poaceae	SPOAIR	N	*Sporobolus airoides*	*Agrostis airoides*	P	–
Poaceae	SPOCON	N	*Sporobolus contractus*	*Sporobolus cryptandrus* var. *strictus*	P	–
Poaceae	SPOCRY	N	*Sporobolus cryptandrus*	*Agrostis cryptandra; Sporobolus cryptandrus* ssp. *fuscicola; Sprobolus cryptandrus* var. *fuscicola; Sporobolus cryptandrus* var. *occidentalis*	P	Y
Poaceae	THIELO	Ex	*Thinopyrum elongatum*	–		–
Poaceae	THIINT	Ex	*Thinopyrum intermedium*	*Agropyron intermedium; Agropyron intermedium* var. *trichophorum; Agropyron trichophorum; Elymus hispidus; Elymus hispidus* var. *ruthenicus; Elymus hispidus* ssp. *barbulatus; Elytrigia intermedia; Elytrigia intermedia* ssp. *barbulata; Elytrigia intermedia* ssp. *trichophora; Thinopyrum intermedium* ssp. *barbulatum*	P	–
Poaceae	THIPON	Ex	*Thinopyrum ponticum*	*Agropyron elongatum; Agropyron varnense; Elymus elongatus; Elymus elongatus* var. *ponticus; Elymus varnensis; Elytrigia elongata; Elytrigia pontica; Lophopyrum elongatum*	P	–
Poaceae	VULOCT	N	*Vulpia octoflora*	*Diarrhena setacea; Festuca octoflora; Festuca octoflora* var. *aristulata; Festuca parviflora; Festuca setacea; Festuca tenella* var. *aristulata; Gnomonia octoflora; Vulpia antofagastensis*	P	Y
Poaceae	ZULBUL	N	*Zuloagaea bulbosa*	*Panicum avenaceum; Panicum bulbosum; Panicum bulbosum* ssp. *sciaphilum; Panicum bulbosum* var. *avenaceum; Panicum bulbosum* var. *minor; Panicum bulbosum* var. *minus; Panicum bulbosum* var. *violaceum; Panicum maximum* var. *bulbosum; Panicum nodosum; Panicum paucifolium; Panicum plenum; Panicum sciaphilum*	P	Y
Polemoniaceae	IPOAGG	N	*Ipomopsis aggregata*	–	P	Y
Polemoniaceae	IPOLON	N	*Ipomopsis longiflora*	–	P	Y
Polemoniaceae	PHLNAN	N	*Phlox nana*	–	P	Y
Polygonaceae	ERIALA	N	*Eriogonum alatum*	–	P	Y
Polygonaceae	ERIANN2	N	*Eriogonum annuum*	–	P	–
Polygonaceae	ERIJAM	N	*Eriogonum jamesii*	–	C	Y
Polygonaceae	ERIRAC	N	*Eriogonum racemosum*	*Eriogonum racemosum* var. *racemosum*	P	–
Polygonaceae	POLCON	Ex	*Fallopia convolvulus*	*Bilderdykia convolvulus; Polygonum convolvulus; Polygonum convolvulus* var. *convolvulus; Polygonum convolvulus* var. *subulatum; Reynoutria convolvulus; Tiniaria convolvulus*	P	–

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Polygonaceae	PERMAC	N	*Persicaria maculosa*	*Persicaria maculata; Persicaria persicaria; Persicaria ruderalis; Persicaria ruderalis* var. *vulgaris; Persicaria vulgaris; Polygonum dubium; Polygonum fusiforme; Polygonum minus; Polygonum persicaria; Polygonum persicaria* var. *angustifolium; Polygonum persicaria* var. *ruderale*	P	–
Polygonaceae	POLAVI	Ex	*Polygonum aviculare*	*Polygonum aviculare* var. *vegetum; Polygonum heterophyllum; Polygonum monspeliense*	P	–
Polygonaceae	POLDOU	N	*Polygonum douglasii*	*Polygonum buxiforme* var. *montanum; Polygonum douglasii* ssp. *douglasii; Polygonum douglasii* var. *latifolium; Polygonum emaciatum; Polygonum montanum*	P	Y
Polygonaceae	POLLAP	N	*Polygonum lapathifolium*	*Persicaria incarnata; Persicaria lapathifolia; Persicaria tomentosa; Polygonum incanum; Polygonum incarnatum; Polygonum lapathifolium* ssp. *pallidum; Polygonum lapathifolium* var. *incanum; Polygonum lapathifolium* var. *nodosum; Polygonum lapathifolium* var. *ovatum; Polygonum lapathifolium* var. *prostratum; Polygonum lapathifolium* var. *salicifolium; Polygonum nodosum; Polygonum oneillii; Polygonum pensylvanicum* ssp. *oneillii; Polygonum scabrum; Polygonum tomentosum*	P	Y
Polygonaceae	RUMCRI	Ex	*Rumex crispus*	*Rumex crispus ssp. Fauriei; Rumex crispus* ssp. *crispus; Rumex fauriei*	P	–
Portulacaceae	PHEAUR	N	*Phemeranthus aurantiacus*	–	–	–
Portulacaceae	PHEBRE	N	*Phemeranthus brevicaulis*	*Talinum brevicaule; Talinum pulchellum; Talinum youngiae*	R	Y
Portulacaceae	PHEPAR	N	*Phemeranthus parviflorus*	*Phemeranthus confertiflorus; Talinum appalachianum; Talinum confertiflorum; Talinum gooddingii; Talinum parviflorum*	R	Y
Portulacaceae	POROLE	N	*Portulaca oleracea*	*Portulaca neglecta; Portulaca oleracea* ssp. *granulatostellulata; Portulaca oleracea* ssp. *impolita; Portulaca oleracea* ssp. *nicaraguensis; Portulaca oleracea* ssp. *nitida; Portulaca oleracea* ssp. *papillatostellulata; Portulaca oleracea* ssp. *stellata; Portulaca retusa*	P	Y
Primulaceae	ANDOCC	N	*Androsace occidentalis*	*Androsace arizonica; Androsace occidentalis* var. *arizonica; Androsace occidentalis* var. *simplex*	P	–
Primulaceae	ANDSEP	N	*Androsace septentrionalis*	*Androsace diffusa; Androsace glandulosa; Androsace puberulenta; Androsace septentrionalis* ssp. *glandulosa; Androsace septentrionalis* ssp. *puberulenta; Androsace septentrionalis* ssp. *robusta; Androsace septentrionalis* ssp. *septentrionalis; Androsace septentrionalis* ssp. *subulifera; Androsace septentrionalis* ssp. *subumbellata; Androsace septentrionalis* var. *diffusa; Androsace septentrionalis* var. *glandulosa; Androsace septentrionalis* var. *puberulenta; Androsace septentrionalis* var. *robusta; Androsace septentrionalis* var. *subulifera; Androsace septentrionalis* var. *subumbellata; Douglasia ochotensis* ssp. *gormanii*	P	Y

Table A2-1 (continued). Plant species list for Pecos National Historical Park. Veg Code: six letter abbreviation of the scientific name. Nativity: N = native plant, Ex = exotic (non-native) plant. Synonyms: other scientific names used for the species. Abundance in Pecos NHP: A = abundant, C = common, U = uncommon, R = rare, P = present. Voucher: Yes or No indicates if there is a vouchered specimen collected by Natural Heritage New Mexico (Chauvin 2015).

Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Pteridaceae	CHEFEE	N	*Cheilanthes feei*	–	P	–
Pteridaceae	CHEFEN	N	*Cheilanthes fendleri*	–	P	Y
Pteridaceae	PELATR	N	*Pellaea atropurpurea*	–	R	–
Ranunculaceae	CLECOL	N	*Clematis columbiana*	–	P	Y
Ranunculaceae	CLELIG	N	*Clematis ligusticifolia*	*Clematis brevifolia; Clematis ligusticifolia* var. *brevifolia; Clematis ligusticifolia* var. *californica; Clematis ligusticifolia* var. *ligusticifolia; Clematis neomexicana; Clematis suksdorfii*	P	Y
Ranunculaceae	CLETER	Ex	*Clematis terniflora*	*Clematis dioscoreifolia; Clematis dioscoreifolia* var. *robusta; Clematis maximowicziana; Clematis paniculata*	P	–
Ranunculaceae	RANACR	Ex	*Ranunculus acris*	*Ranunculus acris* ssp. *friesianus; Ranunculus acris* ssp. *strigulosus; Ranunculus acris* var. *acris; Ranunculus acris* var. *frigidus; Ranunculus acris* var. *latisectus; Ranunculus acris* var. *stevenii; Ranunculus acris* var. *typicus; Ranunculus acris* var. *villosus; Ranunculus boreanus; Ranunculus grandis; Ranunculus grandis* var. *austrokurilensis*	R	–
Ranunculaceae	RANCYM	N	*Ranunculus cymbalaria*	*Cyrtorhyncha cymbalaria* ssp. *alpina; Halerpestes cymbalaria; Halerpestes cymbalaria* ssp. *saximontana; Ranunculus cymbalaria* var. *alpinus; Ranunculus cymbalaria* ssp. *saximontanus; Ranunculus cymbalaria* var. *saximontanus; Ranunculus cymbalaria* var. *typicus*	R	Y
Ranunculaceae	RANMAC	N	*Ranunculus macounii*	*Ranunculus macounii* var. *oreganus*	P	Y
Ranunculaceae	THAFEN	N	*Thalictrum fendleri*	*Thalictrum fendleri* var. *fendleri; Thalictrum fendleri* var. *platycarpum; Thalictrum fendleri* var. *wrightii*	U	Y
Rhamnaceae	COLTEX	N	*Colubrina texensis*	–	P	–
Rosaceae	CERMON	N	*Cercocarpus montanus*	*Cercocarpus argenteus; Cercocarpus montanus* var. *montanus; Cercocarpus montanus* var. *argenteus; Cercocarpus montanus* var. *flabellifolius; Cercocarpus parvifolius; Cercocarpus parvifolius* var. *hirsutissimus; Cercocarpus parvifolius* var. *minimus*	P	Y
Rosaceae	FALPAR	N	*Fallugia paradoxa*	*Fallugia micrantha; Fallugia paradoxa* var. *acuminata; Sieversia paradoxa*	P	Y
Rosaceae	MALPUM	Ex	*Malus pumila*	*Malus communis; Malus domestica; Pyrus pumila*	P	Y
Rosaceae	PETCAE	N	*Petrophyton caespitosum*	–	P	Y
Rosaceae	PHYMON	N	*Physocarpus monogynus*	*Physocarpus torreyi; Spiraea monogyna*	P	Y

Table A2-1 (continued). Plant species list for Pecos National Historical Park. Veg Code: six letter abbreviation of the scientific name. Nativity: N = native plant, Ex = exotic (non-native) plant. Synonyms: other scientific names used for the species. Abundance in Pecos NHP: A = abundant, C = common, U = uncommon, R = rare, P = present. Voucher: Yes or No indicates if there is a vouchered specimen collected by Natural Heritage New Mexico (Chauvin 2015).

Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Rosaceae	POTANS	N	*Potentilla anserina*	*Argentina anserina; Argentina anserina* var. *concolor; Argentina argentea; Potentilla anserina* var. *concolor; Potentilla anserina* var. *sericea; Potentilla anserina* var. *yukonensis; Potentilla egedii* ssp. *yukonensis; Potentilla yukonensis*	P	Y
Rosaceae	POTHIP	N	*Potentilla hippiana*	*Potentilla argyrea; Potentilla hippiana* var. *argyrea; Potentilla hippiana* var. *diffusa; Potentilla hippiana* var. *hippiana; Potentilla leneophylla; Potentilla propinqua*	P	Y
Rosaceae	POTPEN	N	*Potentilla pensylvanica*	*Potentilla atrovirens; Potentilla brooksensis; Potentilla pensylvanica var. arida; Potentilla pensylvanica var. atrovirens; Potentilla pensylvanica var. brevipila; Potentilla pensylvanica var. pensylvanica; Potentilla pensylvanica var. strigosa; Potentilla platyloba; Potentilla pseudosericea; Potentilla sibirica; Potentilla strigosa*	P	Y
Rosaceae	PRUVIR	N	*Prunus virginiana*	–	P	Y
Rosaceae	ROSWOO	N	*Rosa woodsii*	–	U	Y
Salicaceae	POPACU	N	*Populus acuminata*	*Populus acuminata* var. *rehderi; Populus x acuminata*	R	Y
Salicaceae	POPANG	N	*Populus angustifolia*	*Populus balsamifera* var. *angustifolia; Populus balsamifera angustifolia; Populus canadensis* var. *iangustifolia; Populus fortissima; Populus salicifolia; Populus x sennii; Populus tweedyi*	C	Y
Salicaceae	POPDEL	N	*Populus deltoides*	–	C	–
Salicaceae	SALAMY	N	*Salix amygdaloides*	*Salix amygdaloides* var. *wrightii; Salix nigra* var. *amygdaloides; Salix nigra* var. *wrightii; Salix wrightii*	R	Y
Salicaceae	SALEXI	N	*Salix exigua*	*Salix argophylla; Salix exigua* var. *angustissima; Salix exigua* var. *columbiana; Salix exigua* var. *hindsiana; Salix exigua* var. *luteosericea; Salix exigua* var. *nevadensis; Salix exigua* var. *parishiana; Salix exigua* var. *stenophylla; Salix exigua* var. *virens; Salix fluviatilis* var. *argophylla; Salix hindsiana; Salix hindsiana* var. *leucodendroides; Salix hindsiana* var. *parishiana; Salix hindsiana* var. *tenuifolia; Salic interior* var. *angustissima; Salix interior* var. *liteosericea; Salix linearifolia; Salix longifolia* var. *argophylla; Salix longifolia* var. *exigua; Salix longifolia* var. *opaca; Salix luteosericea; Salix macrostachya* var. *leucodendroides; Salix malacophylla; Salix nevadensis; Salix parishiana; Salix sessilifolia* var. *hindsiana; Salix sessilifolia* var. *leucodendroides; Salix stenophylla; Salix thurberi*	C	Y
Salicaceae	SALGOO	N	*Salix gooddingii*	*Salix gooddingii* var. *vallicola; Salix gooddingii* var. *variabilis; Salix nigra* var. *vallicola; Salix vallicola*	R	Y
Salicaceae	SALIRR	N	*Salix irrorata*	–	U	Y

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Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Salicaceae	SALLUC	N	*Salix lucida*	*Salix arguta; Salix arguta* var. *erythrocoma; Salix arguta* var. *lasiandra; Salix lancifolia; Salix lasiandra; Salix lasiandra* var. *abramsii; Salix lasiandra* var. *lancifolia; Salix lasiandra* var. *lyallii; Salix lasiandra* var. *macrophylla; Salix lasiandra* var. *recomponens; Salix lucida* var. *macrophylla; Salix lyallii; Salix speciosa*	P	Y
Santalaceae	COMUMB	N	*Comandra umbellata*	*Comandra pallida; Comandra umbellata* var. *angustifolia; Comandra umbellata* var. *pallida*	P	–
Saururaceae	ANECAL	N	*Anemopsis californica*	*Anemia californica; Anemopsis californica* var. *subglabra*	P	Y
Saxifragaceae	HEUPAR	N	*Heuchera parvifolia*	*Heuchera duranii; Heuchera flabellifolia; Heuchera flabellifolia* var. *flabellifolia; Heuchera flabellifolia* var. *subsecta; Heuchera nivalis; Heuchera parvifolia* var. *arizonica; Heuchera parvifolia* var. *dissecta; Heuchera parvifolia* var. *flavescens; Heuchera parvifolia* var. *major; Heuchera parvifolia* var. *microcarpa; Heuchera parvifolia* var. *nivalis; Heuchera parvifolia* var. *parvifolia; Heuchera parvifolia* var. *utahensis*	R	Y
Scrophulariaceae	BESPLA	N	*Besseya plantaginea*	*Synthyris plantaginea*	P	Y
Scrophulariaceae	CASCOC	N	*Castilleja coccinea*	*Castilleja ludoviciana*	P	–
Scrophulariaceae	CASINT	N	*Castilleja integra*	–	P	Y
Scrophulariaceae	CORWRI1	N	*Cordylanthus wrightii*	–	P	Y
Scrophulariaceae	PENBAR	N	*Penstemon barbatus*	–	U	Y
Scrophulariaceae	PENJAM	N	*Penstemon jamesii*	*Penstemon brevivarbatus; Penstemon jamesii* ssp. *typicus*	U	Y
Scrophulariaceae	PENSEC	N	*Penstemon secundiflorus*	*Penstemon unilateralis*	U	–
Scrophulariaceae	PENVIR	N	*Penstemon virgatus*	–	P	Y
Scrophulariaceae	PENWHI	N	*Penstemon whippleanus*	–	P	Y
Scrophulariaceae	VERTHA	Ex	*Verbascum thapsus*	–	P	Y
Scrophulariaceae	VERAME	N	*Veronica americana*	–	P	Y
Scrophulariaceae	VERPER	N	*Veronica peregrina*	*Veronica peregrina* ssp. *peregrina; Veronica peregrina* ssp. *xalapensis; Veronica peregrina* var. *typica; Veronica peregrina* var. *xalapensis; Veronica sherwoodii; Veronica xalapensis*	P	Y
Selaginellaceae	SELMUT	N	*Selaginella mutica*	–	R	Y
Solanaceae	PHYHED	N	*Physalis hederifolia*	–	U	Y
Solanaceae	PHYNEO	N	*Physalis neomexicana*	*Physalis subulata* var. *neomexicana; Physalis foetens* var. *neomexicana*	R	–
Solanaceae	PHYVIR1	N	*Physalis virginiana*	–	P	–

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Family	Veg Code	Nativity	Species Scientific Name	Synonyms	Pecos NHP Abundance	Voucher
Solanaceae	SOLELA	N	*Solanum elaeagnifolium*	–	U	–
Solanaceae	SOLFEN	N	*Solanum fendleri*	*Solanum fendleri* var. *fendleri; Solanum fendleri* var. *texense; Solanum leptosepalum; Solanum stoloniferum*	R	–
Solanaceae	SOLJAM	N	*Solanum jamesii*	–	P	–
Tamaricaceae	TAMCHI	Ex	*Tamarix chinensis*	*Tamarix pentandra*	P	–
Typhaceae	TYPDOM	N	*Typha domingensis*	*Typha angustata*	P	Y
Typhaceae	TYPLAT	N	*Typha latifolia*	–	P	Y
Ulmaceae	ULMPUM	Ex	*Ulmus pumila*	–	P	Y
Valerianaceae	VALACU	N	*Valeriana acutiloba*	–	P	–
Verbenaceae	GLABIP	N	*Glandularia bipinnatifida*	–	P	Y
Verbenaceae	GLAWRI	N	*Glandularia wrightii*	*Verbena wrightii; Glandularia bipinnatifida* var. *ciliata?*	P	–
Verbenaceae	VERBRA1	N	*Verbena bracteata*	*Verbena bracteosa; Verbena imbricata*	P	–
Verbenaceae	VERMAC	N	*Verbena macdougalii*	–	P	Y
Viscaceae	PHOJUN	N	*Phoradendron juniperinum*	*Phoradendron juniperinum* var. *ligatum; Phoradendron ligatum*	P	Y
Vitaceae	PARQUI	N	*Parthenocissus quinquefolia*	*Ampelopsis hederacea* var. *murorum; Ampelopsis latifolia; Ampelopsis quinquefolia; Hederacea quinquefolia; Parthenocissus hirsuta; Parthenocissus inserta; Parthencissus quinquefolia* var. *hirsuta; Parthenocissus quinquefolia* var. *murorum; Parthenocissus quinquefolia* var. *saintpaulii; Psedera quinquefolia; Psedera quinquefolia* var. *murorum; Vitis inserta; Vitis quinquefolia*	P	Y
Zygophyllaceae	TRITER	Ex	*Tribulus terrestris*	–	P	–


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